A5 – Audit & Calibration Reports

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

Pinyon Ridge Mill Site
Montrose County, CO

April 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 March 26-27, 2008; personnel from VSI performed the audits. Results of the audit indicated compliance with the EPA Guidelines or Manufacturer's Recommendations for most meteorological and air quality parameters. The delta temperature at Site 1 slightly exceeded the PSD Tolerance during the initial audit, but a second audit following its recalibration by the site operator indicated compliance. The audit flow of the TSP sampler at Site 5 slightly exceeded the recommended tolerance. 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 March 26-27, 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.

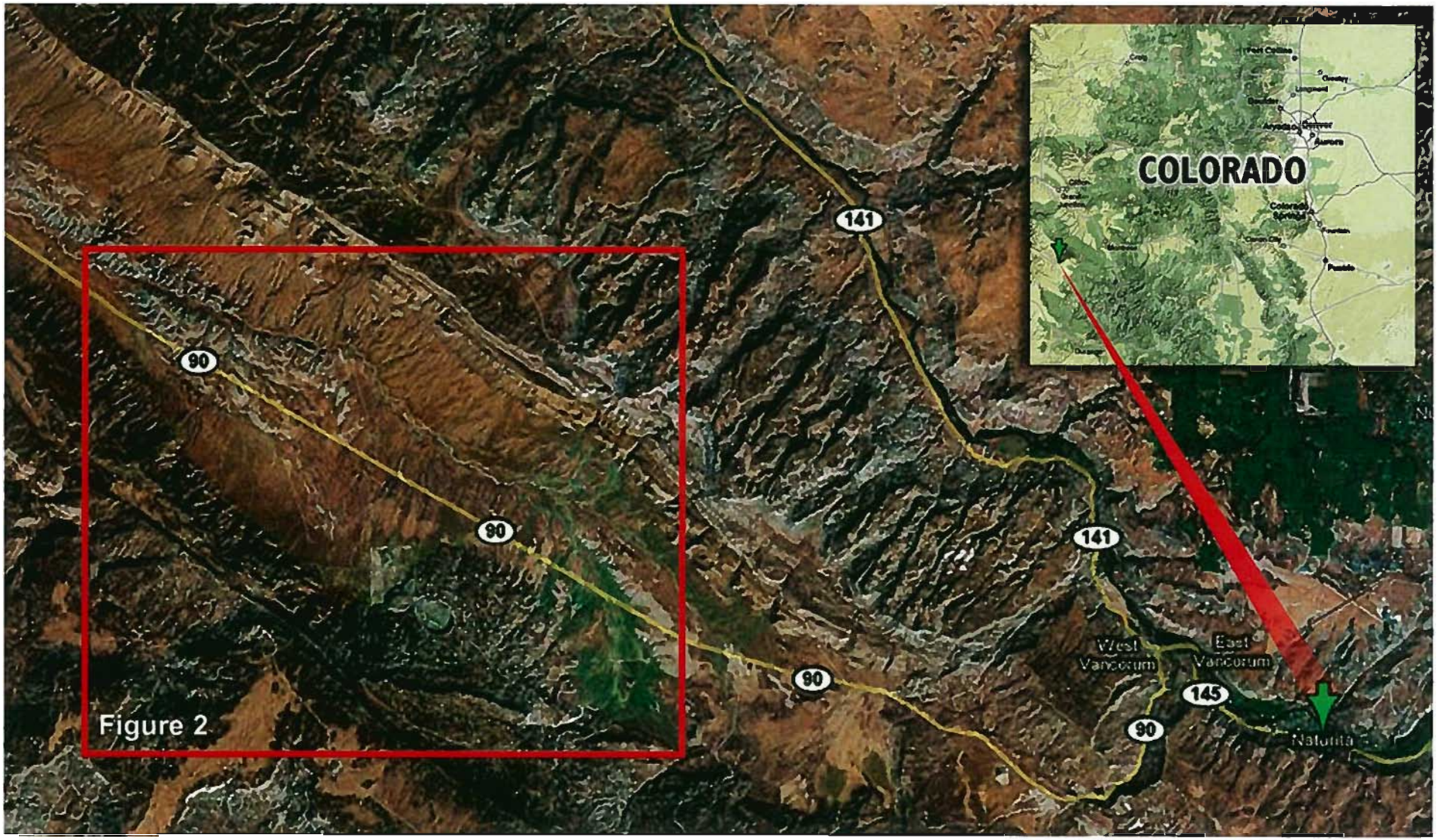
Site No.	Description / Parameters
1	North Site: 10-meter tower (Met/Air Quality) Latitude/Longitude: N 38° 15.862' W 108° 46.091'
2	East Site: 30-meter tower (Met/Air Quality) Latitude/Longitude: N 38° 14.729' W 108° 45.626'
3	West Site (Air Quality) Latitude/Longitude: N 38° 14.912' W 108° 46.638'
4.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

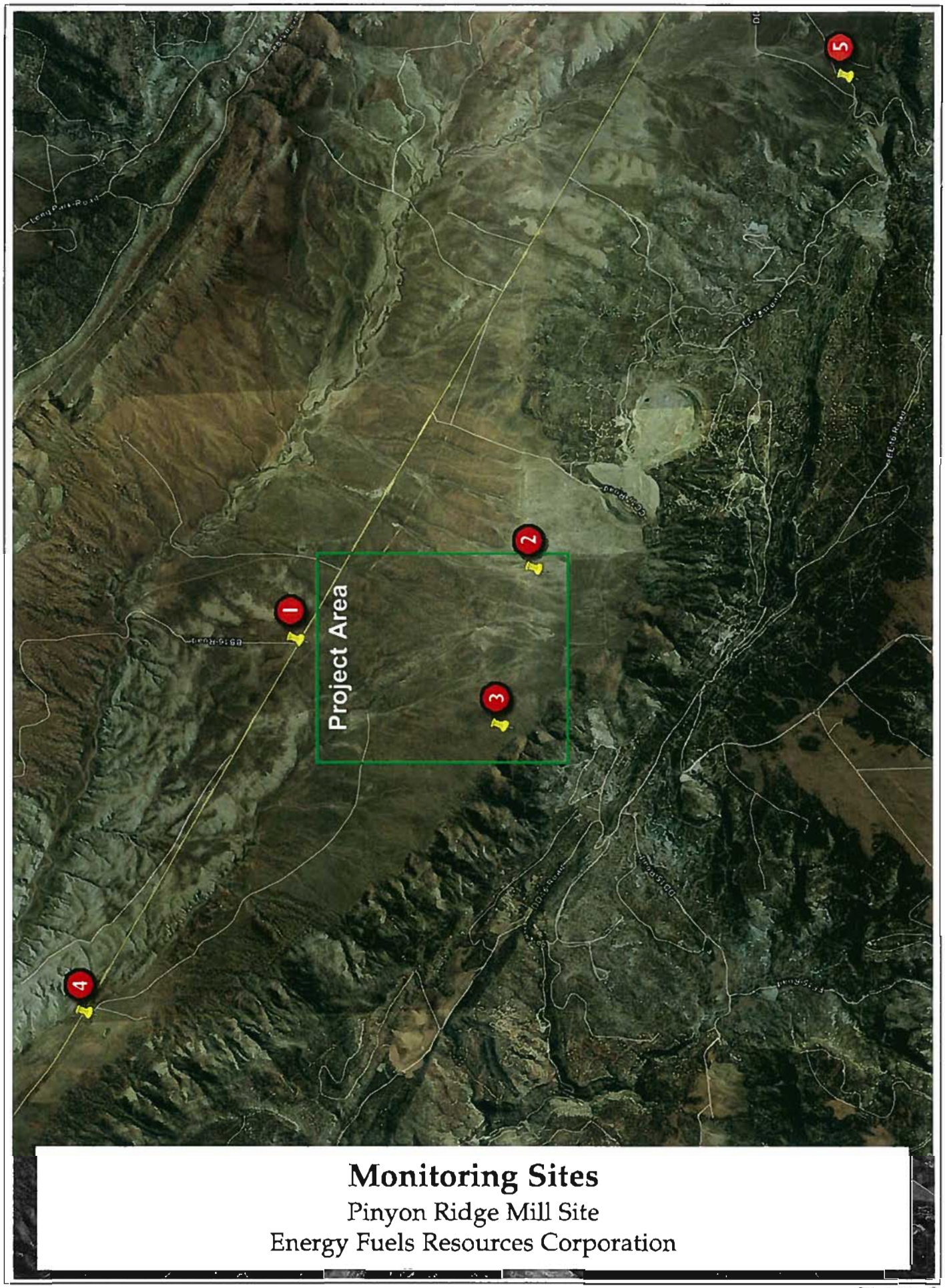


Project Location

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, 9.8, 19.6, 34.3, 49.0, 98.0, 196.0, 343.0 and 490.0 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 four 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 four temperatures between 32^{0}F and 110^{0}F and recording the outputs of the DAS. Monitoring of the water temperature was accomplished using a NIST-certified mercury thermometer with a 0.1^{0}C resolution. Results of the audit indicated that the DAS responses were within PSD Tolerances for the delta temperature at Site 2, but fell outside the tolerance at Site 1. The system was recalibrated by the site operator and the audit repeated. Results of the second audit indicated that the DAS responses were within PSD Tolerances for the delta temperature at Site 1; 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 18 tips (0.18 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 ±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 ±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 Sites 1-4 showed that the audit flow rates were within tolerance with the indicated flow rates; the TSP sampler at Site 5 slightly exceeded the tolerance for the audit flow. 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	+2.7^0 / -2.4^0	±5.0^0

