

## Certificate of Calibration

**Calibration Certification Information**

Cal. Date: September 11, 2026      Rootsmeter S/N: 438320      Ta: 296 °K  
 Operator: Jim Tisch      Pa: 752.6 mm Hg  
 Calibration Model #: TE-5025A      Calibrator S/N: 0438

| Run | Vol. Init (m3) | Vol. Final (m3) | ΔVol. (m3) | ΔTime (min) | ΔP (mm Hg) | ΔH (in H2O) |
|-----|----------------|-----------------|------------|-------------|------------|-------------|
| 1   | 1              | 2               | 1          | 1.3100      | 3.2        | 2.00        |
| 2   | 3              | 4               | 1          | 0.9240      | 6.4        | 4.00        |
| 3   | 5              | 6               | 1          | 0.8270      | 7.8        | 5.00        |
| 4   | 7              | 8               | 1          | 0.7880      | 8.7        | 5.50        |
| 5   | 9              | 10              | 1          | 0.6520      | 12.6       | 8.00        |

**Data Tabulation**

| Vstd (m3)   | Qstd (x-axis) | $\sqrt{\Delta H \left( \frac{Pa}{Pstd} \right) \left( \frac{Tstd}{Ta} \right)}$ (y-axis) | Va        | Qa (x-axis) | $\sqrt{\Delta H \left( \frac{Ta}{Pa} \right)}$ (y-axis) |
|-------------|---------------|--|-----------|-------------|---|
| 0.9927      | 0.7578        | 1.4121   | 0.9957    | 0.7601      | 0.8869  |
| 0.9885      | 1.0698        | 1.9970   | 0.9915    | 1.0730      | 1.2543  |
| 0.9866      | 1.1930        | 2.2327   | 0.9896    | 1.1967      | 1.4023  |
| 0.9854      | 1.2505        | 2.3416   | 0.9884    | 1.2544      | 1.4708  |
| 0.9803      | 1.5035        | 2.8241   | 0.9833    | 1.5081      | 1.7738  |
| <b>QSTD</b> | m=            | 1.89377  | <b>QA</b> | m=          | 1.18584   |
|             | b=            | -0.02567   |           | b=          | -0.01612  |
|             | r=            | 0.99999  |           | r=          | 0.99999   |

**Calculations**

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

**Standard Conditions**

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

**RECALIBRATION**

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



CRYSTAL CALIBRATION SALES AND SERVICE CO., LTD.

45/48 Soi Salathammasop31, Salathammasop Rd.,

Salathammasop, Thawewatthana, Bangkok 10170 Thailand

Tel : 0-2408-8474-5 Fax : 0-2408-8477 Email : info@crystalcal.com www.crystalcal.com



## CERTIFICATE OF CALIBRATION

Issue Date : 25 December 2024

Certificate No. : 24-1739-002

Work Order No. : 24/1739

Customer Name : Faculty of Science and Technology  
Suan Sunandha Rajabhat University  
1 U-Thong nok Road, Dusit, Bangkok 10300 Thailand

Date of Received : 22 December 2024

Date of Calibration : 22 December 2024

Instrument Details : Description : Electronic Balance  
Manufacturer : METTLER TOLEDO  
Model : ME204  
Serial No. : B534348442  
ID No. : สส.07.14.02.0003/59  
Resolution : 0.0001 g  
Capacity : 220 g  
Location : ห้อง 26311 อาคาร 26 คณะวิทยาศาสตร์และเทคโนโลยี

Calibration Method : This calibration was conducted by using in-house method according to calibration procedure no. CWI-B-01 based on UKAS LAB14 edition 6, October 2019

### Environmental Condition

Temperature : Maximum 25.1°C / Minimum 24.6°C  
Humidity : Maximum 48%R.H. / Minimum 44%R.H.  
Air Pressure : Maximum 1019.1hPa / Minimum 1018.9hPa

### Traceability of Measurement

: This certificate of calibration documents the traceability to national standard, which realize the unit of measurement according to the International system of Units (SI)

Calibrated by : Mr. Kritsada Kaewwangpa  
Calibration Engineer

Approved by :   
( Mr. Thichakorn Srisupob )  
Technical Manager

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## CERTIFICATE OF CALIBRATION

Issue Date : 25 December 2024

Certificate No. : 24-1739-002

Work Order No. : 24/1739

### Details of Calibration

#### 1. Reference Standards Instrument

| Instrument    | Capacity of Weight | Serial No. / ID No. | Certificate No. | Due date        |
|---------------|--------------------|---------------------|-----------------|-----------------|
| Weight Set E2 | 1mg to 200g        | B744909236          | 22-130801       | 6 December 2025 |

2. Certificate traceable : This certificate traceable to The International System of Unit refer to  
Asia Medical and Agricultural Laboratory and Research center Co., Ltd. , NAC Calibration No.  
0152

3. Condition of item : Used

4. Calibration site : On-site

### Result of Calibration

#### 1. Calibration result : Check performance before calibration

| Applied Weight<br>g | Balance Reading<br>g | Correction Value<br>g | Uncertainty<br>( $\pm$ ) g | Coverage Factor<br>(k) |
|---------------------|----------------------|-----------------------|----------------------------|------------------------|
| 100.0000            | 100.0000             | 0.0000                | 0.00019                    | 2.00                   |
| 200.0000            | 200.0000             | 0.0000                | 0.00032                    | 2.00                   |

2. The result of check performance in frist step has to Without Reset span

#### 3. Calibration result : Without adjustment

3.1 Repeatability number of repeatability is 10 times

| Norminal Value ( g ) | Standard Deviation of Reading ( g ) |
|----------------------|-------------------------------------|
| 100                  | 0.0000422                           |
| 200                  | 0.0000422                           |



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

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





# CRYSTAL CALIBRATION SALES AND SERVICE CO., LTD.

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## CERTIFICATE OF CALIBRATION

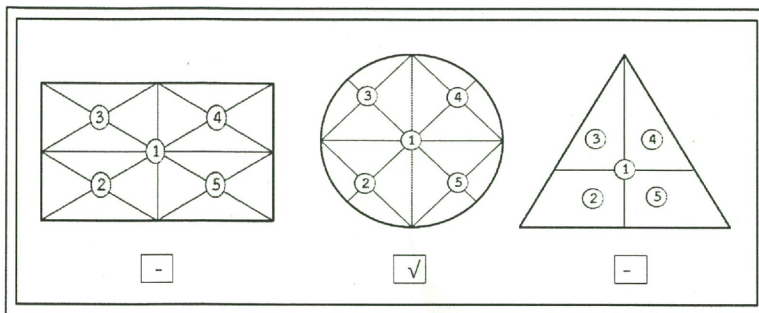
Certificate No. : 24-1739-002

Issue Date : 25 December 2024

Work Order No. : 24/1739

### 3. Calibration result : Without adjustment (continued)

3.2 Eccentric or Off-center Error A mass of 100 g was placed and moved to various position on pan.



| Result of Eccentric Error |          |   |
|---------------------------|----------|---|
| Position 1                | 100.0000 | g |
| Position 2                | 100.0001 | g |
| Position 3                | 100.0000 | g |
| Position 4                | 100.0000 | g |
| Position 5                | 100.0001 | g |
| (Maximum Difference)      | 0.0001   | g |

### 3.3 Departure of indication from nominal value

| Applied Weight<br>g | Balance Reading<br>g | Correction Value<br>g | Uncertainty<br>(±) g | Coverage<br>Factor (k) |
|---------------------|----------------------|-----------------------|----------------------|------------------------|
| Unload              | 0.0000               | 0.0000                | 0.00010              | 2.00                   |
| 0.1000              | 0.1000               | 0.0000                | 0.00010              | 2.00                   |
| 0.5000              | 0.5000               | 0.0000                | 0.00010              | 2.00                   |
| 1.0000              | 1.0000               | 0.0000                | 0.00010              | 2.00                   |
| 2.0000              | 2.0000               | 0.0000                | 0.00010              | 2.00                   |
| 3.0000              | 3.0000               | 0.0000                | 0.00010              | 2.00                   |
| 4.0000              | 4.0000               | 0.0000                | 0.00010              | 2.00                   |
| 5.0000              | 5.0000               | 0.0000                | 0.00010              | 2.00                   |
| 10.0000             | 10.0000              | 0.0000                | 0.00011              | 2.00                   |
| 50.0000             | 50.0000              | 0.0000                | 0.00013              | 2.00                   |
| 100.0000            | 100.0000             | 0.0000                | 0.00019              | 2.00                   |
| 150.0000            | 150.0000             | 0.0000                | 0.00026              | 2.00                   |
| 200.0000            | 200.0000             | 0.0000                | 0.00032              | 2.00                   |

### Note

Calibrate items it good condition and this report customer request and accepted in certificate

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

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





# THAI METEOROLOGICAL DEPARTMENT

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

## Calibration Certificate

Issued by : Calibration & Test Section : Meteorological Instruments Bureau

Date of Issue 24 January, 2025

Certification No. 045/25

Page : 1 of 3

Object : Wind speed and wind direction

Manufacturer : Davis Instruments Inc.

Type : Weather Wizard III Product No. 7425

Serial No. : WC90601A48

Customer : Evergreen Consulting Co.,Ltd.  
17/106 Moo 3, Sattahip, Sattahip,  
Chonburi 20180 Thailand.

Calibration Condition : Temperature 25.1 °C Barometric Pressure 1012.2 hPa

NATIONAL STANDARD WIND TUNNEL :

: Thermal Anemometer 642 S/N 91563

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

N.I.S.T. Test Reference Number 731/241460

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

Serial Number 110730029 (sensor 120629586)

JAPAN QUALITY ASSURANCE ORGANIZATION

STANDARD THERMOMETER

: Theodor Friedrich : Dry No.8380/94 Wet No. 8389/94

: Thermoschneider No.918802

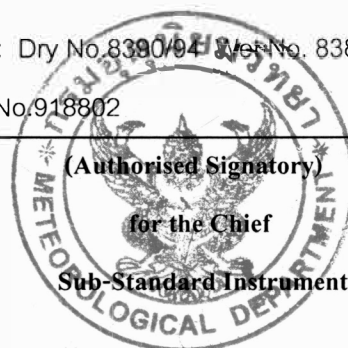
Calibrated by :

Signed :

Mr. Watcharapol Subwat

Mr. Pisood Promsut

Mechanical Engineer





# THAI METEOROLOGICAL DEPARTMENT

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

## The Result of Calibration

Certification No. 045/25

24 January, 2025

Page : 2 of 3

| Standard<br>Ultrasonic Anemometer<br>m/sec | HOOK GAGE NO. 1425 |                  |                 | TESTED ANEMOMETER |                     |
|--|--------------------|------------------|-----------------|-------------------|---------------------|
|  | Pressure<br>inches | Vacumm<br>inches | Pressure<br>hPa | Velocity<br>m/sec | Correction<br>m/sec |
| 1.00                                       | -                  | -                | -               | 0.9               | 0.10                |
| 3.02                                       | -                  | -                | -               | 2.7               | 0.32                |
| 5.00                                       | -                  | -                | -               | 4.9               | 0.10                |
| 7.00                                       | -                  | -                | -               | 6.7               | 0.30                |
| 9.02                                       | -                  | -                | -               | 8.1               | 0.92                |
| 11.01                                      | -                  | -                | -               | 10.3              | 0.71                |
| 13.01                                      | -                  | -                | -               | 12.1              | 0.91                |
| 15.01                                      | -                  | -                | -               | 14.3              | 0.71                |
| 17.02                                      | -                  | -                | -               | 16.1              | 0.92                |
| 20.02                                      | -                  | -                | -               | 19.3              | 0.72                |

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

Calibrated by :



Mr. Watcharapol Subwat

Mechanical Engineer





## THAI METEOROLOGICAL DEPARTMENT

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

### The Result of Calibration

Certification No. 045/25

24 January, 2025

Page : 3 of 3

| Standard<br>Temp.<br>°C | Temperature Sensor Reading |                  |
|-------------------------|----------------------------|------------------|
|                         | Reading<br>°C              | Correction<br>°C |
| 45.1                    | 44.8                       | 0.3              |
| 30.4                    | 30.2                       | 0.2              |
| 15.6                    | 15.4                       | 0.2              |

Calibrated by :

Mr. Watchapol Subwat  
Mechanical Engineer





## Calibration Test

Calibrated Date: 29 July 2025

Certificate No. 031/25

### Instruments Information

Manufacturer : YOUNG Instrument Type : four blade helicoid propeller  
Model : 40C Serial Number : Logger 428007859

Environment : Temperature 25.5 °C Humidity: 51 %RH

NATIONAL STANDARD WIND TUNNEL : Thermal Anemometer 642 S/N 91563  
: HOOK GAGE NO 1425 : Wind Aloft Plotting Board  
N.I.S.T. Test Reference Number 731/241460  
: Ultrasonic Anemometer Model DA-650-3TV (sensor TR-90AH)  
Serial Number 110730029 (sensor 120629586) JAPAN QUALITY ASSURANCE ORGANIZATION

| Standard<br>Ultrasonic<br>Anemometer<br>m/sec | HOOK GAGE NO 1425  |                  |                 | TESTED ANEMOMETER |                   |                   |                     |
|---|--------------------|------------------|-----------------|-------------------|-------------------|-------------------|---------------------|
|   | Pressure<br>inches | Vacuum<br>inches | Pressure<br>hPa | Pressure<br>hPa   | Correction<br>hPa | Velocity<br>m/sec | Correction<br>m/sec |
| 1.00  | -                  | -                | -               | -                 | -                 | 0.9               | 0.1                 |
| 3.02  | -                  | -                | -               | -                 | -                 | 2.9               | 0.12                |
| 5.04  | -                  | -                | -               | -                 | -                 | 4.8               | 0.24                |
| 7.03  | -                  | -                | -               | -                 | -                 | 6.8               | 0.23                |
| 9.01  | -                  | -                | -               | -                 | -                 | 8.7               | 0.31                |
| 11.03   | -                  | -                | -               | -                 | -                 | 10.7              | 0.33                |
| 13.01   | -                  | -                | -               | -                 | -                 | 12.5              | 0.51                |
| 15.03   | -                  | -                | -               | -                 | -                 | 14.4              | 0.63                |
| 17.05   | -                  | -                | -               | -                 | -                 | 16.5              | 0.55                |
| 20.02   | -                  | -                | -               | -                 | -                 | 19.3              | 0.72                |

| Wind Aloft Plotting Board.<br>US. DEPARTMENT OF COMMERCE WEATHER BUREAU |                       |           |        |
|---|-----------------------|-----------|--------|
| WIND DIRECTION  | TESTED WIND DIRECTION | Deviation | Result |
| 0   | 0                     | 0         | Pass   |
| 90  | 90                    | 0         | Pass   |
| 180   | 180                   | 0         | Pass   |
| 270   | 270                   | 0         | Pass   |

Calibrate By :

MR. KITTISAK JANSANGWATTANA

Approve by :

MR. PASAGORN SAMOL



SCARLET | TECH

# Certificate of Calibration

## WL-21 Wireless Anemometer

Scarlet Tech Ltd. hereby certifies that the WL-21 wireless anemometer listed below was thoroughly calibrated, test and inspected following the standard calibration procedure (st-wl-21) and is within manufacture's specification at the time when the calibration is don

Client: Envir Service Co., Ltd.

Serial: 2122DR0059

Calibration Date: 2025/5/7

Calibration Expiry Date: 2026/5/6

### The Result of Calibration

| Measured Value (m/s) | Actual Value (m/s) | Velocity  |           | Result |
|----------------------|--------------------|-----------|-----------|--------|
|                      |                    | Deviation | Tolerance |        |
| 1.0                  | 1.0                | 0.0       | 0.9-1.1   | Pass   |
| 1.9                  | 2.0                | 0.1       | 1.8-2.2   | Pass   |
| 4.9                  | 5.0                | 0.1       | 4.7-5.3   | Pass   |
| 7.0                  | 7.0                | 0.0       | 6.0-8.0   | Pass   |
| 10.0                 | 10.0               | 0.0       | 9.5-10.5  | Pass   |
| 19.6                 | 20.0               | 0.4       | 19.0-21.0 | Pass   |

| Measured Value (m/s) | Actual Value (m/s) | Wind Direction |           | Result |
|----------------------|--------------------|----------------|-----------|--------|
|                      |                    | Deviation      | Tolerance |        |
| 48°                  | 47°                | 1              | 42-48     | Pass   |
| 135°                 | 135°               | 0              | 132-138   | Pass   |
| 226°                 | 225°               | 1              | 222-228   | Pass   |
| 316°                 | 315°               | 1              | 312-318   | Pass   |
| 359°                 | 0°                 | 1              | 357-3     | Pass   |

| Inspection Room Temp | Actual Value | Deviation | Tolerance | Result |
|----------------------|--------------|-----------|-----------|--------|
| 22.2°C               | 22.5         | 0.3       | 21.5-23.5 | Pass   |

| Atmospheric Pressure Inspection | Actual Value | Deviation | Tolerance | Result |
|---------------------------------|--------------|-----------|-----------|--------|
| 1007                            | 1005         | 2         | 1001-1019 | Pass   |

#### Environment Conditions :

Air temperature: 22 °C

Relative humidity: 55 %

Static pressure: 102.2 kPa

Performed by: \_\_\_\_\_



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4F-3, No. 347, 2nd Sec., Heping E. Rd., Daan Dist. Taipei City 106, Taiwan



SCARLET | TECH

# Certificate of Calibration

## WL-21 Wireless Anemometer

Scarlet Tech Ltd. hereby certifies that the WL-21 wireless anemometer listed below was thoroughly calibrated, test and inspected following the standard calibration procedure (st-wl-21) and is within manufacture's specification at the time when the calibration is don

Client: Envir Service Co., Ltd.

Serial: 2112DR0071

Calibration Date: 2025/5/7

Calibration Expiry Date: 2026/5/6

### The Result of Calibration

| Measured Value (m/s) | Actual Value (m/s) | Velocity  |           | Result |
|----------------------|--------------------|-----------|-----------|--------|
|                      |                    | Deviation | Tolerance |        |
| 1.0                  | 1.0                | 0.0       | 0.9-1.1   | Pass   |
| 1.9                  | 2.0                | 0.1       | 1.8-2.2   | Pass   |
| 4.9                  | 5.0                | 0.1       | 4.7-5.3   | Pass   |
| 7.0                  | 7.0                | 0.0       | 6.0-8.0   | Pass   |
| 10.0                 | 10.0               | 0.0       | 9.5-10.5  | Pass   |
| 19.6                 | 20.0               | 0.4       | 19.0-21.0 | Pass   |

| Measured Value (m/s) | Actual Value (m/s) | Wind Direction |           | Result |
|----------------------|--------------------|----------------|-----------|--------|
|                      |                    | Deviation      | Tolerance |        |
| 48°                  | 47°                | 1              | 42-48     | Pass   |
| 135°                 | 135°               | 0              | 132-138   | Pass   |
| 226°                 | 225°               | 1              | 222-228   | Pass   |
| 316°                 | 315°               | 1              | 312-318   | Pass   |
| 359°                 | 0°                 | 1              | 357-3     | Pass   |

| Inspection Room Temp | Actual Value | Deviation | Tolerance | Result |
|----------------------|--------------|-----------|-----------|--------|
| 22.2°C               | 22.5         | 0.3       | 21.5-23.5 | Pass   |

| Atmospheric Pressure Inspection | Actual Value | Deviation | Tolerance | Result |
|---------------------------------|--------------|-----------|-----------|--------|
| 1007                            | 1005         | 2         | 1001-1019 | Pass   |

#### Environment Conditions:

Air temperature: 22 °C

Relative humidity: 55 %

Static pressure: 102.2 kPa



Performed by: [Redacted]

Certified by Head of Engineering Department

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# QUALITY CALIBRATION CO.,LTD.

