SDMS Document ID
1061584

METEOROLOGICAL SOLUTIONS INC.

ADMINISTRATIVE RECORD

CALIBRATION VERIFICATION OF METEOROLOGICAL EQUIPMENT AT THE LIBBY STATION JUNE 2007

Prepared for

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By

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MSI Project Number 06070750
July 2007

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CALIBRATION VERIFICATION OF METEOROLOGICAL EQUIPMENT AT THE LIBBY STATION JUNE 2007

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1-1
2.0	CALIBRATION EQUIPMENT	2-1
3.0	SENSOR CALIBRATION VERIFICATION	3-1
3.1	Meteorological Station Description	3-1
3.2	Calibration Verification Methods	3-3
3.2.1	Wind Direction	3-4
3.2.2	Wind Speed	3-5
3.2.3	Temperature	3-5
3.2.4	Relative Humidity	3-5
3.2.5	Barometric Pressure	3-5
3.2.6	Solar Radiation	3-6
4.0	LIBBY METEOROLOGICAL STATION RESULTS	4-1
4.1	Meteorological Tower Equipment	4-1
4.1.1	Wind Direction	4-1
4.1.2	Horizontal Wind Speed	4-2
4.1.3	Temperature	4-2
4.1.4	Relative Humidity	4-2
4.1.5	Barometric Pressure	4-3
4.1.6	Solar Radiation	4-3
5.0	CONCLUSION	5-1

Table of Contents
Continued

Table

2-1 MSI Calibration Equipment 2-1
3-1 Libby Meteorological Station Sensors 3-3
3-2 Calibration Methods and Acceptable Tolerances 3-4
5-1 Calibration Verification Results of the Libby Meteorological Sensors 5-1

Figure

3.1 Topographical Map of the Libby Monitoring Station Location 3-2
4.1 Intercomparison Plot - Reference Standard Versus Libby Solar Radiation Sensor 4-4
4.2 Linear Regression Plot - Reference Standard Versus Libby Solar Radiation Sensor . . 4-4

Appendices

A Calibration Equipment Certifications
B Calibration Field Data Sheets

CALIBRATION VERIFICATION OF METEOROLOGICAL EQUIPMENT AT THE LIBBY STATION

JUNE 2007

MSI Project 06070750

1.0 INTRODUCTION

Meteorological Solutions Inc. (MSI) was contracted by MWH to conduct calibration verification checks of the Libby Montana meteorological monitoring station. This report summarizes the calibration activities during a site visit on June 21, 2007.

Meteorological calibration checks at the Libby facility were conducted in accordance with the following guidelines:

- EPA's Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), 1987,

- Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, (DRAFT) 2006

2.0 CALIBRATION EQUIPMENT

The following calibration reference standard instruments, presented in Table 2-1, were used to conduct the site calibration verification checks.

Table 2-1

MSI Calibration Equipment

Parameter	Equipment	Serial Number
Wind Direction	Brunton Pocket Transit Model 5008 RM Young Model 18212 Vane Angle Fixture RM Young Model 18331 Vane Torque Gauge	5080101344 NA NA
Horizontal Wind Speed	RM Young Model 18810 Anemometer Drive RM Young Model 18310 Prop Torque Disc	CAO1889 NA
Temperature	Brooklyn Digital Model 6661	C404690
Relative Humidity	Vaisala HMP45AC	B3550019
Barometric Pressure	Suunto Model Escape	62900526
Solar Radiation	Licor Li200x	PY54999

NA = Not Available.

Copies of calibration equipment certifications are included in Appendix A.

3.0 SENSOR CALIBRATION VERIFICATION

This section describes the meteorological calibration verfication activities conducted by MSI at the Libby meteorological station on June 21, 2007.

3.1 Meteorological Station Description

The latitude and longitude coordinates of the Libby meteorological station are:

Latitude:	48.4306
Longitude:	115.3972
Elevation:	4244 feet

Figure 3.1 presents a topographical representation of the location of the Libby meteorological station.

The station is equipped to measure horizontal wind speed and wind direction at 10 meters, aspirated temperature sensors at 2 and 10 meters, relative humidity, barometric pressure, and solar radiation at 2 meters. Sensors installed at the Libby meteorological station are presented in Table 3-1.

