Report
Meteorological / Air Quality
Performance Audits
for
Energy Fuels Resources Corporation

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Pinyon Ridge Mill Site
Montrose County, CO

October 2008

Prepared by

VSI
729 W. Lynwood St
Phoenix, AZ 85007

EXECUTIVE SUMMARY

A performance audit of the air quality and meteorological monitoring systems at five locations near the Energy Fuels Resources Corporation's Pinyon Ridge Mill Site in Montrose County, Colorado was accomplished on October 8, 2008; personnel from VSI performed the audits. Results of the audit indicated compliance with the EPA Guidelines or Manufacturer's Recommendations for all the meteorological and air quality parameters. Details of the audit results are discussed in latter sections of this report.

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INTRODUCTION

A performance audit of the air quality and meteorological monitoring systems at five locations near the Energy Fuels Resources Corporation's Pinyon Ridge Mill Site in Montrose County, Colorado was accomplished on October 8, 2008. The location of the project and monitoring sites are presented in Figures 1 and 2. The monitoring locations, the parameters monitored and their latitude/longitude are listed below.

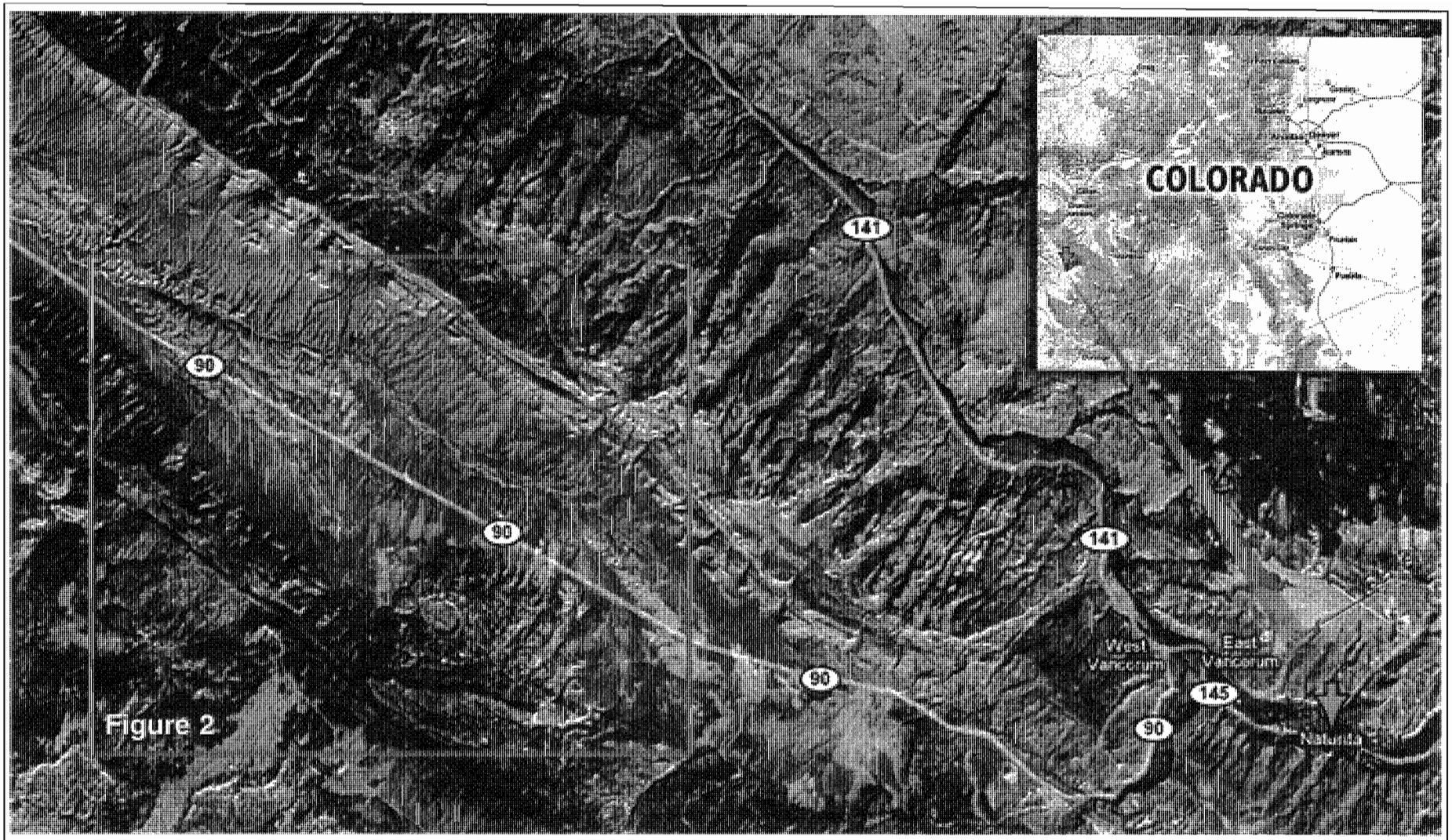
Site No.	Description / Parameters
1	North Site: 10-meter tower (Met/Air Quality) Latitude/Longitude: N 38° 15.862' W 108° 46.091'
2	East Site: 30-meter tower (Met/Air Quality) Latitude/Longitude: N 38° 14.729' W 108° 45.626'
3	West Site (Air Quality) Latitude/Longitude: N 38° 14.912' W 108° 46.638'
4.	Northwest Residence: (Air Quality) Latitude/Longitude N 38° 16.881' W 108° 48.392'
5.	Southeast Residence: (Air Quality) Latitude/Longitude N 38° 13.335' W 108° 42.789'

All equipment and forms required for the audit were provided by VSI. Copies of the certificates of traceability to the National Institute of Standards and Technology (NIST) for the audit devices are included in Appendix A; copies of the completed audit forms are provided in Appendix B.

The procedures and tolerances used during the audit followed the general guidelines of *EPA-600/R-94/038d, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV, Meteorological Measurements; EPA-450/4-87-007, Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD); EPA-454/R-99-005, Meteorological Monitoring Guidance for Regulatory Modeling Applications;* and equipment manufacturer recommendations.

The discussions that follow describe those activities performed by VSI in the completion of the audit, the associated results, and instrumentation accuracies.

Not to scale

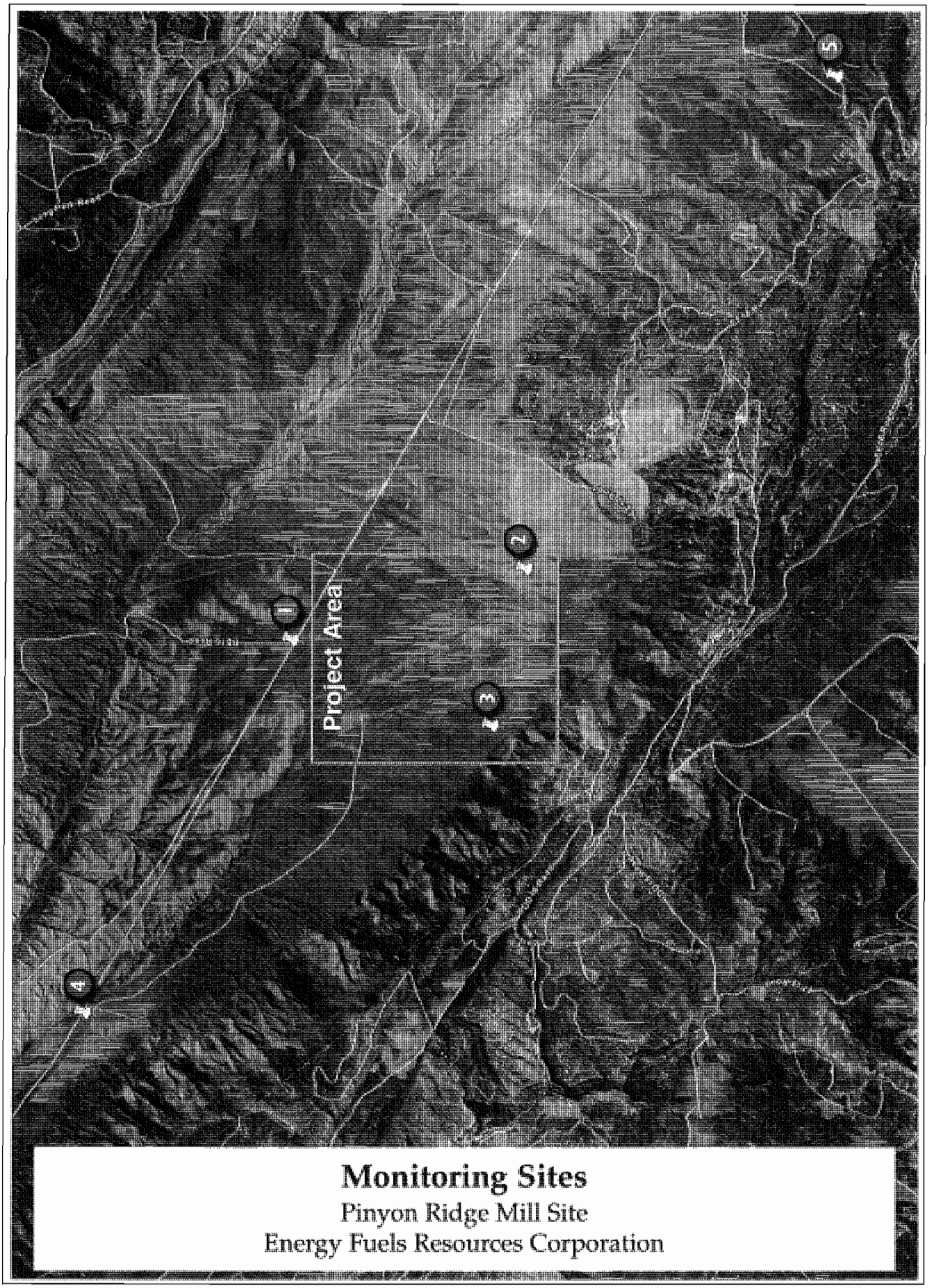


Project Location

Pinyon Ridge Mill Site

Energy Fuels Resources Corporation

Figure 1



Monitoring Sites

Pinyon Ridge Mill Site

Energy Fuels Resources Corporation

Figure 2

AUDIT ACTIVITIES AND RESULTS

METEOROLOGICAL INSTRUMENTATION

WIND SPEED-Horizontal

The audits of the horizontal wind speed systems at Sites 1 and 2 were performed by rotating the sensor shaft at known rates and recording the data acquisition system (DAS) responses. Shaft rotations corresponding to speeds of 0.0, 1.02, 2.05, 4.10, 6.14, 12.29, and 25.48 meters per second (mps) were applied to the sensor. Responses of the DAS were within the PSD Tolerances at both locations.

The sensors' propellers were inspected and found to be in good condition with no deformities. Sensor bearing wear was checked by measuring the force necessary to initiate rotation of the propeller shaft. The manufacturer indicates that the propeller shaft should begin rotation with a force of less than 1.0 gm-cm, corresponding to a starting threshold of 0.4 mps. Measurement with a torque-wheel indicated that the sensors' bearing torques were within the manufacturer's recommendations; copies of the audit forms are included in Appendix B.

WIND DIRECTION

The wind direction systems at Sites 1 and 2 were audited by checking the orientation of the sensors when aligned parallel with the sensors' supporting cross-arm. The alignment of the cross-arm was checked with a compass corrected for the magnetic declination of the area. The declination, approximately 11.0^0 east, was obtained from "*Denver Sectional Aeronautical Chart, NOAA, January 17, 2008*". Following this check, the tower was lowered and the sensor was placed on a degree wheel and the sensor response checked at thirteen directions, spaced around the compass. This continuity check and the check of the sensors' orientation indicated the sensors and DAS responses were within PSD Tolerances at both locations.

The sensors' vanes were inspected and found to be in good condition with no deformities. Sensor bearing wear was checked by measuring the force necessary to move the vane from a static position. A gram-gauge was applied to the vane at a distance of 5 cm from the vane center and a reading taken when the vane began to move. The manufacturer indicated that the vane should move with a force of less than 11.0 gm-cm, corresponding to a starting threshold of 0.5 mps or less. Measurement with the gauge indicated that the sensors' bearings met the manufacturer's recommendations; copies of the audit forms are included in Appendix B. Following the erection of the tower, the sensors' orientations were again checked.

WIND SPEED-Vertical

The audits of the two vertical wind speed systems at each of the two sites (1 and 2) were performed by rotating the sensor shaft at known rates and recording the data acquisition system (DAS) responses. Shaft rotations corresponding to speeds of 0.0, 10.0, 19.7, 34.4, 49.2, 99.8, 198.0, 344.0 and 492.5 centimeters per second (cmps) were applied to the sensor. Responses of the DAS were compared with the PSD Tolerances for horizontal wind speeds of 5 meters per second or less; DAS responses were within PSD Tolerance at both locations.

The sensors' propellers were inspected and found to be in good condition with no deformities. Sensor bearing wear was checked by measuring the force necessary to initiate rotation of the propeller shaft. The manufacturer indicates that the propeller shaft should begin rotation with a force of less than 0.5 gm-cm. Measurement with a torque-wheel indicated that the sensors' bearing torques were within the manufacturer's recommendations; copies of the audit forms are included in Appendix B.

AMBIENT TEMPERATURE (2, 10, and 30 meters)

The audits of the ambient temperature systems at Sites 1 and 2 were accomplished by sequentially placing the temperature probe in a water bath at multiple temperatures between 32^0F and 110^0F and recording the outputs of the DAS. Monitoring of the water temperature was accomplished using a NIST-certified mercury thermometer with a 0.1^0C resolution. Results of the audit indicated that the DAS responses were within PSD Tolerances for the ambient temperature at all elevations and locations; copies of the audit forms are included in Appendix B.

DELTA TEMPERATURE (Site 1: 2-10 meters / Site 2: 2-30 meters)

The audits of the delta temperature systems at Sites 1 and 2 were accomplished by sequentially placing the temperature probes in a water bath at multiple temperatures between 32^0F and 110^0F and recording the outputs of the DAS. Monitoring of the water temperature was accomplished using a NIST-certified mercury thermometer with a 0.1^0C resolution. Results of the audit indicated that the DAS responses were within PSD Tolerances for the delta temperature at both sites; copies of the audit forms are included in Appendix B.

RELATIVE HUMIDITY / TEMPERATURE

The audit of the Vaisala relative humidity/temperature sensors at Sites 1 and 2 involved comparing the relative humidity derived from the wet and dry bulb temperatures of a psychrometer with the relative humidity displayed by the data logger; there is no PSD standard for relative humidity. The response of the data logger met the manufacturer's specifications for the sensor's accuracy. The Vaisala temperature data is recorded by the data logger but is not utilized. A summary of the audit result is provided in a later section; a copy of the audit form is included in Appendix B.

BAROMETRIC PRESSURE

The audit of the barometric pressure sensors at Sites 1 and 2 indicated agreement with the collocated transfer standard (CTS) within EPA Guidelines of $\pm$3.0 mb. A summary of the audit results is provided in a later section; copies of the audit forms are included in Appendix B.

PRECIPITATION

The audit of the tipping bucket rain gauge at Site 1 began by introducing a small quantity of water into the assembly to wet the mechanism and ensure the operation of the tipping bucket. Following this a graduated cylinder of water was slowly introduced into the bucket until 11 tips (0.11 inches) were recorded. The quantity of water required to actuate the 18 tips was recorded and used to evaluate the sensor response. The responses of the sensor and data logger were within the PSD Tolerance of $\pm$10% of the observed value or 0.5mm (16.2 ml). A summary of the audit results is provided in a later section; copies of the audit forms are included in Appendix B.

AIR QUALITY INSTRUMENTATION

PM_{10}

The audit of the PM_{10} Partisol Samplers at Sites 1 and 2 included checks of the samplers' flows, internal and external temperature sensors and pressure sensors. The audit of the samplers' flows was accomplished by removing the inlet, installing a flow adapter and flow meter. The sampler was then activated and allowed to operate for a few minutes. Five or six flow readings, each an average of 10 readings, were then recorded to provide an indication of the sampler flow rate and stability. Audit flows from samplers at both locations were within the manufacturer's guidelines; copies of the audit forms are included in Appendix B.

The audit of the internal and external temperature sensors was accomplished by measuring the ambient temperature adjacent to the sensor probe. The audit device was a mercury thermometer with a resolution of 1°C. Results of the audit indicated that the temperature sensors from both samplers were within the manufacturer's guidelines. The audit of the barometric pressure sensors of both units indicated agreement with a collocated transfer standard (CTS) within the manufacturer's guideline of $\pm$10 mmHg.

TSP

Volumetric flow-controlled (VFC) samplers are used to collect total suspended particulate matter (TSP) at all five sites. The audit of the samplers was accomplished by placing an audit orifice and faceplate directly on the filter cassette and a new, clean filter. The sampler was then activated and allowed to operate for a few minutes. After allowing the sampler to operate for approximately 5 minutes, a manometer reading was taken from the audit orifice and, based on the calibration curve for the orifice, audit flow rates were determined for the site conditions, Q_a. The site flow was derived using a pressure-temperature factor to correct the orifice-indicated flow rate from standard conditions to the site conditions. The audit flow (Q_a) was then compared with the indicated flow derived by the operator during the audit. The audit of the samplers at all sites showed that the audit flow rates were within tolerance with the indicated flow rates. A summary of the results for the samplers is provided in a later section; copies of the forms are included in Appendix B.

INSTRUMENTATION ACCURACIES

Previously each of the parameters was reported as either meeting or exceeding a given tolerance. This section lists the accuracies for each parameter and the corresponding tolerance; the accuracies are for the audited range, not necessarily for the total range of the sensor.

