APPENDIX F

First Quarter 2010 IML Calibration and Quality Assurance Audit Report

Energy Fuels Resources Corporation
Piñon Ridge Mill

Calibration and Quality Assurance Audit Report for Meteorological and Ambient Air Monitoring Network

1st Quarter 2010

Prepared by:

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1 Introduction

Inter-Mountain Laboratories – Air Science Division performed calibrations and quality assurance audits on January 27, 2010. The calibrations and audits included all (5) of the ambient air monitoring systems and the (2) meteorological monitoring systems at the Piñon Ridge Mill Site located approximately 15 miles from Naturita, Colorado. The Piñon Ridge Mill Site is operated by Energy Fuels Resources Corporation. This is a list of the monitoring sites and the associated equipment:

Site 1

- Meteorological Station – 10m Tower
  - Wind Speed
  - Wind Direction
  - Vertical Wind Speed
  - Temperature (2m & 10m)
  - Delta Temperature
  - Relative Humidity
  - Solar Radiation
  - Barometric Pressure
  - Precipitation
  - Evaporation
- PM_{10} Sampler – Thermo FRM 2000 PM_{10}
- TSP Sampler – Tisch Hi-Vol 5170

Site 2

- Meteorological Station – 30m Tower
  - Wind Speed
  - Wind Direction
  - Vertical Wind Speed
  - Temperature (2m & 30m)
  - Delta Temperature
  - Relative Humidity
  - Solar Radiation
  - Barometric Pressure
- PM_{10} Sampler – Thermo FRM 2000 PM_{10}
- TSP Sampler – Tisch Hi-Vol 5170

Site 3

- TSP Sampler – Tisch Hi-Vol 5170

Site 4

- TSP Sampler – Tisch Hi-Vol 5170

Site 5

- TSP Sampler – Tisch Hi-Vol 5170

1.1 Calibration and Audit References

The calibrations and audits were conducted in accordance with the following guideline documents:

- Ambient Monitoring Guidelines for the Prevention of Significant Deterioration (PSD), May 1987
- Environmental Protection Agency (EPA) Meteorological Monitoring Guidance for Regulatory Modeling Applications, February 2000 (MMGRMA) (EPA-454/R-99-005)
- Quality Assurance Handbook for Air Pollution Measurements Systems, Vol. I – A Field Guide to Environmental Quality Assurance, April 1994
- Quality Assurance Handbook for Air Pollution Measurements Systems, Vol. II – Ambient Air Quality Monitoring Program, December 2008
- Quality Assurance Handbook for Air Pollution Measurements Systems, Vol. IV – Meteorological Measurements, March 2008
- Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. V, Meteorological Measurements, EPA 1995
- Ambient Air Monitoring Requirements for the Air Pollution Control Division of the Colorado Department of Public Health and Environment, Technical Services Program Air Pollution Control Division, April 2001
- U.S. Nuclear Regulatory Commission Regulatory Guide, Office of Standards Development, Regulatory Guide 4.14 – Radiological Effluent and Environmental Monitoring at Uranium Mills, Revision 1, April 1980
- U.S. Nuclear Regulatory Commission Regulatory Guide, Office of Nuclear Regulatory Research, Regulatory Guide 3.63 – Onsite Meteorological Measurement Program For Uranium Recovery Facilities – Data Acquisition and Reporting, March 1988.

2 Calibration and Audit Methodology and Accuracy Goals

2.1 Meteorological Stations

2.1.1 Wind Speed

The wind speed was verified by rotating the sensor shaft using a DC-powered variable-speed motor equipped with an optical encoder output referenced to a crystal oscillator. A standard sensor speed was calculated based on the audit rotational speed and compared to the instantaneous logger reading. An R.M. Young Torque Disc was used to ensure bearing integrity of the wind speed sensor. All data were recorded on a standardized audit form.

2.1.2 Wind Direction

The wind direction sensor orientation was verified by using a Brunton precision magnetic compass. Instantaneous direction readings from the logger were compared to the standards and recorded on a standardized form.

2.1.3 Temperature

Proper operation of the temperature sensors was verified by placing the sensors and a precision NIST-traceable electronic thermometer in three equilibrated temperature baths (ice bath, warm bath, and ambient bath). Both reference thermometer and logger readings were recorded on a standardized form.

2.1.4 Delta Temperature

Proper operation of the temperature sensors was verified by placing the sensors and a precision NIST-traceable electronic thermometer in three equilibrated temperature baths (ice bath, warm bath, and ambient bath). Both reference thermometer and logger readings were recorded on a standardized form.

2.1.5 Relative Humidity

The relative humidity was checked by co-locating a reference sensor next to the station sensor. The reading was taken and the difference between the calibration standard and the on-site data logger were compared to acceptance criteria.

2.1.6 Solar Radiation

The solar radiation was checked by co-locating a reference sensor next to the station sensor. The readings of covered and uncovered were taken and the differences between the calibration standard and the on-site data logger were compared to acceptance criteria.

2.1.7 Barometric Pressure

The barometric pressure was checked by co-locating a reference sensor next to the station sensor. The reading was taken and the difference between the calibration standard and the on-site data logger were compared to acceptance criteria.

2.1.8 Precipitation

The precipitation gauge was challenged three times using a lab quality burette and water. The volume of water required to cause the tipping bucket to activate was measured and volumes were recorded along with the calculated value for activation on a standardized form.

2.1.9 Evaporation

The evaporation pan was calibrated by using five points to calculate the resulting slope and intercept for the sensor. The calibration is completed by adding water to the evaporation pan and recording the values from a yardstick and the logger.

2.2 Ambient Air Monitoring

2.2.1 PM_{10} FRM Partisol Samplers

The PM_{10} FRM Partisol Sampler audits included a verification of the flow, barometric pressure, ambient temperature, and filter temperature. The flow audit was completed by removing the inlet of the sampler and installing a Flow Transfer Standard (FTS) with an associated digital manometer. The calculated flow of the FTS and the sampler flow were compared to the acceptance criteria.

