1st QUARTER 2008
AIR QUALITY AND METEOROLOGICAL MONITORING AUDIT REPORT

YERINGTON MINE SITE AIR QUALITY AND METEOROLOGICAL MONITORING PROGRAM

PREPARED FOR:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

1.0 Audit and Oversight Summary

On behalf of the US Environmental Protection Agency (EPA), Tetra Tech EMI (Tetra Tech) personnel are providing ongoing regulatory support for the Yerington Mine air quality and meteorological monitoring program. Tetra Tech is performing work for EPA under the U.S. Army Corps of Engineers Contract NO-GS-10F-0076K. Atlantic Richfield Company's (ARC) environmental contractor, Brown and Caldwell (B & C), is currently performing all aspects of this program. Tetra Tech reviewed and provided comments and feedback on the Air Quality Monitoring Work Plan for the Yerington Mine Site, authored by B & C.

On March 5, 2008, Tetra Tech audited the following air quality and meteorological monitoring parameters:

Site AM-1:

- One Thermo Electron (Thermo) Tapered Element Oscillating Microbalance 1400A (TEOM) PM_{10} monitor (PM_{10} is particulate matter less than 10 microns in diameter.)
- One 10-meter meteorological tower (wind sensor only)

Site AM-3:

- One Thermo TEOM monitor
- One 10-meter meteorological tower (wind sensor only)

Site AM-6:

- One Thermo TEOM monitor
- One 10-meter meteorological tower (all parameters)

The revised air quality and meteorological monitoring parameters and instrumentation for the Yerington Mine Site for 1st quarter 2008 are summarized in Table 1-1.

TABLE 1-1
AIR QUALITY AND METEOROLOGICAL MONITORING PARAMETERS FOR YERINGTON MINE SITE

Parameter	Instrument Description-Model	Instrument Location at Respective Site	Air Monitoring Site Location
Wind Speed	RM Young Model 05305 AQ	10 Meters AGL	AM-1, AM-3, AM-6
Wind Direction	RM Young Model 05305 AQ	10 Meters AGL	AM-1, AM-3, AM-6
Ambient Temperature	RM Young RTD Temperature Probe with Aspirated Shield	2 and 10 Meters AGL	AM-6
Relative Humidity	Vaisala Temperature/Humidity Probe	2 Meters AGL	AM-6
Solar Radiation	Kipp and Zonen Silicon Pyronometer	2 Meters AGL	AM-6
Station Barometric Pressure Sensor	Vaisala CS105 Barometric Pressure Sensor	TEOM Enclosure Shed	AM-6
Meteorological Tower /TEOM Datalogger	Campbell Scientific CR1000	TEOM Enclosure Shed	AM-1, AM-3, AM-6
Continuous PM_{10} FEM Monitor	Rupprect and Patashnick TEOM 1400AB	Inside Shed –Inlet on Rooftop	AM-1, AM-3, AM-6
TEOM ACCU Sampler	Rupprect and Patashnick TEOM 1400AB ACCU System	Inside Shed –Inlet on Rooftop	AM-6

Notes:

AGL	Above ground level
FEM	Federal Equivalency Method
PM_{10}	Particulate matter less than 10 microns in diameter
TEOM	Tapered Element Oscillating Microbalance

Tetra Tech personnel coordinated with B & C personnel to meet at the site and perform EPA-reference method audit procedures at the three TEOM monitors and three meteorological towers. The TEOM monitors and meteorological towers were audited using certified reference sensors where required.

Mr. Doug Herlocker of Tetra Tech conducted the following tasks at the sites referenced above:

- EPA-approved audit of all TEOM continuous monitors using a certified flow meter, temperature sensor, and barometric pressure sensor.

- EPA and Prevention of Significant Deterioration (PSD)-quality audit of all 10-meter meteorological towers

All TEOM monitors and meteorological towers audited on March 5, 2008, successfully passed all audit criteria. No equipment failures, leaks, or anomalies were observed during the audit procedure. Details of the quality oversight and audit summary are presented in the following sections and appendices:

- Section 2.0 TEOM PM_{10} and Meteorological Audit Methods
- Section 3.0 Audit Equipment Reference Standards
- Section 4.0 TEOM PM_{10} and Meteorological Audit Summary of Results and Recommendations
- Appendix A Quality Assurance Audit Data Tables
- Appendix B Audit Equipment Standards Certification and Field Logbook Notes

2.0 TEOM PM_{10} and Meteorological Audit Methods

Tetra Tech personnel audited three TEOM monitors and three 10-meter meteorological towers on March 5, 2008.

The TEOM monitors and meteorological towers' sensors were audited in their normal operating modes. The accuracy of all sensors was verified using National Institute of Standards and Technology (NIST) or Certified Reference Material (CRM) traceable transfer standard reference audit sensors.

A description of audit procedures and methods is presented below.

TEOM Audit Procedure

Three TEOM PM_{10} monitors are installed at three locations at or near the perimeter of the Yerington Mine site. The monitors operate by pulling ambient air through a size selective inlet and across a filter media. The media sits on an oscillating microbalance that vibrates at a specific frequency. As particle mass accumulates on the filter, the oscillating frequency changes and this change is correlated to a mass per unit of air measurement in micrograms per cubic meters. The audit devices consist of a certified primary standard flow-meter, and certified temperature and ambient pressure sensors.

The TEOM unit has a designed flow rate of 3 liters per minute (LPM) for the main sample flow and 16.67 LPM for the total flow. The TEOM adjusts the flow rate based on ambient temperature and pressure. Therefore, the audit consists of verifying the following parameters: 1) main flow, 2) total flow, 3) ambient temperature, and 4) ambient pressure. All sensors used for the audit had current NIST (or other authoritative reference) certifications. The audit criterion for flow (in LPM) is +/- 10 percent, the ambient temperature criterion is +/- 1 degrees Celsius, and the ambient pressure criterion is +/- 10 mm mercury (Hg). All three TEOM monitors located at AM-1, AM-3, and AM-6 audited on March 5, 2008 were found to be within the acceptable range for ambient temperature and barometric pressure. Unfortunately, the audit flow meter malfunctioned and a flow reading was not obtained. A summary of TEOM audit results is presented in Table 2-1. Quality assurance audit data tables are presented in Appendix A.