235 Petchkasem 63/2 Road, Laksong, Bangkae, Bangkok 10160  
Tel (662) 421-5402, (662) 444-0152-3, Fax (662) 809-4584

[www.qcalibration.com](http://www.qcalibration.com)

CERTIFICATE No : 25E1474  
REFERENCE No : 72222-1

PAGE : 1 OF 2

## Certificate of Calibration

**EQUIPMENT** : SOUND LEVEL CALIBRATOR  
**MANUFACTURER** : DELTAOHM  
**MODEL** : HD2020  
**SERIAL No** : 17000992  
**ID No** : EM-SC01/17  
**SUBMITTED BY** : OKLA TESTING & CONSULTING SERVICE CO.,LTD.  
67/35-36, 3 RD FLOOR., PHETKHEM 7/1 RD.,  
WAT THA PRA, BANGKOKYAI, BANGKOK,  
THAILAND 10600

**CALIBRATED BY** : CHAICHARN CH.  
**CALIBRATION DATE** : 28-Feb-25

**APPROVED BY** :   
PONGSAK J.

**ISSUED DATE** : 28-Feb-25

**RECEIVED DATE** : 20-Feb-25

THIS CERTIFICATE MAY NOT BE REPRODUCED OTHER THAN IN FULL EXCEPT WITH THE PRIOR WRITTEN APPROVAL OF  
QUALITY CALIBRATION CO., LTD.

F-G010 REV 03





# QUALITY CALIBRATION CO.,LTD.

235 Petchkasem 63/2 Road, Laksong, Bangkae, Bangkok 10160  
Tel (662) 421-5402, (662) 444-0152-3, Fax (662) 809-4584

www.qcalibration.com

CERTIFICATE No : 25E1474

PAGE : 2 OF 2

## Calibration Report

EQUIPMENT : SOUND LEVEL CALIBRATOR  
MANUFACTURER : DELTAOHM MODEL : HD2020  
S/N : 17000992 ID No : EM-SC01/17  
RECEIVED DATE : 20-Feb-25 CALIBRATION DATE : 28-Feb-25  
AMBIENT TEMPERATURE : 23°C ± 3°C RELATIVE HUMIDITY : 50 % RH ± 20% RH

### CONDITION OF THIS RESULTS OF CALIBRATION

1. THIS INSTRUMENT WAS CALIBRATED BY DIRECT MEASUREMENT WITH STANDARD MICROPHONE.
2. REFERENCE STANDARD INSTRUMENTS :-

| <u>INSTRUMENT</u>      | <u>MODEL</u> | <u>SERIAL No</u> | <u>CERTIFICATE No</u> | <u>DUE DATE</u> |
|------------------------|--------------|------------------|-----------------------|-----------------|
| 1) STANDARD MICROPHONE | 4192         | 2595198          | AA-1007-23            | 16-Jun-28       |
| 2) STANDARD MULTIMETER | 8846A        | 2044006          | CA20220138EA          | 14-Mar-25       |

3. THE CERTIFICATE IS VALID FOR THE ITEM CALIBRATED AS SHOWN ON THE DATE AND PLACE OF CALIBRATION ONLY.
4. THIS RESULT EXCLUDE LONG TERM STABILITY OF THE UNIT UNDER CALIBRATION.
5. THIS CERTIFICATE IS TRACEABLE TO :-
  - NATIONAL INSTITUTE OF METROLOGY (THAILAND)

### RESULT OF CALIBRATION :- WITHOUT ADJUSTMENT

#### 1. ACOUSTIC OUTPUT

| FREQUENCY (Hz) | UUC SETTING (dB) | STANDARD READING (dB) | CORRECTION (dB) | UNCERTAINTY OF MEASUREMENT (± dB) |
|----------------|------------------|-----------------------|-----------------|-----------------------------------|
| 1000.00        | 94.00            | 94.242                | 0.242           | 0.28                              |
| 1000.00        | 114.00           | 114.069               | 0.069           | 0.28                              |

#### 2. FREQUENCY TEST

| UUC FREQUENCY SETTING (Hz) | STANDARD READING (Hz) | CORRECTION (Hz) | UNCERTAINTY OF MEASUREMENT (± Hz) |
|----------------------------|-----------------------|-----------------|-----------------------------------|
| 1000                       | 998.793               | -1.207          | 0.36                              |

UUC\* : UNIT UNDER CALIBRATION

THE REPORTED UNCERTAINTY OF MEASUREMENT WAS BASED ON A STANDARD UNCERTAINTY MULTIPLIED BY A COVERAGE FACTOR k =2, PROVIDING A LEVEL OF CONFIDENCE APPROXIMATELY 95%.

END OF CALIBRATION REPORT





A Trescal company

**METROLOGY SYSTEM ( THAILAND ) CO.,LTD.**



ID LINE : IEC17025



# Certificate of Calibration

Certificate Number : SPR25010221-1

Page : 1 of 3

Customer : ATOM-LAB ENVIRONMENTAL CO., LTD.

54/110 Moo 4, Klong 4, Klong Luang, Pathum Thani 12120

Equipment Name : pH Meter

Manufacturer : Eutech

Model : pH700

Serial Number : 3089393

ID. Number : ALE-TOOL-001

## Environmental Conditions

Ambient Temperature : 25 °C ± 10 °C

Relative Humidity : 60 % ± 20 %

Location of Calibration : On-Site

Calibration Procedure : SP-CPC-04-01,  
SP-CPT-04-05

Received Date : 15 Jan 2025

Calibration Date : 21 Jan 2025

Recommend Due Date : 21 Jan 2026

Date of Issue : 22 Jan 2025

## Method of Calibration

This certifies that the above instrument was calibrated in compliance with the calibration system requirement of ISO/IEC 17025:2017 in accordance with reference procedure. Standards used to perform this calibration are certified by to NIST or equivalent, National metrology institute, Natural physical constants, consensus standards. The result reported herein apply only to the calibration of the item described above as received. Our decision rule is to contact the customer if the item pass and fail calibration when the results include the uncertainties and the customer must determine if the results meets their needs.

The calibration certificate shall not be reproduced except in full, without written approval of SP Metrology System (Thailand).

Calibrated by : Mr. Prayoon Topart

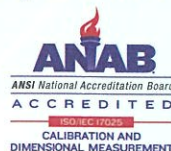
Calibration Officer

Approved by

( Mr. Pootthipong A. )

Authorized Signatory





## Calibration Report

Certificate Number : SPR25010221-1

Page : 2 of 3

### Reference Standards

| Equipment Name             | Model            | Serial No.    | Certificate No. | Due. Date    |
|----------------------------|------------------|---------------|-----------------|--------------|
| Standard pH Solution       | PH016.L5         | Lot No.970880 | 61278486        | 25 Apr '2025 |
| Standard pH Solution       | PH107.L5         | Lot No.970881 | 61281486        | 25 Apr 2025  |
| Standard pH Solution       | PH020.L5         | Lot No.970882 | 61297722        | 25 Apr 2025  |
| Super Thermometer with PRT | 1575/3850-40-392 | 58087/100288  | PSL-T 0377/67   | 23 Feb 2025  |

### Traceability

This certification is traceable to the International System of Unit maintained at :

C.P.A. Chem - ANAB#AT-1836 (ISO/IEC 17025:2017) and ANAB#AR-1835 (ISO/IEC 17034:2016)

TISTR - Thailand Institute of Scientific and Technological Research



## Result of Calibration

Certificate Number : SPR25010221-1

Page : 3 of 3

pH Measurement @ 25 °C

Unit : pH

| Standard Solution | UUC Reading | Error  | Uncertainty ( ± ) |
|-------------------|-------------|--------|-------------------|
| 4.008             | 4.01        | 0.002  | 0.012             |
| 6.984             | 7.00        | 0.016  | 0.012             |
| 10.011            | 10.01       | -0.001 | 0.012             |

Temperature Measurement

Unit : °C

| Standard Value | UUC Reading | Error  | Uncertainty ( ± ) |
|----------------|-------------|--------|-------------------|
| 20.011         | 20.1        | 0.089  | 0.070             |
| 25.020         | 25.0        | -0.020 | 0.070             |
| 30.013         | 30.0        | -0.013 | 0.070             |

### Note :

The result of calibration was found accurate as show on date and place of calibration only.  
This Certificate is not certified for any commercial transaction.

### Measurement Uncertainty

The reported uncertainty of measurement is the expanded uncertainty obtained by multiplying the standard uncertainty with the coverage factor  $k = 2.00$ , providing a level of confidence approximately 95%.

- End of Certificate -



BETAGRO

Equipment : pH Meter(METTLER) with electrode

## Verify Record

บริษัท ศูนย์วิทยาศาสตร์บริการ จำกัด

ID No.: CL\_PH\_04

Operating limit : pH 0 - 14

Date of Calibration : 5-Sep-23

S/N No.: B619434158

### 1. DC Voltage measurement

| Nominal Value<br>(pH) | Applied DC<br>(mV) | Average Indicator Reading |        | Uncertainty<br>(±mV) | ERROR<br>(mV) | E-U<br>(pH) | E-U<br>(pH) | ค่าเฉลี่ย<br>(mV) | Result | Remark |
|-----------------------|--------------------|---------------------------|--------|----------------------|---------------|-------------|-------------|-------------------|--------|--------|
|                       |                    | (mV)                      | (pH)   |                      |               |             |             |                   |        |        |
| 0                     | 414.113            | 414.0                     | 0.000  | 0.083                | -0.113        | -0.030      | -0.196      | 2.0               | P      |        |
| 4                     | 177.477            | 177.4                     | 4.000  | 0.083                | -0.077        | 0.006       | -0.160      | 2.0               | P      |        |
| 7                     | 0.000              | 0.0                       | 7.000  | 0.083                | 0.000         | 0.083       | -0.083      | 2.0               | P      |        |
| 10                    | -177.477           | -177.4                    | 10.000 | 0.083                | 0.077         | 0.160       | -0.006      | 2.0               | P      |        |
| 14                    | -414.113           | -413.9                    | 14.000 | 0.083                | 0.213         | 0.296       | 0.130       | 2.0               | P      |        |

### 2. Performance electrode system

S/N: 2285923

| Std. Buffer sol<br>pH (±0.01) | Average Indicator Reading |        | ERROR<br>(pH) | Uncertainty<br>(±pH) | E-U<br>(pH) | E-U<br>(pH) | ค่าเฉลี่ย<br>(pH) | Result | Remark |
|-------------------------------|---------------------------|--------|---------------|----------------------|-------------|-------------|-------------------|--------|--------|
|                               | (pH)                      | (mV)   |               |                      |             |             |                   |        |        |
| 4.008                         | 4.008                     | 171.5  | 0.000         | 0.0083               | 0.008       | -0.008      | 0.1               | P      |        |
| 6.985                         | 6.985                     | -3.2   | 0.000         | 0.0083               | 0.008       | -0.008      | 0.1               | P      |        |
| 10.010                        | 10.015                    | -178.1 | 0.005         | 0.0083               | 0.013       | -0.003      | 0.1               | P      |        |

### 3. Temperature

| Calibration point<br>(°C) | Average Indicator |      | Unit Under Calibration  |                     | E-U<br>(°C) | E-U<br>(°C) | ค่าเฉลี่ย<br>(°C) | Result | Remark |
|---------------------------|-------------------|------|-------------------------|---------------------|-------------|-------------|-------------------|--------|--------|
|                           | Reading<br>(°C)   | (mV) | Average Reading<br>(°C) | Uncertainty<br>(°C) |             |             |                   |        |        |
| 25                        | 25.000            | 100  | 25.000                  | 0.000               | 0.140       | -0.140      | 2                 | P      |        |

Certificate No : 23-102701

Certificate By : AMARC

Reported By

6/11/23  
( อติเรก จิมพัฒน์วงศ์ )

Approved By

( บุญจมาภรณ์ มาตชาว )



NSC-TISI-TIS17025  
CALIBRATION 0152

Page 1 of 2

## CERTIFICATE OF CALIBRATION

Certificate No. : 23-102701

Sample Code : 23-37664-002

Customer : Betagro Science Center (Lopburi)  
219 Moo 1, Chongsarika, Pattananikom,  
Lopburi 15220

Location of Calibration : Betagro Science Center (Lopburi)  
(Laboratory)

Equipment : pH Meter

Manufacturer : METTLER TOLEDO Model : SevenCompact S220

Serial No. : B619434158 ID No. : CL\_PH\_04

Date of Receipt : 05 September 2023 Date of Calibration : 05 September 2023

## Condition of Calibration

## 1. Environment

1.1 Ambient temperature : 24.1  $\pm$  1.2  $^{\circ}\text{C}$  1.2 Relative humidity : 64.6 %  $\pm$  2.5 %

## 2. Calibration method

In house method WI-CL-019: based on direct measurement by using standard voltage calibrator and using certified reference material (CRM).

## 3. Reference standard / Certified reference material

| Instrument                    | ID No.    | Certificate No. | Due Date        |
|-------------------------------|-----------|-----------------|-----------------|
| 3.1 Voltage Calibrator        | LB-AMC-01 | 22E3240         | 03 October 2023 |
| 3.2 Digital Thermometer       | LB-TH-33  | 22-107027       | 02 October 2023 |
| Certified Reference Material  | Lot. No.  | Ref No.         | Expire Date     |
| 3.3 Buffer Solution pH 4.008  | 888850    | PH216.L5        | 13 April 2025   |
| 3.4 Buffer Solution pH 6.985  | 888851    | PH107.L5        | 13 April 2024   |
| 3.5 Buffer Solution pH 10.010 | 888852    | PH220.L5        | 13 April 2024   |

## 4. This certificate is traceable to the international system of unit (SI Unit).

- 4.1 Instrument No. 3.1 through Technology Promotion Association (Thailand-Japan).
- 4.2 Instrument No. 3.2 through Asia Medical and Agricultural Laboratory and Research Center Public Company Limited.
- 4.3 Buffer Solution No. 3.3 and No. 3.5 traceable to CPA chem (through primary measurement method-Harned cell using calibrated thermometer, barometer, and nanovoltmeter Accredited laboratory ISO/IEC 17025 and ISO/IEC 17034).
- 4.4 Buffer Solution No. 3.4 traceable to CPA chem (CPA RefN HARNED CELL LotN 61275737; CPA RefN HARNED CELL LotN 61273986 Accredited laboratory ISO/IEC 17025 and ISO/IEC 17034).

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

## 6. Condition of calibration item : Normal

Calibrated by Mr. Nuttaput Timula  
Scientist

Approved by (Ms. Pawana Pan-on)  
Signed for Director

Issue date 12 September 2023

The uncertainties are for a confidence probability of approximately 95%.

The calibration result is applied only to the above calibrated item and was found accurate as shown on date and place of calibration only.

This Certificate is issued in accordance with the conditions of accreditation granted by the Thai Laboratory Accreditation scheme which has assessed the measurement capability of the laboratory and its traceability to recognized national standards and to the unit of measurement realized at the corresponding national standards laboratory. This certificate may not be reproduced other than in full except with the prior written approval of the Asia Medical and Agricultural Laboratory and Research Center Public Company Limited (AMARC).

NSC-TISI-TIS17025  
CALIBRATION 0152

## REPORT OF CALIBRATION

Page 2 of 3

Certificate No. : 23-102701

Sample Code : 23-37664-002

Equipment : pH Meter Resolution : 0.001 pH ; 0.1 mV ; 0.1°C  
Manufacturer : METTLER TOLEDO Model : SevenCompact S220  
Serial No. : B619434158 ID No. : CL\_PH\_04  
Range : -2.000 pH to 20.000 pH ; ± 2000.0 mV ; -5.0°C to 130.0°C

## Results of Calibration

## Part 1. DC Voltage measurement

pH Meter Serial No. : B619434158

| Nominal Value<br>pH | Applied DC Voltage<br>mV | Average indicator reading |        | Uncertainty<br>mV | Coverage factor<br>k |
|---------------------|--------------------------|---------------------------|--------|-------------------|----------------------|
|                     |                          | mV                        | pH     |                   |                      |
| 0                   | 414.113                  | 414.0                     | 0.000  | ± 0.083           | 2.00                 |
| 4                   | 177.477                  | 177.4                     | 4.000  | ± 0.083           | 2.00                 |
| 7                   | 0.000                    | 0.0                       | 7.000  | ± 0.083           | 2.00                 |
| 10                  | -177.477                 | -177.4                    | 10.000 | ± 0.083           | 2.00                 |
| 14                  | -414.113                 | -413.9                    | 14.000 | ± 0.083           | 2.00                 |

## Part 2. Performance of Electrode system

Electrode Manufacturer : METTLER TOLEDO Model : InLab Routine

Electrode Serial No. : 2285923

Three-Point Calibration at pH4, pH7 and pH10 Percent Slope : 97.5

| Standard Buffer Solution<br>pH (@ 25 °C) | Average indicator reading |        | Error Value<br>pH | Uncertainty<br>pH | Coverage factor<br>k |
|--|---------------------------|--------|-------------------|-------------------|----------------------|
|  | pH                        | mV     |                   |                   |                      |
| 4.008                                    | 4.008                     | 171.5  | 0.000             | ± 0.0083          | 2.00                 |
| 6.985                                    | 6.985                     | -3.2   | 0.000             | ± 0.0083          | 2.00                 |
| 10.010                                   | 10.015                    | -178.1 | 0.005             | ± 0.0087          | 2.00                 |

The result expanded uncertainty of measurement  $U$  is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with UKAS M3003.

NSC-TISI-TIS17025  
CALIBRATION 0152

Page 3 of 3

## REPORT OF CALIBRATION

Certificate No. : 23-102701

Sample Code : 23-37664-002

Equipment : pH Meter (Digital Thermometer with sensor)

## Thermometer readout

Manufacturer : METTLER TOLEDO Model : SevenCompact S220  
Serial No. : B619434158 ID No. : CL\_PH\_04  
Resolution : 0.1 °C Range : -5.0 °C to 130.0 °C

## Thermometer sensor

Manufacturer : METTLER TOLEDO Model : InLab Routine  
Serial No. : 2285923 ID No. : N/A

## Condition of Calibration

1. Environment 1.1 Ambient temperature : 24.1 °C ± 1.2 °C  
1.2 Relative humidity : 64.6 % ± 2.5 %

## 2. Calibration method

- 2.1 The calibration use in house method WI-CL-021 : by comparison with standard thermometer  
2.2 The calibration by comparison unit under calibration (UUC) to the standard thermometer in a calibration bath at the controlled temperature.  
2.3 The temperature scale in use of this laboratory is the international temperature scale of 1990 (ITS-90).

## 3. Reference standard instrument

| Instrument                          | Model  | ID. No.  | Certificate No. | Due date        |
|-------------------------------------|--------|----------|-----------------|-----------------|
| 3.1 Platinum Resistance Thermometer | PT-100 | RTD-90   | 22-107027       | 02 October 2023 |
| 3.2 Thermometer Readout             | GT-11  | LB-TH-33 | 22-107027       | 02 October 2023 |

## 4. This certificate is traceable to the international system of unit (SI Unit).

Asia Medical and Agricultural Laboratory and Research Center Public Company Limited (Accreditation Under TLAS Laboratory Calibration No.0152)

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

## 6. Condition of Calibration item : Normal

## Results of Calibration

| Calibration point<br>°C | Average of standard reading<br>°C | Unit under calibration |                       |                        | Expanded uncertainty<br>°C | Coverage factor<br>k |
|-------------------------|-----------------------------------|------------------------|-----------------------|------------------------|----------------------------|----------------------|
|                         |                                   | Immersion depth<br>mm  | Average reading<br>°C | Correction value<br>°C |                            |                      |
| 25                      | 25.000                            | 100                    | 25.0                  | 0.000                  | ± 0.14                     | 2.00                 |

## Notes

- Calibration results without adjustment

The result expanded uncertainty of measurement  $U$  is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with UKAS M3003.