WIND SPEED-VERTICAL (CMPS)

Model # 27106

Range	Data Logger	Tolerance
≤ 5 mps	+0.3 / -9.8 cmps	±25 cmps

Model # 27106T

Range	Data Logger	Tolerance
≤ 5 mps	+0.4 / -9.8 cmps	±25 cmps

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

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.1 / -0.0^{0}C	±0.5^{0}C

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

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.2 / -0.0^{0}C	±0.5^{0}C

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

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.1 / -0.4^{0}C	±0.5^{0}C

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

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

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

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.00 / -0.51 ^{0}C	±0.1^{0}C

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

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.05 / -0.08 ^{0}C	±0.1^{0}C

BAROMETRIC PRESSURE (mb)

Range	Data Logger	Tolerance
Ambient-Collocated	+1.6/-0.0 mb	± 3 mb

SOLAR RADIATION (W/m^2)

Range	Data Logger	Tolerance
0-2000 W/m^2	+1.9 / -0.3%	±5.0%

RELATIVE HUMIDITY (%)/TEMPERATURE (^oF)

Range	Data Logger	Tolerance
Ambient- Collocated	+0.0 / -1.5%	No Tolerance
	+0.8/-0.0^oF	Non-PSD

PRECIPITATION (inches)

Range	Data Logger	Tolerance
Ambient	±0.0 in. /-1.5 ml /-0.5%	±10% Observed Value
		±0.5mm (16.2ml)

Air Quality Instrumentation

Partisol-PM_{10}

Flow Difference (%)	Tolerance
+0.00/-2.41	±5%

Temp (ext) Difference (°C)	Tolerance
+0.5/-0.0	±2°C

Temp (int) Difference (°C)	Tolerance
+0.0/-0.2	±2°C

Pressure Difference (mmHg)	Tolerance
+0.0/-2.2	±10mmHg

TSP

Audit Flow Difference (%)	Tolerance
+0.00 / -3.38	±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	+3.4^0 / -1.8^0	±5.0^0

WIND SPEED-VERTICAL (CMPS)

Model # 27106

Range	Data Logger	Tolerance
≤ 5 mps	+13.6 / -22.3 cmps	±25 cmps

Model # 27106T

Range	Data Logger	Tolerance
≤ 5 mps	+2.0 / -8.0 cmps	±25 cmps

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

Range	Data Logger	Tolerance
0 to +50^{0}C	+0.0 / -0.2^{0}C	±0.5^{0}C

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

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

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

Range	Data Logger	Tolerance
0 to +50^{o}C	+0.00 / -0.05 ^{o}C	±0.1^{o}C

BAROMETRIC PRESSURE (mb)

Range	Data Logger	Tolerance
Ambient-Collocated	+2.3/-0.0 mb	± 3 mb

SOLAR RADIATION (W/m^{2})

Range	Data Logger	Tolerance
0-2000 W/m^{2}	+2.9 / -0.9%	±5.0%

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

Range	Data Logger	Tolerance
Ambient- Collocated	+0.0 / -1.9%	No Tolerance
	+0.0/-1.7^{o}F	Non-PSD

Air Quality Instrumentation

Partisol-PM_{10}

Flow Difference (%)	Tolerance
+0.00/-4.52	±5%

Temp (ext) Difference (°C)	Tolerance
+0.0/-0.2	±2°C

Temp (int) Difference (°C)	Tolerance
+0.5/-0.0	±2°C

Pressure Difference (mmHg)	Tolerance
+0.5/-0.0	±10mmHg

TSP

Audit Flow Difference (%)	Tolerance
+3.41 / -0.00	±7%

Site 3

Air Quality Instrumentation

TSP

Audit Flow Difference (%)	Tolerance
+0.00 / -5.23	±7%

Site 4

Air Quality Instrumentation

TSP

Audit Flow Difference (%)	Tolerance
+0.00 / -3.20	±7%

Site 5

Air Quality Instrumentation

TSP

Audit Flow Difference (%)	Tolerance
+0.00 / -7.60	±7%

DATA INVALIDATION PERIODS

The audit of the meteorological/air quality systems was performed on March 26-27, 2008; data invalidation periods for each location and parameter are listed below.

Site 1:

Wind speed, Wind direction, and Temperature: 3/27/08 (0842-1230 MST)

Solar Radiation: 3/27/08 (0732-0745 MST)

Precipitation: 3/27/08 (0750-0818 MST)

Site 2:

Wind speed, Wind direction, and Temperature: 3/26/08 (1402-1720 MST)

Solar Radiation: 3/26/08 (1338-1345 MST)

Site 3:

None

Site 4:

None

Site 5:

None

RECOMMENDATIONS

Site 5:

Correct TSP flow

RECOMMENDATIONS

Site 5:

Correct TSP flow

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 DP4863

Date of inspection 18 October 2002

Tested By EJC

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

National Calibration Inc.

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

The Quality People
Since 1956

ON LINE RECORDS powered by CalHub

Calibration Report

Report No: 59354 **Order No:** 13702-70111

Customer:	VSI 729 W. Lynwood St. Phoenix, AZ 85007	**Calibration Date:**	01/17/2007
		Recall Date:	01/17/2008
		Ambient Temperature:	71°F
		Relative Humidity:	31%
Equipment Type:	Multimeter	**Received:**	In Tolerance
Make:	Fluke	**Returned:**	In Tolerance
Model:	8060A	**Received Condition:**	Good
Asset Number:	4515375	**Accuracy:**	Per Mfg. Specifications
Serial Number:	4515375		
Procedure:	Navair 17-20AQ-206		
Technician:	Weeks, Don	**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
7000100	Fluke	5700	Calibrator	09/19/2006	9/19/2007

Technician Comments:

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Since 1955

National Calibration Inc.

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

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 2540-1-1994. 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	

National Calibration Inc.

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

The Quality People
Since 1955

ONLINE RECORDS powered by CalHub

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:	33K5-4-42-1		
Technician:	Pikey, Glenn	**Authorized By:**	Robert V. Halloran

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

TISCH ENVIROMENTAL, INC.
145 SOUTH MIAMI AVE.
VILLAGE OF CLEVES, OH 45002
513.467.9000
877.263.7610 TOLL FREE
513.467.9009 FAX
WWW.TISCH-ENV.COM

AIR POLLUTION MONITORING EQUIPMENT

ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5025A

Date - Jul 12, 2007 Rootsmeter S/N 9833620 Ta (K) - 298
Operator Tisch Orifice I.D. - G73 Pa (mm) - 751.84

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	1.3500	3.2	2.00
2	NA	NA	1.00	0.9530	6.4	4.00
3	NA	NA	1.00	0.8510	8.0	5.00
4	NA	NA	1.00	0.8120	8.8	5.50
5	NA	NA	1.00	0.6700	12.8	8.00

DATA TABULATION

Vstd	(x axis) Qstd	(y axis)		Va	(x axis) Qa	(y axis)
0.9850	0.7296	1.4066		0.9957	0.7376	0.8903
0.9809	1.0292	1.9892		0.9915	1.0404	1.2591
0.9786	1.1500	2.2240		0.9893	1.1625	1.4078
0.9777	1.2040	2.3326		0.9883	1.2171	1.4765
0.9724	1.4513	2.8132		0.9829	1.4671	1.7807
Qstd slope (m) =		1.94962		Qa slope (m) =		1.22082
intercept (b) =		-0.01660		intercept (b) =		-0.01051
coefficient (r) =		0.99999		coefficient (r) =		0.99999
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}

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.

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: 3/27/08
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: 3/27/08
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	180	177.6	-2.4
AS LEFT	180	178.6	-1.4

CONTINUITY CHECK

INPUT: COMPASS POINT (Degrees)	DATA ACQUISITION (Degrees)	DIFFERENCE (Degrees)
5	7.2	2.2
30	32.7	2.7
60	62.1	2.1
90	91.1	1.1
120	120.2	0.2
150	150.2	0.2
180	180.0	0.0
210	209.9	-0.1
240	240.3	0.3
270	270.7	0.7
300	300.7	0.7
330	331.2	1.2
355	354.4	-0.6

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: 3/27/08
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	0.00	0.3	0.0
20	9.8	-9.9	9.58	0.1	-0.2
40	19.6	-18.9	18.29	-0.7	-1.3
70	34.3	-33.4	33.69	-0.9	-0.6
100	49.0	-47.1	48.18	-2.0	-0.8
200	98.0	-98.2	98.43	0.2	0.4
400	196.0	-194.3	194.03	-1.7	-2.0
700	343.0	-334.6	337.48	-8.4	-5.5
1000	490.0	-484.2	480.21	-5.8	-9.8

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: 3/27/08
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	0.00	0.0	0.0
20	10.0	-10.4	10.08	0.4	0.1
40	20.0	-20.3	19.56	0.3	-0.4
70	35.0	-34.1	34.38	-0.9	-0.6
100	50.0	-49.2	48.60	-0.8	-1.4
200	100.0	-99.3	99.29	-0.7	-0.7
400	200.0	-201.5	199.17	1.5	-0.8
700	350.0	-345.3	344.40	-4.7	-5.6
1000	500.0	-490.2	498.52	-9.8	-1.5

PSD TOLERANCES (cm/s)

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

PERFORMANCE AUDIT: AMBIENT TEMPERATURE (2M)
(AS FOUND)

SENSOR:
Manuf./Model: RMY/41342
Serial No.: 13638
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 3/27/08
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)
33.6	0.9	33.8	1.0	0.1
58.3	14.6	58.5	14.7	0.1
79.2	26.2	79.3	26.3	0.1
104.0	40.0	104.2	40.1	0.1

PSD TOLERANCES (Deg. C.)

