ภาคผนวกที่ 5

เอกสารสอบเทียบเครื่องมือตรวจวัด

envi research
ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

Environment Research & Technology Company Limited
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Head Office/Tax ID 0105 542 064 981

Sound Level Meter Calibration Report

Support Equipment Type : Sound Level Calibrator
Manufacture : Rion
Model : NC-73
Serial No. : 10876348
Range of Calibrator
- Sound Pressure Level : 94.3 dB.
- Frequency : 1,000 Hz.
Calibrated By : Mr.Assada Chaiyawong
Calibration Date : February 16, 2023
Customer Name : Korachindustry Co., Ltd. (โครงการโรงไฟฟ้าชีวมวลโครงการ 3 (SPP Hybrid Firm))

Item	Equipment			Actual Reading (dB(A))		Status
	Brand	Model	Serial Number	Before Adjustment	After Adjustment	
1	Scarlet	ST-21D	820453	94.2	94.3	Pass
2	Scarlet	ST-21D	820444	94.2	94.3	Pass
3	Scarlet	ST-21D	820452	93.8	94.3	Pass
4	Scarlet	ST-21D	820468	94.7	94.3	Pass
5	Scarlet	ST-21D	820462	94.3	94.3	Pass
6	Scarlet	ST-21D	820466	94.1	94.3	Pass
7	Scarlet	ST-21D	820458	93.5	94.3	Pass
8	Scarlet	ST-21D	820447	95.5	94.3	Pass
9	Rion	NL-21	00788083	94.0	94.3	Pass
10	Scarlet	ST-21D	820470	93.7	94.3	Pass

Checked By
Mr.Prayun Detkla
Technician

Approved By
Ms.Sutatip Im-noi
Environmental Scientist

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Sound Level Meter Calibration Report

Support Equipment Type : Sound Level Calibrator
Manufacture : Larson Davis
Model : CAL200
Serial No. : 2903
Range of Calibrator
- Sound Pressure Level : 93.7 dB.
- Frequency : 1,000 Hz.
Calibrated By : Mr.Assada Chaiyawong
Calibration Date : June 6, 2023
Customer Name : Korachindustry Co., Ltd. (โรงไฟฟ้าชีวมวลโครงการ 3 (SPP Hybrid Firm)

Item	Equipment			Actual Reading (dB(A))		Status
	Brand	Model	Serial Number	Before Adjustment	After Adjustment	
1	Scarlet	ST-11D	820869	94.1	93.7	Pass
2	Scarlet	ST-21D	820470	93.6	93.7	Pass
3	Scarlet	ST-21D	820463	93.2	93.7	Pass
4	Scarlet	ST-11D	820863	92.1	93.7	Pass
5	Scarlet	ST-11D	820867	94.3	93.7	Pass
6	Scarlet	ST-21D	820453	93.5	93.7	Pass
7	Scarlet	ST-21D	820466	94.1	93.7	Pass
8	Scarlet	ST-21D	820469	93.8	93.7	Pass
9	Scarlet	ST-21D	820454	93.5	93.7	Pass
10	Scarlet	ST-21D	820444	96.7	93.7	Pass

Checked By ..... Approved By .....
Mr.Prayun Detkla
Technician
Ms.Sutatip Im-noi
Environmental Scientist

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0186 **MTC No.** EEL. BP. 43/0166

CALIBRATION CERTIFICATE

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

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

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

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

Instrument Calibrated :

Description : Sound Level Calibrator

Manufacturer : Rion

Model : NC-73

Serial No. : 10876348

Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325 ± 1.500) kPa

Standards used :

1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Bruel&Kjaer 2636 S/N 1537484.
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
4. Digital Multimeter Agilent 34401A S/N MY44005560.
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
6. Audio Analyzer Panasonic VP-7722A S/N 041477D122.
7. Condenser Microphone Bruel&Kjaer 4180 S/N 2889871.

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

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

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

Date of Receipt : 29 Dec. 2022

Date of Calibration : 4 Jan. 2023

The results relate only to the items tested/calibrated or value assigned.
Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0186 **MTC No.** EEL. BP. 43/0166

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

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

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

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	94.30	0.30	± 0.10	±0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	944.6	-55.4	± 1.5	±1.0%

3. Total distortion

Standard Microphone Type	Measured Total distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	1.60	± 0.60	±3.0%

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by :

.....

(Mr.Weerachai Deechaiyae)

Approved by :

.....

(Mr.Prawate Kluaypa)

Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 4 Jan. 2023

Date of Issue : 5 Jan. 2023

Ref : 20112651229055150l0

End of Certificate

The results relate only to the items tested/calibrated or value assigned.
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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0186 **MTC No.** EEL. BP. 43/0166

CALIBRATION CERTIFICATE

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

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

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

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

Instrument Calibrated :

Description : Sound Level Calibrator

Manufacturer : Rion

Model : NC-73

Serial No. : 10876348

Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325 ± 1.500) kPa

Standards used :

1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Bruel&Kjaer 2636 S/N 1537484.
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
4. Digital Multimeter Agilent 34401A S/N MY44005560.
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
6. Audio Analyzer Panasonic VP-7722A S/N 041477D122.
7. Condenser Microphone Bruel&Kjaer 4180 S/N 2889871.

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

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

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

Date of Receipt : 29 Dec. 2022

Date of Calibration : 4 Jan. 2023

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0186 **MTC No.** EEL. BP. 43/0166

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

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

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

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	94.30	0.30	± 0.10	±0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	944.6	-55.4	± 1.5	±1.0%

3. Total distortion

Standard Microphone Type	Measured Total distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	1.60	± 0.60	±3.0%

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by :

.....

(Mr.Weerachai Deechaiyae)

Approved by :

.....

(Mr.Prawate Kluaypa)

Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 4 Jan. 2023

Date of Issue : 5 Jan. 2023

Ref : 20112651229055150l0

End of Certificate

The results relate only to the items tested/calibrated or value assigned.
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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0308 **MTC No.** EEL. BP. 92/0266

CALIBRATION CERTIFICATE

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

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

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

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

Instrument Calibrated :

Description : Precision Acoustic Calibrator

Manufacturer : Larson Davis

Model : CAL200

Serial No. : 2903

Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325 ± 1.500) kPa

Standards used :

1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Bruel&Kjaer 2636 S/N 1537484.
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
4. Digital Multimeter Agilent 34401A S/N MY44005560.
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
6. Audio Analyzer Keithley 2015-P S/N 4106495.
7. Condenser Microphone Bruel&Kjaer 4180 S/N 2889871.

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

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

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

Date of Receipt : 13 Feb. 2023

Date of Calibration : 21 Feb. 2023

The results relate only to the items tested/calibrated or value assigned.
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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0308 **MTC No.** EEL. BP. 92/0266

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

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

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

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer4180	93.72	-0.28	± 0.10	±0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer4180	999.9	-0.1	± 1.5	±1.0%

3. Total distortion

Standard Microphone Type	Measured Total distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer4180	2.30	± 0.60	±3.0%

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

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

Date of Calibration : 21 Feb. 2023

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0308 **MTC No.** EEL. BP. 92/0266

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

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

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	113.72	-0.28	± 0.10	±0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	999.9	-0.1	± 1.5	±1.0%

3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	0.35	± 0.50	±3.0%

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

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

Calibrated by :

.....

(Mr.Weerachai Deechaiyae)

Approved by :

.....

(Mr.Prawate Kluaypa)

Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 21 Feb. 2023

Date of Issue : 23 Feb. 2023

Ref : 2011266021300647001

End of Certificate

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

NSC-TISI-TIS17025
CALIBRATION 0008

Certificate of Calibration

Equipment :	pH Meter
Manufacturer :	WTW
Model :	inoLab pH 730
Serial No. :	10510388
ID No. :	ERTC-L-In.-049
Condition As-Received:	Used Item
Received Date :	04 January 2023
Calibration Date :	05 January 2023
Reference :	2301-0002ON-15
Submitted by :	Environment Research & Technology Company Limited. 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210
Calibration Place :	ห้องปฏิบัติการ BOD (501)
Ambient Temperature :	(24.6 - 24.8) °C
Relative Humidity :	(50.8 - 51.1) %
Calibration Procedure :	In - house method : - CP-OCH2 by direct measurement with standard voltage calibrator and direct measurement with certified reference material (CRM)

Calibrated by : Krisda Malee

Approved by : Malee .
Approved Signatory

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

Issue Date : 17 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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

A 0045991

Condition of this calibration result

1. Reference Standard Instrument : -

Instrument	Serial No.	ID No.	Cert. No.	Due Date
1) Document Process Calibrator	43160066	130RC092	22E1223	13 Apr 2023
2) Digital Thermometer	-	130RC018	22T778	20 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

Buffer Solution	Manufacturer	Lot No.	Exp. date
pH 4.008	CPA chem	826588	09 July 2024
pH 6.987	CPA chem	823322	20 June 2023
pH 10.008	CPA chem	826590	09 July 2023

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 *k*
	pH	mV	mV	pH		
pH Meter	4.000	177.48	177.5	4.000	0.058	2.00
S/N.: 10510388	7.000	0.00	0.0	7.000	0.058	2.00
	10.000	-177.48	-177.5	10.000	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 *k*
pH Electrode	4.008	4.007	174.0	0.0049	2.00
S/N.: C211621046	6.987	6.987	3.8	0.0097	2.00
	10.008	10.010	-166.0	0.015	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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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)

CORPORATE SERVICES 3 : EQUIPMENT CALIBRATION AND TESTING SERVICES

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

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

Certificate of Testing

Equipment :	DO Meter
Manufacturer :	YSI
Model :	5000-115
Serial No. :	17H104220
ID No. :	ERTC-L-In.137
Received Date :	26 October 2022
Test Date :	27 October 2022
Reference :	2210-0840WN-1
Submitted by :	Environment Research & Technology Company Limited. 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210
Laboratory Condition :	Temperature (25 ± 5) °C Humidity (50 ± 20) %
Test Procedure :	In - house method : CP-CH9 by Comparison Technique with Azide Modification Method
Tested by :	Walalak Sirithean
Approved by :	Malee. Approved Signatory

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

Issue Date : 1 November 2022

B 0300521

Condition of this result of calibration

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

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

2. Standard Material :-

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

Result : **Dissolved Oxygen Meter Adjustment With Air 100 %**

Dissolved Oxygen Probe No.: 15K100353

Titration Method (Azide Modification Method) (mg/L)	**DO Meter Reading** (mg/L)	**Standard Deviation** (mg/L)
8.14	8.13	0.0071

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

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Malu.

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

ACCREDITED
Calibration Cert. # 3884.01
ISO/IEC 17025

Certificate of Calibration

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

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

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

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

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

Reference Standard Instruments :

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

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

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

CALIBRATION LABORATORY * INCTECH METROLOGICAL CENTER CO.,LTD. * IMC

Calibrated by : Mr.Jiraphan Sreebannasarn
Issue date : Dec 19, 2022

Approved by : (Mr.Choophong Khumdet)

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

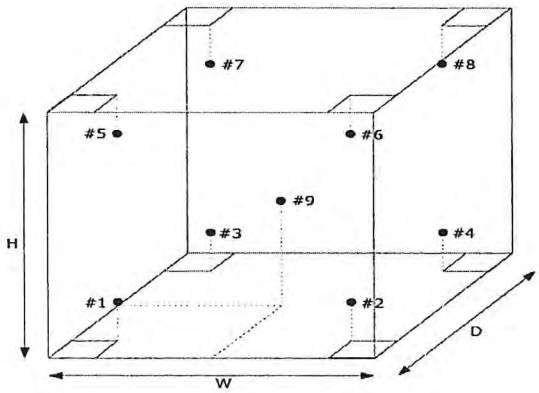
Inctech Metrological Center Co.Ltd.
39/1 Soi 82, Sukhapiban 5 Rd., O ngoen,
Saimai, Bangkok 10220, Thailand
Tel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.com

ACCREDITED
Calibration Cert. # 3884.01
ISO/IEC 17025

Function : Temperature measurement
Calibration point : 20 °C
Result : Without adjustment
Resolution : 0.1 °C

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

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



#1 Lower Left Front
#2 Lower Right Front
#3 Lower Left Rear
#4 Lower Right Rear
#5 Upper Left Front
#6 Upper Right Front
#7 Upper Left Rear
#8 Upper Right Rear
#9 Geometric Center

Front view

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

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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

NSC-TISI-TIS17025
CALIBRATION 0008

Cert.No.: 23CHO3

Certificate of Calibration

Equipment :	UV-VIS Spectrophotometer
Manufacturer :	PerkinElmer
Model :	Lambda 365+
Serial No. :	365PK22072603
ID No. :	ERTC-L-In.-180
Condition As-Received:	Used Item
Received Date :	04 January 2023
Calibration Date :	04 January 2023
Reference :	2301-0002ON-14
Submitted by :	Environment Research & Technology Company Limited. 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210
Calibration Place :	ห้องปฏิบัติการวิเคราะห์ Spectrophotometer
Ambient Temperature :	(24.8 - 25.2) °C (On-Site)
Relative Humidity :	(56 - 61) % (On-Site)
Calibration Procedure :	In - house method : CP-OCH4 based on ASTM E 275-01
Calibrated by :	Uthen Kankawi
Approved by :	Malee . Approved Signatory

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

Issue Date : 17 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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

A 0045992

Condition of calibration result

1. Reference Standard Material :

Material	Serial No.	Certificate No.	Due date
1. Absorbance Standard set	32588	103225	08 July 2024
2. Absorbance Standard set	32592	104226	04 Aug 2024
3. Absorbance Standard set	39130	106269	10 Oct 2024
4. Wavelength Standard set	29829	94776	02 Sep 2023
5. Wavelength Standard set	29829	94777	02 Sep 2023
6. Stray Light Standard set	32629	9112980	03 Aug 2024

2. This certificate is valid only to the item calibrated on date and place of calibration.
3. This certificate is traceable to the International System of Unit maintained at :
   - National Physical Laboratory (NPL), The United Kingdom of Great Britain and Northern Ireland
   - National Institute of Standards and Technology (NIST), The United States of America
4. Spectral BandWidth : 1 nm
   Scan Speed : 30 nm/min

Calibration Results : without adjustment

Wavelength Accuracy

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

Malee.

Calibration Results : without adjustment

Photometric Accuracy

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

Stray Light

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

Remark

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

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

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Agilent CrossLab Compliance

Qualification Type:	ES-OQ
System ID:	MY15330001
EQP Name:	AgilentRecommended
EQP Revision:	ES.02.50
EQP Publish Date:	March 2020
Date:	November 28, 2022 4:16:06 PM
Report Type:	Report
Org. Name:	Environment Research & Technology Co.,Ltd
Org. Location:	25/114 Moo 6 Soi Chinaket, Ngamwongwan Rd.,Bangkok 10210

Table of Contents

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

Test Summary

Purpose

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

Details

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

Overall Qualification Status

Pass

Service Details

Purpose

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

General Details

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

Organization Details

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

Local Contact Details

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

Operator Details

Name:	Worawit Timakul
Job Title:	Field Service Engineer

Data Acquisition Details

Acquisition Software Name:	ICP Expert
Acquisition Software Revision:	7.1.0.6821
Customer Data System (CDS):	Es: ICP Expert

Instrument Details

Purpose

This section describes the as found system configuration.

Details

Spectrometer 1

Manufacturer	Agilent Technologies
Name	5100 VDV
Model Number	G8011A
Sample Introduction	Double pass glass cyclonic spraychamber and seaspray nebulizer
Serial Number	MY15330001
Firmware Revision	2994

Chiller 1

Manufacturer	Agilent Technologies
Name	Chiller
Model Number	G8481A
Serial Number	1A1560387

Autosampler 1

Manufacturer	Agilent Technologies
Name	SPS4
Model Number	G8410A
Serial Number	AU15220240

Vapor Generator 1

Manufacturer	Agilent Technologies
Name	VGA77P
Model Number	G8475A
Serial Number	MY15330002

Protocol Details

Purpose

This section lists the revisions for all test units used in this report. For complete test-specific and high-level change details, refer to the Revision History document.

Test Revision	Test
ES.02.50	Autosampler Operation
ES.02.50	Instrument Tests
ES.02.50	Preparation

Preparation

Purpose

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

Configuration Details

Model/Serial No.:	G8011A	MY15330001

Results

Criteria	Observed Result	Expected Result	Status
Does the plasma ignite successfully in the first three attempts?	Yes	Yes	Pass
Was the detector calibration performed and completed successfully?	Yes	Yes	Pass
Was the instrument calibration performed and completed successfully?	Yes	Yes	Pass

Test Evidence

Image Details:	Was the detector calibration performed and completed successfully?
Date and Time:	November 28, 2022 4:07:22 PM
Host Name:	5CG0202NQ4

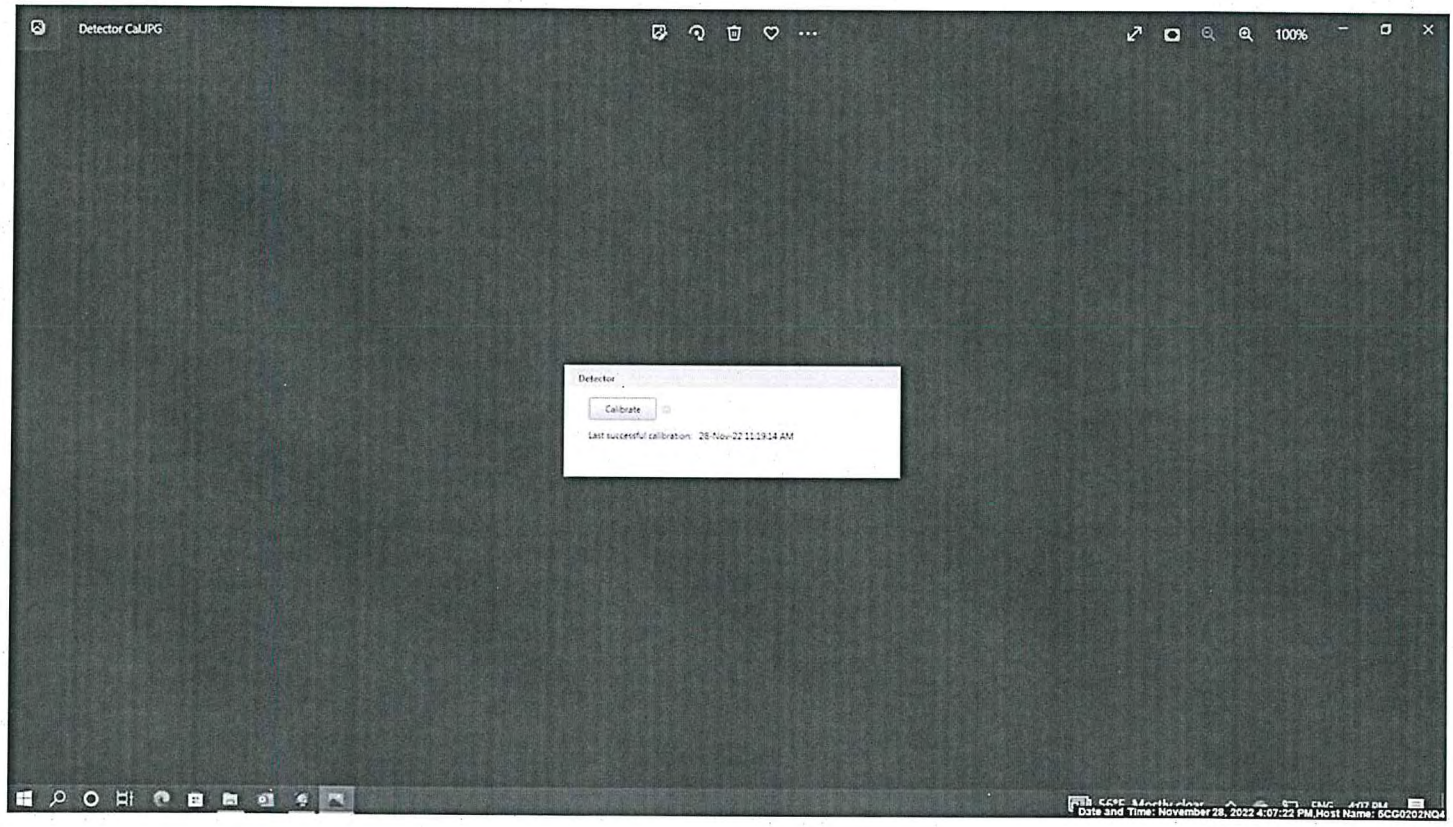
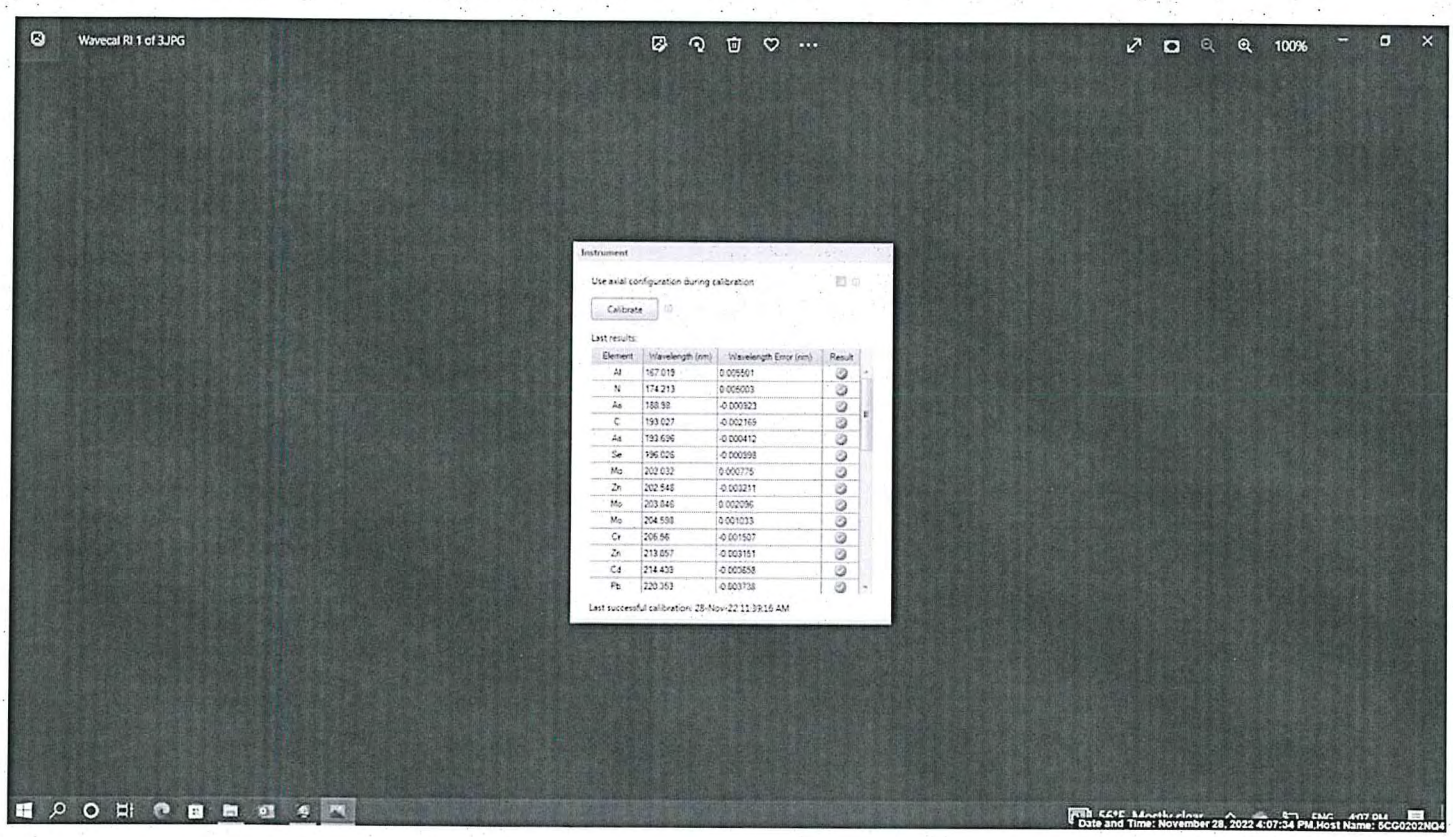


Image Details: Was the instrument calibration performed and completed successfully?

Date and Time: November 28, 2022 4:07:34 PM

Host Name: 5CG0202NQ4



Overall Test Status

Pass

Runs: 1

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Instrument Tests

Purpose

This test records a status for each of the automated tests within the Agilent ICP-OES CDS. For detailed test criteria, refer to the attached report.

Configuration Details

Model/Serial No.:	G8011A	MY15330001

Results	Observed Result	Expected Result	Status
Are the Functional Tests results within acceptance criteria?			
Subsystem Communications	Yes	Yes	Pass
Air Flow	Yes	Yes	Pass
Water Flow	Yes	Yes	Pass
Gas Flows	Yes	Yes	Pass
RF Generator	Yes	Yes	Pass
Camera	Yes	Yes	Pass
Optics	Yes	Yes	Pass
Are the Instrument Performance Tests results within acceptance criteria?			
Resolution	Yes	Yes	Pass
Sensitivity	Yes	Yes	Pass
Precision	Yes	Yes	Pass

Overall Test Status

Pass

Runs: 1

Autosampler Operation

Purpose

This test verifies that the autosampler operates properly.

Configuration Details

Model/Serial No.:	G8410A	AU15220240

Results

Criteria	Observed Result	Expected Result	Status
Does the autosampler successfully move to the specified location(s)?	Yes	Yes	Pass

Overall Test Status

Pass

Runs: 1

Declaration of Change Control

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

Attachments

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

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

Document Name: Certificate of Qualification for ACE

Agilent Technologies

Agilent Compliance Engine Self Qualification

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

Drive Serial #: 90593EBA **Platform Revision:** ACE 3.11.27

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

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

Overall Qualification Status

Conforms

Document Name: Operator's training certificate and qualifications

Agilent Technologies

Certificate of Completion

Learner Name:	Worawit Timakul
Title Of Course:	ANV-CE-ICPOES-2-008-A: Agilent 5100 ICP-OES Support Neophyte Training
Completion Date:	August 25, 2016
Certified By Company:	Learning at Agilent

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

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

Document Name: Operator's training certificate and qualifications

Agilent Technologies

Certificate of Completion

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

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

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

Document Name: Certificate of System Qualification

Agilent Technologies

Certificate of Completion

Learner Name:	Worawit Timakul
Title Of Course:	AN-CE-SS-II-030-A: ACE 3.X User Update Training
Completion Date:	July 1, 2020
Certified By Company:	Learning at Agilent

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

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

General

Document Name: Instrument's Test Report

Report Summary

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

Result Summary

Resolution Test	Pass
Sensitivity Test	Pass
Precision Test	Pass

Resolution Test **Pass**

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

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Document Name: Instrument's Test Report

Sensitivity Test **Pass**

Radial

Element Wavelength	Specification	Method	Ratio	Standard	Blank
As (188.980 nm)	≥ 46.0	SRBR	124.4	1263.4	89.1
Se (196.026 nm)	≥ 41.0	SRBR	74.4	903.6	112.9
Zn (213.857 nm)	≥ 1421.0	SRBR	4159.8	58879.6	199.0
Pb (220.353 nm)	≥ 46.0	SRBR	191.9	3092.4	223.5
Mn (257.610 nm)	≥ 3518.0	SRBR	12083.1	303064.1	626.5
Al (396.152 nm)	≥ 3.4	SBR	8.0	41307.1	4600.0
Ba (493.408 nm)	≥ 34.0	SBR	103.1	1275727.5	12253.3
K (766.491 nm)	≥ 1.8	SBR	3.9	111109.8	22733.2

Axial

Element Wavelength	Specification	Method	Ratio	Standard	Blank
As (188.980 nm)	≥ 208.0	SRBR	250.8	3667.4	192.0
Se (196.026 nm)	≥ 159.0	SRBR	172.2	2902.2	239.1
Zn (206.200 nm)	≥ 234.0	SRBR	1360.5	17846.2	168.8
Zn (213.857 nm)	≥ 1743.0	SRBR	9129.7	200493.0	480.0
Cd (214.439 nm)	≥ 4227.0	SRBR	8255.6	156439.2	357.4
Pb (220.353 nm)	≥ 320.0	SRBR	666.7	16502.1	571.0
Mn (257.610 nm)	≥ 10625.0	SRBR	39180.3	1593731.9	1651.2
Cr (267.716 nm)	≥ 1048.0	SRBR	4862.3	176423.2	1297.2
Cu (324.754 nm)	≥ 19.0	SBR	65.7	268073.8	4020.3
Al (396.152 nm)	≥ 6.0	SBR	24.3	271032.8	10722.4
Ba (493.408 nm)	≥ 60.0	SBR	275.4	8034589.3	29068.7
K (766.491 nm)	≥ 24.0	SBR	81.9	3677804.4	44370.4

Precision Test **Pass**

Radial

Element Wavelength	Specification	Measured Value % RSD
As (188.980 nm)	≤ 2.60	0.99
Se (196.026 nm)	≤ 2.60	1.01
Zn (213.857 nm)	≤ 1.50	0.31
Pb (220.353 nm)	≤ 2.60	0.41
Mn (257.610 nm)	≤ 1.50	0.43
Al (396.152 nm)	≤ 1.50	0.39
Ba (493.408 nm)	≤ 1.50	0.65
K (766.491 nm)	≤ 1.50	0.29

Axial

Element Wavelength	Specification	Measured Value % RSD
As (188.980 nm)	≤ 1.50	0.87
Se (196.026 nm)	≤ 1.50	0.76
Zn (206.200 nm)	≤ 1.50	0.42
Zn (213.857 nm)	≤ 1.50	0.51
Cd (214.439 nm)	≤ 1.50	0.50
Pb (220.353 nm)	≤ 1.50	0.49
Mn (257.610 nm)	≤ 1.50	0.50
Cr (267.716 nm)	≤ 1.50	0.43
Cu (324.754 nm)	≤ 1.50	0.48
Al (396.152 nm)	≤ 1.50	0.48
Ba (493.408 nm)	≤ 1.50	0.71
K (766.491 nm)	≤ 1.50	0.50

Document Name: Software verification

Software Verification Report

Date:	Monday, November 28, 2022	**Time:**	3:44:56 PM [UTC +07:00:00]	**Host Name:**	5100VDV-HP
Windows User Name :	Admin	**Base Revision Number:**	7.0.1	**Product Name :**	ICP Expert
Install Type:	N/A	**Additional Packages:**	NA		

Base Reference File Name : ICPReferenefile.xml

Summary :

Overall Evaluation of Installation Check : PASS

File Report Summary

No missing files or invalid files found

No system file difference found

Files Registration Report Summary

Files Registration check not required for this product

Registry Report Summary

Registry entries check not required for this product

Document Name: Certificate of Analysis Wavelength calibration solution

Agilent

CERTIFICATE OF ANALYSIS

Agilent Product Name: Wavelength Calibration Solution for ICP-OES & MP-AES, 5 mg/L, 500mL

Agilent Part No: 6610030100

Lot No: 0012183521

Product Specifications

Analyte	Starting Material	CAS #	Certified Conc.	Analyte	Starting Material	CAS #	Certified Conc.
Al	$Al(NO_3)_3$	7784-27-2	5.000 ± 0.025 mg/L	Mn	Mn	7439-96-5	5.001 ± 0.025 mg/L
As	As	7440-38-2	5.001 ± 0.025 mg/L	Mo	$(NH_4)_2MoO_4$	13106-76-8	5.000 ± 0.025 mg/L
Ba	$Ba(NO_3)_2$	10022-31-8	5.000 ± 0.025 mg/L	Ni	Ni	7440-02-0	5.000 ± 0.025 mg/L
Cd	Cd	7440-43-9	5.000 ± 0.025 mg/L	Pb	Pb	7439-92-1	5.001 ± 0.025 mg/L
Co	Co	7440-48-4	5.000 ± 0.025 mg/L	Se	Se	7782-49-2	5.000 ± 0.025 mg/L
Cr	$Cr(NO_3)_3$	13548-38-4	5.000 ± 0.025 mg/L	Sr	$Sr(NO_3)_2$	10042-76-9	5.000 ± 0.025 mg/L
Cu	Cu	7440-50-8	5.000 ± 0.025 mg/L	Zn	Zn	7440-66-6	4.999 ± 0.025 mg/L
K	KNO_3	7757-79-1	50.00 ± 0.25 mg/L				

Matrix: 5% HNO_3

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

Certification & Traceability: This CRM was manufactured under a quality management system that is registered to **ISO 9001, ISO 17034** and **ISO/IEC 17025**. This CRM was prepared to the certified concentrations shown above by gravimetric methods using single-element concentrates that were certified using the "High Performance ICP-OES" protocol developed by NIST and are directly traceable to the NIST SRMs listed below. This solution was stabilized using high purity nitric acid (HNO_3) and diluted with filtered (0.22µm), 18 M-ohm deionized water. The balances used in the preparation of this CRM are calibrated regularly with traceability to NIST. All volumetric dilutions are performed in Class A calibrated glassware. The certified concentrations were determined based upon gravimetric procedures. Secondary verification of the certified concentrations was performed using ICP-OES that was calibrated and/or referenced against NIST SRMs: 3101a, 3103a, 3104a, 3108, 3113, 3112a, 3114, 3141a, 3132, 3134, 3136, 3128, 3149, 3153a, and 3168a. The uncertainty associated with each certified concentration represents the expanded uncertainty at the 95% confidence level using a coverage factor of k=2.

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

Page 1 of 3

Agilent

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

Sample lot approver:

Chuck Goudreau

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

Chuck Goudreau, Certifying Officer

Agilent

Hazard Information: Refer to the Safety Data Sheet (SDS), which can be obtained at www.agilent.com/chem/sds.

