

# Appendix C Calibration Certificates of Monitoring Equipment



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TISCH ENVIRONMENTAL, INC. 145 SOUTH MIAMI AVE VILLAGE OF CLEVES, OH 45002 513.467.9000 877.263.7610 TOLL FREE 513.467.9009 FAX

### ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5025A

|   | Date - Apr 07, 2014 Rootsmeter S/N 0438320 Ta (K) - 294<br>Operator Tisch Orifice I.D 1612 Pa (mm) - 742.95 |                            |                                      |  |                                  |                                      |  |
|---|---|----------------------------|--------------------------------------|--|----------------------------------|--------------------------------------|--|
| PLATEVOLUMEVOLUMEDIFFDIFFDIFFORSTARTSTOPVOLUMETIMEHgH2ORun #(m3)(m3)(m1)(mm)(in.) |   |                            |                                      |  |                                  |                                      |  |
| 1<br>2<br>3<br>4<br>5   | NA<br>NA<br>NA<br>NA<br>NA  | NA<br>NA<br>NA<br>NA<br>NA | 1.00<br>1.00<br>1.00<br>1.00<br>1.00 | 1.3940<br>0.9790<br>0.8800<br>0.8350<br>0.6910 | 3.2<br>6.4<br>7.8<br>8.8<br>12.7 | 2.00<br>4.00<br>5.00<br>5.50<br>8.00 |  |

#### DATA TABULATION

| Vstd   | (x axis)<br>Qstd                               | (y axis)                                       |      | Va   | (x axis)<br>Qa                                 | (y axis)                                       |
|--|--|--|------|--|--|--|
| 0.9866<br>0.9823<br>0.9804<br>0.9791<br>0.9739 | 0.7077<br>1.0034<br>1.1140<br>1.1726<br>1.4094 | 1.4077<br>1.9908<br>2.2258<br>2.3345<br>2.8155 |      | 0.9957<br>0.9914<br>0.9894<br>0.9881<br>0.9829 | 0.7142<br>1.0127<br>1.1243<br>1.1834<br>1.4224 | 0.8896<br>1.2581<br>1.4066<br>1.4753<br>1.7793 |
| Qstd slop<br>intercept<br>coefficie            | t (b) =<br>ent (r) =                           | 2.00757<br>-0.01628<br>0.99989                 | 1611 | Qa slope<br>intercept<br>coefficie             | t (b) =  | 1.25710<br>-0.01029<br>0.99989                 |
| y axis =                                       | SQRT [H2O (H                                   | Pa/760) (298/                                  | Ta)] | y axis =                                       | SQRT [H2O (7                                   | [a/Pa)]  |

#### CALCULATIONS

Vstd = Diff. Vol[(Pa-Diff. Hg)/760](298/Ta) Qstd = Vstd/Time

Va = Diff Vol [(Pa-Diff Hg)/Pa] Qa = Va/Time

For subsequent flow rate calculations:

Qstd =  $1/m\{[SQRT(H2O(Pa/760)(298/Ta))] - b\}$ Qa =  $1/m\{[SQRT(H2O(Ta/Pa)] - b\}$ 

#### TSP Sampler Calibration

| Location: Lian Tang 3                  | Data  | N 1 5 0015    |
|--|-------|---------------|
|  |       | March 5, 2015 |
| Sampler: TE-5170 MFC (Serial # : 2359) | Tech: | Sam Wong      |

|                     |          | cc    | ONDITIONS          |          |      |
|---------------------|----------|-------|--------------------|----------|------|
|                     |          |       |                    |          |      |
| Barometric Pressure | (in Hg): | 40.00 | Corrected Pressure | (mm Hg): | 1016 |
| Temperature         | (deg F): | 66    | Temperature        | (deg K): | 292  |
| Average Press.      | (in Hg): | 40.00 | Corrected Average  | (mm Hg): | 1016 |
| Average Temp.       | (deg F): | 66    | Average Temp.      | (deg K): | 292  |

| CALIBRATION ORIFICE |                   |                                |                     |  |  |  |
|---------------------|-------------------|--------------------------------|---------------------|--|--|--|
| Model:              | Tisch<br>TE-5025A | Qstd Slope:<br>Qstd Intercept: | 2.00757<br>-0.01628 |  |  |  |
| Serial#:            | 1612              | Date Certified:                | April 7, 2014       |  |  |  |