TABLE 2-1

SUMMARY OF PM_{10} TEOM AUDIT RESULTS
YERINGTON MINE SITE
MARCH 5, 2008

TEOM Monitor/ Location/ Serial #	TEOM Main Flow Rate (LPM)	Audit Main Flow Rate (LPM)	TEOM Total Flow Rate (LPM)	Audit Total Flow Rate (LPM)	TEOM Ambient Temp. (^oC)	Audit Ambient Temp. (^oC)	TEOM Barometric Pressure (mm Hg)	Audit Barometric Pressure (mm Hg)	All Parameters Within Acceptable Range[1]
AM-1/ 24713	**3.00**	**NR**	**16.68**	**NR**	**27.2**	**26.3**	**638.40**	**645.41**	**Yes**
AM-3/ 24707	**3.00**	**NR**	**16.70**	**NR**	**23.7**	**24.6**	**644.40**	**644.40**	**Yes**
AM-6/ 24708	**3.01**	**NR**	**16.69**	**NR**	**27.9**	**27.5**	**649.04**	**649.73**	**Yes**

Notes:

[1] Acceptable Range: Total and Main Flow = +/- 10%; Temperature = +/- 1.0 ^oC; Barometric Pressure = +/- 10 mm Hg

^oC Degree Celsius
Hg Mercury
LPM Liters Per Minute
mm Millimeter
NR No reading (flow meter failed to operate correctly)
PM_{10} Particulate matter less than 10 microns
TEOM Tapered Element Oscillating Microbalance

Wind Vane Alignment Verification/Audit

The Yerington meteorological tower wind speed/direction sensors are mounted at the top of the three 10-meter towers at AM-1, AM-3, and AM-6. The wind sensors are mounted on a 1-meter horizontal cross arm fixture oriented in a north/south direction, equivalent to a degree of zero. The vane alignment audit was achieved using a calibrated compass set on a tripod and corrected for true north offset for the Yerington, Nevada area of approximately 15.3 degrees easterly. An additional audit was achieved using a handheld global positioning system (GPS), which automatically corrects for true north readings. Audit devices were aligned with the cross arm of each tower facing north. The orientation of the cross arm was then compared to the audit device reading. The results from the true north vane alignment audit are presented below.

AM-1 Meteorological Tower

- Audit compass (corrected 15.3 degrees easterly) = 359 degrees
- Audit GPS (automatically corrected for true north) = 0-2 degrees
- AM-1 Wind direction sensor aligned north-facing = 0.13 degree

AM-3 Meteorological Tower

- Audit compass (corrected 15.3 degrees easterly) = 359 degrees
- Audit GPS (automatically corrected for true north) = 1 degree
- AM-3 Wind direction sensor aligned north-facing = 1.21 degrees

AM-6 Meteorological Tower

- Audit compass (corrected 15.3 degrees easterly) = 358 degree
- Audit GPS (automatically corrected for true north) = 0 degree
- AM-6 Wind direction sensor aligned north-facing = 1.7 degrees

Wind Speed Audit

The wind speed audit was achieved using a R.M. Young Motor Drive (Model # 18802) attached to the wind speed/direction sensors at AM-1, AM-3, and AM-6 and was rotated at different speeds. The simulated wind speed was compared to datalogger readouts for wind speed accuracy.

In addition, a wind speed starting threshold torque audit was performed using a R.M. Young Torque Disc (Model # 18310) to verify the sensitivity of the wind speed sensor to fluctuations in wind speed. Acceptance and accuracy criteria are presented in Table 2-2.

Wind Direction Audit

The wind direction audit was achieved using a R.M. Young Wind Direction Linearity Gauge (Model # 18802) attached to the wind speed/direction sensor at AM-1, AM-3, and AM-6 and was rotated between 0 and 360 degrees in 30-degree increments. The circular gauge has marks in 1-degree increments that were compared to the datalogger readouts for wind direction accuracy.

In addition, a wind direction starting torque audit was performed using a R.M. Young Wind Direction Torque Gauge (Model # 18331) to verify the sensitivity of the wind direction sensor to fluctuations in wind speed. Acceptance and accuracy criteria are presented in Table 2-2.

Temperature Audit

The temperature audit at AM-6 was achieved using a NIST traceable reference temperature sensor collocated with the 2- and 10-meter temperature sensors. Ambient temperature readings were recorded for both sensors as well as the audit sensor. The NIST traceable reference temperature sensor was compared to the 2- and 10-meter sensors for temperature accuracy. Acceptance and accuracy criteria are presented in Table 2-2.

Humidity Audit

The humidity audit at AM-6 was achieved using a NIST traceable reference humidity sensor (hygrometer) collocated with the AM-6 humidity sensor. Ambient humidity conditions were recorded for both sensors and dew point temperatures were calculated for both sensors using ambient temperature and humidity readouts, and were compared for humidity accuracy. Acceptance and accuracy criteria are presented in Table 2-2.

Solar Radiation Audit

The solar radiation sensor readout was verified for a zero reading by placing a light-blocking device on the solar radiation sensor and readouts were recorded for each sensor and compared for solar radiation accuracy. Acceptance and accuracy criteria are presented in Table 2-2.

Precipitation Audit

The precipitation audit at AM-6 was achieved using a precise liquid dispensing tool to measure the amount of water required to initiate a tip for each tipping bucket mechanism. Three filling runs were performed for each bucket and compared to specified volume required for one tip. Acceptance and accuracy criteria are presented in Table 2-2.

