

ภาคผนวกที่ ง

เอกสารสอบเทียบความถูกต้องของเครื่องมือ
ตรวจวัดคุณภาพสิ่งแวดล้อม

**ตารางสรุปรายการเอกสารการสอบเทียบความถูกต้องของเครื่องมือเก็บตัวอย่าง
และเครื่องมือตรวจวิเคราะห์คุณภาพสิ่งแวดล้อม**

| รายการตรวจวัด | เครื่องมือเก็บตัวอย่าง | เครื่องมือตรวจวิเคราะห์ |
|-------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------------------------------------------------------|
| | ชื่อเครื่องมือ | ชื่อเครื่องมือ |
| คุณภาพอากาศในบรรยากาศ | | |
| Total Suspended Particulate (TSP) | High Volume Air Sampler No. B02, B08, B10, B29 | Digital Balance |
| Total Suspended Particulate (PM ₁₀) | High Volume PM-10 Air Sampler No. B05, B06, B09, B24 | Digital Balance |
| Sulfur Dioxide (SO ₂) | SO ₂ Analyzer No. B03, B04, B07, B11 | SO ₂ Analyzer No. B03, B04, B07, B11 |
| Nitrogen Dioxide (NO ₂) | NO ₂ Analyzer No. B03, B06, B18, B21 | NO ₂ Analyzer No. B03, B06, B18, B21 |
| คุณภาพน้ำ | | |
| Color | - | Spectrophotometer |
| pH | - | pH Meter |
| Total Suspended Solids | - | Digital Balance |
| Total Dissolved Solids | - | Digital Balance |
| BOD ₅ | - | BOD Analyzer |
| COD | - | COD Reactor |
| Cadmium | - | Inductively Coupled Plasma |
| Total Chromium | - | Inductively Coupled Plasma |
| Lead | - | Inductively Coupled Plasma |
| Manganese | - | Inductively Coupled Plasma |
| Nickel | - | Inductively Coupled Plasma |
| Mercury | - | Atomic Absorption Spectrophotometer |
| Zinc | - | Inductively Coupled Plasma |
| Trivalent Chromium | - | Inductively Coupled Plasma |
| | - | Spectrophotometer |
| Hexavalent Chromium | - | Spectrophotometer |
| Grease & Oil | - | Digital Balance |
| Fecal Coliform Bacteria | - | Water Bath |
| ระดับเสียงในบรรยากาศ | | |
| L _{eq} 24 hr, L _{max} และ L _{dn} | - | Acoustic Calibrator Sound Level Meter No. ACO- B07, B12, B13, B19, B32, B35, B36, R05 |

คุณภาพอากาศในบรรยากาศ



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High Volume Air Sampler Calibration Report

Calibration Method : Multipoint Orifice Flow Transfer Standard

Model : TE 5025A

S/N : 3611

Calibration Data

| High Volume Air Sampler Data | | Calibration Data | | |
|------------------------------|------------|------------------|----------------------------------------|----------------|
| Recorder No. | Blower No. | Date | Actual Flowrate (ft ³ /min) | R ² |
| B01 | B01 | 01/11/2022 | $y = 1.277x - 6.403$ | 0.999 |
| B02 | B02 | 03/11/2022 | $y = 1.083x + 3.505$ | 0.995 |
| B03 | B03 | 03/11/2022 | $y = 1.143x - 1.010$ | 0.996 |
| B04 | B04 | 04/11/2022 | $y = 1.206x - 3.858$ | 0.995 |
| B05 | B05 | 01/11/2022 | $y = 1.317x - 8.733$ | 0.997 |
| B06 | B06 | 01/11/2022 | $y = 1.268x - 5.920$ | 0.998 |
| B07 | B07 | 01/11/2022 | $y = 1.228x - 6.265$ | 0.998 |
| B08 | B08 | 08/11/2022 | $y = 1.160x - 3.496$ | 0.995 |
| B09 | B09 | 03/11/2022 | $y = 1.245x - 5.341$ | 0.997 |
| B10 | B10 | 01/11/2022 | $y = 1.097x + 1.837$ | 0.997 |
| B11 | B11 | 07/11/2022 | $y = 1.153x - 2.164$ | 0.998 |
| B12 | B12 | 04/11/2022 | $y = 1.201x - 3.884$ | 0.998 |
| B13 | B13 | 01/11/2022 | $y = 1.266x - 6.916$ | 0.995 |
| B14 | B14 | 02/11/2022 | $y = 1.269x - 6.120$ | 0.999 |
| B15 | B15 | 02/11/2022 | $y = 1.149x - 1.829$ | 0.997 |
| B16 | B16 | 02/11/2022 | $y = 1.212x - 4.259$ | 0.999 |
| B17 | B17 | 04/11/2022 | $y = 1.172x - 2.143$ | 0.997 |
| B18 | B18 | 04/11/2022 | $y = 1.321x - 9.418$ | 0.996 |
| B19 | B19 | 02/11/2022 | $y = 1.356x - 11.184$ | 0.997 |
| B20 | B20 | 04/11/2022 | $y = 1.310x - 8.682$ | 0.997 |
| B21 | B21 | 03/11/2022 | $y = 1.156x - 2.174$ | 0.999 |
| B22 | B22 | 02/11/2022 | $y = 1.288x - 8.740$ | 0.998 |
| B23 | B23 | 04/11/2022 | $y = 1.247x - 5.764$ | 0.996 |
| B24 | B24 | 01/11/2022 | $y = 1.161x - 2.123$ | 0.999 |
| B25 | B25 | 02/11/2022 | $y = 1.025x + 3.341$ | 0.997 |
| B26 | B26 | 02/11/2022 | $y = 1.234x - 6.128$ | 0.995 |
| B27 | B27 | 03/11/2022 | $y = 1.220x - 5.822$ | 0.997 |
| B28 | B28 | 02/11/2022 | $y = 1.253x - 6.605$ | 0.999 |
| B29 | B29 | 08/11/2022 | $y = 1.311x - 8.876$ | 0.997 |
| B30 | B30 | 07/11/2022 | $y = 1.264x - 7.252$ | 0.998 |
| B31 | B31 | 07/11/2022 | $y = 1.215x - 4.628$ | 0.995 |
| B32 | B32 | 03/11/2022 | $y = 1.258x - 6.433$ | 0.997 |
| B33 | B33 | 03/11/2022 | $y = 1.329x - 7.779$ | 0.995 |
| B34 | B34 | 03/11/2022 | $y = 1.267x - 7.491$ | 0.998 |

Calibrated by :

(Mr. Adul Dangkiom)

Approved by :

(Mr. Peera Detudom)



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High Volume Air Sampler Calibration Report

Calibration Method : Multipoint Orifice Flow Transfer Standard

Model : TE 5025A

S/N : 3611

Calibration Data

| High Volume Air Sampler Data | | Calibration Data | | |
|------------------------------|------------|------------------|----------------------------------------|----------------|
| Recorder No. | Blower No. | Date | Actual Flowrate (ft ³ /min) | R ² |
| B35 | B35 | 03/11/2022 | $y = 1.306x - 9.466$ | 0.997 |
| B36 | B36 | 02/11/2022 | $y = 1.213x - 5.932$ | 0.996 |
| B37 | B37 | 01/11/2022 | $y = 1.253x - 5.209$ | 0.999 |
| B38 | B38 | 01/11/2022 | $y = 1.228x - 5.530$ | 0.995 |
| B39 | B39 | 01/11/2022 | $y = 1.319x - 9.149$ | 0.998 |
| B40 | B40 | 01/11/2022 | $y = 1.196x - 4.045$ | 0.999 |
| B41 | B41 | 07/11/2022 | $y = 1.179x - 2.611$ | 0.999 |
| B42 | B42 | 01/11/2022 | $y = 1.209x - 3.713$ | 0.995 |
| B43 | B43 | 02/11/2022 | $y = 1.187x - 3.331$ | 0.998 |
| B44 | B44 | 07/11/2022 | $y = 1.298x - 8.171$ | 0.996 |
| R01 | R01 | 02/11/2022 | $y = 1.289x - 8.287$ | 0.998 |
| R02 | R02 | 07/11/2022 | $y = 1.307x - 10.165$ | 0.999 |
| R03 | R03 | 03/11/2022 | $y = 1.259x - 7.634$ | 0.995 |
| R04 | R04 | 04/11/2022 | $y = 1.157x - 2.287$ | 0.995 |
| R05 | R05 | 03/11/2022 | $y = 1.273x - 8.311$ | 0.999 |
| R06 | R06 | 01/11/2022 | $y = 1.297x - 8.271$ | 0.999 |
| R07 | R07 | 02/11/2022 | $y = 1.071x + 1.468$ | 0.995 |
| R08 | R08 | 01/11/2022 | $y = 1.206x - 5.068$ | 0.997 |
| R09 | R09 | 01/11/2022 | $y = 1.252x - 7.084$ | 0.995 |
| R10 | R10 | 03/11/2022 | $y = 1.246x - 5.817$ | 0.999 |
| R11 | R11 | 03/11/2022 | $y = 1.117x - 1.156$ | 0.998 |
| R12 | R12 | 02/11/2022 | $y = 1.351x - 12.068$ | 0.996 |
| R13 | R13 | 03/11/2022 | $y = 1.118x - 0.601$ | 0.999 |
| R14 | R14 | 03/11/2022 | $y = 1.164x - 2.415$ | 0.996 |
| R15 | R15 | 03/11/2022 | $y = 1.134x - 1.793$ | 0.998 |
| R16 | R16 | 04/11/2022 | $y = 1.182x - 4.717$ | 0.996 |
| R17 | R17 | 07/11/2022 | $y = 1.218x - 5.356$ | 0.998 |
| R18 | R18 | 04/11/2022 | $y = 1.233x - 5.977$ | 0.996 |
| R19 | R19 | 07/11/2022 | $y = 1.277x - 7.752$ | 0.997 |
| R20 | R20 | 04/11/2022 | $y = 1.327x - 10.628$ | 0.997 |

Calibrated by :

(Mr. Abdul Dangklom)

Approved by :

(Mr. Peera Detudom)



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High Volume PM-10 Air Sampler Calibration Report

Calibration Method : Multipoint Orifice Flow Transfer Standard

Model : TE 5025A

S/N : 3611

Calibration Data

| High Volume PM-10 Data | | Calibration Data | | |
|------------------------|------------|------------------|---------------------------------------|----------------|
| Recorder No. | Blower No. | Date | Actual Flowrate (l ³ /min) | R ² |
| B01 | B01 | 02/11/2022 | $y = 1.206x - 0.557$ | 0.998 |
| B02 | B02 | 02/11/2022 | $y = 1.024x + 3.762$ | 0.999 |
| B03 | B03 | 02/11/2022 | $y = 1.243x - 4.455$ | 0.998 |
| B04 | B04 | 03/11/2022 | $y = 1.293x - 7.303$ | 0.997 |
| B05 | B05 | 03/11/2022 | $y = 1.252x - 5.903$ | 0.999 |
| B06 | B06 | 04/11/2022 | $y = 1.313x - 7.710$ | 0.997 |
| B07 | B07 | 02/11/2022 | $y = 1.290x - 6.671$ | 0.999 |
| B08 | B08 | 04/11/2022 | $y = 1.330x - 6.996$ | 0.999 |
| B09 | B09 | 04/11/2022 | $y = 1.280x - 6.331$ | 0.995 |
| B10 | B10 | 02/11/2022 | $y = 1.298x - 8.225$ | 0.997 |
| B11 | B11 | 04/11/2022 | $y = 1.273x - 5.540$ | 0.995 |
| B12 | B12 | 04/11/2022 | $y = 1.282x - 7.018$ | 0.996 |
| B13 | B13 | 01/11/2022 | $y = 1.320x - 9.281$ | 0.998 |
| B14 | B14 | 02/11/2022 | $y = 1.230x - 3.665$ | 0.998 |
| B15 | B15 | 02/11/2022 | $y = 1.166x - 2.184$ | 0.997 |
| B16 | B16 | 01/11/2022 | $y = 1.260x - 2.121$ | 0.998 |
| B17 | B17 | 04/11/2022 | $y = 1.277x - 4.847$ | 0.998 |
| B18 | B18 | 01/11/2022 | $y = 1.165x - 1.164$ | 0.999 |
| B19 | B19 | 02/11/2022 | $y = 1.094x + 1.145$ | 0.999 |
| B20 | B20 | 02/11/2022 | $y = 1.221x - 5.301$ | 0.997 |
| B21 | B21 | 01/11/2022 | $y = 1.176x - 0.519$ | 0.999 |
| B22 | B22 | 02/11/2022 | $y = 1.286x - 7.131$ | 0.998 |
| B23 | B23 | 03/11/2022 | $y = 1.181x - 2.246$ | 0.999 |
| B24 | B24 | 03/11/2022 | $y = 1.253x - 5.274$ | 0.995 |
| B25 | B25 | 04/11/2022 | $y = 1.159x - 3.062$ | 0.996 |
| B26 | B26 | 03/11/2022 | $y = 1.264x - 6.317$ | 0.998 |
| B27 | B27 | 03/11/2022 | $y = 1.332x - 10.385$ | 0.996 |
| B28 | B28 | 03/11/2022 | $y = 1.165x - 2.689$ | 0.998 |
| B29 | B29 | 03/11/2022 | $y = 1.271x - 7.065$ | 0.996 |
| B30 | B30 | 01/11/2022 | $y = 1.274x - 7.435$ | 0.996 |
| B31 | B31 | 01/11/2022 | $y = 1.244x - 3.676$ | 0.999 |
| B32 | B32 | 01/11/2022 | $y = 1.186x - 1.847$ | 0.999 |
| B33 | B33 | 04/11/2022 | $y = 1.268x - 6.742$ | 0.996 |
| B34 | B34 | 01/11/2022 | $y = 1.321x - 5.654$ | 0.998 |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)



