



Certificate of Calibration

Calibration Certification Information
Cal. Date: April 30, 2021

Rootsmeter S/N: 438320

Ta: 297

°K
Operator: Jim Tisch

Pa: 742.4

mm Hg
Calibration Model #: TE-5025A

Calibrator S/N: 1089

Run	Vol. Init (m3)	Vol. Final (m3)	ΔVol. (m3)	ΔTime (min)	ΔP (mm Hg)	ΔH (in H2O)
1	1	2	1	1.3900	3.2	2.00
2	3	4	1	0.9790	6.4	4.00
3	5	6	1	0.8800	7.9	5.00
4	7	8	1	0.8350	8.9	5.50
5	9	10	1	0.6900	12.8	8.00

Data Tabulation

Vstd (m3)	Qstd (x-axis)	$\sqrt{\Delta H \left(\frac{Pa}{Pstd} \right) \left(\frac{Tstd}{Ta} \right)}$ (y-axis)	Va	Qa (x-axis)	$\sqrt{\Delta H \left(\frac{Ta}{Pa} \right)}$ (y-axis)
0.9760	0.7021	1.4001	0.9957	0.7163	0.8945
0.9717	0.9926	1.9801	0.9914	1.0126	1.2650
0.9698	1.1020	2.2138	0.9894	1.1243	1.4143
0.9684	1.1598	2.3219	0.9880	1.1832	1.4833
0.9633	1.3961	2.8003	0.9828	1.4243	1.7889
QSTD	m=	2.01976	QA	m=	1.26474
	b=	-0.01895		b=	-0.01211
	r=	0.99996		r=	0.99996

Calculations

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

Standard Conditions
Tstd: 298.15 °K

Pstd: 760 mm Hg

Key
ΔH: calibrator manometer reading (in H2O)

ΔP: rootsmeter manometer reading (mm Hg)

Ta: actual absolute temperature (°K)

Pa: actual barometric pressure (mm Hg)

b: intercept

m: slope

RECALIBRATION

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

Certificate No.: CP20210086EA

Operation No.: CP2021100015

Certificate of Calibration

Equipment: Sound Level Meter

Manufacturer: RION

Model/Type: NL-22 (Meter), UC-52 (Microphone), NH-21 (Preamplifier)

Serial No.: 01252583 (Meter), 106158 (Microphone), 18050 (Preamplifier)

ID No.: -

Customer: TPI Polene Public Company Limited.

Address: 299 Moo5, Mittraphap Road, Thap kwang Sub-district,
Kaeng Khoi District, Saraburi 18260 Thailand

Received Date: 11 November 2021

Calibrated Date: 28 November 2021 - 17 December 2021

Issued Date: 21 December 2021

Calibrated by: Ms. Juntaporn Kunhakom

Approved by:

(Mr. Sittichai Swaksuriyawong)
Group Manager

This report was prepared electronically using applicable electronic signature. Printing or copy of file are considered as a copy of the document.

The reported uncertainty of measurement was based on standard uncertainty multiplied by a coverage factor $k = 2.00$, providing a level of confidence of approximately 95%. This certificate may not be reproduced other than in full except with the prior written approval of the Electrical and Electronics Institute, Foundation for Industrial Development.

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Calibration Report

Equipment: Sound Level Meter
 Manufacturer: RION
 Model/Type: NL-22 (Meter), UC-52 (Microphone), NH-21 (Preamplifier)
 Serial No.: 01252583 (Meter), 106158 (Microphone), 18050 (Preamplifier)
 ID No.: -
 Ambient Temperature: (23 ± 2) °C
 Relative Humidity: (50 ± 15) %
 Pressure: (101.3 ± 1.5) kPa
 Method of Calibration :-
 IEC61672-3:2013.