- End of report -



# BETAGRO

## Verify Record

บริษัท ศูนย์วิทยาศาสตร์บริการ จำกัด

Equipment : pH Meter(ORION) with electrode

ID No.: CL\_PH\_03

S/N No.: B 38711

Operating limit : pH 0 - 14

Date of Calibration : 5-Sep-23

### 1. DC Voltage measurement

| Nominal Value<br>pH | Applied DC<br>(mV) | Average indicator reading |        | Uncertainty<br>(± mV) | ERROR<br>(mV) | E+U<br>(pH) | E-U<br>(pH) | เกณฑ์การยอมรับ<br>(± mV) | Result | Remark |
|---------------------|--------------------|---------------------------|--------|-----------------------|---------------|-------------|-------------|--------------------------|--------|--------|
|                     |                    | (mV)                      | (pH)   |                       |               |             |             |                          |        |        |
| 0                   | 414.113            | 413.9                     | 0.000  | 0.083                 | -0.213        | -0.130      | -0.296      | 2.0                      | P      |        |
| 4                   | 177.477            | 177.4                     | 4.000  | 0.083                 | -0.077        | 0.006       | -0.160      | 2.0                      | P      |        |
| 7                   | 0.000              | -0.1                      | 7.000  | 0.083                 | -0.100        | -0.017      | -0.183      | 2.0                      | P      |        |
| 10                  | -177.477           | -177.5                    | 10.000 | 0.083                 | -0.023        | 0.060       | -0.106      | 2.0                      | P      |        |
| 14                  | -414.113           | -414.0                    | 14.000 | 0.083                 | 0.113         | 0.196       | 0.030       | 2.0                      | P      |        |

### 2. Performance electrode system S/N: WQ1-15236

| Set Point (pH) | Applied DC (mV) | Average indicator reading |        | Uncertainty (± pH) | ERROR (pH) | E+U (pH) | E-U (pH) | Remark |
|----------------|-----------------|---------------------------|--------|--------------------|------------|----------|----------|--------|
|                |                 | (mV)                      | (pH)   |                    |            |          |          |        |
| 4.008          | 4.001           | 152.6                     | -0.007 | 0.0083             | 0.001      | -0.015   | 0.1      | P      |
| 6.985          | 6.982           | -18.6                     | -0.003 | 0.0083             | 0.005      | -0.011   | 0.1      | P      |
| 10.010         | 10.003          | -191.7                    | -0.007 | 0.0083             | 0.001      | -0.015   | 0.1      | P      |

### 3. Temperature

| Calibration point<br>(°C) | Average indicator<br>reading<br>(°C) | Unit Under calibration  |                         |               |                     | E+U<br>(°C) | E-U<br>(°C) | เกณฑ์การยอมรับ<br>(± °C) | Result | Remark |
|---------------------------|--------------------------------------|-------------------------|-------------------------|---------------|---------------------|-------------|-------------|--------------------------|--------|--------|
|                           |                                      | Immersion depth<br>(mm) | Average reading<br>(°C) | ERROR<br>(°C) | Uncertainty<br>(°C) |             |             |                          |        |        |
| 25                        | 24.997                               | 100                     | 25.200                  | 0.203         | 0.140               | 0.343       | 0.063       | 2                        | P      |        |

Certificate No : 23-102700

Certificate By : AMARC

Reported By

6/11/23

( อติเรก จิมพัฒน์พงษ์ )

Approved By

6/11/23

( เบนจุมภรณ์ มาศขาว )

NSC-TISI-TIS17025  
CALIBRATION 0152

Page 1 of 3

## CERTIFICATE OF CALIBRATION

Certificate No. : 23-102700

Sample Code : 23-37664-001

Customer : Betagro Science Center (Lopburi)  
219 Moo 1, Chongsarika, Pattananikom,  
Lopburi 15220

Location of Calibration : Betagro Science Center (Lopburi)  
(Chemica Department)

Equipment : pH Meter

Manufacturer : ORION Model : 2 STAR

Serial No. : B 38711 ID No. : CL\_PH\_03

Date of Receipt : 05 September 2023 Date of Calibration : 05 September 2023

## Condition of Calibration

## 1. Environment

1.1 Ambient temperature : 23.0  $\pm$  0.1  $^{\circ}$ C 1.2 Relative humidity : 69.7 %  $\pm$  0.1 %

## 2. Calibration method

In house method WI-CL-019: based on direct measurement by using standard voltage calibrator and using certified reference material (CRM).

## 3. Reference standard / Certified reference material

| Instrument                    | ID No.    | Certificate No. | Due Date        |
|-------------------------------|-----------|-----------------|-----------------|
| 3.1 Voltage Calibrator        | LB-AMC-01 | 22E3240         | 03 October 2023 |
| 3.2 Digital Thermometer       | LB-TH-33  | 22-107027       | 02 October 2023 |
| Certified Reference Material  | Lot. No.  | Ref No.         | Expire Date     |
| 3.3 Buffer Solution pH 4.008  | 888850    | PH216.L5        | 13 April 2025   |
| 3.4 Buffer Solution pH 6.985  | 888851    | PH107.L5        | 13 April 2024   |
| 3.5 Buffer Solution pH 10.010 | 888852    | PH220.L5        | 13 April 2024   |

## 4. This certificate is traceable to the international system of unit (SI Unit).

- 4.1 Instrument No. 3.1 through Technology Promotion Association (Thailand-Japan).
- 4.2 Instrument No. 3.2 through Asia Medical and Agricultural Laboratory and Research Center Public Company Limited.
- 4.3 Buffer Solution No. 3.3 and No. 3.5 traceable to CPA chem (through primary measurement method-Harned cell using calibrated thermometer, barometer, and nanovoltmeter Accredited laboratory ISO/IEC 17025 and ISO/IEC 17034).
- 4.4 Buffer Solution No. 3.4 traceable to CPA chem (CPA RefN HARNED CELL LotN 61275737; CPA RefN HARNED CELL LotN 61273986 Accredited laboratory ISO/IEC 17025 and ISO/IEC 17034).

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

## 6. Condition of calibration item : Normal

Calibrated by Mr. Nuttaput Timula  
Scientist

Approved by (Ms. Pawana Pan-on)  
Signed for Director

Issue date 12 September 2023

The uncertainties are for a confidence probability of approximately 95%.

The calibration result is applied only to the above calibrated item and was found accurate as shown on date and place of calibration only.

This Certificate is issued in accordance with the conditions of accreditation granted by the Thai Laboratory Accreditation scheme which has assessed the measurement capability of the laboratory and its traceability to recognized national standards and to the unit of measurement realized at the corresponding national standards laboratory. This certificate may not be reproduced other than in full except with the prior written approval of the Asia Medical and Agricultural Laboratory and Research Center Public Company Limited (AMARC).





## REPORT OF CALIBRATION

Certificate No. : 23-102700

Sample Code : 23-37664-001

Equipment : pH Meter Resolution : 0.001 pH ; 0.1 mV ; 0.1°C  
 Manufacturer : ORION Model : 2 STAR  
 Serial No. : B 38711 ID No. : CL\_PH\_03  
 Range : 0.001 pH to 14.999 pH ; ± 1999.9 mV ; -5.0°C to 105.0 °C

## Results of Calibration

## Part 1. DC Voltage measurement

pH Meter Serial No. : B 38711

| Nominal Value<br>pH | Applied DC Voltage<br>mV | Average indicator reading |        | Uncertainty<br>mV | Coverage factor<br>k |
|---------------------|--------------------------|---------------------------|--------|-------------------|----------------------|
|                     |                          | mV                        | pH     |                   |                      |
| 0                   | 414.113                  | 413.9                     | 0.000  | ± 0.083           | 2.00                 |
| 4                   | 177.477                  | 177.4                     | 4.000  | ± 0.083           | 2.00                 |
| 7                   | 0.000                    | -0.1                      | 7.000  | ± 0.083           | 2.00                 |
| 10                  | -177.477                 | -177.5                    | 10.000 | ± 0.083           | 2.00                 |
| 14                  | -414.113                 | -414.0                    | 14.000 | ± 0.083           | 2.00                 |

## Part 2. Performance of Electrode system

Electrode Manufacturer : ORION Model : 9107BNMD

Electrode Serial No. : WQ1-15236

Three-Point Calibration at pH4, pH7 and pH10 Percent Slope : 98.1

| Standard Buffer Solution<br>pH (@ 25 °C) | Average indicator reading |        | Error Value<br>pH | Uncertainty<br>pH | Coverage factor<br>k |
|--|---------------------------|--------|-------------------|-------------------|----------------------|
|  | pH                        | mV     |                   |                   |                      |
| 4.008                                    | 4.001                     | 152.6  | -0.007            | ± 0.0083          | 2.00                 |
| 6.985                                    | 6.982                     | -18.6  | -0.003            | ± 0.0083          | 2.00                 |
| 10.010                                   | 10.003                    | -191.7 | -0.007            | ± 0.0083          | 2.00                 |

The result expanded uncertainty of measurement  $U$  is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with UKAS M3003.



## REPORT OF CALIBRATION

Certificate No. : 23-102700

Sample Code : 23-37664-001

Equipment : pH Meter (Digital Thermometer with sensor)

## Thermometer readout

Manufacturer : ORION Model : 2 STAR  
Serial No. : B 38711 ID No. : CL\_PH\_03  
Resolution : 0.1 °C Range : -5.0 °C to 105.0 °C

## Thermometer sensor

Manufacturer : ORION Model : N/A  
Serial No. : WQ1-15236 ID No. : N/A

## Condition of Calibration

1. Environment  
1.1 Ambient temperature : 23.0 °C ± 0.1 °C  
1.2 Relative humidity : 69.9 % ± 0.1 %

## 2. Calibration method

- 2.1 The calibration use in house method WI-CL-021 : by comparison with standard thermometer  
2.2 The calibration by comparison unit under calibration (UUC) to the standard thermometer in a calibration bath at the controlled temperature.  
2.3 The temperature scale in use of this laboratory is the international temperature scale of 1990 (ITS-90).

## 3. Reference standard instrument

| Instrument                          | Model  | ID. No.  | Certificate No. | Due date        |
|-------------------------------------|--------|----------|-----------------|-----------------|
| 3.1 Platinum Resistance Thermometer | PT-100 | RTD-90   | 22-107027       | 02 October 2023 |
| 3.2 Thermometer Readout             | GT-11  | LB-TH-33 | 22-107027       | 02 October 2023 |

## 4. This certificate is traceable to the international system of unit (SI Unit).

Asia Medical and Agricultural Laboratory and Research Center Public Company Limited (Accreditation Under TLAS Laboratory Calibration No.0152)

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

## 6. Condition of Calibration item : Normal

## Results of Calibration

| Calibration point<br>°C | Average of standard reading<br>°C | Unit under calibration |                       |                        | Expanded uncertainty<br>°C | Coverage factor<br>k |
|-------------------------|-----------------------------------|------------------------|-----------------------|------------------------|----------------------------|----------------------|
|                         |                                   | Immersion depth<br>mm  | Average reading<br>°C | Correction value<br>°C |                            |                      |
| 25                      | 24.997                            | 100                    | 25.2                  | - 0.203                | ± 0.14                     | 2.00                 |

## Notes

- Calibration results without adjustment

The result expanded uncertainty of measurement  $U$  is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with UKAS M3003.

- End of report -

## ประเมินประสิทธิภาพเครื่องมือ

☐ Calibration
 ☐ Verification
 ☒ Preventive Maintenance
 ☐ Other.....

Instrument Name : UV/Vis Spectrophotometer
 ID No. : CL-SP-02
 S/N. : 1663352  
 Service No.: LABX2202945
 Service by.: HACH
 Issue date: 10 Oct 2022

Instrument checked :

| Item | Characteristic                    | Before    | After     | Remark |
|------|-----------------------------------|-----------|-----------|--------|
|      |                                   | Pass/Fail | Pass/Fail |        |
| 1    | Visual Inspect                    | Pass      | Pass      |        |
| 2    | Power Supply ( 200 - 240 VAC)     | Pass      | Pass      |        |
| 3    | Self Test                         | Pass      | Pass      |        |
| 4    | Display and Touch screen Check    | Pass      | Pass      |        |
| 5    | Battery Backup Test ( >2.85 VDC ) | Pass      | Pass      |        |
| 6    | Barcode Test                      | Pass      | Pass      |        |
| 7    | Lamp Halogen test                 | Pass      | Pass      |        |
| 8    | Lamp Deuterium test               | Pass      | Pass      |        |

Instrument checked :

| Item | Event      | Before | After | Remark |
|------|------------|--------|-------|--------|
| 9    | Error list | none   | none  |        |
|      |            |        |       |        |

Instrument checked :

| Item | Characteristic                               | Before (ABS) | After (ABS) | Remark |
|------|--|--------------|-------------|--------|
| 10   | Blank (0.000 ABS)                            | 0.000        | 0.000       |        |
| 11   | Wave Length 420 nm (0.547 ± 0.050 ABS) STD_1 | 0.548        | 0.550       |        |
| 12   | Wave Length 520 nm (0.569 ± 0.050 ABS) STD_1 | 0.562        | 0.564       |        |
| 13   | Wave Length 560 nm (0.588 ± 0.050 ABS) STD_1 | 0.581        | 0.582       |        |
| 14   | Wave Length 610 nm (0.550 ± 0.050 ABS) STD_1 | 0.548        | 0.548       |        |
| 15   | Wave Length 420 nm (1.119 ± 0.100 ABS) STD_2 | 1.110        | 1.110       |        |
| 16   | Wave Length 520 nm (1.158 ± 0.100 ABS) STD_2 | 1.136        | 1.137       |        |
| 17   | Wave Length 560 nm (1.193 ± 0.100 ABS) STD_2 | 1.176        | 1.176       |        |
| 18   | Wave Length 610 nm (1.120 ± 0.100 ABS) STD_2 | 1.110        | 1.110       |        |
| 19   | Wave Length 420 nm (1.739 ± 0.150 ABS) STD_3 | 1.723        | 1.730       |        |
| 20   | Wave Length 520 nm (1.777 ± 0.150 ABS) STD_3 | 1.755        | 1.757       |        |
| 21   | Wave Length 560 nm (1.844 ± 0.150 ABS) STD_3 | 1.817        | 1.815       |        |
| 22   | Wave Length 610 nm (1.731 ± 0.150 ABS) STD_3 | 1.717        | 1.720       |        |
|      |  |              |             |        |

# ประเมินประสิทธิภาพเครื่องมือ

☐ Calibration
 ☐ Verification
 ☒ Preventive Maintenance
 ☐ Other.....

Instrument Name : UV/Vis Spectrophotometer
 ID No. : CL-SP-02
 S/N. : 1663352  
 Service No.: LABX2202945
 Service by.: HACH
 Issue date: 10 Oct 2022

Instrument checked :

| Standard Equipment Used |                |                      |  |
|-------------------------|----------------|----------------------|--|
| Equipment               | Equipment I.D. |                      |  |
| Standard Absorbance     | Lot No. A2181  | Exp date : Jul-24    |  |
| Digital multi meter     | S/N : 23452230 | Due date : 17-Aug-23 |  |
| Thermo Hygrometer       | S/N : 4514635  | Due date : 17-Aug-23 |  |
|                         |                |                      |  |

Report by: [Signature] date: 27/12/22  
 (อดิเรก ชิมพัฒน์พงษ์)

Approved by: [Signature] date: 28/12/22  
 (เบญจมาภรณ์ มาศขาว)

Acknowledge by:

- 1) ศศิอาภา แก่นจันทร์
- 2) ปานทิพย์ พุ่มพฤษ

: [Signature] date: 28/12/22  
 : [Signature] date: 28/12/22

# Verify Record

Instrument Name : Spectrophotometer

ID No. : CL\_SP\_02

Calibration date : 20-Oct-22

## Wavelength Accuracy

| standard wavelength (nm) | UUC Reading (nm) | Correction (nm) | Uncertainty [U] ±(nm) | G+U ±(nm) | เกณฑ์ ±(nm) | Pass (P)/Fail(F) |
|--------------------------|------------------|-----------------|-----------------------|-----------|-------------|------------------|
| 418.61                   | 418.1            | 0.51            | 0.13                  | 0.64      | 2.0         | P                |
| 536.66                   | 536.5            | 0.16            | 0.13                  | 0.29      |             | P                |
| 637.98                   | 637.9            | 0.08            | 0.13                  | 0.21      |             | P                |
| 748.48                   | 748.3            | 0.18            | 0.13                  | 0.31      |             | P                |
| 807.03                   | 807.0            | 0.03            | 0.13                  | 0.16      |             | P                |

## Photometric Accuracy (Absorbance)

| wavelength (nm) | standard Absorbance(A) | UUC Reading (A) | Correction (A) | Uncertainty [U] ±(A) | G+U ±(A) | เกณฑ์ ±(A) | Pass (P)/Fail(F) |
|-----------------|------------------------|-----------------|----------------|----------------------|----------|------------|------------------|
| 420             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2899                 | 0.288           | 0.0019         | 0.0045               | 0.0064   |            | P                |
|                 | 0.5170                 | 0.516           | 0.0010         | 0.0045               | 0.0055   |            | P                |
|                 | 1.0286                 | 1.026           | 0.0026         | 0.0045               | 0.0071   |            | P                |
| 440             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2837                 | 0.283           | 0.0007         | 0.0045               | 0.0052   |            | P                |
|                 | 0.5074                 | 0.507           | 0.0004         | 0.0045               | 0.0049   |            | P                |
|                 | 1.0071                 | 1.006           | 0.0011         | 0.0045               | 0.0056   |            | P                |
| 465             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2487                 | 0.248           | 0.0007         | 0.0045               | 0.0052   |            | P                |
|                 | 0.4593                 | 0.460           | -0.0007        | 0.0045               | 0.0038   |            | P                |
|                 | 0.9322                 | 0.932           | 0.0002         | 0.0045               | 0.0047   |            | P                |
| 546.1           | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2434                 | 0.243           | 0.0004         | 0.0045               | 0.0049   |            | P                |
|                 | 0.4649                 | 0.465           | -0.0001        | 0.0045               | 0.0044   |            | P                |
|                 | 0.9457                 | 0.944           | 0.0017         | 0.0045               | 0.0062   |            | P                |
| 590             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2570                 | 0.257           | 0.0000         | 0.0045               | 0.0045   |            | P                |
|                 | 0.5035                 | 0.503           | 0.0005         | 0.0045               | 0.0050   |            | P                |
|                 | 1.0022                 | 1.000           | 0.0022         | 0.0045               | 0.0067   |            | P                |
| wavelength (nm) | standard Absorbance(A) | UUC Reading (A) | Correction (A) | Uncertainty [U] ±(A) | G+U ±(A) | เกณฑ์ ±(A) | Pass (P)/Fail(F) |
| 635             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2560                 | 0.256           | 0.0000         | 0.0045               | 0.0045   |            | P                |
|                 | 0.4968                 | 0.496           | 0.0008         | 0.0045               | 0.0053   |            | P                |
|                 | 0.9713                 | 0.969           | 0.0023         | 0.0045               | 0.0068   |            | P                |



## Verify Record

Instrument Name : Spectrophotometer ID No. : CL\_SP\_02 Calibration date : 20-Oct-22

|     |        |        |         |        |        |      |   |
|-----|--------|--------|---------|--------|--------|------|---|
| 253 | 0.0000 | 0.0000 | 0.0000  | 0.0080 | 0.0080 | 0.02 | P |
|     | 0.7361 | 0.7360 | 0.0001  | 0.0080 | 0.0081 |      | P |
| 257 | 0.0000 | 0.0000 | 0.0000  | 0.0080 | 0.0080 | 0.02 | P |
|     | 0.8585 | 0.8540 | 0.0045  | 0.0080 | 0.0125 |      | P |
| 313 | 0.0000 | 0.0000 | 0.0000  | 0.0080 | 0.0080 | 0.02 | P |
|     | 0.2861 | 0.2910 | -0.0049 | 0.0080 | 0.0031 |      | P |
| 350 | 0.0000 | 0.0000 | 0.0000  | 0.0080 | 0.0080 | 0.02 | P |
|     | 0.6378 | 0.6320 | 0.0058  | 0.0080 | 0.0138 |      | P |

### Stray light\*

| Standard cut-off | UUC Reading     | UUC Reading  | Absorbance |
|------------------|-----------------|--------------|------------|
|                  | wavelength (nm) | Transmission | (A)        |
| 260.67 ± 0.11 nm | 260.7           | 1.7          | 1.770      |
| 391.7 ± 0.11 nm  | 391.7           | 2.4          | 1.620      |

หมายเหตุ เป็นการตรวจวัดค่าแสงที่ผ่านรูในเครื่องที่เป็นรูให้แสงส่องผ่าน ตามใบ Certificate กำหนดเกณฑ์ %T < 1 และ Abs > 2 ที่ 1 nm. (วัดที่ละ 1 wavelength) ดังนั้นกรณีที่ไม่ผ่าน จะกระทบกับการวัดที่ > 1 wave length กรณีวัดที่ละ 1 wave length จะไม่กระทบมากนัก ทั้งนี้ดูผลการสอบเทียบแต่ละ wave length ประกอบการพิจารณา

