



Thunder Scientific Corporation
623 Wyoming Blvd. SE • Albuquerque, NM 87123 • 505-265-8701

Certificate of Conformance

Customer: MESA LABORATORIES, INC.
12100 W. 6th Avenue, Lakewood, CO 80228
Purchase Order: PO-013120
Item: Thunder Scientific 2500 Humidity Generator
ID Number: TE10228
Serial Number: 9709106
Quality Manual: CL-QM-01, Issue 8, 08 Jan 15
Procedure: CL-SOP-0013, Issue 7, 10 Oct 16
Calibration Date: 12 Mar 18
Cert. Number: 15887

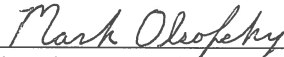
This certifies the above product was calibrated in compliance with ISO/IEC 17025:2005 and ANSI/NCSL Z540-1-1994; Part 1 using applicable Thunder Scientific procedures.

At planned intervals, Thunder Scientific measurement and generation standards are calibrated by comparison to or measurement against national standards, natural physical constants, consensus standards, or by ratio type measurements using self-calibrating techniques.

This calibration is traceable to the International System of Units (SI) through NIST-maintained standards.

At the time of shipment, this instrument did meet published operating/user specifications at the required test points and did conform to the procurement document requirements. Refer to calibration report.

Supporting documentation relative to traceability is on file and is available for examination upon request. This report contains flow data that is not covered by the NVLAP accreditation.


Thunder Scientific Corporation

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REPORT OF
HUMIDITY COMPARISON

Customer: MESA LABORATORIES, INC.
12100 W. 6th Avenue, Lakewood, CO 80228
Purchase Order Number: PO-013120

Item: Thunder Scientific 2500 Humidity Generator s/n 9709106 ID# TE10228
Comparison Required: As Rcvd/As Left at 10, 20, 50 & 80 %RH at 25 °C.

Cert. Number: 15887
Quality Manual: CL-QM-01, Issue 8, 08 Jan 15
Procedure: CL-SOP-0013, Issue 7, 10 Oct 16
Comparison Date: 12 Mar 18
Ambient Conditions: 24 °C (±4 °C) & 40 %RH (±20 %RH)
Generator Flow Rate: 20 slpm
Test Gas: Air

Stds Used: MBW DP-30 EN0040 exp 08 Sep 18
0.08 °C FP/DP uncertainty, k=2
Hart 1504/5665 EN0124 exp 26 Jul 18
0.03 °C uncertainty, k=2
Heise DXD EN0138 exp 23 May 18
0.01 psiA uncertainty (0 to 50 psiA), k=2

The Model 2500 produces an atmosphere of known humidity based on the "two-pressure" principle. The accuracy was verified using a reference chilled mirror hygrometer. "Ref %RH" was calculated using "Ref DP", "Ref Temp" and "Ref Pressure" measurements. This comparison is traceable to the International System of Units (SI) through NIST-maintained standards. Supporting documentation relative to traceability is available for review by appointment.

U_{Comparison} (Measurement Comparison Uncertainty) is the RSS (root sum square) of the UUT's standard deviation of ten readings at each test point, the UUT resolution and the uncertainty of the standards, with a coverage factor of k=2 at a 95 percent confidence level.

As Rcvd Data:

Ref DP °C	2500 DP °C	Ref Temp °C	Ref Pressure psiA	2500 Saturator psiA	2500 Saturator °C	2500 Chamber psiA	2500 Chamber °C	Ref %RH	2500 %RH	Difference %RH	U _{Comparison} %RH
-8.78	-8.78	24.94	12.156	125.1	25.00	12.17	24.97	9.98	10.00	0.02	0.07
0.46	0.48	24.95	12.153	61.57	25.00	12.17	24.99	19.99	20.00	0.01	0.12
13.83	13.87	24.96	12.148	24.39	25.00	12.16	25.00	49.99	50.01	0.02	0.30
21.28	21.32	24.98	12.145	15.20	25.00	12.16	25.01	79.94	79.97	0.03	0.42

As Left Data:

Ref DP °C	2500 DP °C	Ref Temp °C	Ref Pressure psiA	2500 Saturator psiA	2500 Saturator °C	2500 Chamber psiA	2500 Chamber °C	Ref %RH	2500 %RH	Difference %RH	U _{Comparison} %RH
-8.81	-8.77	24.95	12.194	125.4	25.00	12.21	24.99	9.95	10.00	0.05	0.07
0.47	0.48	24.96	12.185	61.71	25.00	12.20	25.00	19.99	20.00	0.01	0.12
13.85	13.88	24.97	12.177	24.43	25.00	12.19	25.01	50.03	50.04	0.01	0.28
21.27	21.32	24.97	12.166	15.23	25.00	12.18	25.01	79.94	79.99	0.05	0.42

Adjustments: System verification before and after all adjustments.

Thunder Scientific 2500 uncertainty is 0.5 %RH. This uncertainty includes the long term stability, reproducibility, repeatability and resolution of the 2500 for a period of up to one year, as long as the unit is maintained per Thunder Scientific's recommendations.

As Rcvd: Within Tolerance: YES
Operational Failure: NONE
Physical Damage: NONE

As Left: Within Tolerance: YES
Limited Range: NONE
Calibration Seals: 0

Mark Olsosky
Mark Olsosky, Cal Tech

Jarred Crouse
Jarred Crouse, Lab Manager

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THUNDER SCIENTIFIC CORPORATION
623 Wyoming Blvd SE, Albq, NM 87123

REPORT OF
PRESSURE CALIBRATION



Customer: MESA LABORATORIES, INC.
12100 W. 6th Avenue, Lakewood, CO 80228
Purchase Order Number: PO-013120

Item: Thunder Scientific 2500 Humidity Generator s/n 9709106 ID# TE10228
Low Range Pressure Transducer s/n: 565342
High Range Pressure Transducer s/n: 564872

Low Pressure Calibration Required: As Rcvd/As Left at 12.5, 20, 30, 40 & 50 psiA.
High Pressure Calibration Required: As Rcvd/As Left at 50, 75, 100, 125 & 150 psiA.

Cert. Number: 15887
Quality Manual: CL-QM-01, Issue 8, 08 Jan 15
Procedure: CL-SOP-0013, Issue 7, 10 Oct 16
Calibration Date: 06 Mar 18
Ambient Conditions: 24 °C (±4 °C) & 40 %RH (±20 %RH)
Test Gas: Nitrogen

Std Used: Mensor PCS400 EN0037 exp 16 May 18
0.02 psiA uncertainty (0 to 100 psiA), k=2
0.04 psiA uncertainty (100 to 300 psiA), k=2

Reference pressures were generated for each transducer and curve fit coefficients were verified, or calculated and stored to memory. This calibration is traceable to the International System of Units (SI) through NIST-maintained standards. Supporting documentation relative to traceability is available for review by appointment.

U (Measurement Uncertainty) is the RSS (root sum square) of the standard deviation of the UUT's error over the test range, the UUT resolution and the uncertainty of the standard, with a coverage factor of k=2 at a 95 percent confidence level.

As Rcvd Data:

Low Pressure Transducer:				High Pressure Transducer:			
Ref psiA	2500 psiA	Error psiA	U psiA	Ref psiA	2500 psiA	Error psiA	U psiA
12.500	12.49	-0.01	0.02	50.000	49.99	-0.01	0.09
20.000	19.99	-0.01	0.02	75.000	74.98	-0.02	0.09
30.000	29.99	-0.01	0.02	100.00	99.98	-0.02	0.09
40.000	40.00	0.00	0.02	125.00	124.9	-0.10	0.12
50.000	49.99	-0.01	0.02	150.00	149.9	-0.10	0.12

As Left Data:

Low Pressure Transducer:				High Pressure Transducer:			
Ref psiA	2500 psiA	Error psiA	U psiA	Ref psiA	2500 psiA	Error psiA	U psiA
12.500	12.50	0.00	0.02	50.000	50.00	0.00	0.02
20.006	20.00	-0.01	0.02	75.012	75.00	-0.01	0.02
30.004	30.00	0.00	0.02	100.00	100.0	0.00	0.06
40.000	40.00	0.00	0.02	125.00	125.0	0.00	0.07
50.004	50.00	0.00	0.02	150.00	150.0	0.00	0.07

Adjustments: New calibration coefficients were calculated and saved to memory.

Manufacturer's specifications: ±0.15% of full scale.

As Rcvd: Within Tolerance: YES
Operational Failure: NONE
Physical Damage: NONE

As Left: Within Tolerance: YES
Limited Range: NONE

Mark Olsosky
Mark Olsosky, Cal Tech

Jarred Crouse
Jarred Crouse, Lab Manager

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THUNDER SCIENTIFIC CORPORATION
623 Wyoming Blvd SE, Albq, NM 87123



REPORT OF
TEMPERATURE CALIBRATION

Customer: MESA LABORATORIES, INC.
12100 W. 6th Avenue, Lakewood, CO 80228
Purchase Order Number: PO-013120

Item: Thunder Scientific 2500 Humidity Generator s/n 9709106 ID# TE10228
Temperature Calibration Required: As Rcvd/As Left at 0, 20, 35, 50 & 70 °C.

Cert. Number: 15887
Quality Manual: CL-QM-01, Issue 8, 08 Jan 15
Procedure: CL-SOP-0013, Issue 7, 10 Oct 16
Calibration Date: 06 Mar 18
Ambient Conditions: 24 °C (±4 °C) & 40 %RH (±20 %RH)
Test Medium: FC-77 Fluorinert™

Std Used: Hart 1504/5665 EN0029 exp 29 Nov 18
0.03 °C uncertainty, k=2

The 2500's four RTD's were compared to the standard thermometer in a temperature bath containing FC-77 Fluorinert™. Reference temperatures were generated and curve fit coefficients were verified, or calculated and stored to memory. This calibration is traceable to the International System of Units (SI) through NIST-maintained standards. Supporting documentation relative to traceability is available for review by appointment.

U (Measurement Uncertainty) is the RSS (root sum square) of the standard deviation of the UUT's error over the test range, the UUT resolution and the uncertainty of the standard, with a coverage factor of k=2 at a 95 percent confidence level.

As Rcvd/As Left Data:

Ref °C	Saturator °C	Error °C	Chamber °C	Error °C	Presat °C	Error °C	Exp Valve °C	Error °C	U °C
70.020	70.02	0.000	70.04	0.020	70.02	0.000	70.02	0.000	0.04
50.032	50.05	0.018	50.05	0.018	50.05	0.018	50.05	0.018	0.04
35.011	35.01	-0.001	35.01	-0.001	35.01	-0.001	35.02	0.009	0.04
20.024	20.03	0.006	20.02	-0.004	20.02	-0.004	20.03	0.006	0.04
0.031	0.02	-0.011	0.02	-0.011	0.01	-0.021	0.03	-0.001	0.04

Adjustments: NONE

Manufacturer's specifications: ±0.06 °C

As Rcvd: Within Tolerance: YES
Operational Failure: NONE
Physical Damage: NONE

As Left: Within Tolerance: YES
Limited Range: NONE

Mark Olsosky
Mark Olsosky, Cal Tech

Jarred Crouse
Jarred Crouse, Lab Manager

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REPORT OF
FLOW CALIBRATION

Customer: MESA LABORATORIES, INC.
12100 W. 6th Avenue, Lakewood, CO 80228
Purchase Order Number: PO-013120

Item: Thunder Scientific 2500 Humidity Generator s/n 9709106 ID# TE10228
Mass Flow Meter s/n: 28664

Mass Flow Calibration Required: As Rcvd/As Left at approximately 0, 10 & 20 slpm

Cert. Number: 15887
Quality Manual: CL-QM-01, Issue 8, 08 Jan 15
Procedure: CL-SOP-0013, Issue 7, 10 Oct 16
Calibration Date: 12 Mar 18
Ambient Conditions: 24 °C (± 4 °C) & 40 %RH (± 20 %RH)
Test Medium: Air

Std Used: BIOS DC-2 EN0003 exp 18 Dec 18
uncertainty 1.4% of reading, k=2

Flow output of the 2500 was monitored by a BIOS DC-2 primary flow meter. Reference flows were generated and curve fit coefficients were verified, or calculated and stored to memory. This calibration is traceable to the International System of Units (SI) through NIST-maintained standards. Supporting documentation relative to traceability is available for review by appointment.

U (Measurement Uncertainty) is the RSS (root sum square) of the standard deviation of the UUT's error over the test range, the UUT resolution and the uncertainty of the standard, with a coverage factor of k=2 at a 95 percent confidence level.

As Rcvd/As Left Data:


Ref slpm	2500 slpm	Error slpm	U slpm
19.84	19.84	0.00	0.29
10.24	10.19	-0.05	0.16
0.00	0.00	0.00	0.06

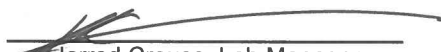
Adjustments: NONE

Manufacturer's specifications: ± 0.8 slpm

As Rcvd: Within Tolerance: YES
Operational Failure: NONE
Physical Damage: NONE

As Left: Within Tolerance: YES
Limited Range: NONE


Mark Olsosky, Cal Tech


Jarred Crouse, Lab Manager

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