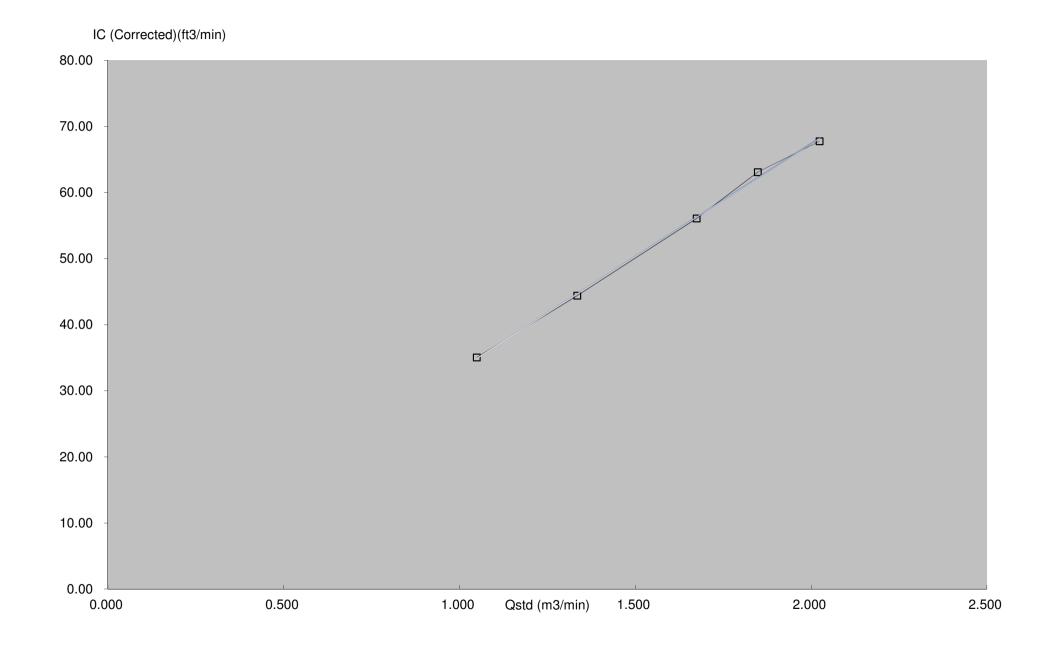
| CALIBRATIONS       |             |                  |              |                   |                               |         |
|--------------------|-------------|------------------|--------------|-------------------|-------------------------------|---------|
| Plate or<br>Test # | H2O<br>(in) | Qstd<br>(m3/min) | I<br>(chart) | IC<br>(corrected) | LINEAR<br>REGRESSION          |         |
| 1                  | 12.00       | 2.024            | 58.0         | 67.76             | Slope =                       | 34.1786 |
| 2                  | 10.00       | 1.848            | 54.0         | 63.09             | Intercept =                   | -0.9414 |
| 3                  | 8.20        | 1.674            | 48.0         | 56.08             | Corr. coeff.=                 | 0.9992  |
| 4                  | 5.20        | 1.335            | 38.0         | 44.39             |                               |         |
| 5                  | 3.20        | 1.049            | 30.0         | 35.05             | <pre># of Observations:</pre> | 5       |

Calculations

IC = I[Sqrt(Pa/Pstd)(Tstd/Ta)]
Qstd = standard flow rate
IC = corrected chart response
I = actual chart response
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)
Tstd = 298 deg K
Pstd = 760 mm Hg
For subsequent calculation of sampler flow:
1/m((I)[Sqrt(298/Tav)(Pav/760)]-b)

Qstd = 1/m[Sqrt(H2O(Pa/Pstd)(Tstd/Ta))-b]

m = sampler slope b = sampler intercept I = chart response Tav = daily average temperature Pav = daily average pressure





