

## **APPENDIX B**

Third Quarter 2010 IML Calibration Report



**Energy Fuels Resources Corporation  
Piñon Ridge Mill**

**Calibration Report for  
Meteorological Monitoring Network**

**3<sup>rd</sup> Quarter 2010**

Prepared by:



***IML Air Science***

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# 1 Introduction

Inter-Mountain Laboratories – Air Science Division performed calibrations on July 27, 2010. The calibrations included 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

## Site 2

- Meteorological Station – 30m Tower
  - Wind Speed
  - Wind Direction
  - Vertical Wind Speed
  - Temperature (2m & 30m)
  - Delta Temperature
  - Relative Humidity
  - Solar Radiation
  - Barometric Pressure

## **1.1 Calibration References**

The calibrations 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. 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 Nuclear Regulatory Research, Regulatory Guide 3.63 – Onsite Meteorological Measurement Program For Uranium Recovery Facilities – Data Acquisition and Reporting, March 1988.

## **2 Calibration 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 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**

<b>Sensor</b>	<b>Specifications</b>
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

### **3 Calibration Results**

Calibration results for Site #1 – 2 can be found in Appendices A.

### **4 Findings/Recommendations**

The calibrations of the Meteorological Monitoring equipment were within the calibration specifications at Site #1 and Site #2, including the evaporation pan. Results of the calibrations can be found in Appendix A.

## **Appendix A**

### Meteorological System Calibrations

## METEOROLOGICAL STATION CALIBRATION SUMMARY

Met Station: Energy Fuels - Site #1 (10m Tower)

Calibration Date: 27-Jul-10

Calibration Performed By: W. Adler, J. Masters -- 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 0896
Wind Direction 10m (WD):	RM Young Wind Monitor AQ	82346	transit, compass	IML 0942
Temperature @ 2 Meters:	RM Young Platinum RTD Temp Probe	13638	digital thermistor	IML 1401
Temperature @ 10 Meters:	RM Young Platinum RTD Temp Probe	13639	digital thermistor	IML 1401
Relative Humidity (RH):	CSI CS 500	C2430074	digital hygrometer	IML 0899
Barometric Pressure (BP):	PTB 101B	C2430048	digital barometer	IML 1404
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	Reference	DAS Value	Difference	Specification	
		RPM	m/s				
AQ WS 10 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
		300	1.54	1.54	0.00	0.20 (2)	
		800	4.10	4.10	0.00	0.20 (2)	
		3000	15.36	15.36	0.00	0.20 (2)	
		8000	40.96	40.96	0.00	0.20 (2)	
		Reference	DAS Value	Difference	Specification		
WS 10 m start torque (gm-cm)		$\tau < 0.5$	N/A	N/A		1.0 (3)	
WD 10 meters (degrees)			0.0	0.8	0.8	5.0 (2)	
			90.0	89.8	0.2	5.0 (2)	
			180.0	180.5	0.5	5.0 (2)	
			270.0	270.4	0.4	5.0 (2)	
			Reference	Reference	DAS Value	Difference	Specification
	Vertical WS 10 meters (cm/s) (Clockwise)		RPM	cm/s			
			0	0.00	-0.29	0.29	below threshold
			20	10.00	9.87	0.13	20.00 (2)
		EPS:	200	100.00	99.26	0.74	20.00 (2)
			300	150.00	147.73	2.27	20.00 (2)
			500	250.00	248.48	1.52	20.00 (2)
			0	0.00	-0.29	0.29	below threshold
			20	10.00	9.78	0.23	20.00 (2)
CFT:		20	100.00	99.89	0.11	20.00 (2)	
		300	150.00	149.59	0.41	20.00 (2)	
		500	250.00	248.53	1.47	20.00 (2)	
Vertical WS 10 meters (cm/s) (Counter-Clockwise)			0	0.00	-0.29	0.29	below threshold
			20	-10.00	-10.16	0.16	20.00 (2)
	EPS:	200	-100.00	-99.86	0.14	20.00 (2)	
		300	-150.00	-146.31	3.69	20.00 (2)	
		500	-250.00	-247.93	2.07	20.00 (2)	
		0	0.00	-0.29	0.29	below threshold	
		20	-10.00	-10.36	0.36	20.00 (2)	
	CFT:	200	-100.00	-99.53	0.47	20.00 (2)	
		300	-150.00	-148.71	1.29	20.00 (2)	
		500	-250.00	-247.94	2.06	20.00 (2)	
	WS 10 m start torque (gm-cm)		$\tau < 0.5$	N/A	N/A		1.0 (3)