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High Volume PM-10 Air Sampler Calibration Report

Calibration Method : Multipoint Orifice Flow Transfer Standard

Model : TE 5025A

S/N : 3611

Calibration Data

| High Volume PM-10 Data | | Calibration Data | | |
|------------------------|------------|------------------|----------------------------------------------|-------|
| Recorder No. | Blower No. | Date | Actual Flowrate (ft^3/min) | R^2 |
| R01 | R01 | 02/11/2022 | $y = 1.257x - 6.210$ | 0.998 |
| R02 | R02 | 07/11/2022 | $y = 1.240x - 5.054$ | 0.996 |
| R03 | R03 | 03/11/2022 | $y = 1.199x - 4.666$ | 0.996 |
| R04 | R04 | 04/11/2022 | $y = 1.215x - 6.193$ | 0.999 |
| R05 | R05 | 04/11/2022 | $y = 1.210x - 5.386$ | 0.998 |
| R06 | R06 | 02/11/2022 | $y = 1.270x - 6.263$ | 0.995 |
| R07 | R07 | 07/11/2022 | $y = 1.227x - 5.259$ | 0.998 |
| R08 | R08 | 03/11/2022 | $y = 1.258x - 7.271$ | 0.998 |
| R09 | R09 | 07/11/2022 | $y = 1.202x - 6.317$ | 0.999 |
| R10 | R10 | 03/11/2022 | $y = 1.196x - 4.622$ | 0.997 |
| R11 | R11 | 02/11/2022 | $y = 1.284x - 7.142$ | 0.996 |
| R12 | R12 | 02/11/2022 | $y = 1.253x - 7.460$ | 0.996 |
| R13 | R13 | 04/11/2022 | $y = 1.262x - 6.240$ | 0.998 |
| R14 | R14 | 04/11/2022 | $y = 1.254x - 6.659$ | 0.999 |
| R15 | R15 | 03/11/2022 | $y = 1.299x - 9.065$ | 0.998 |
| R16 | R16 | 09/11/2022 | $y = 1.263x - 7.053$ | 0.995 |
| R17 | R17 | 07/11/2022 | $y = 1.224x - 4.966$ | 0.997 |
| R18 | R18 | 07/11/2022 | $y = 1.235x - 5.907$ | 0.999 |
| R19 | R19 | 03/11/2022 | $y = 1.302x - 9.454$ | 0.995 |
| R20 | R20 | 04/11/2022 | $y = 1.244x - 8.211$ | 0.999 |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)



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| CALIBRATION REPORT | | | | | |
|----------------------------------------------------|--------------------------------------|-------------------|--------------------------------|--------------------------------|------------|
| SO ₂ FLUORESCENT ANALYZER | | | | | |
| DATE : | 06 November 2022 | BRAND : | API | MODEL : | 100A |
| NO. | SO ₂ -B03 | | | SERIAL NO. | 1846 |
| Calibrator (Dilution System) | | | | | |
| Brand | : API | | | Model | : 700 |
| Last Cal. Date | : 04 August 2022 | | | Serial No. | : 911 |
| Reference Standard Gas | | | | | |
| Standard Gas | : Sulphur Dioxide (SO ₂) | | | Cylinder No. | : A00814SK |
| Certified Date | : 21 June 2021 | Expired Date | : 21 June 2029 | Cylinder Conc. | : 50.0 ppm |
| CALIBRATING CONDITION | | | | | |
| Pressure | 1011 | mmbar | Temp. | 24.5 | °C |
| | | | % RH | 49 | |
| CALIBRATION SETTING | | | | | |
| Span | Initial Reading (Before Adj.),PPB | | | Final Reading (After Adj.),PPB | |
| Set Point | Expected Concentration | Analyzer Response | %Dif | Analyzer Response | Slope |
| Zero | 0 | -0.10 | - | 0 | - |
| SO ₂ Span | 400.0 | 399.7 | -0.075 | 400.0 | 1.005 |
| API Model 100A SO ₂ Analyzer Check list | | | | | |
| Test Values | Observed Value | Units | Nominal Range | | |
| RANGE | 500 | PPB | 0-500 | | |
| SAMPLE PRESS | 28.4 | in-Hg | 25-35 | | |
| SAMPLE FLOW | 656 | cc/min | 650 ± 10% | | |
| PMT | 103.2 | mV | -20-150 with Zero Air | | |
| UV LAMP | 3021.4 | mV | 1000-4900 | | |
| STR. LGT | 61.4 | PPB | <100 | | |
| DRK PMT | 62.8 | mV | -50 - 200 | | |
| DRK LMP | 57.7 | mV | -50 - 200 | | |
| HVPS | 671 | V | 550-900 constant | | |
| DCPS | 2517 | mV | 2500 ± 200 | | |
| RCELL TEMP | 50.4 | °C | 50 ± 1 | | |
| BOX TEMP | 29.2 | °C | 5-40 | | |
| PMT TEMP | 7.0 | °C | 7 ± 2.0 | | |
| SO ₂ Span Conc | 400 | PPB | 20-20,000 | | |
| SO ₂ Slope | 1.005 | - | 1.0 ± 0.3 | | |
| SO ₂ Offset | 21.7 | mV | <250 | | |
| Stability at Zero | 0.1 | PPB | <0.2 | | |
| Stability at Span | 0.2 | PPB | 0.5% of reading (above 50 ppb) | | |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)



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| CALIBRATION REPORT | | | | | |
|----------------------------------------------------|--------------------------------------|-------------------|--------------------------------|--------------------------------|------------|
| SO ₂ FLUORESCENT ANALYZER | | | | | |
| DATE : | 06 November 2022 | BRAND : | API | MODEL : | 100E |
| NO. | SO ₂ -B04 | | | SERIAL NO. | 3159 |
| Calibrator (Dilution System) | | | | | |
| Brand | : API | | | Model | : 700 |
| Last Cal. Date | : 04 August 2022 | | | Serial No. | : 911 |
| Reference Standard Gas | | | | | |
| Standard Gas | : Sulphur Dioxide (SO ₂) | | | Cylinder No. | : A00814SK |
| Certified Date | : 21 June 2021 | Expired Date | : 21 June 2029 | Cylinder Conc. | : 50.0 ppm |
| CALIBRATING CONDITION | | | | | |
| Pressure | 1011 | mmbar | Temp. | 24.5 | °C |
| | | | % RH | 49 | |
| CALIBRATION SETTING | | | | | |
| Span | Initial Reading (Before Adj.),PPB | | | Final Reading (After Adj.),PPB | |
| Set Point | Expected Concentration | Analyzer Response | %Dif | Analyzer Response | Slope |
| Zero | 0 | 0.11 | - | 0 | - |
| SO ₂ Span | 400.0 | 400.1 | 0.025 | 400.0 | 1.009 |
| API Model 100E SO ₂ Analyzer Check list | | | | | |
| Test Values | Observed Value | Units | Nominal Range | | |
| RANGE | 500 | PPB | 0-500 | | |
| SAMPLE PRESS | 28.7 | in-Hg | 25-35 | | |
| SAMPLE FLOW | 654 | cc/min | 650 ± 10% | | |
| PMT | 103.0 | mV | -20-150 with Zero Air | | |
| UV LAMP | 3079.5 | mV | 1000-4900 | | |
| STR. LGT | 61.8 | PPB | <100 | | |
| DRK PMT | 63.6 | mV | -50 - 200 | | |
| DRK LMP | 58.1 | mV | -50 - 200 | | |
| HVPS | 675 | V | 550-900 constant | | |
| DCPS | 2527 | mV | 2500 ± 200 | | |
| RCELL TEMP | 50.1 | °C | 50 ± 1 | | |
| BOX TEMP | 29.4 | °C | 5-40 | | |
| PMT TEMP | 7.2 | °C | 7 ± 2.0 | | |
| SO ₂ Span Conc | 400 | PPB | 20-20,000 | | |
| SO ₂ Slope | 1.009 | - | 1.0 ± 0.3 | | |
| SO ₂ Offset | 21.9 | mV | <250 | | |
| Stability at Zero | 0.1 | PPB | <0.2 | | |
| Stability at Span | 0.2 | PPB | 0.5% of reading (above 50 ppb) | | |

Calibrated by :

(Mr. Adul Dangkom)

Approved by :

(Mr. Peera Detudom)



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Tel : (662) 939-4370-72, Fax : (662) 513-4221, E-mail : sale@spscn.com, www.spscn.com

| CALIBRATION REPORT | | | | | |
|----------------------------------------------------|--------------------------------------|-------------------|--------------------------------|--------------------------------|------------|
| SO ₂ FLUORESCENT ANALYZER | | | | | |
| DATE : | 06 November 2022 | BRAND : | API | MODEL : | 100E |
| NO. | SO ₂ -B07 | SERIAL NO. | 1706 | | |
| Calibrator (Dilution System) | | | | | |
| Brand | : API | | | Model | : 700 |
| Last Cal. Date | : 04 August 2022 | | | Serial No. | : 911 |
| Reference Standard Gas | | | | | |
| Standard Gas | : Sulphur Dioxide (SO ₂) | | | Cylinder No. | : A00814SK |
| Certified Date | : 21 June 2021 | Expired Date | : 21 June 2029 | Cylinder Conc. | : 50.0 ppm |
| CALIBRATING CONDITION | | | | | |
| Pressure | 1011 | mmbar | Temp. | 24.5 | °C |
| % RH | 49 | | | | |
| CALIBRATION SETTING | | | | | |
| Span | Initial Reading (Before Adj.),PPB | | | Final Reading (After Adj.),PPB | |
| Set Point | Expected Concentration | Analyzer Response | %Dif | Analyzer Response | Slope |
| Zero | 0 | 0.10 | - | 0 | - |
| SO ₂ Span | 400.0 | 399.8 | -0.050 | 400.0 | 1.007 |
| API Model 100E SO ₂ Analyzer Check list | | | | | |
| Test Values | Observed Value | Units | Nominal Range | | |
| RANGE | 500 | PPB | 0-500 | | |
| SAMPLE PRESS | 28.5 | in-Hg | 25-35 | | |
| SAMPLE FLOW | 655 | cc/min | 650 ± 10% | | |
| PMT | 103.3 | mV | -20-150 with Zero Air | | |
| UV LAMP | 3015.3 | mV | 1000-4900 | | |
| STR. LGT | 61.6 | PPB | <100 | | |
| DRK PMT | 63.5 | mV | -50 - 200 | | |
| DRK LMP | 57.8 | mV | -50 - 200 | | |
| HVPS | 673 | V | 550-900 constant | | |
| DCPS | 2521 | mV | 2500 ± 200 | | |
| RCELL TEMP | 50.2 | °C | 50 ± 1 | | |
| BOX TEMP | 29.3 | °C | 5-40 | | |
| PMT TEMP | 7.1 | °C | 7 ± 2.0 | | |
| SO ₂ Span Conc | 400 | PPB | 20-20,000 | | |
| SO ₂ Slope | 1.007 | - | 1.0 ± 0.3 | | |
| SO ₂ Offset | 22.1 | mV | <250 | | |
| Stability at Zero | 0.1 | PPB | <0.2 | | |
| Stability at Span | 0.2 | PPB | 0.5% of reading (above 50 ppb) | | |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)