Barometric Pressure Audit

The barometric pressure audit at AM-6 was achieved using a NIST traceable barometric pressure sensor collocated with tower sensor. Three readouts were recorded for both sensors and were compared for barometric pressure accuracy. Acceptance and accuracy criteria are presented in Table 2-2.

All quality assurance audit methods, accuracy requirements, and audit (pass/fail) results for the Yerington meteorological tower are summarized in Table 2-2. Quality assurance audit data tables are presented in Appendix A. Field logbook notes are presented in Appendix B.

TABLE 2-2

PSD QUALITY ASSURANCE AUDIT METHODS, ACCURACY REQUIREMENTS, AND RESULTS YERINGTON METEOROLOGICAL TOWER SYSTEMS AUDIT MARCH 5, 2008

Parameter	Audit Method	Accuracy Requirements (difference between acceptable criteria and sensor response)	Within Acceptance Criteria
10-Meter Wind Speed (AM-1, AM-3, AM-6)	Active Rotation with Certified Drive Unit: ws≤5m/s ws>5m/s	≤ ± 0.25 m/s ≤ ± 5.0%	Yes (AM-1) Yes (AM-3) Yes (AM-6)
	Starting Threshold with Torque Disk	≤0.5 m/s (0.3 gm-cm)	Yes (AM-1) Yes (AM-3) Yes (AM-6)
10-Foot Wind Direction (AM-1, AM-3, AM-6)	Alignment Verification	≤ ± 5° of True North	Yes (AM-1) Yes (AM-3) Yes (AM-6)
	Internal Check of Vane Linearity using Gauge	≤ ± 3°	Yes (AM-1) Yes (AM-3) Yes (AM-6)
	Starting Threshold with Torque Gauge	≤ 0.5 m/s (9 gm-cm)	Yes (AM-1) Yes (AM-3) Yes (AM-6)
2- and 10-Meter Ambient Temperature (AM-6)	Collocated Sensor Comparing Temperatures Using Three Water Baths	≤ ± 0.5 °C	Yes
2- and 10-Meter Delta Temperature (AM-6)	2- and 10-Meter Sensors Collocated Using Three Water Baths Comparing Temperatures	≤ ± 0.1 °C	Yes
2-Meter Relative Humidity (AM-6)	Collocated Sensor Comparing Dew point Temperatures (T_{dp})	≤ ± 1.5 °C Error in T_{dp}	Yes
2-Meter Solar Radiation (AM-6)	Collocated Sensor Comparison	≤ ± 5.0% Full Scale	Yes
Barometric Pressure (AM-6)	Collocated Sensor Comparison	≤ ± 10 millibars Hg	Yes
Precipitation (AM-6)	Comparison to Precipitation Gauge	≤ ± 10.0%	Yes

Notes:

°C	Degree Celsius	gm-cm	Gram centimeter
Hg	Mercury	m/s	Meter per second
PSD	Prevention of significant deterioration	T_{dp}	Dew point temperature
ws	Wind speed		

3.0 Audit Equipment Reference Standards

All audit equipment and reference standards were in current calibration and traceable to the NIST or other authoritative references. Table 3-1 lists specific equipment used and certification dates. Copies of standard certifications for the audit equipment are presented in Appendix B.

TABLE 3-1

QUALITY ASSURANCE AUDIT EQUIPMENT
YERINGTON PM_{10} AND METEOROLOGICAL TOWER AUDIT
MARCH 5, 2008

References/Device	Manufacturer	Model Number	Serial Number	Re-certification Date
Humidity	Control Company	11-661-18	41531319	4/10/2008
Thermometer	Control Company	11-661-18	41531319	4/10/2008
Wind Speed Drive	RM Young	18802	CA02612	4/13/2008
Wind Direction Linearity Gauge	RM Young	18212	N/A	N/A
Wind Speed Starting Threshold Torque Disk	RM Young	18310	N/A	N/A
Wind Direction Starting Threshold Torque Gauge	RM Young	18331	N/A	N/A
Barometric Pressure	Brunton	Multi-Navigator V 2.16	ACP 010796	4/9/2008

Notes:

N/A Not available

4.0 TEOM PM_{10} and Meteorological Audit Summary of Results and Recommendations

TEOM Audit Summary:

At the time of the TEOM audit on March 5, 2008, all monitors successfully passed audit parameters and were observed to be operating correctly.

Meteorological Tower Audit Summary:

At the time of the meteorological tower audits on March 5, 2008, all meteorological tower sensors were within accuracy requirements established in Table 2-2 and were observed to be operating within accuracy requirements.

General Recommendations:

Tetra Tech recommends that B & C continue to perform scheduled bi-weekly site visits to the meteorological tower to download data and visually inspect the sensors. In addition, downloaded data should be screened and evaluated within 48 hours to identify problems and minimize lost data.

