

ใบรับรองการสอบเทียบเครื่องมือ Calibration



Certificate of Calibration

Method 5 Pre-Test Calibration - Liters (L)

UUT Meter Console Information

Model #: XC-572-V
Serial #: A1912535
DGM Model #: SK25EX
DGM Serial #: 00006056

Calibration Conditions

Bar. Pressure (mm Hg): 758.3
Ambient Temperature (°C): 25.6
Relative Humidity (%): 40
Altitude (m): 1.83
Bar. Pressure Corr. (mm Hg): 758.2

Factors/Conversions

Std. Temp. (K): 293.15
Std. Press. (mm Hg): 760
K_f (K/mm Hg): 0.3857

Reference Equipment

Calibration Meter Model: DGMR-200H
Cal. Date: 03-Jun-22
Serial No.: 0000026
Gamma: 1.0000

UUT Meter (DGM)							Reference Meter (WTM)					
Run Time <small>(seconds)</small>	Orifice, ΔH <small>(mm H2O)</small>	Volume			Meter Temperature <small>(°C)</small>		Meter Pressure <small>(in H2O)</small>	Volume <small>(L)</small>			Outlet Temperature <small>(°C)</small>	
		Initial <small>(L)</small>	Final <small>(L)</small>	Total <small>(L)</small>	Initial	Final		Initial	Final	Total	Initial	Final
Θ	P _{m(g)}	V _{mi}	V _{mf}	V _m	t _{mi}	t _{mif}	P _w	V _{wi}	V _{wf}	V _w	t _{wi}	t _{wf}
840.00	13.00	148542.0	148705.2	163.2	25.0	25.0	0.3	0.00	164.61	164.61	25.0	25.0
600.00	25.00	148705.2	148858.4	153.2	25.0	25.0	0.5	0.00	154.10	154.10	25.0	25.0
453.00	50.00	148858.4	149024.2	165.8	25.0	26.0	0.6	0.00	166.50	166.50	25.0	25.0
370.00	80.00	149024.2	149192.8	168.6	26.0	26.0	2.0	0.00	171.82	171.82	25.0	25.0
310.00	120.00	149192.8	149363.6	170.8	26.0	27.0	2.4	0.00	174.51	174.51	25.0	25.0

Standardized Data

Reference Meter (L)		UUT Meter (L)		Correction Factor		ΔH @ (mm H ₂ O)	
Std. Vol.	Std. Flow	Std. Vol.	Std. Flow	Value	Variance	0.0212 SCMM	Variance
V _{w(Std)}	Q _{w(Std)}	V _{m(Std)}	V _{w(Std)}	Y	ΔY	ΔH@	ΔΔH@
161.58	11.54	160.28	11.5	1.0081	-0.0031	43.3	-3.811
151.33	15.13	150.63	15.1	1.0047	-0.0065	48.5	1.425
163.55	21.66	163.14	21.7	1.0025	-0.0087	47.4	0.319
169.36	27.46	166.10	27.5	1.0196	0.0084	47.6	0.487
172.18	33.33	168.63	33.3	1.0211	0.0099	48.7	1.580
				1.0112	= Y Avg.	47.1	= ΔH@ Avg. Metric

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is ±0.02.
Note: For ΔH₀, orifice pressure differential that equates to 0.0212m³/min at standard temperature and pressure, acceptable tolerance of individual values from the average is ±0.2inches (5.1mm) H₂O.

Pass/Fail Judgment : **Pass**

Calibrate By : *Pattanasorn P.*

Approved By : *[Signature]*

Date: 9 Feb 23

The instruments listed and described on this certificate have been calibrated against standards traceable to the National Institute of Standards and Technology (N.I.S.T.) and in reference to EPA Method 5, Section 10.3.1.



Console Information

Model #: XC-572-V
Serial #: A1912535
Units: Metric

Calibration Conditions

Pbar (mm. Hg): 758.3
Humidity (%): 40
Tamb (°C): 25.6
Elevation (m): 1.8
Corr. Pbar (mm. Hg): 758.2

Reference Devices

TC Calibrator Model: CC-VTR-SH
Reference #: 091109289
Barometer Model: 736930
Reference #: EBARODIALSPE01
Pressure Model: 718.30G
Reference #: 9543013