Homogeneity: This solution was determined to be homogeneous by procedures consistent with the requirements of ISO 17034 and ISO Guide 35. Replicate samples of the finished solution were analyzed to confirm its homogeneity, in accordance with QSP 6-13 Assessment of Homogeneity and Stability. To ensure homogeneity, users should not take a smaller sub-sample than specified in the Instructions for Use, as doing so will invalidate the certified values and uncertainties.

Further Information: Please contact Agilent for further information about this CRM.

Quality Certifications: This CRM was prepared under a quality management system that is:

- Registered to ISO 9001 – Quality Management Systems – Requirements (TUV NORD Cert. Reg. No. 44 100 16560231)
- Accredited to ISO 17034– General Requirements for the Competence of Reference Material Producers (A2LA Cert. No. 2848.02)
  - ISO 17034 references additional requirements specified in ISO Guide 31 and ISO Guide 35.
- Accredited to ISO/IEC 17025 – General Requirements for the Competence of Testing and Calibration Laboratories (A2LA Cert. No. 2848.01)
- LGC Standards, 276 Abby Road, Manchester, NH 03103)

Electronic Signature

Purpose

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Details

Full Name of Signer:	Worawit Timakul
Logged On User Name:	worawit.timakul@agilent.com
Signature Creation Date:	November 28, 2022
Reason for Signature:	Executed protocol and published this original version of document

Regulatory Disclaimer

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

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User Name: woraw[illegible]

Hostname: 5CG0202N[illegible]

System Id: MY15330001

Print Date: November 28, 2022 4:16:10 PM

OQ HW ICP 5100 Envi researc Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
November 28, 2022 4:02:15 PM	Audit	SessionCreated	Session	None
November 28, 2022 4:02:15 PM	Start	Configuration	Session	None
November 28, 2022 4:02:15 PM	Audit	Entitlement	Licensing	User is FieldEngineer and does not require an unlock code
November 28, 2022 4:06:30 PM	Audit	EqpLoaded	Session	EQP details for primary technique [Es] - File path: [ProtocolPacks/Es/Configurations/02.50/Es.02.50.eqp], EQP File Name: [Es.02.50.eqp], EQP Name: [AgilentRecommended]
November 28, 2022 4:06:32 PM	End	Configuration	Session	None
November 28, 2022 4:06:35 PM	Start	Qualification	Session	OQ
November 28, 2022 4:06:36 PM	Start	Execution	Preparation : 5100 VDV: Qualitative Test - No setpoints associated	None
November 28, 2022 4:07:38 PM	End	Execution	Preparation : 5100 VDV: Qualitative Test - No setpoints associated	Run Count : 1
November 28, 2022 4:07:39 PM	Start	Execution	Instrument Tests : 5100 VDV: Qualitative Test - No setpoints associated	None
November 28, 2022 4:08:52 PM	End	Execution	Instrument Tests : 5100 VDV: Qualitative Test - No setpoints associated	Run Count : 1

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User Name: worawit.timakul
Hostname: 5CG0202NQ4

System Id: MY15330001
Print Date: November 28, 2022 4:15:10 PM

OQ HW ICP 5100 Envi researc Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
November 28, 2022 4:09:01 PM	Start	Execution	Autosampler Operation : Autosampler 1 - SPS4: Qualitative Test - No setpoints associated	None
November 28, 2022 4:09:05 PM	End	Execution	Autosampler Operation : Autosampler 1 - SPS4: Qualitative Test - No setpoints associated	Run Count : 1
November 28, 2022 4:09:09 PM	End	Qualification	Session	OQ
November 28, 2022 4:09:09 PM	Start	Reporting	Session	None
November 28, 2022 4:14:49 PM	Audit	Reporting	Session	Report Generated : Certificate
November 28, 2022 4:15:27 PM	Audit	Reporting	Session	Report Signed : Certificate PDF Name: OQ HW ICP 5100 Envi researc_20221128_Certificate_1.pdf User Name: worawit.timakul@agilent.com Full Name of Signer: Worawit Timakul Reason for signature: Executed protocol and published this original version of document
November 28, 2022 4:15:43 PM	Audit	Reporting	Session	Report Generated : Report

PerkinElmer
For the Better

PinAAcle 900Z
Preventive Maintenance Report

Company Name: ENVIRONMENT RESEARCH

Instrument Location: 25/114 M.6, THANON NGAMWONGWAN

THUNGSONGHONG, LAKSI, BANGKOK, 10210

Instrument Serial No.: PZAS19031401

Date: 30-Jun-2023

PinAAcle 900Z Preventive Maintenance (PM)

Company Name:	ENVIRONMENT RESEARCH		
Address (Instrument Location):	25/114 M.6, THANON NGAMWONGWAN, THUNGSONGHONG, LAKSI, BANGI		
Serial Number:	PZAS19031401	**PM Number:**	1/2
Customer Name (if applicable):	K. RAIWIN	**Telephone Number:**	099-182-9241
Customer Support Engineer Name:	K. DUANG	**Service Order Number:**	WO-02273780
Date PM Performed: (DD-MMM-YYYY)	30-Jun-2023	**Next PM Due Date:** (DD-MMM-YYYY)	30-Dec-2023
Standard Labor Hours to Complete PM :		**5 hours**	

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

Scope

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

The customer should save their method before the PM begins.

General Instructions:

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

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

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

Update the PM sticker and instrument logbook as required.

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Component List

Component / Specific Model	Serial #	Configuration Notes

Parts Lists

Parts Included with the PM		
Part Number (if applicable)	**Description**	**Quantity**
B0501696	Fan Filters	2
B3002013	THGA Contact Cylinders	1
B3141064	Glycerol for THGA Cooling	N/A

Additional Reagents and Standards Required for PM				
Part Number (if applicable)	**Description**	**Quality**	**Batch/Lot #**	**Expired Date (MM/YY)**
N9300244	GFAAS Mixed Standard	AR	56-021CRY1	30-Jun-2023

Additional Reagents and Standards Required for PM (Customer Support Solution)				
Part Number (if applicable)	**Description**	**Quantity**	**Batch/Lot #**	**Expiration Date (MM/YY)**
N/A	DI Water	250 ml.	AR	AR
N/A	0.5% $HN0_3$	250 ml.	AR	AR

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

Procedure Checklist

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

1. **General:**

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

2. **PC Instrument Software:**

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

3. **Mechanical:**

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

4. Electrical:

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

5. Optics:

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

6. Gasses:

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

7. After PM Performance tests [THGA]:

7.1 Furnace Gas Flows

Description: Ensures the flow rates are within specification.

Parameter	Specification	Test Results	Pass/Fail
Internal Flow Rate	250 mL/min ± 25 mL/min	255	Passed
External Flow Rate	100 mL/min ± 10 mL/min	105	Passed

7.2 Chromium Baseline Noise

Description: Signal to noise check.

Parameter	Specification	Results	Pass/Fail
Baseline Noise	≤ 0.005 Abs.	0.0011	Passed
Standard Deviation	≤ 0.005	0.0003	Passed

7.3 Chromium Characteristic Mass and Precision

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

Parameter	Specification	Results	Pass/Fail
Cr m_0 Results	≤ 7.0 pg/0.0044 A-s	6.6	Passed
Precision	≤ 2.0 %	1.47	Passed

7.4 Copper Characteristic Mass and Zeeman Ratio

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

Parameter	Specification	Results	Pass/Fail
Cu m_0 Result	≤ 16.5 pg/0.0044 A-s	15.4	Passed
Zeeman Ratio	0.52 ± 0.04	0.52	Passed

8. Review:

☑ Review with the customer PM work performed.

☑ Review with the customer routine maintenance procedures.

☑ Discuss recommended customer supplied materials to have on hand.

☑ Attach PM sticker.

Additional Comments

Additional Comments Regarding the PM
Zeeman Ratio $= \frac{Atomic\ Signal\ (Peak\ area\ )}{Atomic\ Signal\ (Peak\ area\ ) + Background\ Signal\ (Peak\ area\ )}$ $= \frac{0.1456}{0.1456+0.1293}$ $= 0.52$

Review

The preventive maintenance checks and if applicable performance tests for PinAAcle 900Z have been completed. ***This PinAAcle 900Z Passes ☑ Fails ☐ the preventive maintenance.***	
Review of Preventive Maintenance:	
Authorized PerkinElmer Representative: Dhanraj	Date: 30-Jun-2023 (DD-MMM-YYYY)
Authorized Customer Representative: Rajwin Posit	Date: 30-Jun-2023 (DD-MMM-YYYY)

Calibration Certificate ID
TH2036-003-011723-ACC-TH

METTLER TOLEDO

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

NSC-TISI-TIS 17025
CALIBRATION 0062

Accuracy Calibration Certificate

Customer

Company:	Environment Research & Technology Co., Ltd.		
Address:	25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Toongsonghong		
City:	Laksi	**Contact:**	Ramita Taengthai
Zip / Postal:	10210		
State / Province:	Bangkok		
Order Number:	*0332617856*		

Weighing Device

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

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

Procedure

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

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

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

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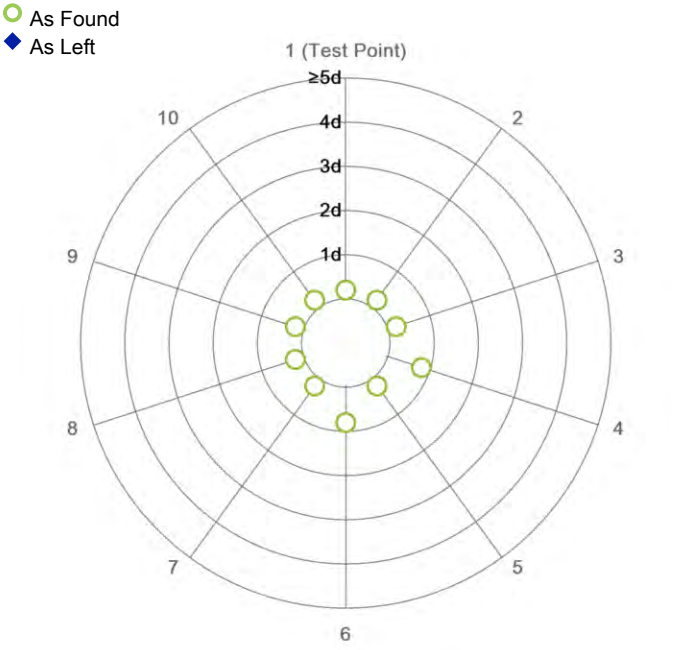
Measurement Results

Repeatability

Test Load: 100 g

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

Standard Deviation	**0.00004 g**	**N/A**



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

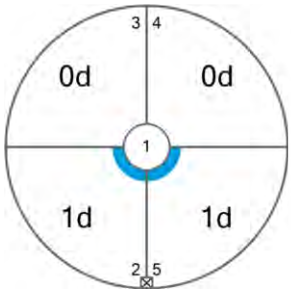
The results of this graph are based upon the absolute values of the differences from the mean value.