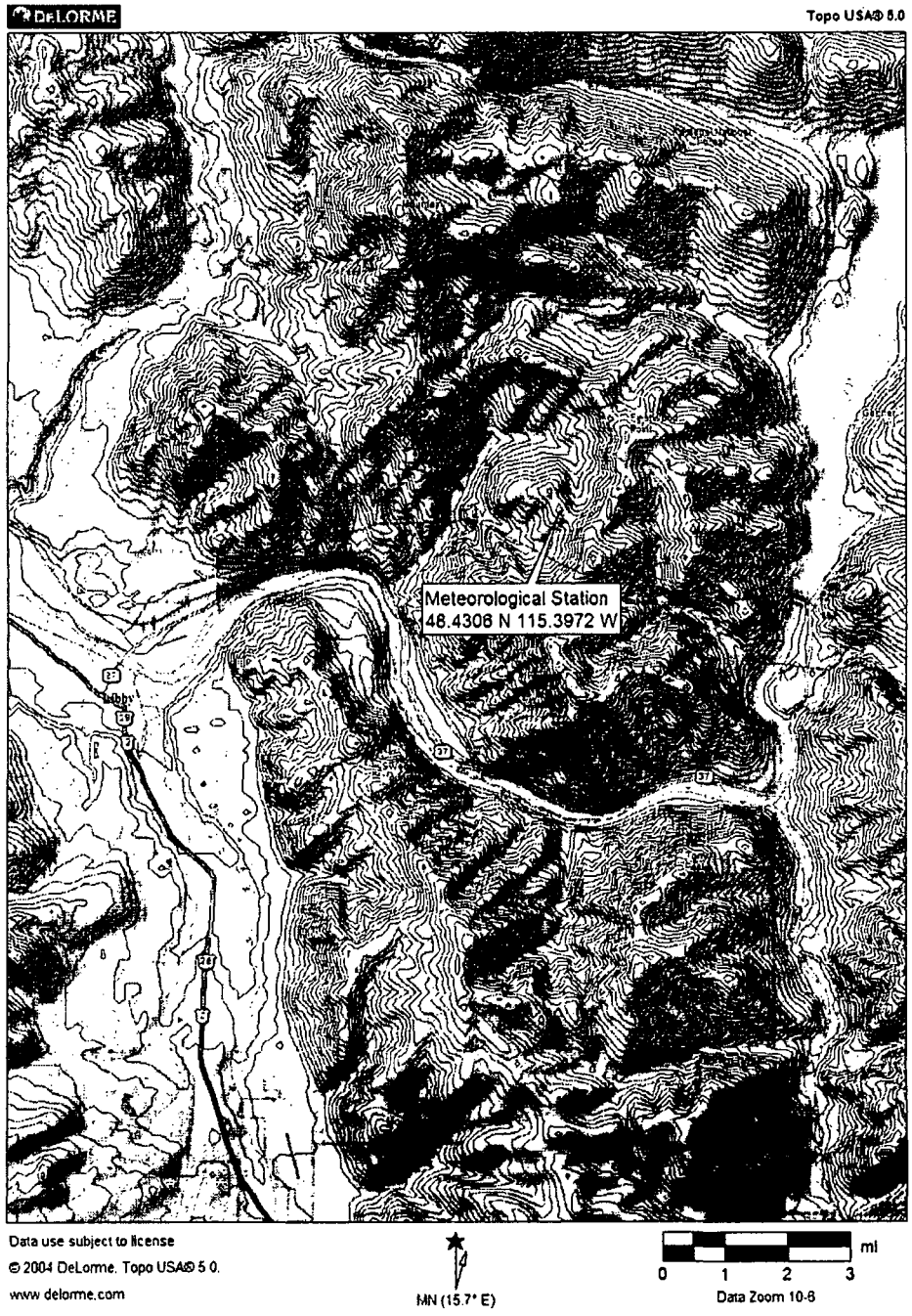

Figure 3.1 Topographical Map of the Libby Monitoring Station Location

Table 3-1

Libby Meteorological Station Sensors

Parameter	Station Sensor	Serial Number
Wind Direction	RM Young Model 05305-5	75312
Horizontal Wind Speed	RM Young Model 05305-5	75312
Relative Humidity	CSI Model CS215	N/A
Barometric Pressure	CSI Model CS100	2966542
Solar Radiation	LiCor Model 200X	PY54971
Temperature	Met One Model 062 (2 meter) Met One Model 062 (10 meter)	F6450 1 of 2 F6450 2 of 2

3.2 Calibration Verification Methods

This section describes the calibration methods used to verify the performance of the equipment installed at the Libby meteorological monitoring station. A summary of the calibration methods and the acceptable tolerances for each method is presented in Table 3-2.

Table 3-2

Calibration Verification Methods and Acceptable Tolerances

Parameter	Calibration Method	Acceptable Tolerances
Wind Direction	Orientation plus Linearity Starting Threshold	±5° <.5 m/s
Horizontal Wind Speed	Synchronous Motor Starting Threshold	±.2 m/s <.5 m/s
Temperature	Collocated Reference Comparison	±0.9°F
Delta Temperature	Collocated Reference Comparison	±0.18°F
Relative Humidity	Certified Reference Collocation	±10 %
Barometric Pressure	Certified Reference Collocation	±3 mb
Solar Radiation	Certified Reference Collocation	±5 %

3.2.1 Wind Direction

The orientation of the wind direction sensor was checked using a professional magnetic compass. The compass was set using a magnetic declination of 16 degrees east of north.

In addition, the wind direction sensor linearity was verified by checking the sensor output at 30 degree increments throughout the entire 0 to 360 degree range in both clockwise and counterclockwise directions. The sensor starting threshold was determined by measuring shaft rotational torque.

3.2.2 Wind Speed

The calibration of the wind speed sensors was verified by applying known revolutions per minute using a variable speed motor drive. The shaft of the synchronous motor was attached to the bearing shaft of the anemometer with the propeller removed. Synchronous motor speeds were translated into calculated wind speeds in miles per hour using manufacturer's specifications. The sensor response was compared to the calculated wind speeds. Wind speed sensor shaft rotational torque was measured with a torque gauge to evaluate starting threshold.

3.2.3 Temperature

For the dual temperature system, sensor calibration was verified by direct comparison of sensor outputs to a collocated calibrated reference standard thermometer at three different temperatures over the measurement range. Both 2 and 10-meter temperatures were checked simultaneously in the same medium so that the Δ temperature function could be verified.

3.2.4 Relative Humidity

The relative humidity sensor calibration was verified by comparison of the station sensor outputs with a collocated relative humidity reference sensor in ambient conditions.

3.2.5 Barometric Pressure

The barometric pressure sensor output was verified by comparing the output of a certified reference barometer with sensor outputs recorded on the data acquisition system.

3.2.6 Solar Radiation

The solar radiation pyranometer was verified by collocating a certified reference pyranometer adjacent to the system sensor. The reference pyranometer was interfaced with a separate data logger synchronized with the station data logger. Readings from the pyranometers were compared both manually with secondly data and from stored hourly averages over a several hour period to verify conformance with acceptable tolerances.

4.0 LIBBY METEOROLOGICAL STATION RESULTS

This section presents the calibration verification results for the meteorological equipment located at Libby meteorological monitoring station.

4.1 Meteorological Tower Equipment

This subsection describes the results of calibration verification of the equipment installed at the Libby meteorological station. Calibration verification of the meteorological sensors was conducted on June 21, 2007.