### Spectral Resolution

| Nominal concentration 0.02% v/v | Peak   | Trough | Ratio | SBW  | Pass (P)/Fail(F) |
|---------------------------------|--------|--------|-------|------|------------------|
| Standard wavelength (nm)        | 268.73 | 266.77 | 1.22  | 2.00 | Pass             |
| UUC:wavelength (nm)             | 268.3  | 266.4  |       |      |                  |
| Std. Absorbance (A)             | 0.4237 | 0.2591 |       |      |                  |
| Absorbance (A)                  | 0.356  | 0.293  |       |      |                  |

หมายเหตุ The spectral bandwidth of Std. at 2 nm and UUC at 2 nm

Certificate No. C06220524

Certificate By DKSH

Report by:  date: 27/12/22

(อดิเรก ชัยพัฒน์วงศ์)

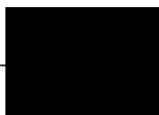
Approved by:  date: 28/12/22

(เบญจมาภรณ์ มาศขาว)

Acknowledge by:

1) ศศิธราภา แก่นจันทร์

:



date: 28/12/22

2) ปานทิพย์ พุ่มพฤกษ์

:

date: 29/12/22

## HACH COMPANY

บริษัท เอบี ซายเอ็กซ์ (ประเทศไทย) จำกัด | อาคาร ดี ห้องเลขที่ ดี 3 11 ชั้นที่ 3 เลขที่ 735/4 ถนนศรีนครินทร์ แขวงพัฒนาการ เขตสวนหลวง กรุงเทพฯ 10250  
C/O AB Sciex (Thailand) Limited | Building D Room No. D3 11, 3<sup>rd</sup> Floor, No. 735/4, Srinakarin Rd., Pattanakarn, Suanluang, Bangkok 10250  
Phone +66 (02) 026-3529 | Fax +66(02) 026-3572 | www.sea.hach.com | Tax ID. 0105552107330

Ref. Job Number ; LABX2202945

### Test Report

|                         |  |                       |            |
|-------------------------|--|-----------------------|------------|
| Customers               | : BETAGRO SCIENCE CENTER CO.,LTD.  |                       |            |
| Equipment               | : Spectrophotometer  | Manufacturer          | : HACH     |
| Controller Model        | : <input type="checkbox"/> DR5000 <input checked="" type="checkbox"/> DR6000 | Controller Serial No. | : 1663352  |
| Date of test            | : 10 Oct 2022  | Period                | : 1/1      |
| Environment temperature | : 24.2 °C  | Humidity              | : 62.6 %RH |

### Results

#### Instrument Checked

| Item | Characteristic                    | Before   | After  | Remark |
|------|-----------------------------------|--|--|--------|
| 1    | Visual Inspect                    | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail |        |
| 2    | Power Supply ( 200 – 240 VAC )    | 223 VDC  | 223 VDC  |        |
| 3    | Self-Test                         | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail |        |
| 4    | Display and Touch screen Check    | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail |        |
| 5    | Battery Backup Test ( >2.85 VDC ) | 3.034 VDC  | 3.034 VDC  |        |
| 6    | Barcode Test                      | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail |        |
| 7    | Lamp Halogen Test                 | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail |        |
| 8    | Lamp Deuterium Test               | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail |        |

#### Warning and Error Checked

| Item | Event      | Before   | After  |
|------|------------|--|--|
| 9    | Error list | <input checked="" type="checkbox"/> None<br><input type="checkbox"/> _____ | <input checked="" type="checkbox"/> None<br><input type="checkbox"/> _____ |

#### Check with Standard

| Item | Characteristic                                | Before    | After     | Remark |
|------|---|-----------|-----------|--------|
| 10   | Blank ( 0.000 ABS )                           | 0.000 ABS | 0.000 ABS |        |
| 11   | Wave Length 420 nm ( 0.547 ± 0.050 ABS ) STD1 | 0.548 ABS | 0.550 ABS |        |
| 12   | Wave Length 520 nm ( 0.569 ± 0.050 ABS ) STD1 | 0.562 ABS | 0.564 ABS |        |
| 13   | Wave Length 560 nm ( 0.588 ± 0.050 ABS ) STD1 | 0.581 ABS | 0.582 ABS |        |
| 14   | Wave Length 610 nm ( 0.550 ± 0.050 ABS ) STD1 | 0.548 ABS | 0.548 ABS |        |
| 15   | Wave Length 420 nm ( 1.119 ± 0.100 ABS ) STD2 | 1.110 ABS | 1.110 ABS |        |
| 16   | Wave Length 520 nm ( 1.158 ± 0.100 ABS ) STD2 | 1.136 ABS | 1.137 ABS |        |
| 17   | Wave Length 560 nm ( 1.193 ± 0.100 ABS ) STD2 | 1.176 ABS | 1.176 ABS |        |
| 18   | Wave Length 610 nm ( 1.120 ± 0.100 ABS ) STD2 | 1.110 ABS | 1.110 ABS |        |
| 19   | Wave Length 420 nm ( 1.739 ± 0.150 ABS ) STD3 | 1.723 ABS | 1.730 ABS |        |
| 20   | Wave Length 520 nm ( 1.777 ± 0.150 ABS ) STD3 | 1.755 ABS | 1.757 ABS |        |
| 21   | Wave Length 560 nm ( 1.844 ± 0.150 ABS ) STD3 | 1.817 ABS | 1.815 ABS |        |
| 22   | Wave Length 610 nm ( 1.731 ± 0.150 ABS ) STD3 | 1.717 ABS | 1.720 ABS |        |

#### Summary of checked

- ☒ The instrument can work normally and efficiently. (เครื่องมือวัดสามารถทำงานได้ปกติและมีประสิทธิภาพ)  
☐ The instrument can work but it's requiring to maintenance. (เครื่องมือวัดสามารถทำงานได้แต่ต้องบำรุงรักษา)  
☐ The instrument could not work it's requiring to repair. (เครื่องมือวัดไม่สามารถทำงานได้และต้องการซ่อมบำรุง)



## HACH COMPANY

บริษัท เอบี ซายเอ็กซ์ (ประเทศไทย) จำกัด | อาคาร ดี ห้องเลขที่ ดี 3 11 ชั้นที่ 3 เลขที่ 735/4 ถนนศรีนครินทร์ แขวงพัฒนาการ เขตสวนหลวง กรุงเทพฯ 10250  
C/O AB Sciex (Thailand) Limited | Building D Room No. D3 11, 3<sup>rd</sup> Floor, No. 735/4, Srinakarin Rd., Pattanakarn, Suanluang, Bangkok 10250  
Phone +66 (02) 026-3529 | Fax +66(02) 026-3572 | www.sea.hach.com | Tax ID. 0105552107330

Ref. Job Number ; LABX2202945

### Standard Equipment Used

| Equipment           | Equipment I.D. |                      |
|---------------------|----------------|----------------------|
| Standard Absorbance | Lot No. A2181  | Exp date : Jul-24    |
| Digital multi meter | S/N : 23452230 | Due date : 17-Aug-23 |
| Thermo hygrometer   | S/N : 45146335 | Due date : 17-Aug-23 |

Test By :

[Redacted Signature]

( Mr. Monthian Boonchaiwattana )

Position : Service Engineer Section Head

Approved by :

[Redacted Signature]

( Mr. Suanun Sartyangkool )

Position : Assistant Service Division Manager



Be Right™



## Certificate of Calibration

**Equipment:** SPECTROPHOTOMETER  
**Model:** DR6000  
**Serial No. (or ID.):** 1663352 (CL\_SP\_02)  
**Manufacturer:** HACH  
**Condition:** In Condition

**Certificate No.:** C06220524  
**Issued Date:** 22 October 2022  
**Job No.:** KSPR2213183  
**Page:** 1 of 3

**Customer:** BETAGRO SCIENCE CENTER CO., LTD.  
219 Moo 1, Tambon Chongsarika,  
Amphur Pattananikom, Lopburi 15220 Thailand

**Environment Condition:** Temperature 24.6 °C ± 0.2 °C  
Humidity 62.5 %RH ± 2.1 %RH

**Calibration Place:** BETAGRO SCIENCE CENTER CO., LTD. ( Water Testing )  
219 Moo 1, Tambon Chongsarika,  
Amphur Pattananikom, Lopburi 15220 Thailand

**Calibration By:** Mr.Preecha Phooarsai

**Calibration Date:** 20 October 2022

**The Method used:** In house method, CAL-WI-24, base on ASTM E 275-08 and ASTM E 387-04

**Traceability:** This certificate is traceable to the CRM maintained by National Institute of Standards and Technology (NIST) through Sarna Scientific Limited.

The standard for Wavelength Certificate No. 97349 and 97350

The standard for Photometric Certificate No. 9112739 and 103073

The standard for Stray light Certificate No. 103141 and 103142

The standard for Spectral resolution Certificate No. 103140

(Mr. Preecha Phooarsai)

Person in charge

(Mr. Thalemgkeat POUNGNGAM)

Authorized signatory

This certificate is issued the units of measurement according to the International System of Units (SI). It provides traceability of measurement to International or national standard or other recognized national standard laboratories.

The measurement uncertainty stated is the expanded uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor ( $k=2$ ) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM).

These results may be affected by deviations from specified conditions. The results relate only to the items tested, calibrated or sampled. The report shall not be reproduced except in full without approval of DKSH Technology Limited.

บริษัท ดีเคเอสเอช เทคโนโลยี จำกัด  
DKSH Technology Limited  
2533 ถนนสุขุมวิท แขวงบางจาก เขตพระโขนง กรุงเทพมหานคร 10260  
2533 Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260  
Phone: +66 2639 7000 Email: info.calibration@dksh.com Website: www.dksh.com/scientific-thailand

Delivering Growth – in Asia and Beyond.

CAL-FM-C06-15: 12 Sep 2022

**Calibration Results:**
**Without Adjustment**
**Wavelength Accuracy (nm), The spectral bandwidth of Std at 2 nm and UUC at 2 nm**

| Standard Wavelength | Unit Under Calibration | Correction | Uncertainty |
|---------------------|------------------------|------------|-------------|
| 418.61              | 418.1                  | 0.51       | 0.13        |
| 536.66              | 536.5                  | 0.16       | 0.13        |
| 637.98              | 637.9                  | 0.08       | 0.13        |
| 748.48              | 748.3                  | 0.18       | 0.13        |
| 807.03              | 807.0                  | 0.03       | 0.13        |

**Photometric Accuracy (Absorbance)**

| Wavelength | Standard absorbance | Unit Under Calibration | Correction | Uncertainty |
|------------|---------------------|------------------------|------------|-------------|
| 420 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2899              | 0.288                  | 0.0019     | 0.0045      |
|            | 0.5170              | 0.516                  | 0.0010     | 0.0045      |
|            | 1.0286              | 1.026                  | 0.0026     | 0.0045      |
| 440 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2837              | 0.283                  | 0.0007     | 0.0045      |
|            | 0.5074              | 0.507                  | 0.0004     | 0.0045      |
|            | 1.0071              | 1.006                  | 0.0011     | 0.0045      |
| 465 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2487              | 0.248                  | 0.0007     | 0.0045      |
|            | 0.4593              | 0.460                  | -0.0007    | 0.0045      |
|            | 0.9322              | 0.932                  | 0.0002     | 0.0045      |
| 546.1 nm   | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2434              | 0.243                  | 0.0004     | 0.0045      |
|            | 0.4649              | 0.465                  | -0.0001    | 0.0045      |
|            | 0.9457              | 0.944                  | 0.0017     | 0.0045      |
| 590 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2570              | 0.257                  | 0.0000     | 0.0045      |
|            | 0.5035              | 0.503                  | 0.0005     | 0.0045      |
|            | 1.0022              | 1.000                  | 0.0022     | 0.0045      |
| 635 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2560              | 0.256                  | 0.0000     | 0.0045      |
|            | 0.4968              | 0.496                  | 0.0008     | 0.0045      |
|            | 0.9713              | 0.969                  | 0.0023     | 0.0045      |

บริษัท ดีเคเอสเอช เทคโนโลยี จำกัด  
 DKSH Technology Limited  
 2533 ถนนสุขุมวิท แขวงบางจาก เขตพระโขนง กรุงเทพมหานคร 10260  
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 Phone: +66 2639 7000 Email: info.calibration@dksh.com Website: www.dksh.com/scientific-thailand

Delivering Growth – in Asia and Beyond.

CAL-FM-C06-15: 12 Sep 2022



## ใบตรวจสอบสภาพเครื่องวัดสิ่งแวดล้อม

เลขที่ใบงาน: KSPR2213183

ชนิดเครื่องมือ: SPECTROPHOTOMETER

รุ่น: DR6000

หมายเลขเครื่อง: 1663352

| ตรวจสอบ (รับ)                       |                          | รายการตรวจเช็ค                                    | ตรวจสอบ (ส่ง)                       |                          | หมายเหตุ                            |
|-------------------------------------|--------------------------|---|-------------------------------------|--------------------------|-------------------------------------|
| 20 Oct 2022                         |                          |   | 20 Oct 2022                         |                          |                                     |
| ปกติ                                | ไม่ปกติ                  |   | ปกติ                                | ไม่ปกติ                  |                                     |
|                                     |                          | General   |                                     |                          |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 1. ความสมบูรณ์เครื่อง                             | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 2. ความสะอาด ( ช่องใส่ตัวอย่าง, ภายใน-นอกเครื่อง) | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 3. สวิตช์ ปิด – เปิด เครื่อง (On-Off Swicth)      | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 4. ปุ่มกด (Keypad)                                | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 5. หน้าจอ (Display, Screen Contrast)              | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
|                                     |                          | Spectrophotometer                                 |                                     |                          |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 6. แรงดันไฟฟ้า (Battery Backup) >= 2.5 VDC        | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 7. ตัวหมุนเลือกความยาวคลื่น (Wavelength Control)  | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 8. ความยาวคลื่น (Wavelength Check)                | <input checked="" type="checkbox"/> | <input type="checkbox"/> | 656.1nm=656.0nm,<br>486.0nm=485.7nm |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 9. แหล่งกำเนิดแสง (UV < 3,000 hour)               | <input checked="" type="checkbox"/> | <input type="checkbox"/> | 214.9 Hours                         |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 10. แหล่งกำเนิดแสง (Visible < 5,000 hour)         | <input checked="" type="checkbox"/> | <input type="checkbox"/> | 202.6 Hours                         |
| <input type="checkbox"/>            | <input type="checkbox"/> | 11. ช่องวัดหลายตัวอย่าง (Carousel Module)         | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
|                                     |                          | pH Meter and Conductivity Meter                   |                                     |                          |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 12. อิเล็กโทรด ( Electrode and Connection Cable ) | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 13. ระดับสารละลายใน Electrode (Level KCl )        | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 14. ฝาปิดกันปลาย Electrode (Dust Protection Hood) | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 15. ขาจับอิเล็กโทรด (Stand)                       | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
|                                     |                          | Turbidimeter                                      |                                     |                          |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 16. ค่าความขุ่นที่ต่ำสุด (No Sample)              | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 17. ระดับการส่องสว่างของแสง (>= 2.5 ไม่นเกิน 3.0) | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
|                                     |                          | Automatic titrator                                |                                     |                          |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 18. สภาพ Piston Burettes                          | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 19. Function Rinsing and Dosing                   | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 20. ระบบท่อสายยางและอุปกรณ์ประกอบ                 | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |

เพิ่มเติม/ข้อแนะนำ :

Mr.Preecha Phooarsai

Service Engineer

## ประเมินประสิทธิภาพเครื่องมือ

☐ Calibration
 ☐ Verification
 ☒ Preventive Maintenance
 ☐ Other.....

Instrument Name : UV/Vis Spectrophotometer ID No. : CL-SP-03 S/N. : 1743215  
 Service No.: LABX2202636 Service by.: HACH Issue date: 10 Oct 2022

Instrument checked :

| Item | Characteristic                    | Before    | After     | Remark |
|------|-----------------------------------|-----------|-----------|--------|
|      |                                   | Pass/Fail | Pass/Fail |        |
| 1    | Visual Inspect                    | Pass      | Pass      |        |
| 2    | Power Supply ( 200 - 240 VAC)     | Pass      | Pass      |        |
| 3    | Self Test                         | Pass      | Pass      |        |
| 4    | Display and Touch screen Check    | Pass      | Pass      |        |
| 5    | Battery Backup Test ( >2.85 VDC ) | Pass      | Pass      |        |
| 6    | Barcode Test                      | Pass      | Pass      |        |
| 7    | Lamp Halogen test                 | Pass      | Pass      |        |
| 8    | Lamp Deuterium test               | Pass      | Pass      |        |

Instrument checked :

| Item | Event      | Before | After | Remark |
|------|------------|--------|-------|--------|
| 9    | Error list | none   | none  |        |
|      |            |        |       |        |

Instrument checked :

| Item | Characteristic                               | Before (ABS) | After (ABS) | Remark |
|------|--|--------------|-------------|--------|
| 10   | Blank (0.000 ABS)                            | 0.000        | 0.000       |        |
| 11   | Wave Length 420 nm (0.547 ± 0.050 ABS) STD_1 | 0.545        | 0.549       |        |
| 12   | Wave Length 520 nm (0.569 ± 0.050 ABS) STD_1 | 0.559        | 0.563       |        |
| 13   | Wave Length 560 nm (0.588 ± 0.050 ABS) STD_1 | 0.579        | 0.581       |        |
| 14   | Wave Length 610 nm (0.550 ± 0.050 ABS) STD_1 | 0.550        | 0.550       |        |
| 15   | Wave Length 420 nm (1.119 ± 0.100 ABS) STD_2 | 1.105        | 1.114       |        |
| 16   | Wave Length 520 nm (1.158 ± 0.100 ABS) STD_2 | 1.130        | 1.139       |        |
| 17   | Wave Length 560 nm (1.193 ± 0.100 ABS) STD_2 | 1.171        | 1.177       |        |
| 18   | Wave Length 610 nm (1.120 ± 0.100 ABS) STD_2 | 1.114        | 1.177       |        |
| 19   | Wave Length 420 nm (1.739 ± 0.150 ABS) STD_3 | 1.721        | 1.731       |        |
| 20   | Wave Length 520 nm (1.777 ± 0.150 ABS) STD_3 | 1.754        | 1.766       |        |
| 21   | Wave Length 560 nm (1.844 ± 0.150 ABS) STD_3 | 1.816        | 1.825       |        |
| 22   | Wave Length 610 nm (1.731 ± 0.150 ABS) STD_3 | 1.730        | 1.733       |        |
|      |  |              |             |        |

## ประเมินประสิทธิภาพเครื่องมือ

☐ Calibration
 ☐ Verification
 ☒ Preventive Maintenance
 ☐ Other.....