DAS
±0.5

PERFORMANCE AUDIT: AMBIENT TEMPERATURE (2M)
(AS LEFT)

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

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 3/27/08
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)
32.5	0.3	32.9	0.5	0.2
54.1	12.3	54.2	12.3	0.0
77.4	25.2	77.4	25.2	0.0
95.0	35.0	95.0	35.0	0.0

PSD TOLERANCES (Deg. C.)

DAS
±0.5

PERFORMANCE AUDIT: AMBIENT TEMPERATURE (10M)
(AS FOUND)

SENSOR:
Manuf./Model: RMY/41342
Serial No.: 13639
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 3/27/08
BY: VSI

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

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

INPUT TEMPERATURE (Deg. F)	INPUT TEMPERATURE (Deg. C.)	DATA ACQUISITION (Deg. F)	DATA ACQUISITION (Deg. C.)	DIFF. (Deg. C.) (DAS)
33.6	0.9	33.8	1.0	0.1
58.3	14.6	58.1	14.5	-0.1
79.2	26.2	78.5	25.8	-0.4
104.0	40.0	103.2	39.6	-0.4

PSD TOLERANCES (Deg. C.)

DAS
±0.5

PERFORMANCE AUDIT: AMBIENT TEMPERATURE (10M)
(AS LEFT)

SENSOR:
Manuf./Model: RMY/41342
Serial No.: 13639
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 3/27/08
BY: VSI

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

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

INPUT TEMPERATURE (Deg. F)	INPUT TEMPERATURE (Deg. C.)	DATA ACQUISITION (Deg. F)	DATA ACQUISITION (Deg. C.)	DIFF. (Deg. C.) (DAS)
32.5	0.3	33.0	0.6	0.3
54.1	12.3	54.2	12.3	0.0
77.4	25.2	77.2	25.1	-0.1
95.0	35.0	94.8	34.9	-0.1

PSD TOLERANCES (Deg. C.)

DAS
±0.5

PERFORMANCE AUDIT: DELTA TEMPERATURE (2-10M)
(AS FOUND)

SENSOR (Upper):
Manuf./Model: RMY/41342
Serial No.: 13639
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 3/27/08
BY: VSI

SENSOR (Lower):
Manuf./Model: RMY/41342
Serial No.: 13638
Range: -50 to + 50°C

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

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

INPUT TEMPERATURE (Deg. F)	(Deg. C.)	DATA ACQUISITION (Upper)	(Lower)	DIFF. (Deg. C.) (DAS)
33.6	0.9	1.0	1.0	0.00
58.3	14.6	14.5	14.7	-0.21
79.2	26.2	25.8	26.3	-0.46
104.0	40.0	39.6	40.1	-0.51

PSD TOLERANCES (Deg. C.)

DAS
±0.1

PERFORMANCE AUDIT: DELTA TEMPERATURE (2-10M)
(AS LEFT)

SENSOR (Upper):
Manuf./Model: RMY/41342
Serial No.: 13639
Range: -50 to + 50°C

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 3/27/08
BY: VSI

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

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

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

INPUT TEMPERATURE (Deg. F)	(Deg. C.)	DATA ACQUISITION (Upper)	(Lower)	DIFF. (Deg. C.) (DAS)
32.5	0.3	0.6	0.5	0.05
54.1	12.3	12.3	12.3	-0.01
77.4	25.2	25.1	25.2	-0.08
95.0	35.0	34.9	35.0	-0.08

PSD TOLERANCES (Deg. C.)

DAS
±0.1

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: 3/27/08
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		DATA ACQUISITION		DIFF. (mb)
(in. Hg.)	(mb)	(in. Hg.)	(mb)	(DAS)
24.4	826.4	24.5	828.0	1.6

EPA GUIDELINES (mb)

DAS

±3.0

PERFORMANCE AUDIT: SOLAR RADIATION

SENSOR:
Manuf./Model: Licor/LI-200SZ
Serial No.: PY57101
Range: 0-2000 W/m^2
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: 3/27/08
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
945	941	0.4
220	216	1.9

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	886	-0.26
1332	6.66	6.66	1332	0.02
1776	8.88	8.88	1773	-0.17
2220	11.10	11.10	2219	-0.07

PSD TOLERANCES

DAS
±5.0%

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: 3/27/08
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)
32	33.5	-1.5

*NO STANDARD

MANUFACTURER'S SPECIFICATIONS:

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

PERFORMANCE AUDIT: AMBIENT TEMPERATURE

SENSOR:
Manuf./Model: Vaisala/HMP45C-L
Serial No 2730074
Range: -50 to +50^{0}C

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 3/27/08
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 (^{0}F)	DATA ACQUISITION (^{0}F)	DIFFERENCE* (DAS)
52.5	51.7	0.8

PERFORMANCE AUDIT: PRECIPITATION

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

OWNER: ENERGY FUELS
LOCATION: SITE 1 (10M)
DATE: 3/27/08
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

No. Tips	INPUT (in. H_2O)	INPUT (ml H_2O)	DATA ACQUISITION (in. H_2O)	DATA ACQUISITION (ml H_2O)	DIFF. (inches / ml / %) (DAS)
18	0.18	333.5	0.18	332.0	0.0 in. / -1.5ml / -0.5%

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: 3/27/08
BY: VSI

AUDIT DEVICES:

FLOW:
Manuf./Model: BIOS/DCL-H
Serial No 4916

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

FLOW AUDIT:

INDICATED FLOW (lpm)	AUDIT FLOW (lpm)	DIFFERENCE (%)
16.6	17.0	-2.41

TOLERANCE: ±5%

TEMP (EXT) AUDIT:

INDICATED TEMP (°C)	AUDIT TEMP (°C)	DIFFERENCE (°C)
16.8	16.3	0.5

TOLERANCE: ±2°C

TEMP (INT) AUDIT:

INDICATED TEMP (°C)	AUDIT TEMP (°C)	DIFFERENCE (°C)
17.6	17.8	-0.2

TOLERANCE: ±2°C

PRESSURE AUDIT:

INDICATED PRS. (mmHg)	AUDIT PRS.(mmHg)	DIFFERENCE (mmHg)
621	623.2	-2.2

TOLERANCE: ±10mmHg

PERFORMANCE AUDIT: TSP SAMPLER (VFC)

SAMPLER:

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

SERIAL NO: 7151

OWNER: ENERGY FUELS

LOCATION: SITE 1 (10m)

DATE: 3/26/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	16.3	16.3	16.3 ^{0}C
SERIAL NO.:	G73	PRESSURE (P_0):	623.2	623.3	623.25 mmHg
CAL DATE:	7/12/07				
SLOPE (m):	1.22082				
INTERCEPT (b):	-0.01051				
CORRELATION (r):	0.999990				

ORIFICE MANOMETER (in. H_2O)			STAGNATION PORT (ΔP)				FLOWS	
							Q_a	Q_{ind}
LEFT	RIGHT	TOTAL	(in. H_2O)	(mm H_g)	P_1	P_1/P_o	(cmm)	(cmm)
2.50	1.70	4.20	25.3	47.3	576.0	0.9242	1.153	1.114

AUDIT FLOW
% DIFF.
-3.38

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 (from table)

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: 3/26/08
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: 3/26/08
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	102.4	-1.6
AS LEFT	104	102.6	-1.4

CONTINUITY CHECK

INPUT: COMPASS POINT (Degrees)	DATA ACQUISITION (Degrees)	DIFFERENCE (Degrees)
5	8.4	3.4
30	32.8	2.8
60	62.9	2.9
90	92.5	2.5
120	121.7	1.7
150	152.4	2.4
180	180.8	0.8
210	211.9	1.9
240	240.4	0.4
270	270.2	0.2
300	300.4	0.4
330	330.8	0.8
355	353.2	-1.8

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: 3/26/08
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	-10.6	10.25	0.8	0.4
40	19.6	-20.8	21.68	1.2	2.1
70	34.3	-34.6	35.44	0.3	1.1
100	49.0	-50.4	49.21	1.4	0.2
200	98.0	-97.8	95.48	-0.2	-2.5
400	196.0	-190.4	190.69	-5.6	-5.3
700	343.0	-356.6	328.32	13.6	-14.7
1000	490.0	-469.5	467.73	-20.5	-22.3

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: 3/26/08
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	0.00	0.0	0.0
20	10.0	-10.5	11.95	0.5	2.0
40	20.0	-19.4	20.32	-0.6	0.3
70	35.0	-34.7	35.26	-0.3	0.3
100	50.0	50.5	50.21	0.5	0.2
200	100.0	-98.3	99.21	-1.7	-0.8
400	200.0	-200.8	199.33	0.8	-0.7
700	350.0	-345.2	349.36	-4.8	-0.6
1000	500.0	-496.1	491.99	-3.9	-8.0

PSD TOLERANCES (cm/s)

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

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: 3/26/08
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	32.7	0.4	0.3
56.1	13.4	56.4	13.6	0.2
80.6	27.0	80.5	26.9	-0.1
99.5	37.5	99.0	37.2	-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: 3/26/08
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	0.4	0.4	0.00
56.1	13.4	13.6	13.5	0.05
80.6	27.0	26.9	27.0	-0.05
99.5	37.5	37.2	37.3	-0.04

PSD TOLERANCES (Deg. C.)