Temperature Display Calibration Data

Reference Point ¹	Reference Temp. °C	Test Thermocouple Calibrations						Reference Point Status ²
		Aux °C	Stack °C	Probe °C	Oven °C	Filter °C	Exit °C	
1	-18	-17	-17	-17	-17	-17	-17	PASS/Fail
2	38	38	38	38	38	37	37	PASS
3	93	93	94	94	94	93	93	PASS
4	149	149	150	150	150	149	149	PASS
5	260	259	259	260	260	259	259	PASS
6	371	371	372	372	371	371	372	PASS
7	482	482	482	483	483	482	482	PASS
8	593	593	594	594	593	593	593	PASS
9	816	815	816	816	815	815	815	PASS
10	1038	1037	1038	1038	1038	1038	1038	PASS
Overall Audit Status								PASS

NIST Reference Thermocouple ID:

Ref Point	Theoretical Temp.	DGM Thermocouple Sensor Reading	ΔT _{abs} ⁴
#	°C	°C	°C
1	0.2	0	0.07%
2	25.6	24	0.33%
Maximum ²			0.33%
Status			PASS

Internal temperature thermocouple is not audited to EPA standards, and should not be used as an official reference for ambient temperature.

Calibrate By: *Talman P.*

Approved By: *Kh*

Date: 9 Feb 23

Notes

- ¹ Suggested, minimum reference points are 10 (0, 100, 200, 300, 500, 700, 900, 1100, 1500, 1900 °F), can test for more.
- ² For valid test results, the maximum difference between temperature and reference readings should be less than ±5.4 °F (±3 °C), for all thermocouples except for the stack thermocouple which should be less than ±1.5% absolute temperature from the reference reading and the exit thermocouple which should be less than ±2 °F (±1 °C) from the reference reading (EPA Method 2, Section 6.3 and EPA Method 5, Sections 6.1.1, 6.1.2).
- ³ Do not change this cell value, it is instead based on input from Cell 18 at the top of this sheet under "Calibration Conditions".
- ⁴ Absolute temperature difference and other formulas are calculated based on unit input from cell C8 at the top of this sheet under "Meter Console Information".
- ⁵ For valid test results, the maximum difference between console and reference barometric pressure readings should be less than ±0.1 in. Hg (±2.5 mm Hg). (EPA Method 5, Section 6.1.2)
- ⁶ For valid test results, the maximum difference between console and reference vacuum readings should be less than ±0.5 in. Hg (±12.5 mm Hg).
- ⁷ For valid test results, the maximum difference between console and reference vacuum readings should be less than ±0.05 in. Hg (±1.25 mm Hg), or 5% of full scale.

Nomenclature

P_b - Barometric Pressure
DGM - Dry Gas Meter
K₁ - Constant based on standard temp and press
t - Run time, in minutes
P_m - ΔH (Meter Pressure, gauge)
V_m - Volume collected by test meter, corrected for STP
Q_{m(std)} - Calculated flow rate of test meter
K' - Critical orifice coefficient
P_w - Measured pressure of reference meter
T_w - Temperature measured in reference meter

Equations

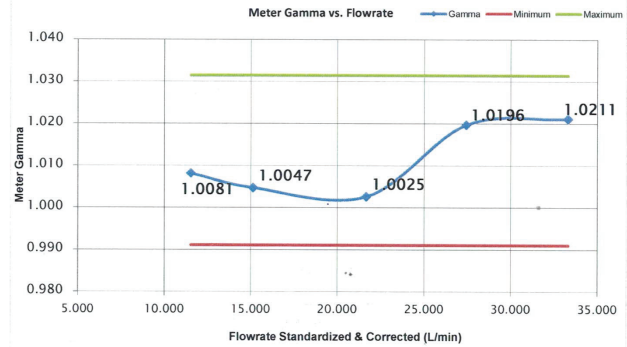
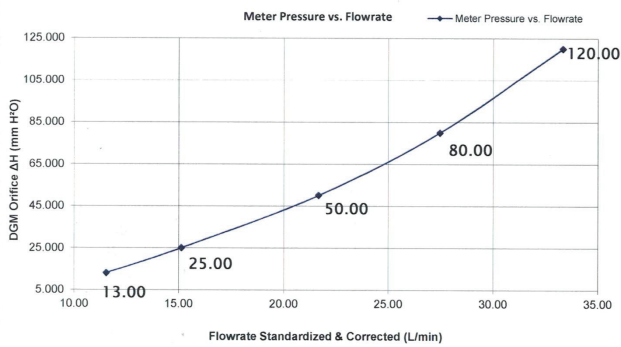
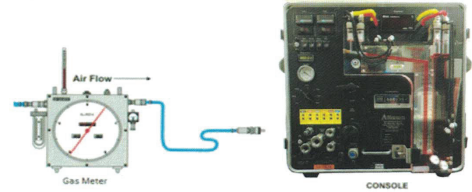
$$V_{w(std)} = Y * K_1 \frac{V_w * (P_{bar} + \frac{P_{m(std)}}{13.6})}{T_w}$$

