

ADDENDUM 2.5-A
METEOROLOGICAL SYSTEM AUDIT REPORT

Prepared for:
AUC LLC: Reno Creek Uranium Project
Wright, Wyoming

Meteorological System Audit Report

**Project-to-Date
December, 2011**

Prepared by:



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1.0 Introduction

On October 6th, 2010 a meteorological monitoring system was installed at the Reno Creek Project operated by AUC LLC. The meteorological monitoring system consists of a set of sensors mounted on a 10 meter tower. The table below provides the sensor type, make and model, accuracy, and measurement method.

Reno Creek Meteorological Monitoring Program Parameter Configuration and Measurement Methods						
Parameter	Manufacturer/Model	Sample Frequency	Averaging Period	Measurement Range	Lower Detection Limit	Method
Wind Speed (10-meter)	RM Young 05305 Wind Monitor AQ	Continuous	15 minute 1- hour	0 to 50 m/s	0.2 m/s	AC Sine Wave Voltage
Wind Direction (10-meter)	RM Young 05305 Wind Monitor AQ	Continuous	15 minute 1- hour	0 to 360°	N.A.	Vane/Potentiometer
Wind Speed Gust (10-meter)	RM Young 05305 Wind Monitor AQ	Continuous	15 minute 1- hour	0 to 50 m/s	0.2 m/s	5 sec and 2 min running average
Wind Direction Gust (10-meter)	RM Young 05305 Wind Monitor AQ	Continuous	15 minute 1- hour	0 to 360°	N.A.	5 sec and 2 min running average
Sigma Theta ($\sigma\theta$) (10-meter)	Campbell Scientific Model CR1000 Datalogger	Continuous	15 minute 1- hour	0 to 103.9°	N.A.	Yamartino Single Pass Estimator of $\sigma\theta$ (Yamartino 1984)
Temperature (2-meter)	RM Young 41342	Continuous	15 minute 1- hour	-35°C to 50°C	N.A.	Thermistor
Relative Humidity (2-meter)	Vaisala HMP50	Continuous	15 minute 1- hour	0 to 98%	3%	Vaisala INTERCAP® capacitive relative humidity sensor
Precipitation (1-meter)	Hydrological Services TB3 Low Power Heated Tipping Bucket	Continuous	15 minute 1- hour	0 to 700 mm/hr	0.01 in	Heated tipping Bucket
Barometric Pressure (1.5-meter)	Vaisala PTB110	4 samples per hour	15 minute 1- hour	500 mb to 1100 mb	< 1.5 mb	Aneroid Barometer/ Capacitive Transducer
Total Solar Radiation (2-meter)	LiCor LI-200X	Continuous	15 minute 1- hour	285 to 2800 W/m ²	< 1 W/m ²	High stability silicon photovoltaic Pyranometer

A performance audit of the system was performed immediately following the installation. Semi-annual performance audits of the system were performed in the 2nd and 4th quarters of 2011. The audit results are discussed in detail in section 3.0 with a summary for included for each audit. The installed equipment, station siting, operation, and audit results are conducted in accordance with the following guideline documents:

- U.S. Nuclear Regulatory Commission: Regulatory Guide, version 3.63, March 1988.
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV – Meteorological Measurements Version 2.0 (Final), March 2008
- Meteorological Monitoring Guidance for Regulatory Modeling Applications, February 2000

2.0 Audit Methodology and Accuracy Goals

The accuracy of meteorological measurements is assessed by auditing the performance of the system for each measured parameter. Traceable reference standards are used to provide known conditions with which to evaluate system response. Independent audits are conducted using a different set of traceable reference standards and by different personnel from those used to perform system adjustments and/or calibrations.

Start-up audits are required to be performed within 30 days of installation and on a semi-annual basis thereafter to ensure data quality. In the event of repairs, alterations, or calibrations to any or all portions of the system, an audit will be performed before returning the system online. Before decommissioning of the system, a shut-down audit will be performed to ensure accurate data collection.