Eccentricity

Test Load: 100 g

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

Maximum Deviation	**0.0001 g**	**N/A**



As Found

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

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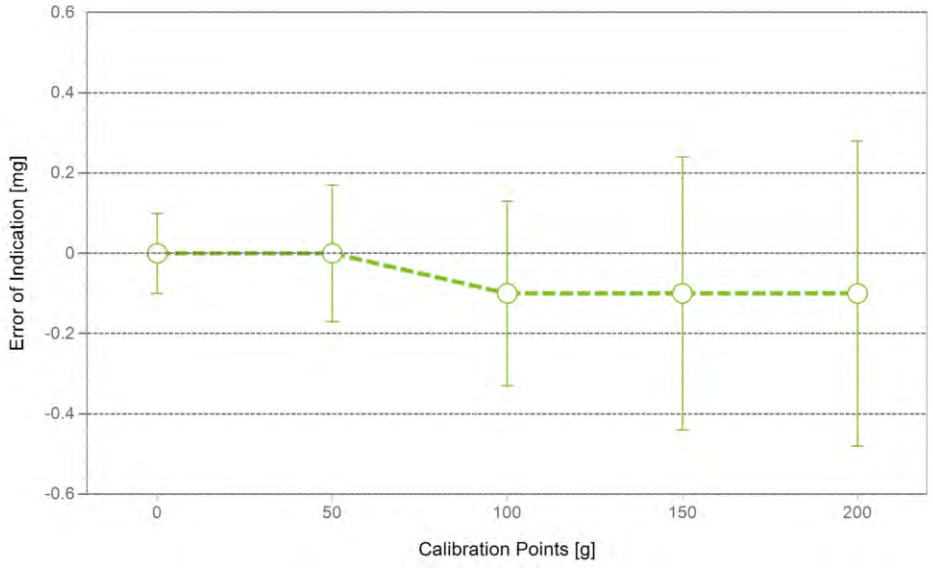
Error of Indication

As Found

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



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.

Test Equipment

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

Weight Set 1: OIML E2

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

Thermo Hygrometer

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

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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

End of Accredited Section

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

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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

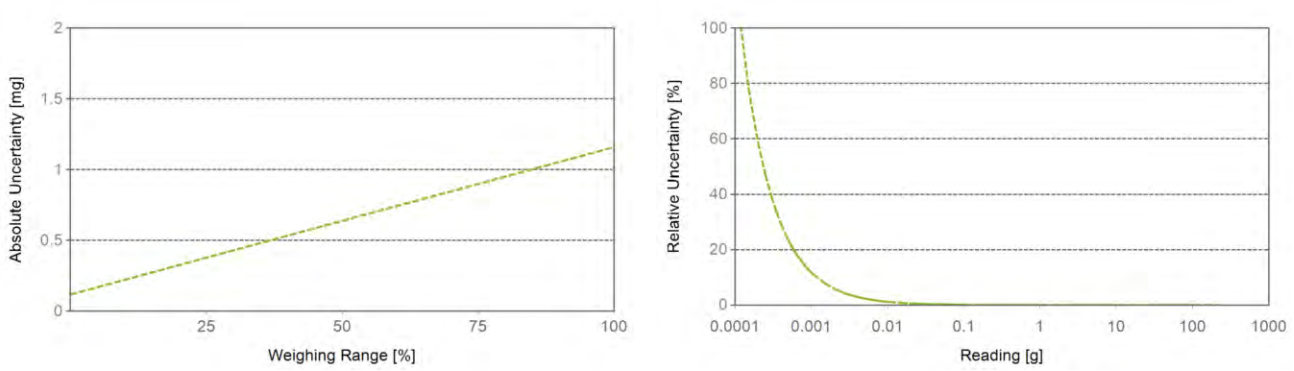
Linearization of Uncertainty Equation

Range			As Found	As Left
	d	Max		
1	0.0001 g	220 g	U_1 = 0.12 mg + 0.00474 mg/g · R	N/A

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

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

Net Indication	As Found		As Left	
0.0220 g	0.12 mg	0.55%	N/A	N/A
0.2200 g	0.12 mg	0.055%	N/A	N/A
2.2000 g	0.13 mg	0.0059%	N/A	N/A
22.0000 g	0.22 mg	0.0010%	N/A	N/A
220.0000 g	1.2 mg	0.00053%	N/A	N/A



As Found As Left

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METTLER TOLEDO Service

GWP® Certificate

As Found

The weighing device meets the given process requirements.

As Left

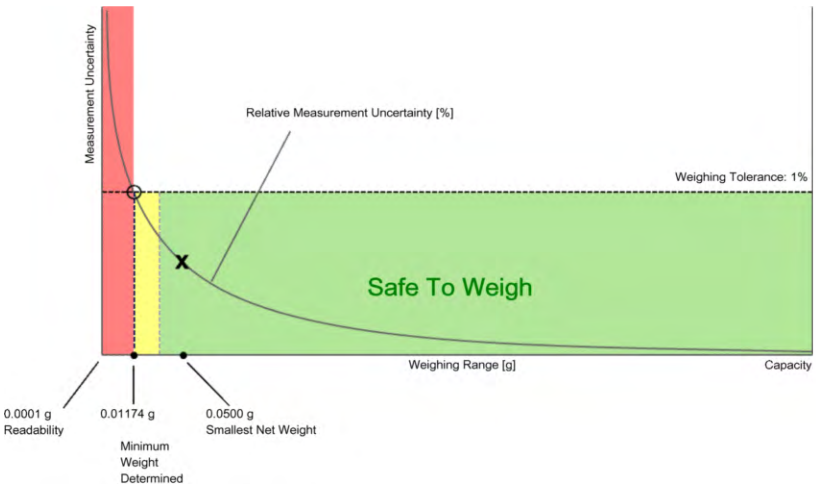
The weighing device meets the given process requirements.

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: **0.0500 g** | Safety Factor: **2**

Safe Weighing Range



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

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Minimum Weight

As Found Minimum Weight Table

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

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

As Left Minimum Weight Table

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

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

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

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

Notes on minimum weight values in above table:

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

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Measurement Results

Results Summary

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

✓ = Passed

✗ = Failed

⚠ = Safety Factor not met

Repeatability

Test Load: 100 g

		As Found		As Left	
Tolerance	Control Limit	Std. Deviation	Result	Std. Deviation	Result
0.1%	N/A	0.00004 g*	N/A	0.00004 g*	N/A
0.2%	0.00005 g		✓		⚠
0.5%	0.00013 g		✓		✓
1%	0.00025 g		✓		✓
2%	0.00050 g		✓		✓
5%	0.00125 g		✓		✓

*The calculated standard deviation value is below the rounding error of the balance. The 0.41*d rule is used for the assessment of this repeatability test and the calculation of the minimum weight.

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

Eccentricity

Test Load: 100 g

		As Found		As Left	
Tolerance	Control Limit	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.

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Error of Indication

As Found

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

As Left

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

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

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534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484

NSC-TISI-TIS17025
CALIBRATION 0008

Certificate of Calibration

Equipment :	Hot Air Oven
Manufacturer :	Memmert
Model :	UF 110
Serial No. :	B414.0652
ID No. :	ERTC-L-In.-098
Submitted by :	Environment Research & Technology Company Limited. 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210
Location :	Laboratory (ERTC)
Received Order :	4 January 2023
Calibration Date :	4 January 2023
Ambient Temperature :	(26 ± 10) °C
Relative Humidity :	(50 ± 30) %
Calibrated by :	Preecha Hlahib

Approved by : Malu .
Approved Signatory

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

Issue Date : 16 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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

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

Cert. No.: 23TM32

Procedure Used :-

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

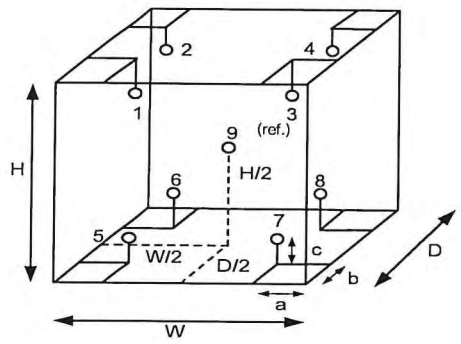
1. Reference standard instrument:-

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

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

Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

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



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

Probe Installation Details :

a =	5.0	cm
b =	5.0	cm
c =	5.0	cm

Dimension of Chamber :

D =	0.40	m
W =	0.56	m
H =	0.48	m
Capacity =	0.11	m^3

Malu.

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

Cert. No.: 23TM32

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

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

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

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

-o0o-

Malu.

TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
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534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484

NSC-TISI-TIS17025
CALIBRATION 0008

Certificate of Calibration

Equipment :	Hot Air Oven
Manufacturer :	Binder
Model :	FED 115 E2
Serial No. :	11-22823
ID No. :	ERTC-L-In.-076
Submitted by :	Environment Research & Technology Company Limited. 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210
Location :	Laboratory (ERTC)
Received Order :	4 January 2023
Calibration Date :	4 January 2023
Ambient Temperature :	(26 ± 10) °C
Relative Humidity :	(50 ± 30) %
Calibrated by :	Preecha Hlahib

Approved by : Malee .
Approved Signatory

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

Issue Date : 16 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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

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

Cert. No.: 23TM31

Procedure Used :-

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

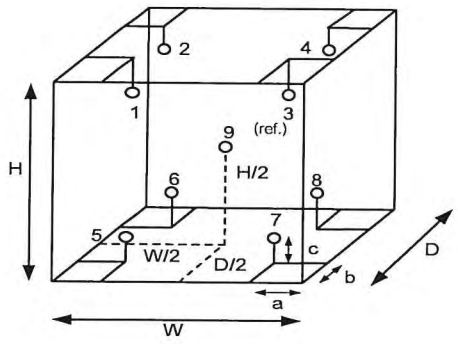
1. Reference standard instrument:-

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

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

Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

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



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

Probe Installation Details :

a =	5.0	cm
b =	5.0	cm
c =	5.0	cm

Dimension of Chamber :

D =	0.40	m
W =	0.60	m
H =	0.48	m
Capacity =	0.12	m^3

Malu .

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

Cert. No.: 23TM31

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

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

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

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

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Malu.

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

NSC-TISI-TIS17025
CALIBRATION 0008

Cert.No.: 22CH1758

Certificate of Calibration

Equipment :	Conductivity Meter
Manufacturer :	HM DIGITAL
Model :	COM-100
Serial No. :	PONPE5860865
ID No. :	NO.1
Condition As-Received:	Used Item
Received Date :	27 December 2022
Calibration Date :	27 December 2022
Reference :	2212-0734WN-7
Submitted by :	Environment Research & Technology Company Limited. 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210
Ambient Temperature :	(25 ± 2.5) °C
Relative Humidity :	(50 ± 15) %
Calibration Procedure:	In -house method : - CP-CH6 : based on direct measurement by using certified reference material (CRM)
Calibrated by :	Walalak Sirithean
Approved by :	Warakorn. Approved Signatory

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

Issue Date : 28 December 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 0048995

Condition of this result of calibration

1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Certificate No.	Due date
1) Thermometer	9549224	130RC003	22I484	17 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 :-

- Conductivity calibration solution, Thermo Scientific (traceable to NIST)
- Conductivity calibration solution, CPA chem Ltd., The measurement results are traceable to SI through CPA chem Ltd., ANSI-ASQ National Accreditation Board, Accredited No. AR-1835

Conductivity Solution	Manufacturer	Lot No.	Exp. date
*100 µS/cm	Thermo Scientific	152/01	14 Apr 2023
1413.0 µS/cm	CPA Chem	823328	20 June 2023

- Control Conductivity calibration solution temperature by Water bath (25±0.1) °C

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

Calibration results

Function : Conductivity Measurement

(*) After Adjustment at 1413.0 µS/cm

Conductivity Electrode Serial No.: PONPE5860865

Standard Conductivity Solution	Before Adjustment UUC* Reading	After Adjustment UUC* Reading	Uncertainty of Measurement (±)	Coverage factor k
*100 µS/cm	95.8 µS/cm	95.0 µS/cm	5.1 µS/cm	2.00
1413.0 µS/cm	1430 µS/cm	1410 µS/cm	11 µS/cm	2.00

Remark **- UUC* = Unit Under Calibration**

- * = Not NSC - ONSC Accredited

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

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Warakorn.

TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
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534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484

NSC-TISI-TIS17025
CALIBRATION 0008

Certificate of Calibration

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

Approved by : Malee.

Approved Signatory

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

Issue Date : 16 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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

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

Cert. No.: 23TM3

Procedure Used :-

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

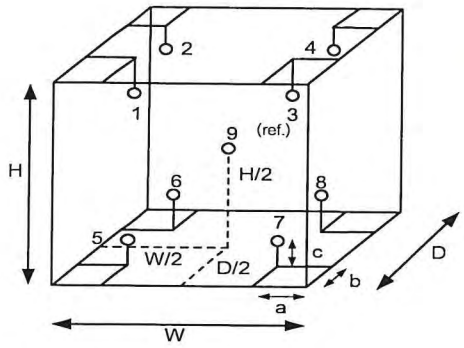
1. Reference standard instrument:-

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

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

Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

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



Probe Installation Details :

a =	5.0	cm
b =	5.0	cm
c =	5.0	cm

Dimension of Chamber :

D =	0.40	m
W =	0.56	m
H =	0.73	m
Capacity =	0.16	m^3

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

Malu -

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

Cert. No.: 23TM3

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (±°C)	Coverage Factor *k*
35.0	35.0	35.0	0.026	0.30	0.33	0.30	2

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

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

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

-o0o-

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

NSC-TISI-TIS17025
CALIBRATION 0008

Certificate of Calibration

Equipment :	Incubator
Manufacturer :	Ehret
Model :	BK 4106
Serial No. :	22162
ID No. :	ERTC-L-In.-022
Submitted by :	Environment Research & Technology Company Limited. 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210
Location :	ห้องปฏิบัติการบ่มอาหารเลี้ยงเชื้อ (408/2)
Received Order :	4 January 2023
Calibration Date :	4 January 2023
Ambient Temperature :	(26 ± 10) °C
Relative Humidity :	(50 ± 30) %
Calibrated by :	Krisda Malee

Approved by : Malee .
Approved Signatory

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

Issue Date : 17 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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

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

Cert. No.: 23TM1

Procedure Used :-

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

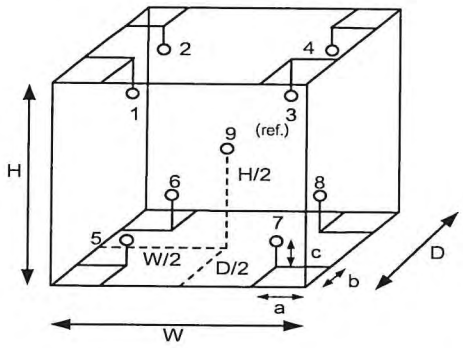
1. Reference standard instrument:-

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

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

Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

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



Probe Installation Details :

a =	5.0	cm
b =	5.0	cm
c =	5.0	cm

Dimension of Chamber :

D =	0.50	m
W =	0.60	m
H =	0.50	m
Capacity =	0.15	m^3

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

Malu

Equipment : Incubator
Condition As-Received : Used Item
Reference : 2301-0002ON-6
Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

Cert. No.: 23TM1

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (±°C)	Coverage Factor *k*
44.5	44.5	44.5	0.34	1.3	1.9	0.80	2

Calibration Point (°C)	Measured Temperature (°C) Position								
	1	2	3	4	5	6	7	8	9 (ref.)
44.5	44.527	45.501	45.139	45.606	43.898	44.165	44.411	44.551	45.204

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

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

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Malu .

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www.enviresearch.co.th
Head Office/Tax ID 0105 542 064 981

Sound Level Meter Calibration Report

Support Equipment Type : Sound Level Calibrator
Manufacture : Quest Technologies
Model : QC-10
Serial No. : QE2080089
Range of Calibrator
- Sound Pressure Level : 114.0 dB.
- Frequency : 1,000 Hz.
Calibrated By : Ms.Natnalita Kotphan
Calibration Date : February 17, 2023
Customer Name : Korachindustry Co., Ltd. (โครงการโรงไฟฟ้าชีวมวลโครงการ 3 (SPP Hybrid Firm))

Item	Equipment			Actual Reading (dB(A))		Status
	Brand	Model	Serial Number	Before Adjustment	After Adjustment	
1	ACO	6236	222109	114.0	114.0	Pass
2	ACO	6236	222121	113.9	114.0	Pass
3	EXTECH	SL400	180200301	113.9	114.0	Pass
4	EXTECH	SL400	180200315	113.8	114.0	Pass

Checked By

Mr.Prayun Detkla
Technician

Approved By

Ms.Sutatip Im-noi
Environmental Scientist

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Sound Level Meter Calibration Report

Support Equipment Type : Sound Level Calibrator
Manufacture : Quest Technologies
Model : QC-10
Serial No. : QE8100348
Range of Calibrator
- Sound Pressure Level : 113.8 dB.
- Frequency : 1,000 Hz.
Calibrated By : Ms.Rawipa Jarana
Calibration Date : May 6, 2023
Customer Name : Korachindustry Co., Ltd. (โครงการโรงไฟฟ้าชีวมวลโครงการ 3 (SPP Hybrid Firm))

Item	Equipment			Actual Reading (dB(A))		Status
	Brand	Model	Serial Number	Before Adjustment	After Adjustment	
1	ACO	6226	160111	114.0	113.8	Pass
2	ACO	6226	180066	114.1	113.8	Pass
3	EXTECH	SL400	190800236	113.7	113.8	Pass
4	EXTECH	SL400	180200304	113.8	113.8	Pass

Checked By ..... Mr.Prayun Detkla
Technician

Approved By ..... Ms.Sutatip Im-noi
Environmental Scientist

NSC-TISI-TIS 17025
CALIBRATION 0037

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0080 **MTC No.** EEL. BP. 28/1165

CALIBRATION CERTIFICATE

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

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

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

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

Instrument Calibrated :

Description : Acoustic Calibrator

Manufacturer : Quest Technology

Model : QC-10

Serial No. : QE8100348

Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325 ± 1.500) kPa

Standards used :

1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Bruel&Kjaer 2636 S/N 1537484.
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
4. Digital Multimeter Agilent 34401A S/N MY44005560.
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
6. Audio Analyzer Panasonic VP-7722A S/N 041477D122.
7. Condenser Microphone B&K 4180 S/N 2633526.

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

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

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

Date of Receipt : 7 Nov. 2022

Date of Calibration : 14 Nov. 2022

The results relate only to the items tested/calibrated or value assigned.
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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0080 **MTC No.** EEL. BP. 28/1165

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

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

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

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	113.77	-0.23	± 0.10	±0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	992.4	-7.6	± 1.5	±1.0%

3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	0.52	± 0.50	±3.0%

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by :

.....

(Mr.Weerachai Deechaiyae)

Approved by :

.....

(Mr.Prawate Kluaypa)

Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 14 Nov. 2022

Date of Issue : 15 Nov. 2022

Ref : 20112651107048340O5

End of Certificate

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0605 **MTC No.** EEL. BP. 100/0665

CALIBRATION CERTIFICATE

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

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

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.
: Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Calibrator

Manufacturer : Quest Electronics

Model : QC-10

Serial No. : QE2080089

Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325 ± 1.500) kPa

Standards used : 1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Bruel&Kjaer 2636 S/N 1537484.
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
4. Digital Multimeter Agilent 34401A S/N MY44005560.
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
6. Audio Analyzer Panasonic VP-7722A S/N 041477D122.
7. Condenser Microphone Bruel&Kjaer 4180 S/N 2633526.

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

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

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

Date of Receipt : 29 Jun. 2022

Date of Calibration : 4 Jul. 2022

The results relate only to the items tested/calibrated or value assigned.
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E-mail : sumalee@tistr.or.th

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0605 **MTC No.** EEL. BP. 100/0665

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

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

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

1. Sound Pressure Level

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

2. Frequency

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

3. Total Distortion

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

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by :

(Mr.Nuttapong Niljrusvanit)

(Mr.Tawikiat Iamsamran)

Approved by :

(Mr.Prawate Kluaypa)

Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 4 Jul. 2022

Date of Issue : 6 Jul. 2022

Ref : 20112650629029320005 2 / 2

End of Certificate

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Personal Pump Calibration Report

Equipment Type : Personal Pump
Equipment Range : 0.005 – 5.0 L/min
Calibration Range : 0.01 – 3.0 L/min
Calibration Type : DryCal Bubble Type
Volume for Calibration : 0.20 L/min, 1.0 L/min, 1.7 L/min, 2.0 L/min
Calibrated By : Ms.Nattina Patcha
Calibration Date : February 13, 2023
Customer Name : Korachindustry Co., Ltd. (โครงการโรงไฟฟ้าชีวมวลโครงการ 3 (SPP Hybrid Firm))

Item	Personal Pump Serial Number	High Flow/ Low Flow	First Time	Second Time	Third Time	Average	Uncertainty
1	ERTC26: 3-43438	0.20 L/min	0.2034	0.2038	0.2040	0.2037	±0.0003
2	ERTC157: 20190605036	2.0 L/min	2.040	2.049	2.050	2.046	±0.0055
3	ERTC159: 20190605039	1.7 L/min	1.721	1.718	1.710	1.716	±0.0057
4	ERTC176: 20210803025	2.0 L/min	2.033	2.035	2.032	2.033	±0.0015
5	ERTC180: 20220201002	1.0 L/min	1.074	1.068	1.071	1.071	±0.0030

Checked By ..... Mr.Prayun Detkla
Technician

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Approved By ..... Ms.Sutatip Im-noi
Environmental Scientist

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Personal Pump Calibration Report

Equipment Type : Personal Pump
Equipment Range : 0.005 – 5.0 L/min
Calibration Range : 0.005 – 3.0 L/min
Calibration Type : DryCal Bubble Type
Volume for Calibration : 1.7 L/min, 2.0 L/min
Calibrated By : Mr.Natthapon Suttimon
Calibration Date : May 3, 2023
Customer Name : Korachindustry Co., Ltd. (โครงการโรงไฟฟ้าชีวมวลโครงการ 3 (SPP Hybrid Firm))

Item	Personal Pump Serial Number	High Flow/ Low Flow	First Time	Second Time	Third Time	Average	Uncertainty
1	ERTC126: 12466	1.7 L/min	1.701	1.703	1.701	1.702	±0.0012
2	ERTC166: 20070301002	2.0 L/min	2.017	2.031	2.052	2.033	±0.0176

Checked By ..... Mr.Prayun Detkla
Technician

Approved By ..... Ms.Sutatip Im-noi
Environmental Scientist

NSC-TISI-TIS 17025
CALIBRATION 0060

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

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

Request No.23-66/0125

MTC.No.23-66/0125

Number of page(s) 2

CALIBRATION CERTIFICATE

Nomenclature : DRYCAL DC-LITE

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

Serial No.: 108398

Model : DCL-ML

Scale range : 50 ml/min to 2000 ml/min

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

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

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

Toongsonghong, Laksi, Bangkok 10210, Thailand.