SITE 1

Meteorological Instrumentation

WIND SPEED-HORIZONTAL (MPS)

Range	Data Logger	Tolerance
≤ 5 mps	+0.00 / -0.00 mps	±0.25 mps
> 5 mps	+0.00% / - 0.00%	±5.0% NE 2.5mps

WIND DIRECTION (Deg)

Range	Data Logger	Tolerance
0-360^0	+1.6^0 / -1.8^0	±5.0^0

WIND SPEED-VERTICAL (CMPS)

Model # 27106

Range	Data Logger	Tolerance
≤ 5 mps	+2.6 / -5.1 cmps	±25 cmps

Model # 27106T

Range	Data Logger	Tolerance
≤ 5 mps	+1.5 / -2.8 cmps	±25 cmps

AMBIENT TEMPERATURE (^{0}C) @ 2 M

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.2 / -0.1^{0}C	$\pm$0.5^{0}C

AMBIENT TEMPERATURE (^{0}C) @ 10 M

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.2 / -0.1^{0}C	$\pm$0.5^{0}C

DELTA TEMPERATURE 2-10 M (^{0}C)

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.07 / -0.07 ^{0}C	$\pm$0.1^{0}C

BAROMETRIC PRESSURE (mb)

Range	Data Logger	Tolerance
Ambient-Collocated	+1.7/-0.0 mb	$\pm$ 3 mb

SOLAR RADIATION (W/m^2)

Range	Data Logger	Tolerance
0-2000 W/m^2	+1.0 / -0.3%	$\pm$5.0%

RELATIVE HUMIDITY (%)/TEMPERATURE (^{O}F)

Range	Data Logger	Tolerance
Ambient- Collocated	+1.0 / -0.0%	No Tolerance
	+0.0/-0.0^{O}F	Non-PSD

PRECIPITATION (inches)

Range	Data Logger	Tolerance
Ambient	±0.003 in. /5.8 ml /3.0%	±10% Observed Value ±0.5mm (16.2ml)

Air Quality Instrumentation

Partisol-PM_{10}

Flow Difference (%)	Tolerance
+0.00/-2.46	±5%

Temp (ext) Difference (°C)	Tolerance
+0.0/-1.0	±2°C

Temp (int) Difference (°C)	Tolerance
+0.0/-0.6	±2°C

Pressure Difference (mmHg)	Tolerance
+0.0/-4.0	±10mmHg

TSP

Audit Flow Difference (%)	Tolerance
+0.00 / -0.59	±7%

SITE 2

Meteorological Instrumentation

WIND SPEED-HORIZONTAL (MPS)

Range	Data Logger	Tolerance
≤ 5 mps	+0.00 / -0.00 mps	±0.25 mps
> 5 mps	+0.00% / - 0.00%	±5.0% NE 2.5mps

WIND DIRECTION (Deg)

Range	Data Logger	Tolerance
0-360^0	+2.0^0 / -2.2^0	±5.0^0

WIND SPEED-VERTICAL (CMPS)

Model # 27106

Range	Data Logger	Tolerance
≤ 5 mps	+0.6 / -13.6 cmps	±25 cmps

Model # 27106T

Range	Data Logger	Tolerance
≤ 5 mps	+1.6 / -4.0 cmps	±25 cmps

AMBIENT TEMPERATURE (^{0}C) @ 2 M

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.1 / -0.3^{0}C	±0.5^{0}C

AMBIENT TEMPERATURE (^{0}C) @ 30 M

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.1 / -0.3^{0}C	±0.5^{0}C

DELTA TEMPERATURE 2-30 M (^{0}C)

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.06 / -0.01 ^{0}C	$\pm$0.1^{0}C

BAROMETRIC PRESSURE (mb)

Range	Data Logger	Tolerance
Ambient-Collocated	+1.3/-0.0 mb	$\pm$ 3 mb

SOLAR RADIATION (W/m^2)

Range	Data Logger	Tolerance
0-2000 W/m^2	+1.5 / -0.2%	$\pm$5.0%

RELATIVE HUMIDITY (%)/TEMPERATURE (^{O}F)

Range	Data Logger	Tolerance
Ambient- Collocated	+0.0 / -1.0%	No Tolerance
	+0.2/-0.0^{O}F	Non-PSD

Air Quality Instrumentation

Partisol-PM_{10}

Flow Difference (%)	Tolerance
+0.54/-0.00	±5%

Temp (ext) Difference (°C)	Tolerance
+0.0/-0.3	±2°C

Temp (int) Difference (°C)	Tolerance
+0.6/-0.0	±2°C

Pressure Difference (mmHg)	Tolerance
+0.0/-1.1	±10mmHg

TSP

Audit Flow Difference (%)	Tolerance
+0.93 / -0.00	±7%

Site 3

Air Quality Instrumentation

TSP

Audit Flow Difference (%)	Tolerance
+3.79 / -0.00	±7%

Site 4

Air Quality Instrumentation

TSP

Audit Flow Difference (%)	Tolerance
+0.00 / -0.61	±7%

Site 5

Air Quality Instrumentation

TSP

Audit Flow Difference (%)	Tolerance
+0.00 / -1.83	±7%

APPENDIX A

Certificates of Traceability

Meteorological Instruments

YOUNG

Certificate of Calibration and Testing

Test Unit:			
Model:	18802	Serial Number:	CA02194
Description:	Anemometer Drive - 200 to 15,000 Rpm		
	- Comprised of Models 18820A Control Unit & 18830A 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	27106D Output Frequency Hz (1)	Calculated Rpm (2)	Indicated Rpm (3)
300	50	300	300
2700	450	2700	2700
5100	850	5100	5100
7500	1250	7500	7500
10,200	1700	10200	10200
12,600	2100	12600	12600
15,000	2500	15000	15000
☒ Clockwise and Counterclockwise rotation verified			

(1) Measured frequency output of RM Young Model 27106D standard anemometer attached to motor shaft
(2) 27106D produces 10 pulses per revolution of the anemometer 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 Model: DPS 740 SN: 4863

Date of inspection 5/9/08
Inspection Interval One Year

Tested By RP

R.M. YOUNG COMPANY 2801 Aero Park Drive, Traverse City, Michigan 49686 USA
Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com

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Since 1955

National Calibration Inc.

3737 East Broadway Road
Phoenix, AZ 85040
(602) 437-0114

ONLINE RECORDS powered by CalHub

Calibration Report

Report No: 83419 **Order No:** 18202-80109

Customer:	VSI 729 W. Lynwood St. Phoenix, AZ 85007	**Calibration Date:**	01/18/2008
		Recall Date:	01/18/2009
		Ambient Temperature:	74°F
		Relative Humidity:	22%
Equipment Type:	Tachometer	**Received:**	In Tolerance
Make:	Vsi	**Returned:**	In Tolerance
Model:	Unknown	**Received Condition:**	Good
Asset Number:	27838-03	**Accuracy:**	Per Mfg. Spec
Serial Number:	27838-03		
Procedure:	Commercial Data		
Technician:	Tofuri, David	**Authorized By:**	

The accuracy of this instrument has been verified under the conditions stated above in ANSI/ISO/IEC 17025:2005 and Z540-1-1994. Our standards have traceability to NIST or an international, or intrinsic standard and evidence is on file at our Metrology Laboratory. Unless stated otherwise, the collective uncertainty of the measurement process does not exceed 25% of the tolerance allowed for the individual characteristics measured. This certificate shall not be reproduced, except in full, without the written approval of National Calibration Inc.

Standards Used

Asset	Make	Model	Description	Cal Date	Due Date
7000415	Ametek	1726	Digital Tachometer	08/27/2007	8/27/2008
7000937	Radio Shack	SPORTS	Stop Watch	01/04/2008	1/4/2009

Test Data

UUT	Standard		UUT	Standard		UUT	Standard
RPM	RPM		RPM	RPM		RPM	RPM
2	2.00		20	19.95		200	199.6
4	3.97		40	39.46		400	396
7	6.89		70	68.77		700	688
10	9.85		100	98.39		1,000	985
Range x 1			Range x 10			Range x 100	

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Phoenix, AZ 85040
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Calibration Report

Report No: 83430 **Order No:** 18202-80109

Customer:	VSI 729 W. Lynwood St. Phoenix, AZ 85007	**Calibration Date:**	01/18/2008
		Recall Date:	01/18/2009
		Ambient Temperature:	70°F
		Relative Humidity:	21%
Equipment Type:	Spring Scale	**Received:**	In Tolerance
Make:	Correx	**Returned:**	In Tolerance
Model:	0-3 g	**Received Condition:**	Fair
Asset Number:	4160	**Accuracy:**	0 to 3 grams 0.01 x (max dial rdg + actual test rdg)
Serial Number:			
Procedure:	33K6-4-18-1		
Technician:	Holmes, Richard	**Authorized By:**	

The accuracy of this instrument has been verified under the conditions stated above in ANSI/ISO/IEC 17025:2005 and Z540-1-1994. Our standards have traceability to NIST or an international, or intrinsic standard and evidence is on file at our Metrology Laboratory. Unless stated otherwise, the collective uncertainty of the measurement process does not exceed 25% of the tolerance allowed for the individual characteristics measured. This certificate shall not be reproduced, except in full, without the written approval of National Calibration Inc.

Standards Used

Asset	Make	Model	Description	Cal Date	Due Date
7000357	AND	HM-202	Analytical Balance	06/11/2007	6/11/2008

Test Data

Standard Equipment Reading	Unit Under Test Reading	Error	Standard Equipment Reading	Unit Under Test Reading	Error
grams	grams	grams	grams	grams	grams
1.03	1	0.03	1.02	1	0.02
2.04	2	0.04	2.03	2	0.03
3.06	3	0.06	3.05	3	0.05
	CW			CCW	

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Phoenix, AZ 85040
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Calibration Report

Report No: 97000 **Order No:** 20548-81902

Customer:	VSI 729 W. Lynwood St. Phoenix, AZ 85007	**Calibration Date:**	07/10/2008
		Recall Date:	07/10/2009
		Ambient Temperature:	70°F
		Relative Humidity:	50%
Equipment Type:	Multimeter	**Received:**	In Tolerance
Make:	Fluke	**Returned:**	In Tolerance
Model:	8060A	**Received Condition:**	Good
Asset Number:	4515375	**Accuracy:**	Per Mfg. Specs.
Serial Number:	4515375		
Procedure:	Metcal		
Technician:	Lemoi, Mike	**Authorized By:**	

The accuracy of this instrument has been verified under the conditions stated above in ANSI/ISO/IEC 17025:2005. Our standards have traceability to NIST or an international, or intrinsic standard and evidence is on file at our Metrology Laboratory. Unless stated otherwise, the collective uncertainty of the measurement process does not exceed 25% of the tolerance allowed for the individual characteristics measured. The stated uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2. The results relate only to the item being calibrated. This certificate shall not be reproduced, except in full, without the written approval of National Calibration Inc.

Standards Used

Asset	Make	Model	Description	Cal Date	Due Date
7000701	Fluke	5520A-SC1100	Multi-function Calibrator	02/22/2008	2/22/2009

Technician Comments:

National Calibration Inc.

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Phoenix, AZ 85040
(602) 437-0114

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ONLINE RECORDS
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Calibration Report

Report No: 77317 **Order No:** 17093-72795

Customer:	VSI 729 W. Lynwood St. Phoenix, AZ 85007	**Calibration Date:**	10/04/2007
		Recall Date:	10/04/2008
		Ambient Temperature:	72°F
		Relative Humidity:	36%
Equipment Type:	Precision Thermometer	**Received:**	In Tolerance
Make:	Ertco	**Returned:**	In Tolerance
Model:	1003-3	**Received Condition:**	Fair
Asset Number:	7296	**Accuracy:**	±0.1°C
Serial Number:	7296		
Procedure:	33KS-4-42-1		
Technician:	Pikoy, Glenn	**Authorized By:**	Robert V. Hallaran

The accuracy of this instrument has been verified under the conditions stated above in ANSI/ISO/IEC 17025:2005 and Z540-1-1994. Our standards have traceability to NIST or an international, or intrinsic standard and evidence is on file at our Metrology Laboratory. Unless stated otherwise, the collective uncertainty of the measurement process does not exceed 25% of the tolerance allowed for the individual characteristics measured. This certificate shall not be reproduced, except in full, without the written approval of National Calibration Inc.

Standards Used

Asset	Make	Model	Description	Cal Date	Due Date
7000400	Hart Scientific	1502A	Digital Thermometer Readout	08/10/2007	08/10/2008
7000382	Hart Scientific	5628	Platinum Resistance Thermometer	07/19/2007	10/19/2008

Test Data

STD	UUT	Error
°C	°C	°C
0.021	0	0.021
24.925	25	0.075
50.080	50	0.080

Readings are as found / as left.

CHECK OF BAROMETRIC PRESSURE SENSOR

Manuf./Model: Garmin/Etrex GPS
Serial No.: 79524134

DATE	READING	NWS-El PASO	Garmin GPS
04/17/02	Station Prs.	873 mb	873 mb
10/20/02	Station Prs.	872 mb	873 mb
04/14/03	Station Prs.	873 mb	873 mb
07/14/03	Station Prs.	873 mb	873 mb
01/26/04	Station Prs.	877 mb	877 mb
07/27/04	Station Prs.	875 mb	875 mb
01/24/05	Station Prs.	883 mb	882 mb
07/18/05	Station Prs.	872 mb	871 mb
10/24/05	Station Prs.	881 mb	880 mb
01/30/06	Station Prs.	876 mb	875 mb
07/17/06	Station Prs.	878 mb	877 mb
01/29/07	Station Prs.	872 mb	873 mb
07/16/07	Station Prs.	873 mb	872 mb
01/21/08	Station Prs.	874 mb	873 mb
07/21/08	Station Prs.	874 mb	873 mb

BARchk.doc

DATE	READING	NWS-PHX	Garmin GPS
09/26/08	Station Prs.	974 mb	973 mb

Bios International Corporation • 10 Park Place, Butler, NJ 07405 USA
Phone (973) 492 8400 Fax (973) 492 8270 Web www.biosint.com

calibration certificate

Report No. 21360
Product DCL-H
Serial No. 4916
Mfg. Date October 30, 2003

DryCal DC1, DC2 and DC Lite Flow Calibrators are all calibrated using the same methodology. Each device is dynamically tested by comparing it to a Laboratory Standard primary piston prover of much higher accuracy, (±0.25%) but of similar operating principles. Flow generators of ±0.003% stability (included in prover accuracy) are used for the comparison. Use of provers of similar construction to the devices under test assures the validity of the flow generator as a transfer standard.

The primary Laboratory Standards are qualified by direct measurement of their dimensions (diameter, length of measured path, time base) against NIST-traceable gauges and instruments. A rigorous analysis of their accuracy in accordance with the International Guide to Uncertainty in Measurements has been performed assuring their traceable accuracy. Test procedures assure temperature matching of the Laboratory Standards and the devices under test.

Calibration Standards Used

Asset Number	Description	Cal Date	Due Date
ML-500-10 1064	ML-500 Low Flow Cell	4/1/2003	4/1/2004
ML-500-24 1086	ML-500 Medium Flow Cell	4/1/2003	4/1/2004
ML-500-44 1070	ML-500 High Flow Cell	4/1/2003	4/1/2004

All units calibrated in accordance with Bios International Corporation test number PR01-10 Rev B.
Expanded uncertainty ±0.25% at two times coverage.

As Shipped Test Data:

Laboratory Environment:

Temperature Ambient: 22.78°C Pressure Ambient: 757.27 mmHg Humidity Ambient: 40 %

Instrument Reading ml/min	Lab Standard Reading ml/min	Lab Standard Unit #	Deviation Percentage	Allowable Deviation	Condition Shipped
503.2	500.4	1086	0.56	1.00%	in tolerance
2018	2007.5	1070	0.52	1.00%	in tolerance
4967	5007.5	1070	-0.81	1.00%	in tolerance
17080	17060	1070	0.12	1.00%	in tolerance
30160	30085	1070	0.25	1.00%	in tolerance

Calibration Notes

By: _____ Calibration Date: 10/30/03

Zenaida Ortiz
Calibration Technician

All calibrations performed in accordance with ISO 17025.

TISCH ENVIROMENTAL, INC.
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513.467.9009 FAX
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AIR POLLUTION MONITORING EQUIPMENT

ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5025A

Date - Jul 24, 2008 Rootsmeter S/N 9833620 Ta (K) - 295
Operator Tisch Orifice I.D. - G73 Pa (mm) - 753.11

PLATE OR Run #	VOLUME START (m3)	VOLUME STOP (m3)	DIFF VOLUME (m3)	DIFF TIME (min)	METER DIFF Hg (mm)	ORFICE DIFF H2O (in.)
1	NA	NA	1.00	1.3700	3.2	2.00
2	NA	NA	1.00	0.9610	6.4	4.00
3	NA	NA	1.00	0.8590	7.9	5.00
4	NA	NA	1.00	0.8180	8.7	5.50
5	NA	NA	1.00	0.6750	12.7	8.00

DATA TABULATION

Vstd	(x axis) Qstd	(y axis)		Va	(x axis) Qa	(y axis)
0.9967	0.7275	1.4149		0.9957	0.7268	0.8851
0.9925	1.0328	2.0010		0.9915	1.0318	1.2517
0.9904	1.1530	2.2372		0.9894	1.1518	1.3995
0.9894	1.2096	2.3464		0.9884	1.2083	1.4678
0.9841	1.4579	2.8299		0.9831	1.4564	1.7702
Qstd slope (m) =		1.93776		Qa slope (m) =		1.21339
intercept (b) =		0.00292		intercept (b) =		0.00183
coefficient (r) =		0.99998		coefficient (r) =		0.99998
y axis = SQRT[H2O(Pa/760)(298/Ta)]				y axis = SQRT[H2O(Ta/Pa)]		

CALCULATIONS

Vstd = Diff. Vol[(Pa-Diff. Hg)/760](298/Ta)
Qstd = Vstd/Time

Va = Diff Vol [(Pa-Diff Hg)/Pa]
Qa = Va/Time

For subsequent flow rate calculations:

Qstd = 1/m{[SQRT(H2O(Pa/760)(298/Ta))]- b}
Qa = 1/m{[SQRT H2O(Ta/Pa)]- b}

Appendix B

Performance Audit Forms

Appendix B – 1

Site 1

PERFORMANCE AUDIT: WIND SPEED

SENSOR:
Manuf./Model: RMY/5305AQ
Serial No.: 82346
Range: 0-50m/s

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

PROPELLER:
Manuf./Model: RMY/08254
Serial No.: 65892

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2397

CALIB. FACTORS:
WS(mps)=(RPM*0.00512)
WS(mph)=mps*2.2369

AUDIT DEVICE:
Manuf./Model: RMY/18802
Serial No.: CA02194

PROPELLER CONDITION:
BEARING CONDITION: (<1.0 gm-cm)

INPUT:	SPEED		DATA ACQUISITION			
RPM	(mph)	(mps)	(mph)	(mps)	DIFF.(mps)	/ %
0	0.00	0.00	0.00	0.00	0.00	-
200	2.29	1.02	2.29	1.02	0.00	-
400	4.58	2.05	4.58	2.05	0.00	-
800	9.16	4.10	9.16	4.10	0.00	-
1200	13.74	6.14	13.74	6.14	0.00	0.00
2400	27.49	12.29	27.49	12.29	0.00	0.00
4000	45.81	20.48	45.81	20.48	0.00	0.00

PSD TOLERANCES (mps)

SPEED	DAS
≤5 mps	±0.25
>5 mps	±5.0% (≤ 2.5)

PERFORMANCE AUDIT: WIND DIRECTION

SENSOR:
Manuf./Model: RMY/05305AQ
Serial No.: 82346
Range: 0-360 Degrees

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

VANE CONDITION: GOOD
BEARING CONDITION: GOOD (<11.0 gm-cm)

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2397

SENSOR ALIGNMENT CHECK

	X-ARM ALIGNMENT (Degrees)	SENSOR ALIGNMENT (Degrees)	DIFFERENCE (Degrees)
AS FOUND	181	179.2	-1.8
AS LEFT	181	180.2	-0.8

CONTINUITY CHECK

INPUT: COMPASS POINT (Degrees)	DATA ACQUISITION (Degrees)	DIFFERENCE (Degrees)
5	6.3	1.3
30	31.6	1.6
60	60.7	0.7
90	90.3	0.3
120	119.6	-0.5
150	149.4	-0.6
180	179.6	-0.4
210	209.7	-0.3
240	239.9	-0.1
270	270.4	0.4
300	300.6	0.6
330	330.7	0.7
355	354.5	-0.5

PSD TOLERANCES (Degrees)

DAS
±5.0

PERFORMANCE AUDIT: VERTICAL WIND SPEED

SENSOR:
Manuf./Model: RMY/27106
Serial No.: EPS
Range: 0-30 mps

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

PROPELLER:
Manuf./Model: RMY/08274
Serial No.: 73196

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2397

CALIB. FACTORS:
WS(mps)=(RPM*0.00512)
WS(mph)=mps*2.2369

AUDIT DEVICE:
Manuf./Model: VSI
Serial No.: NSN

PROPELLER CONDITION: GOOD
BEARING CONDITION: GOOD (<0.5 gm-cm)

INPUT: RPM	SPEED (cm/s)	DATA ACQUISITION (CW)	(CCW)	ABS DIFF.(cm/s)	
0	0.0	-0.3	0.0	0.3	0.0
20	9.8	-9.6	11.0	-0.2	1.3
39	19.3	-20.9	18.3	1.6	-1.0
69	33.7	-33.7	34.5	0.0	0.8
98	48.2	-48.8	49.1	0.6	0.8
200	97.8	-100.4	97.2	2.6	-0.6
396	194.0	-194.5	195.9	0.5	1.9
688	337.1	-333.8	333.8	-3.3	-3.3
985	482.7	-480.1	477.5	-2.5	-5.1

PSD TOLERANCES (cm/s)

SPEED	DAS
≤500 cm/s	±25
>500 cm/s	±5.0% (≤ 250)

PERFORMANCE AUDIT: VERTICAL WIND SPEED

SENSOR:
Manuf./Model: RMY/27106T
Serial No.: CFT
Range: 0-30 mps

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

PROPELLER:
Manuf./Model: RMY/08254
Serial No.: 66197

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2397

CALIB. FACTORS:
WS(mps)=(RPM*0.00512)
WS(mph)=mps*2.2369

AUDIT DEVICE:
Manuf./Model: VSI
Serial No.: NSN

PROPELLER CONDITION: GOOD
BEARING CONDITION: GOOD (<0.5 gm-cm)

INPUT: RPM	SPEED (cm/s)	DATA ACQUISITION (CW)	(CCW)	ABS DIFF.(cm/s)	
0	0.0	0.0	0.0	0.0	0.0
20	10.0	-10.9	9.8	1.0	-0.2
39	19.7	-19.8	19.3	0.1	-0.5
69	34.4	-35.8	34.4	1.5	0.0
98	49.2	-49.8	48.9	0.6	-0.3
200	99.8	-98.9	98.3	-0.9	-1.5
396	198.0	-197.9	198.5	-0.1	0.5
688	344.0	-342.3	342.7	-1.7	-1.3
985	492.5	-490.8	489.7	-1.7	-2.8

PSD TOLERANCES (cm/s)

SPEED	DAS
≤500 cm/s	±25
>500 cm/s	±5.0% (≤ 250)

PERFORMANCE AUDIT: AMBIENT TEMPERATURE (2M)

SENSOR:
Manuf./Model: RMY/41342
Serial No.: 13642
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

CALIBRATOR:
Manuf./Model: ERTCO/1003-3
Serial No.: 7296

DATA ACQUSITION:
Manuf./Model: CS/3000
Serial No.: 2397

INPUT TEMPERATURE (Deg. F)	(Deg. C.)	DATA ACQUISITION (Deg. F)	(Deg. C.)	DIFF. (Deg. C.) (DAS)
32.1	0.1	32.4	0.2	0.2
63.9	17.7	63.8	17.6	-0.1
108.3	42.4	108.3	42.4	0.0

PSD TOLERANCES (Deg. C.)