 Instrument Name : UV/Vis Spectrophotometer

 ID No. : CL-SP-03

 S/N. : 1743215

 Service No.: LABX2202636

 Service by.: HACH Issue date: 10 Oct 2022

Instrument checked :

| Standard Equipment Used |                |                      |
|-------------------------|----------------|----------------------|
| Equipment               | Equipment I.D. |                      |
| Standard Absorbance     | Lot No. A2181  | Exp date : Jul-24    |
| Digital multi meter     | S/N : 23452230 | Due date : 17-Aug-23 |
| Thermo Hygrometer       | S/N : 4514635  | Due date : 17-Aug-23 |
|                         |                |                      |

 Report by: [Signature] date: 28/12/22  
 (อติเรก ชิมพัฒน์วงศ์)

 Approved by: [Signature] date: 28/12/22  
 (เบญจมาภรณ์ มาศขาว)

Acknowledge by:

1) ศศิอาภา แก่นจันทร์

 : [Signature] date: 28/12/22

2) ปานทิพย์ พุ่มพฤษ

 : [Signature] date: 28/12/22

## Verify Record

Instrument Name : Spectrophotometer

ID No. : CL\_SP\_03

Calibration date : 20-Oct-22

### Wavelength Accuracy

| standard wavelength (nm) | UUC Reading (nm) | Correction (nm) | Uncertainty [U] ±(nm) | C+U ±(nm) | เกณฑ์ ±(nm) | Pass (P)/Fail(F) |
|--------------------------|------------------|-----------------|-----------------------|-----------|-------------|------------------|
| 418.61                   | 418.1            | 0.51            | 0.13                  | 0.64      | 2.0         | P                |
| 536.66                   | 536.5            | 0.16            | 0.13                  | 0.29      |             | P                |
| 637.98                   | 637.9            | 0.08            | 0.13                  | 0.21      |             | P                |
| 748.48                   | 748.3            | 0.18            | 0.13                  | 0.31      |             | P                |
| 807.03                   | 807.0            | 0.03            | 0.13                  | 0.16      |             | P                |

### Photometric Accuracy (Absorbance)

| wavelength (nm) | standard Absorbance(A) | UUC Reading (A) | Correction (A) | Uncertainty [U] ±(A) | C+U ±(A) | เกณฑ์ ±(A) | Pass (P)/Fail(F) |
|-----------------|------------------------|-----------------|----------------|----------------------|----------|------------|------------------|
| 420             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2899                 | 0.288           | 0.0019         | 0.0045               | 0.0064   |            | P                |
|                 | 0.5170                 | 0.516           | 0.0010         | 0.0045               | 0.0055   |            | P                |
|                 | 1.0286                 | 1.027           | 0.0016         | 0.0045               | 0.0061   |            | P                |
| 440             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2837                 | 0.283           | 0.0007         | 0.0045               | 0.0052   |            | P                |
|                 | 0.5074                 | 0.507           | 0.0004         | 0.0045               | 0.0049   |            | P                |
|                 | 1.0071                 | 1.006           | 0.0011         | 0.0045               | 0.0056   |            | P                |
| 465             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2487                 | 0.249           | -0.0003        | 0.0045               | 0.0042   |            | P                |
|                 | 0.4593                 | 0.460           | -0.0007        | 0.0045               | 0.0038   |            | P                |
|                 | 0.9322                 | 0.932           | 0.0002         | 0.0045               | 0.0047   |            | P                |
| 546.1           | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2434                 | 0.244           | -0.0006        | 0.0045               | 0.0039   |            | P                |
|                 | 0.4649                 | 0.465           | -0.0001        | 0.0045               | 0.0044   |            | P                |
|                 | 0.9457                 | 0.944           | 0.0017         | 0.0045               | 0.0062   |            | P                |
| 590             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2570                 | 0.257           | 0.0000         | 0.0045               | 0.0045   |            | P                |
|                 | 0.5035                 | 0.503           | 0.0005         | 0.0045               | 0.0050   |            | P                |
|                 | 1.0022                 | 1.000           | 0.0022         | 0.0045               | 0.0067   |            | P                |
| wavelength (nm) | standard Absorbance(A) | UUC Reading (A) | Correction (A) | Uncertainty [U] ±(A) | C+U ±(A) | เกณฑ์ ±(A) | Pass (P)/Fail(F) |
| 635             | 0.0000                 | 0.000           | 0.0000         | 0.0045               | 0.0045   | 0.02       | P                |
|                 | 0.2560                 | 0.256           | 0.0000         | 0.0045               | 0.0045   |            | P                |
|                 | 0.4968                 | 0.496           | 0.0008         | 0.0045               | 0.0053   |            | P                |
|                 | 0.9713                 | 0.969           | 0.0023         | 0.0045               | 0.0068   |            | P                |

## Verify Record

Instrument Name : Spectrophotometer      ID No. : CL\_SP\_03      Calibration date : 20-Oct-22

|     |        |       |         |        |        |      |   |
|-----|--------|-------|---------|--------|--------|------|---|
| 253 | 0.0000 | 0.000 | 0.0000  | 0.0080 | 0.0080 | 0.02 | P |
|     | 0.7361 | 0.737 | -0.0009 | 0.0080 | 0.0071 |      | P |
| 257 | 0.0000 | 0.000 | 0.0000  | 0.0080 | 0.0080 | 0.02 | P |
|     | 0.8585 | 0.855 | 0.0035  | 0.0080 | 0.0115 |      | P |
| 313 | 0.0000 | 0.000 | 0.0000  | 0.0080 | 0.0080 | 0.02 | P |
|     | 0.2861 | 0.290 | -0.0039 | 0.0080 | 0.0041 |      | P |
| 350 | 0.0000 | 0.000 | 0.0000  | 0.0080 | 0.0080 | 0.02 | P |
|     | 0.6378 | 0.634 | 0.0038  | 0.0080 | 0.0118 |      | P |

### Stray light\*

| Standard cut-off | UUC Reading     | UUC Reading  | Absorbance |
|------------------|-----------------|--------------|------------|
|                  | wavelength (nm) | Transmission | (A)        |
| 260.67 ± 0.11 nm | 260.7           | 1.4          | 1.854      |
| 391.7 ± 0.11 nm  | 391.7           | 1.8          | 1.745      |

หมายเหตุ เป็นการตรวจวัดค่าแสงที่ผ่านรูในเครื่องที่เป็นรูให้แสงส่องผ่าน ตามใบ Certificate กำหนดเกณฑ์ %T < 1 และ Abs > 2 ที่ 1 nm. (วัดทีละ 1 wavelength) ดังนั้นกรณีที่ไม่ผ่าน จะกระทบกับการวัดที่ > 1 wave length กรณีวัดทีละ 1 wave length จะไม่กระทบมากนัก ทั้งนี้ดูผลการสอบเทียบแต่ละ wave length ประกอบการพิจารณา

### Spectral Resolution

| Nominal concentration 0.02% v/v | Peak   | Trough | Ratio | SBW  | Pass (P)/Fail (F) |
|---------------------------------|--------|--------|-------|------|-------------------|
| Standard wavelength (nm)        | 268.73 | 266.77 | 1.38  | 2.00 | Pass              |
| UUC:wavelength (nm)             | 268.3  | 266.4  |       |      |                   |
| Std. Absorbance (A)             | 0.4237 | 0.2591 |       |      |                   |
| Absorbance (A)                  | 0.384  | 0.279  |       |      |                   |

หมายเหตุ The spectral bandwidth of Std. at 2 nm and UUC at 2 nm

Certificate No. C06220525

Certificate By DKSH

Report by:  date: 27/12/22

(อดิเรก จัฒพัฒน์วงศ์)

Approved by:  date: 28/12/22

(เบญจมาภรณ์ มาศขาว)

Acknowledge by:

1) ศศิอาภา แก่นจันทร์

:  date: 28/12/22

2) ปานทิพย์ พุ่มพฤษ

:  date: 29/12/22



## HACH COMPANY

บริษัท เอบี ซาไบเอ็กซ์ (ประเทศไทย) จำกัด | อาคาร ดี ห้องเลขที่ ดี 3 11 ชั้นที่ 3 เลขที่ 735/4 ถนนศรีนครินทร์ แขวงพัฒนาการ เขตสวนหลวง กรุงเทพฯ 10250  
C/O AB Sciex (Thailand) Limited | Building D Room No. D3 11, 3<sup>rd</sup> Floor, No. 735/4, Srinakarin Rd., Pattanakarn, Suanluang, Bangkok 10250  
Phone +66 (02) 026-3529 | Fax +66(02) 026-3572 | www.sea.hach.com | Tax ID. 0105552107330

Ref. Job Number ; LABX2202636

### Test Report

|                         |  |                       |            |
|-------------------------|--|-----------------------|------------|
| Customers               | : BETAGRO SCIENCE CENTER CO.,LTD.  |                       |            |
| Equipment               | : Spectrophotometer  | Manufacturer          | : HACH     |
| Controller Model        | : <input type="checkbox"/> DR5000 <input checked="" type="checkbox"/> DR6000 | Controller Serial No. | : 1743215  |
| Date of test            | : 10 Oct 2022  | Period                | : 1/1      |
| Environment temperature | : 26.4 °C  | Humidity              | : 56.1 %RH |

### Results

#### Instrument Checked

| Item | Characteristic                    | Before                                   |                               | After                                    |                               | Remark |
|------|-----------------------------------|--|-------------------------------|--|-------------------------------|--------|
| 1    | Visual Inspect                    | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail |        |
| 2    | Power Supply ( 200 – 240 VAC )    | 225 VDC                                  |                               | 225 VDC                                  |                               |        |
| 3    | Self-Test                         | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail |        |
| 4    | Display and Touch screen Check    | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail |        |
| 5    | Battery Backup Test ( >2.85 VDC ) | 3.027 VDC                                |                               | 3.027 VDC                                |                               |        |
| 6    | Barcode Test                      | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail |        |
| 7    | Lamp Halogen Test                 | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail |        |
| 8    | Lamp Deuterium Test               | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail | <input checked="" type="checkbox"/> Pass | <input type="checkbox"/> Fail |        |

#### Warning and Error Checked

| Item | Event      | Before                                   |  | After                                    |  |
|------|------------|--|--|--|--|
| 9    | Error list | <input checked="" type="checkbox"/> None |  | <input checked="" type="checkbox"/> None |  |
|      |            | <input type="checkbox"/>                 |  | <input type="checkbox"/>                 |  |

#### Check with Standard

| Item | Characteristic                                | Before    |  | After     |  | Remark |
|------|---|-----------|--|-----------|--|--------|
| 10   | Blank ( 0.000 ABS )                           | 0.000 ABS |  | 0.000 ABS |  |        |
| 11   | Wave Length 420 nm ( 0.547 ± 0.050 ABS ) STD1 | 0.545 ABS |  | 0.549 ABS |  |        |
| 12   | Wave Length 520 nm ( 0.569 ± 0.050 ABS ) STD1 | 0.559 ABS |  | 0.563 ABS |  |        |
| 13   | Wave Length 560 nm ( 0.588 ± 0.050 ABS ) STD1 | 0.579 ABS |  | 0.581 ABS |  |        |
| 14   | Wave Length 610 nm ( 0.550 ± 0.050 ABS ) STD1 | 0.550 ABS |  | 0.550 ABS |  |        |
| 15   | Wave Length 420 nm ( 1.119 ± 0.100 ABS ) STD2 | 1.105 ABS |  | 1.114 ABS |  |        |
| 16   | Wave Length 520 nm ( 1.158 ± 0.100 ABS ) STD2 | 1.130 ABS |  | 1.139 ABS |  |        |
| 17   | Wave Length 560 nm ( 1.193 ± 0.100 ABS ) STD2 | 1.171 ABS |  | 1.177 ABS |  |        |
| 18   | Wave Length 610 nm ( 1.120 ± 0.100 ABS ) STD2 | 1.114 ABS |  | 1.117 ABS |  |        |
| 19   | Wave Length 420 nm ( 1.739 ± 0.150 ABS ) STD3 | 1.721 ABS |  | 1.731 ABS |  |        |
| 20   | Wave Length 520 nm ( 1.777 ± 0.150 ABS ) STD3 | 1.754 ABS |  | 1.766 ABS |  |        |
| 21   | Wave Length 560 nm ( 1.844 ± 0.150 ABS ) STD3 | 1.816 ABS |  | 1.825 ABS |  |        |
| 22   | Wave Length 610 nm ( 1.731 ± 0.150 ABS ) STD3 | 1.730 ABS |  | 1.733 ABS |  |        |

#### Summary of checked

- ☒ The instrument can work normally and efficiently. (เครื่องมือวัดสามารถทำงานได้ปกติและมีประสิทธิภาพ)  
☐ The instrument can work but it's requiring to maintenance. (เครื่องมือวัดสามารถทำงานได้แต่ต้องบำรุงรักษา)  
☐ The instrument could not work it's requiring to repair. (เครื่องมือวัดไม่สามารถทำงานได้และต้องการซ่อมบำรุง)



## HACH COMPANY

บริษัท เอบี ซายเอกซ์ (ประเทศไทย) จำกัด | อาคาร ดี ห้องเลขที่ ดี 3 11 ชั้นที่ 3 เลขที่ 735/4 ถนนศรีนครินทร์ แขวงพัฒนาการ เขตสวนหลวง กรุงเทพฯ 10250  
C/O AB Sciex (Thailand) Limited | Building D Room No. D3 11, 3<sup>rd</sup> Floor, No. 735/4, Srinakarin Rd., Pattanakarn, Suanluang, Bangkok 10250  
Phone +66 (02) 026-3529 | Fax +66(02) 026-3572 | [www.sea.hach.com](http://www.sea.hach.com) | Tax ID. 0105552107330

Ref. Job Number ; LABX2202636

### Standard Equipment Used

| Equipment           | Equipment I.D. |                      |
|---------------------|----------------|----------------------|
| Standard Absorbance | Lot No. A2181  | Exp date : Jul-24    |
| Digital multi meter | S/N : 23452230 | Due date : 17-Aug-23 |
| Thermo hygrometer   | S/N : 45146335 | Due date : 17-Aug-23 |

Test By :

[Redacted Signature]

( Mr. Monthian Boonchaiwattana )

Position :

Service Engineer Section Head

Approved by :

[Redacted Signature]

( Mr. Suanun Sartyangkool )

Position :

Assistant Service Division Manager



Be Right™



## Certificate of Calibration

**Equipment:** SPECTROPHOTOMETER  
**Model:** DR6000  
**Serial No. (or ID.):** 1743215 (CL\_SP\_03)  
**Manufacturer:** HACH  
**Condition:** In Condition

**Certificate No.:** C06220525  
**Issued Date:** 22 October 2022  
**Job No.:** KSPR2213184  
**Page:** 1 of 3

**Customer:** BETAGRO SCIENCE CENTER CO., LTD.  
219 Moo 1, Tambon Chongsarika,  
Amphur Pattananikom, Lopburi 15220 Thailand

**Environment Condition:** Temperature 24.7 °C ± 0.2 °C  
Humidity 62.8 %RH ± 2.7 %RH

**Calibration Place:** BETAGRO SCIENCE CENTER CO., LTD. ( Water Testing )  
219 Moo 1, Tambon Chongsarika,  
Amphur Pattananikom, Lopburi 15220 Thailand

**Calibration By:** Mr.Preecha Phooarsai

**Calibration Date:** 20 October 2022

**The Method used:** In house method, CAL-WI-24, base on ASTM E 275-08 and ASTM E 387-04


**Traceability:** This certificate is traceable to the CRM maintained by National Institute of Standards and Technology (NIST) through Sarna Scientific Limited.

The standard for Wavelength Certificate No. 97349 and 97350

The standard for Photometric Certificate No. 9112739 and 103073

The standard for Stray light Certificate No. 103141 and 103142

The standard for Spectral resolution Certificate No. 103140

  
(Mr. Preecha Phooarsai)

Person in charge

  
(Mr. Thalemgkeat Pongngam)

Authorized signatory

This certificate is issued the units of measurement according to the International System of Units (SI). It provides traceability of measurement to international or national standard or other recognized national standard laboratories.

The measurement uncertainty stated is the expanded uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor ( $k=2$ ) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM).

These results may be affected by deviations from specified conditions. The results relate only to the items tested, calibrated or sampled. The report shall not be reproduced except in full without approval of DKSH Technology Limited.

บริษัท ดีเคเอสเอช เทคโนโลยี จำกัด

DKSH Technology Limited

2533 ถนนสุขุมวิท แขวงบางจาก เขตพระโขนง กรุงเทพมหานคร 10260

2533 Sukhumvit Road, Bangchak, Phraekhanong, Bangkok 10260

Phone: +66 2639 7000 Email: info.calibration@dksh.com Website: www.dksh.com/scientific-thailand

Delivering Growth - in Asia and Beyond.

CAL-FM-C06-15: 12 Sep 2022

**Calibration Results:**
**Without Adjustment**

**Wavelength Accuracy (nm), The spectral bandwidth of Std at 2 nm and UUC at 2 nm**

| Standard Wavelength | Unit Under Calibration | Correction | Uncertainty |
|---------------------|------------------------|------------|-------------|
| 418.61              | 418.3                  | 0.31       | 0.13        |
| 536.66              | 536.3                  | 0.36       | 0.13        |
| 637.98              | 637.4                  | 0.58       | 0.13        |
| 748.48              | 748.2                  | 0.28       | 0.13        |
| 807.03              | 806.7                  | 0.33       | 0.13        |

**Photometric Accuracy (Absorbance)**

| Wavelength | Standard absorbance | Unit Under Calibration | Correction | Uncertainty |
|------------|---------------------|------------------------|------------|-------------|
| 420 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2899              | 0.288                  | 0.0019     | 0.0045      |
|            | 0.5170              | 0.516                  | 0.0010     | 0.0045      |
|            | 1.0286              | 1.027                  | 0.0016     | 0.0045      |
| 440 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2837              | 0.283                  | 0.0007     | 0.0045      |
|            | 0.5074              | 0.507                  | 0.0004     | 0.0045      |
|            | 1.0071              | 1.006                  | 0.0011     | 0.0045      |
| 465 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2487              | 0.249                  | -0.0003    | 0.0045      |
|            | 0.4593              | 0.460                  | -0.0007    | 0.0045      |
|            | 0.9322              | 0.932                  | 0.0002     | 0.0045      |
| 546.1 nm   | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2434              | 0.244                  | -0.0006    | 0.0045      |
|            | 0.4649              | 0.465                  | -0.0001    | 0.0045      |
|            | 0.9457              | 0.944                  | 0.0017     | 0.0045      |
| 590 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2570              | 0.257                  | 0.0000     | 0.0045      |
|            | 0.5035              | 0.503                  | 0.0005     | 0.0045      |
|            | 1.0022              | 1.000                  | 0.0022     | 0.0045      |
| 635 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0045      |
|            | 0.2560              | 0.256                  | 0.0000     | 0.0045      |
|            | 0.4968              | 0.496                  | 0.0008     | 0.0045      |
|            | 0.9713              | 0.969                  | 0.0023     | 0.0045      |

บริษัท ดีเคเอสเอช เทคโนโลยี จำกัด  
 DKSH Technology Limited  
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 Phone: +66 2639 7000 Email: info.calibration@dksh.com Website: www.dksh.com/scientific-thailand

Delivering Growth – in Asia and Beyond.

CAL-FM-C06-15: 12 Sep 2022

**Calibration Results:**
**Without Adjustment**
**Photometric Accuracy (Absorbance)**

| Wavelength | Standard absorbance | Unit Under Calibration | Correction | Uncertainty |
|------------|---------------------|------------------------|------------|-------------|
| 235 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0080      |
|            | 0.7361              | 0.737                  | -0.0009    | 0.0080      |
| 257 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0080      |
|            | 0.8585              | 0.855                  | 0.0035     | 0.0080      |
| 313 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0080      |
|            | 0.2861              | 0.290                  | -0.0039    | 0.0080      |
| 350 nm     | 0.0000              | 0.000                  | 0.0000     | 0.0080      |
|            | 0.6378              | 0.634                  | 0.0038     | 0.0080      |

**Stray light \***

| Standard: cut-off  | UUC: Wavelength (nm) | UUC: Transmission (%T) | Absorbance (A) |
|--------------------|----------------------|------------------------|----------------|
| 260.67 +/- 0.11 nm | 260.7                | 1.4                    | 1.854          |
| 391.7 +/- 0.11 nm  | 391.7                | 1.8                    | 1.745          |

**Spectral Resolution \***

| Nominal Concentration 0.02 % v/v | Peak   | Trough | Ratio | SBW  |
|----------------------------------|--------|--------|-------|------|
| Standard Wavelength ( nm )       | 268.73 | 266.77 | 1.38  | 2.00 |
| UUC: Wavelength (nm)             | 268.3  | 266.4  |       |      |
| Std Absorbance ( A )             | 0.4237 | 0.2591 |       |      |
| Absorbance ( A )                 | 0.384  | 0.279  |       |      |

\* Calibration Marked " Not TISI Accredited " in this Certificate have been included for completeness.