$$V_{m(std)} = \frac{K_1 V_m (P_{bar} + \frac{\Delta H}{13.6})}{T_m}$$

$$K_1 = \frac{T_{std}}{P_{std}} \quad Y = \frac{V_{cr(std)}}{V_{m(std)}} \quad Q_{w(std)} = \frac{V_{w(std)}}{\Theta}$$

$$Metric \Delta H_{th} = \frac{P_{m(g)} * 0.0011696 * (P_{bar} + \frac{P_{m(g)}}{13.6})}{T_m} * \left(\frac{T_w + \Theta}{V_w * P_{bar}} \right)^2$$

Calibration Train





Console Sensor Audit QA Sheet

Meter Console Information (UUT)

Model #:	XC-572-V	Calibration Conditions	TC Simulator Model:	CC-VTR-SH
Serial #:	A1912535	Pbar (mm. Hg):	Reference #:	91109269
Units:	Metric	Humidity (%):	Barometer Model:	369307
		Amb. Temp. (°C):	Reference #:	EBARODIALSPE01
		Altitude (m):	DP Calibrator Model:	718 30G
		Corrected Pbar (mm. Hg):	Reference #:	9543013

Reference Devices

Model #:	XC-572-V	Calibration Conditions	TC Simulator Model:	CC-VTR-SH
Serial #:	A1912535	Pbar (mm. Hg):	Reference #:	91109269
Units:	Metric	Humidity (%):	Barometer Model:	369307
		Amb. Temp. (°C):	Reference #:	EBARODIALSPE01
		Altitude (m):	DP Calibrator Model:	718 30G
		Corrected Pbar (mm. Hg):	Reference #:	9543013

Calibration Conditions

Model #:	XC-572-V	Calibration Conditions	TC Simulator Model:	CC-VTR-SH
Serial #:	A1912535	Pbar (mm. Hg):	Reference #:	91109269
Units:	Metric	Humidity (%):	Barometer Model:	369307
		Amb. Temp. (°C):	Reference #:	EBARODIALSPE01
		Altitude (m):	DP Calibrator Model:	718 30G
		Corrected Pbar (mm. Hg):	Reference #:	9543013

Reference Devices

Model #:	XC-572-V	Calibration Conditions	TC Simulator Model:	CC-VTR-SH
Serial #:	A1912535	Pbar (mm. Hg):	Reference #:	91109269
Units:	Metric	Humidity (%):	Barometer Model:	369307
		Amb. Temp. (°C):	Reference #:	EBARODIALSPE01
		Altitude (m):	DP Calibrator Model:	718 30G
		Corrected Pbar (mm. Hg):	Reference #:	9543013

Audit Data

Reference Point	Thermocouple Probe Audit						Reference Point (Status) ³
	Aux °C	Stack °C	Probe °C	Oven °C	Filter °C	Exit °C	
Boiling	100	100	100	101	100	101	PASS
Room	25.4	25	24	25	25	25	PASS
Ice Water	0.2	0	0	1	1	0	PASS

Console Vacuum Audit			
Reference Point	Reference Vacuum	Console Vacuum	Reference Point Status ³
#	in. Hg	in. Hg	Pass/Fail
1	17.0	17.0	PASS

Calibrate By: Pattinson P.

Approved By: Ma

Date: 9 Feb 23

Notes

¹For valid test results, the maximum difference between test and reference readings should be less than 5.4 °F (3 °C) for all thermocouples except for the stack thermocouple which should be less than 1.5% absolute temperature from the reference reading and the exit thermocouple which should be less than 2 °F (1 °C) from the reference reading (EPA Method 2, Section 6.3 and EPA Method 5, Sections 6.1.1, 7.6, 1.1.8)

²For valid test results, the maximum difference between console and reference barometric pressure readings should be less than 0.1 in. Hg (2.5 mm Hg). (EPA Method 5, Section 6.1.2)

³For valid test results, the maximum difference between console and reference vacuum readings should be less than 0.5 in. Hg (12.5 mm Hg)

I certify that the above Thermocouple, Barometric, and Vacuum Sensors were calibrated and audited in accordance with US EPA Methods, CFR 40 Part 90



Neediss Supply Instrument Co., Ltd.