Condition of this result of calibration

1. Reference standards instrument :-

	Instrument	Model	Serial No.	Cert. No.	Due Date
1)	Standard microphone	4180	2661000	AA-1010-21	13 June 2022
2)	Arbitrary Function Generator	AFG2021	C010063	0145RF21	17 June 2022
3)	Programmable Attenuator	PA5	2913	EF-0017-21	1 April 2022
4)	6.5 Digit precision multimeter	8846A	9610014	CB20210023EA	1 November 2022
5)	Pressure humidity and Temperature Transmitter	PTU301	F0640002	CL1-P210047 0255TE21	16 June 2022 7 July 2022
6)	Pressure humidity and Temperature Transmitter	PTU301	F0640003	CL1-P210048 0256TE21	17 June 2022 7 July 2022
7)	Performance Audio Analyzer	U8903B	MY56510003	0145EL21 0172RF21	11 February 2022 9 September 2022

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

3. This certification is traceable to the international system of unit maintained at :-

Reference standards instrument for Acoustic function

- National Institute of Metrology (Thailand)

Reference standards instrument for Electrical function

- National Institute of Metrology (Thailand)

- Electrical and Electronics Institute; ONSC Accredited Calibration No.0119

Result of Calibration:-

Function : 1. Indication at the calibration check frequency

Reference Acoustic Signal (dB)	Measured value (dB)	Deviation (dB)	Acceptance limits (dB)
94.0	94.0	0.0	±1.0

Note : Absolute sensitivity was established by the use of the Sound Calibrator RION Type NC-74 S/N : 34615278.

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Function : 2. Self-generated Noise

2.1 Microphone Installed

Measured value (dB)
20.7

2.2 Microphone replaced by the electrical input signal device

Frequency Weighting	Measured value (dB)
A-weighting	16.8
C-weighting	22.3
Z-weighting	28.3

Function : 3. Acoustical signal tests of frequency weightings (Without Windscreen)

Meter free-field acoustic response at a level of 84 dB.

Frequency (Hz)	Deviation from various Frequency Weighting Response Curve			
	C-Weighting (dB)	A-Weighting (dB)	Z-Weighting (dB)	Acceptance limits (dB)
125	0.8	0.6	0.7	±1.5
1000	0.1	0.1	0.1	±1.0
8000	-0.5	-0.5	-0.6	±5.0

Function : 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various Frequency Weighting Response Curve			
	C-Weighting (dB)	A-Weighting (dB)	Z-Weighting (dB)	Acceptance limits (dB)
63	-0.1	-0.1	-0.2	±2.0
125	0.0	-0.2	-0.1	±1.5
250	0.0	-0.1	0.0	±1.5
500	0.0	-0.1	0.0	±1.5
1000	0.0	0.0	0.0	±1.0
2000	0.1	0.1	0.1	±2.0
4000	0.2	0.1	0.2	±3.0
8000	0.1	0.1	0.0	±5.0

Function : 5. Frequency and time weighting at 1 kHz

5.1 Frequency weighting at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
C-weighting	94.0	0.0	±0.2
A-weighting	94.0	0.0	±0.2
Z-weighting	94.0	0.0	±0.2

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5.2 Time weighting at 1 kHz

Time Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Fast	94.0	0.0	±0.1
Slow	94.0	0.0	±0.1
LAeq	94.0	0.0	±0.1

Function : 6. Long-Term Stability

Long-term stability over 30 minutes, with steady 1 kHz signal at reference level.

Time Period to Apply Signal (min)	Reference SPL (dB)	Record SPL at Conclusion of Time Period (dB)	Deviated value (dB)	Acceptance limits (dB)
30	94.0	94.0	0.0	±0.3

Function : 7. Level Linearity on the reference level range

7.1 Level Linearity on the reference level range, Upper

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
94.0	94.0	0.0	±1.1
99.0	99.0	0.0	±1.1
104.0	104.0	0.0	±1.1
109.0	109.0	0.0	±1.1
114.0	114.0	0.0	±1.1
119.0	119.0	0.0	±1.1
120.0	120.0	0.0	±1.1
121.0	121.0	0.0	±1.1
122.0	122.0	0.0	±1.1
123.0	123.0	0.0	±1.1
124.0	124.0	0.0	±1.1
125.0	125.0	0.0	±1.1

7.2 Level Linearity on the reference level range, Lower

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
94.0	94.0	0.0	±1.1
89.0	89.1	0.1	±1.1
84.0	84.0	0.0	±1.1
79.0	79.0	0.0	±1.1
74.0	74.0	0.0	±1.1
69.0	69.0	0.0	±1.1
64.0	64.0	0.0	±1.1
59.0	59.0	0.0	±1.1
54.0	54.0	0.0	±1.1
49.0	49.0	0.0	±1.1
44.0	44.0	0.0	±1.1

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7.2 Level Linearity on the reference level range, Lower (Cont.)