DAS
±0.5

PERFORMANCE AUDIT: AMBIENT TEMPERATURE

SENSOR:
Manuf./Model: Vaisala/HMP45C-L
Serial No. 2730074
Range: -50 to +50°C

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No. 2397

CALIB. FACTORS:
Deg. C = 0.5556(Deg. F - 32)

CALIBRATOR:
Manuf./Model: ERTCO/1003-3
Serial No. 7296

AMBIENT READING (°F)	DATA ACQUISITION (°F)	DIFFERENCE* (DAS)
63.5	63.5	0.0

PERFORMANCE AUDIT: RELATIVE HUMIDITY

SENSOR:
Manuf./Model: Vaisala/HMP45C-L
Serial No. 2730074
Range: 0 to 100%

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No. 2397

CALIB. FACTORS:
Deg. C = 0.5556(Deg. F - 32)

CALIBRATOR:
Manuf./Model: PSYCHROMETER
Serial No. NSN

AMBIENT READING (%)	DATA ACQUISITION (%)	DIFFERENCE* (DAS)
36	35.0	1.0

*NO STANDARD

MANUFACTURER'S SPECIFICATIONS:

RANGE	SENSOR ACCURACY
0-90%	±2%
90-100%	±3%

PERFORMANCE AUDIT: AMBIENT PRESSURE

SENSOR:
Manuf./Model: Vaisala/CS106
Serial No.: NA
Range: 1100 to 500 mb

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

CALIBRATOR:
Manuf./Model: Garmin/Etrex GPS
Serial No.: 79524134

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2397

CALIB. FACTORS:
1013.25 mb = 29.92 in. Hg. = 760.0 mm Hg.

AMBIENT PRESSURE (in. Hg.)	AMBIENT PRESSURE (mb)	DATA ACQUISITION (in. Hg.)	DATA ACQUISITION (mb)	DIFF. (mb) (DAS)
24.4	836.5	24.8	838.2	1.7

EPA GUIDELINES (mb)

DAS

±3.0

PERFORMANCE AUDIT: SOLAR RADIATION

SENSOR:
Manuf./Model: Licor/LI-200SZ
Serial No.: PY57101
Range: 0-2000 W/m²
Calib. Factors:
mV/Wm-2: 0.005 Date: 5/17/07

COLL. STD:
Manuf./Model: Licor
Serial No.: PY30431
Calib. Factors:
mV/Wm-2: 0.008629 Date: 5/6/02

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2397

1. Place a dark cover over the sensor and record output.

Output (mV)	DAS (W/m2)
0.00	0.0000

2. Record the output of the Collocated Standard and the Sensor.

Sensor	Standard	% Difference DAS
770	765	0.7
685	678	1.0

3. Disconnect the sensor and input voltages listed below to TB5.7(+) and TB5.8(-).

INPUT (W/m2)	Target Voltage (mVdc)	Actual Voltage	Data Acquisition (W/m2)	Diff.(%) (DAS)
444	2.22	2.22	443	-0.32
888	4.44	4.44	888	-0.03
1332	6.66	6.66	1331	-0.11
1776	8.88	8.88	1778	0.09
2220	11.10	11.10	2221	0.04

PSD TOLERANCES

DAS
±5.0%

PERFORMANCE AUDIT: PRECIPITATION

SENSOR:
Manuf./Model: MetOne/385
Serial No.: G6356
Resolution: 0.01 inch

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

CALIBRATOR:
Manuf./Model: Graduated Cyl.
Serial No.: NSN

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2397

CALIB. FACTORS:
1 tip = 0.01 inch = 18.53 ml = 0.254 mm

	INPUT		DATA ACQUISITION		DIFF. (inches / ml / %)
No. Tips	(in. H_2O)	(ml H_2O)	(in. H_2O)	(ml H_2O)	(DAS)
11	0.107	198.0	0.110	203.8	0.003 in. / 5.8ml / 3.0%

PSD TOLERANCES (% / mm H_2O))

DAS

±10% Observed Value / ±0.5 mm (16.2 ml)

PERFORMANCE AUDIT: PARTICULATE MATTER (PM_{10})

SENSOR:
Manuf./Model: R&P/Partisol 2000 - PM_{10}
Serial No.: 200FB208060708

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 10/8/08
BY: VSI

AUDIT DEVICES:

FLOW:
Manuf./Model: BIOS/DCL-H
Serial Nc 4916

TEMP:
Manuf./Model: ERTCO/1003-3
Serial No.: 7296

FLOW AUDIT:

INDICATED FLOW (lpm)	AUDIT FLOW (lpm)	DIFFERENCE (%)
16.6	17.0	-2.46

TOLERANCE: ±5%

TEMP (EXT) AUDIT:

INDICATED TEMP (°C)	AUDIT TEMP (°C)	DIFFERENCE (°C)
19.2	20.2	-1.0

TOLERANCE: ±2°C

TEMP (INT) AUDIT:

INDICATED TEMP (°C)	AUDIT TEMP (°C)	DIFFERENCE (°C)
19.1	19.7	-0.6

TOLERANCE: ±2°C

PRESSURE AUDIT:

INDICATED PRS. (mmHg)	AUDIT PRS.(mmHg)	DIFFERENCE (mmHg)
623	627.0	-4.0

TOLERANCE: ±10mmHg

PERFORMANCE AUDIT: TSP SAMPLER (VFC)

SAMPLER:

MANUF./MODEL: Tisch/TE-5170V-BL

SERIAL NO: 7152

OWNER: ENERGY FUELS

LOCATION: SITE 1

DATE: 10/8/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	22.1	22.1	22.1 ^{0}C
SERIAL NO.:	G73	PRESSURE (P_0):	622	622	622 mmHg
CAL DATE:	7/24/08				
SLOPE (m):	1.21339				
INTERCEPT (b):	0.00183				
CORRELATION (r):	0.999980				

ORIFICE MANOMETER (in. H_2O)			FLOWS	
LEFT	RIGHT	TOTAL	Q_a (cmm)	Q_{ind} (cmm)
0.60	3.85	4.45	1.196	1.189

AUDIT FLOW % DIFF.
-0.59

GUIDELINE: ± 7%

T_0 : Ambient Temperature (^{0}C)

$^0C = (^0F-32)*5/9$

P_0 : Ambient Pressure (mm Hg)

mm Hg = inches Hg * 25.4

$P_1 = P_o - \Delta P$

ΔH = Total Manometer (inches H_2O)

$Q_a = [1/m]*[[(\Delta H*(T_0+273.16)/P_o]^{1/2} - b]$

Audit % Difference = $[(Q_{ind} - Q_a)/Q_a] * 100$

where: Q_a = actual flow (from orifice)

Q_{ind} = indicated flow

Appendix B – 2

Site 2

PERFORMANCE AUDIT: WIND SPEED

SENSOR:
Manuf./Model: RMY/5305AQ
Serial No.: 82347
Range: 0-50m/s

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

PROPELLER:
Manuf./Model: RMY/08254
Serial No.: 65886

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2421

CALIB. FACTORS:
WS(mps)=(RPM*0.00512)
WS(mph)=mps*2.2369

AUDIT DEVICE:
Manuf./Model: RMY/18802
Serial No.: CA02194

PROPELLER CONDITION:
BEARING CONDITION: (<1.0 gm-cm)

INPUT:	SPEED		DATA ACQUISITION			
RPM	(mph)	(mps)	(mph)	(mps)	DIFF.(mps)	/ %
0	0.00	0.00	0.00	0.00	0.00	-
200	2.29	1.02	2.29	1.02	0.00	-
400	4.58	2.05	4.58	2.05	0.00	-
800	9.16	4.10	9.16	4.10	0.00	-
1200	13.74	6.14	13.74	6.14	0.00	0.00
2400	27.49	12.29	27.49	12.29	0.00	0.00
4000	45.81	20.48	45.81	20.48	0.00	0.00

PSD TOLERANCES (mps)

SPEED	DAS
≤5 mps	±0.25
>5 mps	±5.0% (≤ 2.5)

PERFORMANCE AUDIT: WIND DIRECTION

SENSOR:
Manuf./Model: RMY/05305AQ
Serial No.: 82347
Range: 0-360 Degrees

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

VANE CONDITION: GOOD
BEARING CONDITION: GOOD (<11.0 gm-cm)

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2421

SENSOR ALIGNMENT CHECK

	X-ARM ALIGNMENT (Degrees)	SENSOR ALIGNMENT (Degrees)	DIFFERENCE (Degrees)
AS FOUND	104	101.8	-2.2
AS LEFT	104	102.0	-2.0

CONTINUITY CHECK

INPUT: COMPASS POINT (Degrees)	DATA ACQUISITION (Degrees)	DIFFERENCE (Degrees)
5	7.0	2.0
30	31.0	1.0
60	60.5	0.5
90	89.9	-0.1
120	120.0	0.0
150	150.8	0.8
180	179.8	-0.2
210	210.2	0.2
240	239.9	-0.1
270	270.1	0.1
300	299.7	-0.3
330	330.0	-0.1
355	354.5	-0.5

PSD TOLERANCES (Degrees)

DAS

±5.0

PERFORMANCE AUDIT: VERTICAL WIND SPEED

SENSOR:
Manuf./Model: RMY/27106
Serial No.: EPS
Range: 0-30 mps

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

PROPELLER:
Manuf./Model: RMY/08274
Serial No.: 77997

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2421

CALIB. FACTORS:
WS(mps)=(RPM*0.00512)
WS(mph)=mps*2.2369

AUDIT DEVICE:
Manuf./Model: VSI
Serial No.: NSN

PROPELLER CONDITION: GOOD
BEARING CONDITION: GOOD (<0.5 gm-cm)

INPUT: RPM	SPEED (cm/s)	DATA ACQUISITION (CW)	(CCW)	ABS DIFF.(cm/s)	
0	0.0	0.0	0.00	0.0	0.0
20	9.8	-10.0	9.96	0.2	0.2
39	19.3	-19.3	18.5	0.0	-0.9
69	33.7	-34.3	33.1	0.6	-0.6
98	48.2	-48.3	48.6	0.1	0.4
200	97.8	-98.1	96.1	0.3	-1.7
396	194.0	-191.7	190.4	-2.4	-3.6
688	337.1	-329.9	329.9	-7.3	-7.2
985	482.7	-470.8	469.0	-11.9	-13.6

PSD TOLERANCES (cm/s)

SPEED	DAS
≤500 cm/s	±25
>500 cm/s	±5.0% (≤ 250)

PERFORMANCE AUDIT: VERTICAL WIND SPEED

SENSOR:
Manuf./Model: RMY/27106T
Serial No.: CFT
Range: 0-30 mps

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

PROPELLER:
Manuf./Model: RMY/08254
Serial No.: 66156

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2421

CALIB. FACTORS:
WS(mps)=(RPM*0.00512)
WS(mph)=mps*2.2369

AUDIT DEVICE:
Manuf./Model: VSI
Serial No.: NSN

PROPELLER CONDITION: GOOD
BEARING CONDITION: GOOD (<0.5 gm-cm)

INPUT: RPM	SPEED (cm/s)	DATA ACQUISITION (CW)	(CCW)	ABS DIFF.(cm/s)	
0	0.0	0.0	0.0	0.0	0.0
20	10.0	-11.3	10.2	1.3	0.2
39	19.7	-19.7	20.9	0.0	1.2
69	34.4	-35.8	34.7	1.4	0.3
98	49.2	-50.8	49.3	1.6	0.1
200	99.8	-97.8	98.9	-2.0	-0.9
396	198.0	-199.1	197.0	1.1	-1.0
688	344.0	-345.3	341.9	1.3	-2.1
985	492.5	-489.7	488.5	-2.8	-4.0

PSD TOLERANCES (cm/s)

SPEED	DAS
≤500 cm/s	±25
>500 cm/s	±5.0% (≤ 250)

PERFORMANCE AUDIT: AMBIENT TEMPERATURE (2M)

SENSOR:
Manuf./Model: RMY/41342
Serial No.: 13640
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

CALIBRATOR:
Manuf./Model: ERTCO/1003-3
Serial No.: 7296

DATA ACQUSITION:
Manuf./Model: CS/3000
Serial No.: 2421

INPUT TEMPERATURE (Deg. F)	(Deg. C.)	DATA ACQUISITION (Deg. F)	(Deg. C.)	DIFF. (Deg. C.) (DAS)
32.2	0.1	32.3	0.2	0.1
59.7	15.4	59.6	15.4	0.0
80.2	26.8	80.1	26.7	-0.1
120.4	49.1	119.8	48.8	-0.3

PSD TOLERANCES (Deg. C.)

DAS
±0.5

PERFORMANCE AUDIT: AMBIENT TEMPERATURE (30M)

SENSOR:
Manuf./Model: RMY/41342
Serial No.: 13641
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

CALIBRATOR:
Manuf./Model: ERTCO/1003-3
Serial No.: 7296

DATA ACQUSITION:
Manuf./Model: CS/3000
Serial No.: 2421

INPUT TEMPERATURE (Deg. F)	(Deg. C.)	DATA ACQUISITION (Deg. F)	(Deg. C.)	DIFF. (Deg. C.) (DAS)
32.2	0.1	32.3	0.2	0.1
59.7	15.4	59.6	15.4	-0.1
80.2	26.8	80.1	26.7	-0.1
120.4	49.1	119.9	48.8	-0.3

PSD TOLERANCES (Deg. C.)

DAS
±0.5

PERFORMANCE AUDIT: DELTA TEMPERATURE (2-30M)

SENSOR (Upper):
Manuf./Model: RMY/41342
Serial No.: 13641
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

SENSOR (Lower):
Manuf./Model: RMY/41342
Serial No.: 13640
Range: -50 to + 50°C

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2421

CALIBRATOR:
Manuf./Model: ERTCO/1003-3
Serial No.: 7296

INPUT TEMPERATURE (Deg. F)	(Deg. C.)	DATA ACQUISITION (Upper)	(Lower)	DIFF. (Deg. C.) (DAS)
32.2	0.1	0.2	0.2	0.00
59.7	15.4	15.4	15.4	-0.01
80.2	26.8	26.7	26.7	0.02
120.4	49.1	48.8	48.8	0.06

PSD TOLERANCES (Deg. C.)

DAS
±0.1

PERFORMANCE AUDIT: AMBIENT TEMPERATURE

SENSOR:
Manuf./Model: Vaisala/HMP45C-L
Serial No. 2730148
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No. 2421

CALIB. FACTORS:
Deg. C = 0.5556(Deg. F - 32)

CALIBRATOR:
Manuf./Model: ERTCO/1003-3
Serial No. 7296

AMBIENT READING (°F)	DATA ACQUISITION (°F)	DIFFERENCE* (DAS)
45.3	45.1	0.2

PERFORMANCE AUDIT: RELATIVE HUMIDITY

SENSOR:
Manuf./Model: Vaisala/HMP45C-L
Serial No. 2730148
Range: 0 to 100%

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No. 2421

CALIB. FACTORS:
Deg. C = 0.5556(Deg. F - 32)

CALIBRATOR:
Manuf./Model: PSYCHROMETER
Serial No. NSN

AMBIENT READING (%)	DATA ACQUISITION (%)	DIFFERENCE* (DAS)
66	67.0	-1.0

*NO STANDARD

MANUFACTURER'S SPECIFICATIONS:

RANGE	SENSOR ACCURACY
0-90%	±2%
90-100%	±3%

PERFORMANCE AUDIT: AMBIENT PRESSURE

SENSOR:
Manuf./Model: Vaisala/CS106
Serial No.: NA
Range: 110-500mb

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

CALIBRATOR:
Manuf./Model: Garmin/Etrex GPS
Serial No.: 79524134

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2421

CALIB. FACTORS:
1013.25 mb = 29.92 in. Hg. = 760.0 mm Hg.