Console Sensor Calibration Data Sheet

Console Information

Model #:	XC-572-V	Calibration Conditions	TC Simulator Model:	CC-VTR-SH
Serial #:	A1912535	Pbar (mm. Hg):	Reference #:	091109269
Units:	Metric	Humidity (%):	Barometer Model:	736930
		Tamb (°C):	Reference #:	EBARODIALSPE01
		Corr. Pbar (mm. Hg):	Digital Pressure Calibrator Model:	718 30G
			Reference #:	3891001

Reference Devices

Model #:	XC-572-V	Calibration Conditions	TC Simulator Model:	CC-VTR-SH
Serial #:	A1912535	Pbar (mm. Hg):	Reference #:	091109269
Units:	Metric	Humidity (%):	Barometer Model:	736930
		Tamb (°C):	Reference #:	EBARODIALSPE01
		Corr. Pbar (mm. Hg):	Digital Pressure Calibrator Model:	718 30G
			Reference #:	3891001

Calibration Conditions

Model #:	XC-572-V	Calibration Conditions	TC Simulator Model:	CC-VTR-SH
Serial #:	A1912535	Pbar (mm. Hg):	Reference #:	091109269
Units:	Metric	Humidity (%):	Barometer Model:	736930
		Tamb (°C):	Reference #:	EBARODIALSPE01
		Corr. Pbar (mm. Hg):	Digital Pressure Calibrator Model:	718 30G
			Reference #:	3891001

Reference Devices

Model #:	XC-572-V	Calibration Conditions	TC Simulator Model:	CC-VTR-SH
Serial #:	A1912535	Pbar (mm. Hg):	Reference #:	091109269
Units:	Metric	Humidity (%):	Barometer Model:	736930
		Tamb (°C):	Reference #:	EBARODIALSPE01
		Corr. Pbar (mm. Hg):	Digital Pressure Calibrator Model:	718 30G
			Reference #:	3891001

Pressure Gauge / Manometer Calibration Data

Console Vacuum Calibration			
Reference Point	Reference Vacuum	Console Vacuum	Reference Point Status ³
#	in. Hg	in. Hg	Pass/Fail
1	-5.0	-5.0	PASS
2	-15.0	-15.0	PASS
3	-20.0	-20.0	PASS

ΔH Manometer Calibration			
Reference Point ¹	Reference mm H ₂ O	Positive (+) Pilot mm H ₂ O	Negative (-) Pilot mm H ₂ O
#			
1	-200.000	0.0	-200.0
2	-150.000	0.0	-150.0
3	-100.000	0.0	-100.0
4	-80.000	0.0	-80.0
5	-50.000	0.0	-50.0
6	0.000	0.0	0.0
7	50.000	50.0	0.0
8	80.000	80.0	0.0
9	100.000	100.0	0.0
10	150.000	150.0	0.0
11	200.000	200.0	0.0
ΔH Overall Audit Status			
PASS			

ΔP Manometer Calibration			
Reference Point ¹	Reference mm H ₂ O	Positive (+) Pilot mm H ₂ O	Negative (-) Pilot mm H ₂ O
#			
1	-200.000	0.0	-200.0
2	-150.000	0.0	-150.0
3	-100.000	0.0	-100.0
4	-80.000	0.0	-80.0
5	-50.000	0.0	-50.0
6	0.000	0.0	0.0
7	50.000	50.0	0.0
8	80.000	80.0	0.0
9	100.000	100.0	0.0
10	150.000	150.0	0.0
11	200.000	200.0	0.0
ΔP Overall Audit Status			
PASS			

Calibrate By: Pattinson P.

