

## ภาคผนวกที่ 4

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เอกสารสอบเทียบเครื่องมือ



**BECTHAI BANGKOK EQUIPMENT & CHEMICAL CO., LTD.**  
**CALIBRATION LABORATORY**

300 Phaholyothin Road, Phayathai, Bangkok 10400, Thailand Tel: +66 2615-2929 Fax: +66 2615-2350-1  
E-mail: bkk@becthai.com Website: www.becthai.com



Certificate No. : CAL-23-297

Page : 1 of 3

## CERTIFICATE OF CALIBRATION

Equipment	:	Spectrophotometer
Manufacturer	:	Thermo Scientific
Model	:	Genesys 20
Serial No.	:	3SGT041007
ID No.	:	LB-Eq-029
Customer	:	Special Lab Envi And Consultant Co., Ltd.
	:	47/91-93 Moo 3, Tambol Tait , Amphur Pakrad,
	:	Nonthaburi, 11120.
Location	:	Becthai Laboratory (Bangkok)
Date of Receipt	:	3 May 2023
Date of Calibration	:	3 May 2023
Date of Issue	:	3 May 2023
Ambient Temperature	:	(25±10) °C
Relative Humidity	:	(60±20) %
Condition As-Received	:	Used Item

Calibrated by

( Mr.Somphop Duangnguan)

Calibration Engineer

Approved by

( Ms. Jintana Sangthaijaroenlap )

Calibration Manager

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

This certificate may not be reproduced other than in full, except with the prior written approval of the head of Calibration Laboratory.

Indicated values are valid for the state of the Spectrophotometer at the time of calibration only.



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Certificate No. : CAL-23-297

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## CALIBRATION REPORT

### Conditions of this result of calibration

#### 1. Reference Standard Material :

<u>Material</u>	<u>Model</u>	<u>Serial No.</u>	<u>Cert.No.</u>	<u>Due date</u>
Holmium Glass Filter	RM-HG	12705	98236	12 Feb 24
Didymium Glass Filter	RM-DG	13498	98233	12 Feb 24
Neutral Density Filter	RM-1N2N3N	8323	98259	13 Feb 24

2. Traceability : This certification is traceable to the International System of Unit maintained at;  
The Starna Scientific Ltd. Accredited Calibration Laboratory No. 0659.

#### 3. Method of calibration :

The calibration procedure was carried out according to ASTM E275-08 (2022) and ASTM E925-09 (2014).

#### 4. Result of calibration :

( ☒ ) without adjustment

( ☐ ) after adjustment

#### 5. Equipment Specifications:

Spectral Bandwidth :	5	nm
Data Interval :	1	nm
Scan Speed :	N/A	nm/min



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Certificate No. : CAL-23-297

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## CALIBRATION REPORT

### Wavelength Calibration

Certified Values of Reference Material (nm)	Nominal Value (nm)	UUC* Reading (nm)	Error (nm)	Uncertainty of Measurement ( $\pm$ nm)
418.40	418	418	-0.40	0.59
537.00	537	537	0.00	0.59
638.00	638	638	0.00	0.59

### Photometric Calibration for Visible

Wavelength (nm)	Certified Values of Reference Material (A)	UUC* Reading (A)	Error (A)	Uncertainty of Measurement ( $\pm$ A)
420.0	Zero	0.000	0.0000	0.0028
	0.5716	0.572	0.0004	0.0044
	0.7358	0.733	-0.0028	0.0040
	1.0713	1.073	0.0017	0.0039
440.0	Zero	0.000	0.0000	0.0028
	0.561	0.560	-0.0010	0.0042
	0.718	0.714	-0.0040	0.0037
	1.0459	1.044	-0.0019	0.0037
465.0	Zero	0.000	0.0000	0.0028
	0.5111	0.513	0.0019	0.0044
	0.6618	0.661	-0.0008	0.0035
	0.9635	0.966	0.0025	0.0034
546.1 (546.0)	Zero	0.000	0.0000	0.0028
	0.5222	0.523	0.0008	0.0036
	0.6687	0.668	-0.0007	0.0031
	0.9768	0.978	0.0012	0.0043
590.0	Zero	0.000	0.0000	0.0028
	0.5541	0.554	-0.0001	0.0035
	0.6975	0.696	-0.0015	0.0031
	1.0206	1.021	0.0004	0.0045
635.0	Zero	0.000	0.0000	0.0028
	0.5398	0.543	0.0032	0.0035
	0.6658	0.667	0.0012	0.0033
	0.9741	0.977	0.0029	0.0045

Remark : Each individual filter is measured against the empty filter holder (blank) used to zero the Spectrophotometer.

Note:

UUC\* : Unit Under Calibration

- End of Report -



**BECTHAI BANGKOK EQUIPMENT & CHEMICAL CO., LTD.**  
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E-mail: bkk@becthai.com Website: www.becthai.com



Certificate No. : CAL-22-284

Page : 3 of 3

## CALIBRATION REPORT

### Wavelength Calibration

Certified Values of Reference Material (nm)	Nominal Value (nm)	UUC*Reading (nm)	Error (nm)	Uncertainty of Measurement ( $\pm$ nm)
418.40	418	419	0.60	0.59
537.00	537	537	0.00	0.59
638.00	638	638	0.00	0.59

### Photometric Calibration for Visible

Wavelength (nm)	Certified Values of Reference Material (A)	UUC* Reading (A)	Error (A)	Uncertainty of Measurement ( $\pm$ A)
420.0	Zero	0.000	0.0000	0.0028
	0.5824	0.583	0.0006	0.0044
	0.7266	0.726	-0.0006	0.0040
	1.0377	1.036	-0.0017	0.0040
440.0	Zero	0.000	0.0000	0.0028
	0.5659	0.566	0.0001	0.0042
	0.7126	0.710	-0.0026	0.0037
	1.0172	1.014	-0.0032	0.0037
465.0	Zero	0.000	0.0000	0.0028
	0.5256	0.527	0.0014	0.0044
	0.6705	0.670	-0.0005	0.0035
	0.9562	0.956	-0.0002	0.0034
546.1 (546.0)	Zero	0.000	0.0000	0.0028
	0.5236	0.524	0.0004	0.0036
	0.6962	0.696	-0.0002	0.0031
	0.9933	0.994	0.0007	0.0032
590.0	Zero	0.000	0.0000	0.0028
	0.5578	0.559	0.0012	0.0036
	0.7523	0.752	-0.0003	0.0031
	1.0747	1.075	0.0003	0.0032
635.0	Zero	0.000	0.0000	0.0028
	0.5655	0.568	0.0025	0.0035
	0.7321	0.734	0.0019	0.0031
	1.0454	1.047	0.0016	0.0031

**Remark :** Each individual filter is measured against the empty filter holder (blank) used to zero the Spectrophotometer.

**Note:**

UUC\* : Unit Under Calibration

- End of Report -

## Certificate of Calibration

**Certificate No. :** 66-400220-2

**Page : 1 of 2**

**Submitted by :** Special Lab Envi and Consultant Co., Ltd.  
47/91 Moo 3 Thambol Tha-it, Pakkret, Nonthaburi 11120

**Equipment :** Air Chamber (Incubator)  
Manufacturer : Lovibond Model : FKU 1800  
Range : N/A °C Resolution : 0.1 °C  
Serial No. : 0914643-01 ID No. : LB-Eq-004

**Environment :** On site calibration was carried out at the Laboratory, Special Lab Envi and Consultant Co., Ltd.  
Ambient Temperature : (29.0 to 29.6) °C  
Relative Humidity : (40 to 45) %  
Line Voltage : (226.0 to 226.5) V

**Date of Received :** 24 April 2023

**Date of Calibration :** 24 April 2023

**Date of Issue :** 26 April 2023

**Calibrated by :** Permpoon Chanpu

**Calibration Method :** CAL-M4004, TLAS G-20

The temperature scale used was based on ITS-90

**Reference Standard Instruments :** This certification is traceable to the International System of Units  
Standard Digital Thermometer with RTD Probe

ID No.	Cert. No.	Due Date	Traceability
400046 & 400042	66-400066-1	02 Aug 2023	National Institute of Metrology Thailand (NIMT)

Approved by :



( Bunjerd Masri )

Supervisor

The Uncertainties are for a confidence probability of approximately 95%

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## Certificate of Calibration

Certificate No. : 66-400220-2

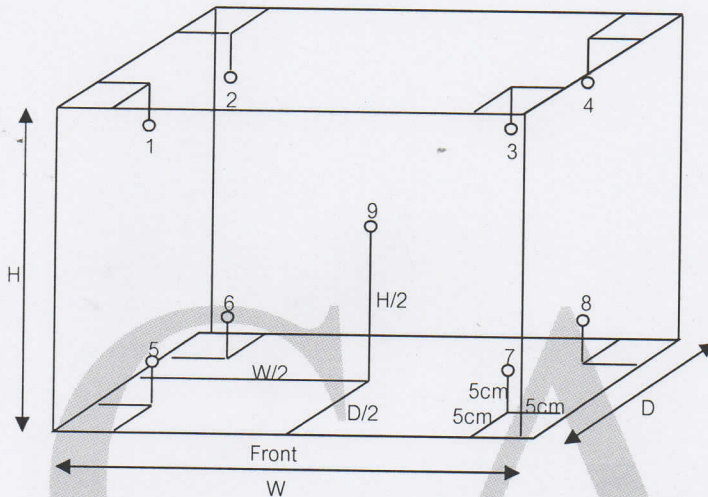
Page : 2 of 2

Result of Calibration : Without Adjustment

UUC Condition As-Received : Good

Function : Temperature measurement

This instrument was setting air ventilation at position 0 (close)



Inside of Chamber

W = 0.55 m

D = 0.73 m

H = 0.50 m

Capacity = 0.20 m<sup>3</sup>

Test Point (°C)	Setting Temperature (°C)	Indicating Temperature (°C)	Measured Temperature (°C) @ Sensor No.									Uncertainty (± °C)
			1	2	3	4	5	6	7	8	9	
20.0	19.9	19.9	20.35	20.35	20.23	20.25	20.12	20.12	20.14	20.28	20.08	0.42

Test Point (°C)	Setting Temperature (°C)	Indicating Temperature (°C)	Measured Uniformity (°C)	Measured Stability (°C)	Overall Variation (°C)
20.0	19.9	19.9	0.37	0.16	0.6

**Remark** The uncertainty is not combine uniformity of the air chamber

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

This 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%

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## Certificate of Calibration

**Certificate No. :** 66-200145-1

**Page : 1 of 2**

**Submitted by :** Special Lab Envi and Consultant Co., Ltd.  
47/91 Moo 3, Tambol Tha-It, Pakkret, Nonthaburi 11120

**Equipment :** Electronic Balance  
Manufacturer : AND Model : GR-200  
Serial No. : 14245322 ID No. : LB-Eg-016  
Capacity : 210 g Resolution : 0.0001 g

**Environment :** On site calibration was carried out at the Laboratory, Special Lab Envi and Consultant Co., Ltd.  
Ambient Temperature : (29.4 to 29.7) °C  
Relative Humidity : (50.9 to 51.5) %  
Air Pressure : 1011.0 mbar

**Date of Received :** 24 April 2023

**Date of Calibration :** 24 April 2023

**Date of Issue :** 26 April 2023

**Calibrated by :** Akaradath Thippichai

**Calibration Method :** In-house method CAL-M2001 based on UKAS Publication ref : LAB 14  
Edition 7 - November 2022

**Reference Standard Instruments :** This certification is traceable to the International System of Units

Standard Weights

ID No.	Cert. No.	Due Date	Traceability
E261-E2624	C02222345	10 Nov 2023	National Institute of Metrology (Thailand), (NIMT)

Approved by :



( Surachai Promthong )

Laboratory Manager

The Uncertainties are for a confidence probability of approximately 95%

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## Certificate of Calibration

**Certificate No. : 66-200145-1**

**Page : 2 of 2**

**Result of Calibration :** Without Adjustment

**UUC Condition As-Received :** Good

Departure of indication from nominal value

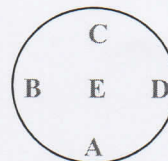
Nominal Value (g)	Correction (g)	Uncertainty $\pm$ (g)
0.001	0.0000	0.00010
0.01	0.0000	0.00011
0.1	0.0000	0.00011
0.5	0.0000	0.00010
2	0.0000	0.00011
5	-0.0001	0.00011
10	0.0000	0.00012
50	-0.0001	0.00014
100	-0.0001	0.00020
200	0.0000	0.00038

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

This reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor  $k = 2.06$ , providing a level of confidence of approximately 95%

Eccentric error

Load test : 50 g  
 A B C D E  
 -0.0003 0.0001 0.0004 0.0000 0.0000 g



Repeatability

Load test : 200 g  
 Stdev. : 0.00005 g

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*Handwritten signature*



## Certificate of Calibration

**Certificate No. :** 66-400220-1

**Page : 1 of 2**

**Submitted by :** Special Lab Envi and Consultant Co., Ltd.  
47/91 Moo 3 Thambol Tha-it, Pakkret, Nonthaburi 11120

**Equipment :** Air Chamber (Incubator)  
Manufacturer : Lovibond Model : FKU 1800  
Range : N/A °C Resolution : 0.1 °C  
Serial No. : 0925481-19 ID No. : LB-Eq-005

**Environment :** On site calibration was carried out at the Laboratory, Special Lab Envi and Consultant Co., Ltd.  
Ambient Temperature : (31.0 to 32.0) °C  
Relative Humidity : (40 to 45) %  
Line Voltage : (226.0 to 226.5) V

**Date of Received :** 24 April 2023

**Date of Calibration :** 24 April 2023

**Date of Issue :** 26 April 2023

**Calibrated by :** Permpoon Chanpu

**Calibration Method :** CAL-M4004, TLAS G-20

The temperature scale used was based on ITS-90

**Reference Standard Instruments :** This certification is traceable to the International System of Units  
Standard Digital Thermometer with RTD Probe

ID No.	Cert. No.	Due Date	Traceability
400046 & 400047	66-400066-2	03 Aug 2023	National Institute of Metrology Thailand (NIMT)

Approved by :

( Bunjerd Masri )

Supervisor

The Uncertainties are for a confidence probability of approximately 95%

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## Certificate of Calibration

Certificate No. : 66-400220-1

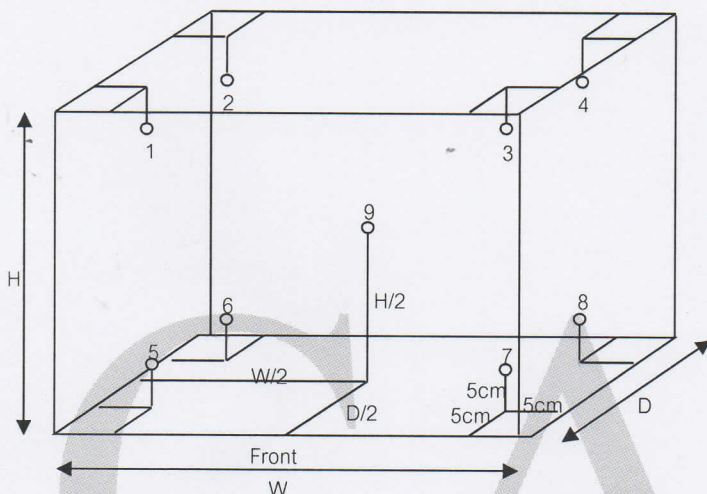
Page : 2 of 2

Result of Calibration : Without Adjustment

UUC Condition As-Received : Good

Function : Temperature measurement

This instrument was setting air ventilation at position 0 (close)



Inside of Chamber

W = 0.55 m

D = 0.73 m

H = 0.50 m

Capacity = 0.20 m<sup>3</sup>

Test Point (°C)	Setting Temperature (°C)	Indicating Temperature (°C)	Measured Temperature (°C) @ Sensor No.									Uncertainty (± °C)
			1	2	3	4	5	6	7	8	9	
30.0	30.0	30.0	30.30	30.42	30.25	30.34	30.43	30.48	30.30	30.44	30.01	0.31
35.0	35.0	35.0	35.06	35.48	34.86	35.50	35.46	35.52	35.04	35.51	35.06	0.32
37.0	37.0	37.0	37.08	37.47	36.92	37.48	37.45	37.56	37.06	37.56	37.05	0.33

Test Point (°C)	Setting Temperature (°C)	Indicating Temperature (°C)	Measured Uniformity (°C)	Measured Stability (°C)	Overall Variation (°C)
30.0	30.0	30.0	0.48	0.04	0.5
35.0	35.0	35.0	0.49	0.05	0.7
37.0	37.0	37.0	0.57	0.06	0.7

Remark The uncertainty is not combine uniformity of the air chamber

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

This 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%

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



Cert.No.: 22CH1158

Page.: 1 of 2

## Certificate of Calibration

Equipment : pH Meter  
Manufacturer : Eutech  
Model : pH 700  
Serial No. : 2858459  
ID No. : LB-Eq-027  
Condition As-Received: Used Item  
Received Date : 31 August 2022  
Calibration Date : 01 September 2022  
Reference : 2208-1091WN-1  
Submitted by : Special Lab Envi And Consultant Co.,Ltd  
47/91-93 Moo 3 Thambon Tha-it,  
Pakkret Nonthaburi 11120  
Ambient Temperature : (25  $\pm$  2.5) °C  
Relative Humidity : (50  $\pm$  15) %  
Calibration Procedure : In - house method :  
- CP-CH5 by direct measurement with standard  
voltage calibrator and direct measurement  
with certified reference material (CRM)

Calibrated by : Warakorn Lernagtrakul

Approved by :

Approved Signatory

- (☒) Malee Butkruea  
( ) Saithip Meangmai  
( ) Warakorn Lernagtrakul

Issue Date : 6 September 2022

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.

A 0044873



Cert. No.: 22CH1158

Page.: 2 of 2

**Condition of this calibration result**

1. Reference Standard Instrument : -

<u>Instrument</u>	<u>Serial No.</u>	<u>ID No.</u>	<u>Cert. No.</u>	<u>Due Date</u>
1) Document Process Calibrator	43160066	130RC092	22E1223	13 Apr 2023

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

- Traceable to National Institute of Metrology (Thailand), NIMT

2. Certified Reference Materials : The measurement results are traceable to SI through CPA chem Ltd.,  
ANSI-ASQ National Accreditation Board, Accredited No. AR-1835

<u>Buffer Solution</u>	<u>Manufacturer</u>	<u>Lot No.</u>	<u>Exp. date</u>
pH 4.008	CPA chem	794120	14 Feb 2024
pH 6.985	CPA chem	794122	14 Feb 2023
pH 10.008	CPA chem	823323	20 June 2023

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

**Calibration Results****Function : mV Measurement**

Performing standard curve by Fluke at pH (4,7,10)

Unit Under Calibration	Nominal Value	Standard Voltage Input	Actual Reading		Uncertainty of Measurement ( ±mV )	Coverage factor <i>k</i>
	pH	mV	mV	pH		
pH Meter S/N.: 2858459	4.00	177.48	177.4	4.01	0.058	2.00
	6.86	8.28	8.3	6.86	0.058	2.00
	7.00	0.00	0.1	7.00	0.058	2.00
	9.18	-128.97	-128.9	9.19	0.058	2.00
	10.00	-177.48	-177.4	10.01	0.058	2.00

**Function : pH Measurement**

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

Unit Under Calibration	Standard pH Buffer Solution	Actual pH Reading	Actual mV Reading ( mV )	Uncertainty of pH measurement ( ± )	Coverage factor <i>k</i>
pH Electrode S/N.: 3101624	4.008	4.01	177.4	0.0085	2.05
	6.985	6.99	3.0	0.0099	2.00
	10.008	10.01	-169.4	0.0092	2.00

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

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Malu.

a 1124653



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TEL. 0-2717-3000-27 FAX. 0-2719-9484



Cert. No.: 22LM126

Page.: 1 of 2

## Certificate of Calibration

**Equipment :** pH Meter with Sensor

**Manufacturer :** Eutech

**Model :** pH 700

**Serial No. :** 2858459

**ID No. :** LB-Eq-027

**Submitted by :** Special Lab Envi And Consultant Co.,Ltd  
47/91-93 Moo 3 Thambon Tha-it,  
Pakkret Nonthaburi 11120

**Location :** Chemistry Calibration Lab.2

**Received Order :** 31 August 2022

**Calibrated Date :** 1 September 2022

**Ambient Temperature :** (  $26 \pm 10$  ) °C

**Relative Humidity :** (  $50 \pm 30$  ) %

**AC Line Voltage :** (  $220 \pm 22$  ) V

**Calibrated by :** Warakorn Lerngagtrakul

**Approved by :**

*Malee*

Approved Signatory

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

**Issue Date :**

6 September 2022

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.

A 0044921



Equipment : pH Meter with Sensor

Condition As-Received : Used Item

Reference : 2208-1091WN-2

Cert. No.: 22LM126

Page.: 2 of 2

**Procedure Used :-**

Calibration were conducted using in-house calibration procedure CP-OT01 according to comparison with Industrial Platinum Resistance Thermometer ( IPRT ) into Temperature Bath.

The temperature scale used was based on ITS-90.

**Condition of this result of calibration**

1. Reference standard instrument:-

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Cert. No.</u>	<u>Due Date</u>
1) Digital Thermometer	53 II B	20410013	22I555	06 May 2023

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

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

**Result of Calibration :-** ( \* ) Without Adjustment

**Function :** Temperature measurement.

This instrument was connected with temperature sensor, S/N.: PH5TEMB01P

<u>Calibration Point</u> ( °C )	<u>Immersion Depth</u> ( mm )	<u>Standard Temperature</u> ( °C )	<u>UUC* Reading</u> ( °C )	<u>Error</u> ( °C )	<u>Uncertainty</u> ( ± °C )	<u>Coverage Factor</u> <i>k</i>
25.0	80	25.004	25.0	-0.004	0.16	2.00

**UUC\* :** Unit Under Calibration

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

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*Malu*