4.1.1 Wind Direction

The "as found" wind direction sensor orientation checks indicated that the cross arm alignment was 315.0 / 135.0 degrees in reference to true north. The vane was positioned parallel to the cross arm and the data system reported 312.0 and 138.9 degrees, respectively. After the as found check the cross arm was repositioned to 0.0 and 180.0 in reference to true north. The vane was positioned parallel to the cross arm in the 0 and 180 degree positions and the data system reported 0.4 and 179.1 degrees, respectively.

Sensor linearity was checked at 30 degree increments over the entire 0-360 degree range in both clockwise and counterclockwise directions and found to be within ±1.9 degrees. The wind direction sensor orientation plus linearity were within the acceptable tolerances of ±5° respectively. Sensor shaft rotational torque was less than 5.0 gram-centimeters (gm-cm) clockwise and counterclockwise which translates to a starting threshold of less than 0.5 meters per second (m/s). The starting threshold was within the allowable tolerance of <0.5 m/s.

4.1.2 Horizontal Wind Speed

Wind speed sensor responses were checked over the range of 0-91 mph and were identical to the audit inputs. The allowable tolerances for wind speed is ±0.2 m/s . Shaft rotational torque was < 0.1 gm-cm counterclockwise and clockwise translating to a starting threshold less than 0.5 m/s which is within the allowable tolerance of <0.5 m/s.

4.1.3 Temperature

A reference standard digital thermometer was collocated with the sensors simultaneously in water baths at 32.0, 71.0 and 101.6°F for intercomparison. Temperature sensor output for the 2-meter level was within ±0.44°F and the 10-meter level was within ±0.33°F of the reference standard. These outputs were within the acceptable tolerance of ±0.9°F (0.5°C).

Delta temperature outputs between the 2 and 10 meter levels at all three temperatures were within ±0.11 °F. This is within the acceptable tolerance of ±0.18 °F (0.1°C).

4.1.4 Relative Humidity

The relative humidity sensor output was checked during ambient collocation and showed an absolute average difference of 1.3 percent from the reference. This is within the acceptable tolerance of ±10 percent.

4.1.5 Barometric Pressure

A certified reference barometer was collocated with the site barometric pressure sensor. The values from the reference sensor were corrected to sea level pressure in "hg using the Smithsonian Meteorological Tables 6th edition and a site elevation of 4244 feet. The site sensor output was an average of 2.3 percent higher than the reference, which when converted to mb was not within the acceptable tolerance of ±3 mb.

4.1.6 Solar Radiation

A calibrated reference pyranometer was collocated with the station sensor for approximately 3.0 hours. Manual readings of instantaneous data taken at eight different times during this period showed an absolute average percent difference of 1.1 percent. This is within the allowable ±10 percent tolerance. The reference solar radiation sensor was also logged on a separate data logger over the three hour period, the data was compared with the logged data from the site and found to be 0.83 percent different. This is also within the ±10 percent tolerance. An intercomparison plot showing the one hour average reference standard data with one hour average Libby monitoring station data is shown in Figure 4.1. A linear regression plot showing paired MSI reference solar radiation versus Libby monitoring station values is shown in Figure 4.2.

Copies of the calibration verification field data sheets are included in Appendix B.

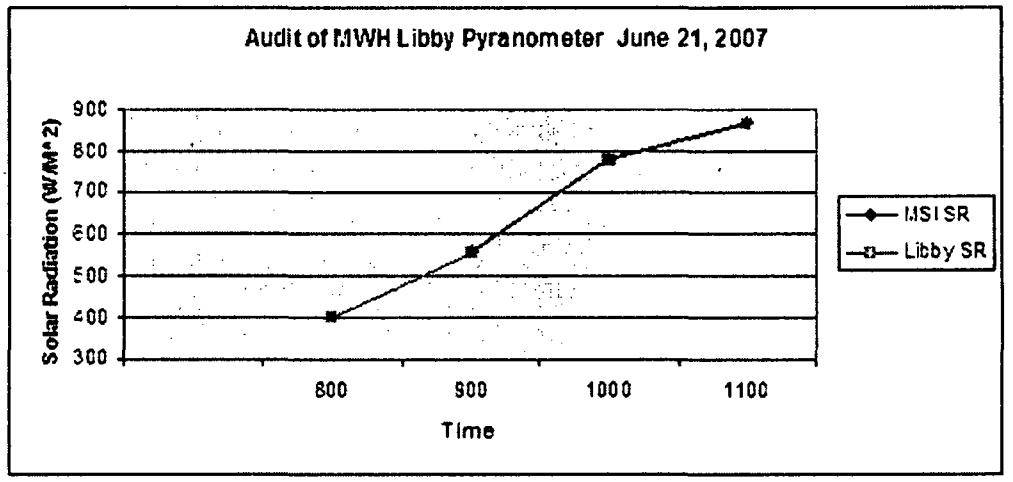

Figure 4.1 Intercomparison Plot - Reference Standard Versus Libby Solar Radiation Sensor.

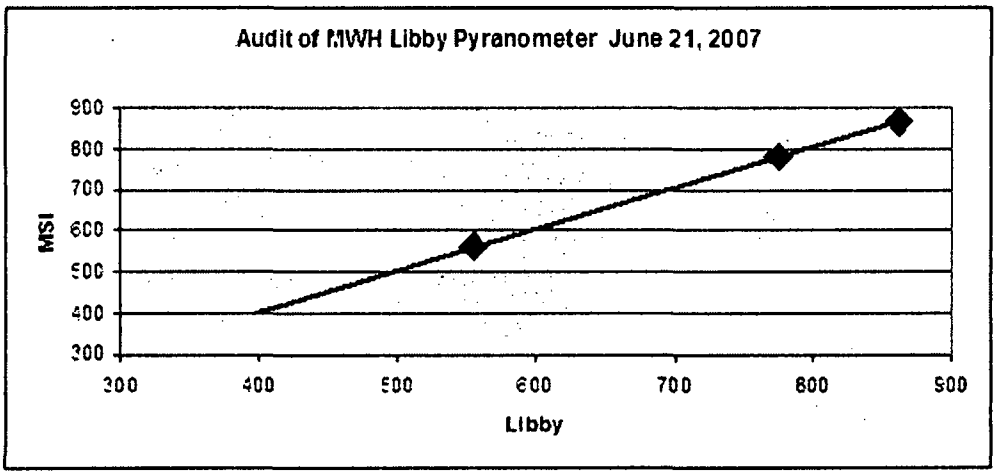

Figure 4.2 Linear Regression Plot - Reference Statndard Versus Libby Solar Radiation Sensor.