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Tel : (662) 939-4370-72, Fax : (662) 513-4221, E-mail : sale@spscon.com., www.spscon.com

| CALIBRATION REPORT | | | | | |
|------------------------------------------------------|--------------------------------------|-------------------|--------------------------------|--------------------------------|------------|
| SO ₂ FLUORESCENT ANALYZER | | | | | |
| DATE : | 06 November 2022 | BRAND : | TELEDYNE | MODEL : | TML-50 |
| NO. | SO ₂ -B11 | SERIAL NO. | SO2187 | | |
| Calibrator (Dilution System) | | | | | |
| Brand | : API | | | Model | : 700 |
| Last Cal. Date | : 04 August 2022 | | | Serial No. | : 911 |
| Reference Standard Gas | | | | | |
| Standard Gas | : Sulphur Dioxide (SO ₂) | | | Cylinder No. | : A00814SK |
| Certified Date | : 21 June 2021 | Expired Date | : 21 June 2029 | Cylinder Conc. | : 50.0 ppm |
| CALIBRATING CONDITION | | | | | |
| Pressure | 1011 | mmbar | Temp. | 24.5 | °C |
| | | | % RH | 49 | |
| CALIBRATION SETTING | | | | | |
| Span | Initial Reading (Before Adj.),PPB | | | Final Reading (After Adj.),PPB | |
| Set Point | Expected Concentration | Analyzer Response | %Dif | Analyzer Response | Slope |
| Zero | 0 | 0.11 | - | 0 | - |
| SO ₂ Span | 400.0 | 400.2 | 0.050 | 400.0 | 1.011 |
| API Model TML-50 SO ₂ Analyzer Check list | | | | | |
| Test Values | Observed Value | Units | Nominal Range | | |
| RANGE | 500 | PPB | 0-500 | | |
| SAMPLE PRESS | 28.6 | in-Hg | 25-35 | | |
| SAMPLE FLOW | 659 | cc/min | 650 ± 10% | | |
| PMT | 103.5 | mV | -20-150 with Zero Air | | |
| UV LAMP | 3020.4 | mV | 1000-4900 | | |
| STR. LGT | 61.5 | PPB | <100 | | |
| DRK PMT | 63.2 | mV | -50 - 200 | | |
| DRK LMP | 57.9 | mV | -50 - 200 | | |
| HVPS | 672 | V | 550-900 constant | | |
| DCPS | 2515 | mV | 2500 ± 200 | | |
| RCELL TEMP | 50.3 | °C | 50 ± 1 | | |
| BOX TEMP | 29.0 | °C | 5-40 | | |
| PMT TEMP | 7.4 | °C | 7 ± 2.0 | | |
| SO ₂ Span Conc | 400 | PPB | 20-20,000 | | |
| SO ₂ Slope | 1.011 | - | 1.0 ± 0.3 | | |
| SO ₂ Offset | 22.2 | mV | <250 | | |
| Stability at Zero | 0.1 | PPB | <0.2 | | |
| Stability at Span | 0.2 | PPB | 0.5% of reading (above 50 ppb) | | |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)



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Tel : (662) 939-4370-72, Fax : (662) 513-4221, E-mail : sale@spscon.com, www.spscon.com

| CALIBRATION REPORT | | | | | |
|------------------------------------------------------------------|-----------------------------------|-------------------|----------------------------|--------------------------------|-------|
| CHEMILUMINESCENT NO / NO ₂ / NO _x ANALYZER | | | | | |
| DATE : | 06 November 2022 | BRAND : | API | MODEL : | 200A |
| NO. | NOX-B03 | SERIAL NO. | 2617 | | |
| Calibrator (Dilution System) | | | | | |
| Brand | : API | | Model | : 700 | |
| Last Cal. Date | : 04 August 2022 | | Serial No. | : 911 | |
| Reference Standard Gas | | | | | |
| Standard Gas | : Nitric Oxide (NO) | | Cylinder No. | : D636192 | |
| Certified Date | : 20 April 2022 | | Expired Date | : 20 April 2024 | |
| | | | Cylinder Conc. | : 49.1 ppm | |
| CALIBRATING CONDITION | | | | | |
| Pressure | 1011 | mmbar | Temp. | 24.5 | °C |
| | | | % RH | 49 | |
| CALIBRATION SETTING | | | | | |
| Span | Initial Reading (Before Adj.),PPB | | | Final Reading (After Adj.),PPB | |
| Set Point | Expected Concentration | Analyzer Response | %Dif | Analyzer Response | Slope |
| Zero | 0 | 0.10 | - | 0 | - |
| NO Span | 400 | 400.1 | 0.025 | 400.0 | 1.009 |
| NO _x Span | 400 | 400.3 | 0.075 | 400.0 | 1.012 |
| API Model 200A NO _x Analyzer Check List | | | | | |
| Test Values | Observed Value | Units | Nominal Range | | |
| RANGE | 500 | PPB | 500 standard | | |
| STABILITY (Zero Gas) | 0.1 | PPB | < 2 with zero air | | |
| SAMPLE FLOW | 511 | cc/min | 500 ± 50 | | |
| OZONE FLOW | 79 | cc/min | 80 ± 15 | | |
| PMT | 103.3 | mV | -20 - 150 | | |
| AZERO | 94.1 | mV | -20 - 150 | | |
| HVPS | 671 | V | 420 - 900 constant | | |
| RCELL TEMP | 50.2 | °C | 50 ± 1 | | |
| BOX TEMP | 29.0 | °C | 8 - 48 | | |
| PMT TEMP | 7.3 | °C | 7 ± 2 | | |
| MOLY TEMP | 314.9 | °C | 315 ± 5 | | |
| RCELL PRESS | 8.4 | IN-Hg-A | 2 - 10 constant | | |
| SAMPLE PRESS | 28.7 | IN-Hg-A | 25 - 30 constant | | |
| NO Span Conc | 400 | PPB | 20 - 20,000 | | |
| NO _x Span Conc | 400 | PPB | 20 - 20,000 | | |
| NO Slope | 1.009 | - | 1.0 ± 0.3 | | |
| NO _x Slope | 1.012 | - | 1.0 ± 0.3 | | |
| NO Offset | 1.6 | mV | -20 to +150 | | |
| NO _x Offset | 1.0 | mV | -20 to 150 | | |
| Stability at Zero | 0.1 | PPB | < 0.2 | | |
| Stability at Span | 0.2 | PPB | < 2 ppb @ 400 ppb span gas | | |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)



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CALIBRATION REPORT

CHEMILUMINESCENT NO / NO₂ / NO_x ANALYZER

DATE : 06 November 2022

BRAND : API

MODEL : 200E

NO. NOX-B06

SERIAL NO. 2286

Calibrator (Dilution System)

Brand : API

Model : 700

Last Cal. Date : 04 August 2022

Serial No. : 911

Reference Standard Gas

Standard Gas : Nitric Oxide (NO)

Cylinder No. : D636192

Certified Date : 20 April 2022

Expired Date : 20 April 2024

Cylinder Conc. : 49.1 ppm

CALIBRATING CONDITION

Pressure 1011 mmbar

Temp. 24.5 °C

% RH 49

CALIBRATION SETTING

| Span Set Point | Initial Reading (Before Adj.),PPB | | | Final Reading (After Adj.),PPB | |
|----------------------|-----------------------------------|-------------------|-------|--------------------------------|-------|
| | Expected Concentration | Analyzer Response | %Dif | Analyzer Response | Slope |
| Zero | 0 | 0.11 | - | 0 | - |
| NO Span | 400 | 400.2 | 0.050 | 400.0 | 1.010 |
| NO _x Span | 400 | 400.4 | 0.100 | 400.0 | 1.014 |

API Model 200E NO_x Analyzer Check List

| Test Values | Observed Value | Units | Nominal Range |
|---------------------------|----------------|---------|----------------------------|
| RANGE | 500 | PPB | 500 standard |
| STABILITY (Zero Gas) | 0.1 | PPB | < 2 with zero air |
| SAMPLE FLOW | 508 | cc/min | 500 ± 50 |
| OZONE FLOW | 78 | cc/min | 80 ± 15 |
| PMT | 102.9 | mV | -20 - 150 |
| AZERO | 93.7 | mV | -20 - 150 |
| HVPS | 669 | V | 420 - 900 constant |
| RCELL TEMP | 50.0 | °C | 50 ± 1 |
| BOX TEMP | 28.9 | °C | 8 - 48 |
| PMT TEMP | 7.1 | °C | 7 ± 2 |
| MOLY TEMP | 315.2 | °C | 315 ± 5 |
| RCELL PRESS | 8.2 | IN-Hg-A | 2 - 10 constant |
| SAMPLE PRESS | 28.5 | IN-Hg-A | 25 - 30 constant |
| NO Span Conc | 400 | PPB | 20 - 20,000 |
| NO _x Span Conc | 400 | PPB | 20 - 20,000 |
| NO Slope | 1.010 | - | 1.0 ± 0.3 |
| NO _x Slope | 1.014 | - | 1.0 ± 0.3 |
| NO Offset | 1.7 | mV | -20 to +150 |
| NO _x Offset | 1.0 | mV | -20 to 150 |
| Stability at Zero | 0.1 | PPB | < 0.2 |
| Stability at Span | 0.2 | PPB | < 2 ppb @ 400 ppb span gas |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)



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CALIBRATION REPORT

CHEMILUMINESCENT NO / NO₂ / NO_x ANALYZER

DATE : 06 November 2022

BRAND : API

MODEL : TML-41M

NO. NOX-B18

SERIAL NO. N07543

Calibrator (Dilution System)

Brand : API

Model : 700

Last Cal. Date : 04 August 2022

Serial No. : 911

Reference Standard Gas

Standard Gas : Nitric Oxide (NO)

Cylinder No. : D636192

Certified Date : 20 April 2022

Expired Date : 20 April 2024

Cylinder Conc. : 49.1 ppm

CALIBRATING CONDITION

Pressure 1011 mmbar

Temp. 24.5 °C

% RH 49

CALIBRATION SETTING

| Span | Initial Reading (Before Adj.), PPB | | | Final Reading (After Adj.), PPB | |
|----------------------|------------------------------------|-------------------|--------|---------------------------------|-------|
| Set Point | Expected Concentration | Analyzer Response | % Dif | Analyzer Response | Slope |
| Zero | 0 | -0.10 | - | 0 | - |
| NO Span | 400 | 399.7 | -0.075 | 400.0 | 1.003 |
| NO _x Span | 400 | 400.1 | 0.025 | 400.0 | 1.007 |

API Model TML-41M NO_x Analyzer Check List

| Test Values | Observed Value | Units | Nominal Range |
|---------------------------|----------------|---------|----------------------------|
| RANGE | 500 | PPB | 500 standard |
| STABILITY (Zero Gas) | 0.1 | PPB | < 2 with zero air |
| SAMPLE FLOW | 510 | cc/min | 500 ± 50 |
| OZONE FLOW | 79 | cc/min | 80 ± 15 |
| PMT | 103.2 | mV | -20 - 150 |
| AZERO | 94.0 | mV | -20 - 150 |
| HVPS | 670 | V | 420 - 900 constant |
| RCELL TEMP | 50.4 | °C | 50 ± 1 |
| BOX TEMP | 29.1 | °C | 8 - 48 |
| PMT TEMP | 7.0 | °C | 7 ± 2 |
| MOLY TEMP | 315.1 | °C | 315 ± 5 |
| RCELL PRESS | 8.3 | IN-Hg-A | 2 - 10 constant |
| SAMPLE PRESS | 28.4 | IN-Hg-A | 25 - 30 constant |
| NO Span Conc | 400 | PPB | 20 - 20,000 |
| NO _x Span Conc | 400 | PPB | 20 - 20,000 |
| NO Slope | 1.003 | - | 1.0 ± 0.3 |
| NO _x Slope | 1.007 | - | 1.0 ± 0.3 |
| NO Offset | 1.2 | mV | -20 to +150 |
| NO _x Offset | 0.7 | mV | -20 to 150 |
| Stability at Zero | 0.1 | PPB | < 0.2 |
| Stability at Span | 0.2 | PPB | < 2 ppb @ 400 ppb span gas |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)