DAS
±0.1

PERFORMANCE AUDIT: AMBIENT PRESSURE

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

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 3/26/08
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		DATA ACQUISITION		DIFF. (mb)
(in. Hg.)	(mb)	(in. Hg.)	(mb)	(DAS)
24.4	826.4	24.5	828.7	2.3

EPA GUIDELINES (mb)

DAS

±3.0

PERFORMANCE AUDIT: SOLAR RADIATION

SENSOR:
Manuf./Model: Licor/LI-200SZ
Serial No.: PY57102
Range: 0-2000 W/m^2
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: 3/26/08
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
884	887	-0.3
459	446	2.9

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)
424	2.12	2.12	420	-0.94
848	4.24	4.24	844	-0.47
1272	6.36	6.36	1269	-0.24
1696	8.48	8.48	1692	-0.24
2120	10.60	10.60	2114	-0.28

PSD TOLERANCES

DAS
±5.0%

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: 3/27/08
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)
32	33.9	-1.9

*NO STANDARD

MANUFACTURER'S SPECIFICATIONS:

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

PERFORMANCE AUDIT: AMBIENT TEMPERATURE

SENSOR:
Manuf./Model: Vaisala/HMP45C-L
Serial No 2730148
Range: -50 to + 50^{0}C

OWNER: ENERGY FUELS
LOCATION: SITE 2 (30M)
DATE: 3/26/08
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 (^{0}F)	DATA ACQUISITION (^{0}F)	DIFFERENCE* (DAS)
50.0	51.7	-1.7

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: 3/26/08
BY: VSI

AUDIT DEVICES:

FLOW:
Manuf./Model: BIOS/DCL-H
Serial No 4916

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

FLOW AUDIT:

INDICATED FLOW (lpm)	AUDIT FLOW (lpm)	DIFFERENCE (%)
16.7	17.5	-4.52

TOLERANCE: ±5%

TEMP (EXT) AUDIT:

INDICATED TEMP (°C)	AUDIT TEMP (°C)	DIFFERENCE (°C)
6.5	6.7	-0.2

TOLERANCE: ±2°C

TEMP (INT) AUDIT:

INDICATED TEMP (°C)	AUDIT TEMP (°C)	DIFFERENCE (°C)
8.7	8.2	0.5

TOLERANCE: ±2°C

PRESSURE AUDIT:

INDICATED PRS. (mmHg)	AUDIT PRS.(mmHg)	DIFFERENCE (mmHg)
621	621.5	-0.5

TOLERANCE: ±10mmHg

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: 3/26/08
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	32.7	0.4	0.3
56.1	13.4	56.3	13.5	0.1
80.6	27.0	80.6	27.0	0.0
99.5	37.5	99.1	37.3	-0.2

PSD TOLERANCES (Deg. C.)

DAS
±0.5

PERFORMANCE AUDIT: TSP SAMPLER (VFC)

SAMPLER:

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

SERIAL NO: 7150

OWNER: ENERGY FUELS

LOCATION: SITE 2 (30m)

DATE: 3/26/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	6.7	6.7	6.7 ^{0}C
SERIAL NO.:	G73	PRESSURE (P_0):	621.5	621.5	621.5 mmHg
CAL DATE:	7/12/07				
SLOPE (m):	1.22082				
INTERCEPT (b):	-0.01051				
CORRELATION (r):	0.999990				

ORIFICE MANOMETER (in. H_2O)			STAGNATION PORT (ΔP)				FLOWS	
							Q_a	Q_{ind}
LEFT	RIGHT	TOTAL	(in. H_2O)	(mm H_g)	P_1	P_1/P_o	(cmm)	(cmm)
2.40	1.70	4.10	24.5	45.8	575.7	0.9264	1.122	1.160

AUDIT FLOW

% DIFF.

3.41

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 (from table)

Appendix B-3

Site 3

PERFORMANCE AUDIT: TSP SAMPLER (VFC)

SAMPLER:

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

SERIAL NO: 7153

OWNER: ENERGY FUELS

LOCATION: SITE 3

DATE: 3/26/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	11.5	11.5	11.5 ^{0}C
SERIAL NO.:	G73	PRESSURE (P_0):	621.5	621.5	621.5 mmHg
CAL DATE:	7/12/07				
SLOPE (m):	1.22082				
INTERCEPT (b):	-0.01051				
CORRELATION (r):	0.999990				

ORIFICE MANOMETER (in. H_2O)			STAGNATION PORT (ΔP)				FLOWS	
							Q_a	Q_{ind}
LEFT	RIGHT	TOTAL	(in. H_2O)	(mm H_g)	P_1	P_1/P_o	(cmm)	(cmm)
2.60	1.80	4.40	24.5	45.8	575.7	0.9264	1.171	1.110

	AUDIT FLOW % DIFF.
	-5.23
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 (from table)

Appendix B-4

Site 4

PERFORMANCE AUDIT: TSP SAMPLER (VFC)

SAMPLER:

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

SERIAL NO: 7154

OWNER: ENERGY FUELS

LOCATION: SITE 4

DATE: 3/26/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	16.7	16.7	16.7 ^{0}C
SERIAL NO.:	G73	PRESSURE (P_0):	628.8	628.8	628.8 mmHg
CAL DATE:	7/12/07				
SLOPE (m):	1.22082				
INTERCEPT (b):	-0.01051				
CORRELATION (r):	0.999990				

ORIFICE MANOMETER (in. H_2O)			STAGNATION PORT (ΔP)				FLOWS	
							Q_a	Q_{ind}
LEFT	RIGHT	TOTAL	(in. H_2O)	(mm H_g)	P_1	P_1/P_o	(cmm)	(cmm)
2.60	1.70	4.30	25.2	47.1	581.7	0.9252	1.162	1.125

	AUDIT FLOW % DIFF.
	-3.20
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 (from table)

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: 3/26/08

BY: VSI

			INITIAL	FINAL	AVERAGE
ORIFICE MODEL:	25A	TEMPERATURE (T_0):	17.7	17.7	17.7 °C
SERIAL NO.:	G73	PRESSURE (P_0):	617.2	617.2	617.2 mmHg
CAL DATE:	7/12/07				
SLOPE (m):	1.22082				
INTERCEPT (b):	-0.01051				
CORRELATION (r):	0.999990				

ORIFICE MANOMETER (in. H_2O)			STAGNATION PORT (ΔP)				FLOWS	
LEFT	RIGHT	TOTAL	(in. H_2O)	(mm H_g)	P_1	P_1/P_o	Q_a (cmm)	Q_{ind} (cmm)
2.60	1.60	4.20	25.0	46.7	570.5	0.9244	1.161	1.073

AUDIT FLOW % DIFF.
-7.60

GUIDELINE: ± 7%

T_0 : Ambient Temperature (°C)

°C = (°F-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 (from table)

Energy Fuels Resources Corporation
Piñon Ridge Mill

Calibration Report for
Meteorological and Ambient Air Monitoring Network

2nd Quarter 2008

Prepared by:

IML Air Science
a division of Inter-Mountain Laboratories, Inc.
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1 Introduction

Inter-Mountain Laboratories – Air Science Division performed a startup calibration on February 27 – 29, 2008. A follow-up calibration was completed on March 26-27, 2008 that verified the February calibrations. The calibrations included all (5) of the meteorological and ambient air 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 °C to the nearest ±1 °C and referenced to a NIST or American Society for Testing and Materials (ASTM) thermometer within ±2 °C at least annually.
3) Portable barometer, capable of accurately measuring ambient barometric pressure over the range of 500 to 800 millimeters of mercury (mm Hg) to the nearest millimeter of mercury, and referenced within ±5 mm Hg to a barometer of known accuracy at least annually.
4) Digital manometers (0 – 20" and 0 – 40") with tubing.

2.3 Calibration Thresholds

Calibration goals for the parameters measured by the meteorological monitoring system are those specified in the US EPA *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Measurements*, March 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 °C
Delta Temperature	±0.1 °C
Relative Humidity	±5.0 %
Solar Radiation	±5.0 percent of observed
Barometric Pressure	±0.09 in Hg
Precipitation	±10 percent of observed

Table 2-2 – PM_{10} Sampler Criteria

Sensor	Specifications
Ambient Temperature	±2.0 °C
Filter Temperature	±2.0 °C
Pressure	± 10 mm Hg
Flow Rate	±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 sites and all of the equipment were fully operational to begin monitoring of data at the beginning of the 2nd Quarter of 2008.