Temperature accuracy is assessed at a minimum of three points using either wet or dry thermal mass devices and a traceable temperature reference standard. Wind speed is assessed by rotating the anemometer shaft at a minimum of five known rotation rates with a quartz drive motor. Using the transfer equation for the anemometer, known wind speeds are determined and compared with the system response. Cross arm mount or landmark alignment is checked with a transit. The anemometer/wind vane is aligned perpendicular and parallel to the cross arm or pointed at a landmark and the system response is compared to transit readings. Wind direction linearity is also checked by evaluating system response at the four cardinal directions with a clockwise and counter clockwise rotation. Precipitation gauge accuracy is checked by introducing a known volume of water into the gauge and recording the output. Barometric pressure and relative humidity undergo a one-point comparison to a traceable reference standard for their respective measured parameter. Solar radiation undergoes at least one daylighted and one dark (zero) instantaneous or time averaged comparison to a traceable reference standard.

Meteorological measurement system audit results are reported by determining the difference between reference conditions and system response. The difference is compared directly to control limits for each parameter.

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

Meteorological System Accuracy Parameters		
Temperature	±0.5°C of standard	Semi-annually
Relative Humidity	±7% of standard	Semi-annually
Wind speed	± 0.2 m/s	Semi-annually
Wind direction	±5° at the DAS	Semi-annually
Precipitation	±10% of input volume	Semi-annually
Barometric Pressure	±3 mb Hg	Semi-annually
Solar Radiation	±5% > 500 w/m ² observed, 25 w/m ² < 500 w/m ²	Semi-annually

3.0 Audit Results

The results for the start-up (4Q 2010) and 2011 semi-annual audits are presented on subsequent pages in chronological order.

4.0 Findings/Recommendations

The parameters were found to be within the accuracy specifications for all three audits performed. No adjustments, alterations, or calibrations were required following the audits.

METEOROLOGICAL STATION AUDIT SUMMARY



Met Station: Reno Creek
 Audit Date: 6-Oct-10
 Audit Performed By: C. Medill, D. Barkan -- IML Air Science

Sensor	Mfr./Model	Serial #	Reference Device	Serial ID
Wind Speed (WS):	R.M. Young Wind Monitor AQ	102448	quartz drive motor	IML 1407
Wind Direction (WD):	R.M. Young Wind Monitor AQ	102448	transit, compass	IML 0894
Temperature (T):	Fenwal 107		Digital Thermistor	IML 1402
Evap Water Temperature (T):	Fenwal 107		Digital Thermistor	IML 1402
Barometric Pressure (BP):	Vaisala PTB 110	F2310009	digital barometer	IML 1404
Solar Radiation (SR):	Li-Cor LI200X	PY68879	co-located sensor	PY65374
Relative Humidity (RH):	HMP 50		digital psychrometer	IML 0892
Precipitation (Ppt.):	Hydrological Services TB3		lab grade burette	N/A
Evaporation Pan Sensor:	Novalynx		tape measure	N/A
Data acquisition system (DAS):	Campbell Scientific CR1000		N/A	N/A

Audit Results

	Reference	Reference	DAS Value	Difference	Specification	
WS (mph)	0	0.00	0.00	0.00	0.56	✓ (1)
	300	3.44	3.44	0.00	0.56	✓ (1)
	800	9.16	9.16	0.00	0.56	✓ (1)
	3000	34.35	34.35	0.00	0.56	✓ (1)
	8000	91.60	91.60	0.00	0.56	✓ (1)
Crossarm Alignment (°)		182.0	180.2	1.8	5.0	✓ (2)
WS start torque (gm-cm)		1.0	t<1.0	N/A	1.0	✓ (3)
WD (degrees)	Clockwise	0.0	0.7	0.7	5.0	✓ (1)
		90.0	90.0	0.0	5.0	✓ (1)
		180.0	179.8	0.2	5.0	✓ (1)
		270.0	270.1	0.1	5.0	✓ (1)
	Counter Clockwise	0.0	0.2	0.2	5.0	✓ (1)
		90.0	90.8	0.8	5.0	✓ (1)
		180.0	179.2	0.8	5.0	✓ (1)
		270.0	269.2	0.8	5.0	✓ (1)
WD start torque (gm-cm)	Clockwise	11.0	t<11.0	N/A	11.0	✓ (3)
	Counter Clockwise	11.0	t<11.0	N/A	11.0	✓ (3)
Temperature (°C)		0.29	0.49	0.20	0.9	✓ (1)
		19.20	19.00	0.20	0.9	✓ (1)
		35.01	35.01	0.00	0.9	✓ (1)
Evap Water Temperature (°C)		1.10	0.86	0.24	0.9	(1)
		17.84	17.34	0.50	0.9	(1)
		31.27	30.98	0.29	0.9	(1)
Precipitation (0.1" equiv.)		75.7	79.7	4.0	7.9	(1)
		81.8	79.7	2.1	7.9	(1)
		82.1	79.7	2.4	7.9	(1)
Relative Humidity (%)		39.9	39.9	0.0	7.0	(1)
RH Sensor Temp (°F)		61.0	64.4	3.4		
Pressure (in. Hg)		24.95	24.98	0.03	0.09	(2)
Solar Radiation (W/m ²)		10.5	11.0	0.5	0.5	(3)