Received date : 8 December 2022 **Condition of measured item :** Normal

Calibration date : 15 December 2022

Standard :

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

Calibrated by : Terasak Panna .....

(Mr.Terasak Panna)

Approved by : .....

(Ms.Kirana Luanghirun)

Director

Mechanical Engineering Standards Laboratory

Ref. 2013265120805271001

Issued Date 15 December 2022

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

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

Request No.23-66/0125 **2/2** MTC.No.23-66/0125

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

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

Atmospheric pressure (1010±13) hPa

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

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

Measurement data :

UUC Value (ml/min)	Standard Value (ml/min)	Temperature (°C)	Pressure (hPa)	Deviation (%)	Uncertainty (%)
50.78	49.685	23.783	1012.46	+2.21	1.08
200.3	195.56	23.787	1013.15	+2.44	0.98
2017	1956.0	23.659	1022.46	+3.12	0.86

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

The end of calibration certificate.

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E-mail : sumalee@tistr.or.th

Request No. 22-65 / 0800 **MTC No.** PSL-H 0316 / 65

Certificate of Calibration

Customer :	Environment Research & Technology Company Limited 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok
Equipment :	Thermo-Hygrometer (Area Heat Stress Monitor)
Model /Type :	hs-32
Serial Number :	MCH110038
Maker :	METROSONICS
Date of Request :	5 August 2022
Date of Calibation :	16 August 2022

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

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

Calibrated by :

Panit T.

(Ms. Panit Thummasri)

Approved by :

(Mr. Kamchai Singhapiwat)
Director
Photometry and Temperature Standards Laboratory

วว.TISTR

Ref. No : 20222650805034680001

Issued Date : 12 September 2022

The results relate only to the items tested/calibrated or value assigned.
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Head Office
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Fax. (66) 0 2579 8592
E-mail : sumalee@tistr.or.th

Request No. 22-65 / 0800 **MTC No.** PSL-H 0316 / 65

Description of Unit Under Calibration :

Customer :	Environment Research & Technology Company Limited
Address :	25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok
Equipment :	Thermo-Hygrometer (Area Heat Stress Monitor)
Serial Number :	MCH110038
Calibration Required :	Temperature at (30, 35, 40) °C
Ambient Condition :	Ambient temperature (23 ± 3) °C
	Relative humidity (55 ± 20) %
Laboratory Address :	Photometry and Temperature Standards Laboratory
	Soi 1, Bangpoo Industrial Estate, Sukhumvit Rd., Samutprakan

Reference Standard :

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

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

Calibration Procedure :

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

Support Equipment :

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

Adjustments : NONE

P.T.

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Request No. 22-65 / 0800 **MTC No.** PSL-H 0316 / 65

Results of Calibration :-

Table : Temperature Measurement @ Wet Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	30.4	-0.4	0.50
35.0	35.4	-0.4	0.50
40.1	40.1	0.0	0.50

Table : Temperature Measurement @ Dry Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	30.3	-0.3	0.50
35.0	35.3	-0.3	0.50
40.1	40.4	-0.3	0.50

P.T.

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Request No. 22-65 / 0800 **MTC No.** PSL-H 0316 / 65

Results of Calibration :-

Table : Temperature Measurement @ Globe Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	30.3	-0.3	0.50
35.0	35.2	-0.2	0.50
40.1	40.1	0.0	0.50

Note :

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

...end of certificate...

P.T.

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NSC-TISI-TIS 17025
CALIBRATION 0015

Request No. 22-65 / 0863 **MTC No.** PSL-H 0329 / 65

Certificate of Calibration

Customer :	Environment Research & Technology Company Limited
	25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok
Equipment :	Thermo-Hygrometer (Area Heat Stress Monitor)
Model /Type :	hs-32
Serial Number :	MCD070019
Maker :	METROSONICS
Date of Request :	31 August 2022
Date of Calibation :	15 September 2022

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

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

Calibrated by :

(Ms. Panit Thummasri)

Approved by :

(Mr. Kamchai Singhapiwat)
Director
Photometry and Temperature Standards Laboratory

Ref. No : 20122650831038840001
Issued Date : 3 October 2022

The results relate only to the items tested/calibrated or value assigned.
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Request No. 22-65 / 0863 **MTC No.** PSL-H 0329 / 65

Description of Unit Under Calibration :

Customer :	Environment Research & Technology Company Limited
Address :	25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok
Equipment :	Thermo-Hygrometer (Area Heat Stress Monitor)
Serial Number :	MCD070019
Calibration Required :	Temperature at (30, 35, 40) °C
Ambient Condition :	Ambient temperature (23 ± 3) °C
	Relative humidity (55 ± 20) %
Laboratory Address :	Photometry and Temperature Standards Laboratory
	Soi 1, Bangpoo Industrial Estate, Sukhumvit Rd., Samutprakan

Reference Standard :

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

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

Calibration Procedure :

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

Support Equipment :

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

Adjustments : NONE

P.T.

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Request No. 22-65 / 0863 **MTC No.** PSL-H 0329 / 65

Results of Calibration :-

Table : Temperature Measurement @ Wet Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	29.6	0.4	0.50
35.0	34.5	0.5	0.50
40.0	39.4	0.6	0.50

Table : Temperature Measurement @ Dry Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	29.9	0.1	0.50
35.0	34.8	0.2	0.50
40.0	39.7	0.3	0.50

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Request No. 22-65 / 0863 **MTC No.** PSL-H 0329 / 65

Results of Calibration :-

Table : Temperature Measurement @ Globe Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	29.7	0.3	0.50
35.0	34.6	0.4	0.50
40.0	39.4	0.6	0.50

Note :

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

...end of certificate...

P.T.

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NSC-TISI-TIS 17025
CALIBRATION 0015

Request No. 22-65 / 0700 **MTC No.** PSL-H 0308 / 65

Certificate of Calibration

Customer :	Environment Research & Technology Company Limited
	25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok
Equipment :	Thermo-Hygrometer (Area Heat Stress Monitor)
Model /Type :	hs-32
Serial Number :	MCH110063
Maker :	METROSONICS
Date of Request :	29 June 2022
Date of Calibation :	26 July 2022

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

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

Calibrated by :

Panit T

(Ms. Panit Thummasri)

Approved by :

(Mr. Kamchai Singhapiwat)
Director
Photometry and Temperature Standards Laboratory

Ref. No : 20122650629029280 01

Issued Date : 8 August 2022

The results relate only to the items tested/calibrated or value assigned.
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E-mail : sumalee@tistr.or.th

Request No. 22-65 / 0700 **MTC No.** PSL-H 0308 / 65

Description of Unit Under Calibration :

Customer :	Environment Research & Technology Company Limited
Address :	25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok
Equipment :	Thermo-Hygrometer (Area Heat Stress Monitor)
Serial Number :	MCH110063
Calibration Required :	Temperature at (30, 35, 40) °C
Ambient Condition :	Ambient temperature (23 ± 3) °C
	Relative humidity (55 ± 20) %
Laboratory Address :	Photometry and Temperature Standards Laboratory
	Soi 1, Bangpoo Industrial Estate, Sukhumvit Rd., Samutprakan

Reference Standard :

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

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

Calibration Procedure :

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

Support Equipment :

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

Adjustments : NONE

P.T.

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Request No. 22-65 / 0700 **MTC No.** PSL-H 0308 / 65

Results of Calibration :-

Table : Temperature Measurement @ Wet Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	30.3	-0.3	0.50
35.0	35.2	-0.2	0.50
39.9	40.2	-0.3	0.50

Table : Temperature Measurement @ Dry Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	30.1	-0.1	0.50
35.0	35.1	-0.1	0.50
39.9	40.1	-0.2	0.50

P.T.

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Request No. 22-65 / 0700 **MTC No.** PSL-H 0308 / 65

Results of Calibration :-

Table : Temperature Measurement @ Globe Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	30.2	-0.2	0.50
35.0	35.1	-0.1	0.50
39.9	40.1	-0.2	0.50

Note :

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

...end of certificate...

P.T.

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NSC-TISI-TIS 17025
CALIBRATION 0015

Request No. 22-65 / 0905 **MTC No.** PSL-H 0336 / 65

Certificate of Calibration

Customer :	Environment Research & Technology Company Limited 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok
Equipment :	Thermo-Hygrometer (Area Heat Stress Monitor)
Model /Type :	hs-32
Serial Number :	MCD050029
Maker :	METROSONICS
Date of Request :	16 September 2022
Date of Calibation :	5 October 2022

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

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

Calibrated by :

Panit T.

(Ms. Panit Thummasri)

Approved by :

(Mr. Kamchai Singhapiwat)

Director

Photometry and Temperature Standards Laboratory

Ref. No : 20222650916040860001

Issued Date : 6 October 2022

The results relate only to the items tested/calibrated or value assigned.
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Request No. 22-65 / 0905 **MTC No.** PSL-H 0336 / 65

Description of Unit Under Calibration :

Customer :	Environment Research & Technology Company Limited
Address :	25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok
Equipment :	Thermo-Hygrometer (Area Heat Stress Monitor)
Serial Number :	MCD050029
Calibration Required :	Temperature at (30, 35, 40) °C
Ambient Condition :	Ambient temperature (23 ± 3) °C
	Relative humidity (55 ± 20) %
Laboratory Address :	Photometry and Temperature Standards Laboratory
	Soi 1, Bangpoo Industrial Estate, Sukhumvit Rd., Samutprakan

Reference Standard :

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

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

Calibration Procedure :

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

Support Equipment :

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

Adjustments : NONE

P.T.

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E-mail : sumalee@tistr.or.th

Request No. 22-65 / 0905 **MTC No.** PSL-H 0336 / 65

Results of Calibration :-

Table : Temperature Measurement @ Wet Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	29.9	0.0	0.50
34.9	34.8	0.1	0.50
40.0	39.7	0.3	0.53

Table : Temperature Measurement @ Dry Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	30.0	-0.1	0.50
34.9	34.9	0.0	0.50
40.0	39.8	0.2	0.50

P.T.

The results relate only to the items tested/calibrated or value assigned.
Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

Head Office
35 Mu 3 Tambon Khlong Ha, Amphoe Khlong Luang, Changwat Pathumthani 12120, Thailand
Tel. (66) 0 2577 9000
Fax. (66) 0 2577 9009
E-mail : rumpai@tistr.or.th Website:www.tistr.or.th

Office/Laboratory
Soi 1C, Bangpoo Industrial Estate, Sukhumvit Road, Amphoe Muang, Changwat Samutprakan 10280, Thailand
Tel. (66) 0 2323 1672-80 ext. 115, 116
Fax. (66) 0 2323 9165
E-mail : mtc@tistr.or.th

Office
196 Phahonyothin Road, Chatuchak, Bangkok 10900, Thailand
Tel. (66) 0 2579 1121-30 ext. 5219, 5225, 5217
Fax. (66) 0 2579 8592
E-mail : sumalee@tistr.or.th

Request No. 22-65 / 0905 **MTC No.** PSL-H 0336 / 65

Results of Calibration :-

Table : Temperature Measurement @ Globe Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	29.8	0.1	0.50
34.9	34.6	0.3	0.50
40.0	39.5	0.5	0.53

Note :

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

...end of certificate...

P.T.

The results relate only to the items tested/calibrated or value assigned.
Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

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

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

NSC-TISI-TIS17025
CALIBRATION 0008

Certificate of Calibration

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

Approved by : Malee.