Appendix A

PM_{10} Sampler Calibrations and Verifications

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

Partisol FRM Single Point Verification

Network:	Energy Fuels
Date:	2/26/2008
Time:	1528
Verification by:	T. Mendenhall
Streamline Pro CU ID:	CU05096
Streamline Pro MU ID:	M050906

Sampler ID: 1-2 (20806)

As-Found Calibration Values

Parameter	Offset	Span
A/I	-0.0003	0.9993
Amb. Temp.	0.0031	
Filter Temp.	0.0017	
Pressure	0.0053	
Flow	0.0198	0.962

Notes as found:

Sensors Verification

Sensor	Indicated	ΔP	Actual	Difference	Specification
Amb. Temp.	10.5		10.6	**0.1**	±2°C
Filter Temp.	11.7		11.1	**0.6**	±2°C
Pressure	637		627.3	**9.7**	± 10 mmHg
Flow	16.6		16.64	**0.0**	16.7 lpm ± 2% (± 0.33 lpm)

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

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

Maintenance

Inspect&clean inlets: 1st Stage

WINS seals replaced? No

Inspect cassette seals, any replaced? No

In-line filter replaced?: No

Inspect rubber hoses, tubing, connectors: No

Check board battery voltage:

Maintenance notes:

If any seals, fittings or other flow related parts were replaced, verify that the sampler is leak tight and operating at 16.7 liters/min.

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

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

	indicated	ΔP	actual
post-service flow check			

Notes:

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

Partisol FRM Single Point Verification

Network:	Energy Fuels
Date:	2/28/2008
Time:	1530
Verification by:	T. Mendenhall
Streamline Pro CU ID:	CU05096
Streamline Pro MU ID:	M050906

Sampler ID: 2-2 (20813)

As-Found Calibration Values

Parameter	Offset	Span
A/I	-0.0020	0.9996
Amb. Temp.	-0.0003	
Filter Temp.	-0.0032	
Pressure	0.0407	
Flow	-0.0115	0.9898

Notes as found:

Sensors Verification

Sensor	Indicated	ΔP	Actual	Difference	Specification
Amb. Temp.	13.4		13.7	**0.3**	±2°C
Filter Temp.	15.1		15.3	**0.2**	±2°C
Pressure	629		620.9	**8.1**	± 10 mmHg
Flow	16.7		16.92	**0.2**	16.7 lpm ± 2% (± 0.33 lpm)

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

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

Maintenance

Inspect&clean inlets: **1st Stage**

WINS seals replaced? **No**

Inspect cassette seals, any replaced? **No**

In-line filter replaced?: **Yes**

Inspect rubber hoses, tubing, connectors: **No**

Check board battery voltage:

Maintenance notes:

If any seals, fittings or other flow related parts were replaced, verify that the sampler is leak tight and operating at 16.7 liters/min.

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

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

	indicated	ΔP	actual
post-service flow check			

Notes:

Appendix B

TSP Sampler Calibrations

Sampler Flow Rate Calibration

Network: Energy Fuels
Sampler ID: 1-1
AIRS Site ID:
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 2/28/08
Calibrated By: Tim Mendenhall
Orifice ID: V1
Orifice Calibration Date: 12/14/07
Ambient Temperature (°C): 4.7
Ambient Pressure ("Hg): 24.70
Ambient Temperature (°K): 277.9
Ambient Pressure (mmHg): 627

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.954 and b = 0.005

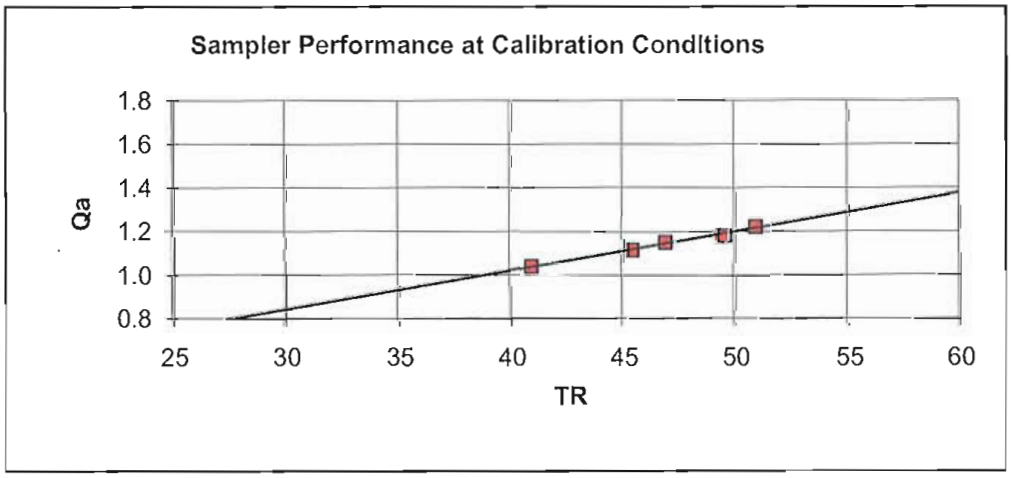
Calibration Point	Δ P ("H20)	TR (unitless)	It	Qa* (m3/min)	Qa** (m3/min)	% diff.
1	3.1	51.0	35.73	1.2230	1.2173	-0.5%
2	2.9	49.5	34.67	1.1806	1.1905	0.8%
3	2.8	47.0	32.92	1.1516	1.1459	-0.5%
4	2.6	45.5	31.87	1.1152	1.1191	0.3%
5	2.3	41.0	28.72	1.0411	1.0388	-0.2%

* flow rate from orifice equation
** flow rate from calibration equation

It = I*SQRT((Ta+30)/Pa)

Sampler Calibration:
Slope (m) **39.2414**
Intercept (b) **-12.0425**
r **0.9952**

For subsequent flow rate calculations:
Qa = {TR * SQRT[(Ta+30)/Pa] - b} * {1/m}
where: Qa = flow rate in m3/min
I = transducer recorder reading
Ta = ambient temperature in K
Pa = standard site pressure in mmHg



Notes:

Sampler Flow Rate Calibration

Network: Energy Fuels
Sampler ID: 2-1
AIRS Site ID:
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 2/28/08
Calibrated By: Tim Mendenhall
Orifice ID: V1
Orifice Calibration Date: 12/14/07
Ambient Temperature (°C): 3.1
Ambient Pressure ("Hg): 24.54
Ambient Temperature (°K): 276.3
Ambient Pressure (mmHg): 623

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.954 and b = 0.005

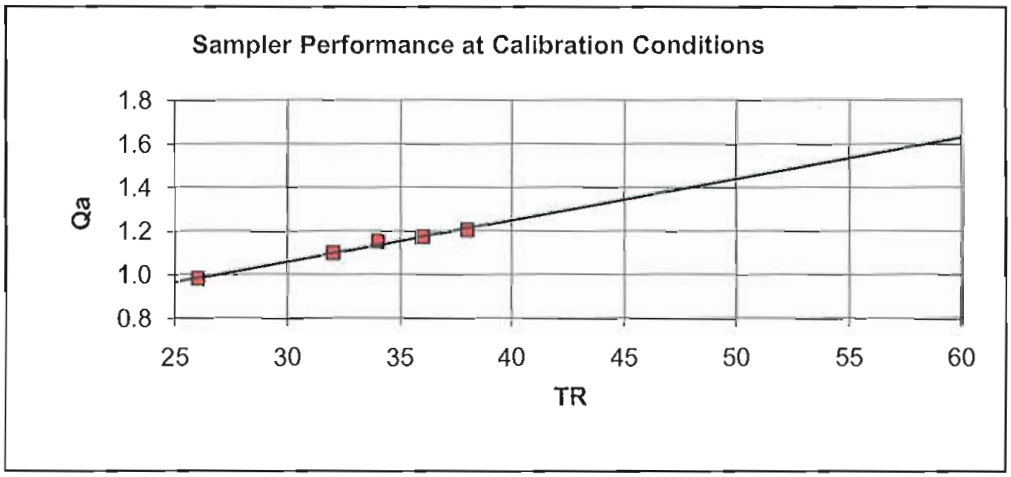
Calibration Point	Δ P ("H20)	TR (unitless)	It	Qa* (m3/min)	Qa** (m3/min)	% diff.
1	3.0	38.0	26.64	1.2034	1.2130	0.8%
2	2.9	36.0	25.23	1.1728	1.1749	0.2%
3	2.8	34.0	23.83	1.1520	1.1368	-1.3%
4	2.5	32.0	22.43	1.0981	1.0988	0.1%
5	2.0	26.0	18.22	0.9816	0.9846	0.3%

* flow rate from orifice equation
** flow rate from calibration equation

It = I*SQRT((Ta+30)/Pa)

Sampler Calibration:
Slope (m) **36.8286**
Intercept (b) **-18.0356**
r **0.9946**

For subsequent flow rate calculations:
Qa = {TR * SQRT[(Ta+30)/Pa] - b} * {1/m}
where: Qa = flow rate in m3/min
I = transducer recorder reading
Ta = ambient temperature in K
Pa = standard site pressure in mmHg



Notes:

Sampler Flow Rate Calibration

Network: Energy Fuels
Sampler ID: 3-1
AIRS Site ID:
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 2/28/08
Calibrated By: Tim Mendenhall
Orifice ID: V1
Orifice Calibration Date: 12/14/07
Ambient Temperature (°C): 12.3
Ambient Pressure ("Hg): 24.60
Ambient Temperature (°K): 285.5
Ambient Pressure (mmHg): 625