| Certificate No.  | 407497   | Page                     | 1 of                     | 2 Pages     | 5             |            |
|--|--|--------------------------|--------------------------|-------------|---------------|------------|
| Customer :   | Enovative Environmental Service  | e Limited                |                          |             |               |            |
| Address :  | Flat 6, 3/F, Block E, Wah Lok Ind  | dustrial Centre, 31-3    | 5 Shan Mei Stree         | et, Shatin, | N.T., Hor     | ıg Kong.   |
| Order No. :  | Q43167   |                          | Date of receipt          | •           | 10-Oc         | xt-14      |
| Item Tested  |  |                          |                          |             |               |            |
| Manufacturer :   | Sound Level Calibrator<br>B&K<br>Type 4231   |                          | Serial No.               | : 2685      | 684           |            |
| Test Conditi   | ons  |                          |                          |             |               |            |
| Date of Test :   | 18-Oct-14  |                          | Supply Voltage           | :           |               |            |
| Ambient Temperature :(23 ± 3)°CRelative Humidity : (50 ± 25) % |  |                          |                          |             |               |            |
| Test Specifie  | cations  |                          |                          |             |               |            |
| Calibration chec<br>Ref. Document/                             | k.<br>Procedure : F21, Z02, IEC 942.   |                          |                          |             |               |            |
| Test Results   | 3  |                          |                          |             |               |            |
|  | within the IEC 942 Class1 specifi<br>shown in the attached page(s).                        | ication.                 |                          |             |               |            |
| Main Test equip  | oment used:  |                          |                          |             |               |            |
| Equipment No.  | Description  | Cert. No.                |                          | Traceable   | <u>e to</u>   |            |
| S014   | Spectrum Analyzer  | 405316                   |                          | NIM-PRC     | & SCL-H       | KSAR       |
| S205   | Ref. Sound Level Calibrator  | PHCO40002                |                          | SCL-HKS     | SAR           |            |
| S041   | Universal Counter  | 405317                   |                          | SCL-HKS     | SAR           |            |
| S206   | Sound Level Meter  | 405322                   |                          | SCL-HKS     | SAR           |            |
| S031   | 61/2 dgt. Multimeter   | 39256                    |                          | NIM-PRO     |               |            |
| <b>7</b> 1   | this Calibration Certificate only relate to  | the values measured at   | the time of the test ar  | nd anv unce | rtainties quo | ted        |
| will not include allow   | wance for the equipment long term drift, v<br>andling, or the capability of any other labo | ariations with environme | ental changes, vibration | on and shoc | k during tran | sponation, |

The test equipment used for calibration are traceable to International System of Units (SI). The test results apply to the above Unit-Under-Test only

Calibrated by : Dorothy Cheuk

for any loss or damage resulting from the use of the equipment.

Approved by : Steve Kwan

Date: 18-Oct-14

This Certificate is issued by: Hong Kong Calibration Ltd.

Unit 88, 24/F., Weil Fung Industrial Centre, No. 58-76, Ta Chuen Ping Street,Kwai Chung, NT,Hong Kong, Tel: 2425 8801 Fax: 2425 8646

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Results :

### 1. Level Accuracy

| UUT Nominal Value (dB) | Measured Value (dB) | IEC 942 Class 1 Spec. |
|------------------------|---------------------|-----------------------|
| 94                     | 94.1                | ± 0.3 dB              |
| 114                    | 114.1               |                       |

Uncertainty :  $\pm 0.1 \text{ dB}$ 

### 2. Frequency

| UUT Nominal Value | Measured Value | IEC 942 Class 1 Spec. |
|-------------------|----------------|-----------------------|
| 1 kHz             | 1.000 kHz      | ± 2 %                 |

Uncertainty :  $\pm$  3.6 x 10 <sup>-6</sup>

- Level Stability : 0.0 dB IEC 942 Class 1 Spec. : ± 0.1 dB Uncertainty : ± 0.01 dB
- 4. Total Harmonic Distortion : < 0.6 % IEC 942 Class 1 Spec. : < 3 % Uncertainty : ± 2.3 % of reading

### Remark : 1. UUT : Unit-Under-Test

- 2. The uncertainty claimed is for a confidence probability of not less than 95%.
- 3. Atmospheric Pressure : 1005 hPa.