AMBIENT PRESSURE (in. Hg.)	AMBIENT PRESSURE (mb)	DATA ACQUISITION (in. Hg.)	DATA ACQUISITION (mb)	DIFF. (mb) (DAS)
24.7	836.2	24.7	837.5	1.3

EPA GUIDELINES (mb)

DAS

±3.0

PERFORMANCE AUDIT: SOLAR RADIATION

SENSOR:
Manuf./Model: Licor/LI-200SZ
Serial No.: PY57102
Range: 0-2000 W/m²
Calib. Factors:
mV/Wm-2: 0.005 Date: 5/17/07

COLL. STD:
Manuf./Model: Licor
Serial No.: PY30431
Calib. Factors:
mV/Wm-2: 0.008629 Date: 5/6/02

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

DATA ACQUISITION:
Manuf./Model: CS/3000
Serial No.: 2421

1. Place a dark cover over the sensor and record output.

Output (mV)	DAS (W/m2)
0.00	0.0000

2. Record the output of the Collocated Standard and the Sensor.

Sensor	Standard	% Difference DAS
140	138	1.5
674	671	0.4

3. Disconnect the sensor and input voltages listed below to TB-8.

INPUT (W/m2)	Target Voltage (mVdc)	Actual Voltage	Data Acquisition (W/m2)	Diff.(%) (DAS)
424	2.12	2.12	424	-0.05
848	4.24	4.24	849	0.07
1272	6.36	6.36	1272	-0.03
1696	8.48	8.48	1700	0.23
2120	10.60	10.60	2123	0.14

PSD TOLERANCES

DAS
±5.0%

PERFORMANCE AUDIT: PARTICULATE MATTER (PM_{10})

SENSOR:
Manuf./Model: R&P/Partisol 2000 - PM_{10}
Serial No.: 200FB208130708

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 10/8/08
BY: VSI

AUDIT DEVICES:
FLOW:
Manuf./Model: BIOS/DCL-H
Serial Nc 4916

TEMP:
Manuf./Model: ERTCO/1003-3
Serial No.: 7296

FLOW AUDIT:

INDICATED FLOW (lpm)	AUDIT FLOW (lpm)	DIFFERENCE (%)
16.7	16.6	0.54

TOLERANCE: ±5%

TEMP (EXT) AUDIT:

INDICATED TEMP (°C)	AUDIT TEMP (°C)	DIFFERENCE (°C)
7.1	7.4	-0.3

TOLERANCE: ±2°C

TEMP (INT) AUDIT:

INDICATED TEMP (°C)	AUDIT TEMP (°C)	DIFFERENCE (°C)
8.7	8.1	0.6

TOLERANCE: ±2°C

PRESSURE AUDIT:

INDICATED PRS. (mmHg)	AUDIT PRS.(mmHg)	DIFFERENCE (mmHg)
626	627.1	-1.1

TOLERANCE: ±10mmHg

PERFORMANCE AUDIT: TSP SAMPLER (VFC)

SAMPLER:

MANUF./MODEL: Tisch/TE-5170V-BL

SERIAL NO: 7152

OWNER: ENERGY FUELS

LOCATION: SITE 2

DATE: 10/8/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	9.5	9.5	9.5 ^{0}C
SERIAL NO.:	G73	PRESSURE (P_0):	626	626	626 mmHg
CAL DATE:	7/24/08				
SLOPE (m):	1.21339				
INTERCEPT (b):	0.00183				
CORRELATION (r):	0.999980				

ORIFICE MANOMETER (in. H_2O)			FLOWS	
LEFT	RIGHT	TOTAL	Q_a (cmm)	Q_{ind} (cmm)
0.00	4.20	4.20	1.133	1.144

AUDIT FLOW % DIFF.
0.93

GUIDELINE: ± 7%

T_0 : Ambient Temperature (^{0}C)

$^0C = (^0F-32)*5/9$

P_0 : Ambient Pressure (mm Hg)

mm Hg = inches Hg * 25.4

$P_1 = P_o - \Delta P$

ΔH = Total Manometer (inches H_2O)

$Q_a = [1/m]*[[(\Delta H*(T_0+273.16)/P_o]^{1/2} - b]$

Audit % Difference = $[(Q_{ind} - Q_a)/Q_a] * 100$

where: Q_a = actual flow (from orifice)

Q_{ind} = indicated flow

Appendix B – 3

Site 3

PERFORMANCE AUDIT: TSP SAMPLER (VFC)

SAMPLER:

MANUF./MODEL: Tisch/TE-5170V-BL

SERIAL NO: 7152

OWNER: ENERGY FUELS

LOCATION: SITE 3

DATE: 10/8/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	14.9	14.9	14.9 ^{0}C
SERIAL NO.:	G73	PRESSURE (P_0):	625.6	625.6	625.6 mmHg
CAL DATE:	7/24/08				
SLOPE (m):	1.21339				
INTERCEPT (b):	0.00183				
CORRELATION (r):	0.999980				

ORIFICE MANOMETER (in. H_20)			FLOWS	
LEFT	RIGHT	TOTAL	Q_a (cmm)	Q_{ind} (cmm)
0.40	3.60	4.00	1.117	1.159

AUDIT FLOW % DIFF.
3.79

GUIDELINE: ± 7%

T_0 : Ambient Temperature (^{0}C)

$^0C = (^0F-32)*5/9$

P_0 : Ambient Pressure (mm Hg)

mm Hg = inches Hg * 25.4

$P_1 = P_o - \Delta P$

ΔH = Total Manometer (inches H_2O)

$Q_a = [1/m]*[[(\Delta H*(T_o+273.16)/P_o]^{1/2} - b]$

Audit % Difference = $[(Q_{ind} - Q_a)/Q_a] * 100$

where: Q_a = actual flow (from orifice)

Q_{ind} = indicated flow

Appendix B – 4

Site 4

PERFORMANCE AUDIT: TSP SAMPLER (VFC)

SAMPLER:

MANUF./MODEL: Tisch/TE-5170V-BL

SERIAL NO: 7152

OWNER: ENERGY FUELS

LOCATION: SITE 4

DATE: 10/8/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	23.3	23.3	23.3 ^{0}C
SERIAL NO.:	G73	PRESSURE (P_0):	630.5	630.5	630.5 mmHg
CAL DATE:	7/24/08				
SLOPE (m):	1.21339				
INTERCEPT (b):	0.00183				
CORRELATION (r):	0.999980				

ORIFICE MANOMETER (in. H_20)			FLOWS	
LEFT	RIGHT	TOTAL	Q_a (cmm)	Q_{ind} (cmm)
0.60	3.80	4.40	1.184	1.177

AUDIT FLOW % DIFF.
-0.61

GUIDELINE: $\pm$ 7%

T_0 : Ambient Temperature (^{0}C)

$^0C = (^0F-32)*5/9$

P_0 : Ambient Pressure (mm Hg)

mm Hg = inches Hg * 25.4

$P_1 = P_o - \Delta P$

ΔH = Total Manometer (inches H_2O)

$Q_a = [1/m]*[[(\Delta H*(T_0+273.16)/P_o]^{1/2} - b]$

Audit % Difference = $[(Q_{ind} - Q_a)/Q_a] * 100$

where: Q_a = actual flow (from orifice)

Q_{ind} = indicated flow

Appendix B – 5

Site 5

PERFORMANCE AUDIT: TSP SAMPLER (VFC)

SAMPLER:

MANUF./MODEL: Tisch/TE-5170V-BL

SERIAL NO: 7152

OWNER: ENERGY FUELS

LOCATION: SITE 5

DATE: 10/8/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	23.7	23.7	23.7 ^{0}C
SERIAL NO.:	G73	PRESSURE (P_0):	619.4	619.4	619.4 mmHg
CAL DATE:	7/24/08				
SLOPE (m):	1.21339				
INTERCEPT (b):	0.00183				
CORRELATION (r):	0.999980				

ORIFICE MANOMETER (in. H_2O)			FLOWS	
LEFT	RIGHT	TOTAL	Q_a (cmm)	Q_{ind} (cmm)
0.60	3.85	4.45	1.202	1.180

AUDIT FLOW % DIFF.
-1.83

GUIDELINE: ± 7%

T_0 : Ambient Temperature (^{0}C)

$^0C = (^0F-32)*5/9$

P_0 : Ambient Pressure (mm Hg)

mm Hg = inches Hg * 25.4

$P_1 = P_o - \Delta P$

ΔH = Total Manometer (inches H_2O)

$Q_a = [1/m]*[[(\Delta H*(T_0+273.16)/P_o]^{1/2} - b]$

Audit % Difference = $[(Q_{ind} - Q_a)/Q_a] * 100$

where: Q_a = actual flow (from orifice)

Q_{ind} = indicated flow

Energy Fuels Resources Corporation
Piñon Ridge Mill

Calibration Report for
Meteorological and Ambient Air Monitoring Network

4th Quarter 2008

Prepared by:

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1 Introduction

Inter-Mountain Laboratories – Air Science Division performed calibrations on October 8, 2008. The calibrations 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 Reference

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. IV – Meteorological Measurements, September 1989
- 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 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 calibrations included a verification of the flow, barometric pressure, ambient temperature, and filter temperature. The flow calibration 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 calibration standard and the sampler was compared to acceptance criteria.

2.2.2 TSP Hi-Volume Samplers
A calibration of the Hi-Volume Sampler was 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 a multiple point (multi-point) calibration was completed on the sampler. The multi-point calibration uses the five points to calculate the calibration flow rates, resulting slope and intercept for the sampler. The following equipment was required for the calibration:

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 N IST or American Society for Testing and Materials (ASTM) thermometer within ±2 ℃ at le ast 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 1995. 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 ℃
Delta Temperature	±0.1 ℃
Relative Humidity	±5.0 %
Solar Radiation	±5.0 percent of observed
Barometric Pressure	±0.09 in Hg
Precipitation	±10 percent of observed

Table 2-2 – PM_{10} Sampler Criteria

Sensor	Specifications
Ambient Temperature	±2.0 ℃
Filter Temperature	±2.0 ℃
Pressure	± 10 mm Hg
Flow Rate	±2.0 percent of observed (±0.33 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
Flow Rate between 1.1 to 1.7 m^3/min	Three (3) points
Difference Percentage	±2.0 percent
Correlation Coefficient	>0.990

3 Calibration Results

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

4 Findings/Recommendations

The calibrations of the Ambient Air Monitoring equipment were within the calibration specifications during the 4th Quarter of 2008. The calibrations of the Meteorological Monitoring equipment were within the calibration specifications, with the exception of Site #1 meteorological stations' precipitation bucket. The precipitation bucket failed the initial verification. The unit was verified with 180 milliliters of water, resulting in no tips being recorded. The tipping mechanism of the unit was repaired and the calibration was completed. Results of the calibration can be found in Appendix C.

Appendix A

PM_{10} Sampler Verifications and Calibrations

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

Partisol FRM Single Point Verification

Network:	Energy Fuels Resources
Date:	10/8/2008
Time:	1206 MST
Verified by:	W. Adler
Streamline FTS ID:	D000201
Streamline FTS cal. expires:	1/16/2009
Streamline FTS "m":	0.4120
Streamline FTS "b":	-0.6382
Temp Standard ID:	IML 0876
Press Standard ID:	IML 0913
Manometer ID:	IML 0949

Sampler ID: 1-2

As-Found Calibration Values

Parameter	Offset	Span
A/I	-0.0003	0.9993
Amb. Temp.	0.0031	
Filter Temp.	0.0017	
Pressure	-0.0492	
Flow	0.9598	-0.0156

Notes as found:

Sensors Verification

Sensor	Indicated	ΔP	Actual	Difference	Specification
Amb. Temp.	18.7		18.9	0.2	±2℃
Filter Temp.	20.0		19.8	0.2	±2℃
Pressure	623		626.6	3.6	± 10 mmHg
Flow	16.70	4.97	16.65	0.05	16.7 lpm ± 2% (± 0.33 lpm)

External Leak Check: Pass
(<5"Hg/60 sec.)

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

Notes:

IML Air Science
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555 Absaraka, Sheridan, WY 82801

Partisol FRM Single Point Verification

Network:	Energy Fuels Resources
Date:	10/8/2008
Time:	0701 MST
Verified by:	W. Adler
Streamline FTS ID:	D000201
Streamline FTS cal. expires:	1/16/2009
Streamline FTS "m":	0.4120
Streamline FTS "b":	-0.6382
Temp Standard ID:	IML 0876
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	-0.0115	0.9898

Notes as found:

Sensors Verification

Sensor	Indicated	ΔP	Actual	Difference	Specification
Amb. Temp.	6.6		7.5	0.9	±2℃
Filter Temp.	8.2		8.2	0.0	±2℃
Pressure	626		626.1	0.1	± 10 mmHg
Flow	16.70	5.07	16.48	0.22	16.7 lpm ± 2% (± 0.33 lpm)

External Leak Check: Pass
(<5"Hg/60 sec.)

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

Notes:

Appendix B

TSP Sampler Verifications and Calibrations

Sampler Flow Rate Verification

Network: Energy Fuels Resources
Sampler ID: 1-1-TSP
Sampler Type: Tisch TE-5170-DV-BL
AIRS Site ID: N/A
Verification By: MB
Sampler Verification Date: 10/8/2008
Sampler Calibration Date: 7/30/2008
Orifice ID: 8041589
Orifice Calibration Date: 4/7/2008
Ambient Temperature (℃): 22.9
Ambient Pressure ("Hg): 24.67
Ambient Temperature (℃): 296.1
Ambient Pressure (mmHg): 627

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.277 and b = -0.014

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 7.9143 and b = 0.3802

Accuracy Flow Verification

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
4.97	⇒	1.2109	19.5	⇒	1.2211

Sampler Qa percent difference from Orifice Qa: 0.8%

Verification performed according to EPA Quality Assurance Handbook for Air

Notes:

Sampler Flow Rate Verification

Network: Energy Fuels Resources
Sampler ID: 2-1-TSP
Sampler Type: Tisch TE-5170-DV-BL
AIRS Site ID: N/A
Verification By: MB
Sampler Verification Date: 10/8/2008
Sampler Calibration Date: 7/30/2008
Orifice ID: 8041589
Orifice Calibration Date: 4/7/2008
Ambient Temperature (℃): 8.6
Ambient Pressure ("Hg): 24.66
Ambient Temperature (℃): 281.8
Ambient Pressure (mmHg): 626

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.277 and b = -0.014

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 9.6801 and b = 0.2819

Accuracy Flow Verification

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
4.14	⇒	1.0796	17.0	⇒	1.1573

Sampler Qa percent difference from Orifice Qa: 7.2%

Verification performed according to EPA Quality Assurance Handbook for Air

Notes:

Sampler Flow Rate Verification

Network: Energy Fuels Resources
Sampler ID: 3-1-TSP
Sampler Type: Tisch TE-5170-DV-BL
AIRS Site ID: N/A
Verification By: MB
Sampler Verification Date: 10/8/2008
Sampler Calibration Date: 7/30/2008
Orifice ID: 8041589
Orifice Calibration Date: 4/7/2008
Ambient Temperature (℃): 10.1
Ambient Pressure ("Hg): 24.66
Ambient Temperature (℃): 283.3
Ambient Pressure (mmHg): 626

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.277 and b = -0.014

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 6.3218 and b = 0.5184

Accuracy Flow Verification

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
4.92	⇒	1.1790	19.3	⇒	1.1289

Sampler Qa percent difference from Orifice Qa: -4.2%

Verification performed according to EPA Quality Assurance Handbook for Air

Notes:

Sampler Flow Rate Verification

Network: Energy Fuels Resources
Sampler ID: 4-1-TSP
Sampler Type: Tisch TE-5170-DV-BL
AIRS Site ID: N/A
Verification By: MB
Sampler Verification Date: 10/8/2008
Sampler Calibration Date: 7/30/2008
Orifice ID: 8041589
Orifice Calibration Date: 4/7/2008
Ambient Temperature (℃): 26.7
Ambient Pressure ("Hg): 24.85
Ambient Temperature (℃): 299.9
Ambient Pressure (mmHg): 631

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.277 and b = -0.014

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where **m** = 7.8435 and b = 0.4081

Accuracy Flow Verification

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
4.94	⇒	1.2106	19.4	⇒	1.1800

Sampler Qa percent difference from Orifice Qa: -2.5%

Verification performed according to EPA Quality Assurance Handbook for Air

Notes:

Sampler Flow Rate Verification

Network: Energy.Fuels Resources
Sampler ID: 5-1-TSP
Sampler Type: Tisch TE-5170-DV-BL
AIRS Site ID: N/A
Verification By: MB
Sampler Verification Date: 10/8/2008
Sampler Calibration Date: 7/30/2008
Orifice ID: 8041589
Orifice Calibration Date: 4/7/2008
Ambient Temperature (°C): 23.9
Ambient Pressure ("Hg): 24.46
Ambient Temperature (°K): 297.1
Ambient Pressure (mmHg): 621

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 1.277 and b = -0.014

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 7.7384 and b = 0.4082

Accuracy Flow Verification

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
4.98	⇒	1.2193	19.4	⇒	1.1882

Sampler Qa percent difference from Orifice Qa: -2.6%

Verification performed according to EPA Quality Assurance Handbook for Air

Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 1-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 10/8/08
Calibrated By: Will Adler
Orifice ID: 8A
Orifice Calibration Date: 4/7/08
Ambient Temperature (°C): 22.9
Ambient Pressure ("Hg): 24.67
Ambient Temperature (°K): 296.1
Ambient Pressure (mmHg): 627

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.944 and b = 0.012

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.1	0.38	24.30	0.9848
2	13.7	1.01	23.66	0.9592
3	18.1	1.33	23.34	0.9461
4	23.6	1.74	22.93	0.9297
5	31.1	2.29	22.38	0.9073

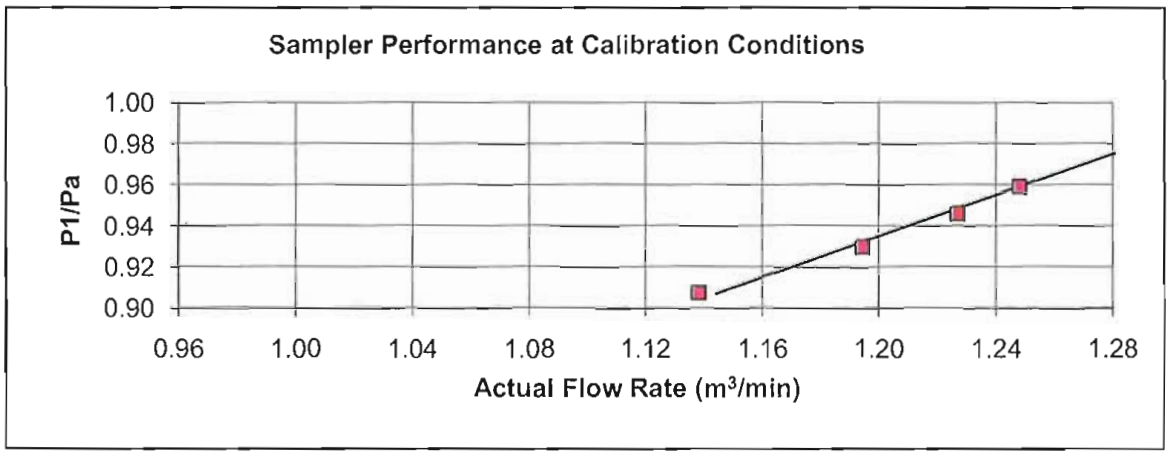
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.22	1.2935	0.0752	1.2989	0.4%
2	3.00	1.2481	0.0726	1.2478	0.0%
3	2.90	1.2269	0.0713	1.2216	-0.4%
4	2.75	1.1944	0.0694	1.1889	-0.5%
5	2.50	1.1383	0.0662	1.1443	0.5%

Sampler Calibration:

Slope	**8.6199**
Intercept	**0.3339**
r	**0.9954**
Failure Temp (°C)	**-66.6**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.3339] * [SQRT(Ta)]} * {1/8.6199}



Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 2-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 10/8/08
Calibrated By: Will Adler
Orifice ID: 8A
Orifice Calibration Date: 4/7/08
Ambient Temperature (℃): 8.6
Ambient Pressure ("Hg): 24.66
Ambient Temperature (℃): 281.8
Ambient Pressure (mmHg): 626

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.944 and b = 0.012

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.0	0.37	24.29	0.9851
2	7.2	0.53	24.13	0.9785
3	11.5	0.85	23.81	0.9657
4	17.2	1.26	23.40	0.9487
5	28.4	2.09	22.57	0.9153

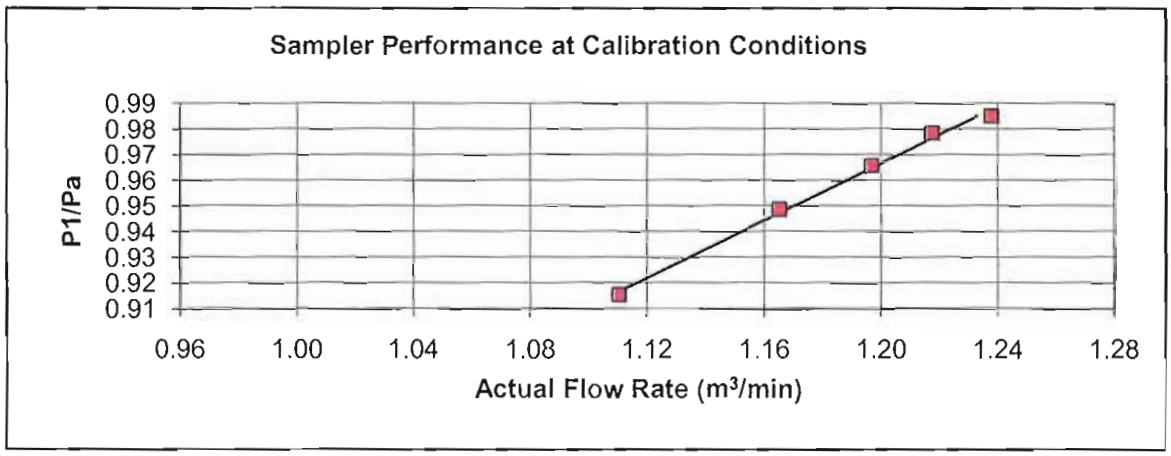
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.10	1.2379	0.0738	1.2329	-0.4%
2	3.00	1.2175	0.0726	1.2211	0.3%
3	2.90	1.1969	0.0713	1.1981	0.1%
4	2.75	1.1652	0.0694	1.1677	0.2%
5	2.50	1.1103	0.0662	1.1079	-0.2%

Sampler Calibration:

Slope	**9.3686**
Intercept	**0.2968**
r	**0.9974**
Failure Temp (℃)	**-56.2**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.2968] * [SQRT(Ta)]} * {1/9.3686}



Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 3-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 10/8/08
Calibrated By: Will Adler
Orifice ID: 8A
Orifice Calibration Date: 4/7/08
Ambient Temperature (℃): 10.1
Ambient Pressure ("Hg): 24.66
Ambient Temperature (℃): 283.3
Ambient Pressure (mmHg): 626

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.944 and b = 0.012

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.3	0.39	24.27	0.9842
2	10.5	0.77	23.89	0.9687
3	13.3	0.98	23.68	0.9603
4	20.6	1.51	23.15	0.9386
5	28.1	2.07	22.59	0.9162

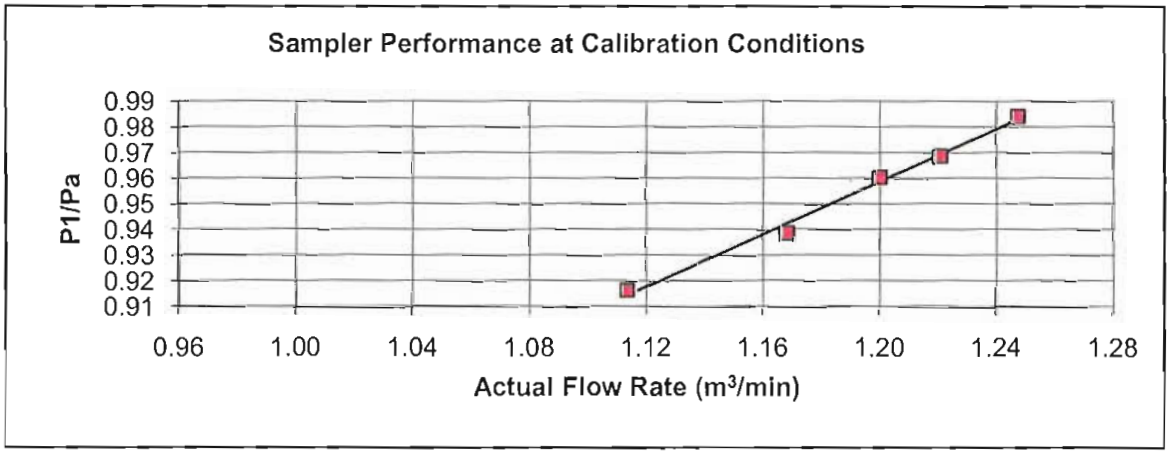
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.13	1.2472	0.0741	1.2496	0.2%
2	3.00	1.2208	0.0726	1.2194	-0.1%
3	2.90	1.2001	0.0713	1.2031	0.3%
4	2.75	1.1683	0.0694	1.1607	-0.7%
5	2.50	1.1133	0.0662	1.1171	0.3%

Sampler Calibration:

Slope	**8.6308**
Intercept	**0.3432**
r	**0.9959**
Failure Temp (℃)	**-59.6**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.3432] * [SQRT(Ta)]} * {1/8.6308}



Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 4-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 10/8/08
Calibrated By: Will Adler
Orifice ID: 8A
Orifice Calibration Date: 4/7/08
Ambient Temperature (℃): 26.7
Ambient Pressure ("Hg): 24.85
Ambient Temperature (K): 299.9
Ambient Pressure (mmHg): 631

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.944 and b = 0.012

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	4.9	0.36	24.49	0.9855
2	9.4	0.69	24.16	0.9722
3	15.0	1.10	23.75	0.9556
4	21.5	1.58	23.27	0.9364
5	30.6	2.25	22.60	0.9095

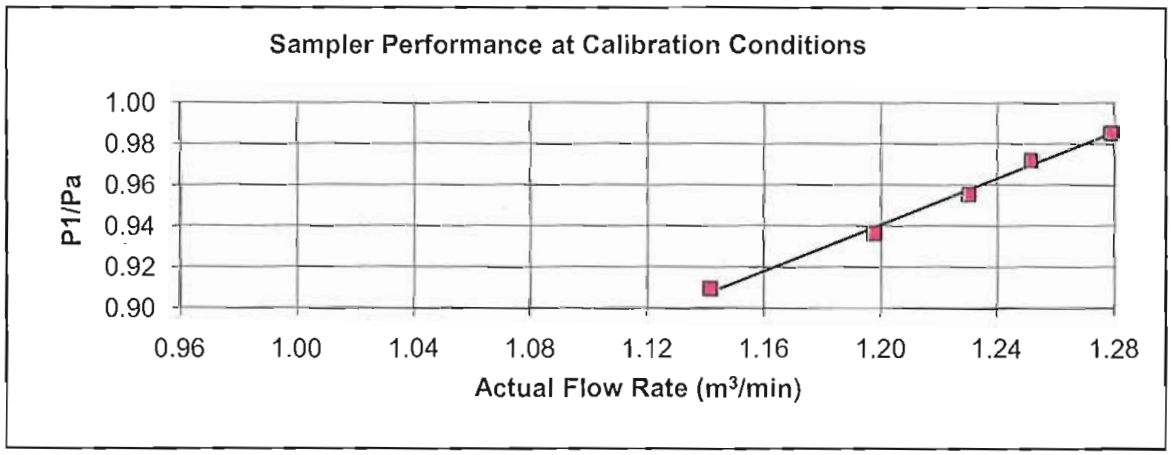
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.13	1.2787	0.0739	1.2795	0.1%
2	3.00	1.2516	0.0723	1.2559	0.3%
3	2.90	1.2303	0.0711	1.2266	-0.3%
4	2.75	1.1978	0.0692	1.1925	-0.4%
5	2.50	1.1414	0.0659	1.1448	0.3%

Sampler Calibration:

Slope	**9.7712**
Intercept	**0.2633**
r	**0.9968**
Failure Temp (℃)	**-59.8**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.2633] * [SQRT(Ta)]} * {1/9.7712}



Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 5-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 10/8/08
Calibrated By: Will Adler
Orifice ID: 8A
Orifice Calibration Date: 4/7/08
Ambient Temperature (℃): 23.9
Ambient Pressure ("Hg): 24.46
Ambient Temperature (℃): 297.1
Ambient Pressure (mmHg): 621

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.944 and b = 0.012

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.0	0.37	24.09	0.9850
2	8.4	0.62	23.84	0.9747
3	13.0	0.96	23.50	0.9609
4	20.9	1.54	22.92	0.9372
5	29.8	2.19	22.27	0.9104

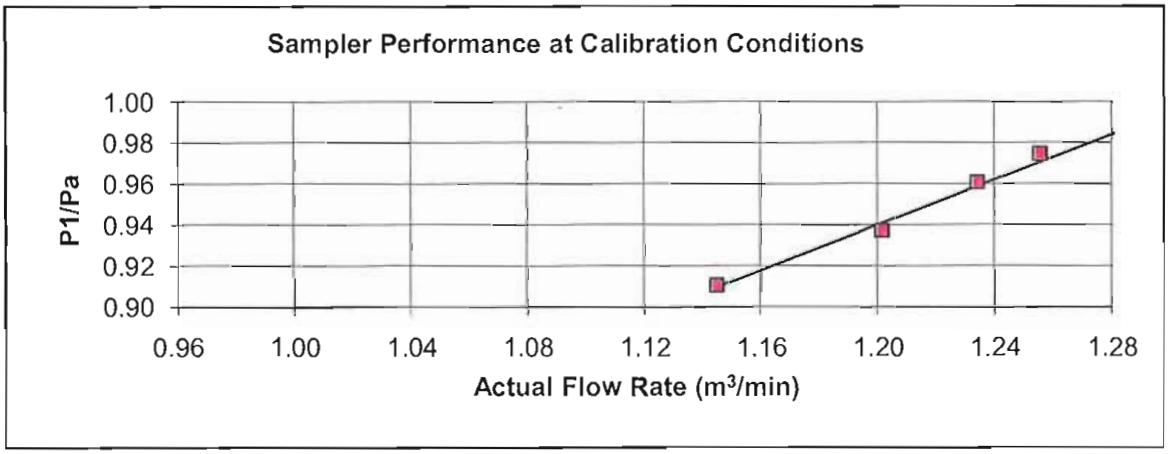
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.15	1.2870	0.0747	1.2816	-0.4%
2	3.00	1.2557	0.0729	1.2630	0.6%
3	2.90	1.2343	0.0716	1.2379	0.3%
4	2.75	1.2017	0.0697	1.1948	-0.6%
5	2.50	1.1452	0.0665	1.1462	0.1%

Sampler Calibration:

Slope	**9.4891**
Intercept	**0.2792**
r	**0.9939**
Failure Temp (℃)	**-62.2**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.2792] * [SQRT(Ta)]} * {1/9.4891}



Notes:

Appendix C

Meteorological System Calibrations

METEOROLOGICAL STATION CALIBRATION SUMMARY

Met Station: EFRC - Site #1 Calibration Date: 8-Oct-08

Calibration Performed By: M. Butler, 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	5080800158
Temperature @ 2 Meters:	RM Young Platinum RTD Temp Probe	13638	digital thermistor	IML 0885
Temperature @ 10 Meters:	RM Young Platinum RTD Temp Probe	13639	digital thermistor	IML 0885
Relative Humidity (RH):	CSI CS 500	C2430074	digital hygrometer	IML 0936
Barometric Pressure (BP):	PTB 101B	C2430048	digital barometer	IML 0887
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	0.1	0.1	5.0	(2)
		90.0	89.9	0.1	5.0	(2)
		180.0	180.3	0.3	5.0	(2)
		270.0	270.2	0.2	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)		200	100.00	97.53	2.47	25.00	(2)
	EPS:	600	300.00	281.60	18.40	35.00	(2)
		2000	1000.00	973.30	26.70	70.00	(2)
		5000	2500.00	2437.10	62.90	145.00	(2)
		0	0.00	-0.30	0.30	below threshold	
		200	100.00	101.20	1.20	25.00	(2)
	CFT:	600	300.00	301.30	1.30	35.00	(2)
		2000	1000.00	1007.31	7.31	70.00	(2)
		5000	2500.00	2498.20	1.80	145.00	(2)
Vertical WS 10 meters (cm/s)		0	0.00	-0.29	0.29	below threshold	
(Counter-Clockwise)		200	-100.00	-98.11	1.89	25.00	(2)
	EPS:	600	-300.00	-291.30	8.70	35.00	(2)
		2000	-1000.00	-976.04	23.96	70.00	(2)
		5000	-2500.00	-2440.20	59.80	145.00	(2)
		0	0.00	-0.30	0.30	below threshold	
		200	-100.00	-101.20	1.20	25.00	(2)
	CFT:	600	-300.00	-302.60	2.60	35.00	(2)
		2000	-1000.00	-1000.80	0.80	70.00	(2)
		5000	-2500.00	-2503.10	3.10	145.00	(2)

WS 10 m start torque (gm-cm)		τ<0.5	N/A	N/A	1.0	(3)

			Reference (℃):	DAS Value	|Difference|	Specification	
			0.04	0.36	0.32	0.5	(2)
Temp. (℃): 2 meter			17.64	17.70	0.06	0.5	(2)
			42.34	42.42	0.08	0.5	(2)
Temp. (℃): 10 meter			0.04	0.36	0.32	0.5	(2)
			17.64	17.67	0.03	0.5	(2)
			42.34	42.45	0.11	0.5	(2)

			Reference	DAS Value	|Difference|	Specification	
Relative Humidity (%)	Hourly Averages		34.1	36.1	2.0	2.4	(2)
RH Sensor Temp (℃):	Hourly Averages		65.3	61.7	3.7		
Solar Radiation (W/m^2)	Hourly Averages	un-covered	793.5	788	5.6	39.7	(4)
		covered	0.00	0.00			
Barometric Pressure ("Hg)			24.70	24.75	0.05	0.09	(4)

	DAS Value (in)	Reference (ml)	DAS Equivalent	|Difference|	Specification	
Precipitation (0.1" equiv.)	0.10	190.6	185.3	5.3	18.5	(2)
	0.10	189.2	185.3	3.9	18.5	(2)
	0.10	187.6	185.3	2.3	18.5	(2)
			Average Diff:	3.8	18.5	(2)

	2m sensor	10m sensor	ΔT - B	Specification	
Delta Temperature (℃):	0.36	0.36	0.00	0.1	(2)
	17.70	17.67	0.03	0.1	(2)
	42.42	42.45	0.03	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

Time Offline: 1111 MST

Time Online: 1345 MST

Precipitation Bucket: 180ml - No tips

Precipitation Bucket: Adjusted tipping mechanism and completed the calibration

METEOROLOGICAL STATION CALIBRATION SUMMARY

Met Station: EFRC - Site #2 Calibration Date: 8-Oct-08

Calibration Performed By: M. Butler, 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 0857
Wind Direction 30m (WD):	RM Young Wind Monitor AQ	82347	transit, compass	5080800156
Temperature @ 2 Meters:	RM Young Platinum RTD Temp Probe	13640	digital thermistor	IML 0885
Temperature @ 30 Meters:	RM Young Platinum RTD Temp Probe	13641	digital thermistor	IML 0885
Relative Humidity (RH):	CSI CS 500	C2730148	digital hygrometer	IML 0936
Barometric Pressure (BP):	PTB 101B	C2750056	digital barometer	IML 0887
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	0.4	0.4	5.0	(2)
		90.0	90.3	0.3	5.0	(2)
		180.0	180.1	0.1	5.0	(2)
		270.0	270.6	0.6	5.0	(2)

		Reference RPM	Reference cm/s	DAS Value	|Difference|	Specification	
Vertical WS 30 meters (cm/s)		0	0.00	-0.30	0.30	below threshold	
(Clockwise)		200	100.00	102.30	2.30	25.00	(2)
	EPS:	600	300.00	300.26	0.26	35.00	(2)
		2000	1000.00	963.10	36.90	70.00	(2)
		5000	2500.00	2391.30	108.70	145.00	(2)
		0	0.00	-0.29	0.29	below threshold	
		200	100.00	104.30	4.30	25.00	(2)
	CFT:	600	300.00	300.69	0.69	35.00	(2)
		2000	1000.00	1004.20	4.20	70.00	(2)
		5000	2500.00	2485.30	14.70	145.00	(2)
Vertical WS 30 meters (cm/s)		0	0.00	-0.30	0.30	below threshold	
(Counter-Clockwise)		200	-100.00	-97.80	2.20	25.00	(2)
	EPS:	600	-300.00	-301.10	1.10	35.00	(2)
		2000	-1000.00	-956.40	43.60	70.00	(2)
		5000	-2500.00	-2389.70	110.30	145.00	(2)
		0	0.00	-0.30	0.30	below threshold	
		200	-100.00	-101.30	1.30	25.00	(2)
	CFT:	600	-300.00	-301.20	1.20	35.00	(2)
		2000	-1000.00	-1001.40	1.40	70.00	(2)
		5000	-2500.00	-2490.30	9.70	145.00	(2)

WS 30 m start torque (gm-cm)		τ<0.5	N/A	N/A	1.0	(3)

Evaporation Pan Verification Sheet

Evap Span	**9.11661**
Evap Offset	**1.24504**

Empty Pan Logger Reading:

Verification Point	Yardstick Reading (in)*	Logger Reading	Percent Difference
1	4.9375	5.15000	4.3%

Notes:
* Yard Stick Reading - taken at the pan outlet to the gauge
Offline: 1111 MST
Online: 1345 MST

			Reference (℃):	DAS Value	|Difference|	Specification	
			0.07	0.18	0.11	0.5	(2)
Temp. (℃): 2 meter			15.38	15.37	0.01	0.5	(2)
			48.73	48.84	0.11	0.5	(2)
Temp. (℃): 30 meter			0.07	0.18	0.11	0.5	(2)
			15.38	15.38	0.00	0.5	(2)
			48.73	48.81	0.08	0.5	(2)
			Reference	DAS Value	|Difference|	Specification	
Relative Humidity (%)	Hourly Averages		69.5	68.8	0.7	4.9	(2)
RH Sensor Temp (℃):	Hourly Averages		45.3	45.1	0.2		
Solar Radiation (W/m^2)	Hourly Averages	un-covered	145.21	145.17	0.0	7.3	(4)
		covered	0.00	0.00			
Barometric Pressure ("Hg)			24.70	24.72	0.02	0.09	(4)
			2m sensor	10m sensor	ΔT - B	Specification	
Delta Temperature (℃):			0.18	0.18	0.00	0.1	(2)
			15.37	15.38	0.01	0.1	(2)
			48.84	48.81	0.03	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

Time Offline: 0930 MST
Time Online:1053 MST

Appendix D

Transfer Standard Certifications

Certificate of Accuracy

Transfer Standard Type: Electronic Thermometer Certificate No: **T 012908. 01**

Transfer standard, model/type: Cole Parmer Thermistor Thermometer 8402-00 Model 7000H TH
Serial number: JC 13255 IML 0876 Probe S/N: 07M18477
submitted by/owner: Inter-Mountain Laboratories, Inc.
Air Science Division
555 Absaraka Street
Was compared to: Sheridan, WY 82801

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: 01/29/08 Lab temperature: 72.5 °F
Barometric Pressure: 652.4 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.1	0.1	-0.1
10.0	10.1	0.1	-0.1
25.0	25.1	0.1	-0.1
41.4	41.4	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-callbration measurements:

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

Reviewed: R Sanders Date: 1/29/08

Roger L. Sanders, PE

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chinook@imlinc.com

Certificate of Accuracy

Transfer Standard Type: Electronic Thermometer Certificate No: T 012908. 03

Transfer standard, model/type: Cole Parmer Digi-Sense ThermoLogR Thermistor Thermometer
Serial number: 374476 IML 0885 Probe S/N: IML 0885
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: 01/29/08 Lab temperature: 72.5 °F
Barometric Pressure: 652.4 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.00	0.0	0.0
10.0	10.00	0.0	0.0
25.0	25.00	0.0	0.0
38.8	38.80	0.0	0.0
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)
See Offset and measurements above			

Reviewed: RWL Date: 1/29/08

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Certificate of Accuracy

Transfer Standard Type: Barometric Pressure/Altimeter

Certificate No: B 012808. 03

Transfer standard model: Pretel AltiPlus A2
Serial number: 13785 IML 0913 Kit B
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: 01/28/08 Lab temperature 73.5 °F
Lab pressure 644.1 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
25.36	25.39	0.03	-0.03
27.50	27.51	0.01	-0.01
30.00	30.00	0.00	0.00

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: R Sf Date: 1/28/08

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Certificate of Accuracy

Transfer Standard Type: Barometric Pressure/Altimeter

Certificate No: B 102808. 02

Transfer standard model: Suunto Escape 203 Electronic Altimeter/Barometer
Serial number: 61901099 IML 0887
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: 10/28/08 Lab temperature 74.1 °F
Lab pressure 668.6 mm Hg

Reference barometer ("Hg)	Transfer Standard ("Hg)	Difference from Reference ("Hg)	Transfer Standard Correction* ("Hg)
24.00	24.00	0.00	0.00
24.99	25.00	0.01	-0.01
25.97	25.95	-0.02	0.02
26.32	26.30	-0.02	0.02
27.51	27.50	-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: R Sanders Date: 10/28/08

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Certificate of Accuracy

Transfer Standard Type: Electronic Hygrometer Certificate No: H 122206 01

Transfer standard, model/type: Dwyer Series 485 Digital hygrometer
Serial number: 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: 12/22/2006

Lab temperature:	68 - 72	°F
Barometric Pressure:	661 - 665	mmHG
Lab %RH:	35 - 45%	

Reference Salt Standard	Reference Temperature °C	Reference Standard (%RH)	Transfer Standard (%RH)	Difference from Reference (%RH)	Transfer Standard Correction* (%RH)
Potassium Acetate	20.1	23.10	26.3	3.2	-3.2
Magnesium Nitrate	19.7	54.47	56.5	2.0	-2.0
Sodium Chloride	19.8	75.48	79.5	4.0	-4.0

Temperature Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
20.1	19.3	-0.8	0.8
19.7	18.9	-0.8	0.8
19.8	18.9	-0.9	0.9