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| CALIBRATION REPORT | | | | | |
|------------------------------------------------------------------|-----------------------------------|-------------------|----------------------------|--------------------------------|---------|
| CHEMILUMINESCENT NO / NO ₂ / NO _x ANALYZER | | | | | |
| DATE : | 06 November 2022 | BRAND : | API | MODEL : | TML-41M |
| NO. | NOX-B21 | SERIAL NO. | N02374 | | |
| Calibrator (Dilution System) | | | | | |
| Brand | : API | | Model | : 700 | |
| Last Cal. Date | : 04 August 2022 | | Serial No. | : 911 | |
| Reference Standard Gas | | | | | |
| Standard Gas | : Nitric Oxide (NO) | | Cylinder No. | : D636192 | |
| Certified Date | : 20 April 2022 | | Expired Date | : 20 April 2024 | |
| | | | Cylinder Conc. | : 49.1 ppm | |
| CALIBRATING CONDITION | | | | | |
| Pressure | 1011 | mmbar | Temp. | 24.5 | °C |
| | | | % RH | 49 | |
| CALIBRATION SETTING | | | | | |
| Span | Initial Reading (Before Adj.),PPB | | | Final Reading (After Adj.),PPB | |
| Set Point | Expected Concentration | Analyzer Response | %Dif | Analyzer Response | Slope |
| Zero | 0 | -0.10 | - | 0 | - |
| NO Span | 400 | 399.6 | -0.100 | 400.0 | 0.999 |
| NO _x Span | 400 | 399.8 | -0.050 | 400.0 | 1.004 |
| API Model TML-41M NO _x Analyzer Check List | | | | | |
| Test Values | Observed Value | Units | Nominal Range | | |
| RANGE | 500 | PPB | 500 standard | | |
| STABILITY (Zero Gas) | 0.1 | PPB | < 2 with zero air | | |
| SAMPLE FLOW | 505 | cc/min | 500 ± 50 | | |
| OZONE FLOW | 78 | cc/min | 80 ± 15 | | |
| PMT | 103.1 | mV | -20 - 150 | | |
| AZERO | 93.9 | mV | -20 - 150 | | |
| HVPS | 674 | V | 420 - 900 constant | | |
| RCELL TEMP | 50.1 | °C | 50 ± 1 | | |
| BOX TEMP | 29.2 | °C | 8 - 48 | | |
| PMT TEMP | 7.4 | °C | 7 ± 2 | | |
| MOLY TEMP | 314.7 | °C | 315 ± 5 | | |
| RCELL PRESS | 8.4 | IN-Hg-A | 2 - 10 constant | | |
| SAMPLE PRESS | 28.6 | IN-Hg-A | 25 - 30 constant | | |
| NO Span Conc | 400 | PPB | 20 - 20,000 | | |
| NO _x Span Conc | 400 | PPB | 20 - 20,000 | | |
| NO Slope | 0.999 | - | 1.0 ± 0.3 | | |
| NO _x Slope | 1.004 | - | 1.0 ± 0.3 | | |
| NO Offset | 1.1 | mV | -20 to +150 | | |
| NO _x Offset | 0.6 | mV | -20 to 150 | | |
| Stability at Zero | 0.1 | PPB | < 0.2 | | |
| Stability at Span | 0.2 | PPB | < 2 ppb @ 400 ppb span gas | | |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)

คุณภาพน้ำ

SITHIPHORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY



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NSC-TISI-TIS 17025
CALIBRATION 0394

Cert. No. : SP21011

Pages 1 of 3

Calibration Certificate

Equipment : UV-VIS SPECTROPHOTOMETER
Manufacturer : PERKINELMER
Model : LAMBDA 25
Serial No.: 501S14123010
ID No.: SP03/58
Calibration Mode : WAVELENGTH ACCURACY
PHOTOMETRIC ACCURACY
Condition As Found : GOOD
Customer : S.P.S. CONSULTING SERVICE CO., LTD.
7 SOI PHAHOLYOTHIN 24, PHAHOLYOTHIN ROAD,
CHOMPHON, CHATUCHAK,
BANGKOK 10900, THAILAND.
Location : ORGANIC LABORATORY IV
Ambient Temperature : (24.5 ± 5) °C
Relative Humidity : (68.0 ± 25) %
Received Date : 30 AUGUST 2021
Calibration Date : 30 AUGUST 2021
Date of Issue : 31 AUGUST 2021

Calibrated by :

Nathakorn Pisutpaisan

Approved by :

(Thanakul Petchurai)

This certificate is issued in accordance with the requirements of ISO/IEC 17025 standard, may not be reproduced other than in full, except with the prior written approval of the head of Calibration Laboratory.

Continuation of Calibration Certificate

Cert. No. : SP21011
Job No. : VC64SP0012
Pages : 2 of 3

Calibration Method :

This instrument was calibrated by using on-site calibration procedure In-house method : CP-SP-01

The calibration procedure to direct measurement wavelength accuracy by using wavelength standard solution, Photometric accuracy by using absorbance standard filter and absorbance standard solution

The calibration procedure used was based on ASTM E275-01,ASTM E925-02

Condition of this result of calibration :

1. Certified reference materials

| <u>Material</u> | <u>Ref. type</u> | <u>Cell serial No.</u> | <u>Cert. No.</u> | <u>Due Date</u> |
|--------------------------------|------------------|------------------------|------------------|-----------------|
| Holmium liquid | RM-HL | 29706 | 87569 | 13/10/2022 |
| Didymium liquid | RM-DL | 28912 | 87588 | 15/10/2022 |
| Neutral density filter | RM-1N2N3N | 13877 | 87600 | 15/10/2022 |
| Potassium dichromate solutions | RM-0204060810 | 14204 | 87614 | 16/10/2022 |
| Potassium Iodide solution | - | KI-0701-001 | CI-0030-20 | 13/02/2022 |

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

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

3.1 The UK National Physical Laboratory (NPL)

3.2 The National Institute of Standards and Technology,NIST.

Result of calibration : Wavelength Accuracy

(Without adjustment)

| <u>Material</u> | <u>Certified Values of Reference Material (nm)</u> | <u>UUC* Reading (nm)</u> | <u>Error (nm)</u> | <u>Uncertainty ± (nm)</u> | <u>k Factor</u> |
|-----------------|--------------------------------------------------------|------------------------------|-----------------------|-------------------------------|---------------------|
| RM-HL | 278.13 | 278.3 | 0.17 | 0.16 | 2.00 |
| | 361.25 | 361.4 | 0.15 | 0.16 | 2.00 |
| | 467.82 | 467.8 | -0.02 | 0.16 | 2.00 |
| | 536.56 | 536.6 | 0.04 | 0.16 | 2.00 |
| | 640.50 | 640.5 | 0.00 | 0.16 | 2.00 |
| RM-DL | 740.09 | 740.1 | 0.01 | 0.16 | 2.00 |
| | 864.94 | 865.3 | 0.36 | 0.16 | 2.00 |

UUC* = Unit Under Calibration

Continuation of Calibration Certificate

Cert. No. : SP21011
Job No. : VC64SP0012
Pages : 3 of 3

Result of calibration : Photometric Accuracy

(Without adjustment)

| Material | Wavelength (nm) | Filter S/N | Nominal Absorbance (A) | Certified Absorbance (A) | UUC* Reading Absorbance (A) | Error (A) | Uncertainty ± (A) | k Factor |
|------------------------------|--------------------|--------------------|-----------------------------|--------------------------------|--------------------------------|----------------------|----------------------|-------------|
| Neutral Density glass filter | 440.0 | 29360 | 1.0 | 1.0524 | 1.0530 | 0.0006 | 0.0030 | 2.00 |
| | | 29914 | 0.7 | 0.7454 | 0.7458 | 0.0004 | 0.0032 | 2.00 |
| | | 29381 | 0.5 | 0.5426 | 0.5421 | -0.0005 | 0.0030 | 2.00 |
| | 546.1 | 29360 | 1.0 | 0.9822 | 0.9810 | -0.0012 | 0.0030 | 2.00 |
| | | 29914 | 0.7 | 0.6962 | 0.6960 | -0.0002 | 0.0031 | 2.00 |
| | | 29381 | 0.5 | 0.5076 | 0.5070 | -0.0006 | 0.0030 | 2.00 |
| | 590.0 | 29360 | 1.0 | 1.0221 | 1.0202 | -0.0019 | 0.0030 | 2.00 |
| | | 29914 | 0.7 | 0.7238 | 0.7230 | -0.0008 | 0.0031 | 2.00 |
| | | 29381 | 0.5 | 0.5364 | 0.5360 | -0.0004 | 0.0031 | 2.00 |
| | 635.0 | 29360 | 1.0 | 0.9751 | 0.9732 | -0.0019 | 0.0030 | 2.00 |
| | | 29914 | 0.7 | 0.6912 | 0.6902 | -0.0010 | 0.0031 | 2.00 |
| | | 29381 | 0.5 | 0.5214 | 0.5210 | -0.0004 | 0.0032 | 2.00 |
| Material | Wavelength (nm) | Solution (mg/l) | Certified Absorbance (A) | UUC* Reading Absorbance (A) | Error (A) | Uncertainty ± (A) | k Factor | |
| RM-0204060810 | 235.0 | 20 | 0.2436 | 0.2450 | 0.0014 | 0.0101 | 2.00 | |
| | | 40 | 0.4905 | 0.4880 | -0.0025 | 0.0115 | 2.00 | |
| | | 60 | 0.7453 | 0.7420 | -0.0033 | 0.0067 | 2.00 | |
| | | 80 | 0.9920 | 0.9883 | -0.0037 | 0.0071 | 2.00 | |
| | | 100 | 1.2487 | 1.2475 | -0.0012 | 0.0073 | 2.00 | |

UUC* = Unit Under Calibration

Condition of this result of calibration : Spectrophotometer PERKINELMER Model Lambda 25 S/N 501S141230

Resolution of Wavelength Mode 0.1 nm
Resolution of Photometric Mode 0.0001 A
Parameter Setting
Measurement Mode Wavelength, Absorbance
Wavelength Scan 1100 nm-190 nm
Scanning Speed 7.5 nm/min
Data Pitch 0.1 nm
Band width(Wavelength) 1.0 nm
Band width(Vis) 1.0 nm
Band width(Uv) 1.0 nm

| Stray Light** UUC* Reading at 220 nm | |
|--------------------------------------|---------------|
| Transimission T(%) | Absorbance(A) |
| 0.0159 | 3.8142 |

**Specific Acceptance :

Transmission \leq 1.0 T(%), Absorbance \geq 2.0 A

**Stray light not TISI Accredited

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

End of Calibration Certificate

SITHIPHORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY



451-451/1 Sirinthorn Rd., Bangbumru, Bangplud Bangkok 10700 THAILAND.
Tel.0-2435-8800 Fax.0-2433-1679 e-mail:cal-center@sithiphorn.com http://www.sithiphorn.com

NSC-TISI-TIS 17025
CALIBRATION 0394

Cert. No. : SP22018

Pages 1 of 3

Calibration Certificate

Equipment : UV-VIS SPECTROPHOTOMETER
Manufacturer : PERKINELMER
Model : LAMBDA 25
Serial No.: 501S14123010
ID No.: SP03/58
Calibration Mode : WAVELENGTH ACCURACY
PHOTOMETRIC ACCURACY

Condition As Found : GOOD

Customer : S.P.S. CONSULTING SERVICE CO., LTD.
7 SOI PHAHOLYOTHIN 24, PHAHOLYOTHIN ROAD,
CHOMPHON, CHATUCHAK,
BANGKOK 10900, THAILAND.

Location : ORGANIC LABORATORY IV

Ambient Temperature : (24.4 ± 5) °C
Relative Humidity : (60.1 ± 25) %

Received Date : 30 AUGUST 2022
Calibration Date : 30 AUGUST 2022
Date of Issue : 31 AUGUST 2022

Calibrated by :

Nathakorn Pisutpaisan

Approved by :

(Thanakul Petchurai)

This certificate is issued in accordance with the requirements of ISO/IEC 17025 standard, may not be reproduced other than in full, except with the prior written approval of the head of Calibration Laboratory.