Approved By: Ma

Date: 9 Feb 23

Notes

¹Suggested minimum reference points are 10 (0, 100, 200, 300, 500, 700, 900, 1100, 1300, 1500 °F), can test for more

²For valid test results, the maximum difference between temperature and reference readings should be less than 5.4 °F (3 °C) for all thermocouples except for the stack thermocouple which should be less than 1.5% absolute temperature from the reference reading and the exit thermocouple which should be less than 2 °F (1 °C) from the reference reading

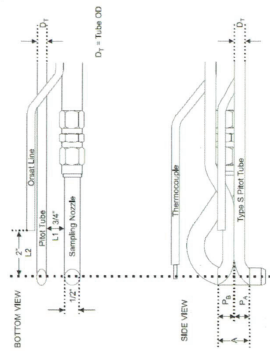
³For valid test results, the maximum difference between console and reference barometric pressure readings should be less than 0.1 in. Hg (2.5 mm Hg). (EPA Method 5, Section 6.1.2)

⁴For valid test results, the maximum difference between console and reference vacuum readings should be less than 0.5 in. Hg (12.5 mm Hg)

⁵For valid test results, the maximum difference between console and reference vacuum readings should be less than 0.05 in. Hg (1.25 mm Hg) or 5% of full scale

I certify that the above Thermocouple Sensors were calibrated in accordance with US EPA Methods 2 and 5, CFR 40 Part 90.

Sampling System Equipment Information		Validation Conditions and Equipment	
Probe Sheat	Apex 1 in., 5 ft.	Digital Calipers	CD-15APX
Probe Number	W1909261	Reference No.	A22070181
Pitot tube Number	A8895	Digital Inclinator	BASELINE
Pitot tube Type	S Type 3/8 Inc.	Reference No.	FEI 12-1057
Validation method	Standard Probe 1 in. and 1/2 in. Sampling Nozzle	Temperature	25.6 °C±3
		Barometric Pressure	758.2 mm Hg



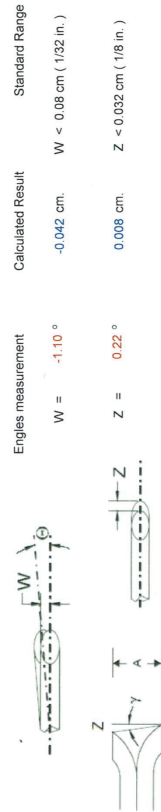
Sampling Probe Validation with Tune up
☒ Measure and Align with 1/2" Sampling Nozzle (12.7 mm)

Measured	Standard Range
$L_1 = 1.90$ cm.	(1.905 cm. or 3/4 in.)
$L_2 = 4.97$ cm.	(5.08 cm. or 2.0 in.)
$D_1 = 0.953$ cm.	(3/8 in.)
$A = 2.19$ cm.	(2.1 D ₁ ≤ A ≤ 3D ₁)
$A/2D_1 = 1.149$ cm.	(1.05 P _A / D ₁ ≤ A ≤ 1.5)

Pitot Tube Validations and Engles measurement Result

☒ Measure Result after Maintenance and Adjustable

P _B Size	Standard Range
$\alpha_1 = 1.40^\circ$	≤ 10°
$\beta_1 = 0.90^\circ$	≤ 5°
P _A Size	Standard Range
$\alpha_2 = 1.40^\circ$	≤ 10°
$\beta_2 = 0.30^\circ$	≤ 5°



Can be use 0.84 for C_p(s) if the type of face-opening misalignment show above with not affect the base line value of C_p(s) Solong as standard range

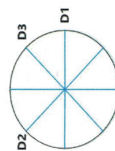
Validation By: Pattaraporn P. Approved By: Kh Date: 9 Feb 23

Sampling System Equipment Information		Validation Conditions	
Console Model	XC-572-V	Digital Calipers	CD-15APX
Console Number	A1912535	Reference No.	A22070181
DGM Model	SK25EX	Temperature	25.6 °C±3
DGM Number	00006056	Barometric Pressure	758.2 mm Hg

Nozzle ID	Validation Data				Results	
	Sizes	Nozzle Diameter			Different	Davg
		D ₁	D ₂	D ₃	ΔD	
NS-4	3.17	3.17	3.17	3.18	0.006	3.173
NS-6	4.77	4.76	4.76	4.76	0.000	4.760
NS-8	6.35	6.36	6.36	6.36	0.000	6.360
NS-10	7.92	7.91	7.92	7.92	0.006	7.917
NS-12	9.52	9.52	9.51	9.51	0.006	9.513
NS-14	11.09	11.09	11.09	11.09	0.000	11.090
NS-16	12.70	12.71	12.71	12.72	0.006	12.713

Where :

D₁, D₂, D₃ = There difference nozzle diameters , mm ; diameter must be within 0.025 mm
 Δ D = Maximum difference between any two diameters , must be ≤ 0.100 mm
 D avg = (D₁ + D₂ + D₃) / 3



Validation By: Pattaraporn P. Approved By: Kh Date: 9 Feb 23