BOLD difference values exceed performance specifications
 (1)= Performance specification listed in facilities' Quality Assurance Project Plan
 (2)= Performance specification listed in EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements Version 2.0, 2008
 (3)= Manufacturer's Specifications

Notes, Recommendations

System online at 18:52 MST.
 New Install.

METEOROLOGICAL STATION AUDIT SUMMARY



Met Station: Reno Creek
 Audit Date: 29-Jun-11
 Audit Performed By: S. Hansen, C. Medill -- IML Air Science

Sensor	Mfr./Model	Serial #	Reference Device	Serial ID
Wind Speed (WS):	R.M. Young Wind Monitor AQ	102448	quartz drive motor	IML 0896
Wind Direction (WD):	R.M. Young Wind Monitor AQ	102448	transit, compass	IML 0894
Temperature (T):	Fenwal 107		Digital Thermistor	IML 0885
Evap Water Temperature (T):	Fenwal 107		Digital Thermistor	IML 0885
Barometric Pressure (BP):	Vaisala PTB 110	F2310009	digital barometer	IML 0918
Solar Radiation (SR):	Li-Cor LI200X	PY68879	co-located sensor	PY65374
Relative Humidity (RH):	HMP 50		digital psychrometer	IML 0890
Precipitation (Ppt.):	Hydrological Services TB3		lab grade burette	N/A
Evaporation Pan Sensor:	Novalynx		tape measure	N/A
Data acquisition system (DAS):	Campbell Scientific CR1000		N/A	N/A

Audit Results

	Reference	Reference	DAS Value	Difference	Specification	
WS (mph)	0	0.00	0.00	0.00	0.56	✓ (1)
	300	3.44	3.44	0.00	0.56	✓ (1)
	800	9.16	9.16	0.00	0.56	✓ (1)
	3000	34.35	34.35	0.00	0.56	✓ (1)
	8000	91.60	91.60	0.00	0.56	✓ (1)
Crossarm Alignment (°)		180.8	180.2	0.6	5.0	✓ (2)
WS start torque (gm-cm)		1.0	<1.0	N/A	1.0	✓ (3)
WD (degrees)	Clockwise	0.0	0.7	0.7	5.0	✓ (1)
		90.0	89.5	0.5	5.0	✓ (1)
		180.0	180.8	0.8	5.0	✓ (1)
		270.0	270.8	0.8	5.0	✓ (1)
	Counter Clockwise	0.0	0.1	0.1	5.0	✓ (1)
		90.0	90.3	0.3	5.0	✓ (1)
		180.0	180.7	0.7	5.0	✓ (1)
		270.0	270.8	0.8	5.0	✓ (1)
WD start torque (gm-cm)	Clockwise	11.0	<11.0	N/A	11.0	✓ (3)
	Counter Clockwise	11.0	<11.0	N/A	11.0	✓ (3)
Temperature (°C)		25.75	26.12	0.37	0.9	✓ (1)
		51.66	51.41	0.25	0.9	✓ (1)
		0.63	0.76	0.13	0.9	✓ (1)
Evap Water Temperature (°C)		1.87	2.07	0.20	0.9	✓ (1)
Precipitation (0.1" equiv.)		86.4	79.7	6.7	7.9	✓ (1)
		78.8	79.7	0.9	7.9	✓ (1)
		76.6	79.7	3.1	7.9	✓ (1)
Relative Humidity (%)		20.9	27.3	6.4	7.0	✓ (1)
RH Sensor Temp (°F)		91.3	88.4	2.9		
Pressure (in. Hg)		24.66	24.69	0.03	0.09	✓ (2)
Solar Radiation (W/m ²)		959.3	928.6	30.7	48.0	✓ (3)

BOLD difference values exceed performance specifications
 (1)= Performance specification listed in facilities' Quality Assurance Project Plan
 (2)= Performance specification listed in EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements Version 2.0, 2008
 (3)= Manufacturer's Specifications

Notes, Recommendations

System taken off-line at 14:04 MST and returned on-line at 14:30 MST.
 Evap tank almost empty.