**The End of Certificate**



## ใบตรวจสอบสภาพเครื่องวัดสิ่งแวดล้อม

เลขที่ใบงาน: KSPR2213184

ชนิดเครื่องมือ: SPECTROPHOTOMETER

รุ่น: DR6000

หมายเลขเครื่อง: 1743215

| ตรวจสอบ (รับ)                       |                          | รายการตรวจเช็ค                                    | ตรวจสอบ (ส่ง)                       |                          | หมายเหตุ                            |
|-------------------------------------|--------------------------|---|-------------------------------------|--------------------------|-------------------------------------|
| 20 Oct 2022                         |                          |   | 20 Oct 2022                         |                          |                                     |
| ปกติ                                | ไม่ปกติ                  |   | ปกติ                                | ไม่ปกติ                  |                                     |
|                                     |                          | General   |                                     |                          |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 1. ความสมบูรณ์เครื่อง                             | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 2. ความสะอาด ( ช่องใส่ตัวอย่าง, ภายใน-นอกเครื่อง) | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 3. สวิตซ์ ปิด – เปิด เครื่อง (On-Off Swicth)      | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 4. ปุ่มกด (Keypad)                                | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 5. หน้าจอ (Display, Screen Contrast)              | <input checked="" type="checkbox"/> | <input type="checkbox"/> |                                     |
|                                     |                          | Spectrophotometer                                 |                                     |                          |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 6. แรงดันไฟฟ้า (Battery Backup) >= 2.5 VDC        | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 7. ตัวหมุนเลือกความยาวคลื่น (Wavelength Control)  | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 8. ความยาวคลื่น (Wavelength Check)                | <input checked="" type="checkbox"/> | <input type="checkbox"/> | 656.1nm=655.7nm,<br>486.0nm=485.7nm |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 9. แหล่งกำเนิดแสง (UV < 3,000 hour)               | <input checked="" type="checkbox"/> | <input type="checkbox"/> | 190.1 Hours                         |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | 10. แหล่งกำเนิดแสง (Visible < 5,000 hour)         | <input checked="" type="checkbox"/> | <input type="checkbox"/> | 75.5 Hours                          |
| <input type="checkbox"/>            | <input type="checkbox"/> | 11. ช่องวัดหลายตัวอย่าง (Carousel Module)         | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
|                                     |                          | pH Meter and Conductivity Meter                   |                                     |                          |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 12. อิเล็กโทรด ( Electrode and Connection Cable ) | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 13. ระดับสารละลายใน Electrode (Level KCl )        | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 14. ฝาปิดกันปลาย Electrode (Dust Protection Hood) | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 15. ขาจับอิเล็กโทรด (Stand)                       | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
|                                     |                          | Turbidimeter                                      |                                     |                          |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 16. ค่าความขุ่นที่ต่ำสุด (No Sample)              | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 17. ระดับการส่องสว่างของแสง (>= 2.5 ไม่นเกิน 3.0) | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
|                                     |                          | Automatic titrator                                |                                     |                          |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 18. สภาพ Piston Burettes                          | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 19. Function Rinsing and Dosing                   | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |
| <input type="checkbox"/>            | <input type="checkbox"/> | 20. ระบบท่อสายยางและอุปกรณ์ประกอบ                 | <input type="checkbox"/>            | <input type="checkbox"/> |                                     |

เพิ่มเติม/ข้อแนะนำ :

Mr.Preecha Phooarsai  
Service Engineer

| ตารางบันทึกผลการทวนสอบปริมาตรเครื่องแก้ว |                              |                       |           |         |   |                        |                     |                |                 | Page: 1/1 |                               |         |
|--|------------------------------|-----------------------|-----------|---------|---|------------------------|---------------------|----------------|-----------------|-----------|-------------------------------|---------|
| Name of Glassware :                      |                              | Glass Burette         |           |         |   |                        | Calibration Range : |                |                 |           | 1 mL                          |         |
| Description :                            | Brand :                      |                       | Witeg     |         |   |                        |                     | Class :        |                 |           |                               | A       |
|  | Capacity :                   |                       | 10 mL     |         |   |                        |                     | Tolerance :    |                 |           |                               | 0.02 mL |
|  | Serial No. :                 |                       | CL-GB10-8 |         |   |                        |                     | 0.98 - 1.02 mL |                 |           |                               |         |
| Measurement data                         |                              |                       |           |         |   |                        |                     |                |                 |           |                               |         |
| Thermometer Serial No.:                  |                              | CL-TH-01              |           |         | Volume of glassware at 20 °C, $V_{20}=(I_L-I_E)Z$ : |                        |                     |                | Verified date : |           | 26/12/2022                    |         |
| Balance Serial No.:                      |                              | 1126481314 (CL_EB_01) |           |         | Capacity :  |                        |                     |                | 220 g           |           |                               |         |
| Room Temperature:                        |                              | 25 °C                 |           |         | Relative Humidity:                                  |                        |                     |                | 54 %            |           | Barometric Pressure: 1004 hPa |         |
| Records :                                | Measured water temp. :       |                       | 23 °C     |         |   | Corrected water temp.: |                     | 23             |                 |           |                               |         |
|  | Z at corrected water temp. : |                       | 1.0035    |         |   |                        |                     |                |                 |           |                               |         |
| Wt. of empty flask ( $I_E$ ),g           | Identification No.           |                       |           |         |   |                        |                     |                |                 |           |                               |         |
|  | 1                            | 2                     | 3         | 4       | 5   | 6                      | 7                   | 8              | 9               | 10        |                               |         |
|  | 36.9345                      | 37.9379               | 38.9321   | 39.9371 | 40.9368   | 41.9319                | 42.9328             | 43.9261        | 44.9240         | 45.9165   |                               |         |
|  | 37.9379                      | 38.9321               | 39.9371   | 40.9368 | 41.9319   | 42.9328                | 43.9261             | 44.9240        | 45.9165         | 46.9149   |                               |         |
|  | 1.0034                       | 0.9942                | 1.0050    | 0.9997  | 0.9951  | 1.0009                 | 0.9933              | 0.9979         | 0.9925          | 0.9984    |                               |         |
|  | 1.0069                       | 0.9977                | 1.0085    | 1.0032  | 0.9986  | 1.0044                 | 0.9968              | 1.0014         | 0.9960          | 1.0019    |                               |         |
| Average volume, mL                       |                              | 1.0015                |           |         | Pass  |                        |                     |                |                 |           |                               |         |
| ผู้ทวนสอบ :                              |                              |                       |           |         | วันที่: 26/12/22                                    |                        |                     |                |                 |           |                               |         |
| ผู้อนุมัติ :                             |                              |                       |           |         | วันที่: 26/12/22                                    |                        |                     |                |                 |           |                               |         |



| ตารางบันทึกผลการทวนสอบปริมาตรเครื่องแก้ว |                              |                       |           |         |         |         |   |                        |         | Page: 1/1       |         |                      |          |
|--|------------------------------|-----------------------|-----------|---------|---------|---------|---|------------------------|---------|-----------------|---------|----------------------|----------|
| Name of Glassware :                      |                              | Glass Burette         |           |         |         |         | Calibration Range :                                 |                        |         |                 | 5 mL    |                      |          |
| Description :                            | Brand :                      |                       | Witeg     |         |         |         |   | Class :                |         |                 |         | A                    |          |
|  | Capacity :                   |                       | 10 mL     |         |         |         |   | Tolerance :            |         |                 |         | 0.02 mL              |          |
|  | Serial No. :                 |                       | CL-GB10-8 |         |         |         |   | 4.98 - 5.02 mL         |         |                 |         |                      |          |
| Measurement data                         |                              |                       |           |         |         |         |   |                        |         |                 |         |                      |          |
| Thermometer Serial No.:                  |                              | CL-TH-01              |           |         |         |         | Volume of glassware at 20 °C, $V_{20}=(I_L-I_E)Z$ : |                        |         | Verified date : |         | 26/12/2022           |          |
| Balance Serial No.:                      |                              | 1126481314 (CL_EB_01) |           |         |         |         | Capacity :  |                        |         | 220 g           |         |                      |          |
| Room Temperature:                        |                              | 25 °C                 |           |         |         |         | Relative Humidity:                                  |                        |         | 54 %            |         | Barometric Pressure: | 1004 hPa |
| Records :                                | Measured water temp. :       |                       | 23 °C     |         |         |         |   | Corrected water temp.: |         |                 | 23      |                      |          |
|  | Z at corrected water temp. : |                       | 1.0035    |         |         |         |   |                        |         |                 |         |                      |          |
|  |                              | Identification No.    |           |         |         |         |   |                        |         |                 |         |                      |          |
|  |                              | 1                     | 2         | 3       | 4       | 5       | 6   | 7                      | 8       | 9               | 10      |                      |          |
| Wt. of empty flask ( $I_E$ ),g           |                              | 37.0117               | 42.0040   | 46.9805 | 51.9713 | 56.9543 | 61.9475   | 66.9311                | 71.9222 | 76.9079         | 81.8986 |                      |          |
| Wt. of flask and water ( $I_L$ ),g       |                              | 42.0040               | 46.9805   | 51.9713 | 56.9543 | 61.9475 | 66.9311   | 71.9222                | 76.9079 | 81.8986         | 86.8864 |                      |          |
| Wt. of water ( $I_L-I_E$ ),g             |                              | 4.9923                | 4.9765    | 4.9908  | 4.9830  | 4.9932  | 4.9836  | 4.9911                 | 4.9857  | 4.9907          | 4.9878  |                      |          |
| Volume of glassware at 20 °C, mL         |                              | 5.0098                | 4.9939    | 5.0083  | 5.0004  | 5.0107  | 5.0010  | 5.0086                 | 5.0031  | 5.0082          | 5.0053  |                      |          |
| Average volume, mL                       |                              | 5.0049 Pass           |           |         |         |         |   |                        |         |                 |         |                      |          |
| ผู้ทวนสอบ :                              |                              |                       |           |         |         |         | วันที่ : 26/12/22                                   |                        |         |                 |         |                      |          |
| ผู้อนุมัติ :                             |                              |                       |           |         |         |         | วันที่ : 26/12/22                                   |                        |         |                 |         |                      |          |

| ตารางบันทึกผลการทวนสอบปริมาตรเครื่องแก้ว |                              |                       |           |         |                   |   |                        |         |                 | Page: 1/1 |                               |
|--|------------------------------|-----------------------|-----------|---------|-------------------|---|------------------------|---------|-----------------|-----------|-------------------------------|
| Name of Glassware :                      |                              | Glass Burette         |           |         |                   | Calibration Range :                                 |                        |         |                 | 10 mL     |                               |
| Description :                            | Brand :                      |                       | Witeg     |         |                   |   | Class :                |         | A               |           |                               |
|  | Capacity :                   |                       | 10 mL     |         |                   |   | Tolerance :            |         | 0.02 mL         |           |                               |
|  | Serial No. :                 |                       | CL-GB10-8 |         |                   |   | 9.98 - 10.02 mL        |         |                 |           |                               |
| Measurement data                         |                              |                       |           |         |                   |   |                        |         |                 |           |                               |
| Thermometer Serial No.:                  |                              | CL-TH-01              |           |         |                   | Volume of glassware at 20 °C, $V_{20}=(I_L-I_E)Z$ : |                        |         | Verified date : |           | 26/12/2022                    |
| Balance Serial No.:                      |                              | 1126481314 (CL_EB_01) |           |         |                   | Capacity :  |                        |         | 220 g           |           |                               |
| Room Temperature:                        |                              | 25 °C                 |           |         |                   | Relative Humidity:                                  |                        |         | 54 %            |           | Barometric Pressure: 1004 hPa |
| Records :                                | Measured water temp. :       |                       | 23 °C     |         |                   |   | Corrected water temp.: |         | 23              |           |                               |
|  | Z at corrected water temp. : |                       | 1.0035    |         |                   |   |                        |         |                 |           |                               |
| Wt. of empty flask ( $I_E$ ),g           | Identification No.           |                       |           |         |                   |   |                        |         |                 |           |                               |
|  | 1                            | 2                     | 3         | 4       | 5                 | 6   | 7                      | 8       | 9               | 10        |                               |
|  | 37.0193                      | 46.9907               | 56.9648   | 66.9371 | 76.9064           | 37.1705   | 47.1402                | 57.1220 | 67.1028         | 77.0768   |                               |
|  | 46.9907                      | 56.9648               | 66.9371   | 76.9064 | 86.8879           | 47.1402   | 57.1220                | 67.1028 | 77.0768         | 87.0479   |                               |
|  | 9.9714                       | 9.9741                | 9.9723    | 9.9693  | 9.9815            | 9.9697  | 9.9818                 | 9.9808  | 9.9740          | 9.9711    |                               |
|  | 10.0063                      | 10.0090               | 10.0072   | 10.0042 | 10.0164           | 10.0046   | 10.0167                | 10.0157 | 10.0089         | 10.0060   |                               |
| Average volume, mL                       | 10.0095                      |                       |           |         | Pass              |   |                        |         |                 |           |                               |
| ผู้ทวนสอบ :                              |                              |                       |           |         | วันที่ : 26/12/22 |   |                        |         |                 |           |                               |
| ผู้อนุมัติ :                             |                              |                       |           |         | วันที่ : 26/12/22 |   |                        |         |                 |           |                               |



บริษัท ศูนย์วิทยาศาสตร์บริการ จำกัด (มหาชน)

### Verify Record

Instrument Name: Electronic Balance

ID No: CL EB 05

Calibration date: 25 Mar 2023

Range : 2200 g

| Normal Value ( g ) | Reference Value ( g ) | Reading Value ( g ) | Error [E]<br>( g ) | Uncertainty [E]<br>( g ) | E + U<br>( g ) | E - U<br>( g ) | เกณฑ์ MPE<br>± ( g ) | เกณฑ์ MPE [E±U]<br>Pass (P)/Fail(F) | Result | Remark |
|--------------------|-----------------------|---------------------|--------------------|--------------------------|----------------|----------------|----------------------|-------------------------------------|--------|--------|
| 0.00               | 0.00                  | 0.00                | 0.00               | 0.001                    | 0.001          | -0.001         | 0.03                 | P                                   | ✓      |        |
| 0.1                | 0.10                  | 0.10                | 0.00               | 0.006                    | 0.006          | -0.006         | 0.03                 | P                                   | ✓      |        |
| 200                | 200.00                | 200.00              | 0.00               | 0.006                    | 0.006          | -0.006         | 0.03                 | P                                   | ✓      |        |
| 400                | 400.00                | 400.00              | 0.00               | 0.006                    | 0.006          | -0.006         | 0.03                 | P                                   | ✓      |        |
| 600                | 600.00                | 600.00              | 0.00               | 0.006                    | 0.006          | -0.006         | 0.03                 | P                                   | ✓      |        |
| 800                | 800.00                | 800.00              | 0.00               | 0.006                    | 0.006          | -0.006         | 0.03                 | P                                   | ✓      |        |
| 1000               | 1000.00               | 1000.00             | 0.00               | 0.006                    | 0.006          | -0.006         | 0.03                 | P                                   | ✓      |        |
| 1200               | 1200.00               | 1200.00             | 0.00               | 0.007                    | 0.007          | -0.007         | 0.03                 | P                                   | ✓      |        |
| 1400               | 1400.00               | 1400.00             | 0.00               | 0.007                    | 0.007          | -0.007         | 0.03                 | P                                   | ✓      |        |
| 1600               | 1600.00               | 1600.00             | 0.00               | 0.014                    | 0.014          | -0.014         | 0.03                 | P                                   | ✓      |        |
| 1800               | 1800.00               | 1800.00             | 0.00               | 0.015                    | 0.015          | -0.015         | 0.03                 | P                                   | ✓      |        |
| 2000               | 2000.00               | 2000.00             | 0.00               | 0.017                    | 0.017          | -0.017         | 0.03                 | P                                   | ✓      |        |

Certificate Number : Q23024862

Certificate By : CLC

Report By

96/4/23

( อติเรก จุ่มพัฒน์พงษ์ )

Approved By

26/4/23

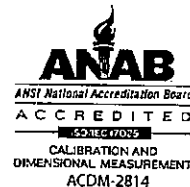
( เบญจมาภรณ์ มาศทาว )





# CALIBRATION LABORATORY Co., LTD.

2/10-11,14,55 Soi Prasert Manukit 29 Yaek 4, Prasert Manukit Rd., Ladphrao, Bangkok 10230  
Tel. 02-578-0353-4 Fax: 02-578-2672 www.cal-laboratory.com E-mail:sale@cal-laboratory.com



## CERTIFICATE OF CALIBRATION FOR

NOMENCLATURE : ANALYTICAL BALANCE  
MANUFACTURER : SARTORIUS  
MODEL / TYPE : ED220S  
SERIAL NO. : 22603760[CL-EB-05]  
CLID. NO. : 362300473  
JOB CONTROL NO. : 230308024862

CUSTOMER : BETAGRO SCIENCE CENTER CO., LTD.  
219 MOO 1, CHONGSARIKA, PATTANANIKOM,  
LOP BURI 15220, THAILAND

DATE OF RECEIVED : 08 March 2023

DATE OF ISSUED : 30 March 2023

Report of calibration screening must not be taken in part. Except complete. Without the approval of the Calibration Laboratory Co., Ltd.

Calibrated By : Sornchai Rattanangam  
Calibration Engineer



Approved By : Mongkol Yotsoontorn  
Authorized Signatory  
30 March 2023



This Calibration Certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI)

Certificate No. Q23024862

F3-011-04/01-12

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@clccalibration



# CALIBRATION LABORATORY Co., LTD.

2/10-11, 14, 55 Soi Prasert Manukit 29 Yaek 4, Prasert Manukit Rd., Ladphrao, Bangkok 10230  
Tel. 02-578-0353-4 Fax: 02-578-2672 www.cal-laboratory.com E-mail:sale@cal-laboratory.com



## REPORT OF CALIBRATION

### FOR

NOMENCLATURE : ANALYTICAL BALANCE  
MANUFACTURER : SARTORIUS  
MODEL / TYPE : ED220S  
SERIAL NO. : 22603760[CL-EB-05]  
LOCATION SITE : CHEMICAL LABORATORY  
DATE OF CALIBRATION : 25 March 2023

#### ENVIRONMENT CONDITIONS :

Temperature : 24 °C to 25 °C

Relative Humidity : 48 % to 50 %

#### PROCEDURE USED :

This instrument was calibrated under procedure No. CLC-CPMB-01 based on EURAMET/cg-18/Version 4.0 (11/2015).  
The calibration was performed by Comparison with Weight Set which maintained by the Calibration Laboratory Co., Ltd.

#### REFERENCE STANDARD USED :

1. Weight Set, Mettler Toledo Class F1 S/N. 158910.
2. Weight Set, N/A Class F2 S/N. MNOPL103037, MNOPL103040, MNOPL103041.

#### TRACEABILITY :

1. The measurements are traceable to International System of Units (SI), through National Institute of Metrology (Thailand).  
Certificate No. MM-0197-22, Due Date 01 December 2023.
2. The measurements are traceable to International System of Units (SI), through Calibration Laboratory Co., Ltd.  
Certificate No. Q22017308, Q22027738. Due Date 03 March 2024, 24 March 2024.

#### UNCERTAINTY :

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor complies with the table which for a normal distribution corresponds to a coverage probability of approximately 95%. It has been evaluated according to the "Evaluation of the Uncertainty of Measurement in Calibration (EA-4/02 M:2022)"

Certificate No. Q23024862

F3-011-04/01-12

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@clc calibration

**CONDITION OF CALIBRATION ITEM : GOOD**

**MEASUREMENT RESULTS : ( X ) without adjustment ( ) adjustment**

## CALIBRATION DATA

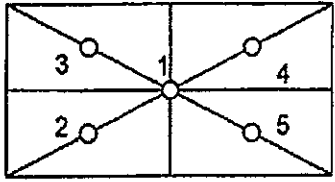
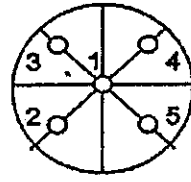
### 1. Error of indications

| Nominal Test Value<br>( g ) | Conventional mass<br>( g ) | Display Value<br>( g ) | Error of<br>Balance ( g ) | Uncertainty<br>$\pm$ ( g ) | Coverage factor <i>k</i> |
|-----------------------------|----------------------------|------------------------|---------------------------|----------------------------|--------------------------|
| Unload                      | 0.00                       | 0.00                   | 0.00                      | 0.001                      | 2,00                     |
| 0.10                        | 0.10                       | 0.10                   | 0.00                      | 0.006                      | 2,00                     |
| 200.00                      | 200.00                     | 200.00                 | 0.00                      | 0.006                      | 2,00                     |
| 400.00                      | 400.00                     | 400.00                 | 0.00                      | 0.006                      | 2,00                     |
| 600.00                      | 600.00                     | 600.00                 | 0.00                      | 0.006                      | 2,00                     |
| 800.00                      | 800.00                     | 800.00                 | 0.00                      | 0.006                      | 2,00                     |
| 1000.00                     | 1000.00                    | 1000.00                | 0.00                      | 0.006                      | 2,00                     |
| 1200.00                     | 1200.00                    | 1200.00                | 0.00                      | 0.007                      | 2,00                     |
| 1400.00                     | 1400.00                    | 1400.00                | 0.00                      | 0.007                      | 2,00                     |
| 1600.00                     | 1600.00                    | 1600.00                | 0.00                      | 0.014                      | 2,00                     |
| 1800.00                     | 1800.00                    | 1800.00                | 0.00                      | 0.015                      | 2,00                     |
| 2000.00                     | 2000.00                    | 2000.00                | 0.00                      | 0.017                      | 2,00                     |

### 2. Repeatability of indications

| Nominal Test Value ( g ) | Standard Deviation of Reading ( g ) |
|--------------------------|-------------------------------------|
| 2000.00                  | 0.000                               |

### 3. Effect of eccentric application of a load on the indication

| <div style="display: flex; align-items: center; justify-content: space-around;"> <div style="text-align: center;"> <input checked="" type="checkbox"/> </div> <div style="text-align: center;">  </div> <div style="text-align: center;"> <input type="checkbox"/> </div> <div style="text-align: center;">  </div> </div> |                     |            |            |            |            |   |
|--|---------------------|------------|------------|------------|------------|---|
| Nominal Test Value ( g )   | Display Value ( g ) |            |            |            |            | Maximum Difference of<br>Center Value ( g ) |
|  | Position 1          | Position 2 | Position 3 | Position 4 | Position 5 |   |
| 1000.00  | 1000.00             | 1000.01    | 999.99     | 999.98     | 1000.00    | 0.02  |

Note. The Scope of Accredited ANAB Certificate No. ACDM-2814 Version 008 Page 41 of 54

**This report is valid for the above stated instrument/s only.**

**### End of Certificate ###**

Certificate No. Q23024862

F3-011-04/01-12

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@clccalibration



### Verify Record

Instrument Name: Electronic Balance

ID No: CL\_EB\_08

Calibration date: 08 Nov 2023

Minimum weight: 0.02249 g

| Reference Value (g) | Reading Value (g) | Error [E]<br>(g) | Uncertainty [E]<br>(g) | E + U<br>(g) | E - U<br>(g) | เกณฑ์ MPE<br>± (g) | เกณฑ์ MPE [E±U]<br>Pass (P)/Fail(F) | Result | Remark |
|---------------------|-------------------|------------------|------------------------|--------------|--------------|--------------------|-------------------------------------|--------|--------|
| 0.0000              | 0.0000            | 0.00000          | 0.00010                | 0.00010      | -0.00010     | 0.0010             | P                                   | ✓      |        |
| 0.1000              | 0.1000            | 0.00000          | 0.00012                | 0.00012      | -0.00012     | 0.0010             | P                                   | ✓      |        |
| 1.0000              | 1.0000            | 0.00000          | 0.00012                | 0.00012      | -0.00012     | 0.0010             | P                                   | ✓      |        |
| 2.0000              | 2.0000            | 0.00000          | 0.00012                | 0.00012      | -0.00012     | 0.0010             | P                                   | ✓      |        |
| 5.0000              | 5.0000            | 0.00000          | 0.00013                | 0.00013      | -0.00013     | 0.0010             | P                                   | ✓      |        |
| 10.0000             | 10.0000           | 0.00000          | 0.00013                | 0.00013      | -0.00013     | 0.0010             | P                                   | ✓      |        |
| 20.0000             | 20.0000           | 0.00000          | 0.00014                | 0.00014      | -0.00014     | 0.0010             | P                                   | ✓      |        |
| 50.0000             | 50.0000           | 0.00000          | 0.00017                | 0.00017      | -0.00017     | 0.0010             | P                                   | ✓      |        |
| 100.0000            | 100.0000          | 0.00000          | 0.00023                | 0.00023      | -0.00023     | 0.0010             | P                                   | ✓      |        |
| 150.0000            | 150.0000          | 0.00000          | 0.00034                | 0.00034      | -0.00034     | 0.0010             | P                                   | ✓      |        |
| 200.0001            | 200.0001          | 0.00000          | 0.00038                | 0.00038      | -0.00038     | 0.0010             | P                                   | ✓      |        |

Certificate Number : TH2070-110-110823-ACC-TH

Certificate By : METTLER TOLEDO

Report By : XXXXXXXXXX 24/11/23

( อติเรก ชีเมพัฒน์วงศ์ )

Approved By

XXXXXXXXXX 24/11/23

( เบญจมาภรณ์ มาศชาวก )

Mettler-Toledo (Thailand) Ltd.

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

Bangna District, Bangkok 10260


+662 723 0382

MT-TH.ServiceSupport@mt.com



## Accuracy Calibration Certificate

### Customer

**Company:** Betagro Science Center Co., Ltd.  
**Address:** 219 Moo 1, Chong Sarika  
**City:** Phatthana Nikhom **Contact:** Adirek Simputtanawong  
**Zip / Postal:** 15220  
**State / Province:** Lopburi  
**Order Number:** 

### Weighing Device

**Manufacturer:** Mettler Toledo **Instrument Type:** Weighing Instrument  
**Model:** XS204 **Asset Number:** CL\_EB\_08  
**Serial No.:** B108115333 **Terminal Model:** SAT  
**Building:** N/A **Terminal Serial No.:** B108115333  
**Floor:** 2 **Terminal Asset No.:** N/A  
**Room:** WATER WEIGHING

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

### Procedure



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

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

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

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

| As Found | Temperature    |              | Humidity      |             |
|----------|----------------|--------------|---------------|-------------|
|          | Start: 25.1 °C | End: 25.4 °C | Start: 72.1 % | End: 69.8 % |

**As Found Calibration Date:** 08-Nov-2023 **Calibrator:**   
**As Left Calibration Date:** N/A  
**Issue Date:** 10-Nov-2023  
**Approved Signatory:**   
Technical Manager / Head of Calibration Center



## Measurement Results

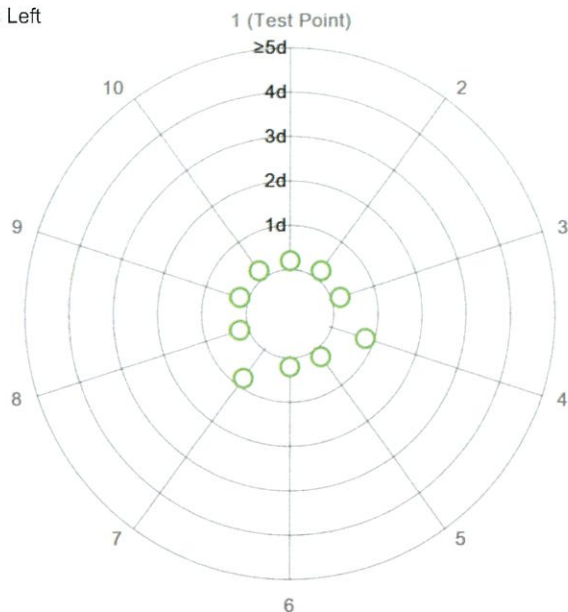
### Repeatability

Test Load: 100 g

|    | As Found   | As Left |
|----|------------|---------|
| 1  | 100.0000 g | N/A     |
| 2  | 100.0000 g | N/A     |
| 3  | 100.0000 g | N/A     |
| 4  | 100.0001 g | N/A     |
| 5  | 100.0000 g | N/A     |
| 6  | 100.0000 g | N/A     |
| 7  | 100.0001 g | N/A     |
| 8  | 100.0000 g | N/A     |
| 9  | 100.0000 g | N/A     |
| 10 | 100.0000 g | N/A     |

|                    |           |     |
|--------------------|-----------|-----|
| Standard Deviation | 0.00004 g | N/A |
|--------------------|-----------|-----|

○ As Found  
◆ As Left



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

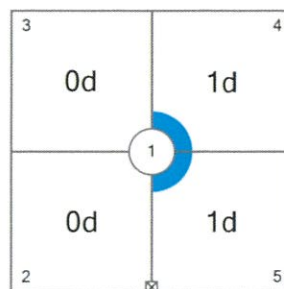
The results of this graph are based upon the absolute values of the differences from the mean value.

### Eccentricity

Test Load: 100 g

| Position | As Found   | As Left |
|----------|------------|---------|
| 1        | 100.0000 g | N/A     |
| 2        | 100.0000 g | N/A     |
| 3        | 100.0000 g | N/A     |
| 4        | 100.0001 g | N/A     |
| 5        | 100.0001 g | N/A     |

|                   |          |     |
|-------------------|----------|-----|
| Maximum Deviation | 0.0001 g | N/A |
|-------------------|----------|-----|



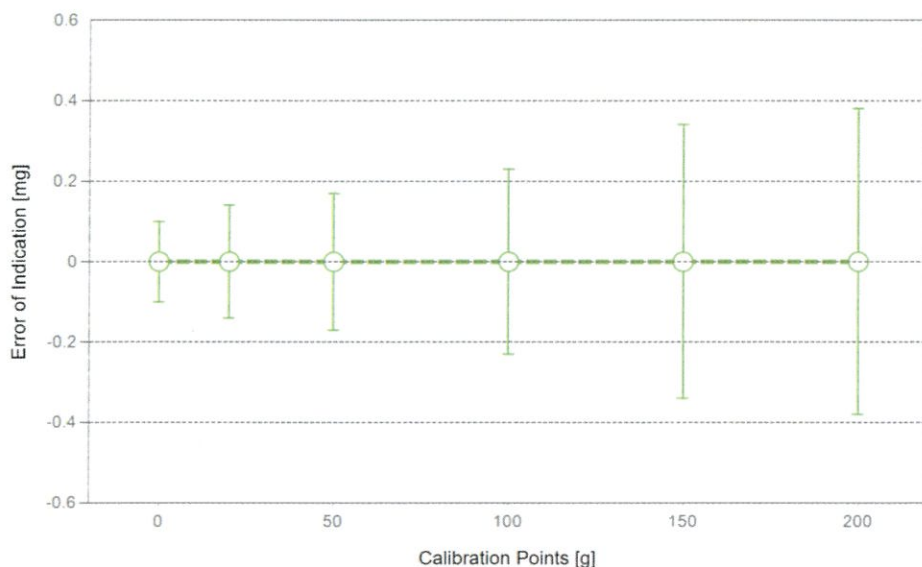
As Found

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  | 0.1000 g        | 0.1000 g   | 0.0000 g            | 0.12 mg              | 2 |
| 3  | 1.0000 g        | 1.0000 g   | 0.0000 g            | 0.12 mg              | 2 |
| 4  | 2.0000 g        | 2.0000 g   | 0.0000 g            | 0.12 mg              | 2 |
| 5  | 5.0000 g        | 5.0000 g   | 0.0000 g            | 0.13 mg              | 2 |
| 6  | 10.0000 g       | 10.0000 g  | 0.0000 g            | 0.13 mg              | 2 |
| 7  | 20.0000 g       | 20.0000 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      | 100.0000 g | 0.0000 g            | 0.23 mg              | 2 |
| 10 | 150.0000 g      | 150.0000 g | 0.0000 g            | 0.34 mg              | 2 |
| 11 | 200.0001 g      | 200.0001 g | 0.0000 g            | 0.38 mg              | 2 |



○ As Found

◆ As Left

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

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

The user is responsible for maintaining environmental conditions and the settings of the weighing instrument when it was calibrated. The results of this calibration certificate relate only to the calibrated item.

## 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.:     | WS01   | Date of Issue:        | 24-Nov-2022 |
| Certificate Number: | 182670 | Calibration Due Date: | 23-May-2024 |

### Thermo Hygrometer

|                     |               |                       |             |
|---------------------|---------------|-----------------------|-------------|
| Equipment No.:      | IN285         | Date of Issue:        | 21-Mar-2023 |
| Certificate Number: | SG-H-00261/66 | Calibration Due Date: | 20-Mar-2024 |

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## Remarks

FACT adjustment functionality activated

Equipment condition: Good

Next calibration according to customer's procedure

Calibration data not decide by calibration laboratory

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### End of Accredited Section

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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

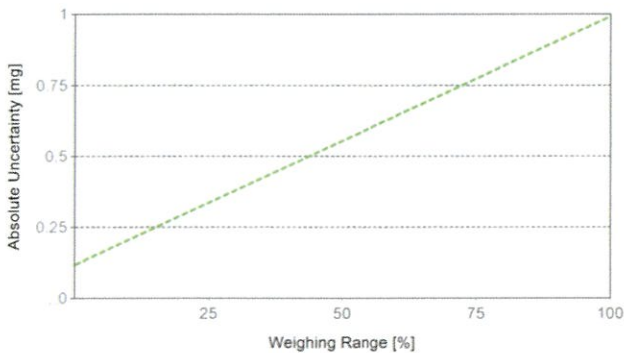
Linearization of Uncertainty Equation

| Range |          |       | As Found   | As Left |
|-------|----------|-------|--|---------|
|       | d        | Max   |  |         |
| 1     | 0.0001 g | 220 g | $U_1 = 0.12 \text{ mg} + 0.00398 \text{ mg/g} \cdot R$ | N/A     |

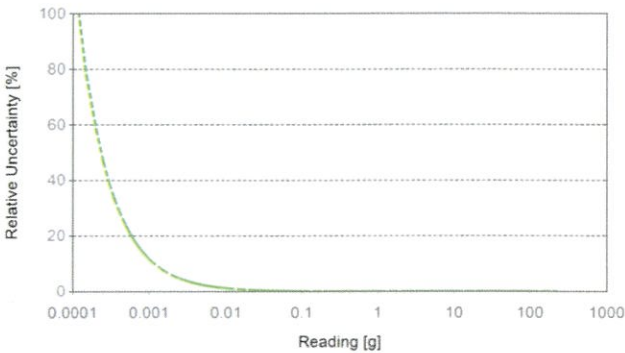
To optimize the stability of the linearization, besides of the zero load only increasing measurement points with a test load of 5% of the measurement range or larger are taken for the calculation of the linear equation.

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

| Net Indication | As Found |          | As Left |     |
|----------------|----------|----------|---------|-----|
| 0.0220 g       | 0.12 mg  | 0.55%    | N/A     | N/A |
| 0.2200 g       | 0.12 mg  | 0.055%   | N/A     | N/A |
| 2.2000 g       | 0.13 mg  | 0.0059%  | N/A     | N/A |
| 22.0000 g      | 0.21 mg  | 0.00094% | N/A     | N/A |
| 220.0000 g     | 1.00 mg  | 0.00045% | N/A     | N/A |



As Found



As Left

# GWP® Certificate



**As  
Found**



The weighing device meets the given process requirements.

**As  
Left**



The weighing device meets the given process requirements.

Tests Performed:

☒ As Found

☐ As Left

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

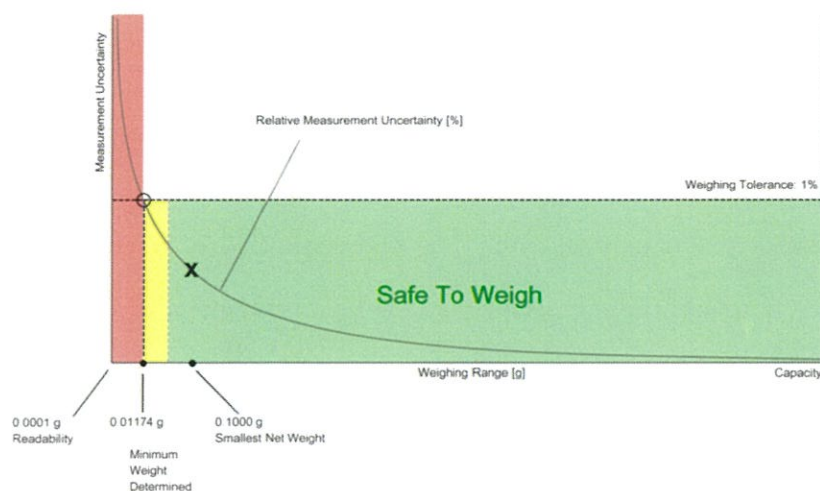
## Process Requirements

Weighing Tolerance: 1%

Smallest Net Weight: **0.1000 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%   | 0.11785 g     | 0.23664 g | 0.35639 g | 0.59881 g | 1.22244 g |
| 0.2%   | 0.05881 g     | 0.11785 g | 0.17713 g | 0.29640 g | 0.59881 g |
| 0.5%   | 0.02349 g     | 0.04703 g | 0.07060 g | 0.11785 g | 0.23664 g |
| 1%   | 0.01174 g     | 0.02349 g | 0.03526 g | 0.05881 g | 0.11785 g |
| 2%   | 0.00587 g     | 0.01174 g | 0.01762 g | 0.02937 g | 0.05881 g |
| 5%   | 0.00235 g     | 0.00470 g | 0.00704 g | 0.01174 g | 0.02349 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%   | 0.11785 g     | 0.23664 g | 0.35639 g | 0.59881 g | 1.22244 g |
| 0.2%   | 0.05881 g     | 0.11785 g | 0.17713 g | 0.29640 g | 0.59881 g |
| 0.5%   | 0.02349 g     | 0.04703 g | 0.07060 g | 0.11785 g | 0.23664 g |
| 1%   | 0.01174 g     | 0.02349 g | 0.03526 g | 0.05881 g | 0.11785 g |
| 2%   | 0.00587 g     | 0.01174 g | 0.01762 g | 0.02937 g | 0.05881 g |
| 5%   | 0.00235 g     | 0.00470 g | 0.00704 g | 0.01174 g | 0.02349 g |



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

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

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

### Notes on minimum weight values in above table:

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



# Measurement Results

## Results Summary

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

✓ = Passed

✗ = Failed

⚠ = Safety Factor not met

## Repeatability

Test Load: 100 g

| Tolerance | Control Limit | As Found       |        | As Left        |        |
|-----------|---------------|----------------|--------|----------------|--------|
|           |               | Std. Deviation | Result | Std. Deviation | Result |
| 0.1%      | 0.00005 g     | 0.00004 g      | ✓      | 0.00004 g      | ⚠      |
| 0.2%      | 0.00010 g     |                | ✓      |                | ✓      |
| 0.5%      | 0.00025 g     |                | ✓      |                | ✓      |
| 1%        | 0.00050 g     |                | ✓      |                | ✓      |
| 2%        | 0.00100 g     |                | ✓      |                | ✓      |
| 5%        | 0.00250 g     |                | ✓      |                | ✓      |

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

## Eccentricity

Test Load: 100 g

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

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



**Error of Indication****As Found**

|                 |          | Control limits for various weighing tolerances |          |          |          |          |          |
|-----------------|----------|--|----------|----------|----------|----------|----------|
| Reference Value | Error    | 0.1%   | 0.2%     | 0.5%     | 1%       | 2%       | 5%       |
| 0.0000 g        | 0.0000 g | N/A  | N/A      | N/A      | N/A      | N/A      | N/A      |
| 20.0000 g       | 0.0000 g | 0.0100 g                                       | 0.0200 g | 0.0500 g | 0.1000 g | 0.2000 g | 0.5000 g |
| 50.0000 g       | 0.0000 g | 0.0250 g                                       | 0.0500 g | 0.1250 g | 0.2500 g | 0.5000 g | 1.2500 g |
| 100.0000 g      | 0.0000 g | 0.0500 g                                       | 0.1000 g | 0.2500 g | 0.5000 g | 1.0000 g | 2.5000 g |
| 150.0000 g      | 0.0000 g | 0.0750 g                                       | 0.1500 g | 0.3750 g | 0.7500 g | 1.5000 g | 3.7500 g |
| 200.0001 g      | 0.0000 g | 0.1000 g                                       | 0.2000 g | 0.5000 g | 1.0000 g | 2.0000 g | 5.0000 g |
| Result          |          | ✓  | ✓        | ✓        | ✓        | ✓        | ✓        |