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.954 and b = 0.005

Calibration Point	Δ P ("H20)	TR (unitless)	It	Qa* (m3/min)	Qa** (m3/min)	% diff.
1	3.0	46.0	32.68	1.2219	1.2292	0.6%
2	2.8	42.0	29.84	1.1697	1.1628	-0.6%
3	2.5	39.0	27.71	1.1150	1.1130	-0.2%
4	2.0	32.0	22.74	0.9967	0.9968	0.0%
5	1.5	24.0	17.05	0.8625	0.8640	0.2%

* flow rate from orifice equation
** flow rate from calibration equation

It = I*SQRT((Ta+30)/Pa)

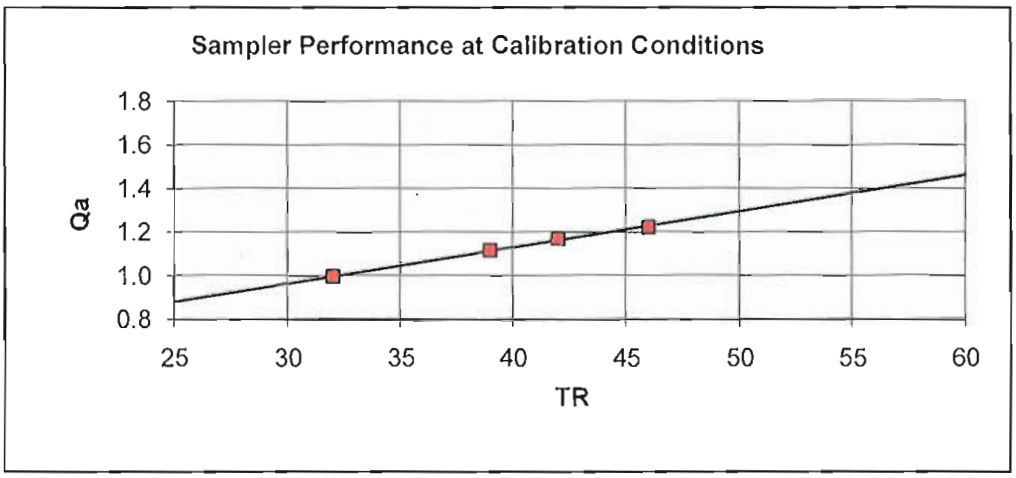
Sampler Calibration:

Slope (m)	**42.8104**
Intercept (b)	**-19.9363**
r	**0.9994**

For subsequent flow rate calculations:

Qa = {TR * SQRT[(Ta+30)/Pa] - b} * {1/m}

where: Qa = flow rate in m3/min
I = transducer recorder reading
Ta = ambient temperature in K
Pa = standard site pressure in mmHg



Notes:

Sampler Flow Rate Calibration

Network: Energy Fuels
Sampler ID: 3-1
AIRS Site ID:
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 3/7/08
Calibrated By: Kris Allen
Orifice ID: 1258
Orifice Calibration Date: 1/22/08
Ambient Temperature (°C): 6.1
Ambient Pressure ("Hg): 24.70
Ambient Temperature (°K): 279.3
Ambient Pressure (mmHg): 627

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.991 and b = -0.015

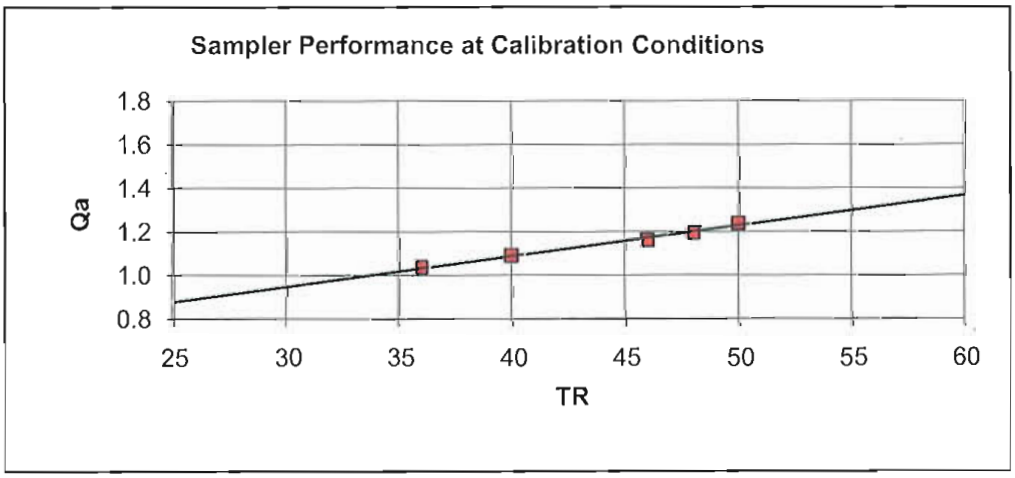
Calibration Point	Δ P ("H20)	TR (unitless)	It	Qa* (m3/min)	Qa** (m3/min)	% diff.
1	3.3	50.0	35.10	1.2381	1.2279	-0.8%
2	3.1	48.0	33.70	1.1947	1.2000	0.4%
3	2.9	46.0	32.30	1.1616	1.1721	0.9%
4	2.6	40.0	28.08	1.0902	1.0883	-0.2%
5	2.3	36.0	25.28	1.0361	1.0324	-0.4%

* flow rate from orifice equation
** flow rate from calibration equation

It = I*SQRT((Ta+30)/Pa)

Sampler Calibration:
Slope (m) **50.2696**
Intercept (b) **-26.6239**
r **0.9951**

For subsequent flow rate calculations:
Qa = {TR * SQRT[(Ta+30)/Pa] - b} * {1/m}
where: Qa = flow rate in m3/min
I = transducer recorder reading
Ta = ambient temperature in K
Pa = standard site pressure in mmHg



Notes:

Sampler Flow Rate Calibration

Network: Energy Fuels
Sampler ID: 4-1
AIRS Site ID:
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 2/29/08
Calibrated By: Tim Mendenhall
Orifice ID: V1
Orifice Calibration Date: 12/14/07
Ambient Temperature (°C): 7.0
Ambient Pressure ("Hg): 24.82
Ambient Temperature (°K): 280.2
Ambient Pressure (mmHg): 630

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.954 and b = 0.005

Calibration Point	Δ P ("H20)	TR (unitless)	It	Qa* (m3/min)	Qa** (m3/min)	% diff.
1	3.1	57.0	39.98	1.2251	1.2326	0.6%
2	3.0	55.0	38.58	1.2050	1.1995	-0.5%
3	2.8	52.0	36.47	1.1535	1.1498	-0.3%
4	2.5	49.0	34.37	1.0996	1.1001	0.0%
5	2.0	42.0	29.46	0.9830	0.9842	0.1%

* flow rate from orifice equation
** flow rate from calibration equation

It = I*SQRT((Ta+30)/Pa)

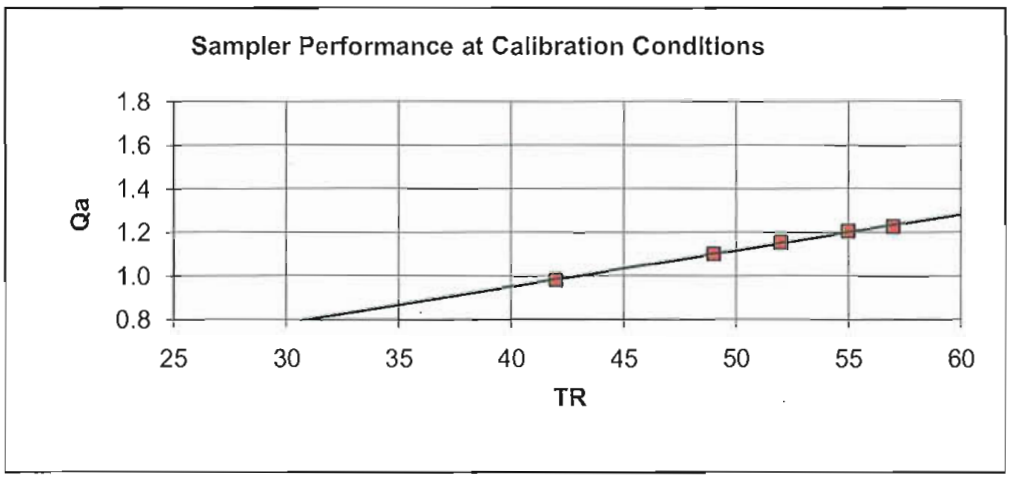
Sampler Calibration:

Slope (m)	**42.3697**
Intercept (b)	**-12.2434**
r	**0.9986**

For subsequent flow rate calculations:

Qa = {TR * SQRT[(Ta+30)/Pa] - b} * {1/m}

where: Qa = flow rate in m3/min
I = transducer recorder reading
Ta = ambient temperature in K
Pa = standard site pressure in mmHg



Notes:

Sampler Flow Rate Calibration

Network: Energy Fuels
Sampler ID: 5-1
AIRS Site ID:
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 2/29/08
Calibrated By: Tim Mendenhall
Orifice ID: V1
Orifice Calibration Date: 12/14/07
Ambient Temperature (°C): 7.0
Ambient Pressure ("Hg): 24.82
Ambient Temperature (°K): 280.2
Ambient Pressure (mmHg): 630

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa)}-b]*[1/m]
where m = 0.954 and b = 0.005