----- END -----

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| Certificate No.   | 406516   |   | Page   | 1 c                             | of 4       | Pages                     |
|---|--|---|--|---------------------------------|------------|---------------------------|
|   | Enovative Environmental Servic<br>Flat 6, 3/F, Block E, Wah Lok In<br>Q42822   |   | 35 Shan Mei Stre<br>Date of receipt          |                                 |            | ., Hong Kong.<br>1-Sep-14 |
| Item Tested   |  |   |  |                                 |            |                           |
| Manufacturer :  | Sound Level Meter (N12-RION<br>Rion<br>NL-52   | <b>1</b> -004)  | Serial No.                                   | : 01                            | 022055     | 3                         |
| Test Conditi  | ons  |   |  |                                 |            |                           |
| Date of Test :<br>Ambient Temp  |  |   | Supply Voltage<br>Relative Humic             |                                 |            | %                         |
| Test Specifi  | cations  |   |  |                                 |            |                           |
| Calibration cheo<br>Ref. Document/                                    | sk.<br>Procedure: Z01, IEC 61672.  |   |  |                                 |            |                           |
| Test Results  | 5  |   |  |                                 |            |                           |
|   | within the IEC 61672 Type1 spec<br>shown in the attached page(s).  | ification.  |  |                                 |            |                           |
| Main Test equip   | ment used:   |   |  |                                 |            |                           |
| Equipment No.<br>S017<br>S205   | Description<br>Multi-Function Generator<br>Ref. Sound Level Calibrator   | <u>Cert. No.</u><br>C127181<br>PHCO40002                      |  | <u>Tracea</u><br>SCL-H<br>SCL-H | IKSAR      |                           |
|   |  |   |  |                                 |            |                           |
| will not include allow<br>overloading, mis-ha<br>for any loss or dama | this Calibration Certificate only relate to t<br>vance for the equipment long term drift, vandling, or the capability of any other labor<br>age resulting from the use of the equipme<br>used for calibration are traceable to Inter | ariations with environmer<br>atory to repeat the meas<br>ent. | ntal changes, vibratio<br>urement. Hong Kong | on and sh                       | lock durin | g transportation.         |
| The test results app  | ly to the above Unit-Under-Test only   |   |  |                                 |            |                           |

Calibrated by : Dorothy Cheuk

Approved by :

re Steve Kwan

Date: 25-Sep-14

This Certificate is issued by: Hong Kong Calibration Ltd.

Unii 8B, 24/F., Well Fung Industrial Centre, No. 58-76, Ta Chuen Ping Street, Kwai Chung, NT, Hong Kong. Tel: 2425 8801 Fax: 2425 8646

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Results :

1. Self-generated noise: 16.0 dBA (Mfr's Spec  $\leq$  17 dBA)

### 2. Acoustical signal test

|            | UUT S     | etting    |        |            |              |
|------------|-----------|-----------|--------|------------|--------------|
|            | Frequency | Time      | Octave | Applied    | UUT          |
| Range (dB) | Weighting | Weighting | Filter | Value (dB) | Reading (dB) |
| 30-130     | А         | F         | OFF    | 94.2       | 94.2         |
|            |           | S         | OFF    | 9          | 94.2         |
|            | С         | F         | OFF    |            | 94.2         |
|            | Z         | F         | OFF    |            | 94.2         |
|            | А         | F         | OFF    | 114.2      | 114.2        |
|            |           | S         | OFF    |            | 114.2        |
|            | С         | F         | OFF    |            | 114.2        |
|            | Z         | F         | OFF    |            | 114.2        |

IEC 61672 Type 1 Spec. :  $\pm$  1.1 dB Uncertainty :  $\pm$  0.1 dB

### 3 Electrical signal tests of frequency weightings (A weighting)

| Frequency | Attenuation (dB) | IEC 61672 Type 1 Spec.         |
|-----------|------------------|--------------------------------|
| 31.5 Hz   | -39.7            | - 39.4 dB, ± 2 dB              |
| 63 Hz     | -26.3            | - 26.2 dB, ± 1.5 dB            |
| 125 Hz    | -16.2            | - 16.1 dB, ± 1.5 dB            |
| 250 Hz    | -8.7             | - 8.6 dB, ± 1 dB               |
| 500 Hz    | -3.2             | - 3.2 dB, ± 1.4 dB             |
| 1 kHz     | 0.0 (Ref)        | $0  dB, \pm 1.1  dB$           |
| 2 kHz     | +1.2             | $+$ 1.2 dB, $\pm$ 1.6 dB       |
| 4 kHz     | +1.0             | $+$ 1.0 dB, $\pm$ 1.6 dB       |
| 8 kHz     | -1.0             | - 1.1 dB, + 2.1 dB ~ -3.1 dB   |
| 16 kHz    | -8.0             | - 6.6 dB, + 3.5 dB ~ - 17.0 dB |

Uncertainty :  $\pm 0.1 \text{ dB}$ 



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### 4. Frequency & Time weightings at 1 kHz

4.1 Frequency Weighting (Fast)

| UUT     | Applied    | UUT          | Difference | IEC 61672    |
|---------|------------|--------------|------------|--------------|
| Setting | Value (dB) | Reading (dB) | (dB)       | Type 1 Spec. |
| А       | 94.2       | 94.2 (Ref.)  |            | ± 0.4 dB     |
| С       | 94.2       | 94.2         | 0.0        |              |
| Z       | 94.2       | 94.2         | 0.0        |              |