APPENDIX A

QUALITY ASSURANCE AUDIT DATA TABLES

TABLE 1
WIND SPEED/DIRECTION RESPONSE AUDIT

YERINGTON AM-1 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

WIND SPEED: (MODEL: RM Young 05305 AQ)				WIND DIRECTION: (MODEL: RM Young 05305 AQ)		
Audit Device: RM Young Model 18802 (serial #CA02415)				Audit Device: RM Young Model 18212 (serial #N/A)		
Acceptable Difference[abc]: @ ws <5.0 m/s; <0.25 m/s, @ws>5.0m/s; <5.0%				Acceptable Difference: +/- 3 degrees		
Clockwise Rotation				Clockwise Rotation		
Calibration Device RPM	Simulated Wind Speed (m/s)	ws Sensor[a] *as found* (m/s)	Difference	Calibration Device (degrees)	wd Sensor *as found* (degrees)	Difference (degrees)
0.0	0.00	0.00	0.00 m/s	0.0	1.3	1.3
200.0	1.02	1.02	0.00 m/s	30.0	31.2	1.2
400.0	2.05	2.05	0.00 m/s	60.0	61.4	1.4
600.0	3.07	3.07	0.00 m/s	90.0	91.9	1.9
800.0	4.10	4.10	0.00 m/s	120.0	122.6	2.6
1000.0	5.12	5.12	0.00 %	150.0	153.0	3.0
1600.0	8.19	8.19	0.0 %	180.0	182.8	2.8
1900.0	9.73	9.73	0.0 %	210.0	213.0	3.0
2200.0	11.26	11.26	0.0 %	240.0	241.9	1.9
3100.0	15.87	15.87	0.0 %	270.0	272.0	2.0
Criteria met (yes/no): YES				300.0	300.8	0.8
Adjustment performed (yes/no): NO				330.0	330.1	0.1
				360/0.0	0.13	0.1
				Criteria met (yes/no): YES		
				Adjustment performed (yes/no): NO		

Notes:

[a]	RM Young wind speed multiplier used with calibration device: (RPM x 0.01096)=mph, (RPM x 0.005)=m/s
[b]	Wind Speed less than or equal to 5 meters per second is compared to actual simulated wind speed meters per second.
[c]	Wind Speed greater than 5 meters per second is compared to percent difference of simulated wind speed meters per second.
%	Percent
mph	Mile per hour
m/s	Meter per second
N/A	Not available
RPM	Revolutions per minute
wd	Wind direction
ws	Wind speed

TABLE 2
WIND DIRECTION/SPEED STARTING THRESHOLD TORQUE AUDIT

YERINGTON AM-1 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

WIND SPEED STARTING TORQUE THRESHOLD: (MODEL: RM Young 05305 AQ)		WIND DIRECTION STARTING TORQUE THRESHOLD: (MODEL: RM Young 05305 AQ)	
Audit Device: RM Young Model 18310 (serial #N/A)		Audit Device: RM Young Model 18331 (serial #N/A)	
Acceptable Difference: ≤ 0.3 g-cm		Acceptable Difference: ≤ 9 g-cm	
Sensor	ws Sensor *as found* (g-cm)	Sensor	wd Sensor *as found* (g-cm)
10-meter ws	0.2	10-meter wd	7.0
Sensor	ws Sensor *as left* (g-cm)	Sensor	wd Sensor *as left* (g-cm)
10-meter ws	0.2	10-meter wd	7.0
Criteria met (yes/no): YES		Criteria met (yes/no): N/A	
Adjustment performed (yes/no): NO		Adjustment performed (yes/no): NO	

Notes:

g-cm	Gram-centimeter
N/A	Not available
ws	Wind speed
wd	Wind direction

TABLE 3
WIND SPEED/DIRECTION RESPONSE AUDIT

YERINGTON AM-3 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

WIND SPEED: (MODEL: RM Young 05305 AQ)				WIND DIRECTION: (MODEL: RM Young 05305 AQ)		
Audit Device: RM Young Model 18802 (serial #CA02415)				Audit Device: RM Young Model 18212 (serial #N/A)		
Acceptable Difference[abc]: @ ws <5.0 m/s; <0.25 m/s, @ws>5.0m/s; <5.0%				Acceptable Difference: +/- 3 degrees		
Clockwise Rotation				Clockwise Rotation		
Calibration Device RPM	Simulated Wind Speed (m/s)	ws Sensor[a] *as found* (m/s)	Difference	Calibration Device (degrees)	wd Sensor *as found* (degrees)	Difference (degrees)
0.0	0.00	0.00	0.00 m/s	0.0	3.0	3.0
200.0	1.02	1.02	0.00 m/s	30.0	33.0	3.0
400.0	2.05	2.05	0.00 m/s	60.0	61.9	1.9
600.0	3.07	3.07	0.00 m/s	90.0	91.8	1.8
800.0	4.10	4.10	0.00 m/s	120.0	122.9	2.9
1000.0	5.12	5.12	0.00 %	150.0	151.9	1.9
1600.0	8.19	8.19	0.0 %	180.0	181.4	1.3
2200.0	11.26	11.26	0.0 %	210.0	212.1	2.1
2500.0	12.80	12.80	0.0 %	240.0	242.0	2.0
3100.0	15.87	15.87	0.0 %	270.0	272.0	2.0
Criteria met (yes/no): YES				300.0	302.2	2.1
Adjustment performed (yes/no): NO				330.0	331.9	1.9
				360/0.0	1.21	1.2
				Criteria met (yes/no): YES		
				Adjustment performed (yes/no): NO		

Notes:

[a]	RM Young wind speed multiplier used with calibration device: (RPM x 0.01096)=mph, (RPM x 0.005)=m/s
[b]	Wind Speed less than or equal to 5 meters per second is compared to actual simulated wind speed meters per second
[c]	Wind Speed greater than 5 meters per second is compared to percent difference of simulated wind speed meters per second
%	Percent
mph	Mile per hour
m/s	Meter per second
N/A	Not available
RPM	Revolutions per minute
wd	Wind direction
ws	Wind speed

TABLE 4
WIND DIRECTION/SPEED STARTING THRESHOLD TORQUE AUDIT

YERINGTON AM-3 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

WIND SPEED STARTING TORQUE THRESHOLD: (MODEL: RM Young 05305 AQ)		WIND DIRECTION STARTING TORQUE THRESHOLD: (MODEL: RM Young 05305 AQ)	
Audit Device: RM Young Model 18310 (serial #N/A)		Audit Device: RM Young Model 18331 (serial #N/A)	
Acceptable Difference: ≤ 0.3 g-cm		Acceptable Difference: ≤ 9 g-cm	
Sensor	ws Sensor *as found* (g-cm)	Sensor	wd Sensor *as found* (g-cm)
10-meter ws	0.2	10-meter wd	7.0
Sensor	ws Sensor *as left* (g-cm)	Sensor	wd Sensor *as left* (g-cm)
10-meter ws	0.2	10-meter wd	7.0
Criteria met (yes/no): YES		Criteria met (yes/no): N/A	
Adjustment performed (yes/no): NO		Adjustment performed (yes/no): NO	