Calibration Point	Δ P ("H20)	TR (unitless)	It	Qa* (m3/min)	Qa** (m3/min)	% diff.
1	3.2	41.0	28.76	1.2447	1.2551	0.8%
2	3.0	39.0	27.35	1.2050	1.2027	-0.2%
3	2.8	37.0	25.95	1.1640	1.1503	-1.2%
4	2.0	31.0	21.74	0.9830	0.9932	1.0%
5	1.8	28.0	19.64	0.9191	0.9146	-0.5%

* flow rate from orifice equation
** flow rate from calibration equation

It = I*SQRT((Ta+30)/Pa)

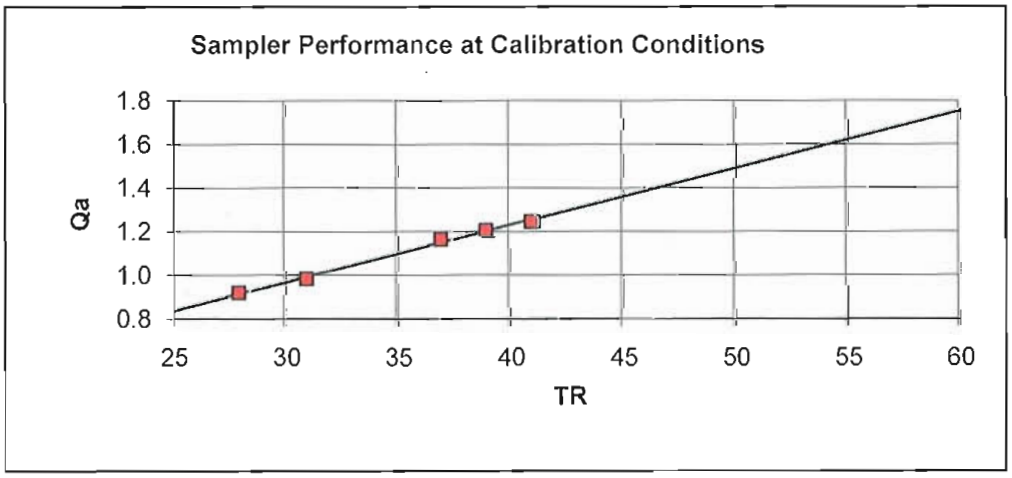
Sampler Calibration:

Slope (m)	**26.7797**
Intercept (b)	**-4.8534**
r	**0.9974**

For subsequent flow rate calculations:

Qa = {TR * SQRT[(Ta+30)/Pa] - b} * {1/m}

where: Qa = flow rate in m3/min
I = transducer recorder reading
Ta = ambient temperature in K
Pa = standard site pressure in mmHg



Notes:

High Volume Sampler Flow Rate Calibration

Network: Energy Fuels
Sampler ID: 5-1
AIRS Site ID:
Sampler Type: Tisch TE-5170-DV-BL
Sampler Calibration Date: 3/26/08
Calibrated By: Tim Mendenhall
Orifice ID: V1
Orifice Calibration Date: 12/14/07
Ambient Temperature (℃): 17.2
Ambient Pressure ("Hg): 24.25
Ambient Temperature (K): 290.4
Ambient Pressure (mmHg): 616

Orifice Relationship: Qa = [SQRT{(ΔP)*(Ta/Pa))-b]*[1/m]
where m = 0.954 and b = 0.005

Sampler:

Calibration Point	ΔP	Pstg/13.6	P1	P1/Pa
1	5.2	0.38	23.87	0.9842
2	11.3	0.83	23.42	0.9657
3	18.9	1.39	22.86	0.9427
4	26.9	1.98	22.27	0.9184
5	31.7	2.33	21.92	0.9039

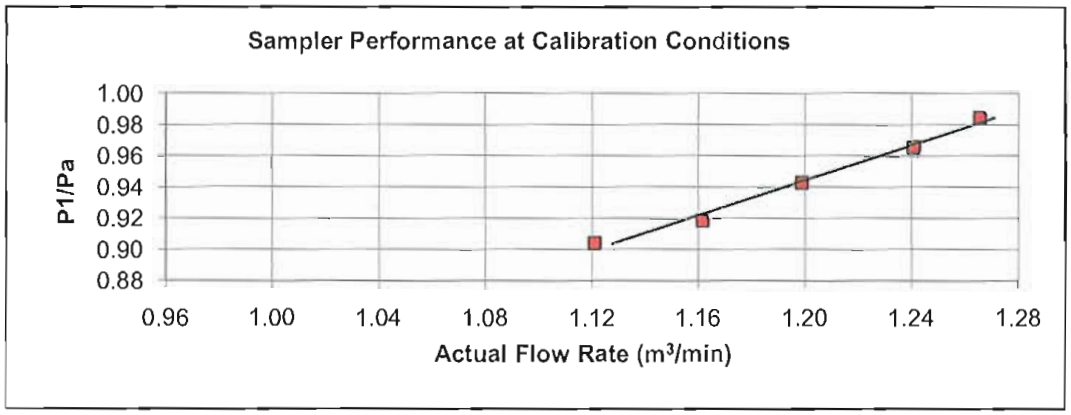
Orifice:

Calibration Point	ΔP	Qa(orf)	Qa/sqrt(Ta)	Qa(eq)	% diff
1	3.12	1.2656	0.0743	1.2710	0.4%
2	3.00	1.2410	0.0728	1.2380	-0.2%
3	2.80	1.1987	0.0704	1.1969	-0.1%
4	2.63	1.1616	0.0682	1.1537	-0.7%
5	2.45	1.1209	0.0658	1.1277	0.6%

Sampler Calibration:

Slope	**9.5540**
Intercept	**0.2714**
r	**0.9946**
Failure Temp (℃)	**-64.2**

Use this equation for subsequent flow calculations:
Qa = {[P1/Pa - 0.2714] * [SQRT(Ta)]} * {1/9.5540}



Notes:

Appendix C

Meteorological System Calibrations

METEOROLOGICAL STATION CALIBRATION SUMMARY

Met Station: Energy Fuels - Site 1 (10m Tower) Calibration Date: 26-Feb-08
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 0857
Wind Direction 10m (WD):	RM Young Wind Monitor AQ	82346	transit, compass	5080800156
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)

		Reference m/s	DAS Value	|Difference|	Specification	
WD 10 meters (degrees)		0.0	0.1	0.1	5.0	(2)
		90.0	90.4	0.4	5.0	(2)
		180.0	179.8	0.2	5.0	(2)
		270.0	270.4	0.4	5.0	(2)

		Reference RPM	Reference cm/s	DAS Value	|Difference|	Specification	
Vertical WS 10 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
(Clockwise)		200	100.00	100.20	0.20	25.00	(2)
	EPS:	600	300.00	298.30	1.70	35.00	(2)
		2000	1000.00	987.30	12.70	70.00	(2)
		5000	2500.00	2451.30	48.70	145.00	(2)
		0	0.00	-0.30	0.30	below threshold	
		200	100.00	100.10	0.10	25.00	(2)
	CFT:	600	300.00	299.60	0.40	35.00	(2)
		2000	1000.00	1001.20	1.20	70.00	(2)
		5000	2500.00	2500.61	0.61	145.00	(2)
Vertical WS 10 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
(Counter-Clockwise)		200	-100.00	-99.60	0.40	15.00	(2)
	EPS:	600	-300.00	-295.31	4.69	5.00	(2)
		2000	-1000.00	-987.10	12.90	-30.00	(2)
		5000	-2500.00	-2450.80	49.20	-105.00	(2)
		0	0.00	0.00	0.00	below threshold	
		200	-100.00	-101.60	1.60	15.00	(2)
	CFT:	600	-300.00	-302.30	2.30	5.00	(2)
		2000	-1000.00	-999.80	0.20	-30.00	(2)
		5000	-2500.00	-2501.30	1.30	-105.00	(2)
WS 10 m start torque (gm-cm)			τ<0.5	N/A	N/A	1.0	(3)

			Reference (°C):	DAS Value	|Difference|	Specification	
			0.05	0.09	0.04	0.5	(2)
Temp. (°C): 2 meter			23.79	24.10	0.31	0.5	(2)
			11.81	11.83	0.02	0.5	(2)
Temp. (°C): 10 meter			0.05	0.06	0.01	0.5	(2)
			23.79	23.92	0.13	0.5	(2)
			11.81	11.76	0.05	0.5	(2)

			Reference	DAS Value	|Difference|	Specification	
Relative Humidity (%)	Hourly Averages		37.6	38.1	0.5	2.6	(2)
RH Sensor Temp (°C):	Hourly Averages		46.8	46.0	0.8		
Solar Radiation (W/m^2)	Hourly Averages	un-covered	773.2	775	1.6	38.7	(4)
		covered	0.00	0.00			
Barometric Pressure ("Hg)			24.90	24.92	0.02	0.09	(4)

	DAS Value (in)	Reference (ml)	DAS Equivalent	|Difference|	Specification	
Precipitation (0.1" equiv.)	0.10	192.8	185.3	7.5	18.5	(2)
	0.10	188.2	185.3	2.9	18.5	(2)
	0.10	189.6	185.3	4.3	18.5	(2)
			Average Diff:	4.9	18.5	(2)

	2m sensor	10m sensor	ΔT - B	Specification	
Delta Temperature (°C):	0.09	0.06	0.03	0.1	(2)
	24.10	23.92	0.18	0.1	(2)
	11.83	11.76	0.07	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: 0759 MST
Time Online: 1245 MST