Approved Signatory

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

Issue Date : 16 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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

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

Cert. No.: 23TM3

Procedure Used :-

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

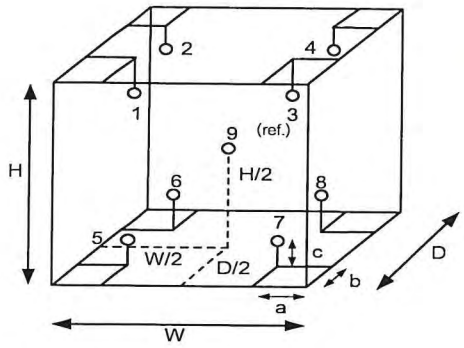
1. Reference standard instrument:-

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

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

Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

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



Probe Installation Details :

a =	5.0	cm
b =	5.0	cm
c =	5.0	cm

Dimension of Chamber :

D =	0.40	m
W =	0.56	m
H =	0.73	m
Capacity =	0.16	m^3

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

Mahe -

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

Cert. No.: 23TM3

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (±°C)	Coverage Factor *k*
35.0	35.0	35.0	0.026	0.30	0.33	0.30	2

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

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

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

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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

NSC-TISI-TIS17025
CALIBRATION 0008

Certificate of Calibration

Equipment :	Incubator
Manufacturer :	Aqualytic
Model :	AL 185 KAT
Serial No. :	12220 0105
ID No. :	ERTC-L-In.-017
Submitted by :	Environment Research & Technology Company Limited. 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210
Location :	408/2 ห้องปฏิบัติการบ่มอาหารเลี้ยงเชื้อ
Received Order :	4 January 2023
Calibration Date :	4 January 2023
Ambient Temperature :	(26 ± 10) °C
Relative Humidity :	(50 ± 30) %
Calibrated by :	Krisda Malee

Approved by : Malee .
Approved Signatory

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

Issue Date : 16 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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

Equipment : Incubator
Condition As-Received : Used Item
Reference : 2301-0002ON-7

Cert. No.: 23TM2

Procedure Used :-

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

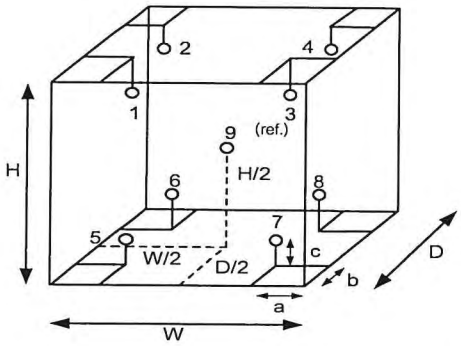
1. Reference standard instrument:-

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

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

Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

Environment during calibration		
	Beginning	Finished
Temp. (°C)	25	26
REL.Humid. (%)	52	50
AC Supply (Volt)	219	221



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

Probe Installation Details :

a =	5.0	cm
b =	5.0	cm
c =	5.0	cm

Dimension of Chamber :

D =	0.50	m
W =	0.60	m
H =	0.50	m
Capacity =	0.15	m^3

Malu .

Equipment : Incubator
Condition As-Received : Used Item
Reference : 2301-0002ON-7
Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (±°C)	Coverage Factor *k*
25.0	24.5	-	0.42	0.38	1.0	0.56	2

Calibration Point (°C)	Measured Temperature (°C) Position								
	1	2	3	4	5	6	7	8	9 (ref.)
25.0	25.019	24.877	24.977	24.968	25.007	25.027	25.138	24.994	25.119

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

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

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

NSC-TISI-TIS17025
CALIBRATION 0008

Certificate of Calibration

Certificate No. : 22PH435
Page : 1 of 2

Equipment : Lux Meter
Manufacturer: Extech
Model : 407026
Serial No.: A.048465
ID No.: -
Condition As-Received: Used Item
Received Date: 25 August 2022
Calibration Date: 29 August 2022

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

Reference: 2208-0898WN
Ambient Temperature: (23 ± 2) °C
Relative Humidity: (50 ± 15) %

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

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

Condition of this result of calibration

1.Reference standards instuments :

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Photometry & Encorder	LMguide 9,6 m	120RC003	61-140006-1	30 Apr 2023
2) High-accuracy Irradiance Standard	OL-FEL-U	F-1471	TP-1037-21	18 Oct 2022

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

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

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

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

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

-National Institute of Metrology Thailand (NIMT)

Calibrated by : Nivat Nitas
Issue Date : 31 August 2022

Approved Signatory : _____

[ ] Phalinee Prabpaipal
[ ] Chatchawan Khunpiluek
[✓] Nuntawat Khamchai

B 0296097

Result of calibration:- (*) Without adjustment ( ) After adjustment

Function : Illuminance Measurement **Range :** 2000 lx

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

Function : Illuminance Measurement **Range :** 20000 lx

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

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

Light source factor setting mode : L
UUC* = Unit Under Calibration.

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
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534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG, BANGKOK 10250
TEL. 0-2717-3000-24 FAX. 0-2719-9484

NSC-TISI-TIS17025
CALIBRATION 0008

Certificate of Calibration

Certificate No. : 22PH391
Page : 1 of 2

Equipment :	Digital Lux Meter
Manufacturer:	Extech
Model :	407026
Serial No.:	A.048597
ID No.:	-
Condition As-Received:	Used Item
Received Date:	27 July 2022
Calibration Date:	02 August 2022
Reference:	2207-0807WN
Ambient Temperature:	(23 ± 2) °C
Relative Humidity:	(50 ± 15) %

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

Submitted by: Environment Research & Technology Company Limited.

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

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

Condition of this result of calibration

1.Reference standards instuments :

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Photometry & Encorder	LMguide 9,6 m	120RC003	61-140006-1	30 Apr 2023
2) High-accuracy Irradiance Standard	OL-FEL-U	F-1471	TP-1037-21	18 Oct 2022

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

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

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

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

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

-National Institute of Metrology Thailand (NIMT)

Calibrated by : Nivat Nitas
Issue Date : 04 August 2022

Approved Signatory : _____

[ ] Phalinee Prabpaipal
[✓] Nuntawat Khamchai

B 0294134

Result of calibration:- (*) Without adjustment ( ) After adjustment

Function : Illuminance Measurement **Range :** 2000 lx

Standard Value	UUC* Reading	Error	Uncertainty
(lx)	(lx)	(lx)	(± lx)
0	0	0	0.60
15	5	-10	0.62
100	92	-8	1.6
500	493	-7	7.3
1000	1001	1	15
1500	1507	7	22
1900	1909	9	28

Function : Illuminance Measurement **Range :** 20000 lx

Standard Value	UUC* Reading	Error	Uncertainty
(lx)	(lx)	(lx)	(± lx)
2000	2010	10	30
3000	2980	-20	45
4000	3910	-90	59
5000	4850	-150	74

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

Light source factor setting mode : L
UUC* = Unit Under Calibration.

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ภาคผนวกที่ 6

เอกสารยินยอมให้ใช้ผลการตรวจวัดร่วมกัน
ของโครงการโรงไฟฟ้าชีวมวล (ส่วนขยาย) ครั้งที่ 1
และโรงงานไฟฟ้าชีวมวลโครงการ 3 (SPP Hybrid Firm)
ของบริษัท อุตสาหกรรมโคราช จำกัด

KORACH INDUSTRY CO., LTD. | บริษัท อุตสาหกรรมโคราช จำกัด
KI ETHANOL CO., LTD. | บริษัท เคไอเอทานอล จำกัด
KI BIOGAS CO., LTD. | บริษัท เคไอไบโอก๊าซ จำกัด
SURIN SUGAR CO., LTD. | บริษัท น้ำตาลสุรินทร์ จำกัด
SURIN ELECTRIC CO., LTD. | บริษัท ไฟฟ้าสุรินทร์ จำกัด

KI SUGAR GROUP | กลุ่มโรงงานน้ำตาลเคไอ
701 Mitrichit Rd., Pom Prab, Pom Prab Sattru Phai, Bangkok 10100
701 ถนนโมตรีจิตต์ แขวงป้อมปราบ เขตป้อมปราบศัตรูพ่าย กรุงเทพฯ 10100
T: (+66) 2 226-5481-7 F: (+66) 2 226-5489

บริษัท อุตสาหกรรมโคราช จำกัด
เลขที่ 111 หมู่ที่ 18 ตำบลหนองระเวียง
อำเภอพิมาย จังหวัดนครราชสีมา 30110
โทรศัพท์ 044-429-400 โทรสาร 044-429-429

ที่ อค. 212/2563

11 มิถุนายน 2563

เรื่อง หนังสือยินยอมให้ใช้ผลการตรวจวัดร่วมกันโครงการโรงไฟฟ้าชีวมวล (ส่วนขยาย) ครั้งที่ 1 ของบริษัท อุตสาหกรรมโคราช จำกัด และโครงการโรงไฟฟ้าชีวมวลโครงการ 3 (SPP Hybrid Firm) ของบริษัท อุตสาหกรรมโคราช จำกัด

ข้าพเจ้าโครงการโรงไฟฟ้าชีวมวล (ส่วนขยาย) ครั้งที่ 1 ของบริษัท อุตสาหกรรมโคราช จำกัด สำนักงานตั้งอยู่เลขที่ 111 หมู่ที่ 18 ตำบลหนองระเวียง อำเภอพิมาย จังหวัดนครราชสีมา ขอทำหนังสือฉบับนี้ขึ้นไว้เพื่อแสดงว่าข้าพเจ้ายินยอมให้ โครงการโรงไฟฟ้าชีวมวลโครงการ 3 (SPP Hybrid Firm) ของบริษัท อุตสาหกรรมโคราช จำกัด ใช้ผลการตรวจวัดคุณภาพอากาศในบรรยากาศโดยทั่วไป จำนวน 4 บริเวณ ได้แก่ บริเวณโรงเรียนหนองบัวลอย, บริเวณโรงเรียนนิคมสร้างตนเองพิมาย 4, บริเวณวัดบ้านเพชร, บริเวณโรงเรียนบ้านหนองโสน ,ระดับเสียงในบรรยากาศทั่วไป จำนวน 6 บริเวณ ได้แก่ บริเวณบ้านหัวถนน, บริเวณบ้านทรัพย์โพธิ์งาม, บริเวณริมรั้วกลุ่มโรงงานด้านทิศเหนือ, บริเวณริมรั้วกลุ่มโรงงานด้านทิศใต้, บริเวณริมรั้วกลุ่มโรงงานด้านทิศตะวันออก, บริเวณริมรั้วกลุ่มโรงงานด้านทิศตะวันตก, คุณภาพน้ำฝน จำนวน 4 บริเวณ ได้แก่ บ้านน้ำตาลพัฒนา, บ้านทรัพย์โพธิ์งาม, บ้านหัวถนน, พื้นที่โครงการ, คุณภาพน้ำทิ้ง จำนวน 1 บริเวณ ได้แก่ บ่อพักน้ำทิ้ง, คุณภาพน้ำผิวดินและทรัพยากรชีวภาพในน้ำ จำนวน 2 บริเวณ ได้แก่ บริเวณลำจักราช, บริเวณคลองจักราช และเพื่อเป็นหลักฐานจึงลงลายมือชื่อไว้เป็นสำคัญ

จึงเรียนมาเพื่อทราบ

บริษัท อุตสาหกรรมโคราช จำกัด

[redacted]

ประธานกรรมการ