Continuation of Calibration Certificate

Cert. No. : SP22018

Job No. : VC65SP0008

Pages : 2 of 3

Calibration Method :

This instrument was calibrated by using on-site calibration procedure In-house method : CP-SP-01

The calibration procedure to direct measurement wavelength accuracy by using wavelength standard solution, Photometric accuracy by using absorbance standard filter and absorbance standard solution

The calibration procedure used was based on ASTM E275-01,ASTM E925-02

Condition of this result of calibration :

1. Certified reference materials

| Material | Ref. type | Cell serial No. | Cert. No. | Due Date |
|--------------------------------|---------------|-----------------|------------|------------|
| Holmium liquid | RM-HL | 29706 | 87569 | 13/10/2022 |
| Didymium liquid | RM-DL | 28912 | 87588 | 15/10/2022 |
| Neutral density filter | RM-1N2N3N | 13877 | 87600 | 15/10/2022 |
| Potassium dichromate solutions | RM-0204060810 | 14204 | 87614 | 16/10/2022 |
| Potassium Iodide solution | - | KI-0701-001 | CI-0090-22 | 08/04/2024 |

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

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

3.1 The UK National Physical Laboratory (NPL)

3.2 The National Institute of Standards and Technology,NIST.

Result of calibration : Wavelength Accuracy

(Without adjustment)

| Material | Certified Values of Reference Material (nm) | UUC* Reading (nm) | Error (nm) | Uncertainty ± (nm) | k Factor |
|----------|------------------------------------------------|----------------------|---------------|-----------------------|-------------|
| RM-HL | 278.13 | 278.3 | 0.17 | 0.16 | 2.00 |
| | 361.25 | 361.4 | 0.15 | 0.16 | 2.00 |
| | 467.82 | 467.8 | -0.02 | 0.16 | 2.00 |
| | 536.56 | 536.5 | -0.06 | 0.16 | 2.00 |
| | 640.50 | 640.5 | 0.00 | 0.16 | 2.00 |
| RM-DL | 740.09 | 740.0 | -0.09 | 0.16 | 2.00 |
| | 864.94 | 865.2 | 0.26 | 0.16 | 2.00 |

UUC* = Unit Under Calibration

Continuation of Calibration Certificate

Cert. No. : SP22018
Job No. : VC65SP0008
Pages : 3 of 3

Result of calibration : Photometric Accuracy

(Without adjustment)

| Material | Wavelength (nm) | Filter: S/N | Nominal Absorbance (A) | Certified Absorbance (A) | UUC* Reading Absorbance (A) | Error (A) | Uncertainty ± (A) | k Factor |
|------------------------------|-----------------|-----------------|--------------------------|-----------------------------|-----------------------------|-------------------|-------------------|----------|
| Neutral Density glass filter | 440.0 | 29360 | 1.0 | 1.0524 | 1.0539 | 0.0015 | 0.0028 | 2.00 |
| | | 29914 | 0.7 | 0.7454 | 0.7459 | 0.0005 | 0.0029 | 2.00 |
| | | 29381 | 0.5 | 0.5426 | 0.5426 | 0.0000 | 0.0028 | 2.00 |
| | 546.1 | 29360 | 1.0 | 0.9822 | 0.9810 | -0.0012 | 0.0028 | 2.00 |
| | | 29914 | 0.7 | 0.6962 | 0.6960 | -0.0002 | 0.0028 | 2.00 |
| | | 29381 | 0.5 | 0.5076 | 0.5070 | -0.0006 | 0.0029 | 2.00 |
| | 590.0 | 29360 | 1.0 | 1.0221 | 1.0202 | -0.0019 | 0.0028 | 2.00 |
| | | 29914 | 0.7 | 0.7238 | 0.7230 | -0.0008 | 0.0029 | 2.00 |
| | | 29381 | 0.5 | 0.5364 | 0.5360 | -0.0004 | 0.0031 | 2.00 |
| | 635.0 | 29360 | 1.0 | 0.9751 | 0.9732 | -0.0019 | 0.0028 | 2.00 |
| | | 29914 | 0.7 | 0.6912 | 0.6902 | -0.0010 | 0.0029 | 2.00 |
| | | 29381 | 0.5 | 0.5214 | 0.5210 | -0.0004 | 0.0032 | 2.00 |
| Material | Wavelength (nm) | Solution (mg/l) | Certified Absorbance (A) | UUC* Reading Absorbance (A) | Error (A) | Uncertainty ± (A) | k Factor | |
| RM-0204060810 | 235.0 | 20 | 0.2436 | 0.2419 | -0.0017 | 0.0101 | 2.00 | |
| | | 40 | 0.4905 | 0.4855 | -0.0050 | 0.0115 | 2.00 | |
| | | 60 | 0.7453 | 0.7388 | -0.0065 | 0.0067 | 2.00 | |
| | | 80 | 0.9920 | 0.9839 | -0.0081 | 0.0071 | 2.00 | |
| | | 100 | 1.2487 | 1.2414 | -0.0073 | 0.0073 | 2.00 | |

UUC* = Unit Under Calibration

Condition of this result of calibration : Spectrophotometer PERKINELMER Model Lambda 25 S/N 501S141230

Resolution of Wavelength Mode 0.1 nm
Resolution of Photometric Mode 0.0001 A
Parameter Setting
Measurement Mode Wavelength, Absorbance
Wavelength Scan 1100 nm-190 nm
Scanning Speed 7.5 nm/min
Data Pitch 0.1 nm
Band width(Wavelength) 1.0 nm
Band width(Vis) 1.0 nm
Band width(Uv) 1.0 nm

| Stray Light** UUC* Reading at 220 nm | |
|--------------------------------------|---------------|
| Transimission T(%) | Absorbance(A) |
| 0.0107 | 3.9886 |

**Specific Acceptance :
Transmission \leq 1.0 T(%), Absorbance \geq 2.0 A
**Stray light not TISI Accredited

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

End of Calibration Certificate



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



Cert.No.: 21CH1216

Page.: 1 of 2

Certificate of Calibration

| | |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Equipment : | pH Meter |
| Manufacturer : | HANNA |
| Model : | HI 3512 |
| Serial No. : | 08685754 |
| ID No. : | - |
| Condition As-Received: | Used Item |
| Received Date : | 14 September 2021 |
| Calibration Date : | 16 September 2021 |
| Reference : | 2109-0508WN-1 |
| Submitted by : | S.P.S. Consulting Service Co.,Ltd. 7 Phaholyothin 24, Phaholyothin Road, Jompol, Chatuchak, Bangkok10900 |
| Ambient Temperature : | (25 ± 2.5) °C |
| Relative Humidity : | (50 ± 15) % |
| Calibration Procedure : | In - house method : - CP-CH5 by direct measurement with standard voltage calibrator and direct measurement with certified reference material (CRM) |

Calibrated by : Walalak Sirithean

Approved by :

Approved Signatory

- (✓) Malee Butkruea
() Saithip Meangmai
() Warakorn Lernagatrakul

Issue Date : 22 September 2021

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 0032410



Cert. No.: 21CH1216

Page.: 2 of 2

Condition of this calibration result

1. Reference Standard Instrument : -

| <u>Instrument</u> | <u>Serial No.</u> | <u>ID No.</u> | <u>Cert. No.</u> | <u>Due Date</u> |
|--------------------------------|-------------------|---------------|------------------|-----------------|
| 1) Document Process Calibrator | 46530031 | 130RC098 | 20E3666 | 14 Oct 2021 |

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

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

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

| <u>Buffer Solution</u> | <u>Manufacturer</u> | <u>Lot No.</u> | <u>Exp. date</u> |
|------------------------|---------------------|----------------|------------------|
| pH 4.008 | CPA chem | 754028 | 28 June 2023 |
| pH 6.985 | CPA chem | 725927 | 12 Jan 2022 |
| pH 10.015 | CPA chem | 761018 | 02 Aug 2022 |

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 (\pm mV) | Coverage factor <i>k</i> |
|----------------------------|---------------|------------------------|----------------|--------|-------------------------------------------|-----------------------------|
| | pH | mV | mV | pH | | |
| pH Meter S/N.: 08685754 | 4.000 | 177.48 | 177.9 | 4.000 | 0.058 | 2.00 |
| | 7.000 | 0.00 | 0.4 | 7.000 | 0.058 | 2.00 |
| | 10.000 | -177.48 | -177.2 | 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 (\pm) | Coverage factor <i>k</i> |
|--------------------------------|-----------------------------|-------------------|---------------------------|--------------------------------------------|-----------------------------|
| pH Electrode S/N.: 061416CM | 4.008 | 4.008 | 169.2 | 0.0046 | 2.00 |
| | 6.985 | 6.985 | -4.4 | 0.0075 | 2.00 |
| | 10.015 | 10.013 | -178.9 | 0.013 | 2.05 |

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-

**QUALITY CALIBRATION CO.,LTD.**

235 Petchkasem 63/2 Road, Laksong, Bangkae, Bangkok 10160

Tel (662) 421-5402, (662) 444-0152-3, Fax (662) 809-4584



CERTIFICATE No : 22E9693

REFERENCE No : 66476-1

PAGE : 1 OF 3

Certificate of Calibration

EQUIPMENT : pH METER

MANUFACTURER : HANNA

MODEL : HI 3512

SERIAL No : TH118035

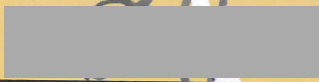
ID No : pH 04/56

CONDITION AS RECEIVED : USED ITEM

SUBMITTED BY : S.P.S. CONSULTING SERVICE CO., LTD.
7 SOI PHAHOLYOTHIN 24, PHAHOLYOTHIN RD.,
JOMPOL, CHATUCHAK, BANGKOK 10900

CALIBRATED BY : ATSAWIN Y.

CALIBRATION DATE : 15-Sep-22

APPROVED BY : 
PONGSAK J.

ISSUED DATE : 15-Sep-22

RECEIVED DATE : 14-Sep-22

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

**QUALITY CALIBRATION CO.,LTD.**

235 Petchkasem 63/2 Road, Laksong, Bangkae, Bangkok 10160

Tel (662) 421-5402, (662) 444-0152-3, Fax (662) 809-4584

CERTIFICATE No : 22E9693

PAGE : 2 OF 3

Calibration Report

EQUIPMENT : pH METER
MANUFACTURER : HANNA
ID No : pH 04/56
RECEIVED DATE : 14-Sep-22
AMBIENT TEMPERATURE : 20 ° C ± 1 ° C

MODEL : HI 3512
SERIAL NUMBER : TH118035
CALIBRATION DATE : 15-Sep-22
RELATIVE HUMIDITY : 50 % RH ± 10% RH

CONDITION OF THIS RESULTS OF CALIBRATION

1. THIS INSTRUMENT WAS CALIBRATED BY DIRECT MEASUREMENT METHOD BASED ON WI-TQ-062 AND WI-TQ-063. THE DISPLAY UNIT WAS TESTED BY GENERATING STANDARD VOLTAGE TO THE UNIT AND READ THE VALUE COMPARED WITH CALCULATED VALUE. THE DISPLAY AND ELECTRODE WAS CALIBRATED BY USING STANDARD pH BUFFER
2. REFERENCE STANDARD INSTRUMENTS :-

| <u>INSTRUMENT</u> | <u>MODEL</u> | <u>SERIAL No/ LOT No</u> | <u>CERTIFICATE No</u> | <u>DUE DATE</u> |
|---------------------------|--------------|------------------------------|-----------------------|-----------------|
| 1) pH STANDARD SOLUTION | 00651-06 | CC719181 | 4880-12119147 | 05-Apr-23 |
| 2) pH STANDARD SOLUTION | 00651-08 | CC718727 | 4881-12110709 | 31-Mar-23 |
| 3) pH STANDARD SOLUTION | 00651-10 | CC717045 | 4882-12065386 | 17-Mar-23 |
| 4) PROCESS CALIBRATOR | CA150 | 91S6079 | 22E1145 | 31-Mar-23 |
| 5) BATH | 260014 | 1247 48074 | 22T9870 | 13-Sep-23 |
| 6) THERMOMETER WITH PROBE | 421504 | 55000379 | 22T9904 | 13-Sep-23 |

3. THIS RESULT WAS FOUND ACCURATE AS SHOWN ON DATE AND PLACE OF CALIBRATION ONLY.
4. THIS RESULT EXCLUDE LONG TERM STABILITY OF THE UNIT UNDER CALIBRATION.
5. THIS CERTIFICATE IS TRACEABLE TO SI UNIT MAINTAINED AT :-
 - NATIONAL INSTITUTE OF STANDARD AND TECHNOLOGY, USA.
 - NATIONAL INSTITUTE OF METROLOGY (THAILAND)

RESULT OF CALIBRATION : ADJUSTMENT

1. DISPLAY UNIT ONLY

SLOPE FACTOR $k = 2.303 \text{ RT/F} = 59 \text{ mV/pH}$

| mV APPLIED | UUC READING (mV) | CORRECTION (mV) | UUC READING (pH) | UNCERTAINTY OF MEASUREMENT (± mV) | COVERAGE FACTOR k |
|---------------|---------------------|--------------------|---------------------|-----------------------------------------|-------------------------|
| 414.11 | 414.8 | -0.69 | -0.171 | 0.14 | 2.0 |
| 354.95 | 355.6 | -0.65 | 0.860 | 0.14 | 2.0 |
| 295.80 | 296.4 | -0.60 | 1.892 | 0.14 | 2.0 |
| 236.64 | 237.2 | -0.56 | 2.922 | 0.14 | 2.0 |
| 177.48 | 178.0 | -0.52 | 3.954 | 0.14 | 2.0 |
| 118.32 | 118.8 | -0.48 | 4.985 | 0.14 | 2.0 |
| 59.16 | 59.7 | -0.54 | 6.016 | 0.14 | 2.0 |
| 0.00 | 0.5 | -0.50 | 7.049 | 0.14 | 2.0 |
| -59.16 | -58.8 | -0.36 | 8.136 | 0.14 | 2.0 |
| -118.32 | -117.9 | -0.42 | 9.223 | 0.14 | 2.0 |
| -177.48 | -177.1 | -0.38 | 10.311 | 0.14 | 2.0 |
| -236.64 | -236.3 | -0.34 | 11.399 | 0.14 | 2.0 |
| -295.80 | -295.5 | -0.30 | 12.487 | 0.14 | 2.0 |
| -354.95 | -354.7 | -0.25 | 13.575 | 0.14 | 2.0 |
| -414.11 | -413.9 | -0.21 | 14.662 | 0.14 | 2.0 |

END OF CALIBRATION REPORT PAGE 2 OF 3

**QUALITY CALIBRATION CO.,LTD.**

235 Petchkasem 63/2 Road, Laksong, Bangkae, Bangkok 10160

Tel (662) 421-5402, (662) 444-0152-3, Fax (662) 809-4584

CERTIFICATE No : 22E9693

PAGE : 3 OF 3

Calibration Report**RESULT OF CALIBRATION (CONTINUE) :****2. DISPLAY UNIT WITH pH ELECTRODE S/N: 09081C6M**

| STANDARD pH BUFFER SOLUTION (pH) | UUC READING (pH) | CORRECTION (pH) | VALUE BEFORE ADJUSTMENT | UNCERTAINTY OF MEASUREMENT (\pm pH) | COVERAGE FACTOR k |
|----------------------------------------|---------------------|--------------------|-------------------------------|----------------------------------------------|-------------------------|
| 4.007 | 4.007 | 0.000 | 3.996 | 0.012 | 2.0 |
| 7.004 | 7.006 | -0.002 | 6.944 | 0.012 | 2.0 |
| 10.016 | 10.012 | 0.004 | 10.194 | 0.014 | 2.0 |

3. DISPLAY UNIT WITH TEMPERATURE

| STANDARD READING ($^{\circ}$ C) | UUC READING ($^{\circ}$ C) | CORRECTION ($^{\circ}$ C) | VALUE BEFORE ADJUSTMENT | UNCERTAINTY OF MEASUREMENT (\pm $^{\circ}$ C) | COVERAGE FACTOR k |
|----------------------------------------|--------------------------------|-------------------------------|-------------------------------|--------------------------------------------------------|-------------------------|
| 25.003 | 25.0 | 0.003 | --- | 0.0085 | 2.0 |

4. PERCENT SLOPE 100%

UUC : UNIT UNDER CALIBRATION

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

END OF CALIBRATION REPORT



CERTIFICATE No : 22M2569

REFERENCE No : 64386-3

PAGE : 1 OF 2

Certificate of Calibration

EQUIPMENT : DIGITAL BALANCE

MANUFACTURER : SARTORIUS

MODEL : BSA224S-CW

SERIAL No : 36591843

ID No : BA 09/61

CONDITION AS RECEIVED : USED ITEM

SUBMITTED BY : S.P.S. CONSULTING SERVICE CO., LTD.
7 SOI PHAHOLYOTHIN 24, PHAHOLYOTHIN RD.,
JOMPOL, CHATUCHAK, BANGKOK 10900

CALIBRATED BY : TETNITHI W.

CALIBRATION DATE : 11-Mar-22

APPROVED BY : 
PONGSAK J.

ISSUED DATE : 17-Mar-22

RECEIVED DATE : 11-Mar-22



CERTIFICATE No : 22M2569

PAGE : 2 OF 2

Calibration Report

EQUIPMENT : DIGITAL BALANCE MODEL : BSA224S-CW
MANUFACTURER : SARTORIUS S/N : 36591843
ID No : BA 09/61 RECEIVED DATE : 11-Mar-22
AIR PRESSURE : 1008mbar \pm 1mbar CALIBRATION DATE : 11-Mar-22
AMBIENT TEMPERATURE : 22° C \pm 1° C RELATIVE HUMIDITY : 51 %RH \pm 10 % RH

CONDITION OF THIS RESULTS OF CALIBRATION

1. THIS INSTRUMENT WAS CALIBRATED BY ACCORDING TO UKAS LAB 14 EDITION 6:2019 BY USING KNOWN WEIGHT STANDARD WEIGHT. THE BALANCE WAS ADJUSTED USING WEIGHT OF QUALITY CALIBRATION TO ADJUST. THE BALANCE HAS NO ZERO TRACKING FUNCTION. REPEATABILITY WAS MEASURED BY USING 10 REPEATED MEASUREMENTS. LINEARITY WAS MEASURED COVERING 10 POINTS, EVENLY SPREAD OVER THE RANGE. THE INSTRUMENT WAS SET ZERO BEFORE PERFORMING THE LINEARITY TEST. OFF-CENTER LOADING WAS MEASURED BY USING STANDARD WEIGHTS PLACED ON THE PAN AND MOVED TO VARIOUS POSITIONS ON THE PAN.

2. REFERENCE STANDARD INSTRUMENTS :-

INSTRUMENT

MODEL

SERIAL No

CERTIFICATE No

DUE DATE

1) STANDARD WEIGHT SET

E2

QK-I-151

C02210415

09-Feb-23

3. THIS RESULT WAS FOUND ACCURATE AS SHOWN ON DATE AND PLACE OF CALIBRATION ONLY.

4. THIS RESULT EXCLUDE LONG TERM STABILITY OF THE UNIT UNDER CALIBRATION.

5. THIS CERTIFICATE IS TRACEABLE TO THE INTERNATIONAL SYSTEM OF UNIT MAINTAINED AT:-

- NATIONAL INSTITUTE OF METROLOGY (THAILAND) THROUGH CENTRAL BUREAU OF WEIGHTS&MEASURES

RESULT OF CALIBRATION :- WITHOUT ADJUSTMENT

1. ZERO SETTING FUNCTION : NORMAL

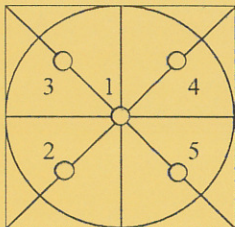
2. TARE FUNCTION : NORMAL

3. REPEATABILITY OF READING AT 200 g WAS 0.000048 g

4. DEPARTURE FROM NOMINAL VALUE/ LINEARITY

| NOMINAL VALUE (g) | BALANCE READING (g) | CORRECTION (g) | UNCERTAINTY (\pm g) |
|-------------------|---------------------|----------------|------------------------|
| 0.00 | 0.0000 | 0.0000 | 0.000078 |
| 0.10 | 0.1000 | 0.0000 | 0.000078 |
| 0.20 | 0.2000 | 0.0000 | 0.000078 |
| 0.50 | 0.5000 | 0.0000 | 0.000079 |
| 1.00 | 1.0000 | 0.0000 | 0.000079 |
| 2.00 | 2.0000 | 0.0000 | 0.000080 |
| 5.00 | 5.0000 | 0.0000 | 0.000081 |
| 10.00 | 10.0000 | 0.0000 | 0.000084 |
| 20.00 | 20.0000 | 0.0000 | 0.000089 |
| 50.00 | 50.0000 | 0.0000 | 0.00011 |
| 100.00 | 100.0000 | 0.0000 | 0.00019 |
| 200.00 | 199.9999 | 0.0001 | 0.00032 |

5. OFF CENTER LOADING ERROR



| POINT | READING (g) |
|--------------------|-------------|
| 1 | 99.9999 |
| 2 | 99.9999 |
| 3 | 100.0000 |
| 4 | 99.9999 |
| 5 | 99.9998 |
| OFF-CENTER LOADING | 0.0001 |

NOTE: THIS CALIBRATION WAS CARRIED OUT AT THE CUSTOMER'S PLACE AT PRODUCTION AREA

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

END OF CALIBRATION REPORT



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

Cert.No.: 22TW98

Page.: 1 of 2

Certificate of Testing

| | |
|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Equipment : | DO Meter |
| Manufacturer : | YSI |
| Model : | 5000-230V |
| Serial No. : | 15B100751 |
| ID No. : | - |
| Received Date : | 20 April 2022 |
| Test Date : | 21 April 2022 |
| Reference : | 2204-0429WC-1 |
| Submitted by : | S.P.S. Consulting Service Co.,Ltd. 7 Phaholyothin 24, Phaholyothin Road., Jompol, Chatuchak, Bangkok 10900 |
| 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 : | <div style="background-color: gray; width: 150px; height: 20px; margin: 0 auto;"></div> Approved Signatory |
| <input checked="" type="checkbox"/> Malee Butkruea <input type="checkbox"/> Saithip Meangmai <input type="checkbox"/> Warakorn Lerngagtrakul | |
| Issue Date : | 25 April 2022 |



Cert.No.: 22TW98

Page.: 2 of 2

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).

| <u>Instruments</u> | <u>Serial No.</u> | <u>ID No.</u> | <u>Certificate No.</u> | <u>Due Date</u> |
|--------------------|-------------------|---------------|------------------------|-----------------|
| 1) Burette | - | 130BU10 | 21CG1389 | 25 Mar 2023 |
| 2) Balance | 1126143764 | 140RC004 | 21MM430 | 21 Sep 2022 |

2. Standard Material :-

| <u>Material</u> | <u>Manufacturer</u> | <u>Lot.No.</u> | <u>Assay</u> |
|---------------------------------|---------------------|----------------|--------------|
| Sodium Thiosulfate pentahydrate | Merck | AM1763316 | 100.2% |

Result : Dissolved Oxygen Meter Adjustment With Air 100 %

Dissolved Oxygen Probe No.: 14J100195

| Titration Method (Azide Modification Method) (mg/L) | DO Meter Reading (mg/L) | Standard Deviation (mg/L) |
|-------------------------------------------------------------------|---------------------------------------|-------------------------------------|
| 8.12 | 8.14 | 0.0084 |

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

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a 1105753



QUALITY CALIBRATION CO.,LTD.

235 Petchkasem 63/2 Road, Laksong, Bangkae, Bangkok 10160

Tel (662) 421-5402, (662) 444-0152-3, Fax (662) 809-4584

www.qcalibration.com

CERTIFICATE No : 22T0570

REFERENCE No : 63773-2

PAGE : 1 OF 2

Certificate of Calibration

EQUIPMENT : COD REACTOR

MANUFACTURER : HACH

MODEL : DRB 200

SERIAL No : 15110C0498

ID No : DRB 06/59

SUBMITTED BY : S.P.S. CONSULTING SERVICE CO., LTD.
7 SOI PHAHOLYOTHIN 24, PHAHOLYOTHIN RD.,
JOMPOL, CHATUCHAK, BANGKOK 10900

CALIBRATED BY : CHAICHARN CH.

CALIBRATION DATE : 21-Jan-22

APPROVED BY : [REDACTED]
PONGSAK J.

ISSUED DATE : 21-Jan-22

RECEIVED DATE : 19-Jan-22



QUALITY CALIBRATION CO.,LTD.

235 Petchkasem 63/2 Road, Laksong, Bangkae, Bangkok 10160

Tel (662) 421-5402, (662) 444-0152-3, Fax (662) 809-4584

CERTIFICATE No : 22T0570

PAGE : 2 OF 2

Calibration Report

EQUIPMENT : COD REACTOR
MANUFACTURER : HACH
ID NUMBER : DRB 06/59
RECEIVED DATE : 19-Jan-22
AMBIENT TEMPERATURE : 23° C ± 1° C

MODEL : DRB 200
SERIAL NUMBER : 15110C0498
CALIBRATION DATE : 21-Jan-22
RELATIVE HUMIDITY : 52 %RH ± 10 % RH

CONDITION OF THIS RESULTS OF CALIBRATION

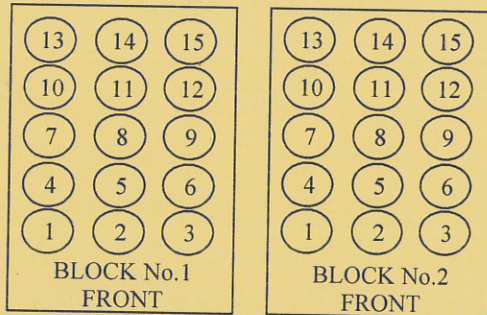
1. THIS INSTRUMENT WAS CALIBRATED BY DIRECT MEASUREMENT TEMPERATURE RECORDER WITH THERMOCOUPLE TYPE K UNDER NO LOAD CONDITION. THE THERMOCOUPLES WERE PLACED ON 15 POINTS AND LOCATED ONE THERMOCOUPLE IN EACH OF THE FOUR CORNERS OF THE REACTOR AND PLACED THE EIGHTH THERMOCOUPLE AT THE CENTER OF THE REACTOR.

2. REFERENCE STANDARD INSTRUMENTS :-

| INSTRUMENT | MODEL | SERIAL No | CERTIFICATE No | DUE DATE |
|-------------------------------|-------------|-----------|----------------|-----------|
| 1) DATA LOGGER WITH TC TYPE K | HYDRA 2635A | 8009008 | 21T6767 | 10-Jul-22 |

3. THIS RESULT WAS FOUND ACCURATE AS SHOWN ON DATE AND PLACE OF CALIBRATION ONLY.
4. THIS RESULT EXCLUDE LONG TERM STABILITY OF THE UNIT UNDER CALIBRATION.
5. THIS CERTIFICATE IS TRACEABLE TO THE INTERNATIONAL SYSTEM OF UNIT MAINTAINED AT:-
- NATIONAL INSTITUTE OF METROLOGY (THAILAND) THROUGH QUALITY CALIBRATION CO.,LTD.

RESULT OF CALIBRATION :- WITHOUT ADJUSTMENT



TEMPERATURE MEASUREMENT ACCURACY TEST

| Block No. | 1 | 2 |
|-----------------------------------------------|------|-------|
| Controller temperature (°C) | 145 | 145 |
| Indicating Temperature | 145 | 145 |
| Measured Temperature (°C) at Spread Locations | 1 | 150.5 |
| | 2 | 150.6 |
| | 3 | 149.7 |
| | 4 | 150.2 |
| | 5 | 149.9 |
| | 6 | 150.1 |
| | 7 | 150.1 |
| | 8 | 149.7 |
| | 9 | 150.6 |
| | 10 | 149.6 |
| | 11 | 149.9 |
| | 12 | 149.6 |
| | 13 | 149.7 |
| | 14 | 149.8 |
| | 15 | 149.6 |
| Uncertainty of Measurement(± °C) | 0.86 | 0.86 |

NOTE 1 : THE UNCERTAINTY OF MEASUREMENT EXCLUDED TEMPERATURE UNIFORMITY OF THE CHAMBER.

NOTE 2 : THIS CALIBRATION WAS CARRIED OUT AT THE CUSTOMER'S PLACE AT LABORATORY AREA.

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

END OF CALIBRATION REPORT



MAINTENANCE AND TEST CERTIFICATE MODEL

OPTIMA 5300DV

| | | |
|-----------------------------------------------------------|-----------------------------------------------|--|
| Customer : <u>S.P.S.Consulting Service Co.,Ltd</u> | Date Tested: <u>July 11, 2022</u> | |
| | Recommendation Recertification | |
| Address : <u>7 Soi Phaholyothin 24</u> | Period <u>6</u> Months | |
| <u>Paholyothin Road</u> | Recertification Due: <u>January 11, 2023</u> | |
| <u>Jompol Chatuchak, Bangkok 1090</u> | Date Last Certified: <u>January 12, 2022</u> | |
| User Name: <u>K.Phenpha Vipasthawatt</u> | Visit Number: <u>1 of 2</u> | |
| Phone: <u>083-9269252</u> | PerkinElmer Phone: <u>02-719-6420 ext 206</u> | |
| Fax: <u>02-513-4221</u> | PerkinElmer Fax: <u>02-318-5597</u> | |

| CONFIGURATION TESTED | | ACCESSORIES/COMPONENT NOT INCLUDED |
|------------------------------|---------------------------|------------------------------------|
| MODEL | SERIAL NUMBER | |
| <u>OPTIMA 5300DV</u> | <u>077C7042401</u> | |
| TESTED EQUIPMENT | CALIBRATION NUMBER | EXPIRATION |
| <u>IPV Methods</u> | | |
| TEST STANDARD USED | PART NUMBER | EXPIRATION DATE |
| <u>Multielement Standard</u> | <u>N069-1579</u> | <u>August 30, 2022</u> |
| <u>Wavecal Solution</u> | <u>N058-2152</u> | <u>November 30, 2022</u> |
| <u>VIS Wavecal solution</u> | <u>N930-2946</u> | <u>August 30, 2023</u> |
| <u>Instrument Cal. STD4</u> | <u>N930-0221</u> | <u>August 30, 2022</u> |
| CUSTOMER SUPPLIED | COMMENTS | CUSTOMER INITIALS |
| <u>2 % HNO3</u> | | |
| <u>10 % HNO3</u> | | |



MAINTENANCE AND TEST CERTIFICATE MODEL

OPTIMA 5300DV

SERIAL NUMBER 077C7042401
DATE TESTED July 11, 2022
1. MECHANICAL CHECKS

- | | |
|----------------------------------------------------------------------------------|-----------------------------|
| A. Inspect and clean all fans and filters. | <input type="checkbox"/> OK |
| B. Inspect and replace as necessary, all torch components including the RF coil. | <input type="checkbox"/> OK |
| C. Inspect all tubing for sign of clacking or leaking. | <input type="checkbox"/> OK |
| D. Adjust water and gas pressure regulator settings. | <input type="checkbox"/> OK |
| E. Inspect and leak check pneumatics drawers. | <input type="checkbox"/> OK |
| F. Clean the exterior of the instrument. | <input type="checkbox"/> OK |

2. OPTICAL CHECKS

- | | |
|-----------------------------------------------------|-----------------------------|
| A. Inspect and clean all optical components. | <input type="checkbox"/> OK |
| B. As required, check and replace all purgefilters. | <input type="checkbox"/> OK |
| C. Recheck optical alignment. | <input type="checkbox"/> OK |

3. COOLING SYSTEM CHECKS

- | | |
|-----------------------------------------------|------------------------------|
| A. Perform preventive maintenance on chiller. | <input type="checkbox"/> OK |
| B. Flush out the chiller every year. | <input type="checkbox"/> N/A |

4. PERFORMANCE CHECKS

- | | |
|----------------------------|-----------------------------|
| A. Torch View Alignment. | <input type="checkbox"/> OK |
| B. Wavelength Calibration. | <input type="checkbox"/> OK |



MAINTENANCE AND TEST CERTIFICATE MODEL

OPTIMA 5300DV

SERIAL NUMBER : 077C7042401
DATE TESTED : July 11, 2022

| PARAMETER | | SPECIFICATION | | FINAL VALUE | |
|-----------------------------------------|----------------------|---------------|-------|-------------|-----|
| Spectral Resolution : UV | As 193.696 nm | ≤ 0.007 | | 0.00544 | |
| | Ni 231.604 nm | ≤ 0.008 | | 0.00709 | |
| | Ni 341.476 nm | ≤ 0.012 | | 0.00757 | |
| Spectral Resolution : VIS | La 408.672 nm | ≤ 0.020 | | 0.01638 | |
| | Ba 455.403 nm | ≤ 0.025 | | 0.02391 | |
| Precision | | | | | |
| | As 193.656 nm | % RSD | < 1.0 | 0.91 | % |
| | Zn 213.856 nm | % RSD | < 1.0 | 0.87 | % |
| | Mn 257.610 nm | % RSD | < 1.0 | 0.76 | % |
| | La 379.478 nm | % RSD | < 1.0 | 0.59 | % |
| | Ba 455.403 nm | % RSD | < 1.0 | 0.53 | % |
| | Ba 493.408 nm | % RSD | < 1.0 | 0.55 | % |
| Detection Limits : Axial | Tl 190.080 nm | 3(sd) | | 5.51 | ppb |
| | As 193.696 nm | 3(sd) | | 8.59 | ppb |
| | Pb 220.353 nm | 3(sd) | | 0.50 | ppb |
| Detection Limits : Radial | As 193.696 nm | 3(sd) | | 2.17 | ppb |
| | Zn 213.856 nm | 3(sd) | | 0.03 | ppb |
| | Mn 257.610 nm | 3(sd) | | 0.01 | ppb |
| | La 379.478 nm | 3(sd) | | 0.04 | ppb |
| | Ba 455.403 nm | 3(sd) | | 0.01 | ppb |
| | Ba 493.408 nm | 3(sd) | | 0.00 | ppb |
| BEC : Axial (IB X 500)/(IS-IB) | Cd 226.502 nm | ≤ 150 ppb | | 12.46 | |
| BEC : Radial (IB X 1000)/(IS-IB) | Mn 257.610 nm | ≤ 45 ppb | | 30.82 | |



MAINTENANCE AND TEST CERTIFICATE MODEL

OPTIMA 5300DV

SERIAL NUMBER 077C7042401**DATE TESTED** July 11, 2022**Remarks :**

Commissioning follow as commissioning performance sheets.

This is to certify that the above tests have been performed and the configuration tested



meets



does not meet

the PerkinElmer Specifications listed on this certificate.

This certificate does not modify PerkinElmer's standard terms and condition of sale, including warranty terms.

Service Department PerkinElmer Ltd.


Authorized Representative:

(Mr. Wiphan Promlumda)

Service Engineer

PinAAcle 900Z Preventive Maintenance (PM)

| | | | |
|----------------------------------------------|-------------------------------------------------|------------------------------------------------|--------------|
| Company Name: | S.P.S.CONSULTING SERVICE CO.,LTD. | | |
| Address (Instrument Location): | PHAHOLYOTHIN RD, JOMPON, BANGKOK, 51, TH, 10900 | | |
| Serial Number: | PZAS19090402 | PM Number: | 1/2 |
| Customer Name (if applicable): | K. PHENPHA | Telephone Number: | 083-926-9252 |
| Customer Support Engineer Name: | K. DUANG | Service Order Number: | WO-01473846 |
| Date PM Performed: (DD-MMM-YYYY) | 01-Jun-2022 | Next PM Due Date: (DD-MMM-YYYY) | 01-Dec-2022 |
| Standard Labor Hours to Complete PM : | | 5 hours | |

| Part Number | Release | Publication Date |  |
|----------------|---------|------------------|-------------------------------------------------------------------------------------|
| 09370144 Rev.9 | A | January 2018 | |

Scope

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

The customer should save their method before the PM begins.

General Instructions:

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

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

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

Update the PM sticker and instrument logbook as required.