**As Left**

|                 |          | Control limits for various weighing tolerances |          |          |          |          |          |
|-----------------|----------|--|----------|----------|----------|----------|----------|
| Reference Value | Error    | 0.1%   | 0.2%     | 0.5%     | 1%       | 2%       | 5%       |
| 0.0000 g        | 0.0000 g | N/A  | N/A      | N/A      | N/A      | N/A      | N/A      |
| 20.0000 g       | 0.0000 g | 0.0100 g                                       | 0.0200 g | 0.0500 g | 0.1000 g | 0.2000 g | 0.5000 g |
| 50.0000 g       | 0.0000 g | 0.0250 g                                       | 0.0500 g | 0.1250 g | 0.2500 g | 0.5000 g | 1.2500 g |
| 100.0000 g      | 0.0000 g | 0.0500 g                                       | 0.1000 g | 0.2500 g | 0.5000 g | 1.0000 g | 2.5000 g |
| 150.0000 g      | 0.0000 g | 0.0750 g                                       | 0.1500 g | 0.3750 g | 0.7500 g | 1.5000 g | 3.7500 g |
| 200.0001 g      | 0.0000 g | 0.1000 g                                       | 0.2000 g | 0.5000 g | 1.0000 g | 2.0000 g | 5.0000 g |
| Result          |          | ✓  | ✓        | ✓        | ✓        | ✓        | ✓        |

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

## Verify Record

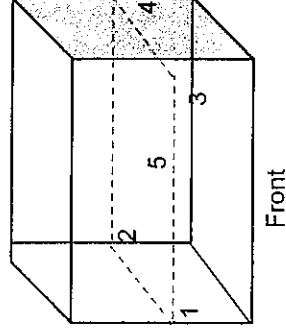
Instrument Name : Water bath

ID No. : CL-WB-08

Calibration date : 6-Sep-23

Operating limit :  $92.5 \pm 2.5$  °C

| UUC Setting<br>(°C) | UUC Reading [R]<br>(°C) | Calibration point [Ts]<br>(°C) | Uncertainty [U]<br>±(°C) | Position | Actual temp. [Ta]<br>(°C) | Error [E=Ta-Ts]<br>(°C) | E+U<br>(°C) | E-U<br>(°C) | เกณฑ์ MPE [E±U] ≤<br>Pass (P)/Fail(F) | 2.5 °C | Correction [Ta <sub>g</sub> -R]<br>(°C) |
|---------------------|-------------------------|--------------------------------|--------------------------|----------|---------------------------|-------------------------|-------------|-------------|---------------------------------------|--------|---|
| 92.5                | 92.5                    | 92.5                           | 0.17                     | 1        | 92.064                    | -0.44                   | -0.27       | -0.61       | P                                     |        |   |
|                     |                         |                                |                          | 2        | 91.987                    | -0.51                   | -0.34       | -0.68       | P                                     |        |   |
|                     |                         |                                |                          | 3        | 91.804                    | -0.70                   | -0.53       | -0.87       | P                                     |        | 0.53                                    |
|                     |                         |                                |                          | 4        | 91.853                    | -0.65                   | -0.48       | -0.82       | P                                     |        |   |
|                     |                         |                                |                          | 5        | 91.973                    | -0.53                   | -0.36       | -0.70       | P                                     |        |   |
| UUC Setting<br>(°C) | UUC Reading [R]<br>(°C) | Calibration point [Ts]<br>(°C) | Uncertainty [U]<br>±(°C) | Position | Actual temp. [Ta]<br>(°C) | Error [E=Ta-Ts]<br>(°C) | E+U<br>(°C) | E-U<br>(°C) | เกณฑ์ MPE [E±U] ≤<br>Pass (P)/Fail(F) | °C     | Correction [Ta <sub>g</sub> -R]<br>(°C) |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |
| UUC Setting<br>(°C) | UUC Reading [R]<br>(°C) | Calibration point [Ts]<br>(°C) | Uncertainty [U]<br>±(°C) | Position | Actual temp. [Ta]<br>(°C) | Error [E=Ta-Ts]<br>(°C) | E+U<br>(°C) | E-U<br>(°C) | เกณฑ์ MPE [E±U] ≤<br>Pass (P)/Fail(F) | °C     | Correction [Ta <sub>g</sub> -R]<br>(°C) |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |
|                     |                         |                                |                          |          |                           |                         |             |             |                                       |        |   |



Certificate No : 23-102707

Certificate By : AMARC

Reported By

6/11/23  
( อติโรก ชิมพิพัฒน์วงศ์ )

Approved By

6/11/23  
( เบญจมาภรณ์ มาศขาว )

## CERTIFICATE OF CALIBRATION

Page 1 of 3

Certificate No. : 23-102707

Sample Code : 23-37664-008

Customer : Betagro Science Center (Lopburi)  
219 Moo 1, Chongsarika, Pattananikom,  
Lopburi 15220

Location of Calibration : Betagro Science Center (Lopburi)  
(WATER TESTING 2)

Equipment : Liquid bath (Water bath)

Manufacturer : Memmert

Model : WNE 45

Serial No. : L716.0051

ID No. : CL\_WB\_08

Date of Receipt : 06 September 2023

Date of Calibration : 06 September 2023

## Condition of Calibration

- |                |                           |           |           |           |           |
|----------------|---------------------------|-----------|-----------|-----------|-----------|
| 1. Environment | 1.1 Ambient temperature   | : Maximum | 25.8 °C   | ; Minimum | 24.8 °C   |
|                | 1.2 Relative humidity     | : Maximum | 69.1 %    | ; Minimum | 53.0 %    |
|                | 1.3 Line voltage supplied | : Maximum | 227.9 VAC | ; Minimum | 221.8 VAC |

## 2. Calibration method

In-house method WI-CL-023 based on ASTM E 715-80: 2001.

## 3. Reference standard instrument

| Instrument                                  | ID No.                        | Certificate No. | Due Date         |
|---|-------------------------------|-----------------|------------------|
| Data acquisition with sensor<br>(RTD-Pt100) | LB-DA-11 (RTD-208 to RTD-212) | 22-126916       | 07 December 2023 |

## 4. This certificate is traceable to the international system of unit (SI Unit).

The measurement is traceable to Asia Medical and Agricultural Laboratory and Research Center Public Company Limited.

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

## 6. Condition of calibration item : Normal

Calibrated by

Mr. Nophanon Anusak

Scientist

Approved by

(Ms. Pawana Pan-on)

Signed for Director

Issue date

11 September 2023

The uncertainties are for a confidence probability of approximately 95%.

The calibration result is applied only to the above calibrated item and was found accurate as shown on date and place of calibration only.

This Certificate is issued in accordance with the conditions of accreditation granted by the Thai Laboratory Accreditation scheme which has assessed the measurement capability of the laboratory and its traceability to recognized national standards and to the unit of measurement realized at the corresponding national standards laboratory. This certificate may not be reproduced other than in full except with the prior written approval of the Asia Medical and Agricultural Laboratory and Research Center Public Company Limited (AMARC).

## REPORT OF CALIBRATION

Page 2 of 3

Certificate No. : 23-102707

Sample Code : 23-37664-008

## Results of Calibration

Resolution : 0.1 °C

## 1. Reporting of Temperature

| Calibration<br>point (°C) | UUC*<br>setting (°C) | UUC*<br>reading (°C) | Measured temperature at each positions (°C) |        |        |        |                     | Uncertainty<br>± (°C) | Coverage<br>factor k |
|---------------------------|----------------------|----------------------|---|--------|--------|--------|---------------------|-----------------------|----------------------|
|                           |                      |                      | # 1   | # 2    | # 3    | # 4    | # 5 <sup>Ref.</sup> |                       |                      |
| 92.5                      | 92.5                 | 92.5                 | 92.064                                      | 91.987 | 91.804 | 91.853 | 91.973              | 0.17                  | 2.00                 |

## 2. Characterization results

| Calibration point (°C) | Stability ± (°C) | Uniformity (°C) | Overall variation (°C) |
|------------------------|------------------|-----------------|------------------------|
| 92.5                   | 0.082            | 0.271           | 0.382                  |

## Notes

- UUC\* = Unit Under Calibration



## REPORT OF CALIBRATION

Page 3 of 3

Certificate No. : 23-102707

Sample Code : 23-37664-008

### Results of Calibration

#### Notes

1. Sensor installation locations
  - 1.1 Place five calibrated temperature sensors in the unloaded water bath with diffuser plate in place and at lowest position and water level approximately 38 mm from the top.
  - 1.2 Locate one sensor in each of the four corners of the bath approximately 50 mm from each wall and midway between the diffuser plate and the water surface.
  - 1.3 Locate the fifth sensor within 25 mm of the geometric center of the bath.
2. The quoted uncertainty includes "Stability of bath and loading effect in bath at 20% of uniformity".
3. 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.
4. Stability - one-half of the greatest maximum difference of measured temperatures at any one sensor.
5. Overall variation - the difference of the maximum and the minimum measured temperatures throughout observation time.
6. UUC\* reading - the average reading of indicating device that forms the integral part of the bath.
7. Controlled circulation or stirrer moter setting : N/A
8. Cooling system : N/A
9. Calibration results without adjustment.

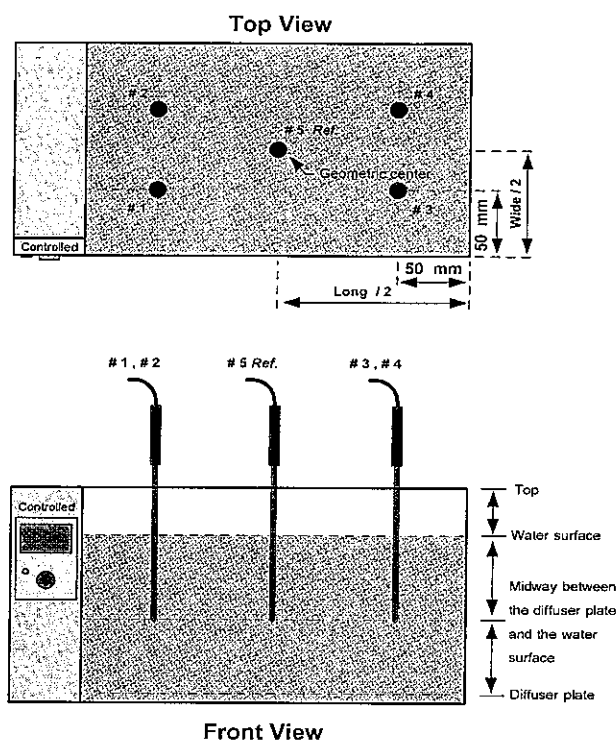


Figure: Example of sensor  
installation Positions

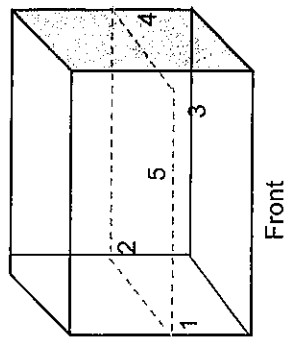
The result expanded uncertainty of measurement  $U$  is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with UKAS M3003.


- End of Report -




# Verify Record

| Instrument Name :   |                         | Water bath                     |                          | ID No. : CL-WB-10 | Calibration date : 6-Sep-23 |                         | Operating limit : 92.5 ± 2.5 °C |             |                          |       |   |
|---------------------|-------------------------|--------------------------------|--------------------------|-------------------|-----------------------------|-------------------------|---------------------------------|-------------|--------------------------|-------|---|
| UUC Setting<br>(°C) | UUC Reading [R]<br>(°C) | Calibration point [Ts]<br>(°C) | Uncertainty [U]<br>±(°C) | Position          | Actual temp. [Ta]<br>(°C)   | Error [E=Ta-Ts]<br>(°C) | E+U<br>(°C)                     | E-U<br>(°C) | เกณฑ์ MPE [E±U] ≤ 2.5 °C |       | Correction [Ta <sub>g</sub> -R]<br>(°C) |
|                     |                         |                                |                          |                   |                             |                         |                                 |             | Pass (P)/Fail(F)         |       |   |
| 92.5                | 92.5                    | 92.5                           | 0.17                     | 1                 | 92.802                      | 0.30                    | 0.47                            | 0.13        | P                        | -0.35 |   |
|                     |                         |                                |                          | 2                 | 92.878                      | 0.38                    | 0.55                            | 0.21        | P                        |       |   |
|                     |                         |                                |                          | 3                 | 92.945                      | 0.44                    | 0.61                            | 0.27        | P                        |       |   |
|                     |                         |                                |                          | 4                 | 92.869                      | 0.37                    | 0.54                            | 0.20        | P                        |       |   |
|                     |                         |                                |                          | 5                 | 92.849                      | 0.35                    | 0.52                            | 0.18        | P                        |       |   |
| UUC Setting<br>(°C) | UUC Reading [R]<br>(°C) | Calibration point [Ts]<br>(°C) | Uncertainty [U]<br>±(°C) | Position          | Actual temp. [Ta]<br>(°C)   | Error [E=Ta-Ts]<br>(°C) | E+U<br>(°C)                     | E-U<br>(°C) | เกณฑ์ MPE [E±U] ≤ 2.5 °C |       | Correction [Ta <sub>g</sub> -R]<br>(°C) |
|                     |                         |                                |                          |                   |                             |                         |                                 |             | Pass (P)/Fail(F)         |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |
| UUC Setting<br>(°C) | UUC Reading [R]<br>(°C) | Calibration point [Ts]<br>(°C) | Uncertainty [U]<br>±(°C) | Position          | Actual temp. [Ta]<br>(°C)   | Error [E=Ta-Ts]<br>(°C) | E+U<br>(°C)                     | E-U<br>(°C) | เกณฑ์ MPE [E±U] ≤ 2.5 °C |       | Correction [Ta <sub>g</sub> -R]<br>(°C) |
|                     |                         |                                |                          |                   |                             |                         |                                 |             | Pass (P)/Fail(F)         |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |
|                     |                         |                                |                          |                   |                             |                         |                                 |             |                          |       |   |



Certificate No : 23-102708  
Certificate By : AMARC  
Reported By :  6/11/23  
( อติเรก ชิมพัฒน์พงษ์ )

Approved By :  6/11/23.  
( เญญจนวรินทร์ มาศขาว )

## CERTIFICATE OF CALIBRATION

Page 1 of 3

Certificate No. : 23-102708

Sample Code : 23-37664-009

Customer : Betagro Science Center (Lopburi)  
219 Moo 1, Chongsarika, Pattananikom,  
Lopburi 15220

Location of Calibration : Betagro Science Center (Lopburi)  
(WATER TESTING 2)

Equipment : Liquid bath (Water bath)

Manufacturer : Memmert

Model : WNE 45

Serial No. : L717.0118

ID No. : CL\_WB\_10

Date of Receipt : 06 September 2023

Date of Calibration : 06 September 2023

## Condition of Calibration

|                |                           |           |           |           |           |
|----------------|---------------------------|-----------|-----------|-----------|-----------|
| 1. Environment | 1.1 Ambient temperature   | : Maximum | 25.8 °C   | ; Minimum | 24.8 °C   |
|                | 1.2 Relative humidity     | : Maximum | 69.1 %    | ; Minimum | 53.0 %    |
|                | 1.3 Line voltage supplied | : Maximum | 227.9 VAC | ; Minimum | 221.8 VAC |

## 2. Calibration method

In-house method WI-CL-023 based on ASTM E 715-80: 2001.

## 3. Reference standard instrument

| Instrument                                 | ID No.                        | Certificate No. | Due Date         |
|--|-------------------------------|-----------------|------------------|
| Data acquisition with sensor<br>(RTD-P100) | LB-DA-11 (RTD-214 to RTD-218) | 22-126916       | 07 December 2023 |

## 4. This certificate is traceable to the international system of unit (SI Unit).

The measurement is traceable to Asia Medical and Agricultural Laboratory and Research Center Public Company Limited.

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

## 6. Condition of calibration item : Normal

Calibrated by Mr. Nophanon Anusak  
Scientist

Approved by

(Ms. Pawana Pan-on)  
Signed for Director

Issue date 11 September 2023

The uncertainties are for a confidence probability of approximately 95%.

The calibration result is applied only to the above calibrated item and was found accurate as shown on date and place of calibration only.

This Certificate is issued in accordance with the conditions of accreditation granted by the Thai Laboratory Accreditation scheme which has assessed the measurement capability of the laboratory and its traceability to recognized national standards and to the unit of measurement realized at the corresponding national standards laboratory. This certificate may not be reproduced other than in full except with the prior written approval of the Asia Medical and Agricultural Laboratory and Research Center Public Company Limited (AMARC).



## REPORT OF CALIBRATION

Certificate No. : 23-102708

Sample Code : 23-37664-009

**Results of Calibration**

Resolution : 0.1 °C

**1. Reporting of Temperature**

| Calibration<br>point (°C) | UUC*<br>setting (°C) | UUC*<br>reading (°C) | Measured temperature at each positions (°C) |        |        |        |                     | Uncertainty<br>± (°C) | Coverage<br>factor <i>k</i> |
|---------------------------|----------------------|----------------------|---|--------|--------|--------|---------------------|-----------------------|-----------------------------|
|                           |                      |                      | # 1   | # 2    | # 3    | # 4    | # 5 <sup>Ref.</sup> |                       |                             |
| 92.5                      | 92.5                 | 92.5                 | 92.802                                      | 92.878 | 92.945 | 92.869 | 92.849              | 0.17                  | 2.00                        |

**2. Characterization results**

| Calibration point (°C) | Stability ± (°C) | Uniformity (°C) | Overall variation (°C) |
|------------------------|------------------|-----------------|------------------------|
| 92.5                   | 0.084            | 0.186           | 0.257                  |

**Notes**

- UUC\* = Unit Under Calibration

## REPORT OF CALIBRATION

Page 3 of 3

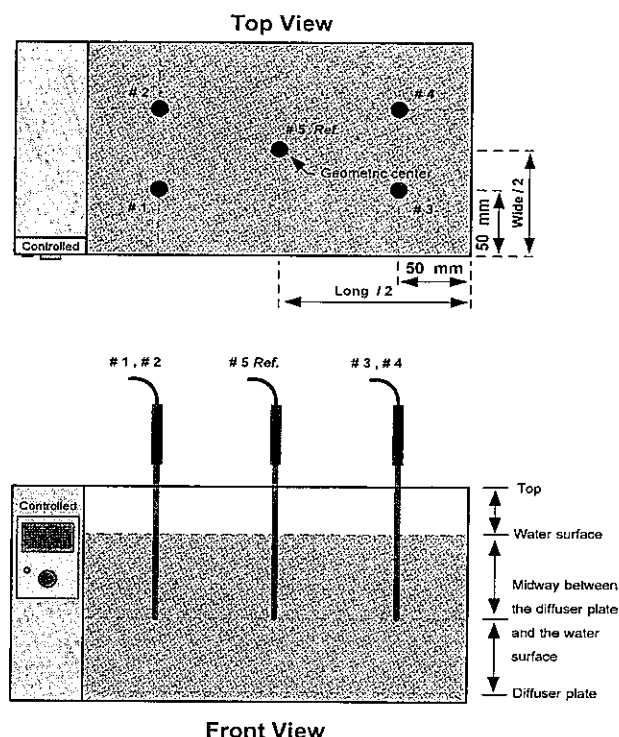
Certificate No. : 23-102708

Sample Code : 23-37664-009

### Results of Calibration

#### Notes

1. Sensor installation locations
  - 1.1 Place five calibrated temperature sensors in the unloaded water bath with diffuser plate in place and at lowest position and water level approximately 38 mm from the top.
  - 1.2 Locate one sensor in each of the four corners of the bath approximately 50 mm from each wall and midway between the diffuser plate and the water surface.
  - 1.3 Locate the fifth sensor within 25 mm of the geometric center of the bath.
2. The quoted uncertainty includes "Stability of bath and loading effect in bath at 20% of uniformity".
3. 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.
4. Stability - one-half of the greatest maximum difference of measured temperatures at any one sensor.
5. Overall variation - the difference of the maximum and the minimum measured temperatures throughout observation time.
6. UUC\* reading - the average reading of indicating device that forms the integral part of the bath.
7. Controlled circulation or stirrer moter setting : N/A
8. Cooling system : N/A
9. Calibration results without adjustment.



Front View  
Figure: Example of sensor  
installation Positions

The result expanded uncertainty of measurement  $U$  is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with UKAS M3003.

- End of Report -