Proper operation of the temperature sensors (ambient and filter) in the sampler were verified by comparing the sensors and a precision NIST-traceable electronic thermometer. Both reference thermometer and sampler readings were recorded on a standardized form.

The barometric pressure was checked by co-locating a reference sensor next to the sampler. The reading was taken and the difference between the audit standard and the sampler was compared to acceptance criteria.

2.2.2 TSP Hi-Volume Samplers

Audits of the Hi-Volume Samplers were completed by finding the numerical relationship between the sampler output (volumetric flow rate) and its flow indicator (stagnation pressure ratio). The stagnation pressure is an area of low pressure underneath the filter caused by the resistance to airflow through the filter. The stagnation pressure ratio is a mathematical relationship of stagnation and ambient pressures. To find the numerical relationship to the multiple point (multi-point) calibration was completed on the sampler. The audit flow and design flow are compared to the acceptable criteria. The following equipment was required for the audit:

1) National Institute of Standards and Technology (NIST) traceable variable resistance transfer standard (calibration orifice) with faceplate.
2) Portable thermometer, capable of accurately measuring temperature over the range of 0 to 50 ℃ to the nearest ±1 ℃ and referenced to a NIST or American Society for Testing and Materials (ASTM) thermometer within ±2 ℃ at least annually.
3) Portable barometer, capable of accurately measuring ambient barometric pressure over the range of 500 to 800 millimeters of mercury (mm Hg) to the nearest millimeter of mercury, and referenced within ±5 mm Hg to a barometer of known accuracy at least annually.
4) Digital manometers (0 – 20” and 0 – 40”) with tubing.

2.3 Calibration Thresholds

Calibration goals for the parameters measured by the meteorological monitoring system are those specified in the US EPA *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Measurements*, March 2008. Accuracy goals by parameter are shown below.

Table 2-1 – Meteorological Sensor Criteria

Sensor	Specifications
Wind Speed	±0.5 m/s
Wind Speed – Starting Threshold	< 0.5 gm-cm
Wind Direction	± 5.0 compass degrees
Vertical Wind Speed	±.2 m/s ± 5.0 percent of observed
Temperature	±0.5 °C
Delta Temperature	±0.1 °C
Relative Humidity	±5.0 %
Solar Radiation	±5.0 percent of observed
Barometric Pressure	±0.09 in Hg
Precipitation	±10 percent of observed

2.4 Audit Thresholds

Audit goals for the parameters measured by the meteorological monitoring system are those specified in the US EPA *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Quality Monitoring Program*, December 2008. Accuracy goals by parameter are shown below.

Table 2-2 – PM_{10} Sampler Criteria

Sensor	Specifications
Ambient Temperature	±2.0 °C
Filter Temperature	±2.0 °C
Pressure	± 10 mm Hg
Flow Rate	±4.0 percent of observed (±0.67 lpm)
External Leak Check	<5.0 in Hg / 60 seconds
Internal Leak Check	<8.5 in Hg / 30 seconds

Table 2-3 – TSP Sampler Criteria

Sensor	Specifications
Audit Flow Difference	±6.0 percent
Design Flow Difference	±7.0 percent

3 Calibration and Audit Results

Calibration and Audit results for Site #1 – 5 can be found in Appendices A, B, and C.

4 Findings/Recommendations

The calibrations and audit of the Ambient Air Monitoring equipment were within the specifications during the 1st Quarter of 2010. The calibrations of the Meteorological Monitoring equipment were within the calibration specifications at Site #1 and Site #2. A calibration of the evaporation pan was not completed due to the system being offline for winter. The quality assurance audits on the equipment at the Site #1, #2, #3, #4, and #5 were all within specifications. Results of the calibration and audits can be found in Appendix A, B, and C.

Appendix A

PM_{10} Sampler Audits

IML Air Science
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Partisol FRM Single Point Audit

Network:	Energy Fuels
Date:	1/27/2010
Time:	10:38 MST
Audited by:	W. Adler
Streamline FTS ID:	IML-1
Streamline FTS cal. expires:	1/12/2011
Streamline FTS "m":	0.4097
Streamline FTS "b":	-0.7532
Temp Standard ID:	IML 0986
Press Standard ID:	IML 0913
Manometer ID:	IML 0949

Sampler ID: 1-2

As-Found Calibration Values

Parameter	Offset	Span
A/I	-0.0035	0.9998
Amb. Temp.	0.0034	
Filter Temp.	0.0048	
Pressure	-0.0228	
Flow	-0.0031	0.9775

Notes as found:

Sensors Audit

Sensor	Indicated	ΔP	Actual	Difference	Specification
Amb. Temp.	-2.4		-2.9	0.5	±2℃
Filter Temp.	0.1		-0.9	1.0	±2℃
Pressure	626		625	1	± 10 mmHg
Flow	16.60	5.30	16.35	0.25	16.7 lpm ± 4% (± 0.67 lpm)

External Leak Check: Pass
(<8.5"Hg/30 sec.)

Internal Leak Check: Pass
(<8.5"Hg/30 sec.)

Notes:

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Partisol FRM Single Point Audit

Network:	Energy Fuels
Date:	1/27/2010
Time:	12:37 MST
Audited by:	R. Campbell
Streamline FTS ID:	IML 1
Streamline FTS cal. expires:	1/12/2011
Streamline FTS "m":	0.4097
Streamline FTS "b":	-0.7532
Temp Standard ID:	IML 0986
Press Standard ID:	IML 0913
Manometer ID:	IML 0949

Sampler ID: 2-2

As-Found Calibration Values

Parameter	Offset	Span
A/I	-0.0020	0.9996
Amb. Temp.	-0.0003	
Filter Temp.	-0.0032	
Pressure	-0.0075	
Flow	-0.0081	1.0000

Notes as found:

Sensors Audit

Sensor	Indicated	ΔP	Actual	Difference	Specification
Amb. Temp.	-1.7		-1.9	0.2	±2℃
Filter Temp.	0.4		0.2	0.2	±2℃
Pressure	621		621	0	± 10 mmHg
Flow	16.70	5.22	16.30	0.40	16.7 lpm ± 4% (± 0.67 lpm)

External Leak Check: Pass
(<8.5"Hg/30 sec.)

Internal Leak Check: Pass
(<8.5"Hg/30 sec.)

Notes:

Appendix B

TSP Sampler Audits

Sampler Flow Rate Audit

Network:	Energy Fuels Resources		
Sampler ID:	1-1	**Sampler Type:**	Tisch TE-5170-DV-BL
AIRS Site ID:	N/A	**Audited By:**	W. Adler
Sampler Audit Date:	1/27/2010	**Sampler Calibration Date:**	1/16/2010
Orifice ID:	B	**Orifice Calibration Date:**	3/3/2009
Ambient Temperature (℃):	-2.4	**Ambient Pressure ("Hg):**	24.59
Ambient Temperature (K):	270.8	**Ambient Pressure (mmHg):**	625

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.268 and b = -0.024

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 11.5485 and b = 0.1288

Accuracy Flow Audit

Orifice			Sampler		
ΔP ("H_2O)		**Qa (m^3/min)**	**ΔP ("H_2O)**		**Qa (m^3/min)**
4.60	⇒	1.1326	22.5	⇒	1.1457

Sampler Qa percent difference from Orifice Qa: 1.2%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		**Qa (m^3/min)**
18.9	⇒	1.1608

Corrected Sampler Qa: 1.1469 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: -4.4%

Audit performed according to EPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, Ambient Air Specific Methods.

Notes:

Sampler Flow Rate Audit

Network: Energy Fuels Resources
Sampler ID: 2-1
Sampler Type: Tisch TE-5170-DV-BL
AIRS Site ID: N/A
Audited By: W. Adler
Sampler Audit Date: 1/27/2010
Sampler Calibration Date: 1/16/2010
Orifice ID: B
Orifice Calibration Date: 3/3/2009
Ambient Temperature (°C): 3.0
Ambient Pressure ("Hg): 24.46
Ambient Temperature (°K): 276.2
Ambient Pressure (mmHg): 621

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.268 and b = -0.024

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 10.3461 and b = 0.2310

Accuracy Flow Audit

Orifice ΔP ("H_2O)		Orifice Qa (m^3/min)	Sampler ΔP ("H_2O)		Sampler Qa (m^3/min)
4.43	⇒	1.1256	21.5	⇒	1.1315

Sampler Qa percent difference from Orifice Qa: 0.5%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		Qa (m^3/min)
18.1	⇒	1.1476

Corrected Sampler Qa: 1.1419 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: -4.8%

Audit performed according to EPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, Ambient Air Specific Methods.

Notes:

Sampler Flow Rate Audit

Network: Energy Fuels Resources
Sampler ID: 3-1
Sampler Type: Tisch TE-5170-DV-BL
AIRS Site ID: N/A
Audited By: W. Adler
Sampler Audit Date: 1/27/2010
Sampler Calibration Date: 1/16/2010
Orifice ID: B
Orifice Calibration Date: 3/3/2009
Ambient Temperature (°C): 2.2
Ambient Pressure ("Hg): 24.45
Ambient Temperature (°K): 275.4
Ambient Pressure (mmHg): 621

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.268 and b = -0.024

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 12.0291 and b = 0.0997

Accuracy Flow Audit

Orifice ΔP ("H_2O)		Orifice Qa (m^3/min)	Sampler ΔP ("H_2O)		Sampler Qa (m^3/min)
4.60	⇒	1.1452	22.5	⇒	1.1488

Sampler Qa percent difference from Orifice Qa: 0.3%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		Qa (m^3/min)
19.0	⇒	1.1632

Corrected Sampler Qa: 1.1597 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: -3.4%

Audit performed according to EPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, Ambient Air Specific Methods.

Notes:

Sampler Flow Rate Audit

Network:	Energy Fuels Resources		
Sampler ID:	4-1	**Sampler Type:**	Tisch TE-5170-DV-BL
AIRS Site ID:	N/A	**Audited By:**	W. Adler
Sampler Audit Date:	1/27/2010	**Sampler Calibration Date:**	1/16/2010
Orifice ID:	B	**Orifice Calibration Date:**	3/3/2009
Ambient Temperature (°C):	0.6	**Ambient Pressure ("Hg):**	24.76
Ambient Temperature (°K):	273.8	**Ambient Pressure (mmHg):**	629

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.268 and b = -0.024

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 11.3268 and b = 0.1486

Accuracy Flow Audit

Orifice ΔP ("H_2O)		Orifice Qa (m^3/min)	Sampler ΔP ("H_2O)		Sampler Qa (m^3/min)
4.79	⇒	1.1577	22.9	⇒	1.1442

Sampler Qa percent difference from Orifice Qa: -1.2%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		Qa (m^3/min)
19.1	⇒	1.1606

Corrected Sampler Qa: 1.1745 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: -2.1%

Audit performed according to EPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, Ambient Air Specific Methods.

Notes:

Sampler Flow Rate Audit

Network:	Energy Fuels Resources		
Sampler ID:	5-1	**Sampler Type:**	Tisch TE-5170-DV-BL
AIRS Site ID:	N/A	**Audited By:**	R. Campbell
Sampler Audit Date:	1/27/2010	**Sampler Calibration Date:**	1/16/2010
Orifice ID:	B	**Orifice Calibration Date:**	3/3/2009
Ambient Temperature (°C):	0.1	**Ambient Pressure ("Hg):**	24.36
Ambient Temperature (°K):	273.3	**Ambient Pressure (mmHg):**	619

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.268 and b = -0.024

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 12.4649 and b = 0.0637

Accuracy Flow Audit

Orifice ΔP ("H_2O)		Orifice Qa (m^3/min)	Sampler ΔP ("H_2O)		Sampler Qa (m^3/min)
4.66	⇒	1.1503	22.9	⇒	1.1500

Sampler Qa percent difference from Orifice Qa: 0.0%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		Qa (m^3/min)
19.3	⇒	1.1645

Corrected Sampler Qa: 1.1645 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: -3.0%

Audit performed according to EPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, Ambient Air Specific Methods.

Notes:

Appendix C

Meteorological System Calibrations

METEOROLOGICAL STATION CALIBRATION SUMMARY

Met Station: Energy Fuels - Site #1 (10m Tower) — Calibration Date: 27-Jan-10

Calibration Performed By: R. Campbell, W. Adler - IML Air Science

Sensor	Mfr./Model	Serial Number	Reference Device	Serial/ID Number
Wind Speed 10m (WS):	RM Young Wind Monitor AQ	82346	quartz referenced drive motor	IML 0855
Wind Direction 10m (WD):	RM Young Wind Monitor AQ	82346	transit, compass	IML 0900
Temperature @ 2 Meters:	RM Young Platinum RTD Temp Probe	13638	digital thermistor	IML 0888
Temperature @ 10 Meters:	RM Young Platinum RTD Temp Probe	13639	digital thermistor	IML 0888
Relative Humidity (RH):	CSI CS 500	C2430074	digital hygrometer	IML 0892
Barometric Pressure (BP):	PTB 101B	C2430048	digital barometer	IML 0904
Solar Radiation:	LI-COR LI200SZ	PY57101	collocated LI200X	PY54289
Precipitation:	Met One 12" tipping bucket	G6356	lab grade burette	N/A
Data acquisition system:	CSI CR3000 datalogger	2397	N/A	N/A

Calibration Results

		Reference RPM	Reference m/s	DAS Value	|Difference|	Specification	
AQ WS 10 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
		300	1.54	1.54	0.00	0.56	(2)
		800	4.10	4.10	0.00	0.56	(2)
		3000	15.36	15.36	0.00	0.77	(2)
		8000	40.96	40.96	0.00	2.05	(2)
			Reference	DAS Value	|Difference|	Specification	
WS 10 m start torque (gm-cm)			τ<0.5	N/A	N/A	1.0	(3)
WD 10 meters (degrees)			0.0	0.6	0.6	5.0	(2)
			90.0	90.2	0.2	5.0	(2)
			180.0	180.7	0.7	5.0	(2)
			270.0	270.1	0.1	5.0	(2)

		Reference RPM	Reference cm/s	DAS Value	|Difference|	Specification	
Vertical WS 10 meters (cm/s)		0	0.00	-0.29	0.29	below threshold	
(Clockwise)		20	10.00	9.88	0.12	20.50	(2)
	EPS:	200	100.00	99.97	0.03	25.00	(2)
		300	150.00	149.40	0.60	27.50	(2)
		500	250.00	249.40	0.60	32.50	(2)
		0	0.00	-0.29	0.29	below threshold	
		20	10.00	10.38	0.38	20.50	(2)
	CFT:	20	100.00	100.53	0.53	25.00	(2)
		300	150.00	150.38	0.38	27.50	(2)
		500	250.00	250.83	0.83	32.50	(2)
Vertical WS 10 meters (cm/s)		0	0.00	-0.29	0.29	below threshold	
(Counter-Clockwise)		20	-10.00	-10.17	0.17	20.50	(2)
	EPS:	200	-100.00	-99.70	0.30	25.00	(2)
		300	-150.00	-149.95	0.05	27.50	(2)
		500	-250.00	-249.12	0.88	32.50	(2)
		0	0.00	-0.29	0.29	below threshold	
		20	-10.00	-10.17	0.17	20.50	(2)
	CFT:	200	-100.00	-99.70	0.30	25.00	(2)
		300	-150.00	-149.95	0.05	27.50	(2)
		500	-250.00	-249.12	0.88	32.50	(2)
WS 10 m start torque (gm-cm)			τ<0.5	N/A	N/A	1.0	(3)

		Reference (℃):	DAS Value	|Difference|	Specification	
		0.03	-0.01	0.04	0.5	(2)
Temp. (℃): 2 meter		25.90	25.66	0.24	0.5	(2)
		30.21	30.18	0.03	0.5	(2)
Temp. (℃): 10 meter		0.03	-0.06	0.09	0.5	(2)
		25.90	25.65	0.25	0.5	(2)
		30.21	30.19	0.02	0.5	(2)

		Reference	DAS Value	|Difference|	Specification	
Relative Humidity (%)		79.2	83.6	4.4	5.0	(2)
RH Sensor Temp (℃):		28.4	28.1	0.3		
Solar Radiation (W/m^2)	un-covered	175.68	175.27	0.4	8.8	(4)
	covered	0.00	0.00			
Barometric Pressure ("Hg)		24.70	24.64	0.06	0.09	(4)

	DAS Value (in)	Reference (ml)	DAS Equivalent	|Difference|	Specification	
Precipitation (0.1" equiv.)	0.10	183.0	185.3	2.3	18.5	(2)
	0.10	182.8	185.3	2.5	18.5	(2)
	0.10	179.2	185.3	6.1	18.5	(2)
			Average Diff:	3.7	18.5	(2)

	2m sensor	10m sensor	ΔT - B	Specification	
Delta Temperature (℃):	-0.01	-0.06	0.05	0.1	(2)
	25.66	25.65	0.01	0.1	(2)
	30.18	30.19	0.01	0.1	(2)

BOLD difference values exceed performance specifications

(1)= Performance specification listed in facilities' Quality Assurance Project Plan

(2)= EPA Quality Assurance Manual for Air Pollution Measurement Systems, Vol. IV, 1989

(3)= Manufacturer's Specifications

(4)= EPA On-Site Meteorological Program Guidance for Regulatory Modeling Applications

Notes, Recommendations

System taken offline at 09:20 MST and returned online at 11:07 MST.

METEOROLOGICAL STATION CALIBRATION SUMMARY

Met Station: Energy Fuels - Site #2 (30m Tower) Calibration Date: 27-Jan-10

Calibration Performed By: R. Campbell, W. Adler - IML Air Science

Sensor	Mfr./Model	Serial Number	Reference Device	Serial/ID Number
Wind Speed 30m (WS):	RM Young Wind Monitor AQ	82347	quartz referenced drive motor	IML 0855
Wind Direction 30m (WD):	RM Young Wind Monitor AQ	82347	transit, compass	IML 0900
Temperature @ 2 Meters:	RM Young Platinum RTD Temp Probe	13640	digital thermistor	IML 0888
Temperature @ 30 Meters:	RM Young Platinum RTD Temp Probe	13641	digital thermistor	IML 0888
Relative Humidity (RH):	CSI CS 500	C2730148	digital hygrometer	IML 0892
Barometric Pressure (BP):	PTB 101B	C2750056	digital barometer	IML 0904
Solar Radiation:	LI-COR LI200SZ	PY57102	collocated LI200X	PY54289
Data acquisition system:	CSI CR3000 datalogger	2421	N/A	N/A

Calibration Results

		Reference RPM	Reference m/s	DAS Value	|Difference|	Specification	
AQ WS 30 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
		300	1.54	1.54	0.00	0.56	(2)
		800	4.10	4.10	0.00	0.56	(2)
		3000	15.36	15.36	0.00	0.77	(2)
		8000	40.96	40.96	0.00	2.05	(2)

	Reference	DAS Value	|Difference|	Specification	
WS 30 m start torque (gm-cm)	τ<0.5	N/A	N/A	1.0	(3)
WD 30 meters (degrees)	0.0	0.2	0.2	5.0	(2)
	90.0	90.2	0.2	5.0	(2)
	180.0	179.5	0.5	5.0	(2)
	270.0	270.0	0.0	5.0	(2)

		Reference RPM	Reference cm/s	DAS Value	|Difference|	Specification	
Vertical WS 30 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
(Clockwise)		20	10.00	9.96	0.04	20.50	(2)
	EPS:	200	100.00	99.63	0.37	25.00	(2)
		300	150.00	148.67	1.33	27.50	(2)
		500	250.00	244.41	5.59	32.50	(2)
		0	0.00	0.00	0.00	below threshold	
		20	10.00	9.86	0.14	20.50	(2)
	CFT:	200	100.00	98.37	1.63	25.00	(2)
		300	150.00	148.61	1.39	27.50	(2)
		500	250.00	247.70	2.30	32.50	(2)
Vertical WS 30 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
(Counter-Clockwise)		20	-10.00	-9.96	0.04	20.50	(2)
	EPS:	200	-100.00	-98.16	1.84	25.00	(2)
		300	-150.00	-150.03	0.03	27.50	(2)
		500	-250.00	-248.08	1.92	32.50	(2)
		0	0.00	0.00	0.00	below threshold	
		20	-10.00	-9.87	0.13	20.50	(2)
	CFT:	200	-100.00	-99.87	0.13	25.00	(2)
		300	-150.00	-148.02	1.98	27.50	(2)
		500	-250.00	-247.89	2.11	32.50	(2)
WS 30 m start torque (gm-cm)			τ<0.5	N/A	N/A	1.0	(3)

		Reference (℃):	DAS Value	|Difference|	Specification	
		-0.03	-0.05	0.02	0.5	(2)
Temp. (℃): 2 meter		24.28	24.18	0.10	0.5	(2)
		11.92	11.78	0.14	0.5	(2)
Temp. (℃): 30 meter		-0.03	-0.05	0.02	0.5	(2)
		24.28	24.18	0.10	0.5	(2)
		11.92	11.76	0.16	0.5	(2)

		Reference	DAS Value	|Difference|	Specification	
Relative Humidity (%)		82.9	88.4	5.5	7.0	(2)
RH Sensor Temp (℃):		30.6	29.5	1.1		
Solar Radiation (W/m^2)	un-covered	230.36	229.79	0.6	11.5	(4)
	covered	0.00	0.06			
Barometric Pressure ("Hg)		24.57	24.55	0.02	0.09	(4)

	2m sensor	10m sensor	ΔT - B	Specification	
Delta Temperature (℃):	-0.05	-0.05	0.00	0.1	(2)
	24.18	24.18	0.00	0.1	(2)
	11.78	11.76	0.02	0.1	(2)

BOLD difference values exceed performance specifications

(1)= Performance specification listed in facilities' Quality Assurance Project Plan

(2)= EPA Quality Assurance Manual for Air Pollution Measurement Systems, Vol. IV, 1989

(3)= Manufacturer's Specifications

(4)= EPA On-Site Meteorological Program Guidance for Regulatory Modeling Applications

Notes, Recommendations

System taken offline at 11:37 MST and returned online at 13:59 MST.

Evaporation Pan Verification Sheet

Evap Span **9.4612**
Evap Offset **1.5018**

Empty Pan Logger Reading:

Verification Point	Yardstick Reading (in)*	Logger Reading	Percent Difference
1	**N/A**	**N/A**	**N/A**

Notes:
* Yard Stick Reading - taken at the pan outlet to the gauge
Offline: System offline due to the Winter Season.

Appendix D

Transfer Standard Certifications

Certificate of Accuracy

Transfer Standard Type: Electronic Thermometer Certificate No: T **042009. 01**

Transfer standard, model/type: Cole Parmer Thermistor Thermometer 8402-00 Model 7000H TH
Serial number: JC11507 IML 0986 Probe 02F1128
submitted by/owner: Inter-Mountain Laboratories, Inc.
Air Science Division
555 Absaraka Street
Sheridan, WY 82801

Was compared to:
NIST Traceable Hg-in-glass thermometers, serial numbers 2J3106, 2Y6027, 3L9452.
Miller & Weber Hg-in-glass thermometer sn 2J3106 and 2Y6027 are traceable to NIST Test No. 209621, Test Method ASTM E-77. 2J3106 is traceable through Standard No. 1S1262. 2Y6027 is traceable through Standard No. 9C8072. Miller & Weber Hg-in-glass thermometer sn 3L9452 is traceable to NIST Thermometer 40350, through Transfer Standards 3C4465 & 1Y9716.

Date: 04/20/09
Lab temperature: 73.5 °F
Barometric Pressure: 663.1 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.0	0.0	0.0
9.4	9.4	0.0	0.0
17.4	17.4	0.0	0.0
24.0	24.0	0.0	0.0
40.1	40.1	0.0	0.0

Note:
If no sign is given on the correction, the true temperature is higher than the indicated temperature. If the sign is negative, the true temperature is lower than the indicated temperature.

Transfer Standard adjustments made? YES ☐ **NO** ☒
Post-calibration measurements:

Reference Thermistor (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)

Reviewed: [signature] Date: 4/20/09

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Certificate of Accuracy

Transfer Standard Type: Electronic Thermometer Certificate No: **T 042609. 01**

Transfer standard, model/type: Cole Parmer Digi-Sense ThermoLogR Thermistor Thermometer
Serial number: 429725 IML 0888 Probe S/N: IML 429725
submitted by/owner: Inter-Mountain Laboratories, Inc.
Air Science Division
555 Absaraka Street
Sheridan, WY 82801

Was compared to:
NIST Traceable Hg-in-glass thermometers, serial numbers 2J3106, 2Y6027, 3L9452.
Miller & Weber Hg-in-glass thermometer sn 2J3106 and 2Y6027 are traceable to NIST Test No. 209621, Test Method ASTM E-77. 2J3106 is traceable through Standard No. 1S1262. 2Y6027 is traceable through Standard No. 9C8072. Miller & Weber Hg-in-glass thermometer sn 3L9452 is traceable to NIST Thermometer 40350, through Transfer Standards 3C4465 & 1Y9716.

Date: 04/26/09 Lab temperature: 70.7 °F
Barometric Pressure: 658.8 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.00	0.00	0.00
8.6	8.58	-0.02	0.02
18.6	18.60	0.00	0.00
25.6	25.61	0.01	-0.01
41.1	41.12	0.02	-0.02

Adjusted Offset = - 0.10

Note:

If no sign is given on the correction, the true temperature is higher than the indicated temperature. If the sign is negative, the true temperature is lower than the indicated temperature.

Transfer Standard adjustments made? **YES** ☒ NO ☐

Post-calibration measurements:

Reference Thermistor (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.00	0.10	0.10	-0.10
See Offset and measurements above			

Reviewed: [signature] Date: April 26, 2009

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Certificate of Accuracy

Transfer Standard Type: Barometric Pressure/Altimeter

Certificate No: B 042209. 01

Transfer standard model: Pretel AltiPlus A2
Serial number: 23206 IML 0904
submitted by/owner: Inter-Mountain Laboratories, Inc.
Air Science Division
555 Absaraka Street
Sheridan, WY 82801

Was compared to Precision Absolute Reference Barometer:
Model number: 355-AI0900 Serial number: 913930-M1
Certified accuracy of ± 0.007"Hg
NIST traceable to Ruska Deadweight Tester SN 38342/C-85

Date: 04/22/09 Lab temperature 72.3 °F
Lab pressure 656.3 mm Hg

Reference barometer ("Hg)	Transfer Standard ("Hg)	Difference from Reference ("Hg)	Transfer Standard Correction* ("Hg)
24.00	24.03	0.03	-0.03
25.00	25.03	0.03	-0.03
25.84	25.88	0.04	-0.04
27.50	27.54	0.04	-0.04
30.00	30.06	0.06	-0.06

Note:
If no sign is given on the correction, the true pressure is higher than the indicated pressure. If the sign is negative, the true pressure is lower than the indicated pressure.

Transfer Standard adjustments made? YES ☐ **NO** ☒
Post-calibration measurements:

Reference barometer ("Hg)	Transfer Standard ("Hg)	Difference from Reference ("Hg)	Transfer Standard Correction* ("Hg)

Reviewed: [signature] Date: April 22, 2009

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Certificate of Accuracy

Transfer Standard Type: Barometric Pressure/Altimeter

Certificate No: B 042209. 02

Transfer standard model: Pretel AltiPlus A2
Serial number: 13785 IML 0913
submitted by/owner: Inter-Mountain Laboratories, Inc.
Air Science Division
555 Absaraka Street
Sheridan, WY 82801

Was compared to Precision Absolute Reference Barometer:
Model number: 355-AI0900 Serial number: 913930-M1
Certified accuracy of ± 0.007"Hg
NIST traceable to Ruska Deadweight Tester SN 38342/C-85

Date: 04/22/09 Lab temperature 73.5 °F
Lab pressure 668.9 mm Hg

Reference barometer ("Hg)	Transfer Standard ("Hg)	Difference from Reference ("Hg)	Transfer Standard Correction* ("Hg)
24.00	24.04	0.04	-0.04
25.00	25.03	0.03	-0.03
25.84	25.86	0.02	-0.02
27.50	27.52	0.02	-0.02
30.00	30.01	0.01	-0.01

Note:
If no sign is given on the correction, the true pressure is higher than the indicated pressure. If the sign is negative, the true pressure is lower than the indicated pressure.

Transfer Standard adjustments made? YES ☐ **NO** ☒
Post-calibration measurements:

Reference barometer ("Hg)	Transfer Standard ("Hg)	Difference from Reference ("Hg)	Transfer Standard Correction* ("Hg)

Reviewed: [signature] Date: April 22, 2009

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Certificate of Accuracy

Transfer Standard Type: Electronic Hygrometer

Certificate No: H 111009. 03

Transfer standard, model/type: Dwyer Series 485 Digital Hygrometer
Serial number: IML 0892
submitted by/owner: Inter-Mountain Laboratories, Inc.
Air Science Division
555 Absaraka Street
Sheridan, WY 82801

Was compared to Saturated Salt Solution Standards using ASTM Method E 104 - 02, Standard Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions, using Temperature Reference Standard Streamline™ Pro MultiCal™ System Remote Temperature Probe
S/N: T030301

Date: 11/05/2009 - 11/10/2009

Lab temperature: 68 - 72 °F
Barometric Pressure: 653 - 663 mmHg
Lab %RH: 35 - 45%

Reference Salt Standard	Reference Temperature °C	Reference Standard (%RH)	Uncertainty	Transfer Standard (%RH)	Difference from Reference (%RH)	Transfer Standard Correction* (%RH)
Lithium Chloride	19.7	11.89	±0.78	15.0	3.1	-3.1
Potassium Acetate						
Magnesium Chloride	20.7	32.94	±0.20	34.1	1.2	-1.2
Magnesium Nitrate	19.8	54.44	±0.23	53.5	-0.9	0.9
Sodium Chloride	19.9	75.47	±0.20	74.3	-1.2	1.2

Temperature Reference Standard (°C)		Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
19.7		19.6	-0.1	0.1
20.7		20.2	-0.5	0.5
19.8		19.4	-0.4	0.4
19.9		19.7	-0.2	0.2

Certified by: [signature] Date: November 10, 2009

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Certificate of Calibration

Streamline™ flow transfer standard (FTS) # IML 1
was calibrated against NIST traceable critical flow venturis
S/Ns 10961, 10962, 10963, 18491, 30421 on: 1/12/2010

This calibration expires: ***1/12/2011*** *r13*

The actual flow rate (Q_a) through the FTS is:

$$Qa = \left[m \times \left(\sqrt{\frac{(\Delta P)(T_{amb})}{(P_{amb})}} \right) \right] + b$$

m= 0.4097
b= -0.7532

Q_a = actual flow rate in liters/minute

ΔP = pressure reading from the manometer in "H_2O

T_{amb} = ambient temperature in Kelvins

P_{amb} = ambient pressure in atmospheres*

* 1 atmosphere = 760 mmHg, = 29.92"Hg, =101,325 Pa

Reviewed: [signature] Date: 1/11/10

Quality Assurance Check

Primary Standard Q_{actual} (l/min)	Streamline FTS ΔP ("H_2O)	Streamline FTS $Q_{line\ fit}$ (l/min)	Absolute Difference (l/min)	% Difference* full scale
20.00	7.54	19.99	-0.01	-0.03%
17.49	5.83	17.49	0.00	0.00%
14.98	4.35	14.99	0.01	0.06%
12.48	3.06	12.47	-0.01	-0.05%
9.98	2.02	9.98	0.00	0.02%
7.49	1.19	7.49	0.00	0.00%
4.99	0.58	4.99	0.00	-0.01%

T_a (°C)= 22.1
Pa (atm)= 0.869 r= 1.0000

*all points must be within ±2%

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Streamline™ FTS, US Patent #5792966

IML Air Science
a division of Inter-Mountain Laboratories, Inc.
555 Absaraka, Sheridan, WY 82801

CERTIFICATE OF CALIBRATION

Orifice Transfer Standard - **B**
IML Air Science   Sheridan, WY

B orifice transfer standard was calibrated on the NIST traceable Dresser rootsmeter serial # 9217756 on 3-Mar-09
Calibration expires 3-Mar-10

The reference flow rate (Qr) through the orifice, in cubic meters per minute, is:

$$Q_r = A(\Delta P_o)^B$$

r = 0.9997

where:
A= **0.510**
B= **0.490**
ΔPo = pressure drop across orifice, in inches of water

The actual flow rate (Qa) through the orifice, in cubic meters per minute, is:

$$Q_a = \frac{\left[\left(\sqrt{(\Delta P_o)\left(\frac{T_a}{P_a}\right)}\right) - b\right]}{m}$$

r = 0.9998

where:
m= **1.268**
b= **-0.024**
ΔPo = pressure drop across orifice, inches of water
Ta = ambient temperature, Kelvin
Pa = ambient pressure, mm Hg

The flow rate through the orifice corrected to standard conditions (Qstd), in cubic meters per minute, is:

$$Q_{std} = \frac{\left[\left(\sqrt{\Delta P_o\left(\frac{P_a}{T_a}\right)\left(\frac{298}{760}\right)}\right) - b\right]}{m}$$

r = 0.9998

where:
m= **2.025**
b= **-0.033**
ΔPo = pressure drop across orifice, inches of water
Ta = ambient temperature, Kelvin
Pa = ambient pressure, mm Hg

SH
Reviewed

3/25/2009
Date

ORIFICE TRANSFER STANDARD CALIBRATION
QUALITY ASSURANCE

Orifice Transfer Standard# **B**

The following table is a comparison of measured flow rate versus the flow rate calculated from the new calibration equation. Quality Assurance guidelines require the difference at each point to be less than 2% for a valid calibration. A minimum of three measurment points are required within the operational flow rate interval (1.019 to 1.246 m3/min for PM10 samplers and 1.1 to 1.7 m3/min for TSP samplers.

Q_a measured	Q_a calculated	difference
0.919	0.914	-0.58%
1.046	1.053	0.61%
1.133	1.131	-0.13%
1.218	1.222	0.38%
1.313	1.312	-0.07%
1.374	1.371	-0.23%
1.447	1.447	-0.01%

References: 40 CFR 50, Appendix B, Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High Volume Method); 40 CFR 50, Appendix J, Reference Method for the Determination of Particulate Matter as PM10 in the Atmosphere; and Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II. Ambient Air Specific Methods, (EPA 600/4-77/027a, June 1992), Sections 2.2.2.5 and 2.11.2.2.1.

Data Input

Roots Meter SN: 629846

DATE:	3-Mar-09
ORIFICE #:	B
TECH:	Cory Medill
TEMP (°C):	23.70
PRES("Hg):	25.83
CLIENT:	IML Air Science
LOCATION:	Sheridan, WY

POINT	DELTA VOLUME m^3	TIME MIN	DELTA H roots mmHg	DELTA H orifice "H2O
1	3.3985	3.6713	4.3902	2.8500
2	3.3985	3.2192	5.8847	3.8000
3	3.3985	2.9692	6.8188	4.4000
4	3.3985	2.7567	8.0331	5.1500
5	3.3985	2.5508	9.3409	5.9500
6	3.3985	2.4348	10.1815	6.5000
7	3.3985	2.3078	11.3958	7.2500

	Actual Flow				Standard Flow		
POINT	Va m^3	Qa m^3/min	Y-AXIS	POINT	Vstd m^3	Qstd m^3/min	Y-AXIS
1	3.376	0.919	1.136	1	2.925	0.797	1.572
2	3.368	1.046	1.311	2	2.919	0.907	1.815
3	3.363	1.133	1.411	3	2.915	0.982	1.953
4	3.357	1.218	1.526	4	2.909	1.055	2.113
5	3.350	1.313	1.641	5	2.903	1.138	2.271
6	3.346	1.374	1.715	6	2.899	1.191	2.373
7	3.339	1.447	1.811	7	2.894	1.254	2.507

Certificate of Accuracy

Transfer Standard Type: Electronic Manometer Certificate No: M 021709. 08

Transfer standard, model: Dwyer Series 475-1 Mark III Digital Manometer
Serial number: IML 0949
submitted by/owner: Inter-Mountain Laboratories, Inc.
Air Science Division
555 Absaraka Street
Sheridan, WY 82801

Was compared to Chinook Engineering Streamline Pro Multi Cal System Serial Number BENCH 1. BENCH 1 is traceable through Meriam Instrument Reference Manometers:

Model number: 30EBX25TM Ser. No.: 131760-M1 Scale number: SC-4208-12
Model number: 30EBX25TM Ser. No.: 158411-S1 Scale number: SC-4208-17

Certified accuracy of ± 0.02 "H_2O

Scale is NIST Traceable to Optical Comparator, SN E37618, and Gage Rod, SN 3388A

Date: 02/17/09 Lab temperature: 69.2 °F
Lab pressure: 651.2 mm Hg

Reference Manometer ("H_2O)	Transfer Standard ("H_2O)	Difference from Reference ("H_2O)	Transfer Standard Correction* ("H_2O)
0.50	0.48	-0.02	0.02
2.00	1.96	-0.04	0.04
5.00	4.94	-0.06	0.06
7.50	7.43	-0.07	0.07
10.00	9.93	-0.07	0.07
15.00	14.94	-0.06	0.06
19.50	19.47	-0.03	0.03

Note:
If no sign is given on the correction, the true pressure is higher than the indicated pressure. If the sign is negative, the true pressure is lower than the indicated pressure.

Transfer Standard adjustments made? YES ☐ **NO** ☒

Post-calibration measurements:

Reference Manometer ("H_2O)	Transfer Standard ("H_2O)	Difference from Reference ("H_2O)	Transfer Standard Correction* ("H_2O)

Reviewed: [signature] Date: 02/17/09

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CERTIFICATE OF CALIBRATION

Test Unit

Model:	18802
Motor SN:	IML 0855
Control Unit SN:	CA 03395
Range:	200 - 15000 RPM

Motor RPM	Indicated RPM					
	Clockwise Output Range			Counter Clockwise Output Range		
	Low	High	Average	Low	High	Average
600	600.0	600.3	600.1	596.0	601.4	599.3
1200	1199.9	1200.1	1199.9	1200.1	1200.1	1200.1
2400	2399.8	2399.8	2399.8	2399.8	2400.3	2400.0
4200	4199.7	4199.8	4199.7	4199.7	4199.8	4199.7
6000	5998.7	6000.6	5999.7	5999.7	5999.7	5999.7
8100	8099.6	8099.6	8099.6	8099.6	8099.6	8099.6
9900	9899.5	9899.5	9899.5	9899.5	9899.5	9899.5

The insrument above has been presented for inspection and test as shown
The indicated work was performed using standards traceable to the National Institute of Standards and Technologies (NIST)

Standard SN:	51892014
Technician:	C. Medill
Date:	12/4/2009

THE BRUNTON COMPANY
Certificate Of Calibration

IML0900

Equipment Owner:
Name: Inter-Mountain Labs

Address: 555 absarake

City, State, Zip: Sheridan Wyo 82801

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 29 Day of January 20 09

DESCRIPTION: Pocket transit

PURCHASE ORDER: 186512

ORDER NUMBER: 2015209

LOT NUMBER: 1218246

MODEL NUMBER: F-5008

SERIAL NUMBER: 5080800156

CALIBRATION DATE: 1-29-09

RECALIBRATION DUE DATE: 1-29-10

Signed: [signature]
QUALITY CONTROL MANAGER

apogee instruments inc.
721 W 1800 N
Logan, UT 84321

Certificate of Calibration

LI-COR PYRANOMETER
MODEL LI-200X

Customer Name	:	Kristy Kola
Serial Number	:	PY54289
Calibration Date	:	17-Apr-2009
Previous Calibration Date	:	12-Aug-2007
Recommended Recalibration Date	:	17-Apr-2011
Calibration Factor	:	**208.60 W m^{-2} per mV**
Output	:	**85.3 μA per 1000 W m^{-2}**
Calibration Factor as Received	:	198.37 W m^{-2} per mV
Output as Received	:	89.7 μA per 1000 W m^{-2}
Resistor Size (Measured)	:	56.2 Ω
Percent Change in Output	:	-4.91%
Percent Change per Year	:	-2.92%

Calibration Procedure

☐ Calibrated to a heated and ventilated Kipp & Zonen CM21 pyranometer under sunlight for an integrated daily total in Logan, Utah.

☒ Calibrated to four LI-COR transfer standard pyranometers under Metal Halide lamps. The transfer standards are calibrated to the Kipp & Zonen CM21.

Traceability

The Kipp & Zonen Model CM21 pyranometer is calibrated every two years at NREL in Boulder, CO. NREL reference standards are calibrated every five years to the world meteorological reference in Davos, Switzerland.

Calibration Technician : [signature]   Date : Apr 17, 2009

Web page: www.apogee-inst.com E-mail: admin@apogee-inst.com Tel: (435)792-4700 Fax: (435)787-8268