### 4.2 Time Weighting (A-weighted)

| UUT            | Applied    | UUT          | Difference | IEC 61672    |
|----------------|------------|--------------|------------|--------------|
| Setting        | Value (dB) | Reading (dB) | (dB)       | Type 1 Spec. |
| Fast           | 94.2       | 94.2 (Ref.)  |            | ± 0.3 dB     |
| Slow           | 94.2       | 94.2         | 0.0        |              |
| Time-averaging | 94.2       | 94.2         | 0.0        |              |

Uncertainty :  $\pm 0.1 \text{ dB}$ 

### 5. Level linearity on the reference level range

|             | Applied    |                  |                 |                        |
|-------------|------------|------------------|-----------------|------------------------|
| UUT Range   | Value (dB) | UUT Reading (dB) | Difference (dB) | IEC 61672 Type 1 Spec. |
| 30-130 dB   | 129.0      | 129.0            | 0.0             | ± 1.1 dB               |
| (Ref Level) | 124.0      | 124.0            | 0.0             |                        |
|             | 119.0      | 119.0            | 0.0             |                        |
|             | 114.0      | 114.0 (Ref)      |                 |                        |
|             | 109.0      | 109.0            | 0.0             |                        |
|             | 104.0      | 104.0            | 0.0             |                        |
|             | 99.0       | 99.0             | 0.0             |                        |
|             | 94.0       | 94.0             | 0.0             |                        |
|             | 89.0       | 89.0             | 0.0             |                        |
|             | 84.0       | 84.0             | 0.0             |                        |
|             | 79.0       | 79.0             | 0.0             |                        |
|             | 74.0       | 74.0             | 0.0             |                        |
|             | 69.0       | 69.0             | 0.0             |                        |
|             | 64.0       | 64.0             | 0.0             |                        |
|             | 59.0       | 59.0             | 0.0             |                        |
|             | 54.0       | 54.0             | 0.0             | -                      |
|             | 49.0       | 49.1             | +0.1            |                        |
|             | 44.0       | 44.1             | +0.1            | -                      |

Uncertainty :  $\pm 0.1 \text{ dB}$ 

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#### 6. Toneburst response (4kHz)

| UUT       | Tone Burst   | UUT         | Difference | IEC 61672                |
|-----------|--------------|-------------|------------|--------------------------|
| Setting   | Duration(ms) | Reading(dB) | (dB)       | Type 1 Spec.             |
| Fast      | Steady       | 127.0(Ref)  |            |                          |
|           | 200          | 126.0       | -1.0       | $-1.0 \pm 0.8$ dB        |
| -         | 2            | 109.0       | -18.0      | -18.0, +1.3 dB ~ -1.8 dB |
|           | 0.25         | 99.9        | -27.1      | -27.0, +1.3 dB ~ -3.3 dB |
| Slow      | Steady       | 127.0(Ref)  |            |                          |
|           | 200          | 119.6       | -7.4       | $-7.4 \pm 0.8$ dB        |
|           | 2            | 100.0       | -27.0      | -27.0, +1.3 dB ~ -3.3 dB |
| Time      | Steady       | 127.0(Ref)  |            |                          |
| averaging | 200          | 120.4       | -6.6       | -7.0±0.8dB               |
|           | 2            | 100.3       | -26.7      | -27.0, +1.3 dB ~ -1.8 dB |
|           | 0.25         | 91.0        | -36.0      | -36.0, +1.3 dB ~ -3.3 dB |

Uncertainty :  $\pm 0.1 \text{ dB}$ 

7. Overload indication (30-130 dB range, A-weighted, Time-average, 4kHz)

| UUT Reading         | at overload (dB)    |                 |                        |
|---------------------|---------------------|-----------------|------------------------|
| + ve one half cycle | - ve one half cycle | Difference (dB) | IEC 61672 Type 1 Spec. |
| 136.1               | 137.2               | 1.1             | < 1.8 dB               |

The overload indicator latched on until reset

Uncertainty :  $\pm 0.1 \text{ dB}$ 

Remarks : 1. UUT : Unit-Under-Test

- 2. The uncertainty claimed is for a confidence probability of not less than 95%.
- 3. Atmospheric Pressure : 1001 hPa.
- 4. Preamplifier model : NH-25, S/N : 10553
- 5. Firmware Version: 1.2
- 6. Power Supply Check: OK
- 7. The UUT was adjusted with the laboratory's sound calibrator at the reference sound pressure level before the calibration.

----- END -----