Reviewed: _____ Date: _____

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Certificate of Accuracy

Transfer Standard Type: Electronic Manometer Certificate No: M 011708. 02

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: 01/17/08 Lab temperature: 69.0 °F
Lab pressure: 656.6 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	4.93	-0.07	0.07
10.00	9.94	-0.06	0.06
19.50	19.48	-0.02	0.02

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: 1/17/08

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Certificate of Calibration

Streamline™ flow transfer standard (FTS) # D000201
was calibrated against NIST traceable critical flow
venturis sn10961, sn10962, sn10963 on: 1/16/2008

This calibration expires: ***1/16/2009*** ***r9***

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= 0.4120
b= -0.6382

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: RLS Date: 1/16/2008

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
20.04	7.45	20.05	0.01	0.07%
17.51	5.75	17.53	0.02	0.10%
15.00	4.25	15.00	0.00	-0.01%
12.49	2.98	12.45	-0.04	-0.19%
9.98	1.95	9.96	-0.03	-0.13%
7.48	1.14	7.47	-0.01	-0.05%
4.98	0.56	5.03	0.04	0.21%

T_a (℃)= 22.8
Pa (atm)= 0.874 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 - **8A**
IML Air Science Sheridan, WY

8A orifice transfer standard was calibrated on the NIST traceable Dresser rootsmeter serial # 9217756 on 7-Apr-08
Calibration expires 7-Apr-09

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

$$Q_r = A(\Delta P_o)^B \qquad r = 0.9999$$

where: A= **0.654**
B= **0.503**
ΔPo = pressure drop across orifice, in inches of water

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

$$Q_a = \frac{\left[\left(\sqrt{(\Delta P_o)\left(\frac{T_a}{P_a}\right)}\right) - b\right]}{m} \qquad r = 0.9998$$

where: m= **0.944**
b= **0.012**
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:

$$Q_{std} = \frac{\left[\left(\sqrt{\Delta P_o\left(\frac{P_a}{T_a}\right)\left(\frac{298}{760}\right)}\right) - b\right]}{m} \qquad r = 0.9998$$

where: m= **1.508**
b= **0.017**
ΔPo = pressure drop across orifice, inches of water
Ta = ambient temperature, Kelvin
Pa = ambient pressure, mm Hg

SH
Reviewed

4/7/2008
Date

IML Air Science
a division of Inter-Mountain Laboratories, Inc.
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ORIFICE TRANSFER STANDARD CALIBRATION QUALITY ASSURANCE

Orifice Transfer Standard# **8A**

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
0.888	0.885	-0.39%
1.041	1.039	-0.14%
1.145	1.142	-0.26%
1.234	1.236	0.19%
1.420	1.432	0.85%
1.619	1.620	0.06%
1.817	1.810	-0.42%

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:	7-Apr-08
ORIFICE #:	8A
TECH:	Cory Medill
TEMP (℃):	21.90
PRES("Hg):	25.89
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	3.8000	4.6704	1.6000
2	3.3985	3.2333	6.3518	2.2000
3	3.3985	2.9333	7.6595	2.6500
4	3.3985	2.7167	8.9672	3.1000
5	3.3985	2.3500	11.7695	4.1500
6	3.3985	2.0500	15.2256	5.3000
7	3.3985	1.8167	18.7751	6.6000

	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	3.374	0.888	0.847	1	2.949	0.776	1.182
2	3.366	1.041	0.994	2	2.941	0.910	1.387
3	3.359	1.145	1.090	3	2.935	1.001	1.522
4	3.352	1.234	1.179	4	2.929	1.078	1.646
5	3.338	1.420	1.365	5	2.917	1.241	1.904
6	3.320	1.619	1.542	6	2.901	1.415	2.152
7	3.301	1.817	1.721	7	2.885	1.588	2.402

IML Air Science
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555 Absaraka, Sheridan, WY 82801

CERTIFICATE OF CALIBRATION

Orifice Transfer Standard - **8041589**
IML Air Science Sheridan, WY

8041589 orifice transfer standard was calibrated on the NIST traceable Dresser rootsmeter serial # 9217756 on 7-Apr-08
Calibration expires 7-Apr-09

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

$$Q_r = A(\Delta P_o)^B \qquad r = 0.9999$$

where: A= **0.499**
B= **0.495**
ΔPo = pressure drop across orifice, in inches of water

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

$$Q_a = \frac{\left[\left(\sqrt{(\Delta P_o)\left(\frac{T_a}{P_a}\right)}\right) - b\right]}{m} \qquad r = 0.9999$$

where: m= **1.277**
b= **-0.014**
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:

$$Q_{std} = \frac{\left[\left(\sqrt{\Delta P_o\left(\frac{P_a}{T_a}\right)\left(\frac{298}{760}\right)}\right) - b\right]}{m} \qquad r = 0.9999$$

where: m= **2.040**
b= **-0.019**
ΔPo = pressure drop across orifice, inches of water
Ta = ambient temperature, Kelvin
Pa = ambient pressure, mm Hg

SH
Reviewed

4/7/2008
Date

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ORIFICE TRANSFER STANDARD CALIBRATION QUALITY ASSURANCE

Orifice Transfer Standard# **8041589**

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
0.912	0.910	-0.23%
1.041	1.045	0.34%
1.133	1.134	0.06%
1.220	1.216	-0.33%
1.297	1.299	0.16%
1.365	1.366	0.06%
1.431	1.430	-0.07%

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:	7-Apr-08
ORIFICE #:	8041589
TECH:	Cory Medill
TEMP (℃):	22.00
PRES("Hg):	25.98
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	3.7000	4.5770	2.9500
2	3.3985	3.2333	6.1650	3.9000
3	3.3985	2.9667	7.1925	4.6000
4	3.3985	2.7500	8.3134	5.3000
5	3.3985	2.5833	9.5277	6.0500
6	3.3985	2.4500	10.3683	6.7000
7	3.3985	2.3333	11.3958	7.3500

	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	3.375	0.912	1.149	1	2.959	0.800	1.608
2	3.367	1.041	1.321	2	2.951	0.913	1.849
3	3.361	1.133	1.434	3	2.947	0.993	2.008
4	3.356	1.220	1.540	4	2.942	1.070	2.156
5	3.349	1.297	1.645	5	2.936	1.137	2.303
6	3.345	1.365	1.731	6	2.933	1.197	2.424
7	3.340	1.431	1.813	7	2.928	1.255	2.538

Energy Fuels Resources Corporation
Piñon Ridge Mill

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

1st Quarter 2009

Prepared by:

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1 Introduction

Inter-Mountain Laboratories – Air Science Division performed calibrations and quality assurance audits on January 14, 2009. 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, September 1989
- 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 N IST or American Society for Testing and Materials (ASTM) thermometer within ±2 ℃ at le ast 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 1995. 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 ℃
Delta Temperature	±0.1 ℃
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 ℃
Filter Temperature	±2.0 ℃
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 2009. 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
a division of Inter-Mountain Laboratories, Inc.
555 Absaraka, Sheridan, WY 82801

Partisol FRM Single Point Audit

Network:	Energy Fuels
Date:	1/14/2009
Time:	0827 MST
Audited by:	M. Butler
SLP Control Unit:	CU05096
SLP Measurement Unit:	M050906
Streamline FTS ID:	N/A
Streamline FTS cal Expires:	N/A
Streamline FTS "m":	N/A
Streamline FTS "b":	N/A
Temp Standard ID:	N/A
Press Standard ID:	N/A
Manometer ID:	N/A

Sampler ID: 1-2

As-Found Calibration Values

Parameter	Offset	Span
A/I	-0.0003	0.9993
Amb. Temp.	0.0072	
Filter Temp.	0.0066	
Pressure	-0.0363	
Flow	-0.0058	0.9656

Notes as found:

Sensors Audit

Sensor	Indicated	ΔP	Actual	Difference	Specification
Amb. Temp.	-7.2		-7.0	0.2	±2℃
Filter Temp.	-4.4		-5.0	0.6	±2℃
Pressure	629		625.7	3.3	± 10 mmHg
Flow	16.60		16.73	0.13	16.7 lpm ± 4% (± 0.67 lpm)

Leak Checks

Start	Start	End	Pass/Fail	Notes:
External (<8.5"H_g/30 sec.)	15.0	12.0	Pass	
Internal (<8.5"Hg/30 sec.)	19.0	14.0	Pass	

Notes:

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

Partisol FRM Single Point Audit

Network:	Energy Fuels
Date:	1/14/2009
Time:	0948 MST
Audited by:	M. Butler
SLP Control Unit:	CU05096
SLP Measurement Unit:	M050906
Streamline FTS ID:	N/A
Streamline FTS cal Expires:	N/A
Streamline FTS "m":	N/A
Streamline FTS "b":	N/A
Temp Standard ID:	N/A
Press Standard ID:	N/A
Manometer ID:	N/A

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	-0.0115	0.9898

Notes as found:

Sensors Audit

Sensor	Indicated	ΔP	Actual	Difference	Specification
Amb. Temp.	-4.2		-3.5	0.7	±2℃
Filter Temp.	-0.6		-1.4	0.8	±2℃
Pressure	628		624.3	3.7	± 10 mmHg
Flow	16.60		16.67	0.07	16.7 lpm ± 4% (± 0.67 lpm)

Leak Checks

	Start	End	Pass/Fail	Notes:
External (<8.5"H_g/30 sec.)	17.0	16.0	Pass	
Internal (<8.5"Hg/30 sec.)	20.0	17.0	Pass	

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:
Audited By: T. Mendenhall
Sampler Audit Date: 1/14/2009
Sampler Calibration Date: 1/1/2009
Orifice ID: 8A
Orifice Calibration Date: 4/7/2008
Ambient Temperature (℃): -6.6
Ambient Pressure ("Hg): 24.85
Ambient Temperature (℃): 266.6
Ambient Pressure (mmHg): 631

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 0.944 and b = 0.012

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 10.2820 and b = 0.2183

Accuracy Flow Audit

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
3.10	⇒	1.1993	19.0	⇒	1.1520

Sampler Qa percent difference from Orifice Qa: -3.9%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		Qa (m^3/min)
14.3	⇒	1.1740

Corrected Sampler Qa: 1.2198 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: 1.6%

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:
Audited By: T. Mendenhall
Sampler Audit Date: 1/14/2009
Sampler Calibration Date: 1/1/2009
Orifice ID: 8A
Orifice Calibration Date: 4/7/2008
Ambient Temperature (℃): 9.5
Ambient Pressure ("Hg): 24.65
Ambient Temperature (℃): 282.7
Ambient Pressure (mmHg): 626

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 0.944 and b = 0.012

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 10.7162 and b = 0.2003

Accuracy Flow Audit

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
2.92	⇒	1.2035	18.5	⇒	1.1680

Sampler Qa percent difference from Orifice Qa: -2.9%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		Qa (m^3/min)
14.0	⇒	1.1891

Corrected Sampler Qa: 1.2236 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: 2.0%

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:
Audited By: T. Mendenhall
Sampler Audit Date: 1/14/2009
Sampler Calibration Date: 1/1/2009
Orifice ID: 8A
Orifice Calibration Date: 4/7/2008
Ambient Temperature (℃): -6.4
Ambient Pressure ("Hg): 24.75
Ambient Temperature (℃): 266.8
Ambient Pressure (mmHg): 629

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 0.944 and b = 0.012

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 11.7163 and b = 0.1123

Accuracy Flow Audit

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
2.85	⇒	1.1522	18.9	⇒	1.1592

Sampler Qa percent difference from Orifice Qa: 0.6%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		Qa (m^3/min)
14.3	⇒	1.1782

Corrected Sampler Qa: 1.1711 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: -2.4%

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: **Audited By:** T. Mendenhall
Sampler Audit Date: 1/14/2009 **Sampler Calibration Date:** 1/1/2009
Orifice ID: 8A **Orifice Calibration Date:** 4/7/2008
Ambient Temperature (℃): -10.7 **Ambient Pressure ("Hg):** 25.05
Ambient Temperature (℃): 262.5 **Ambient Pressure (mmHg):** 636

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 0.944 and b = 0.012

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 12.6720 and b = 0.0540

Accuracy Flow Audit

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
3.15	⇒	1.1948	18.7	⇒	1.1392

Sampler Qa percent difference from Orifice Qa: -4.7%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		Qa (m^3/min)
13.9	⇒	1.1572

Corrected Sampler Qa: 1.2116 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: 1.0%

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:
Audited By: T. Mendenhall
Sampler Audit Date: 1/14/2009
Sampler Calibration Date: 1/1/2009
Orifice ID: 8A
Orifice Calibration Date: 4/7/2008
Ambient Temperature (℃): -6.3
Ambient Pressure ("Hg): 24.60
Ambient Temperature (℃): 266.9
Ambient Pressure (mmHg): 625

Orifice Calibration: Qa = {SQRT [ΔP * (Ta / Pa)] - b} * {1/m}
where m = 0.944 and b = 0.012

Sampler Calibration: Qa = {[P1/Pa - b]*[SQRT(Ta)]}*{1/m}
where m = 11.8682 and b = 0.1005

Accuracy Flow Audit

Orifice			Sampler		
ΔP ("H_2O)		Qa (m^3/min)	ΔP ("H_2O)		Qa (m^3/min)
3.06	⇒	1.1983	19.0	⇒	1.1599

Sampler Qa percent difference from Orifice Qa: -3.2%

Design Flow Audit

Sampler with Orifice Removed

ΔP ("H_2O)		Qa (m^3/min)
14.4	⇒	1.1788

Corrected Sampler Qa: 1.2165 m^3/min
Design Qa: 1.2000 m^3/min

Corrected sampler Qa percent difference from design Qa: 1.4%

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: EFRC - Site #1 Calibration Date: 14-Jan-09

Calibration Performed By: M. Butler, T. Mendenhall - 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 0942
Temperature @ 2 Meters:	RM Young Platinum RTD Temp Probe	13638	digital thermistor	IML 0885
Temperature @ 10 Meters:	RM Young Platinum RTD Temp Probe	13639	digital thermistor	IML 0885
Relative Humidity (RH):	CSI CS 500	C2430074	digital hygrometer	IML 0892
Barometric Pressure (BP):	PTB 101B	C2430048	digital barometer	IML 0887
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	0.1	0.1	5.0	(2)
		90.0	90.1	0.1	5.0	(2)
		180.0	180.2	0.2	5.0	(2)
		270.0	270.2	0.2	5.0	(2)

		Reference RPM	Reference cm/s	DAS Value	|Difference|	Specification	
Vertical WS 10 meters (cm/s)		0	0.00	-0.02	0.02	below threshold	
(Clockwise)		200	100.00	99.10	0.90	25.00	(2)
	EPS:	600	300.00	296.30	3.70	35.00	(2)
		2000	1000.00	980.90	19.10	70.00	(2)
		5000	2500.00	2445.20	54.80	145.00	(2)
		0	0.00	-0.29	0.29	below threshold	
		200	100.00	100.30	0.30	25.00	(2)
	CFT:	600	300.00	294.60	5.40	35.00	(2)
		2000	1000.00	995.80	4.20	70.00	(2)
		5000	2500.00	2492.30	7.70	145.00	(2)
Vertical WS 10 meters (cm/s)		0	0.00	-0.02	0.02	below threshold	
(Counter-Clockwise)		200	-100.00	-101.20	1.20	25.00	(2)
	EPS:	600	-300.00	-295.62	4.38	35.00	(2)
		2000	-1000.00	-985.30	14.70	70.00	(2)
		5000	-2500.00	-2441.30	58.70	145.00	(2)
		0	0.00	-0.29	0.29	below threshold	
		200	-100.00	-101.30	1.30	25.00	(2)
	CFT:	600	-300.00	-306.20	6.20	35.00	(2)
		2000	-1000.00	-999.10	0.90	70.00	(2)
		5000	-2500.00	-2496.20	3.80	145.00	(2)
WS 10 m start torque (gm-cm)			τ<0.5	N/A	N/A	1.0	(3)

			Reference (℃):	DAS Value	|Difference|	Specification	
			0.04	-0.08	0.12	0.5	(2)
Temp. (℃): 2 meter			1.42	1.16	0.26	0.5	(2)
			46.88	47.10	0.22	0.5	(2)
Temp. (℃): 10 meter			0.04	-0.03	0.07	0.5	(2)
			1.42	1.14	0.28	0.5	(2)
			46.88	47.15	0.27	0.5	(2)
			Reference	DAS Value	|Difference|	Specification	
Relative Humidity (%)	Hourly Averages		79.0	82.5	3.5	5.5	(2)
RH Sensor Temp (℃):	Hourly Averages		23.8	22.1	1.7		
Solar Radiation (W/m^2)	Hourly Averages	un-covered	966.3	961	5.8	48.3	(4)
		covered	0.00	0.00			
Barometric Pressure ("Hg)			24.85	24.87	0.02	0.09	(4)
		DAS Value (in)	Reference (ml)	DAS Equivalent	|Difference|	Specification	
Precipitation (0.1" equiv.)		0.10	189.4	185.3	4.1	18.5	(2)
		0.10	188.0	185.3	2.7	18.5	(2)
		0.10	188.8	185.3	3.5	18.5	(2)
				Average Diff:	3.4	18.5	(2)
			2m sensor	10m sensor	ΔT - B	Specification	
Delta Temperature (℃):			-0.08	-0.03	0.05	0.1	(2)
			1.16	1.14	0.02	0.1	(2)
			47.10	47.15	0.05	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

Time Offline: 0843 MST

Time Online: 0926 MST

Heater cord in the way - 3 extra tips

METEOROLOGICAL STATION CALIBRATION SUMMARY

Met Station: EFRC - Site #2 Calibration Date: 14-Jan-09

Calibration Performed By: M. Butler, T. Mendenhall - 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 0942
Temperature @ 2 Meters:	RM Young Platinum RTD Temp Probe	13640	digital thermistor	IML 0885
Temperature @ 30 Meters:	RM Young Platinum RTD Temp Probe	13641	digital thermistor	IML 0885
Relative Humidity (RH):	CSI CS 500	C2730148	digital hygrometer	IML 0892
Barometric Pressure (BP):	PTB 101B	C2750056	digital barometer	IML 0887
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)	$\tau<0.5$	N/A	N/A	1.0	(3)
WD 30 meters (degrees)	0.0	0.5	0.5	5.0	(2)
	90.0	90.0	0.0	5.0	(2)
	180.0	180.2	0.2	5.0	(2)
	270.0	270.9	0.9	5.0	(2)

		Reference RPM	Reference cm/s	DAS Value	|Difference|	Specification	
Vertical WS 30 meters (cm/s)		0	0.00	0.13	0.13	below threshold	
(Clockwise)		200	100.00	106.30	6.30	25.00	(2)
	EPS:	600	300.00	290.30	9.70	35.00	(2)
		2000	1000.00	961.20	38.80	70.00	(2)
		5000	2500.00	2454.10	45.90	145.00	(2)
		0	0.00	0.29	0.29	below threshold	
		200	100.00	98.30	1.70	25.00	(2)
	CFT:	600	300.00	301.20	1.20	35.00	(2)
		2000	1000.00	990.20	9.80	70.00	(2)
		5000	2500.00	2484.30	15.70	145.00	(2)
Vertical WS 30 meters (cm/s)		0	0.00	-0.29	0.29	below threshold	
(Counter-Clockwise)		200	-100.00	-97.80	2.20	25.00	(2)
	EPS:	600	-300.00	-288.30	11.70	35.00	(2)
		2000	-1000.00	-951.03	48.97	70.00	(2)
		5000	-2500.00	-2443.20	56.80	145.00	(2)
		0	0.00	-0.29	0.29	below threshold	
		200	-100.00	-96.60	3.40	25.00	(2)
	CFT:	600	-300.00	-292.30	7.70	35.00	(2)
		2000	-1000.00	-998.10	1.90	70.00	(2)
		5000	-2500.00	-2488.90	11.10	145.00	(2)
WS 30 m start torque (gm-cm)			$\tau<0.5$	N/A	N/A	1.0	(3)