Notes:

g-cm	Gram-centimeter
N/A	Not available
ws	Wind speed
wd	Wind direction

TABLE 5
WIND SPEED/DIRECTION RESPONSE AUDIT

YERINGTON AM-6 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

WIND SPEED: (MODEL: RM Young 05305 AQ)				WIND DIRECTION: (MODEL: RM Young 05305 AQ)		
Audit Device: RM Young Model 18802 (serial #CA02415)				Audit Device: RM Young Model 18212 (serial #N/A)		
Acceptable Difference[abc]: @ ws <5.0 m/s; <0.25 m/s, @ws>5.0m/s; <5.0%				Acceptable Difference: +/- 3 degrees		
Clockwise Rotation				Clockwise Rotation		
Calibration Device RPM	Simulated Wind Speed (m/s)	ws Sensor[a] *as found* (m/s)	Difference	Calibration Device (degrees)	wd Sensor *as found* (degrees)	Difference (degrees)
0.0	0.00	0.00	0.00 m/s	0.0	2.6	2.6
200.0	1.02	1.02	0.00 m/s	30.0	32.9	2.9
400.0	2.05	2.05	0.00 m/s	60.0	61.9	1.9
600.0	3.07	3.07	0.00 m/s	90.0	91.9	1.9
800.0	4.10	4.10	0.00 m/s	120.0	121.7	1.7
1000.0	5.12	5.12	0.00 %	150.0	151.6	1.6
1600.0	8.19	8.19	0.0 %	180.0	181.5	1.5
2200.0	11.26	11.26	0.0 %	210.0	211.4	1.4
2800.0	14.34	14.34	0.0 %	240.0	241.0	1.0
4000.0	20.48	20.48	0.0 %	270.0	270.9	0.9
Criteria met (yes/no): YES				300.0	301.0	1.0
Adjustment performed (yes/no): NO				330.0	331.0	1.0
				360/0.0	1.70	1.7
				Criteria met (yes/no): YES		
				Adjustment performed (yes/no): NO		

Notes:

a	RM Young wind speed multiplier used with calibration device: (RPM x 0.01096)=mph, (RPM x 0.005)=m/s
b	Wind Speed less than or equal to 5 meters per second is compared to actual simulated wind speed meters per second.
c	Wind Speed greater than 5 meters per second is compared to percent difference of simulated wind speed meters per second.
%	Percent
mph	Mile per hour
m/s	Meter per second
N/A	Not available
RPM	Revolutions per minute
wd	Wind direction
ws	Wind speed

TABLE 6
WIND DIRECTION/SPEED STARTING THRESHOLD TORQUE AUDIT

YERINGTON AM-6 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
SITE: Yerington Mine Site, Yerington, NV
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

WIND SPEED STARTING TORQUE THRESHOLD: (MODEL: RM Young 05305 AQ)		WIND DIRECTION STARTING TORQUE THRESHOLD: (MODEL: RM Young 05305 AQ)	
Audit Device: RM Young Model 18310 (serial #N/A)		Audit Device: RM Young Model 18331 (serial #N/A)	
Acceptable Difference: ≤ 0.3 g-cm		Acceptable Difference: ≤ 9 g-cm	
Sensor	ws Sensor *as found* (g-cm)	Sensor	wd Sensor *as found* (g-cm)
10-meter ws	0.3	10-meter wd	6.0
Sensor	ws Sensor *as left* (g-cm)	Sensor	wd Sensor *as left* (g-cm)
10-meter ws	0.3	10-meter wd	6.0
Criteria met (yes/no): NO		Criteria met (yes/no): N/A	
Adjustment performed (yes/no): NO		Adjustment performed (yes/no): NO	

Notes:

g-cm	Gram-centimeter
N/A	Not available
ws	Wind speed
wd	Wind direction

TABLE 7
HUMIDITY AUDIT

YERINGTON AM-6 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

HUMIDITY: Campbell Scientific Model 210 with CR1000 Datalogge

Audit Device[a]: Control Company Model # 11-661-18 (serial #41531319)

Acceptable Difference: +/- 1.5 °C in Dewpoint Temperature

Audit device (% humidity)	Humidity Sensor *as found* (% humidity)	Difference (% humidity)	Audit device Dewpoint Temperature (°C)	Humidity Sensor Dewpoint Temperature (°C)	Dewpoint Difference Temperature (°C)
18.8	16.9	-1.9	-13.55	-14.17	-0.62

Criteria met (yes/no): YES | **Adjustment performed (yes/no): NO**

Notes:

[a] Audit device meets National Institute of Standards and Technology requirements
% Percent
°C Celsius

TABLE 8
TEMPERATURE AUDIT

YERINGTON AM-6 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

Temperature: 2 and 10 Meter-RM Young Model 43347-L with Campbell CR1000 Datalogger

Calibration device:
Hanna Instruments Model HI 9053K (serial #186428)

Acceptable Difference:
+/- 1.0 °C mean error vs calibration device; +/- 0.1 °C delta t (2 meter vs. 10 meter)

Water Bath	Audit device:	2-meter ambient temperature sensor "as found"	10-meter ambient temperature sensor "as found"	Difference 2 meter vs. audit device (°C)	Difference 10 meter vs. audit device (°C)	Difference 2 meter vs. 10 meter (°C)
Ice bath	0.1	0.13	0.22	-0.03	-0.12	-0.09
Hot bath	58.2	57.93	58.02	0.27	0.18	-0.09
Mid-scale bath	9.6	9.97	9.99	-0.37	-0.39	-0.02
			mean error=	0.0	-0.1	-0.07