		Reference (°C):	DAS Value	Difference	Specification		
Temp. (°C): 2 meter		42.74	42.69	0.05	0.5	(2)	
		27.80	28.00	0.20	0.5	(2)	
		2.82	3.16	0.34	0.5	(2)	
Temp. (°C): 10 meter		42.74	42.70	0.04	0.5	(2)	
		27.80	27.93	0.13	0.5	(2)	
		2.82	3.13	0.31	0.5	(2)	
		Reference	DAS Value	Difference	Specification		
Relative Humidity (%)		27.6	32.2	4.6	5.0	(2)	
RH Sensor Temp (°C):		88.1	91.3	3.2			
Solar Radiation (W/m <sup>2</sup> )	un-covered	1094	1063.00	31.0	54.7	(2)	
	covered	0.00	0.00				
Barometric Pressure ("Hg)		24.60	24.64	0.04	0.09	(4)	
		DAS Value (in)	Reference (ml)	DAS Equivalent	Difference	Specification	
Precipitation (0.1" equiv.)		0.10	175.5	185.3	9.8	18.5	(2)
		0.10	189.5	185.3	4.2	18.5	(2)
		0.10	187.7	185.3	2.4	18.5	(2)
				Average Diff:	5.5	18.5	(2)
		2m sensor	10m sensor	ΔT - B	Specification		
Delta Temperature (°C):		42.69	42.70	0.01	0.1	(2)	
		28.00	27.93	0.07	0.1	(2)	
		3.16	3.13	0.03	0.1	(2)	
<b>BOLD difference values exceed performance specifications</b>							
(1)= Performance specification listed in facilities' Quality Assurance Project Plan							
(2)= EPA Quality Assurance Manual for Air Pollution Measurement Systems, Vol. IV, 2008							
(3)= Manufacturer's Specifications							
(4)= EPA On-Site Meteorological Program Guidance for Regulatory Modeling Applications							
<b>Notes, Recommendations</b>							
System taken offline at 12:33 MST and returned online at 13:19 MST.							

## METEOROLOGICAL STATION CALIBRATION SUMMARY

Met Station: Energy Fuels - Site #2 (30m Tower)

Calibration Date: 27-Jul-10

Calibration Performed By: W. Adler, J. Masters - 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 0896
Wind Direction 30m (WD):	RM Young Wind Monitor AQ	82347	transit, compass	IML 0942
Temperature @ 2 Meters:	RM Young Platinum RTD Temp Probe	13640	digital thermistor	IML 1401
Temperature @ 30 Meters:	RM Young Platinum RTD Temp Probe	13641	digital thermistor	IML 1401
Relative Humidity (RH):	CSI CS 500	C2730148	digital hygrometer	IML 0899
Barometric Pressure (BP):	PTB 101B	C2750056	digital barometer	IML 1404
Solar Radiation:	LI-COR LI200SZ	PY57102	collocated LI200X	PY54289
Data acquisition system:	CSI CR3000 datalogger	2421	N/A	N/A