5.0 CONCLUSION

A calibration verification of meteorological sensors at Libby was conducted by MSI on June 21, 2007. Table 5-1 presents the results of this audit.

Table 5-1

Calibration Verification Results of the Libby Meteorological Sensors

Parameter	Sensor/Serial Number	Within Tolerance
Wind Direction	RM Young Model 05305-5, S/N 75312	Yes
Horizontal Wind Speed	RM Young Model 05305-5, S/N 75312	Yes
Temperature	Met One Model 062 (2 m) S/NF6450 Met One Model 062 (10 m) S/N F6450	Yes Yes
Relative Humidity	CSI Model CS215 S/N N/A	Yes
Barometric Pressure	CSI Model CS100, S/N 2966542	No
Solar Radiation	LiCor Model 200X, S/N N/A	Yes

At the end of calibration verification activities, all sensors (except the CSI CS100 barometric pressure sensor) were operating within recommended tolerances.

The sea level corrected barometric pressure at the Libby site was reading approximately 0.75 inches of mercury higher than the MSI reference sensor. Investigation of the problem revealed that there was an error in the elevation setting in the CR1000 data logger program. The elevation is currently set to 5000 feet. The actual elevation is 4244 feet. A program change can be made and uploaded to the CR1000 data logger on the next site visit to correct this problem.

Appendix A
Calibration Equipment Certifications

THE BRUNTON COMPANY
Certificate Of Calibration

Equipment Owner: METEOROLOGIAL SOLUTIONS INC
Name: MIKE PETERSON

Address: 2257 SOUTH 1100 EAST, SUITE 203

City, State, Zip: SALT LAKE CITY, UT 84106

Calibration traceable to the National Institute of Standards and Technology in accordance with Mil-STD-45662A has been accomplished on the instrument listed below by comparison with standards maintained by The Brunton Co. The accuracy and stability of all standards maintained by The Brunton Co. are traceable to national standards maintained by the National Institute of Standards and Technology in Washington, D.C. and Boulder, CO. Complete record of all work performed is maintained by The Brunton Co. and is available for inspection upon request.

This Unit has been calibrated to Lietz TM10E serial number 30937 traceable to N.B.S. no. 738 227675 this 15TH Day of MAY 20 07

DESCRIPTION: POCKET TRANSIT

PURCHASE ORDER: RA 10731

ORDER NUMBER: 213795

LOT NUMBER:

MODEL NUMBER: 5008

SERIAL NUMBER: 508001344

CALIBRATION DATE: 5 15 07

RECALIBRATION DUE DATE: 5-15-08

Signed: Linda Kenyon
QUALITY CONTROL MANAGER

R.M. Young Company
2801 Aero Park Drive
Traverse City, Michigan 49686 USA

Certificate of Calibration and Testing

Test Unit:			
Model:	18810	Serial Number:	CA01889
Description:	Anemometer Drive - 10 to 1,000 RPM - Comprised of Models 18820 Control Unit & 18831 Motor Assembly		

R.M. Young Company certifies that the above equipment has been inspected and calibrated using standards whose accuracies are traceable to the National Institute of Standards and Technologies (NIST).

Nominal Motor Rpm	Output Frequency (1) Hz	Calculated Rpm (2)	Indicated Rpm (3)
60	320	60	600
120	640	120	1200
240	1280	240	2400
420	2240	420	4200
600	3200	600	6000
810	4320	810	8100
990	5280	990	9900
☑ Clockwise and Counterclockwise rotation verified			

(1) Measured at the optical encoder output
(2) Frequency output produces 320 pulses per revolution of the motor shaft
(3) Indicated on the Control Unit LCD display - Note: Divide displayed rpm by 10 to calculate actual motor rpm

*Indicates out of tolerance

☑ No Calibration Adjustments Required ☐ As Found ☐ As Left

Traceable frequency meter used in calibration DP4863

Date of inspection 12 January 2007

Tested By EK

Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Website: www.youngusa.com

R.M. Young Company
2801 Aero Park Drive
Traverse City, Michigan 49686 USA

Certificate of Calibration and Testing

Test Unit:			
Model:	18801	Serial Number:	CA01889
Description:	Anemometer Drive - 10 to 10,000 RPM - Comprised of Models 18820 Control Unit & 18830 Motor Assembly		

R.M. Young Company certifies that the above equipment has been inspected and calibrated using standards whose accuracies are traceable to the National Institute of Standards and Technologies (NIST).