Notes:

°C Celsius
vs. Versus

TABLE 9
BAROMETRIC PRESSURE AUDIT

YERINGTON AM-6 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

BAROMETRIC PRESSURE: Vaisala Model CS105 with Campbell CR1000 Datalogger

Audit Device[a]: Brunton Multi-Navigator, Version 2.16 (serial #ACP 010796)

Acceptable Difference: +/- 0.3 inches Hg

Audit Device (inches Hg)	Barometric Pressure Sensor *as found* (inches Hg)	Difference (inches Hg)
25.75	25.83	0.08
Criteria met (yes/no): YES		Adjustment performed (yes/no): NO

Notes:

[a] Audit device meets National Institute of Standards and Technology requirements
Hg Mercury

TABLE 10
PRECIPITATION AUDIT

YERINGTON AM-6 METEOROLOGICAL TOWER AUDIT
AUDIT DATE: March 5, 2008
AUDITED BY: Doug Herlocker, Tetra Tech EM Inc. on behalf of U.S. EPA

PRECIPITATION: Texas Instruments Model TE525WS-L with Campbell CR1000 Datalogger

Audit device: 10 mL syringe (serial #N/A)

Acceptable Difference: +/- 10% (1 tip = 8.3 mL = 0.01 inches of precipitation), <8.0 mL, > 8.6 mL = adjustment recommended

Volume Checks (number)	Left Bucket *as found*	Right Bucket *as found*
1	8.4	8.6
2	8.3	8.4
3	8.4	8.4
Average =	**8.4**	**8.5**
	Criteria met (yes/no): YES	**Criteria met (yes/no): YES**
	Adjustment performed (yes/no): NO	**Adjustment performed (yes/no): NO**

Notes:

% Percent
mL Milliliter
N/A Not available

APPENDIX B

AUDIT EQUIPMENT STANDARDS CERTIFICATIONS AND FIELD LOGBOOK NOTES

Certificate of Accuracy

Transfer Standard Type: Electronic Thermometer Certificate No: T **041007. 02**

Transfer standard, model/type: Hanna Instruments HI 9060 Microcomputer Thermometer
Serial number: 186428 Probe S/N: None Visible
submitted by/owner: Tetra Tech EM Inc.
106 N 6th Street
Suite 202
Was compared to: Boise, ID 83702

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

Date: 04/10/07 Lab temperature: 73.1 °F
Barometric Pressure: 652.9 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.5	0.5	-0.5
10.2	10.7	0.5	-0.5
20.4	20.9	0.5	-0.5
30.3	30.8	0.5	-0.5

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

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

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

Reviewed: R Sanders Date: 4-10-07

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: Barometric Pressure/Altimeter

Certificate No: B 040907. 02

Transfer standard model: Brunton Multi-Navigator, Version 2.16
Serial number: ACP 010796
submitted by/owner: Tetra Tech EM Inc.
106 N 6th Street
Suite 202
Boise, ID 83702

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

Date: 04/09/07 Lab temperature 72.5 °F
Lab pressure 650.6 mm Hg

Reference barometer ("Hg)	Transfer Standard ("Hg)	Difference from Reference ("Hg)	Transfer Standard Correction* ("Hg)
25.00	24.98	-0.02	0.02
25.61	25.58	-0.03	0.03
27.00	26.98	-0.02	0.02
28.00	27.98	-0.02	0.02

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

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

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

Reviewed: R D H Date: 4-9-07

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

R.M. Young Company
2801 Aero Park Drive
Traverse City, Michigan 49686 USA

Certificate of Calibration and Testing

Test Unit:			
Model:	18802	Serial Number:	CA02612
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 13 April 2006

Tested By EP

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-5028A

Date - Apr 10, 2006 Rootsmeter S/N 9833620 Ta (K) - 293
Operator Tisch Orifice I.D. - W43 Pa (mm) - 756.92

PLATE OR VDC #	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	1.2670	4.4	1.50
2	NA	NA	1.00	0.9780	7.3	2.50
3	NA	NA	1.00	0.8940	8.7	3.00
4	NA	NA	1.00	0.8240	10.2	3.50
5	NA	NA	1.00	0.6250	17.3	6.00

DATA TABULATION

Vstd	(x axis) Qstd	(y axis)		Va	(x axis) Qa	(y axis)
1.0070	0.7948	1.2326		0.9942	0.7846	0.7620
1.0031	1.0257	1.5913		0.9903	1.0126	0.9837
1.0013	1.1200	1.7432		0.9885	1.1057	1.0776
0.9993	1.2127	1.8829		0.9865	1.1972	1.1640
0.9898	1.5837	2.4653		0.9771	1.5634	1.5240
Qstd slope (m) =		1.56257		Qa slope (m) =		0.97846
intercept (b) =		-0.00986		intercept (b) =		-0.00610
coefficient (r) =		0.99998		coefficient (r) =		0.99998
y axis = SQRT[H2O(Pa/760)(298/Ta)]				y axis = SQRT[H2O(Ta/Pa)]		

CALCULATIONS

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

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

For subsequent flow rate calculations:

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

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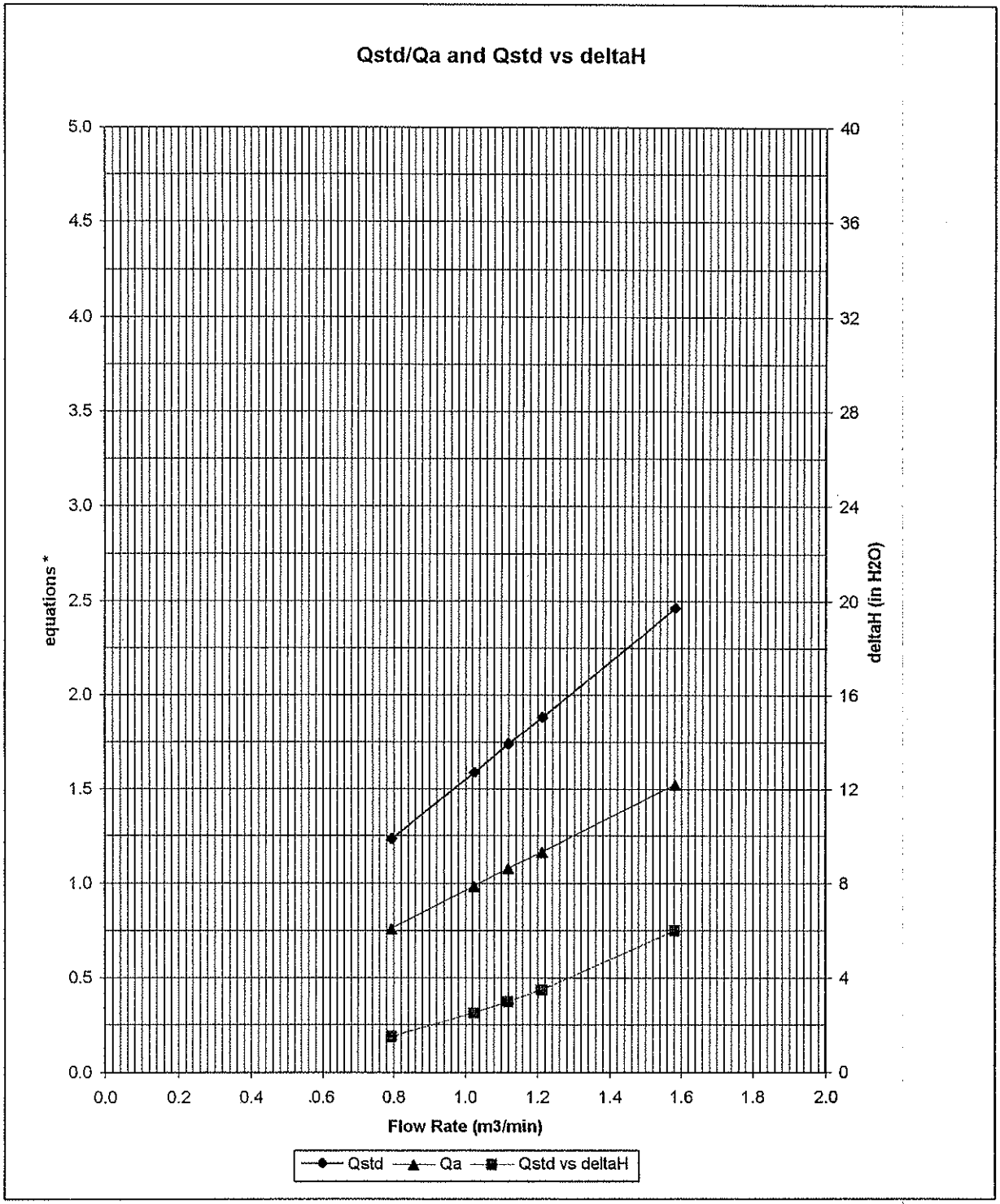
AIR POLLUTION MONITORING EQUIPMENT



*** y-axis equations:**

Qstd series: $\sqrt{\Delta H \left(\frac{Pa}{Pstd}\right)\left(\frac{T\,std}{Ta}\right)}$

Qa series: $\sqrt{(\Delta H\,(Ta / Pa))}$

#W43

CERTIFICATE of CALIBRATION for LI-COR SENSOR

Model Number: LI-200SZ

Serial Number: PY47392 Calibration Date: April 17, 2006

Output: 5.00 millivolts per 1000 watts m^{-2}

57.2 Ω resistor installed in cable.

IMPORTANT: *Read the appropriate instruction manual before using this sensor.*

IMPORTANT: *It is recommended that sensors be recalibrated every two years.*

Calibration Technician: Caron Deschamps

LI-COR Biosciences

LI-COR, inc. ● Environmental ● 4421 Superior Street ● P.O. Box 4425 ● Lincoln, NE 68504
Phone: 402-467-3576 ● FAX: 402-467-2819 ● Toll-free 1-800-447-3576 (U.S. & Canada)
E-mail: envsales@licor.com ● www.licor.com

Certificate of Accuracy

Transfer Standard Type: Electronic Hygrometer Certificate No: H 041007. 01

Transfer standard, model/type: Fisher Scientific Traceable Hygrometer
Serial number: 41531319
submitted by/owner: Tetra Tech EM Inc.
106 N 6th Street
Suite 202
Boise, ID 83702

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

Date: 4/09/2007 - 04/10/07

Lab temperature:	68 - 72	°F
Barometric Pressure:	649 - 653.	mmHG
Lab %RH:	35 - 45	

Reference Salt Standard	Reference Temperature °C	Reference Standard (%RH)	Transfer Standard (%RH)	Difference from Reference (%RH)	Transfer Standard Correction* (%RH)
Potassium Acetate	19.8	23.1	25.2	2.1	-2.1
Magnesium Nitrate	20.6	54.2	52.5	-1.7	1.7
Sodium Chloride	19.3	75.5	74.4	-1.1	1.1

Temperature Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
19.8	20.2	0.4	-0.4
20.6	21.1	0.5	-0.5
19.3	19.8	0.5	-0.5

Reviewed: RLS Date: 4-10-07

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

3-5-08 D. HERLOCKER - TETRA TECH

0800 ARRIVE AT MINE OFFICE
- Sign In & Tailgate Safety Meeting

0830 Arrive at AM-1 - visual inspection
- All sensor operating

0835 Lower Met Tower - OFFline

0850 Begin Audit on Met Tower
- Wind speed Audit

1. visual Alignment W.D. sensor
North Alignment = 0.10
South " = 179.7

RPM	Readout (M/s) (MPH)	RPM
0	0.0	0
200	1.02 2.29	200
400	2.05 4.58	400
600	3.07 6.87	600
800	4.10 9.16	800
1000	5.12 11.45	1000
1300	6.66 14.89	1300
1600	8.19 18.32	1600
1900	9.73 21.76	1900
2200	11.26 25.19	2200
2500	12.80 28.63	2500
2800	14.34 32.06	2800
3100	15.87 35.49	3100
3400	17.41 38.93	3400

VERENGTON A.Q AUDIT 3-5-08 (cont.)

WIND DIRECTION AUDIT

Wind Direction	Readout (degrees)
0	1.30
30	31.21
60	61.41
90	91.98
120	122.63
150	152.97
180	182.83
210	212.99
240	241.88
270	272.03
300	300.83
330	330.07
360/0	0.13

0924 TEOM OFFLINE

TEOM AUDIT

1. TEMP: Audit = 3.5°C TEOM = 4.3°C
2. B. Press Audit = 25.55" TEOM = 0.347
3. Flow Main Audit = TEOM = 3.00
AUX Audit = TEOM = 13.68

0959 Resume TEOM operation

10:05 Leave AM-1

3-5-08 (Cont.) D. HERLOCKER - TETRATECH

1015 Arrive at AB AM-3 - Visual Inspection
- All Sensors operating

10:20 Lower Met Tower
- Wind Speed Audit

RPM (Audit)	Readout (m/s)	(MPH)	(RPM)
0	0.00	0.00	0
200	1.02	2.29	200
400	2.05	4.58	400
600	3.07	6.87	600
800	4.10	9.16	800
1000	5.12	11.45	1,000
1300	6.66	14.89	1,300
1600	8.19	18.32	1,600
1900	9.73	21.76	1,900
2200	11.26	25.19	2,200
2500	12.80	28.63	2,500
2800	14.34	32.06	2,800
3100	15.87	35.49	3,100
3400	17.41	38.93	3,400

- WIND DIRECTION Visual Alignment verification,
Compass = 345 (uncorrected)
GPS (corrected) = 0-1

YERINGTON AQ AUDIT 3-5-08
- WIND DIRECTION Audit

Dial Direction		Readout (degrees)
0		2.95
30		33.00
60		61.86
90		91.80
120	*Redo 122.91	127.11 *
150	* " 151.96	156.33 *
180	* " 181.35	185.16
210	* " 212.13	214.72
240	* " 242.03	244.62
270	* " 271.96	275.14
300	* " 302.15	306.00
330	* " 331.87	335.90
360/0		1.21

Adjust Audit Dial & Re-Audit +360°

Dial Direction	Readout (degrees)
0	
30	32.02
60	62.16
90	91.13
120	120.98
150	149.77
180	181.26
210	210.04

3-5-08 (Cont.) D. HERLOCKER TETRATECH

240	239.60
270	269.86
300	300.35
330	330.80
0	1.35

11:35 Raise Met Tower

TEOM Audit: TEOM not Taken offline

1. TEMP:

Audit = 5.60 TEOM = 5.10

2. B. Press: = Audit = 25.67 TEOM = .858

3. NO Flow Audit - TEOM Flow

Main = 3.00 Total = 16.67

11:55 Leave AM-3

13:15 Arrive at AM-6

13:25 Lower Met Tower - OFF-line

1335 Wind Speed Audit

(Audit) RPM	Readout RPM	MPH	m/s
0	0.0	0.0	0.0
200	600	2.29	1.02
400	1200	4.58	2.05
600	1800	6.87	3.07
800	2400	9.16	4.10

YERINGTON AQ Audit 3-5-08 (Cont.)

1000	3000	11.45	5.12
1300	3900	14.89	6.66
1600	4800	18.32	8.19
1900	5400	21.76	9.73
2200	6600	25.19	11.26
2500	7500	28.63	12.80
2800	8400	32.06	14.34
3100	9300	35.49	15.87
3400	10,200	38.93	17.41
3700	11,100	42.37	18.94
4000	12,000	45.80	20.48

Wind Direction Audit

Dial Reading	DL Readout
0 - 360/0	2.64 - 1.7
30	32.91
60	61.85
90	91.94
120	121.74
150	151.62
180	181.50
210	211.36
240	241.02
270	270.90
300	301.04
330	330.96

3-5-08 (Cont.) Yerington AQ Audit

Barometric Pressure Audit:

Audit 25.75" = 654.05 mm Hg

Sensor = 874.57 mb = 656.01 mm Hg

Humidity Audit:

Audit = 18.8% Temp = 9.0 ~~8.8~~ Dlt

Sensor = ~~15.~~ 16.94% Temp = 9.8

Precipitation Audit (Bucket tips):

	Left (As Found)	Right (As Found)
mL 1.	8.4	8.6
2.	8.3	8.4
3.	8.4	8.4

Temperature Audit:

	Audit	2M	10M
Ice	0.1	0.13	0.22
Mid-Range	9.6	9.97	9.99
Hot	~~60.1~~ Dlt	~~57.~~ Dlt	
	58.2	57.93	58.02

3-5-08 (Cont.) TetraTech - D. Herlocker

Solar Radiation Audit

Zero: Sensor = 0.0

1525 Met tower online

TEOM Audit:

1. Temp: Audit = 12.5°C

TEOM = 12.1°C

2. B. Press: ~~Audit = 0.86 ATM~~

TEOM = 0.86 ATM =

Audit = 25.72" =

3. No Flow Audit - TEOM Flow

Main = 3.00, Total = 16.68

Completed Audit → All parameters passed

15:50 Leave site

enclosure
D. Herlocker