METEOROLOGICAL STATION AUDIT SUMMARY



Met Station: Reno Creek
 Audit Date: 8-Dec-11
 Audit Performed By: K. Hansen, Z. Heid -- IML Air Science

Sensor	Mfr./Model	Serial #	Reference Device	Serial ID
Wind Speed (WS):	R.M. Young Wind Monitor AQ	102448	quartz drive motor	IML 0896
Wind Direction (WD):	R.M. Young Wind Monitor AQ	102448	transit, compass	IML 0900
Temperature (T):	Fenwal 107		Digital Thermistor	IML 1411
Evap Water Temperature (T):	Fenwal 107		Digital Thermistor	IML 1411
Barometric Pressure (BP):	Vaisala PTB 110	F2310009	digital barometer	IML 0918
Solar Radiation (SR):	Li-Cor LI200X	PY68879	co-located sensor	PY68877
Relative Humidity (RH):	HMP 50		digital psychrometer	IML 0877
Precipitation (Ppt):	Hydrological Services TB3		lab grade burette	N/A
Evaporation Pan Sensor:	Novalynx		tape measure	N/A
Data acquisition system (DAS):	Campbell Scientific CR1000		N/A	N/A

Audit Results

	Reference	Reference	DAS Value	Difference	Specification			
WS (mph)	0	0.00	0.00	0.00	0.56	(1)		
	300	3.44	3.44	0.00	0.56	(1)		
	800	9.16	9.16	0.00	0.56	(1)		
	3000	34.35	34.35	0.00	0.56	(1)		
	8000	91.60	91.60	0.00	0.56	(1)		
Crossarm Alignment (°)		177.0	176.0	1.0	5.0	(2)		
WS start torque (gm-cm)		1.0	t<1.0	N/A	1.0	(3)		
WD (degrees)	Clockwise	0.0	0.1	0.1	5.0	(1)		
		90.0	90.5	0.5	5.0	(1)		
		180.0	180.0	0.0	5.0	(1)		
		270.0	270.3	0.3	5.0	(1)		
	Counter Clockwise	0.0	0.1	0.1	5.0	(1)		
		90.0	90.0	0.0	5.0	(1)		
		180.0	180.3	0.3	5.0	(1)		
		270.0	269.8	0.2	5.0	(1)		
		WD start torque (gm-cm)	Clockwise	11.0	t<11.0	N/A	11.0	(3)
			Counter Clockwise	11.0	t<11.0	N/A	11.0	(3)
Temperature (°C)		0.3	0.4	0.1	0.9	(1)		
		20.9	20.8	0.1	0.9	(1)		
		50.0	49.9	0.1	0.9	(1)		
Evap Water Temperature (°C)		N/A	N/A	N/A	0.9	█ (1)		
Precipitation (0.1" equiv.)		76.6	79.7	3.1	7.9	█ (1)		
		79.2	79.7	0.5	7.9	█ (1)		
		76.2	79.7	3.5	7.9	█ (1)		
Relative Humidity (%)		72.0	75.0	3.0	7.0	█ (1)		
RH Sensor Temp (°F)		25.2	25.7	0.5				
Pressure (in. Hg)		24.78	24.78	0.00	0.09	█ (2)		
Solar Radiation (W/m ²)		377.0	369.0	8.0	25.0	█ (3)		
BOLD difference values exceed performance specifications								
(1)= Performance specification listed in facilities' Quality Assurance Project Plan								
(2)= Performance specification listed In EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements Version 2.0, 2008								
(3)= Manufacturer's Specifications								

Notes, Recommendations

System taken off-line at 13:09 MST and returned on-line at 13:49 MST.