### Calibration Results

		Reference	Reference	DAS Value	Difference	Specification	
		RPM	m/s				
AQ WS 30 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
		300	1.54	1.54	0.00	0.20 (2)	
		800	4.10	4.10	0.00	0.20 (2)	
		3000	15.36	15.36	0.00	0.20 (2)	
		8000	40.96	40.96	0.00	0.20 (2)	
WS 30 m start torque (gm-cm)			Reference	DAS Value	Difference	Specification	
			$\tau < 0.5$	N/A	N/A	1.0 (3)	
WD 30 meters (degrees)			0.0	0.2	0.2	5.0 (2)	
			90.0	90.3	0.3	5.0 (2)	
			180.0	180.9	0.9	5.0 (2)	
			270.0	270.6	0.6	5.0 (2)	
Vertical WS 30 meters (cm/s) <b>(Clockwise)</b>		Reference	Reference	DAS Value	Difference	Specification	
		RPM	cm/s				
			0	0.00	0.00	0.00	below threshold
			20	10.00	9.66	0.34	20.00 (2)
		EPS:	200	100.00	98.40	1.60	20.00 (2)
			300	150.00	149.36	0.64	20.00 (2)
			500	250.00	246.31	3.69	20.00 (2)
			0	0.00	-0.29	0.29	below threshold
			20	10.00	10.16	0.16	20.00 (2)
		CFT:	200	100.00	99.51	0.49	20.00 (2)
			300	150.00	146.04	3.96	20.00 (2)
			500	250.00	249.63	0.37	20.00 (2)
	Vertical WS 30 meters (cm/s) <b>(Counter-Clockwise)</b>			0	0.00	0.00	below threshold
			20	-10.00	-9.90	0.10	20.00 (2)
		EPS:	200	-100.00	-100.46	0.46	20.00 (2)
			300	-150.00	-151.71	1.71	20.00 (2)
			500	-250.00	-249.53	0.47	20.00 (2)
			0	0.00	0.00	0.00	below threshold
			20	-10.00	-9.86	0.14	20.00 (2)
		CFT:	200	-100.00	-100.41	0.41	20.00 (2)
			300	-150.00	-147.03	2.97	20.00 (2)
			500	-250.00	-248.35	1.65	20.00 (2)
WS 30 m start torque (gm-cm)				$\tau < 0.5$	N/A	N/A	1.0 (3)

		Reference (°C):	DAS Value	Difference	Specification	
Temp. (°C): 2 meter		7.12	7.25	0.13	0.5	(2)
		27.40	27.85	0.45	0.5	(2)
		40.52	40.57	0.05	0.5	(2)
Temp. (°C): 30 meter		7.12	7.19	0.07	0.5	(2)
		27.40	27.84	0.44	0.5	(2)
		40.52	40.53	0.01	0.5	(2)
		Reference	DAS Value	Difference	Specification	
Relative Humidity (%)		30.3	29.8	0.5	7.0	(2)
RH Sensor Temp (°C):		85.7	85.7	0.0		
Solar Radiation (W/m <sup>2</sup> )	un-covered	110.81	107.56	3.3	5.5	(2)
	covered	0.00	0.63			
Barometric Pressure ("Hg)		24.55	24.55	0.00	0.09	(4)
		2m sensor	10m sensor	ΔT - B	Specification	
Delta Temperature (°C):		7.25	7.19	0.06	0.1	(2)
		27.85	27.84	0.01	0.1	(2)
		40.57	40.53	0.04	0.1	(2)
<b>BOLD difference values exceed performance specifications</b>						
(1)= Performance specification listed in facilities' Quality Assurance Project Plan						
(2)= EPA Quality Assurance Manual for Air Pollution Measurement Systems, Vol. IV, 2008						
(3)= Manufacturer's Specifications						
(4)= EPA On-Site Meteorological Program Guidance for Regulatory Modeling Applications						
<b>Notes, Recommendations</b>						
System taken offline at 12:45 MST and returned online at 17:33 MST.						

# Evaporation Pan Verification Sheet

Evap Span                    9.7221  
Evap Offset                 1.48158

Yardstick Reading (in)*	Logger Reading	Percent Difference
6.25	6.47	3.5%

Notes:  
\* Yard Stick Reading - taken at the pan outlet to the gauge  
Offline: 1233 MST  
Online: 1319 MST

## **Appendix B**

### Transfer Standard Certifications



# Certificate of Accuracy

**Transfer Standard Type: Barometric Pressure/Altimeter**

Certificate No: B 091009. 02

Transfer standard model: Suunto Escape 203 Electronic Altimeter/Barometer

Serial number: 74605246 IML 1404

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  $\pm 0.007$ "Hg

NIST traceable to Ruska Deadweight Tester SN 38342/C-85

Date: 09/10/09      Lab temperature 75.7 °F  
 Lab pressure 663.2 mm Hg

Reference barometer ("Hg)	Transfer Standard ("Hg)	Difference from Reference ("Hg)	Transfer Standard Correction*
24.00	23.95	-0.05	0.05
25.00	24.95	-0.05	0.05
26.10	26.05	-0.05	0.05
26.50	26.45	-0.05	0.05
27.55	27.50	-0.05	0.05

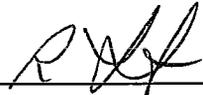
**Note:**

*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*

Certified By: 

Date: September 10, 2009

Roger L. Sanders, PE

**Chinook Engineering**

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# Certificate of Accuracy

**Transfer Standard Type: Electronic Hygrometer**

Certificate No: H 021110. 01

Transfer standard, model/type: Dwyer Series 485 Digital Hygrometer

Serial number: IML 0899 (Previously IML 0936)

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: 02/10/2010 - 02/11/2010

Lab temperature: 68 - 72 °F

Barometric Pressure: 657 - 659 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	18.5	12.06	±0.90	7.5	-4.6	4.6
Potassium Acetate						
Magnesium Chloride	18.7	33.13	±0.23	27.6	-5.5	5.5
Magnesium Nitrate	18.9	54.71	±0.24	49.6	-5.1	5.1
Sodium Chloride	19.0	75.50	±0.20	72.2	-3.3	3.3

Temperature Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
18.5	18.3	-0.2	0.2
18.7	18.5	-0.2	0.2
18.9	18.6	-0.3	0.3
19.0	18.7	-0.3	0.3

Certified By: \_\_\_\_\_



Date: February 11, 2010

Roger L. Sanders, PE

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**CERTIFICATE OF CALIBRATION**

**Test Unit**

Model: 18802  
 Motor SN: IML 0896  
 Control Unit SN: CA 03156  
 Range: 200 - 15000

Motor RPM	Indicated RPM					
	Clockwise Output Range			Counter Clockwise Output Range		
	Low	High	Average	Low	High	Average
600	599.9	600.1	599.9	600.0	600.0	600.0
1200	1199.9	1200.1	1199.9	1199.3	1200.1	1199.8
2400	2399.8	2399.8	2399.8	2399.8	2399.8	2399.8
4200	4199.7	4199.8	4199.7	4199.7	4199.8	4199.7
6000	5999.7	5999.7	5999.7	5999.7	6000.6	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 instrument 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: 1/22/2010

# THE BRUNTON COMPANY

## Certificate Of Calibration

IML 0942

Equipment Owner:

Name: Inter-Mountain Labs

Address: 555 Absarada St.

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 18 Day of February 20 10

DESCRIPTION: Pocket Transit

PURCHASE ORDER: 191843

ORDER NUMBER: 2515318

LOT NUMBER: 2041319

MODEL NUMBER: 5608

SERIAL NUMBER: 5080393535

CALIBRATION DATE: 2/18/10

RECALIBRATION DUE DATE: 2/18/11

Signed: Elio Augello  
QUALITY CONTROL MANAGER



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<sup>-2</sup> per mV**

Output : **85.3 μA per 1000 W m<sup>-2</sup>**

Calibration Factor as Received : 198.37 W m<sup>-2</sup> per mV

Output as Received : 89.7 μA per 1000 W m<sup>-2</sup>

Resistor Size (Measured) : 56.2 Ω

Percent Change in Output : -4.91%    Percent Change : -2.92%  
per Year

- 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 :       Date : Apr 17, 2009