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Component List

| Component / Specific Model | Serial # | Configuration Notes |
|----------------------------|--------------|---------------------|
| AS900 | AS9419052359 | Syngistix 3.1 |
| | | |
| | | |
| | | |

Parts Lists

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

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

| Additional Reagents and Standards Required for PM (Customer Support Solution) | | | | |
|-------------------------------------------------------------------------------|-----------------------|----------|-------------|----------------------------|
| Part Number (if applicable) | Description | Quantity | Batch/Lot # | Expiration Date (MM/YY) |
| N/A | DI Water | 250 ml. | AR | AR |
| N/A | 0.5% HNO 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 \pm 25 mL/min | 255 | Passed |
| External Flow Rate | 100 mL/min \pm 10 mL/min | 105 | Passed |

7.2 Chromium Baseline Noise

Description: Signal to noise check.

| Parameter | Specification | Results | Pass/Fail |
|--------------------|-------------------|---------|-----------|
| Baseline Noise | \leq 0.005 Abs. | 0.0001 | Passed |
| Standard Deviation | \leq 0.005 | 0.0002 | 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 | \leq 7.0 pg/0.0044 A-s | 5.6 | Passed |
| Precision | \leq 2.0 % | 0.56 | 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 | 14.1 | Passed |
| Zeeman Ratio | 0.52 ± 0.04 | 0.53 | Passed |


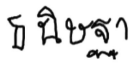
8. Review:

- ☒ 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 | $= \frac{\text{Atomic Signal (Peak area)}}{\text{Atomic Signal (Peak area)} + \text{Background Signal (Peak area)}}$ $= \frac{0.1609}{0.1609 + 0.1377}$ $= 0.53$ |
| REPLACE PM KIT FOR PinAAcle900Z | |

Review

| | | |
|---------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------|
| <i>The preventive maintenance checks and if applicable performance tests for PinAAcle 900Z have been completed.</i> | | |
| <i>This PinAAcle 900Z Passes <input checked="" type="checkbox"/> Fails <input type="checkbox"/> the preventive maintenance.</i> | | |
| Review of Preventive Maintenance: | | |
| Authorized PerkinElmer Representative: |  | Date: 01-Jun-2022 <small>(DD-MMM-YYYY)</small> |
| Authorized Customer Representative: |  | Date: 01-Jun-2022 <small>(DD-MMM-YYYY)</small> |

**QUALITY CALIBRATION CO.,LTD.**

235 Petchkasem 63/2 Road, Laksong, Bangkae, Bangkok 10160

Tel (662) 421-5402, (662) 444-0152-3, Fax (662) 809-4584

www.qcalibration.com



CERTIFICATE No : 22T2575

REFERENCE No : 64387-1

PAGE : 1 OF 2

Certificate of Calibration

EQUIPMENT : WATER BATH

MANUFACTURER : MEMMERT

MODEL : WNB 29

SERIAL No : L614.0123

ID No : WB 05/58

CONDITION AS RECEIVED : USED ITEM

SUBMITTED BY : S.P.S. CONSULTING SERVICE CO., LTD.
7 SOI PHAHOLYOTHIN 24, PHAHOLYOTHIN RD.,
JOMPOL, CHATUCHAK, BANGKOK 10900

CALIBRATED BY : CHAICHARN CH.

CALIBRATION DATE : 11-Mar-22

APPROVED BY : 
PONGSAK J.

ISSUED DATE : 17-Mar-22

RECEIVED DATE : 11-Mar-22

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



Calibration Report

EQUIPMENT : WATER BATH
MANUFACTURER : MEMMERT
ID NUMBER : WB 05/58
RECEIVED DATE : 11-Mar-22
AMBIENT TEMPERATURE : 24 °C ± 1 °C

MODEL : WNB 29
SERIAL NUMBER : L614.0123
CALIBRATION DATE : 11-Mar-22
RELATIVE HUMIDITY : 50 %RH ± 10 % RH

CONDITION OF THIS RESULTS OF CALIBRATION

1. THIS INSTRUMENT WAS CALIBRATED ACCORDING TO ASTM E715-80 (REAPPROVED 2001) BY COMPARISON WITH CALIBRATED RTD. THE PROBES WERE PLACED ON FIVE POINTS AND LOCATED ONE PROBE IN EACH OF THE FOUR CORNERS OF THE BATH AND PLACED THE FIFTH RTD WITHIN 2.5 cm. OF THE GEOMETRIC CENTER OF THE WATER VOLUME (REFERENCE LOCATION) UNDER NO LOAD CONDITION.
2. REFERENCE STANDARD INSTRUMENTS :-

INSTRUMENT

MODEL

SERIAL No

CERTIFICATE No

DUE DATE

1) DATA LOGGER WITH RTD

2625A

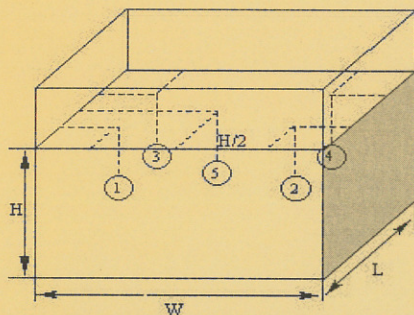
6603614

21T6761

05-Jul-22

3. THIS RESULT WAS FOUND ACCURATE AS SHOWN ON DATE AND PLACE OF CALIBRATION ONLY.
4. THIS RESULT EXCLUDE LONG TERM STABILITY OF THE UNIT UNDER CALIBRATION.
5. THIS CERTIFICATE IS TRACEABLE TO THE INTERNATIONAL SYSTEM OF UNIT MAINTAINED AT:-
- NATIONAL INSTITUTE OF METROLOGY (THAILAND) THROUGH QUALITY CALIBRATION CO.,LTD.

RESULT OF CALIBRATION :- WITHOUT ADJUSTMENT



PROBE INSTALLATION
POSITION IN THE BATH

GENERAL INFORMATION

Overall Variation of Ambient Temperature around the Bath (°C) : 0.8

Overall Variation of Line Voltage (V) : 4

Instrument Condition : Normal

Bath Inner Size (W*L*H) : 59*35*14 cm

BATH PERFORMANCE

| Calibration Point (°C) | Temperature Stability (±°C) | Radius Uniformity (°C) | Axial Uniformity (°C) | Overall Variation (°C) |
|------------------------|-----------------------------|------------------------|-----------------------|------------------------|
| 50.0 | 0.05 | 0.04 | 0.05 | 0.09 |
| 60.0 | 0.04 | 0.05 | 0.05 | 0.12 |

TEMPERATURE MEASUREMENT ACCURACY TEST

| Controller Temp (°C) | Indicating Temp (°C) | Measured Temperature (°C) at Spread Locations | | | | | Uncertainty (± °C) |
|----------------------|----------------------|-----------------------------------------------|-------|-------|-------|--------|--------------------|
| | | #1 | #2 | #3 | #4 | Ref. 5 | |
| 50.3 | 50.3 | 50.07 | 50.08 | 50.05 | 50.04 | 50.07 | 0.14 |
| 60.3 | 60.3 | 60.03 | 60.07 | 60.07 | 60.07 | 60.03 | 0.14 |

NOTE 1 : THE UNCERTAINTY OF MEASUREMENT EXCLUDED TEMPERATURE UNIFORMITY OF THE BATH.

NOTE 2 : THIS CALIBRATION WAS CARRIED OUT AT THE CUSTOMER'S PLACE AT LABORATORY AREA.

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

END OF CALIBRATION REPORT

ระดับเสียงในบรรยากาศ

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0455

MTC No. EEL. BP. 41/0465

CALIBRATION CERTIFICATE

Submitted by : S.P.S. Consulting Service Co.,Ltd.

Address : 7 Soi Phaholyothin 24, Phaholyothin Road, Jompol, Chatuchak, Bangkok 10900.

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 Calibrator

Manufacturer : ACO

Model : 2127

Serial No. : 130006

Ambient Environment

Temperature : $(23 \pm 3) ^\circ\text{C}$

Relative Humidity : $(50 \pm 15) \%$

Ambient Pressure : $(101.325 \pm 1.500) \text{ kPa}$

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 : 22 Apr. 2022

Date of Calibration : 28 Apr. 2022

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.

FM.BL.MTC.002 Rev.4

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0455

MTC No. EEL. BP. 41/0465

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 20 μ Pa at 1000 Hz

Acoustic Output in dB re 20 μ Pa, 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 | 93.93 | -0.07 | ± 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 | $\pm 1.0\%$ |

3. Total Distortion

| Standard Microphone Type | Measured Total Distortion (%) | Uncertainty (%) | Tolerance limit IEC60942:2003 Class 1 |
|---------------------------|-------------------------------|-----------------|---------------------------------------|
| 1/2 inch Bruel&Kjaer 4180 | 1.44 | ± 0.50 | $\pm 3.0\%$ |

- 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 : 28 Apr. 2022

Date of Issue : 28 Apr. 2022

Ref : 2011265042601787001

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End of Certificate

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

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S.P.S. CONSULTING SERVICE CO., LTD.
7 ซอยพหลโยธิน 24 ถนนพหลโยธิน แขวงจันทบุรี เขตจตุจักร กรุงเทพฯ 10900
7 Soi Phaholyothin 24, Phaholyothin Rd., Jompol, Chatuchak, Bangkok 10900
Tel : (662) 939-4370-72, Fax : (662) 513-4221, E-mail : sale@spscon.com., www.spscon.com

Noise B_480/22

Sound Level Meter Calibration Report

Acoustic Calibrator Data

| | | | |
|-------------------|----------------|------------------|---------------|
| Brand | ACO | Number | AC 03/56 |
| Model | 2127 | Serial No. | 130006 |
| Calibration Range | 94 dB, 1000 Hz | Last Calibration | 28 April 2022 |
| | | Due Date | 28 April 2023 |

Calibration Data

| Sound Level Meter Data | | | | Calibration Data | | |
|------------------------------------------------------------------------------------------------|-------|-------|------------|------------------|---------------------|------------------|
| SLM No. | Brand | Model | Serial No. | Date | Actual Reading [dB] | |
| | | | | | Before Adjustment | After Adjustment |
| ACO-B13 | ACO | 6236 | 00152084 | 16 August 2022 | 94.1 | 94.0 |
| ACO-B32 | ACO | 6236 | 00182014 | 16 August 2022 | 93.9 | 94.0 |
| ACO-B36 | ACO | 6236 | 00192027 | 16 August 2022 | 94.0 | 94.0 |
| ACO-R05 | ACO | 6236 | 00142020 | 16 August 2022 | 94.1 | 94.0 |
| Acoustic Certified Value : Thailand Institute of Scientific and Technological Research (TISTR) | | | | | 93.93 \pm 0.10 dB | |

Calibrated by :

(Mr. Phakhinai Khongkomnerd)

Approved by :

(Mr. Peera Detudom)



บริษัท เอส.พี.เอส. คอนซัลติ้ง เซอร์วิส จำกัด
S.P.S. CONSULTING SERVICE CO., LTD.
7 ซอยพหลโยธิน 24 ถนนพหลโยธิน แขวงจอมพล เขตจตุจักร กรุงเทพฯ 10900
7 Soi Phaholyothin 24, Phaholyothin Rd., Jompol, Chatuchak, Bangkok 10900
Tel : (662) 939-4370-72, Fax : (662) 513-4221, E-mail : sale@spscon.com, www.spscon.com

Noise B_664/22

Sound Level Meter Calibration Report

Acoustic Calibrator Data

| | | | |
|-------------------|----------------|------------------|---------------|
| Brand | ACO | Number | AC 03/56 |
| Model | 2127 | Serial No. | 130006 |
| Calibration Range | 94 dB, 1000 Hz | Last Calibration | 28 April 2022 |
| | | Due Date | 28 April 2023 |

Calibration Data

| Sound Level Meter Data | | | | Calibration Data | | |
|------------------------------------------------------------------------------------------------|-------|-------|------------|------------------|---------------------|------------------|
| SLM No. | Brand | Model | Serial No. | Date | Actual Reading [dB] | |
| | | | | | Before Adjustment | After Adjustment |
| ACO-B07 | ACO | 6236 | 00142004 | 13 December 2022 | 94.1 | 94.0 |
| ACO-B12 | ACO | 6236 | 00152081 | 13 December 2022 | 94.1 | 94.0 |
| ACO-B19 | ACO | 6236 | 00172057 | 13 December 2022 | 94.0 | 94.0 |
| ACO-B35 | ACO | 6236 | 00192026 | 13 December 2022 | 94.0 | 94.0 |
| Acoustic Certified Value : Thailand Institute of Scientific and Technological Research (TISTR) | | | | | 93.93 ± 0.10 dB | |

Calibrated by :

(Mr. Adul Dangklom)

Approved by :

(Mr. Peera Detudom)