Nominal Motor Rpm	Output Frequency (1) Hz	Calculated Rpm (2)	Indicated Rpm (3)
600	320	600	600
1200	640	1200	1200
2400	1280	2400	2400
4200	2240	4200	4200
6000	3200	6000	6000
8100	4320	8100	8100
9900	5280	9900	9900
☑ Clockwise and Counterclockwise rotation verified			

(1) Measured at the optical encoder output
(2) Frequency output produces 32 pulses per revolution of the motor shaft
(3) Indicated on the Control Unit LCD display

*Indicates out of tolerance

☑ No Calibration Adjustments Required ☐ As Found ☐ As Left

Traceable frequency meter used in calibration DP4863

Date of inspection 12 January 2007

Tested By EP

Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Website: www.youngusa.com

PRESSURE
Calibration Record

Meteorological Solutions Inc.
2257 South 1100 East, Suite 2F
Salt Lake City, Utah 84106
P: 801.474.3826
F: 801.474.0766
www.metsolution.com

Start Date 11/27/06 - 11/29/06
Sensor Type Suunto digital model Escape
Sensor ID 62900526

Reference Device Novalynx Digital Barometer (MSI REF)
Reference Device ID 930690-Y4
Location MSI Lab
Comments Lab Temp checked with Brooklyn Digital Thermometer s/n C466800
Technician MRP

Date	Time	Lab Temp C	Reference inches Hg	Pressure Sensor inches Hg	% Diff
11/27/06	1522	22.5	25.18	25.15	-0.12%
11/28/06	0910	21.1	25.38	25.35	-0.12%
11/29/06	0730	20.1	25.72	25.70	-0.08%
Average		21.2	25.43	25.40	-0.12%

Calibration Critieria = +/- 0.5 %

Adjustment required ? No

A36637- 20 - 11

E.O. 5706

Date of Issue: 5/19/2006

Certificate of Calibration
Precision Absolute Manometer 355 (.02%)

Certification Date: 5/19/2006

Recertification Date: 11/19/2007

Sensor I.D. AI92YE11.22

Model Number/Range: 355-AI0900 / 0-900 MMHGA

Serial Number: 930690-Y4

The Meriam Instrument Company hereby certifies the accuracy of the above listed instrument to be ± 0.02% of F.S. [includes combined effects of linearity, repeatability, hysteresis and temperature]. This accuracy was verified in accordance with Meriam Instrument procedure A35924 and is traceable to the National Institute of Standards and Technology through the below listed laboratory standards.

Standard #1: C-85 Piston/Mass Set 38342

Standard #2: N/A

Standard #3: N/A

Standard #4: N/A

Standard #5: N/A

Standard #6: N/A

Room Ambient Conditions: Temperature: 22°C ± 3°C Relative Humidity: 10% - 55% RH

As Received Condition	As Left Condition
___ In Tolerance	X In Tolerance
___ Out of Tolerance	___ Out of Tolerance
___ Inoperative	___ Inoperative
X N/A	

Comments:

There are no special limitations of use imposed on this item due to calibration. We suggest the instrument be evaluated (Recertification Date), however, your particular quality system requirements may supersede this date.

This Certificate of Calibration is provided as support documentation for the customer and may not be reproduced, except in full, without written permission of the issuing organization.

The standards and calibration program are based on the guidelines of ANSI/NCSL Z540-1-1994 and ISO 17025.

Issued By: Jim Poorman JP

NovaLynx Corporation PO Box 240 Grass Valley CA 95945
Phone: (530) 823-7185 Fax: (530) 823-8997 USA Toll Free: 1-800-321-3577

SMART INSTRUMENT QC EVALUATION FORM

(A35923)

900 mmHgA (.02%FS DIST) RANGE

INSTRUMENT: Precision Absolute Manometer (NAME) 355-AI0900 (MODEL #) 930690-Y4 (S/N)

Sensor ID No. AI92YE11.22

FULL SCALE	900.0 mm Hg @ 0C
REF PRESSURE	0.2 mm Hg @ 0C
LOCAL GRAVITY	980.224 GALS
AIR DENSITY	1.186415-07 g/cm^3
ERASS DENSITY	8.3805 g/cm^3
K factor	2.24806E-06 10/g*cm/sec^2
TEMPERATURE	24 DEG. C

STANDARDS USED

REF	MODEL	PISTON S/N	WTB. S/N	DATE
AB614HR	2468	C-85	38342	10/1/05

As Received ____

As Left ✓

INPUT PRESSURE

NOMINAL mm Hg @ 0C	NOMINAL PSI	TYPE CAL/QC	DWT REF DEADWEIGHT USED	VALID	CAR.	1	2	4	6	8	10	12	14	16	17	18	20	GRAM WEIGHTS USED	ACTUAL PRESSURE mm Hg @ 0C	ACTUAL PRESSURE PSI
0.0	0.000	QC	CROSSED/EXTENDED																0.20	0.004
225.0	4.351	QC		YES		1					1		1						222.29	4.298
450.0	8.702	QC		YES		1					1		1						449.66	8.695
675.0	13.052	QC		YES		1					1								666.52	12.888
900.0	17.403	QC		YES		1					1		1						893.81	17.284

ROOM TEMPERATURE EVALUATION

TOLERANCE	0	%R +/-	0.03	%FS +/-	0.02%	%FS DRIFT
	DC UNITS			AC AND 4-20mA UNITS		
ACTUAL	MIN	MAX	IN SPEC?	MIN	MAX	IN SPEC?
0.0	0.0	0.4	✓	-0.1	0.5	
222.2	222.1	223.5	✓	222.0	223.6	
449.5	448.4	449.8	✓	448.5	449.5	
666.4	665.3	666.7	✓	666.2	668.6	
893.8	893.6	894.0	✓	893.5	894.1	

COMMENTS:

PASSED: Yes

THE INSTRUMENT IDENTIFIED ABOVE HAS BEEN EVALUATED PER PROCEDURE A35924: James G. Mostach (TECHNICIAN) 19 MAY 06 (DATE)

THIS CERTIFICATE MAY NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE WRITTEN PERMISSION OF MERIAM

ALL STANDARDS USED ARE N.I.S.T. TRACEABLE.

FORM VALID UNTIL 10/1/06

Certificate report nr. H06-06350120

CALIBRATION CERTIFICATE

Instrument	HMP45AC Humidity and temperature probe
Serial number	B3550019
Manufacturer	Vaisala Oyj, Finland
Calibration date	1st September 2006
Test procedure	Doc210426-A

The above instrument was calibrated by comparing the relative humidity and temperature readings to two HMP233 factory working standards. At the time of shipment, the instrument described above met its operating specifications.