			Reference (℃):	DAS Value	|Difference|	Specification	
			-0.01	-0.07	0.06	0.5	(2)
Temp. (℃): 2 meter			1.55	1.29	0.26	0.5	(2)
			37.94	37.95	0.01	0.5	(2)
Temp. (℃): 30 meter			-0.01	-0.05	0.04	0.5	(2)
			1.55	1.29	0.26	0.5	(2)
			37.94	37.93	0.01	0.5	(2)
			Reference	DAS Value	|Difference|	Specification	
Relative Humidity (%)	Hourly Averages		63.8	66.2	2.4	4.5	(2)
RH Sensor Temp (℃):	Hourly Averages		30.5	29.5	1.0		
Solar Radiation (W/m^2)	Hourly Averages	un-covered	492.28	490.72	1.6	24.6	(4)
		covered	0.00	0.00			
Barometric Pressure ("Hg)			24.80	24.78	0.02	0.09	(4)

	2m sensor	10m sensor	ΔT - B	Specification	
Delta Temperature (℃):	-0.07	-0.05	0.02	0.1	(2)
	1.29	1.29	0.00	0.1	(2)
	37.95	37.93	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

Time Offline: 1001 MST

Time Online:1134 MST

Evaporation Pan Verification Sheet

Evap Span **9.11661**
Evap Offset **1.24504**

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 012908. 03**

Transfer standard, model/type: Cole Parmer Digi-Sense ThermoLogR Thermistor Thermometer
Serial number: 374476 IML 0885 Probe S/N: IML 0885
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: 01/29/08 Lab temperature: 72.5 °F
Barometric Pressure: 652.4 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.00	0.0	0.0
10.0	10.00	0.0	0.0
25.0	25.00	0.0	0.0
38.8	38.80	0.0	0.0
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)
See Offset and measurements above			

Reviewed: RLS Date: 1/29/08

Roger L. Sanders, PE

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a division of Inter-Mountain Laboratories, Inc.
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Sheridan, Wyoming 82801 USA
(307) 672-7790
chinook@imlinc.com

Certificate of Accuracy

Transfer Standard Type: Barometric Pressure/Altimeter

Certificate No: B 102808. 02

Transfer standard model: Suunto Escape 203 Electronic Altimeter/Barometer
Serial number: 61901099 IML 0887
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: 10/28/08 Lab temperature 74.1 °F
Lab pressure 668.6 mm Hg

Reference barometer ("Hg)	Transfer Standard ("Hg)	Difference from Reference ("Hg)	Transfer Standard Correction* ("Hg)
24.00	24.00	0.00	0.00
24.99	25.00	0.01	-0.01
25.97	25.95	-0.02	0.02
26.32	26.30	-0.02	0.02
27.51	27.50	-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: R [signature] Date: 10/28/08

Roger L. Sanders, PE

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Certificate of Accuracy

Transfer Standard Type: Electronic Hygrometer Certificate No: H 120408. 01

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: 12/03/2008 - 12/04/2008

Lab temperature: 68 - 72 °F
Barometric Pressure: 666.5 - 671.5 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	19.0	11.99	±0.85	12.6	0.6	-0.6
Potassium Acetate						
Magnesium Chloride	18.8	33.13	±0.22	33.4	0.3	-0.3
Magnesium Nitrate	20.0	54.38	±0.23	54.7	0.3	-0.3
Sodium Chloride	19.1	75.50	±0.20	77.7	2.2	-2.2

Temperature Reference Standard (°C)		Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
19.0		19.0	0.0	0.0
18.8		18.5	-0.3	0.3
20.0		19.5	-0.5	0.5
19.1		18.9	-0.2	0.2

Reviewed: _____ Date: 12/4/08

Roger L. Sanders, PE

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chinook@imlinc.com

Chinook Engineering *innovative measurements*
a division of Inter-Mountain Laboratories, Inc. 555 Absaraka Street, Sheridan, WY 82801 USA

Certificate of Calibration

This Streamline Pro™ MultiCal™ System, serial number: **M050906**
was calibrated against the following NIST-traceable Reference Standards:

Flow: Critical Flow Venturis: sn10961, sn10962, sn10963 on date: 5/15/2008
Barometric Pressure: Precision Barometer: sn913930-M1 on date: 5/15/2008
Temperature: NIST Traceable Hg-in-glass thermometers, sn 2J3106, 2Y6027, 3L9452. on date: 5/7/2008

Quality Assurance:

Flow:

Reference Std. Q_{ref} (l/min)	Streamline Pro Q_{SLPro} (l/min)	Absolute difference (l/min)	% Diff. F.S.
2.00	1.99	-0.01	-0.03%
3.67	3.68	0.01	0.05%
6.67	6.66	-0.01	-0.04%
10.00	10.00	0.00	0.01%
13.66	13.66	0.00	-0.01%
16.67	16.67	0.00	0.01%
20.01	20.01	0.00	0.00%

BP:

Reference Std. BP_{ref} (atm)	Streamline Pro BP_{SLPro} (atm)	Absolute difference (atm)	% Diff. F.S.
0.750	0.750	0.000	0.01%
0.900	0.900	0.000	0.01%
1.050	1.050	0.000	0.00%

Temp.:

Reference Std. T_{ref} (°C)	Streamline Pro T_{SLPro} (°C)	Absolute difference (°C)	% Diff. F.S.*
0.0	0.0	0.0	0.00%
19.6	19.6	0.0	0.00%
41.2	41.2	0.0	0.00%

* based on absolute temp. scale (K)

Lab temp: 23.3 °C Lab pressure: 0.877 atm

Reviewed: Date: 5/15/08

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

CERTIFICATE OF CALIBRATION

Orifice Transfer Standard - **8A**
IML Air Science Sheridan, WY

8A orifice transfer standard was calibrated on the NIST traceable Dresser rootsmeter serial # 9217756 on 7-Apr-08
Calibration expires 7-Apr-09

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

$$Q_r = A(\Delta P_o)^B$$ r = 0.9999

where: A= **0.654**
B= **0.503**
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= **0.944**
b= **0.012**
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= **1.508**
b= **0.017**
ΔPo = pressure drop across orifice, inches of water
Ta = ambient temperature, Kelvin
Pa = ambient pressure, mm Hg

SH
Reviewed

4/7/2008
Date

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

ORIFICE TRANSFER STANDARD CALIBRATION
QUALITY ASSURANCE

Orifice Transfer Standard# **8A**

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
0.888	0.885	-0.39%
1.041	1.039	-0.14%
1.145	1.142	-0.26%
1.234	1.236	0.19%
1.420	1.432	0.85%
1.619	1.620	0.06%
1.817	1.810	-0.42%

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:	7-Apr-08
ORIFICE #:	8A
TECH:	Cory Medill
TEMP (℃):	21.90
PRES("Hg):	25.89
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	3.8000	4.6704	1.6000
2	3.3985	3.2333	6.3518	2.2000
3	3.3985	2.9333	7.6595	2.6500
4	3.3985	2.7167	8.9672	3.1000
5	3.3985	2.3500	11.7695	4.1500
6	3.3985	2.0500	15.2256	5.3000
7	3.3985	1.8167	18.7751	6.6000

	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	3.374	0.888	0.847	1	2.949	0.776	1.182
2	3.366	1.041	0.994	2	2.941	0.910	1.387
3	3.359	1.145	1.090	3	2.935	1.001	1.522
4	3.352	1.234	1.179	4	2.929	1.078	1.646
5	3.338	1.420	1.365	5	2.917	1.241	1.904
6	3.320	1.619	1.542	6	2.901	1.415	2.152
7	3.301	1.817	1.721	7	2.885	1.588	2.402

CERTIFICATE OF CALIBRATION

Test Unit

Model:	18802
Motor SN:	IML 0855
Control Unit SN:	CA03156
Range:	200-15000 RPM

Motor RPM	Indicated RPM					
	Clockwise Output Range			Counter Clockwise Output Range		
	Low	High	Average	Low	High	Average
600	599.7	600.2	600.0	600.0	600.1	600.0
1200	1199.9	1200.1	1199.9	1199.7	1200.1	1199.9
2400	2399.8	2400.3	2399.9	2399.8	2399.8	2399.8
4200	4199.7	4199.8	4199.7	4199.7	4199.8	4199.7
6000	5999.7	6000.6	5999.7	5999.7	6000.6	6000.0
8100	8099.6	8099.6	8099.6	8099.6	8099.7	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:	1/5/2009

THE BRUNTON COMPANY
Certificate Of Calibration

Equipment Owner:
Name: Inter-Mountain Labs (IML 0942)

Address: 555 Absaraka

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 27 Day of February 20 09

DESCRIPTION: Pocket transit

PURCHASE ORDER: 18612

ORDER NUMBER: 2047421

LOT NUMBER: 1751276

MODEL NUMBER: 5008

SERIAL NUMBER: 5080393535

CALIBRATION DATE: 2-27-09

RECALIBRATION DUE DATE: 2-27-10

Signed: Erin Donnelly
QUALITY CONTROL MANAGER

AMBIENT AIR SYSTEMS CALIBRATION REPORT - FIRST QUARTER 2009
ENERGY FUELS RESOURCES CORPORATION
URANIUM MILL LICENSING SUPPORT
PIÑON RIDGE MILL
MONTROSE COUNTY, COLORADO

March 12, 2009
Rev. 0

Prepared By:

Energy Fuels Resources Corporation
44 Union Boulevard, Suite 600
Lakewood, Colorado 80228

Table of Contents

Tables

Appendices

1.0 Introduction

Energy Fuels Resources Corporation (Energy Fuels) personnel performed calibrations on January 6, 2009. The calibrations were performed at all five of the ambient air monitoring sites at the Piñon Ridge Mill Site located approximately 15 miles from Naturita, Colorado. The five ambient air monitoring sires include two PM_{10}(particulate matter less than 10 µm) and five TSP(total suspended particulate) samplers. Audits of the air monitoring systems and calibrations of the two meteorological monitoring systems located on-site were performed by Inter-Mountain Laboratories (IML) on January 14, 2008. Results of the January 14 calibrations and audits are reported by IML under a separate cover. The Piñon Ridge Mill Site is operated by Energy Fuels. Following is a list of the air monitoring sites and associated equipment:

Site 1 – North Site (10m Tower)
- PM_{10} Sampler – Thermo FRM 2000 PM_{10}
- TSP Sampler – Tisch Hi-Vol 5170

Site 2 – East Site (30m Tower)
- PM_{10} Sampler – Thermo FRM 2000 PM_{10}
- TSP Sampler – Tisch Hi-Vol 5170

Site 3 – West Site
- TSP Sampler – Tisch Hi-Vol 5170

Site 4 – Cooper Site (Upwind Resident)
- TSP Sampler – Tisch Hi-Vol 5170

Site 5 – Carver Site (Downwind Resident)
- TSP Sampler – Tisch Hi-Vol 5170

2.0 Calibration Methodology and Accuracy Goals

2.1 Calibration References and Equipment

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

- Ambient Monitoring Guidelines for the Prevention of Significant Deterioration (PSD), EPA-450/4-87-007, May 1987
- 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
- Quality Assurance Handbook for Air Pollution Measurements Systems, Vol. II – Ambient Air Quality Monitoring Program, EPA-454/B-08-003, December 2008
- 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

All calibration equipment is referenced to an NIST-traceable standard at least annually. NIST-traceable certifications for the calibration equipment can be found in Appendix A. The following equipment was required for the calibrations:

- Streamline Pro MultiCal System, Model S with external temperature probe, capable of accurately measuring flow rate over a range of 2.0 to 20 liters per minute(lpm) to the nearest 0.01 lpm, measuring temperature over the range of -30 °C to 50 °C to the nearest 0.1 °C, and measuring barometric pressure over the range 0.25 to 1.1 atm to the nearest 0.002 atm.
- Variable resistance transfer standard (calibration orifice) with faceplate.
- Two Digital manometers (ranges of 0-20 in. water and 0-40 in. water).

2.2 PM_{10} Samplers

The PM_{10} Sampler calibrations included a verification of the flow, barometric pressure, ambient temperature, and filter temperature. In addition, external and internal leak checks were conducted on the instrument. The calibration methods are briefly described as follows:

Flow - The flow calibration was completed by removing the inlet of the sampler and installing the Streamline Pro calibration system. The difference between the calculated flow of the Streamline Pro and the sampler flow were compared to the acceptance criteria.

Ambient Temperature - The ambient temperature calibration was completed by collocating the Streamline Pro external thermometer with the ambient temperature sensor on the sampler. The difference between the temperature recorded by the Streamline Pro and the sampler ambient temperature was compared to the acceptance criteria.

Filter Temperature - The filter temperature calibration was completed by collocating the Streamline Pro external thermometer with the filter temperature sensor on the sampler. The difference between the temperature recorded by the Streamline Pro and the sampler filter temperature was compared to the acceptance criteria.

Barometric Pressure - The barometric pressure calibration was completed by comparing the Streamline Pro barometric pressure reading with that of the sampler. The difference between the pressure recorded by the Streamline Pro and the sampler pressure was compared to the acceptance criteria.

External Leak Check - The external leak check was conducted by the samplers automated external leak check function. The sampler reports the results of the leak check with a “pass” or “fail” and a calculated leakage rate.

Internal Leak Check - The internal leak check was conducted by creating a vacuum within the internal components of the system using a solid disk in place of the filter. The loss of vacuum was measured over a 30 second period and compared to the acceptance criteria.

2.3 TSP Samplers

Calibrations of the TSP 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 measured in 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 a multiple point (multi-point) calibration was completed on the sampler. The multi-point calibration used five points to calculate the flow rates and the resulting slope and intercept for the sampler. The flow rates, calculated differences between the sampler output and flow indicator at each flow rate, and the correlation coefficient were compared to the acceptance criteria.

2.4 Calibration Thresholds

Accuracy goals of the air monitoring stations are shown in Tables 1 and 2 below:

Table 1
PM_{10} Sampler Criteria

Sensor	Specifications
Ambient Temperature	±2.0 °C
Filter Temperature	±2.0 °C
Pressure	± 10 mm Hg
Flow Rate	±2.0 percent of observed (±0.33 lpm)
External Leak Check	<5.0 in. Hg / 60 seconds
Internal Leak Check	<8.5 in. Hg / 30 seconds

Table 2
TSP Sampler Criteria

Sensor	Specifications
Flow Rate	between 1.1 to 1.7 m^3/min (min. of three points)
Difference Percentage	±2.0 percent
Correlation Coefficient	>0.990

3.0 Calibration Results

Calibration results for the PM_{10} Samplers and the TSP Samplers can be found in Appendices B and C, respectively.

4.0 Findings/Recommendations

The calibrations of the two PM10 samplers and five TSP samplers were all within the calibration specifications during the 1st Quarter of 2009.

Appendix A

Calibration Equipment Certifications

Chinook Engineering *innovative measurements*
a division of Inter-Mountain Laboratories, Inc. 555 Absaraka Street, Sheridan, WY 82801 USA

Certificate of Calibration

This Streamline Pro™ MultiCal™ System, serial number: **S070906**
was calibrated against the following NIST-traceable Reference Standards:
Flow: Critical Flow Venturi S/Ns 10961, 10962, 10963, 18491, 30421 on date: 12/03/08
Barometric Pressure: Precision Barometer S/N 913930-M1 on date: 12/02/08
Temperature: NIST Traceable Hg-in-glass thermometers, on date: 12/02/08
S/Ns 2J3106, 2 sn 2J3106, 2Y6027, 3L9452.

Quality Assurance:

Flow:

Reference Std. Q_{ref} (l/min)	Streamline Pro Q_{SLPro} (l/min)	Absolute difference (l/min)	% Diff. F.S.
1.99	1.99	0.00	0.00%
5.00	5.00	0.00	0.00%
6.67	6.67	0.00	-0.01%
10.00	10.00	0.00	0.00%
13.68	13.69	0.01	0.03%
16.67	16.67	-0.01	-0.03%
20.01	20.01	0.00	0.01%

BP:

Reference Std. BP_{ref} (atm)	Streamline Pro BP_{SLPro} (atm)	Absolute difference (atm)	% Diff. F.S.
0.750	0.750	0.000	0.00%
0.900	0.900	0.000	-0.02%
1.050	1.050	0.000	0.00%

Temp.:

Reference Std. T_{ref} (°C)	Streamline Pro T_{SLPro} (°C)	Absolute difference (°C)	% Diff. F.S.*
0.0	0.0	0.0	0.00%
18.3	18.3	0.0	0.00%
36.4	36.4	0.0	0.01%

* based on absolute temp. scale (K)

Lab temp: 20.5 °C Lab pressure: 0.878 atm

Reviewed: Date: 12/3/08

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Chinook Engineering
a division of Inter-Mountain Laboratories, Inc.

innovative measurements
555 Absaraka St., Sheridan, WY 82801 USA

Certificate of Accuracy

Transfer Standard Type: Streamline Pro™ External Temperature Probe

This Streamline Pro MultiCal™ System External Temperature Probe,

Model No. SLPRT203, SERIAL NUMBER: T070906

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: **December 2, 2008**

Lab temperature: 21.5 °C
Barometric Pressure: 660.1 mmHg

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.0	0.0	0.0
18.5	18.5	0.0	0.0
40.2	40.2	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.

Reviewed: [signature] Date: 12/2/08

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555 Absaraka, Sheridan, WY 82801

CERTIFICATE OF CALIBRATION

Orifice Transfer Standard - **1258**

Kleinfelder Albuquerque, NM

1258 orifice transfer standard was calibrated on the NIST traceable Dresser rootsmeter serial # 9217756 on 10-Dec-08

Calibration expires 10-Dec-09

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

$$Q_r = A(\Delta P_o)^B$$ r = 0.9999

where: A= **0.640**
B= **0.499**
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 = 0.9999

where: m= **0.982**
b= **-0.003**
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 = 0.9999

where: m= **1.568**
b= **-0.004**
ΔPo = pressure drop across orifice, inches of water
Ta = ambient temperature, Kelvin
Pa = ambient pressure, mm Hg

KK
Reviewed

12-10-08
Date

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

ORIFICE TRANSFER STANDARD CALIBRATION QUALITY ASSURANCE

Orifice Transfer Standard# **1258**

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
0.976	0.977	0.10%
1.036	1.035	-0.03%
1.138	1.142	0.31%
1.226	1.221	-0.47%
1.391	1.390	-0.12%
1.558	1.563	0.31%
1.831	1.830	-0.08%

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:	10-Dec-08
ORIFICE #:	1258
TECH:	Cory Medill
TEMP (°C):	23.60
PRES("Hg):	26.13
CLIENT:	Kleinfelder
LOCATION:	Albuquerque, NM

POINT	DELTA VOLUME m^3	TIME MIN	DELTA H roots mmHg	DELTA H orifice "H2O
1	3.3985	3.4500	5.7913	2.0500
2	3.3985	3.2500	6.4452	2.3000
3	3.3985	2.9500	7.8463	2.8000
4	3.3985	2.7333	9.0606	3.2000
5	3.3985	2.4000	11.5827	4.1500
6	3.3985	2.1333	14.6651	5.2500
7	3.3985	1.8000	20.0828	7.2000

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	3.369	0.976	0.957	1	2.954	0.856	1.341
2	3.365	1.036	1.014	2	2.951	0.908	1.420
3	3.358	1.138	1.119	3	2.945	0.998	1.567
4	3.352	1.226	1.196	4	2.940	1.075	1.675
5	3.339	1.391	1.362	5	2.928	1.220	1.908
6	3.323	1.558	1.532	6	2.915	1.366	2.146
7	3.296	1.831	1.794	7	2.890	1.606	2.513

Certificate of Accuracy

Transfer Standard Type: Electronic Manometer Certificate No: M 112408. 02

Transfer standard, model: Dwyer Series 475-1 Mark III Digital Manometer
Serial number: N22S
submitted by/owner: ENERGY FUELS RESOURCES
KLEINFELDER
8300 Jefferson NE, Suite B
Albuquerque, NM 87113

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: 11/24/2008 Lab temperature: 68.1 °F
Lab pressure: 663.4 mm Hg

CERTIFIED ON (-) PORT

Reference Manometer ("H_2O)	Transfer Standard ("H_2O)	Difference from Reference ("H_2O)	Transfer Standard Correction* ("H_2O)
0.50	0.50	0.00	0.00
5.00	4.99	-0.01	0.01
7.50	7.51	0.01	-0.01
10.00	10.01	0.01	-0.01
19.50	19.55	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 Manometer ("H_2O)	Transfer Standard ("H_2O)	Difference from Reference ("H_2O)	Transfer Standard Correction* ("H_2O)

Reviewed: [signature] Date: 11/24/08

Roger L. Sanders, PE

Chinook Engineering
a division of Inter-Mountain Laboratories, Inc.
555 Absaraka Street
Sheridan, Wyoming 82801 USA
(307) 672-7790
chinook@imlinc.com

Certificate of Accuracy

Transfer Standard Type: Electronic Manometer Certificate No: M 112408. 01

Transfer standard, model: Dwyer Series 475-2 Mark III Digital Manometer
Serial number: N19S
submitted by/owner: ENERGY FUELS RESOURCES
KLEINFELDER
8300 Jefferson NE, Suite B
Albuquerque, NM 87113

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: 11/24/2008 Lab temperature: 68.1 °F
Lab pressure: 663.4 mm Hg

CERTIFIED ON (-) PORT

Reference Manometer ("H_2O)	Transfer Standard ("H_2O)	Difference from Reference ("H_2O)	Transfer Standard Correction* ("H_2O)
0.50	0.50	0.00	0.00
5.00	4.96	-0.04	0.04
10.00	9.96	-0.04	0.04
15.00	15.00	0.00	0.00
35.00	35.10	0.10	-0.10

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: R L S Date: 11/24/08

Roger L. Sanders, PE

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Sheridan, Wyoming 82801 USA
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chinook@imlinc.com

Appendix B

PM_{10} Sampler Calibration Sheets

Partisol PM_{10} FRM Monthly Verification/Maintenance

Site Name: **Pinon Ridge Mill Site, Site #1**
Date: **1/6/09**
Time: **1100**
Technician Name: **Zach Rogers, Jess Fulbright**
Sampler ID #: **1-2**
Streamline Pro cal. expires: **12/3/09**
Streamline Pro Control Unit S/N: **C070906**
Streamline Pro Measurement Unit S/N: **S070906**

As-Found Calibration Values

Parameter	Offset	Span
A/I	**-0.0003**	**0.9993**
Amb. T	**0.0072**	
Filter T	**0.0066**	
Pressure	**-0.0363**	
Flow	**-0.0058**	**0.9656**

Condition of Instrument: **Good**

Sensors Verification

Sensor	Indicated	Actual	Difference	Specification
Amb. T	**-1.4**	**-1.9**	**0.5**	+/- ˚C verification, +/- 2 ˚C audit
Filter T	**1.0**	**0.5**	**0.5**	+/- ˚C verification, +/- 2 ˚C audit
Pressure	**620**	**621.1**	**1.1**	+/- 10 mmHG
Flow	**16.7**	**16.79**	**0.09**	16.7 L/min +/- 4.0% (+/- 0.66 l/min)

External Leak Check: **Pass**

Internal Leak Check: **Pass**

Initial Vacuum {inches Hg}	Final Vacuum {inches Hg}
19.75	**17.75**

(< 8.5" Hg / 30 sec.)