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
39.0	39.0	0.0	±1.1
34.0	33.9	-0.1	±1.1
33.0	32.9	-0.1	±1.1
32.0	31.9	-0.1	±1.1
31.0	31.0	0.0	±1.1
30.0	30.0	0.0	±1.1
29.0	29.0	0.0	±1.1
28.0	28.1	0.1	±1.1

Function : 8. Level Linearity including level range control

8.1. Level Linearity Including the Level Range (Reference Signal)

Range	Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
20-100	94.0	94.0	0.0	±1.1
20-110	94.0	94.0	0.0	±1.1
30-120	94.0	94.0	0.0	±1.1
40-130	94.0	94.0	0.0	±1.1

8.2. Level Linearity Including the Level range (5dB Above Under-range)

Range	Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
20-80	25.0	25.9	0.9	±1.1
20-90	25.0	25.9	0.9	±1.1
20-100	25.0	25.9	0.9	±1.1
20-110	25.0	25.8	0.8	±1.1
30-120	35.0	35.0	0.0	±1.1
40-130	45.0	45.2	0.2	±1.1

Function : 9. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Fast	200	116.0	0.0	±1.0
	2	99.0	0.0	+1.0 ; -2.5
	0.25	89.9	-0.1	+1.5 ; -5.0
Slow	200	109.6	0.0	±1.0
	2	90.0	0.0	+1.0 ; -5.0
	200	110.0	0.0	±1.0
LAE	2	90.0	0.0	+1.0 ; -2.5
	0.25	80.9	-0.1	+1.5 ; -5.0

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Function : 10. Peak C sound level

Number of cycles in test signal	Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Complete cycle	125.4	125.2	-0.2	±3.0
Positive half cycle	124.4	124.1	-0.3	±2.0
Negative half cycle	124.4	124.1	-0.3	±2.0

Function : 11. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limits (dB)
Positive one-half cycle	Negative one-half cycle		
139.3	139.3	0.0	±1.5

Function : 12. High-Level Stability

High-level stability over 5 minutes, with steady 1 kHz signal, 1 dB below upper boundary.

Time Period to Apply Signal (min)	Reference SPL (dB)	Record SPL at Conclusion of Time Period (dB)	Deviated value (dB)	Acceptance limits (dB)
5	129.0	129.0	0.0	±0.3

Uncertainty of measurement

Function	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1) Indication at the calibration check frequency	0.30	Not applicable
2) Self-generated Noise	0.10	Not applicable
3) Acoustical signal tests of frequency weightings - Free-field sound pressure response level	0.30	0.60 (10Hz to 4kHz) 0.70 (>4kHz to 10kHz)
4) Electrical signal tests of frequency weightings	0.20	0.20
5) Frequency and time weighting at 1 kHz	0.20	0.20
6) Long-Term Stability	0.10	0.10
7) Level Linearity on the reference level range	0.30	0.30
8) Level Linearity including level range control	0.30	0.30
9) Tone burst response	0.20	0.30
10) Peak C sound level	0.20	0.35
11) Overload indication	0.20	0.25
12) High-Level Stability	0.10	0.10

Remarks: 1. The acceptance limit is for the deviated value.
2. Acceptance limits was IEC61672-3:2013 Class 2.