The relative humidity readings of the two HMP233 factory working standards have been calibrated at the Vaisala factory by using Hygro M-3 dewpoint meter. Hygro M-3 dewpoint meter has been calibrated at Vaisala Measurement Standards Laboratory (MSL) by using the MSL primary standard traceable to the NIST. The temperature readings of the two HMP233 factory working standards have been calibrated at MSL by using the MSL working standard traceable to the NIST. The temperature calibration at MSL has been accredited by the FINAS according to the ISO/IEC 17025.

Calibration results

Reference humidity* % RH	Observed humidity % RH	Difference %RH	Permissible difference %RH
0.4	1.2	+0.8	±2.0
45.7	45.9	+0.2	±2.0
71.2	71.9	+0.7	±2.0
Reference temperature* °C	**Observed temperature °C**	**Difference °C**	**Permissible difference °C**
+23.09	+22.99	-0.10	±0.2

*Average of two references.

Equipment used in calibration

Type	Serial number	Calibration date	Certificate number
HMP233 / RH	623075	2006-07-31	H06-06310001
HMP233 / RH	R2420022	2006-07-31	H06-06310002
Vaisala HMP233 / T	623075	2006-05-02	K008-P00547
Vaisala HMP233 / T	R2420022	2006-05-02	K008-P00548
HYGRO M-3	361095	2005-01-26	N00160
HP 34401A	3146A68712	2005-11-03	K004-055719

Uncertainties (95 % confidence level, k=2)
Humidity ±1.0%RH @ 0..15%RH, ±1.5%RH @ 15..78%RH
Temperature ± 0.13 °C
Ambient conditions / Humidity 45 ± 5%RH, Temperature 23 ± 1 °C, Pressure 1000 ± 1 hPa.

For Vaisala Oyj

Sivia Kiasinen

This report shall not be reproduced except in full, without the written approval of Vaisala. *Doc210425-B*

Temperature Sensor Calibration Record

Meteorological Solutions Inc.
2257 South 1100 East, Suite 2F
Salt Lake City, Utah 84106
P: 801.474.3826
F: 801.474.0766
www.metsolution.com

Sensor Type: Brooklyn Digital with utility probe
Sensor ID: C404690
Sensor Range: -40.0 to +150.0 C

CALIBRATION:

Date: 2/14/07
Time: 1000
Location: MSI Lab
Reference Device Brooklyn mercury
Reference Device ID: 3D687
Technician: MRP

LINEAR EQUATION:

Slope (m):
Intercept (b):

Calibration Temperature Point	Calibration Reference Temperature (FE or CE) Tr	Observed Sensor Temperature (FE or CE) Ts	Difference in Degrees (FE or CE)	Percent Error (dT) [dT=((Ts-Tr)*100)/Tr]
1	0.0	0.0	0.0	
2	23.1	23.0	-0.1	
3	40.5	40.4	-0.1	

INTERMOUNTAIN
METROLOGY
SERVICES, INC.

Certificate of Calibration

Firm: *METEOROLOGICAL SOLUT*
P.O. No.: *NONE*
Location: *NONE*
Rpt. of Primary Reference Stds.: *NONE*
Instrument Data Report: *Attached*

Test No.: *295022*
Code No.: *2421A01*
Calibration Interval: *12 MONTHS*
Calibration Procedure: *S051*
Rpt. of Measurement Uncertainty: *NONE*

No sampling plan or other process was used for this calibration and the result(s) reported herein apply only to the calibrated items described within.

Type: *LIQUID IN GLASS THERMOMETER*
Mfg: *BROOKLYN*
ID No.: *NONE*

Model: *-0.5 TO 50.5 DEG C*
Serial No.: *3D687*

Instrument Calibration Condition

Received: *IN TOLERANCE*
Returned: *IN TOLERANCE*
Remarks:
Routine calibration, refer to the attached Instrument Data Report for the measurement results.

IMS, Inc. certifies the above instrument meets or exceeds published specifications and has been calibrated using standards and instruments whose accuracies are traceable to the National Institute of Standards and Technology, an accepted value of a natural physical constant, or ratio type of self-calibration techniques. The policies and procedures at this facility comply with ANSI/NCSL Z540-1, ISO 17025, ISO 10012-1 and the former MIL-STD 45662A.
The Test Uncertainty Ratio (TUR) of this calibration is greater than 4:1 at a confidence level of 95% (k=2) unless otherwise stated within the test results.

Calibration Standards Used

Code No.:	Manufacturer:	Model	Cal Date	Due Date
A H 337	*HART SCIENTIFIC*	*1590*	*06/15/2006*	*06/15/2007*
A H 357	*HART SCIENTIFIC*	*5699*	*04/21/2006*	*04/21/2007*

If the customer has not requested a calibration interval, a non-mandatory recommended interval is provided. Based on past experience and assumed normal usage, it is recommended that this instrument be calibrated by the recommended due date stated below to insure sustained accuracy and reliable performance. Measurements and information provided on this report are valid at the time of calibration only.

Temperature: *70.0 °F*
Rel. Humidity: *18 %*
Cal. Date: *11/17/2006*
Due Date: *11/17/2007*
Date Received: *11/14/2006*
Date of Issue: *11/17/2006*
Technician: *CURTIS P KELLER*

Quality Certified: _____

SS150 5/3/2001

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65 East Wadsworth Park Drive, Suite 101, Draper, UT 84020
www.intermountainmetrology.com
Phone: 801.576.0790 | Fax: 801.576.0784 | Toll Free: 866.481.5997

INTERMOUNTAIN
METROLOGY
SERVICES, INC.

Instrument Data Report

Type: Liquid in Glass Thermometer

Submitted By: Meteorological Solut
ID No.: None
Cal Date: 11/17/2006
Cal Due: 11/17/2007
Temperature (°F): 70
Humidity (%): 18

Manufacturer: Brooklyn
Model No.: -0.5 TO 50.5 DEG C
Serial No.: 3D687
Test No.: 295022
Code No.: 2421A01
Calibration Technician: Curtis P Keller

Test Parameter: Temperature indications — Stated Accuracy: ± 1 division (0.1 °C)

Set Point	Lower Limit	As Received	As Returned	Upper Limit	Uncertainty
0.00 °C	-0.10 °C	0.02 °C	0.02 °C	0.10 °C	0.021 °C
20.00 °C	19.90 °C	20.02 °C	20.02 °C	20.10 °C	0.021 °C
40.00 °C	39.90 °C	40.04 °C	40.04 °C	40.10 °C	0.021 °C

Entries in bold represent out of tolerance readings.

End of Report

Technician Signature: [signature]
Date of Issue: 11/17/2006
Quality Signature: [signature]

RF136 02/03

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CERTIFICATE of CALIBRATION for LI-COR SENSOR

Model Number: LI-200SZ

Serial Number: PY54999 Calibration Date: July 19, 2006

Output: 101.6 microamps per 1000 watts m^{-2}

IMPORTANT: *Read the appropriate instruction manual before using this sensor.*

IMPORTANT: *It is recommended that sensors be recalibrated every two years.*

Calibration Technician: Carson Deschane

LI-COR Biosciences

LI-COR Biosciences • Environmental • 4421 Superior Street • P.O. Box 4425 • Lincoln, NE 68504
Phone: 402-467-3576 • FAX: 402-467-2819 • Toll-free 1-800-447-3576 (U.S. & Canada)
envsales@licor.com • envsupport@licor.com • www.licor.com

Appendix B
Calibration Field Data Sheets

BAROMETRIC PRESSURE CALIBRATION SHEET

Meteorological Solutions Inc.
Meteorological Solutions Inc.
2257 South 1100 East, Suite 203
Salt Lake City, Utah 84106
P: 801.474.3826
F: 801.474.0766
www.metsolution.com

Operator: MWH
Site Name: LIBBY
Project: 07 - 50

Date: 06/21/07
Stn ID: LIBBY
Client: MWH

Start Time: 0822 DAS
Stop Time: 1115 DAS

Sensor Mfg: CSI
Sensor Model: CS100BP
Serial No.: 2966542
Range:

Sensor Height: 1m

Last Calibration Date:

CALIBRATION INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
(Time)	(in)	DAS (v)	DAS (in)	DIFF (%)	DAS (v)	DAS (in)	DIFF (%)
0822	30.08		30.78	2.33			
0943	30.08		30.78	2.33			
1027	30.08		30.79	2.36			

Calibration Criteria: ± 3 mb

Pressure Calibration Device: *Suunto*
Calibration Device Model: Escape
Calibration Device SER #: 62900526

Calibrated By: Mike Peterson

Comments: *Side by side comparison in ambient conditions.* Using met tables from the Smithsonian 6th edition MSI reference sensor values of 25.75"hg were corrected to sea level using site elv. Of 4244' then compared with site data logger values.

SOLAR RADIATION CALIBRATION SHEET

Meteorological Solutions Inc.

Meteorological Solutions Inc.
2257 South 1100 East, Suite 203
Salt Lake City, Utah 84106
P: 801.474.3826
F: 801.474.0766
www.metsolution.com

Operator: MWH
Site Name: LIBBY
Project: 07 - 50

Date: 6/21/2007
Stn ID: LIBBY
Client: MWH

Start Time: 0723 DAS
Stop Time: 1115 DAS

Sensor Mfg: LiCor
Serial No.: PY54971
Range: 0-1400 watts/m^2

Sensor Model: LI200X
Sensor Height: 12' 7"

Last Calibration Date: _____

CALIBRATION INPUT			DAS RESPONSE			DAS RESPONSE	
Time	(watts/m^2)	(Ly/min)	(volts)	(watts/m^2)	(diff %)	(watts/m^2)	(diff)
0724	61.7			60.0	-2.8%	(CLOUDS)	
0736	408.0			405.0	-0.7%		
0813	598.0			593.0	-0.8%		
0859	638.0			632.0	-0.9%		
0917	835.0			827.0	-1.0%		
0943	965.0			960.0	-0.5%		
1016	948.0			937.0	-1.2%		
1057	944.0			938.0	-0.6%		
Calibration Criteri	± 5%						

Solar Radiation Calibration Device: LiCor
Solar Radiation Calibration Model: Li200x
Solar Radiation Calibration SER #: PY54999

Comments: Side by side comparison in ambient conditions. Audit 15 min averages logged on a separate CR10X data logger.

Calibration By: Mike Peterson

RELATIVE HUMIDITY CALIBRATION SHEET

Meteorological Solutions Inc.
Meteorological Solutions Inc.
2257 South 1100 East, Suite 203
Salt Lake City, Utah 84106
P: 801.474.3826
F: 801.474.0766
www.metsolution.com

Operator: MWH
Site Name: LIBBY
Project: 07 - 50

Date: 6/21/2007
Stn ID: LIBBY
Client: MWH

Start Time: 0700 DAS
Stop Time: 1115 DAS

Sensor Mfg: CSI
Sensor Model: CS215 T/RH
Serial No.: N/A
Range: 0 - 100 %

Sensor Height: 7' 10"

Last Calibration Date: _____

CALIBRATION INPUT		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
(Time)	(%)	DAS (v)	DAS (%)	DIFF (%)	DAS (v)	DAS (%)	DIFF (%)
0733	37.3		37.8	1.3%			
0857	32.4		32.7	0.9%			
0920	32.8		32.5	-0.9%			
0941	34.8		34.9	0.3%			
1015	28.1		28.4	1.1%			
1100	24.9		25.7	3.2%			

Criteria: ± 10 %

Rel. Humidity Calibration Device: Vaisala
Rel. Humidity Calibration Model: HMP45AC
Rel. Humidity Calibration SER #: B3550019

Comments

CS215 T/RH temperature comparison.

AIR TEMP	AUD	SITE	DIFF
0820 DAS	70.3	70.5	0.2 F
0900 DAS	71.6	71.9	0.3 F
1100 DAS	72.9	73.8	0.9 F

Side by side comparisons in ambient conditions. Temp audit sensor s/n C404690

Calibration By: Mike Peterson

HORIZONTAL WIND SPEED CALIBRATION SHEET

Meteorological Solutions Inc.
2257 South 1100 East, Suite 203
Salt Lake City, Utah 84106
P: 801.474.3826
F: 801.474.0766
www.metsolution.com

Operator: MWH
Site Name: LIBBY
Project: 07 - 50

Date: 6/21/2007
Stn ID: LIBBY
Client: MWH

Start Time: 0700 DAS
Stop Time: 1115 DAS

Sensor Mfg: RM Young
Serial No.: 75312
Last Calibration Date:

WS Sensor Model: 05305-5
WS Sensor Ht: 28' 6"
WS Range 0 -:

WS Shaft Rotational Torque: <0.1 gm-cm CW & CCW

Sensor Starting Threshold: <0.5 mps

CALIBRATION		PRIMARY DAS RESPONSE			BACKUP DAS RESPONSE		
(rpm)	(mph)	DAS (v)	DAS (mph)	DIFF (mps)	DAS (v)	DAS (mph)	DIFF (mph)
0.0	0.0		0.0	0.0			
200	2.29		2.29	0.0			
400	4.58		4.58	0.0			
600	6.87		6.87	0.0			
2000	22.90		22.90	0.0			
4000	45.80		45.80	0.0			
6000	68.70		68.70	0.0			
8000	91.60		91.60	0.0			

Calibration Criteria: ± .2 m/s
Starting Threshold: <= .5 m/s

WS Calibration Device: RM Young
WS Calibration Model: 18810
WS Calibration SER #: CA01889

Comments: RM Young Prop Torque Disc Model 18310

Cal By: Mike Peterson

HORIZONTAL WIND DIRECTION CALIBRATION SHEET

Meteorological Solutions Inc.

Meteorological Solutions Inc.
2257 South 1100 East, Suite 203
Salt Lake City, Utah 84106
P: 801.474.3826
F: 801.474.0766
www.metsolution.com

Operator: MWH
Site Name: LIBBY
Project: 07 - 50

Date: 6/21/2007
Stn ID: LIBBY
Client: MWH

Start Time: 0700 DAS
Stop Time: 1115 DAS

Sensor Mfg: RM Young
Serial No.: 75312
Crossarm Alignment: pre 315.0 / 135.0 post 0.0 / 180.0
Site Declination (degrees): 16 degrees
Last Calibration Date:

WD Sensor Model: 05305-5
WD Sensor Ht (m): 10
WD Sensor Range 0-: 360
Vane parallel to crossarm= pre 312.0 / 138.9 post 179.1 / 0.4
WD Shaft Rotational Torque: <5 gm-cm CW & CCW
Starting Threshold: <0.5 m/s

CALIBRATION		CLOCKWISE DAS RESPONSE			COUNTERCLOCKWISE DAS RESPONSE		
(deg)	(deg)	DAS (v)	DAS (deg)	DIFF (deg)	DAS (v)	DAS (deg)	DIFF (deg)
	0/360		0.1	0.1		0.1	0.1
	30		29.8	-0.2		30.0	0.0
	60		60.2	0.2		59.8	-0.2
	90		89.8	-0.2		90.3	0.3
	120		120.0	0.0		120.3	0.3
	150		150.1	0.1		150.6	0.6
	180		179.2	-0.8		179.7	-0.3
	210		210.0	0.0		209.6	-0.4
	240		238.9	-1.1		240.1	0.1
	270		268.9	-1.1		269.5	-0.5
	300		298.6	-1.4		299.5	-0.5
	330		328.1	-1.9		328.3	-1.7

Calibration Criteria: Orientation + Linearity : ± 5 degrees
Starting Threshold: <= .5 m/s

WD Calibration Device: RM Young
WD Calibration Model: 18212
WD Calibration Serial #: Vane Angle Fixture

Comments: Brunton Model 5008 #5080101344
RM Young Model 18331 Vane Torque Gauge
Adjusted crossarm from 315.0 / 135.0 deg to
0.0 / 180.0 deg. Then repositioned sensor.

Cal By: Mike Peterson

MULTI-PROBE TEMPERATURE CALIBRATION SHEET

Meteorological Solutions Inc.

Meteorological Solutions Inc.
2257 South 1100 East, Suite 203
Salt Lake City, Utah 84106
P: 801.474.3826
F: 801.474.0766
www.metsolution.com

Operator: MWH
Site Name: LIBBY
Project: 07 - 50

Date: 6/21/2007
Stn ID: LIBBY
Client: MWH

Start Time: 0700 DAS
Stop Time: 1115 DAS

Sensor Mfg: Met One
Range(s): -50 to 50 C
Last Calibration Date:

Sensor Model: 062
Sensor Ht (m): 2 Serial #: F6450 1 of 2
Sensor Ht (m): 10 Serial #: F6450 2 of 2
Sensor Ht (m): N/A Serial #:

CALIBRATION INPUT		2 METER DAS RESPONSE		10 METER DAS RESPONSE				10 M- 2 M	
Time	(°F)	2 M (°F)	DIFF (°F)	10 M (°F)	DIFF (°F)			ΔT (°F)	
0904	32.0	32.44	0.44	32.33	0.33			-0.110	
0908	101.6	101.76	0.16	101.65	0.05			-0.110	
0911	71.0	71.31	0.31	71.31	0.31			0.000	

Calibration Criteria: ± 0.5 ° C from audit input, and ± 0.1 ° C for ΔT

Temperature Calibration Device: Brooklyn
Temperature Calibration Model: Digital
Temperature Calibration SER #: C404690

Comments: Water baths used for teperature medium.

Calibration By: Mike Peterson