METEOROLOGICAL STATION CALIBRATION SUMMARY

Met Station: Energy Fuels - Site 2 (30m Tower) Calibration Date: 26-Feb-08
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 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	0.9	0.9	5.0	(2)
		90.0	90.4	0.4	5.0	(2)
		180.0	179.9	0.1	5.0	(2)
		270.0	270.1	0.1	5.0	(2)

		Reference RPM	Reference cm/s	DAS Value	|Difference|	Specification	
Vertical WS 30 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
(Clockwise)		200	100.00	100.83	0.83	25.00	(2)
	EPS:	600	300.00	301.20	1.20	35.00	(2)
		2000	1000.00	980.30	19.70	70.00	(2)
		5000	2500.00	2482.10	17.90	145.00	(2)
		0	0.00	0.00	0.00	below threshold	
		200	100.00	101.80	1.80	25.00	(2)
	CFT:	600	300.00	303.60	3.60	35.00	(2)
		2000	1000.00	1000.24	0.24	70.00	(2)
		5000	2500.00	2500.10	0.10	145.00	(2)
Vertical WS 30 meters (cm/s)		0	0.00	0.00	0.00	below threshold	
(Counter-Clockwise)		200	-100.00	-101.20	1.20	15.00	(2)
	EPS:	600	-300.00	-301.30	1.30	5.00	(2)
		2000	-1000.00	-979.90	20.10	-30.00	(2)
		5000	-2500.00	-2489.60	10.40	-105.00	(2)
		0	0.00	0.00	0.00	below threshold	
		200	-100.00	-101.30	1.30	15.00	(2)
	CFT:	600	-300.00	-302.60	2.60	5.00	(2)
		2000	-1000.00	-1004.10	4.10	-30.00	(2)
		5000	-2500.00	-2502.30	2.30	-105.00	(2)
WS 30 m start torque (gm-cm)			τ<0.5	N/A	N/A	1.0	(3)

			Reference (°C):	DAS Value	|Difference|	Specification	
			0.90	0.67	0.23	0.5	(2)
Temp. (°C): 2 meter			23.60	23.73	0.13	0.5	(2)
			41.40	41.22	0.18	0.5	(2)
Temp. (°C): 30 meter			0.90	0.63	0.27	0.5	(2)
			23.60	23.75	0.15	0.5	(2)
			41.40	41.27	0.13	0.5	(2)
			Reference	DAS Value	|Difference|	Specification	
Relative Humidity (%)	Hourly Averages		65.0	67.6	2.6	4.6	(2)
RH Sensor Temp (°C):	Hourly Averages		36.7	37.9	1.2		
Solar Radiation (W/m^2)	Hourly Averages	un-covered	710.2	737	27.1	35.5	(4)
		covered	0.26	0.00			
Barometric Pressure ("Hg)			24.55	24.54	0.01	0.09	(4)
			2m sensor	10m sensor	ΔT - B	Specification	
Delta Temperature (°C):			0.67	0.63	0.04	0.1	(2)
			23.73	23.75	0.02	0.1	(2)
			41.22	41.27	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

Not powered. Left system off.

Time Offline:
Time Online:

EVAPORATION CALIBRATION SUMMARY

Met Station: Energy Fuels - Site 1 (10m Tower) Calibration Date: 26-Mar-08
Calibration Performed By: C. Medill & T. Mendenhall - IML Air Science

Evaporation Pan Calibration Results		
Starting Slope:	9.14	
Starting Offset:	1.25	
Empty Pan Logger Reading:		0.00048

Calibration Point	Yardstick Reading (in)*	Logger Reading
1	1.25	0.00050
2	1.75	0.05471
3	4	0.30416
4	6.5	0.57440
5	8.25	0.76915
EvapSpan	9.116612035	
EvapOffset	1.245044217	
Correlation	0.999989688	

Notes, Recommendations

* Yard Stick Reading - taken at the pan outlet to the gauge
The correlation should be greater than .9900
Time Offline: 0759 MST
Time Online: 1245 MST

Appendix D

Transfer Standard Certifications

CERTIFICATE OF CALIBRATION

Orifice Transfer Standard - **V1**
IML Air Science Sheridan, WY

V1 orifice transfer standard was calibrated on the NIST traceable Dresser rootsmeter serial # 9217756 on 14-Dec-07
Calibration expires 14-Dec-08

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= **0.653**
B= **0.501**
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= **0.954**
b= **0.005**
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= **1.523**
b= **0.007**
ΔPo = pressure drop across orifice, inches of water
Ta = ambient temperature, Kelvin
Pa = ambient pressure, mm Hg

SE
Reviewed

12/14/2007
Date

ORIFICE TRANSFER STANDARD CALIBRATION
QUALITY ASSURANCE

Orifice Transfer Standard# **V1**

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
0.811	0.809	-0.24%
1.074	1.081	0.67%
1.133	1.131	-0.14%
1.242	1.234	-0.64%
1.411	1.417	0.42%
1.595	1.594	-0.05%
1.849	1.848	-0.05%

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: 14-Dec-07
ORIFICE #: V1
TECH: Cory Medill
TEMP (℃): 20.70
PRES("Hg): 26.11
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	4.1667	3.8297	1.3600
2	3.3985	3.1333	6.7254	2.4200
3	3.3985	2.9667	7.3793	2.6500
4	3.3985	2.7000	8.9672	3.1500
5	3.3985	2.3667	11.5827	4.1500
6	3.3985	2.0833	14.7585	5.2500
7	3.3985	1.7833	19.7092	7.0500

	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	3.379	0.811	0.776	1	2.990	0.718	1.097
2	3.364	1.074	1.036	2	2.977	0.950	1.463
3	3.361	1.133	1.084	3	2.974	1.002	1.531
4	3.353	1.242	1.181	4	2.967	1.099	1.670
5	3.339	1.411	1.356	5	2.955	1.249	1.916
6	3.323	1.595	1.525	6	2.941	1.411	2.155
7	3.297	1.849	1.767	7	2.918	1.636	2.498

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 22-Jan-08

Calibration expires 22-Jan-09

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

$$Q_r = A(\Delta P_o)^B \qquad r = 0.9998$$

where: A= **0.645**
B= **0.493**
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= **0.991**
b= **-0.015**
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= **1.582**
b= **-0.021**
ΔPo = pressure drop across orifice, inches of water
Ta = ambient temperature, Kelvin
Pa = ambient pressure, mm Hg

SH — Reviewed

1/22/2008 — Date

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
0.967	0.966	-0.08%
1.041	1.035	-0.52%
1.132	1.141	0.77%
1.184	1.180	-0.32%
1.382	1.385	0.27%
1.557	1.556	-0.07%
1.783	1.782	-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:	22-Jan-08
ORIFICE #:	1258
TECH:	Cory Medill
TEMP (℃):	20.10
PRES("Hg):	26.00
CLIENT:	Kleinfelder
LOCATION:	Albuquerque, NM

POINT	DELTA VOLUME m^3	TIME MIN	DELTA H roots mmHg	DELTA H orifice "H2O
1	3.3985	3.4833	5.6979	2.0000
2	3.3985	3.2333	6.5386	2.3000
3	3.3985	2.9667	7.8463	2.8000
4	3.3985	2.8333	8.5002	3.0000
5	3.3985	2.4167	11.5827	4.1500
6	3.3985	2.1333	14.7585	5.2500
7	3.3985	1.8500	19.3356	6.9000

	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	0.967	0.942	1	2.975	0.854	1.329
2	3.365	1.041	1.011	2	2.971	0.919	1.425
3	3.358	1.132	1.115	3	2.965	1.000	1.572
4	3.355	1.184	1.154	4	2.962	1.046	1.628
5	3.339	1.382	1.357	5	2.948	1.220	1.914
6	3.323	1.557	1.527	6	2.934	1.375	2.153
7	3.299	1.783	1.750	7	2.913	1.575	2.468

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

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 Hygrometer

Transfer standard, model/type: Dwyer Series 485 Digital Hygrometer
Serial number: IML 0936
submitted by/owner: IML Air Science

Was compared to Omega Digital Psychrometer
Model number: RH5100C Serial number: 2542, IML 0906

Date: 1/8/2004 Lab temperature: Varies °F
Barometric Pressure: 663.3 mmHG

Reference Hygrometer (%RH)	Transfer Standard (%RH)	Difference from Reference (%RH)	Transfer Standard Correction* (%RH)
20.1	19.9	-0.2	0.2
100.0	100.0	0.0	0.0

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

Transfer Standard adjustments made (calibrated)? YES **NO**
Post-calibration measurements:

Reference Thermistor (%RH)	Transfer Standard (%RH)	Difference from Reference (%RH)

Reviewed: Date:

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

Certificate of Accuracy

Transfer Standard Type: Barometric Pressure/Altimeter

Certificate No: B 050307. 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: 05/03/07 Lab temperature 77.6 ℉
Lab pressure 650.3 mm Hg

Reference barometer ("Hg)	Transfer Standard ("Hg)	Difference from Reference ("Hg)	Transfer Standard Correction* ("Hg)
24.00	24.00	0.00	0.00
25.00	25.00	0.00	0.00
25.60	25.60	0.00	0.00
26.09	26.10	0.01	-0.01
27.96	27.95	-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: Date:

Roger L. Sanders, PE

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