-- End of Report --



Metrology and Calibration Department
Electrical Maintenance Division
Electricity Generating Authority of Thailand



81 Moo 11 Bangkruai - Sainoi Rd., Sainoi, Nonthaburi 11150 Tel. (662) 436-8789 Ext. 6155

Certificate of Calibration

Issued by : Vibration Laboratory

Certificate No. : 21V039

Reference No. : CJIRA01V002

Received Date : 18 May 2021

Calibrated Date : 02 June 2021

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Client : บริษัท ทีพีโอ โพลีน จำกัด (มหาชน)
Address : 299 หมู่ที่ 5 อ.มิตรภาพ ต.ทับกวาง อ.แก่งคอย จ.สระบุรี 18260
Equipment : VIBRATION METER
Manufacture /Brand : INSTANTEL
Model : Minimate Plus
Serial No./ ID No. : BE18677

(Mr. Anusit Parsittipan)

Authorised Signatory

Issue Date ..

This certificate is issued in accordance with the conditions of accreditation granted by The National Accreditation Council of Thailand which has assessed the measurement capability of the laboratory and its traceability to recognised national standards and to the units of measurement realised at the corresponding national standards laboratory. This certificate may not be reproduced other than in full, except with the prior written approval of the head of calibration services and environmental analysis department.

FM-02/QP-MCC-09 Rev.3

e-mail : MCC@egat.co.th



Metrology and Calibration Department
Electrical Maintenance Division
Electricity Generating Authority of Thailand

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Standard Used

The table below is described the calibrator through the International System of Unit.

Description	Manufacture/Model	Serial No.	Traceable No.	Due Date
Conditioning Amplifier Type 2626	B&K	1242376	AV-0045-20	18 September 2022
Accelerometer Type 8305	B&K	1262817	AV-0043-20	07 December 2022
Digital Mutimeter /8846A	FLUKE	4330020	20E457	01 September 2021

Ambient Environment :

The Calibration was performed in an environment of $(23 \pm 2) ^\circ \text{C}$ and $(50 \pm 10) \%$ relative humidity.

Measurement Method :

The unit under Calibration were calibrated against the standard calibrator with direct measurement method.

The procedure is based on WI-MCC-E-301

Measurement Results

The measurement results, labeled in the following pages give the calibration results and associated with measurement uncertainties.

Measurement Uncertainty

The Measurement Uncertainty are labeled on the following pages Completed the expanded uncertainty, that was calculated in accordance with the method in M3003, using coverage factor $k = 2$. The value of the measured lies within the assigned ranges of values of confidence level of approximately 95%.

Traceability :

The measurement is traceable to the International System of Unit through

- The National Institute of Metrology (Thailand)



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DESCRIPTION	INSTRUMENT VALUE		UNCERTAINTY ±
	STANDARD SETTING	UUC READING	
VERTICAL	mm/s_p	mm/s_p	mm/s_p
	5.00	4.92	0.07
Frequency	10.00	9.80	0.14
* 30 Hz	20.00	19.50	0.28
	30.00	29.20	0.41
Frequency	5.00	4.91	0.07
	10.00	9.79	0.14
40 Hz	20.00	19.50	0.28
	30.00	29.20	0.41

Tranducer Part : 718A3301

Serial No. : BT2555

Condition : Installation by vertical direction



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DESCRIPTION	INSTRUMENT VALUE		UNCERTAINTY ±
	STANDARD SETTING	UUC READING	
TRANSVERSE	mm/s_p	mm/s_p	mm/s_p
	5.00	4.94	0.07
Frequency	10.00	9.83	0.14
* 30 Hz	20.00	19.60	0.28
	30.00	29.40	0.42
	5.00	4.93	0.07
Frequency	10.00	9.80	0.14
40 Hz	20.00	19.50	0.28
	30.00	29.20	0.41

Tranducer Part : 718A3301

Serial No. : BT2555

Condition : Installation by Transverse direction



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DESCRIPTION	INSTRUMENT VALUE		UNCERTAINTY ±
	STANDARD SETTING	UUC READING	
LONGITUDE	mm/s_p	mm/s_p	mm/s_p
	5.00	4.84	0.07
Frequency	10.00	9.61	0.14
* 30 Hz	20.00	19.20	0.27
	30.00	28.70	0.41
	5.00	4.82	0.07
Frequency	10.00	9.58	0.14
40 Hz	20.00	19.10	0.27
	30.00	28.60	0.41

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

Tranducer Part : 718A3301

Serial No. : BT2555

Condition : Installation by Longitude direction

End Certificate of Calibration