All Sensors Are Within Specifications, No Calibration Required

Repairs and/or Calibrations Performed:

Sensors Re-Verification

Sensor	Indicated	Actual	Difference	Specification
Amb. T				+/- ˚C verification, +/- 2 ˚C audit
Filter T				+/- ˚C verification, +/- 2 ˚C audit
Pressure				+/- 10 mmHg
Flow				16.7 L/min +/- 2.0% (+/- 0.33 l/min)

External Leak Check:

Leakage Rate {mmHg/min}

Internal Leak Check:

Initial Vacuum {inches Hg}	Final Vacuum {inches Hg}

(< 8.5" Hg / 30 sec.)

Partisol PM_{10} FRM Monthly Verification/Maintenance

Site Name: **Pinon Ridge Mill Site, Site #2**
Date: **1/6/09**
Time: **1300**
Technician Name: **Zach Rogers, Doug Roberts**
Sampler ID #: **2-2**
Streamline Pro cal. expires: **12/3/09**
Streamline Pro Control Unit S/N: **C070906**
Streamline Pro Measurement Unit S/N: **S070906**

As-Found Calibration Values

Parameter	Offset	Span
A/I	**-0.0020**	**0.9996**
Amb. T	**-0.0003**	
Filter T	**-0.0032**	
Pressure	**-0.0075**	
Flow	**-0.0115**	**0.9898**

Condition of Instrument: **Good**

Sensors Verification

Sensor	Indicated	Actual	Difference	Specification
Amb. T	**-1.3**	**0.4**	**1.7**	+/- ˚C verification, +/- 2 ˚C audit
Filter T	**1.4**	**1.8**	**0.4**	+/- ˚C verification, +/- 2 ˚C audit
Pressure	**620**	**619.3**	**0.7**	+/- 10 mmHg
Flow	**16.6**	**16.93**	**0.33**	16.7 L/min +/- 2.0% (+/- 0.33 l/min)

External Leak Check: **Pass**

Leakage Rate {mmHg/min}
73

Internal Leak Check: **Pass**

Initial Vacuum {inches Hg}	Final Vacuum {inches Hg}
20	**16.25**

(< 8.5" Hg / 30 sec.)

All Sensors Are Within Specifications, No Calibration Required

Repairs and/or Calibrations Performed:

Sensors Re-Verification

Sensor	Indicated	Actual	Difference	Specification
Amb. T				+/- ˚C verification, +/- 2 ˚C audit
Filter T				+/- ˚C verification, +/- 2 ˚C audit
Pressure				+/- 10 mmHg
Flow				16.7 L/min +/- 2.0% (+/- 0.33 l/min)

External Leak Check:

Leakage Rate {mmHg/min}

Internal Leak Check:

Initial Vacuum {inches Hg}	Final Vacuum {inches Hg}

(< 8.5" Hg / 30 sec.)

Appendix C

TSP Sampler Calibration Sheets

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 1-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 1/1/09
Calibrated By: Jess Fulbright
Orifice ID: 1258
Orifice Calibration Date: 12/10/08
Ambient Temperature (°C): 6.1
Ambient Pressure ("Hg): 24.63
Ambient Temperature (°K): 279.3
Ambient Pressure (mmHg): 626

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.982 and b = -0.003

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.4	0.39	24.24	0.9840
2	6.4	0.47	24.16	0.9808
3	8.3	0.61	24.02	0.9753
4	12.8	0.94	23.69	0.9617
5	19.6	1.44	23.19	0.9414

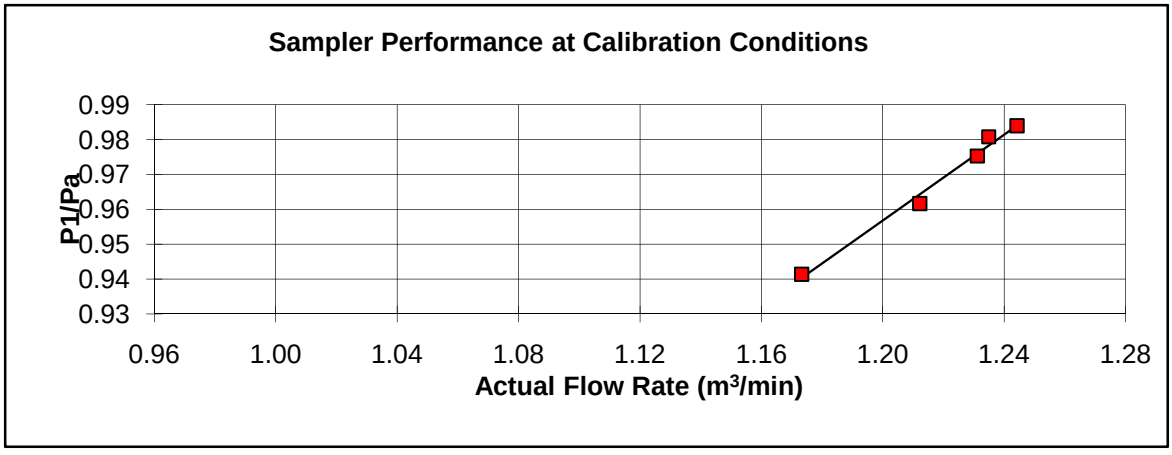
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.33	1.2443	0.0745	1.2441	0.0%
2	3.28	1.2349	0.0739	1.2390	0.3%
3	3.26	1.2311	0.0737	1.2300	-0.1%
4	3.16	1.2122	0.0726	1.2079	-0.4%
5	2.96	1.1733	0.0702	1.1749	0.1%

Sampler Calibration:

Slope	**10.2820**
Intercept	**0.2183**
r	**0.9939**
Failure Temp (°C)	**-65.2**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.2183] * [SQRT(Ta)]} * {1/10.2820}



Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 2-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 1/1/09
Calibrated By: Jess Fulbright
Orifice ID: 1258
Orifice Calibration Date: 12/10/08
Ambient Temperature (°C): 7.9
Ambient Pressure ("Hg): 24.51
Ambient Temperature (°K): 281.1
Ambient Pressure (mmHg): 623

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.982 and b = -0.003

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.2	0.38	24.12	0.9844
2	8.4	0.62	23.89	0.9749
3	13.0	0.95	23.56	0.9611
4	16.6	1.22	23.29	0.9503
5	23.3	1.72	22.79	0.9300

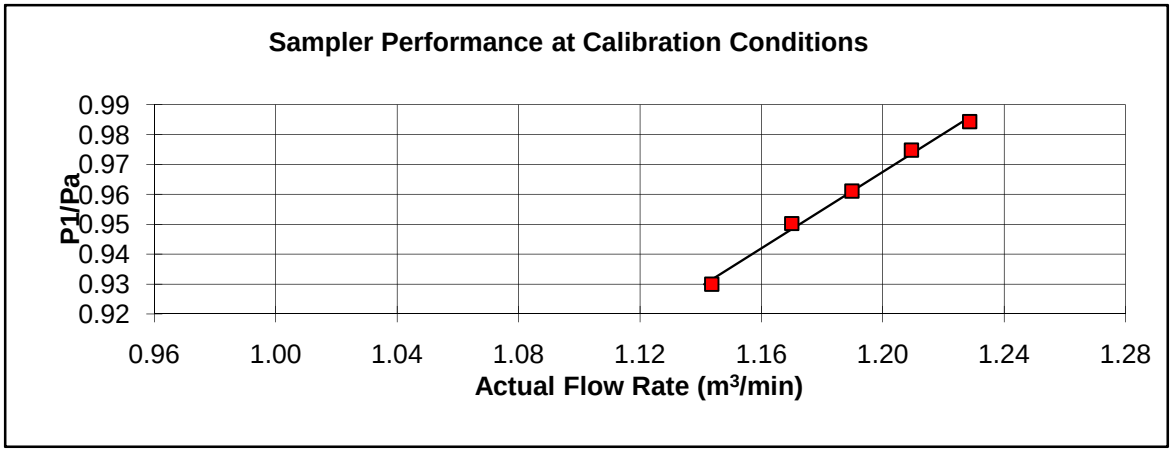
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.21	1.2287	0.0733	1.2263	-0.2%
2	3.11	1.2094	0.0722	1.2114	0.2%
3	3.01	1.1899	0.0710	1.1900	0.0%
4	2.91	1.1700	0.0698	1.1729	0.3%
5	2.78	1.1436	0.0682	1.1412	-0.2%

Sampler Calibration:

Slope	**10.7162**
Intercept	**0.2003**
r	**0.9973**
Failure Temp (°C)	**-58.1**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.2003] * [SQRT(Ta)]} * {1/10.7162}



Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 3-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 1/1/09
Calibrated By: Jess Fulbright
Orifice ID: 1258
Orifice Calibration Date: 12/10/08
Ambient Temperature (°C): 4.7
Ambient Pressure ("Hg): 24.47
Ambient Temperature (°K): 277.9
Ambient Pressure (mmHg): 622

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.982 and b = -0.003

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.4	0.40	24.08	0.9838
2	12.4	0.91	23.56	0.9628
3	16.6	1.22	23.25	0.9502
4	21.7	1.60	22.87	0.9347
5	25.5	1.88	22.60	0.9233

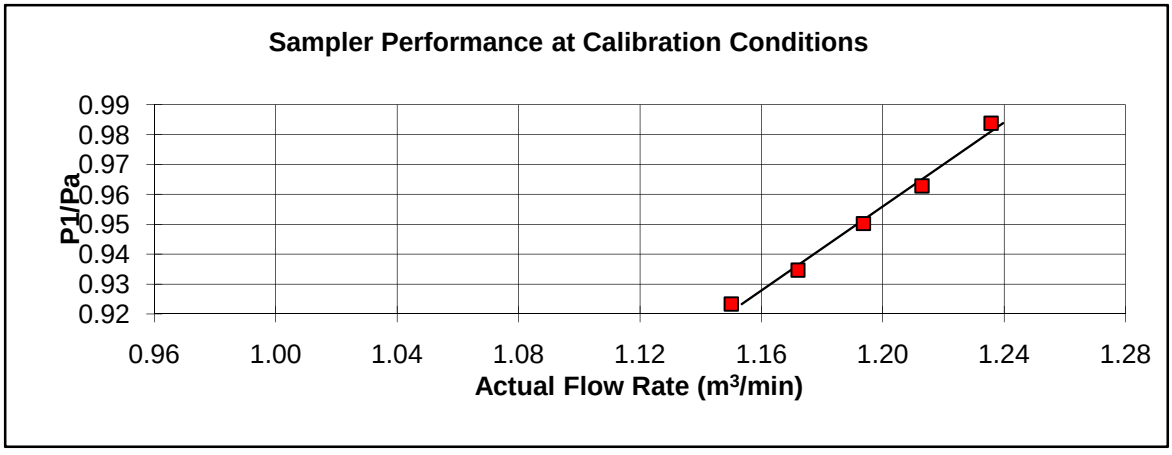
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.28	1.2358	0.0742	1.2396	0.3%
2	3.16	1.2130	0.0728	1.2097	-0.3%
3	3.06	1.1937	0.0716	1.1918	-0.2%
4	2.95	1.1721	0.0703	1.1697	-0.2%
5	2.84	1.1501	0.0690	1.1535	0.3%

Sampler Calibration:

Slope	**11.7163**
Intercept	**0.1123**
r	**0.9948**
Failure Temp (°C)	**-67.5**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.1123] * [SQRT(Ta)]} * {1/11.7163}



Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 4-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 1/1/09
Calibrated By: Jess Fulbright
Orifice ID: 1258
Orifice Calibration Date: 12/10/08
Ambient Temperature (°C): 0.6
Ambient Pressure ("Hg): 24.80
Ambient Temperature (°K): 273.8
Ambient Pressure (mmHg): 630

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.982 and b = -0.003

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.2	0.39	24.41	0.9845
2	11.6	0.85	23.95	0.9656
3	14.8	1.09	23.71	0.9562
4	20.4	1.50	23.30	0.9394
5	26.9	1.98	22.82	0.9201

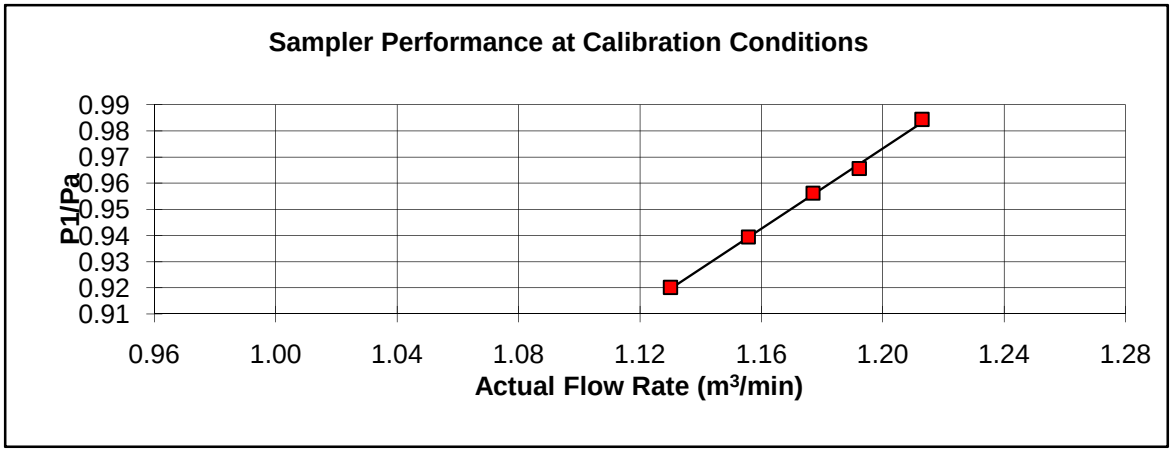
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.25	1.2130	0.0733	1.2145	0.1%
2	3.14	1.1923	0.0721	1.1900	-0.2%
3	3.06	1.1771	0.0712	1.1777	0.1%
4	2.95	1.1558	0.0699	1.1558	0.0%
5	2.82	1.1301	0.0683	1.1306	0.0%

Sampler Calibration:

Slope	**12.6720**
Intercept	**0.0540**
r	**0.9990**
Failure Temp (°C)	**-63.0**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.0540] * [SQRT(Ta)]} * {1/12.6720}



Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels Resources
Sampler ID: 5-1-TSP
AIRS Site ID: N/A
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 1/1/09
Calibrated By: Jess Fulbright
Orifice ID: 1258
Orifice Calibration Date: 12/10/08
Ambient Temperature (°C): -0.2
Ambient Pressure ("Hg): 24.34
Ambient Temperature (°K): 273.0
Ambient Pressure (mmHg): 618

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.982 and b = -0.003

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.3	0.39	23.95	0.9839
2	10.5	0.77	23.57	0.9684
3	16.1	1.19	23.15	0.9512
4	21.3	1.57	22.77	0.9356
5	27.4	2.02	22.32	0.9171

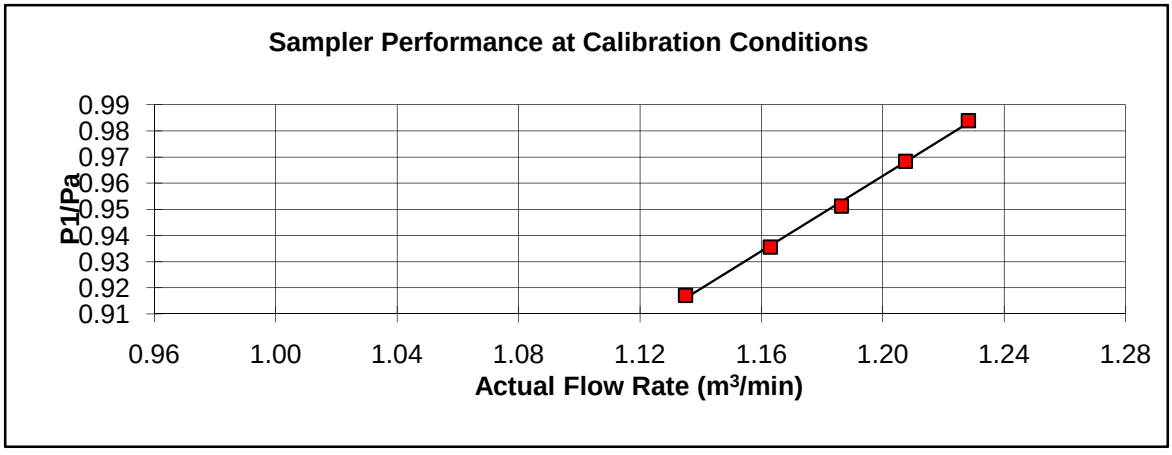
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.28	1.2282	0.0744	1.2294	0.1%
2	3.17	1.2075	0.0731	1.2078	0.0%
3	3.06	1.1864	0.0718	1.1840	-0.2%
4	2.94	1.1630	0.0704	1.1622	-0.1%
5	2.80	1.1350	0.0687	1.1365	0.1%

Sampler Calibration:

Slope	**11.8682**
Intercept	**0.1005**
r	**0.9990**
Failure Temp (°C)	**-68.0**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.1005] * [SQRT(Ta)]} * {1/11.8682}



Notes: