DATA TRANSMITTAL REPORT FOR THE YELLOWSTONE NATIONAL PARK WINTER USE AIR QUALITY STUDY DECEMBER 15, 2009 – MARCH 15, 2010

Prepared for

John Ray
NATIONAL PARK SERVICE
12795 W. Alameda Parkway
Denver, CO 80228

Prepared by

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525
Phone: 970-484-7941
www.air-resource.com

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LIST OF ACRONYMS AND ABBREVIATIONS

AQDB	Air Quality Database
ARS	Air Resource Specialists, Inc.
AT/RH	Ambient Temperature and Relative Humidity
BAM	Beta Attenuation Monitor
CO	Carbon Monoxide
NAAQS	National Ambient Air Quality Standards
NPS	National Park Service
$PM_{2.5}$	Particulate Matter Equal to or Less than 2.5 Microns

1.0 INTRODUCTION

Air Resource Specialists, Inc. (ARS) was contracted by the National Park Service (NPS) to conduct an air quality monitoring study in Yellowstone National Park to help assess the impact of human-caused pollutants during periods of winter activity. In the winter months, Yellowstone National Park opens roads to over-snow vehicles (snowmobiles and snow coaches) as soon as adequate snow accumulations and safe driving conditions allow.

The monitoring program for the 2009-2010 season began December 15, 2009, and ran through March 15, 2010. The monitoring effort included meteorological, gaseous, particulate, and photographic monitoring near the Old Faithful Geyser. The meteorological, gaseous, and particulate variables were monitored continuously. A digital camera system was mounted on top of the monitoring shelter and captured images of the Old Faithful parking area. Similar monitoring programs operated during the seven (7) previous winter seasons.

This data report presents all data collected during the study period, December 15, 2009, through March 15, 2010. The report is organized into the following major sections:

Section 1.0	Introduction
Section 2.0	Site Location and Configuration
Section 3.0	Data Collection, Validation, and Quality Assurance
Section 4.0	Data Summaries
Appendix A	Maintenance and Calibration
Appendix B	Snowmobile Codes

Any questions or comments regarding this report should be addressed to:

Jessica Ward
Air Quality Data Manager

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, CO, 80525
Telephone: 970-484-7941
E-mail: jward@air-resource.com

2.0 SITE LOCATION AND CONFIGURATION

ARS conducted monitoring in the Old Faithful area of Yellowstone National Park. Table 2-1 summarizes the instrumentation type and data collection parameters at the site. A map detailing the location of the monitoring site is presented as Figure 2-1.

2.1 OLD FAITHFUL MONITORING SITE

The Old Faithful monitoring shelter is located east of the main parking lot for the Snow Lodge and southeast of the Old Faithful Geyser. Instrumentation at the site included a wind speed/wind direction sensor, an ambient temperature and relative humidity (AT/RH) sensor, a carbon monoxide (CO) analyzer, and a beta attenuation monitor (BAM) for collection of fine particulate matter. A digital camera was installed on the meteorological tower and overlooked the main vehicle parking lot. Figure 2-2 presents a photograph of the monitoring shelter at the Old Faithful site.

This shelter was located in close proximity to the Old Faithful Geyser. Geysers can emit several types of gases. The most abundant gas is carbon dioxide, but geysers can also emit oxygen, carbon monoxide, hydrogen methane, nitrogen, argon, and hydrogen sulfide. Old Faithful is the most regular geyser in the basin area and erupts approximately every 60-90 minutes. Figure 2-3 presents a map of the Old Faithful area.

Table 2-1

Yellowstone National Park
Winter Use Air Quality Monitoring Study Instrumentation
December 15, 2009 - March 15, 2010

Sampler	Sampler Type	Sampler Model No.	Averaging Period	Sample Frequency
Meteorological	Wind Speed and Wind Direction (R.M. Young)	05305	1-hour	Continuous
Meteorological	Ambient Temperature and Relative Humidity (Vaisala)	HMP 45C	1-hour	Continuous
Gaseous	CO Analyzer (Thermo Environmental)	TEI 48C	1-hour	Continuous
Particulate	BAM $PM_{2.5}$ (ThermoAndersen)	FH 62 C14	1-hour	Continuous
Photographic	Digital Web Camera (Olympus C730UZ)	HRDC-1	--	Every 15 minutes

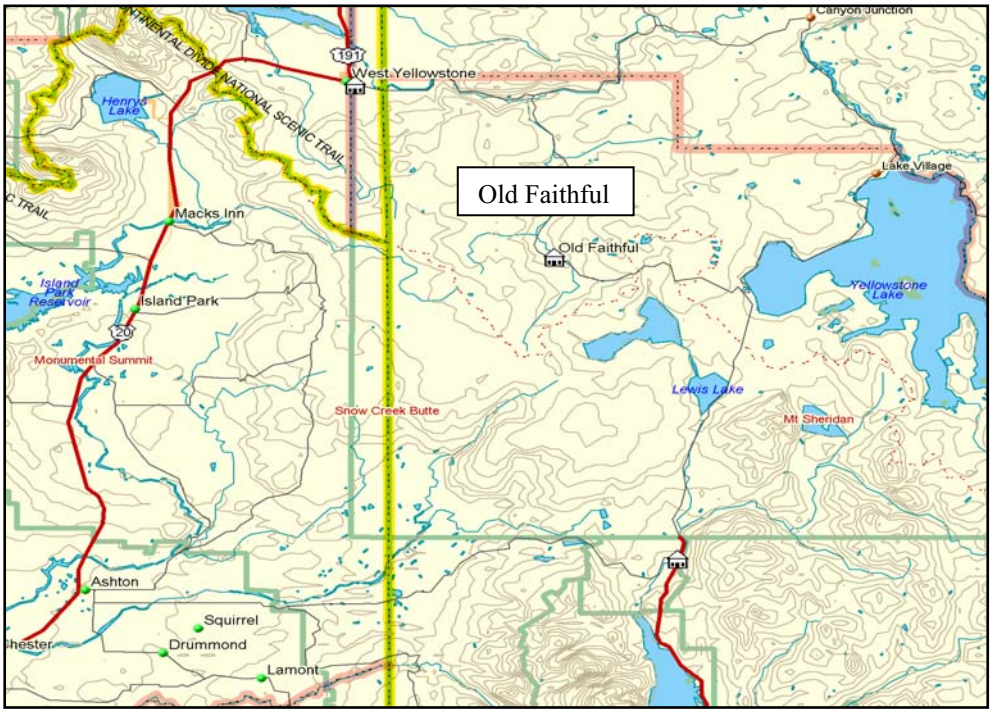

Figure 2-1. Monitoring Site Location.

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Figure 2-2. Monitoring Shelter at the Old Faithful Site.

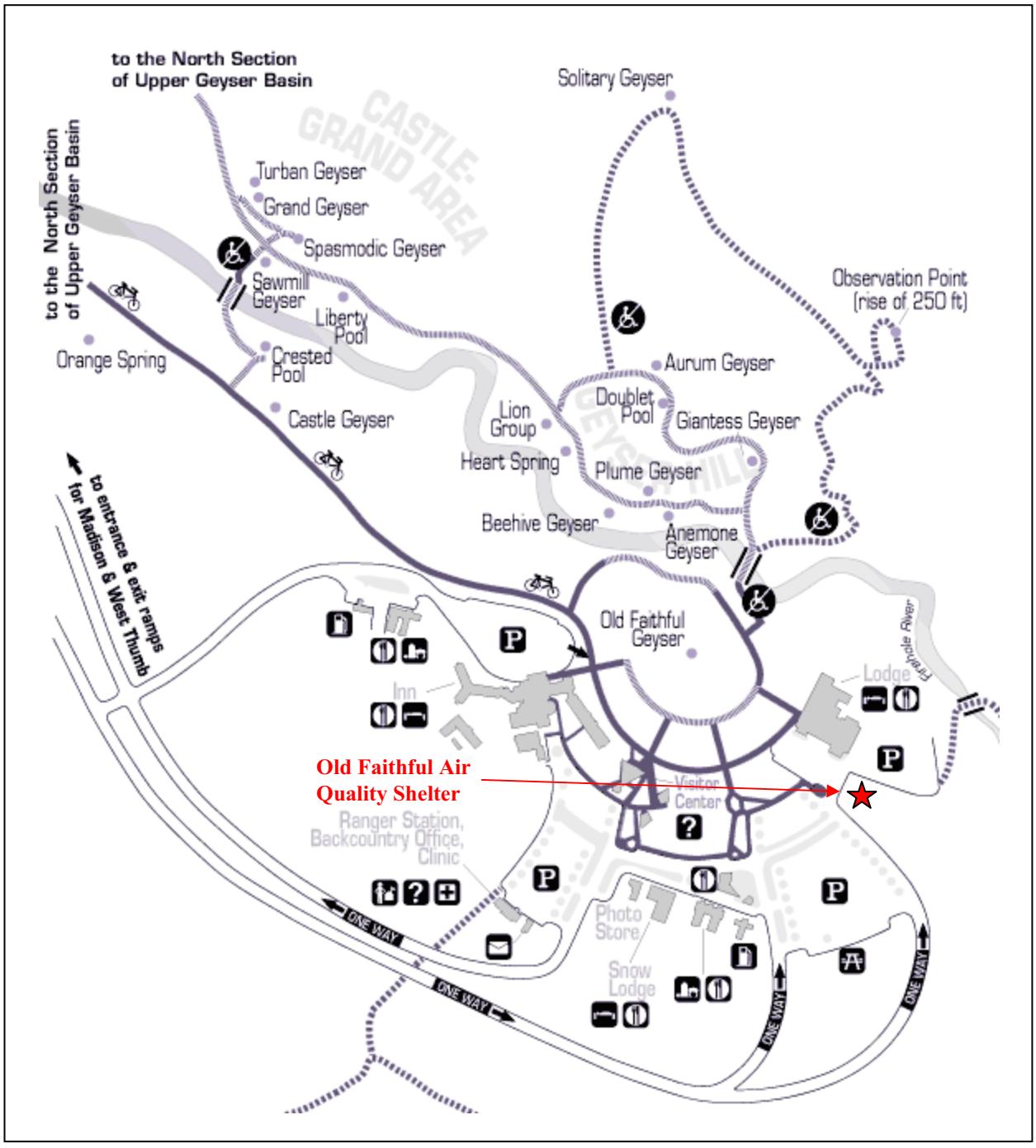


Figure 2-3. Old Faithful Area Map.

3.0 DATA COLLECTION, VALIDATION, AND QUALITY ASSURANCE

This section describes the instrumentation, data acquisition, validation, and quality assurance of meteorological, gaseous, particulate, and photographic monitoring data collected by ARS during the study.

3.1 SUMMARY OF AIR QUALITY AND METEOROLOGICAL MONITORING

At the Old Faithful site, continuous CO and $PM_{2.5}$ analyzers were operated during the study period to help assess the impact of human-caused pollutants during periods of winter activity. Meteorological sensors were operated during the study to better characterize the overall meteorology of the region. All continuous meteorological, gaseous, and particulate data were collected with the site ESC8816 datalogger. The datalogger sampled the measurement channels at a frequency of once per second, and averages were calculated and reported at 1-hour intervals. The datalogger was connected to a Starband satellite communications system, allowing remote access of the data. The data were downloaded nightly. This section describes the collection, validation, and quality assurance of data collected by ARS at the Old Faithful site.

3.1.1 Air Quality and Meteorological Monitoring System

The air quality and meteorological monitoring system at Old Faithful consisted of the following instruments:

- Thermo Environmental Instruments 48C CO Analyzer
- ThermoAndersen Model FH 62 C14 BAM with a $PM_{2.5}$ Size Cut
- Vaisala HMP 45C AT/RH Sensor
- R.M. Young Model No. 05305 Wind Sensor

3.1.2 Air Quality and Meteorological Data Collection and Validation

Meteorological, gaseous, and particulate data collection and validation steps followed the protocol set forth by the NPS Gaseous Pollutant Monitoring Program, and included:

- Raw hourly meteorological, CO, $PM_{2.5}$, and data collected nightly via modem and uploaded to the ARS Air Quality Database (AQDB).
- Raw data and nightly calibration (zero and span) data were plotted and reviewed daily to identify operational problems and initiate corrective procedures as soon as possible.
- Information from communications with the operators was used to identify inconsistencies and errors in the data.

- Recording and reviewing comments on raw data stackplots, and entering validation codes and adjusting values in the AQDB as needed.
- Reviewing validated stackplots, resolving all inconsistencies and labeling the data as final validated.

3.1.3 Air Quality and Meteorological Sensor Uncertainty

The meteorological sensors, CO analyzer, and BAM were calibrated in September before the study began. The CO analyzer was also calibrated in January. All calibrations performed in September and January passed data validation acceptance criteria. All equipment were again calibrated after the study in May 2010. All instruments were within acceptable specifications. Calibration and maintenance results are presented in Appendix A.

Automated zeros were performed by the CO analyzer throughout the study every four (4) hours, and the results of these zeros indicate that the instrument response drifted upwards. All CO data were corrected based on the results of these zeros.

The detection limit for the ThermoAnderson BAM is approximately 6 $\mu g/m^3$ for 1-hour averages.

3.2 SUMMARY OF PHOTOGRAPHIC MONITORING

Routine photographic monitoring was conducted at the Old Faithful site consisting of digital photographs taken every 15 minutes to document weather conditions, type and intensity of activity, and the presence of haze or exhaust. Images were posted to a Web site for easy review by various project participants. Due to the angle of the camera and distance to the snowmobile parking lot, counting the number of snowmobiles in each photograph was not possible. Instead, a coding scheme was used to estimate visible vehicular traffic from low to high. A summary of the codes is presented in Section 4.5, and a full listing of all images and their respective codes is presented in Appendix B.

4.0 DATA SUMMARIES

This section presents a summary of all data collected during the winter use season, December 15, 2009, through March 15, 2010.

4.1 DATA COLLECTION AND VALIDATION STATISTICS

Table 4-1 presents data collection statistics for the study period for the Old Faithful site. The data recovery for all parameters exceeded 99%. Particulate Matter data validity was at 83% due to intermittent problems with the filter tape.

4.1.1 Old Faithful

The CO analyzer at the Old Faithful site experienced a significant amount of zero drift over the study period. During this study, automated zeros ran on the CO analyzer every four (4) hours and the results were automatically applied to the raw data by the datalogger.

4.2 DATA TIME SERIES

Time series plots that display meteorological, gaseous, and particulate parameters can be found in Figures 4-1 through 4-4.

Table 4-1

Data Collection Statistics
Yellowstone National Park
Old Faithful

Final Validation

12/15/2009 - 03/15/2010

Parameter	Interval	Par Code	Data Recovery			Valid Data	
			No. Possible	No. Collected	% Collected	No. Valid	% Valid
Carbon Monoxide	hourly	CO	2184	2179	99.8	2177	99.7
Particulate Matter 2.5 Bam 1020	hourly	PM2.5B	2184	2164	99.1	1814	83.1
Relative Humidity	hourly	RH	2184	2184	100.0	2184	100.0
Standard Deviation for Wind Direction	hourly	SDWD	2184	2179	99.8	2179	99.8
Scalar Wind Speed	hourly	SWS	2184	2179	99.8	2179	99.8
Ambient Temperature (aspirated)	hourly	TMP	2184	2184	100.0	2184	100.0
Vector Wind Direction	hourly	VWD	2184	2179	99.8	2179	99.8
Vector Wind Speed	hourly	VWS	2184	2179	99.8	2179	99.8

Note: The percent valid is calculated against the number possible.

Automatic zeros and spans are performed daily on most ambient gas analyzers, therefore, no ambient data can be collected during this time. As a result, the maximum percent valid for ambient gas data typically can not be greater than 95.8.

Performance Goals:	Quarterly Criteria:	Monthly Criteria:
	100% of sites, >= 85% valid data capture	100% of sites, >= 60% valid data capture
	90% of sites, >= 90% valid data capture	90% of sites, >= 75% valid data capture
	80% of sites, >= 95% valid data capture	80% of sites, >= 85% valid data capture

Figure 4-1
Yellowstone National Park - Old Faithful
December 2009

Figure 4-2
Yellowstone National Park - Old Faithful
January 2010

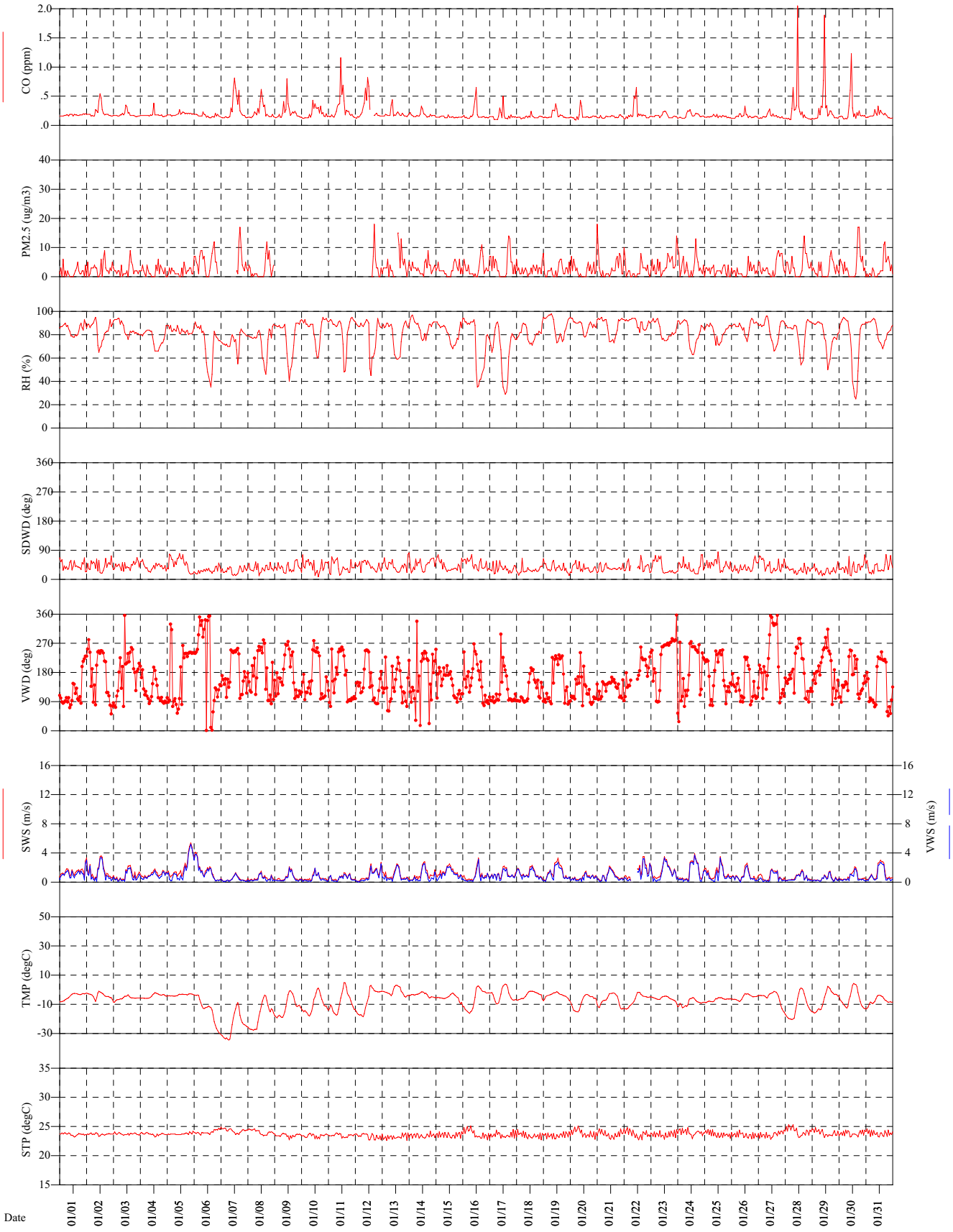


Figure 4-3
Yellowstone National Park - Old Faithful
February 2010

Figure 4-4
Yellowstone National Park - Old Faithful
March 2010

4.3 METEOROLOGICAL DATA

Table 4-2 presents meteorological data summary statistics for the study period from the Old Faithful monitoring site, and Figure 4-5 presents a wind rose for the same period. Winds at the Old Faithful site were mixed with directions predominantly out of the east and southwest. The highest wind speeds were seen when the winds were coming from the southwest and west-southwest.

Table 4-2

Summary of Selected Meteorological Data

Yellowstone National Park

Old Faithful

Final Validation

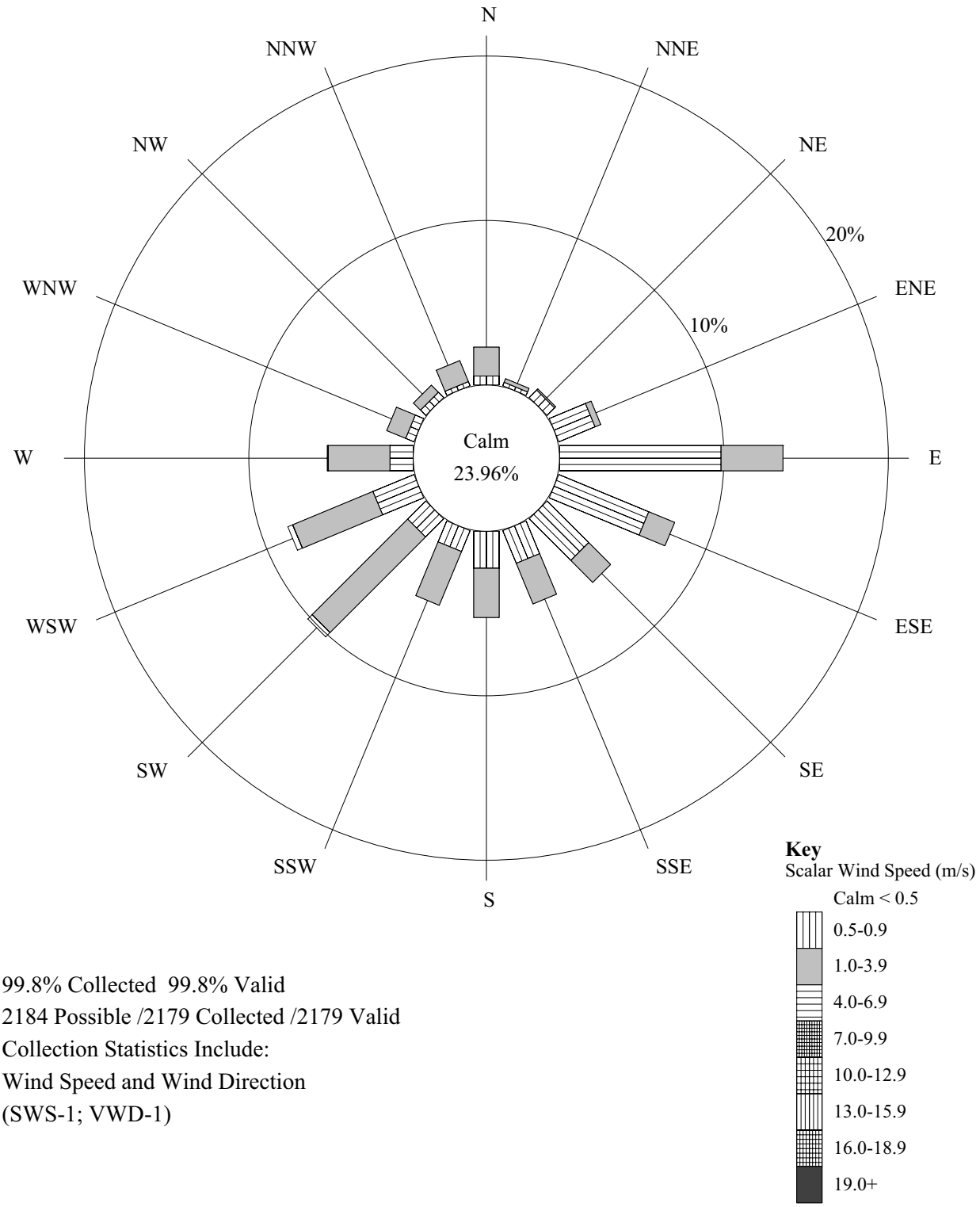
12/15/2009 - 03/15/2010

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	1.1	m/s	2179	0.8
Maximum	5.4	m/s		
Percent calm = 23.96				
AMBIENT TEMPERATURE				
Average	-7.1	degC	2184	6.6
Maximum	8.3	degC		
Minimum	-34.5	degC		
RELATIVE HUMIDITY				
Average	79	percent	2184	14
Maximum	98	percent		
Minimum	24	percent		

Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Figure 4-5

Yellowstone National Park Wind Rose 12/15/2009 - 03/15/2010
Old Faithful



99.8% Collected 99.8% Valid
2184 Possible /2179 Collected /2179 Valid
Collection Statistics Include:
Wind Speed and Wind Direction
(SWS-1; VWD-1)

4.4 AIR QUALITY DATA

4.4.1 Pollutant Roses

Carbon monoxide and BAM $PM_{2.5}$ pollutant roses are presented in Figures 4-6 and 4-7. These pollutant roses, similar in shape to the wind roses presented in the previous section, graphically describe the wind direction and associated magnitude of each pollutant.

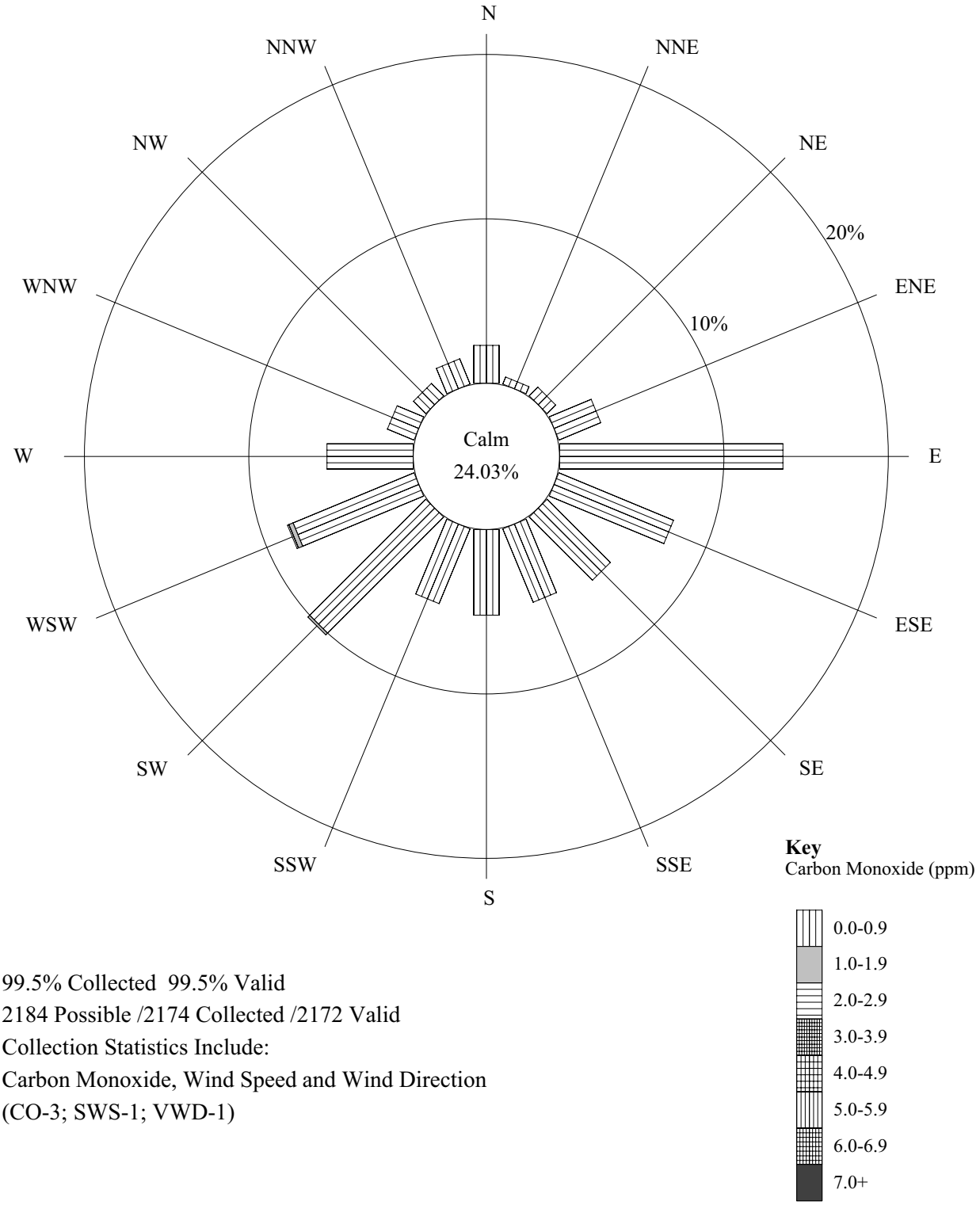
4.4.2 Comparison with National Ambient Air Quality Standards

Table 4-3 lists the five (5) highest 1-hour average daily carbon monoxide maximums and the five (5) highest non-overlapping 8-hour running averages for the Old Faithful site. Table 4-4 lists the five (5) highest 1-hour average daily maximums and the five highest 24-hour averages recorded for $PM_{2.5}$ from the BAM.

Table 4-5 presents a comparison of the 2009-2010 study CO and $PM_{2.5}$ data to the National Ambient Air Quality Standards (NAAQS). At no time during the study period did CO or $PM_{2.5}$ approach their respective standards. The highest hourly CO value was 7.1% of the 1-hour standard and 8.9% of the 8-hour standard. The highest 24-hour average recorded for $PM_{2.5}$ during the study period was 14.5% of the 24-hour standard.

Figure 4-6

Yellowstone National Park | Pollutant Rose | 12/15/2009 - 03/15/2010
Old Faithful | Carbon Monoxide

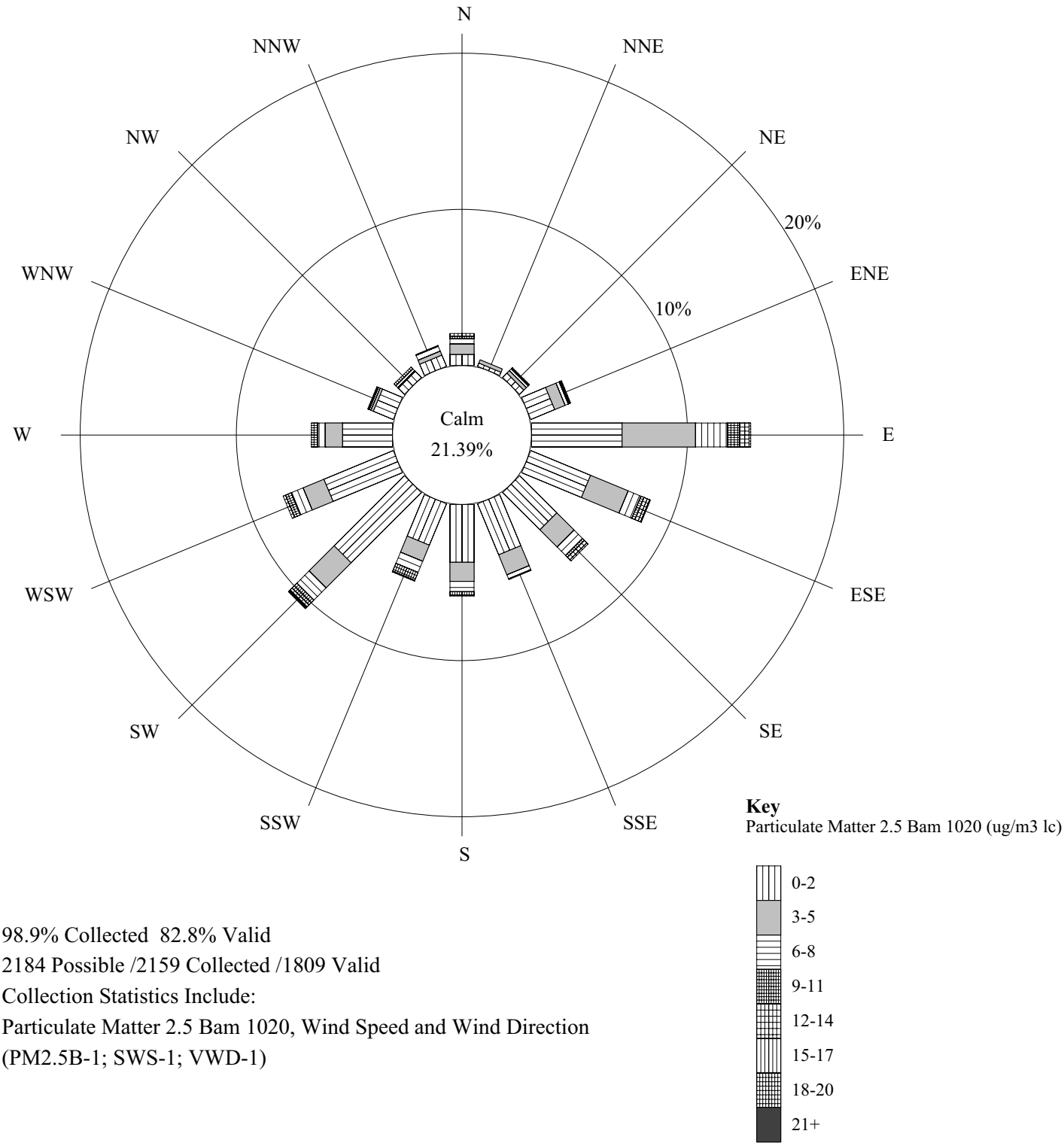


99.5% Collected 99.5% Valid
2184 Possible /2174 Collected /2172 Valid
Collection Statistics Include:
Carbon Monoxide, Wind Speed and Wind Direction
(CO-3; SWS-1; VWD-1)

Figure 4-7

Yellowstone National Park | Pollutant Rose | 12/15/2009 - 03/15/2010

Old Faithful | Particulate Matter 2.5 Bam 1020



98.9% Collected 82.8% Valid

2184 Possible /2159 Collected /1809 Valid

Collection Statistics Include:

Particulate Matter 2.5 Bam 1020, Wind Speed and Wind Direction

(PM2.5B-1; SWS-1; VWD-1)

Table 4-3

Carbon Monoxide Five Highest 1-Hour and 8-Hour Average Concentrations
Yellowstone National Park – 2009-2010 Winter Use Air Quality Monitoring Study

		1-Hour Average Daily Maximums			Highest 8-Hour Running Averages		
Site	Rank	Date	Hour	Concentration (ppm)	Date	Hour Ending	Concentration (ppm)
Old Faithful	1	12/27/09	12	2.49	12/27/09	14	0.80
	2	1/28/10	11	2.05	12/29/09	14	0.80
	3	1/29/10	11	1.89	1/28/10	12	0.60
	4	12/29/09	12	1.76	1/29/10	13	0.60
	5	12/22/09	12	1.35	12/22/09	12	0.50

Table 4-4

$PM_{2.5}$ Five Highest 1-Hour and 24-Hour Average Concentrations
Yellowstone National Park – 2009-2010 Winter Use Air Quality Monitoring Study

		1-Hour Average Daily Maximums			Highest 24-Hour Averages		
Site	Rank	Date	Hour	Concentration ($\mu g/m^3$)	Rank	Date	Concentration ($\mu g/m^3$)
Old Faithful	1	3/9/10	18	21.0	1	1/6/10	5.09
	2	2/24/10	12	19.0	2	3/8/10	4.71
	3	1/12/10	17	18.0	3	3/5/10	4.63
	4	1/21/10	0	18.0	4	3/7/10	4.54
	5	3/14/10	19	18.0	5	3/6/10	4.46

Table 4-5

Comparison of CO and $PM_{2.5}$ Study Results to NAAQS
Yellowstone National Park – 2009-2010 Winter Use Air Quality Monitoring Study

	CO				$PM_{2.5}$		
Site	Max 1-hr avg (ppm)	Percent of Standard	Max 8-hr avg (ppm)	Percent of Standard	Max 1-hr avg (ppm)	Max 24-hr avg (ppm)	Percent of Standard
Old Faithful	2.49	7.1%	0.8	8.9%	21	5.09	14.5%
NAAQS	**CO**		**CO**			**$PM_{2.5}$**	
1-hour	35		--			--	
8-hour	--		9			--	
24-hour	--		--			35	

4.5 DIGITAL PHOTOGRAPHS

Digital photographs were collected every 15 minutes during the study. Due to a low camera angle and distance from the snowmobile parking lot, it was not possible to count the actual number of snowmobiles in each photograph. Instead, the number of snowmobiles represented in the digital images collected for this study were coded using a coding scheme of 0-4. The codes used represent the following approximate counts:

0	No snowmobiles present
1	Parking lot ¼ full
2	Parking lot ½ full
3	Parking lot ¾ full
4	Full parking lot

Figure 4-8 represents a diurnal summary of the codes used. In this graph, the median code value used for each time of the day is plotted. The heaviest snowmobile use during the winter season occurred from 11:45-13:45. Appendix B contains a full listing of images collected and their respective snowmobile codes.

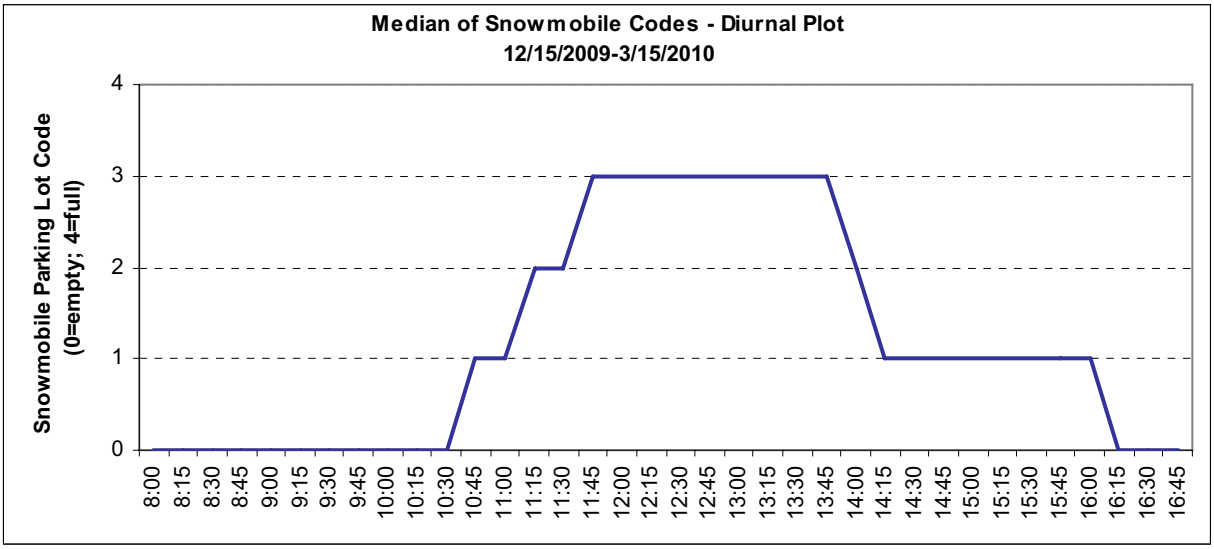


Figure 4-8. Diurnal Plot of Digital Image Codes.

4.6 DIURNAL PATTERNS OF AIR QUALITY PARAMETERS

Diurnal plots were generated for each air quality parameter by averaging all of the validated data for each hour of the day. Figure 4-9 presents diurnal patterns of CO data from the Old Faithful site for the 2009-2010 winter season. CO levels were highest during the daylight hours for the monitoring period, especially around noon. Figure 4-10 presents a diurnal pattern of $PM_{2.5}$ concentrations at the Old Faithful site. $PM_{2.5}$ levels were generally lowest shortly before noon and highest in the late afternoon and early evening.

Figure 4-9

Yellowstone National Park | Diurnal Plot | 12/15/2009 - 03/15/2010

Old Faithful | Carbon Monoxide

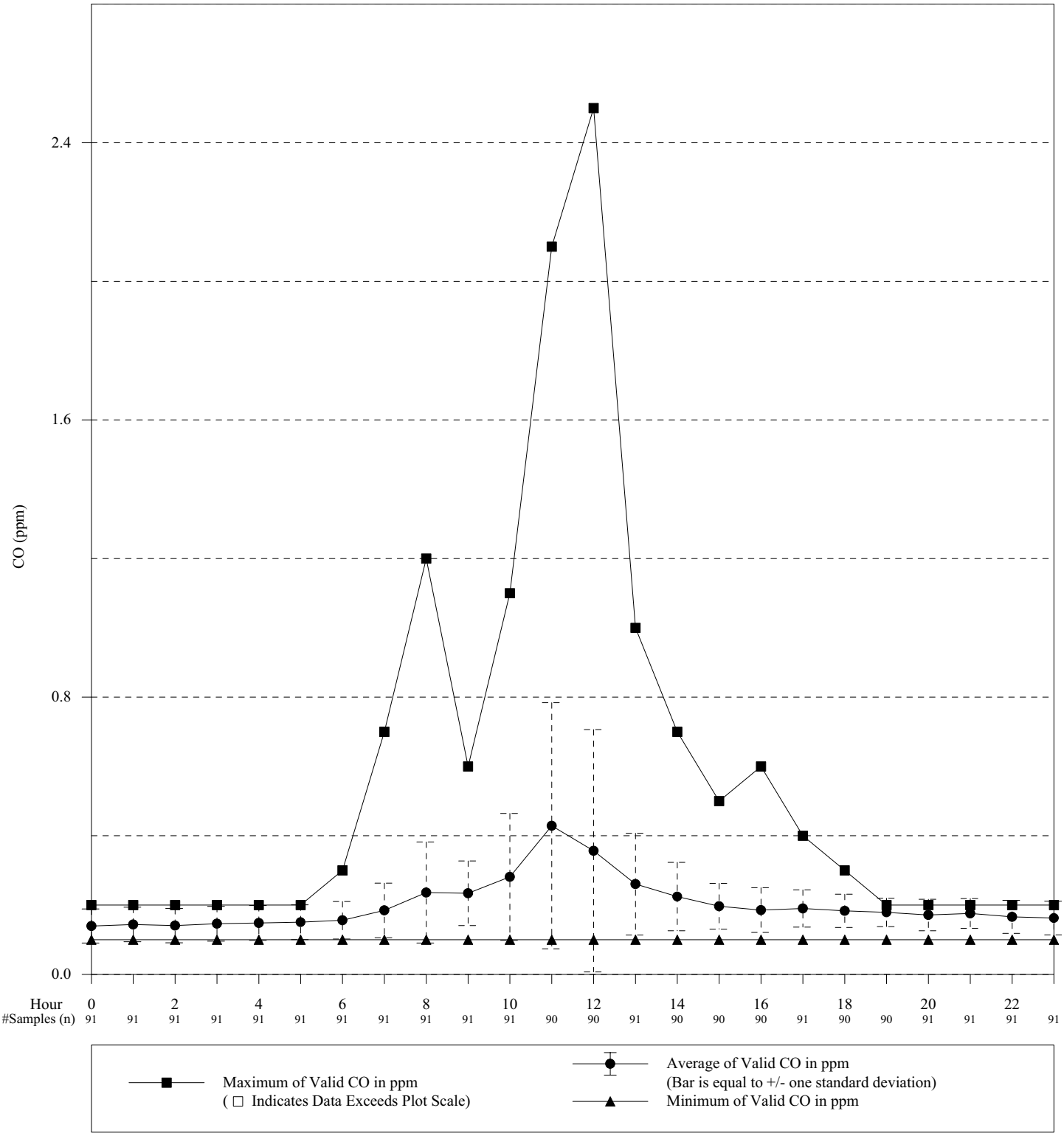
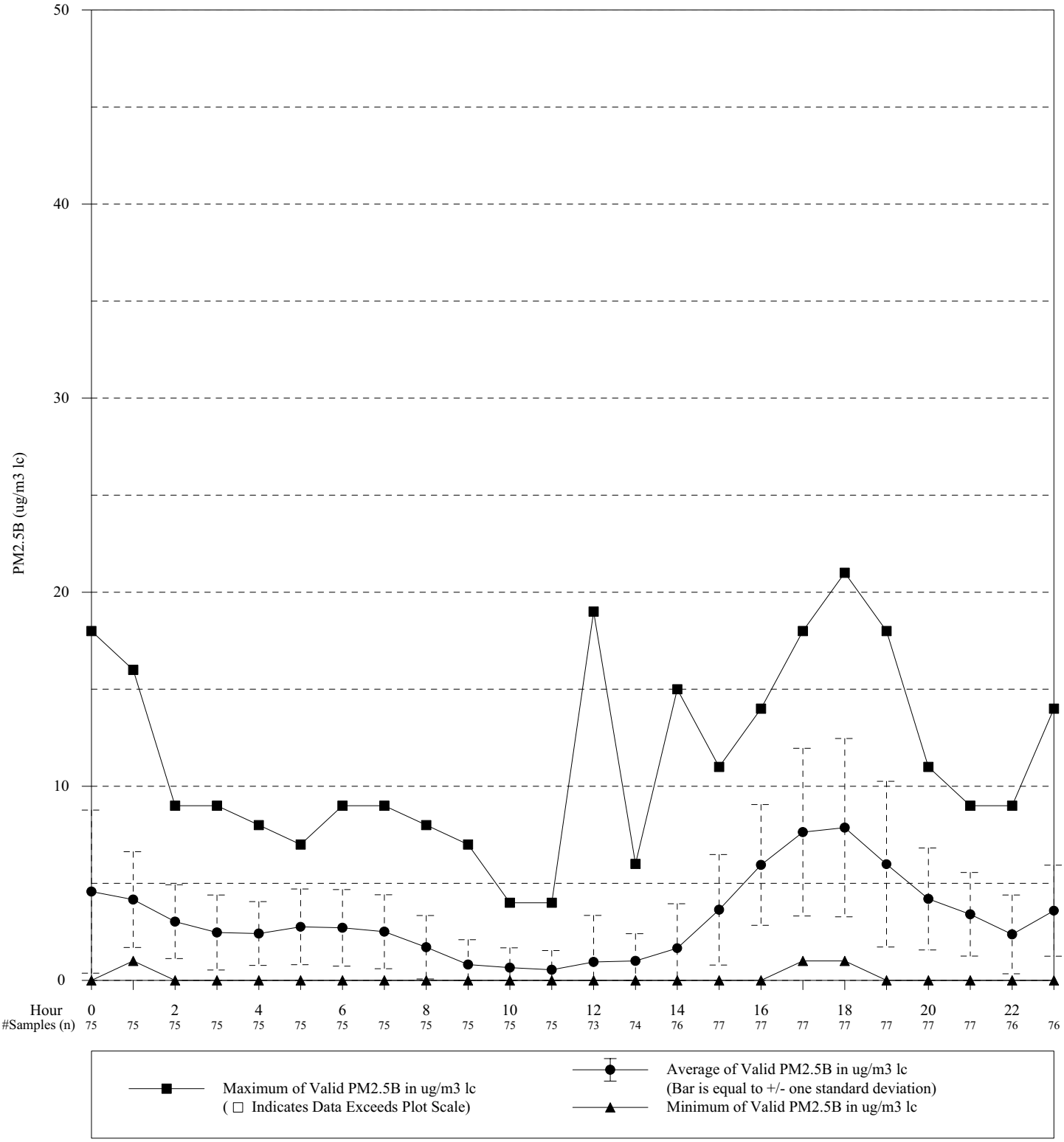


Figure 4-10

Yellowstone National Park | Diurnal Plot | 12/15/2009 - 03/15/2010

Old Faithful | Particulate Matter 2.5 Bam 1020



APPENDIX A

Maintenance and Calibration

Air Resource Specialists, Inc.

Calibration Summary

Network: NPS	Location: Old Faithful	Site: YELL-OF
Date: 09/14/09	Last Site Visit: 05/06/09	Field Specialist: Dave Beichley

Parameter		Criteria	Accuracy Goal	Calibration Results					
				Pre-Maintenance			Post Maintenance		
				Mfg, Model # & Serial #	Value	Pass/Fail	Mfg, Model # & Serial #	Value	Pass/Fail
Beta Attenuation Monitor	*Temperature*	max error	<= ± 2.0º C	TECO FH62C-14 513			TECO FH62C-14		
	Pressure	max error	<= ± 2.0%						
	Flow	max error	<= ± 5.0%						
	Zero Foil	N/A	N/A			N/A			N/A
	Span Foil	N/A	N/A			N/A			N/A
CO Analyzer	*Average Difference*	average error	<= ± 5.0%	TECO 48C 71377-328	6.9%	FAIL	TECO 48C 71377-328	2.6%	PASS
	Maximum Difference	max error	<= ± 5.0%		16.8%	FAIL		5.0%	PASS
	Correlation	actual	r > 0.9950		0.9982	PASS		0.9996	PASS
	Intercept	actual	<= ± 3.0 ppm		0.4	PASS		0.0	PASS
	Slope	actual	0.950 <= m <= 1.050		1.005	PASS		0.989	PASS
Mass Flow Correlation	*Low Cell (Dilution Air)*	correlation coefficient	r >= 0.9995	Millipore AC00463008	N/A	N/A	Millipore AC00463008	1.0000	PASS
	High Cell (Gas)	correlation coefficient	r >= 0.9995	Millipore AA00463029	N/A	N/A	Millipore AA00463029	0.9995	PASS
Relative Humidity	*PRE Sensor ID# C1210008*	max error	<= ± 5.0%	Vaisala HMP45C C1210008	2.3%	PASS	Vaisala HMP45C Z1730047	1.3%	PASS
Temperature		max error	Climatronics <= ± 0.2º C; RM Young <= ± 0.5º C; Rotronics <= ± 1.0º C	Vaisala hmp45c C1210008	1.7º	FAIL	Vaisala hmp45c Z1730047	1.2º	FAIL
Wind Direction	*Alignment*	max error	<= ± 5º	RM Young AQ 05305 44100 / NPS90858	4º	PASS	RM Young AQ 05305 55389 / NPS90879	4º	PASS
	Linearity	max error	<= ± 3º		5º	FAIL		3º	PASS
	Starting Threshold	max error	Climatronics <= 6 g-cm; RM Young AQ <= 9 g-cm; RM Young MA <= 30 g-cm, RM Young RE <= 7 g-cm		4	PASS		4	PASS
Wind Speed	*max Wind Speed <5*	max error	<= ± 0.2 m/s	RM Young AQ 05305 44100/nps90858	N/A	N/A	RM Young AQ 05305 55389 / NPS90879	N/A	N/A
	max Wind Speed >= 5	max error	<= ± 5%		0.1%	PASS		0.1%	PASS
	Starting Threshold	max error	Climatronics <= 0.2 g-cm; RM Young AQ <= 0.3 g-cm; RM Young MA <= 2.9 g-cm, RM Young RE <= 0.3 g-cm		0.1	PASS		0.2	PASS

Air Resource Specialists, Inc.

Calibration Standards

Field Specialist:	Dave Beichley	**Latitude:**	N44 27' 29.6"
Operator:	Gary Nelson	**Longitude:**	W110 49' 31.0"
Network:	NPS	**Elevation:**	7386 ft
Location:	Old Faithful		
Site:	YELL-OF		
Date:	9/14/2009		
Last Site Visit:	5/6/2009		

Parameter	Device	Manufacturer	Model	S/N	Calibration Date
Voltage	DVM	Fluke	189	87970615	1/6/2009
	Voltage Source				
Ozone	Transfer Standard				
Gas Dilution	Mass flow	teco	146c	68947-360	5/21/2008
Barometric Pressure	Barometer/Altimeter				
High Flow	Dry cal	BIOS	dc2-b	2185	8/4/2009
Low Flow	Dry cal	BIOS	DC2	1304	8/4/2009
Precipitation	PPT Calibrator	RM Young	52260		
	Volume (ml):	1000			
Relative Humidity	RH Sensor	Rotronics	Hydro Clip	29206015/87744	6/29/2009
Solar Radiation	Thermopile	LiCor	Pyranometer	py59534	5/8/2008
	Multiplier	-11.56			
Temperature	Digital Thermometer	Eutechnics	Hydro Clip	29206015/87744	6/29/2009
Wind Direction	Torque Gauge	RM Young		2909	
	Linearity Jig	RM Young		2909	
	Compass	Brunton	5006LM	5041192246	1/12/2004
Wind Speed	Torque Disk	RM Young			
	Anemometer Drive	RM Young	18820A/18830A	CA02934	1/9/2009
Volumetric Flow					

Comments:

Air Resource Specialists, Inc.

TEMPERATURE, DELTA TEMPERATURE AND RELATIVE HUMIDITY CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 09/14/09	Date of Last Site Visit: 05/06/09
				Field Specialist: Dave Beichley

Reference Thermometer S/N: 29206015/87744		Calibration Date: 06/29/09
Relative Humidity Reference S/N: 29206015/87744		Calibration Date: 06/29/09

TEMPERATURE / DELTA TEMPERATURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Vaisala	Vaisala
Model #	hmp45c	hmp45c
Temperature Serial #	C1210008	Z1730047
Delta Temp. Serial #		
Translator Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE DVM (volts)	TEMPERATURE DAS (° C)	Difference (° C)	Pass/Fail	Δ TEMPERATURE DVM (volts)	Δ TEMPERATURE DAS (° C)	Difference (° C)	Pass/Fail
16.2		14.4	-1.7	FAIL				
17.7		16.3	-1.4	FAIL				
	Maximum Difference:		1.7	FAIL	Maximum Difference:			

PRE- TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE DVM (volts)	TEMPERATURE DAS (° C)	Δ TEMPERATURE DVM (volts)	Δ TEMPERATURE DAS (° C)
Zero				
Span				

POST MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE DVM (volts)	TEMPERATURE DAS (° C)	Difference (° C)	Pass/Fail	Δ TEMPERATURE DVM (volts)	Δ TEMPERATURE DAS (° C)	Difference (° C)	Pass/Fail
18.4		17.2	-1.2	FAIL				
19.2		18.1	-1.1	FAIL				
20.2		19.1	-1.1	FAIL				
	Maximum Difference:		1.2	FAIL	Maximum Difference:			

POST TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE DVM (volts)	TEMPERATURE DAS (° C)	Δ TEMPERATURE DVM (volts)	Δ TEMPERATURE DAS (° C)
Zero				
Span				

Pre-Maint Temperature Comments:	
Post Maint Temperature Comments:	

RELATIVE HUMIDITY

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Vaisala	Vaisala
Model #	HMP45C	HMP45C
Serial #	C1210008	Z1730047

PRE-MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
8:00	57.5	55.2	2.3%	PASS
9:00	49.5	48.9	0.6%	PASS
10:00				
11:00				
12:00				
13:00				
Average ABS % Difference:			1.5%	PASS
Maximum % Difference:			2.3%	PASS

POST MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00	45.3	46.1	-0.8%	PASS
11:00	43.9	44.8	-0.9%	PASS
12:00	38.5	39.7	-1.3%	PASS
13:00	29.9	30.5	-0.6%	PASS
14:00				
15:00				
Average ABS % Difference:			0.9%	PASS
Maximum % Difference:			1.3%	PASS

Screen dirty/clogged on RH pre-maintenance sensor? (check one):	☐ Yes ☑ No

Pre-Maint Relative Humidity Comments:	
Post Maint Relative Humidity Comments:	

Air Resource Specialists, Inc.

TECO BAM (BETA ATTENUATION MONITOR) CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/06/09	Date of Last Site Visit: 05/06/09
				Field Specialist: Dave Beichley

Volumetric Flow Standard S/N: N/A		Calibration Date:

EQUIPMENT IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	TECO	TECO
Model #	FH62C-14	FH62C-14
Serial #	513	513
Version #		
Diagnostics		
Air Flow Vol. Head		
Air Flow Norm		
T_1		
T_2		
T_3		
T_4		
Status Code		
Error Codes		
RH Control		
RH Set Point		
Databg RH		
Delta-T Control		
Delta-T Setpoint		

ORDER OF STEPS

1. Temperature and pressure check and calibration.
2. Air flow rate calibration (2%).
3. Mass foil calibration/audit. (Yearly - calibrate; Quarterly - verify)

**Note: Never leak check this instrument!

TEMPERATURE/PRESSURE/FLOW CHECKS

PRE-MAINTENANCE

Temp, Pressure, Flow	BAM	Flow Standard	% Difference	Pass/Fail
Ambient Temperature				
Barometric Pressure				
Volumetric Flow				

POST MAINTENANCE

Temp, Pressure, Flow	BAM	Flow Standard	% Difference	Pass/Fail
Ambient Temperature				
Barometric Pressure				
Volumetric Flow				

CALIBRATION TIME

From:		To:	

ZERO/SPAN FOIL PROCEDURE

1. Turn heater off before performing calibration (yg 56).
2. Remove down tube from top of instrument. (Caution: Don't block the flow!) Wait 1 hour for T_1/T_4 to equilibriate.
3. Perform mass foil calibration (PS 65).

PRE-MAINTENANCE

	Expected Response	Actual Response	% Difference
Zero Foil	0		
Span Foil	1347		

POST MAINTENANCE

	Expected Response	Actual Response	% Difference
Zero Foil			
Span Foil			

MAINTENANCE CHECKLIST

- ☑ Clean Inlet
- ☑ Clean Nozzle

	As Found	Actual
Time Reset		

Pre-Maint Comments:	The BAM was removed 1 week prior to visit for repair I reinstalled the instrument on 9/16 after being repaired and calibrated.
Post Maint Comments:	

Air Resource Specialists, Inc.

GAS DILUTION CALIBRATOR CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 09/14/09	Date of Last Site Visit: 05/06/09
				Field Specialist: Dave Beichley

High Flow Standard Reference: BIOS, dc2-b	High Flow Standard Reference S/N: 2185	Calibration Date: 08/04/09
Low Flow Standard Reference: BIOS, DC2	Low Flow Standard Reference S/N: 1304	Calibration Date: 08/04/09

Mass Flow Device (Dilution Air)

Mfg: Millipore	S/N: AC00463008	Range: 0 -10 L
Calibration Gas: Air	This primary standard automatically corrects to standard flow.	

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1	498	494.9
2	1997	1957
3	3502	3431
4	4999	4921
5	6501	6409
6	8000	7800
	9493	9547

Linear Regression

Parameter	Air Flow Controller	Pass/Fail
Slope (m)	1.022246	N/A
Y Intercept (b)	-12.055819	N/A
Correlation Coefficient (r)	0.999956	PASS

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts - b) / m

Mass Flow Device (Gas 1)

Mfg: Millipore	S/N: AA00463029	Range: 0 - 100 cc.
Calibration Gas:	This primary standard automatically corrects to standard flow.	

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1	5	7.621
2	20	19.78
3	35	35.18
4	50	49.78
5	65	65.07
6	80	80.04
	95	93.34

Linear Regression

Parameter	Gas Flow Controller	Pass/Fail
Slope (m)	1.023230	N/A
Y Intercept (b)	-1.408682	N/A
Correlation Coefficient (r)	0.999497	PASS

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts -b) / m

MFC/MFM Comments:	

Air Resource Specialists, Inc.

CARBON MONOXIDE ANALYZER CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 09/14/09	Date of Last Site Visit: 05/06/09
				Field Specialist: Dave Beichley

EQUIPMENT IDENTIFICATION

	Transfer Standard	Analyzer	Station Reference
Mfg.		TECO	teco
Model #		48C	146c
Serial #		71377-328	68947-360

FLOW METER DATA

	Dilution Air	Gas
Slope (m)	0.010	0.988
Y Intercept (b)	0.3	0.3
Correlation Coefficient (r)	1.0000	0.9997

REFERENCE GAS

Tank S/N	CAO1538
Calibration Date	6/23/2012
Pressure Tank / Del.	2000/30
Tank Conc. (ppm)	3100

STATION TUBING

		CALCULATED FLOW		FLOW METER		PRE-MAINTENANCE					
						CO Bkg. (zero) =		CO Coef. (span) =			
Calibration Point	Conc. (ppm)	Dil. Air (cc/min)	Gas (cc/min)	Dil. Air Inst. Dis.	Gas Inst. Dis.	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference	Pass/ Fail
ZERO	0.0	3000	0.0	2996.000	0.000		0.0				
1	18.0	4970	29.0	4979.000	29.020		17.9		-0.110	-0.6%	PASS
2	15.6	4979	25.1	4975.000	25.210		16.4		0.830	5.3%	FAIL
3	10.0	4984	16.1	4989.000	15.940		10.8		0.780	7.8%	FAIL
4	8.0	6982	18.1	6989.000	17.930		8.3		0.306	3.8%	PASS
5	4.0	8	15.0	7000.000	8.670		4.7		0.670	16.8%	FAIL
ZERO	0.0	3000	0.0	30.503	0.000						
						Average ABS % Difference:				6.9%	FAIL
						Maximum ABS % Difference:				16.8%	FAIL

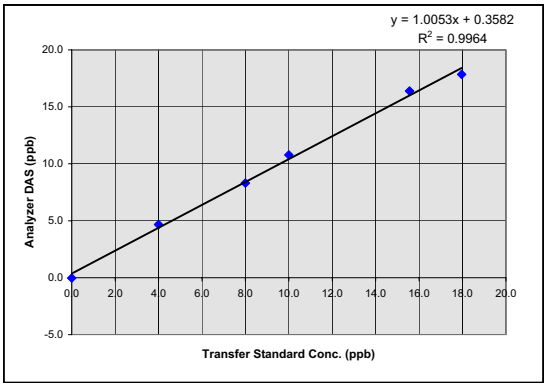
STATION TUBING

		POST MAINTENANCE					
		CO Bkg. (zero) =		CO Coef. (span) =			
Calibration Point	Conc. (ppm)	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference	Pass/ Fail
ZERO	0.000	0.000	0.0				
1	17.960		18.0		0.000	0.0%	PASS
2	15.560		15.3		-0.310	-2.0%	PASS
3	10.000		9.8		-0.210	-2.1%	PASS
4	8.000		7.7		-0.320	-4.0%	PASS
5	4.000		4.2		0.200	5.0%	PASS
ZERO	0.000	0.000	0.0				
		Average ABS % Difference:				2.6%	PASS
		Maximum ABS % Difference:				5.0%	PASS

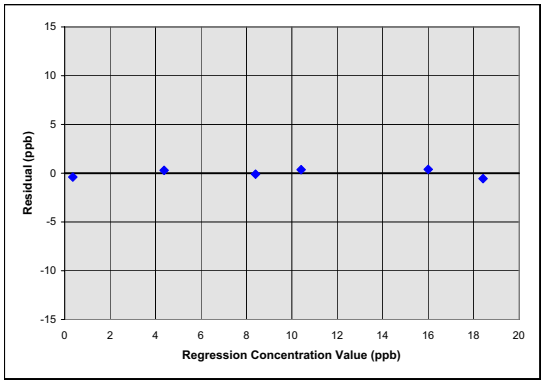
RESULTS

Linear Regression				
	PRE		POST	
Parameter	Analyzer	Pass/Fail	Analyzer	Pass/Fail
Slope	1.005	PASS	0.989	PASS
Y Intercept	0.4	PASS	0.0	PASS
Correlation Coefficient	0.9982	PASS	0.9996	PASS

LINEAR REGRESSION PLOT (PRE-MAINTENANCE)



RESIDUALS PLOT (PRE-MAINTENANCE)



CALIBRATION TIME

From:		To:	

EVENT RESPONSE

		Calculated Flow		Flow Meter		Analyzer Response				
Calibration Point	Conc. (ppm)	Dil. Air (cc/min)	Gas (cc/min)	Dil. Air (cc/min)	Gas (cc/min)	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference
ZERO	0.000	5000	29.02	4979	29		0.004			N/A
Precision	4.000	8500	11	8489	10.99		4.210		0.210	5.25%
Span	17.960	3000	0	3001	0		17.930		-0.030	-0.17%

Pre-Maint Carbon Monoxide Comments:	
Post Maint Carbon Monoxide Comments:	Performed calibration but before cal had to change the S/R ratio from initial to current. Background readings were maxed out unable to calibrate unless S/R ratio was changed. New background at -0.011.

Air Resource Specialists, Inc.

WIND DIRECTION CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 09/14/09	Date of Last Site Visit: 05/06/09
				Field Specialist: Dave Beichley

To Landmark #1:	180	Degrees True	From Landmark #1: 360	LM Description:	orientation rod
To Landmark #2:		Degrees True	From Landmark #2:	LM Description:	
Declination:	Degrees				
Wind Direction Reference S/N: 5041192246				Calibration Date: 01/12/04	

WIND DIRECTION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	RM Young AQ	RM Young AQ
Model #	05305	05305
Serial #	44100 / NPS90858	55389 / NPS90879
Translator Serial #		

WIND DIRECTION TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
360				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND DIRECTION STARTING THRESHOLD

PRE		POST	
Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail
4	PASS	4	PASS

Wind direction starting threshold accuracy goal:
RM Young AQ <= 9 g-cm

WIND DIRECTION ALIGNMENT

Land Mark Reference	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
To 1		177	-3	PASS		178	-2	PASS
From 1		356	-4	PASS		356	-4	PASS
To 2								
From 2								
	Average Difference:		4	PASS	Average Difference:		3	PASS
	Maximum Difference:		4	PASS	Maximum Difference:		4	PASS

WIND DIRECTION LINEARITY

Check Point	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
1		356	-1	PASS		178	2	PASS
2		38	-3	PASS		223	0	PASS
3		87	5	FAIL		266	-2	PASS
4		131	-1	PASS		309	-2	PASS
5		174	-3	PASS		353	-1	PASS
6		222	4	FAIL		37	-1	PASS
7		264	-3	FAIL		85	3	PASS
8		311	2	PASS		132	2	PASS
	Average Difference:		3	PASS	Average Difference:		2	PASS
	Maximum Difference:		5	FAIL	Maximum Difference:		3	PASS

Pre-Maint Wind Direction Comments:	
Post Maint Wind Direction Comments:	

Air Resource Specialists, Inc.

WIND SPEED CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 09/14/09	Date of Last Site Visit: 05/06/09
				Field Specialist: Dave Beichley

Wind Speed Reference S/N: CA02934		Calibration Date: 01/09/09

WIND SPEED

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	RM Young AQ	RM Young AQ
Model #	05305	05305
Serial #	44100/nps90858	55389 / NPS90879
Translator Serial #		

WIND SPEED TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND SPEED STARTING THRESHOLD

PRE		POST	
Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail
0.1	PASS	0.2	PASS

Wind speed starting threshold accuracy goal:
RM Young AQ <= 0.3 g-cm

Motor Speed (rpm)				WIND SPEED PRE-MAINTENANCE					WIND SPEED POST MAINTENANCE				
	Climatronics (m/s)	RM Young (m/s)	Met One	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail
100	2.574	0.510	0.45										
300	7.274	1.540	8.45		1.536	-0.004		PASS		1.536	-0.004		PASS
600	14.324	3.070	16.44										
900	21.375	4.610	24.44		4.608	-0.002		PASS		4.608	-0.002		PASS
1200	28.425	6.140	N/A		6.144	0.004	0.1%	PASS		6.144	0.004	0.1%	PASS
1800	42.526	9.220	48.44		9.216	-0.004	0.0%	PASS		9.216	-0.004	0.0%	PASS
4000	N/A	20.480	N/A		20.480	0.000	0.0%	PASS		20.480	0.000	0.0%	PASS
7000	N/A	35.840	N/A		35.840	0.000	0.0%	PASS		35.840	0.000	0.0%	PASS
Maximum ABS Difference (use if Wind Speed <5):						0.004					0.004		
Maximum ABS % Difference (use if Wind Speed >=5):							0.1%	PASS				0.1%	PASS

FOR REFERENCE

	ESC Met Card				ESC Analog Input Card				CSI 23X Instruction P3 M/S Output		
	WSP High Input	WSP Low Input	WSP High Output (E.U.'s)	WSP Low Output (E.U.'s)	WSP High Input	WSP Low Input	WSP High Output (E.U.'s)	WSP Low Output (E.U.'s)	Config.	Multiplier	Offset
RMY Gray Prop	488.3	0 Hz	50 m/s	0 m/s	1V	0V	50 m/s	0 m/s	21	0.1024	0
RMY Black Prop	510 Hz	0 Hz	50 m/s	0 m/s	1V	0V	47.8 m/s	0 m/s	21	0.980	0
Aluminum Cups Lexan Cups	1059.2	-4.76	50 m/s	0 m/s	1(or 5)V	0V	50 m/s	0 m/s	20	0.04699	0.134

Pre-Maint Wind Speed Comments:	
Post Maint Wind Speed Comments:	

Air Resource Specialists, Inc.

Calibration Summary

Network: NPS	Location: Old Faithful	Site: YELL-OF
Date: 01/12/10	Last Site Visit: 09/14/09	Field Specialist: Faust, John

Parameter		Criteria	Accuracy Goal	Calibration Results					
				Pre-Maintenance			Post Maintenance		
				Mfg, Model # & Serial #	Value	Pass/Fail	Mfg, Model # & Serial #	Value	Pass/Fail
Beta Attenuation Monitor (TECO)	*Temperature*	max error	<= ± 2.0° C	TECO FH62C-14 513			TECO FH62C-14		
	Pressure	max error	<= ± 2.0%						
	Flow	max error	<= ± 5.0%						
	Zero Foil	N/A	N/A			N/A			N/A
	Span Foil	N/A	N/A			N/A			N/A
CO Analyzer - 146C	*Average Difference*	average error	<= ± 5.0%	TECO 48C 48C-71377-368	6.8%	FAIL	TECO 48C 48C-71377-368	2.3%	PASS
	Maximum Difference	max error	<= ± 5.0%		10.3%	FAIL		4.9%	PASS
	Correlation	actual	r > 0.9950		0.9997	PASS		0.9999	PASS
	Intercept	actual	<= ± 3.0 ppb		-0.2	PASS		-0.1	PASS
	Slope	actual	0.950 <= m <= 1.050		1.105	FAIL		1.000	PASS
Mass Flow Correlation	*Low Cell (Dilution Air)*	correlation coefficient	r >= 0.9995	TECO 146C-68497-360	N/A	N/A	TECO 146C-68497-360	1.0000	PASS
	High Cell (Gas)	correlation coefficient	r >= 0.9995		N/A	N/A		1.0000	PASS

Air Resource Specialists, Inc.

Calibration Standards

Field Specialist:	Faust, John	**Latitude:**	
Operator:	John Klaptosky	**Longitude:**	
Network:	NPS	**Elevation:**	
Location:	Old Faithful		
Site:	YELL-OF		
Date:	1/12/2010		
Last Site Visit:	9/14/2009		

Parameter	Device	Manufacturer	Model	S/N	Calibration Date
Voltage	DVM	Fluke	189	793901871	9/14/2002
	Voltage Source	Calib. Inc.	DVC-350A		
Ozone	Transfer Standard	TECO	49PS		
Gas Dilution	Mass flow	ERT	Gas Dil		
Barometric Pressure	Barometer/Altimeter	AIR	AIR-HB-1A	0725	1/28/2002
High Flow	Dry cal	BIOS	Definer 220	117874	10/13/2009
Low Flow	Dry cal	BIOS	Definer 220	117873	10/13/2009
Precipitation	PPT Calibrator			2909	1/4/2004
	Volume (ml):	900			1/5/2004
Relative Humidity	RH Sensor	Visala	MHMP45C	X081049	10/29/2003
Solar Radiation	Thermopile	LiCor	Pyranometer	PY12080	4/11/2003
	Multiplier	95.64			1/8/2004
Temperature	Digital Thermometer	Eutechinics	4400	304020	10/29/2003
Wind Direction	Torque Gauge	RM Young	18331	2909	1/10/2004
	Linearity Jig	RM Young	18212	2909	1/11/2004
	Compass	Brunton	5006LM	5040392346	1/12/2004
Wind Speed	Torque Disk	RM Young	18310	CA 02241	
	Anemometer Drive	RM Young	18801	CA 02241	
Volumetric Flow					

Comments:

Air Resource Specialists, Inc.

TECO BAM (BETA ATTENUATION MONITOR) CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 01/12/10	Date of Last Site Visit: 09/14/09
				Field Specialist: Faust, John

Volumetric Flow Standard S/N: N/A		Calibration Date:

EQUIPMENT IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	TECO	TECO
Model #	FH62C-14	FH62C-14
Serial #	513	
Version #		
Diagnostics		
Air Flow Vol. Head		
Air Flow Norm		
T_1		
T_2		
T_3		
T_4		
Status Code		
Error Codes		
RH Control		
RH Set Point		
Databg RH		
Delta-T Control		
Delta-T Setpoint		

ORDER OF STEPS

1. Temperature and pressure check and calibration.
2. Air flow rate calibration (2%).
3. Mass foil calibration/audit. (Yearly - calibrate; Quarterly - verify)

**Note: Never leak check this instrument!

TEMPERATURE/PRESSURE/FLOW CHECKS

PRE-MAINTENANCE

Temp, Pressure, Flow	BAM	Flow Standard	% Difference	Pass/Fail
Ambient Temperature				
Barometric Pressure				
Volumetric Flow				

POST MAINTENANCE

Temp, Pressure, Flow	BAM	Flow Standard	% Difference	Pass/Fail
Ambient Temperature				
Barometric Pressure				
Volumetric Flow				

CALIBRATION TIME

From:	12:20	To:	13:37

ZERO/SPAN FOIL PROCEDURE

1. Turn heater off before performing calibration (yg 56).
2. Remove down tube from top of instrument. (Caution: Don't block the flow!) Wait 1 hour for T_1/T_4 to equilibriate.
3. Perform mass foil calibration (PS 65).

PRE-MAINTENANCE

	Expected Response	Actual Response	% Difference
Zero Foil			
Span Foil			

POST MAINTENANCE

	Expected Response	Actual Response	% Difference
Zero Foil			
Span Foil			

MAINTENANCE CHECKLIST

- ☑ Clean Inlet
- ☐ Clean Nozzle

	As Found	Actual
Time Reset		

Pre-Maint Comments:	Did not perform flow or temperature calibration. Cleaned 2.5 inlet reservoir.
Post Maint Comments:	Previous amplification value = 7077. New amplification value (saved) = 7004

Air Resource Specialists, Inc.

GAS DILUTION CALIBRATOR CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 01/12/10	Date of Last Site Visit: 09/14/09
				Field Specialist: Faust, John

High Flow Standard Reference: BIOS, Definer 220	High Flow Standard Reference S/N: 117874	Calibration Date: 10/13/09
Low Flow Standard Reference: BIOS, Definer 220	Low Flow Standard Reference S/N: 117873	Calibration Date: 10/13/09

Mass Flow Device (Dilution Air)

Mfg: TECO	S/N: 146C-68497-360	Range: 0-10 LPM
Calibration Gas: Air	This primary standard automatically corrects to standard flow.	

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1	1000	998
2	3001	2951
3	5001	4922
4	7001	6883
5	8988	8836
6		

Linear Regression		
Parameter	Air Flow Controller	Pass/Fail
Slope (m)	1.018767	N/A
Y Intercept (b)	-12.094652	N/A
Correlation Coefficient (r)	0.999999	PASS

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts - b) / m

Mass Flow Device (Gas 1)

Mfg: TECO	S/N:	Range: 0-100 CC
Calibration Gas:	This primary standard automatically corrects to standard flow.	

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1	10.73	11.822
2	17.98	17.662
3	15.96	15.985
4	25.23	24.068
5	28.91	28.286
6		

Linear Regression		
Parameter	Gas Flow Controller	Pass/Fail
Slope (m)	1.107770	N/A
Y Intercept (b)	-1.911071	N/A
Correlation Coefficient (r)	0.998041	PASS

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts -b) / m

MFC/MFM Comments:	

Air Resource Specialists, Inc.

GAS DILUTION CALIBRATOR CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 01/12/10	Date of Last Site Visit: 09/14/09
				Field Specialist: Faust, John

High Flow Standard Reference: BIOS, Definer 220	High Flow Standard Reference S/N: 117874	Calibration Date: 10/13/09
Low Flow Standard Reference: BIOS, Definer 220	Low Flow Standard Reference S/N: 117873	Calibration Date: 10/13/09

Mass Flow Device (Dilution Air)

Mfg: TECO	S/N: 146C-68497-360	Range: 0-10 LPM
Calibration Gas:	This primary standard automatically corrects to standard flow.	

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1	1000	998
2	3001	2951
3	5001	4922
4	7001	6883
5	8988	8836
6		

Linear Regression		
Parameter	Air Flow Controller	Pass/Fail
Slope (m)	1.018767	N/A
Y Intercept (b)	-12.094652	N/A
Correlation Coefficient (r)	0.999999	PASS

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts - b) / m

Mass Flow Device (Gas 1)

Mfg:	S/N:	Range: 0 - 100 CC
Calibration Gas:	This primary standard automatically corrects to standard flow.	

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1	10.97	10.644
2	18.06	17.5
3	16.11	15.6
4	25.1	24.36
5	28.97	28.191
6		

Linear Regression		
Parameter	Gas Flow Controller	Pass/Fail
Slope (m)	1.025817	N/A
Y Intercept (b)	0.085783	N/A
Correlation Coefficient (r)	0.999990	PASS

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts -b) / m

MFC/MFM Comments:	

Air Resource Specialists, Inc.

CARBON MONOXIDE ANALYZER CALIBRATION FORM

(146C Calculations)

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 01/12/10	Date of Last Site Visit: 09/14/09
				Field Specialist: Faust, John

EQUIPMENT IDENTIFICATION

	Transfer Standard	Analyzer	Station Reference
Mfg.		TECO	TECO
Model #		48C	146C
Serial #		48C-71377-368	146C-68497-360

FLOW METER DATA

	Dilution Air	Gas
Slope (m)	1.019	1.026
Y Intercept (b)	-12.1	0.1
Correlation Coefficient (r)	1.0000	1.0000

REFERENCE GAS

Tank S/N	CA 01538
Calibration Date	6/23/2012
Pressure Tank / Del.	30/2500
Tank Conc. (ppm)	3100

STATION TUBING

		CALCULATED FLOW 146C		FLOW METER		PRE-MAINTENANCE CO Bkg. (zero) = -0.011 CO Coef. (span) = 1.115					
Calibration Point	Conc. (ppm)	Dil. Air (cc/min)	Gas (cc/min)	Dil. Air Inst. Dis.	Gas Inst. Dis.	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference	Pass/ Fail
ZERO	0.000	3000	0.0			0.139	0.040				
1	17.910	4982	29.0								
2	15.510	4981	25.1			0.994	17.100		1.590	10.3%	FAIL
3	9.968	4992	16.1			0.678	10.810		0.842	8.4%	FAIL
4	7.961	6979	18.0			0.559	8.530		0.569	7.1%	FAIL
5	3.988	8484	10.9			0.340	4.037		0.049	1.2%	PASS
ZERO											
						Average ABS % Difference:				6.8%	FAIL
						Maximum ABS % Difference:				10.3%	FAIL

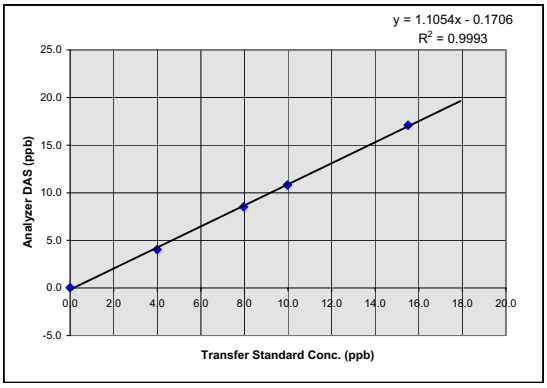
STATION TUBING

		POST MAINTENANCE CO Bkg. (zero) = 2.473 CO Coef. (span) = 1.114					
Calibration Point	Conc. (ppm)	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference	Pass/ Fail
ZERO	0.000	0.000	0.004				
1	17.910	0.896	17.880		-0.030	-0.2%	PASS
2	15.510	0.773	15.390		-0.120	-0.8%	PASS
3	9.968	0.486	9.693		-0.275	-2.8%	PASS
4	7.961	0.389	7.720		-0.241	-3.0%	PASS
5	3.988	0.192	3.791		-0.197	-4.9%	PASS
ZERO	0.000	0.000	0.006				
		Average ABS % Difference:				2.3%	PASS
		Maximum ABS % Difference:				4.9%	PASS

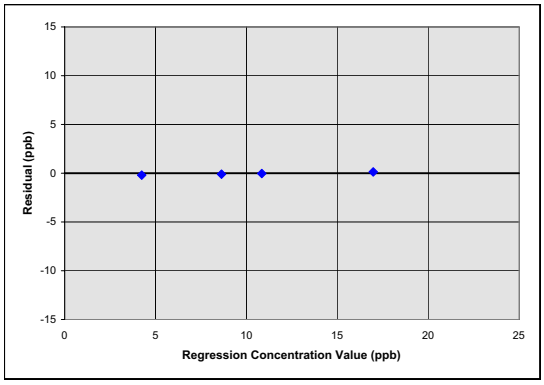
RESULTS

Linear Regression				
	PRE		POST	
Parameter	Analyzer	Pass/Fail	Analyzer	Pass/Fail
Slope	1.105	FAIL	1.000	PASS
Y Intercept	-0.2	PASS	-0.1	PASS
Correlation Coefficient	0.9997	PASS	0.9999	PASS

LINEAR REGRESSION PLOT (PRE-MAINTENANCE)



RESIDUALS PLOT (PRE-MAINTENANCE)



CALIBRATION TIME

From:		To:	

EVENT RESPONSE

		Calculated Flow		Flow Meter		Analyzer Response				
Calibration Point	Conc. (ppm)	Dil. Air (cc/min)	Gas (cc/min)	Dil. Air (cc/min)	Gas (cc/min)	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference
ZERO	0.000									N/A
Precision										
Span										

Pre-Maint Carbon Monoxide Comments:	
Post Maint Carbon Monoxide Comments:	

Air Resource Specialists, Inc.

Calibration Summary

Network: NPS	Location: Old Faithful	Site: YELL-OF
Date: 05/20/10	Last Site Visit: 01/12/10	Field Specialist: Faust, John

Parameter		Criteria	Accuracy Goal	Calibration Results					
				Pre-Maintenance			Post Maintenance		
				Mfg, Model # & Serial #	Value	Pass/Fail	Mfg, Model # & Serial #	Value	Pass/Fail
Beta Attenuation Monitor (TECO)	*Temperature*	max error	<= ± 2.0º C	TECO FH62C-14 513	-1.8	PASS	TECO FH62C-14	0.3	PASS
	Pressure	max error	<= ± 2.0%		-0.7%	PASS			
	Flow	max error	<= ± 5.0%		-2.5%	PASS			
	Zero Foil	N/A	N/A			N/A			N/A
	Span Foil	N/A	N/A			N/A			N/A
CO Analyzer - 146C	*Average Difference*	average error	<= ± 5.0%	TECO 48C 48C-71377-368	4.1%	PASS	TECO 48C 48C-71377-368	1.1%	PASS
	Maximum Difference	max error	<= ± 5.0%		8.1%	FAIL		2.2%	PASS
	Correlation	actual	r > 0.9950		0.9995	PASS		0.9999	PASS
	Intercept	actual	<= ± 3.0 ppb		-0.2	PASS		-0.1	PASS
	Slope	actual	0.950 <= m <= 1.050		1.047	PASS		0.999	PASS
Mass Flow Correlation	*Low Cell (Dilution Air)*	correlation coefficient	r >= 0.9995		N/A	N/A			
	High Cell (Gas)	correlation coefficient	r >= 0.9995		N/A	N/A			
Relative Humidity	*PRE Sensor ID# Z1730047*	max error	<= ± 5.0%	Vaisala HMP45C Z1730047	3.0%	PASS	Vaisala HMP45C A1040003	4.0%	PASS
Temperature		max error	Climatronics <= ± 0.2º C; RM Young <= ± 0.5º C; Rotronics <= ± 1.0º C	Vaisala HMP45C Z1730047	0.0º	PASS	Vaisala HMP45C A1040003	0.1º	PASS
Wind Direction	*Alignment*	max error	<= ± 5º	RM Young AQ 05305 55389	2º	PASS	RM Young AQ 05305 54746	2º	PASS
	Linearity	max error	<= ± 3º		3º	PASS		2º	PASS
	Starting Threshold	max error	Climatronics <= 6 g-cm; RM Young AQ <= 9 g-cm; RM Young MA <= 30 g-cm, RM Young RE <= 7 g-cm						
Wind Speed	*max Wind Speed <5*	max error	<= ± 0.2 m/s	RM Young AQ 05305 55389	N/A	N/A	RM Young AQ 05305 54746	N/A	N/A
	max Wind Speed >= 5	max error	<= ± 5%		0.1%	PASS		0.1%	PASS
	Starting Threshold	max error	Climatronics <= 0.2 g-cm; RM Young AQ <= 0.3 g-cm; RM Young MA <= 2.9 g-cm, RM Young RE <= 0.3 g-cm						

Air Resource Specialists, Inc.

Calibration Standards

Field Specialist:	Faust, John	**Latitude:**	
Operator:	John Klaptosky	**Longitude:**	
Network:	NPS	**Elevation:**	
Location:	Old Faithful		
Site:	YELL-OF		
Date:	5/20/2010		
Last Site Visit:	1/12/2010		

Parameter	Device	Manufacturer	Model	S/N	Calibration Date
Voltage	DVM	Fluke	189	79390171	3/8/2010
	Voltage Source	Calib. Inc.	DVC-350A		
Ozone	Transfer Standard	TECO	49iPS	3722726105	4/12/2010
Gas Dilution	Mass flow	ERT	Gas Dil		
Barometric Pressure		AIRS			
High Flow	Dry cal	BIOS	DC2	1809	1/7/2010
Low Flow	Dry cal	BIOS	DC2	L 961	1/7/2010
Precipitation	PPT Calibrator	NovaLynx	260-2595	LYNX-01	1/7/2010
	Volume (ml):	900			1/5/2010
Relative Humidity	RH Sensor	Rotronic	HM 34	Z3140005	8/14/2009
Solar Radiation	Thermopile	LiCor	Pyranometer	PY 59541	5/8/2009
	Multiplier	97.56			
Temperature	Digital Thermometer	Rotronic	HygroPalm 2	28052 058	3/11/2009
Wind Direction	Torque Gauge	RM Young	18331	2909	1/7/2010
	Linearity Jig	RM Young	18212	2909	1/7/2010
	Compass	Brunton	5006LM	5040392346	1/7/2010
Wind Speed	Torque Disk	RM Young		2909	12/21/2009
	Anemometer Drive	RM Young	18802	CA 02241	12/21/2009
Volumetric Flow		BGI	delta Cal	229	12/22/2009

Comments:

Air Resource Specialists, Inc.

TECO BAM (BETA ATTENUATION MONITOR) CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/20/10	Date of Last Site Visit: 01/12/10
				Field Specialist: Faust, John

Volumetric Flow Standard S/N: 229		Calibration Date: 12/22/09

EQUIPMENT IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	TECO	TECO
Model #	FH62C-14	FH62C-14
Serial #	513	
Version #		
Diagnostics		
Air Flow Vol. Head	1000	
Air Flow Norm	1000	
T_1	4	
T_2	22	
T_3	22	
T_4	19	
Status Code		
Error Codes		
RH Control		
RH Set Point		
Databg RH		
Delta-T Control		
Delta-T Setpoint		

ORDER OF STEPS

1. Temperature and pressure check and calibration.
2. Air flow rate calibration (2%).
3. Mass foil calibration/audit. (Yearly - calibrate; Quarterly - verify)

**Note: Never leak check this instrument!

TEMPERATURE/PRESSURE/FLOW CHECKS

PRE-MAINTENANCE

Temp, Pressure, Flow	BAM	Flow Standard	% Difference	Pass/Fail
Ambient Temperature	6.0	7.8	-1.8	PASS
Barometric Pressure	763	768	-0.7%	PASS
Volumetric Flow	1000.0	1026.0	-2.5%	PASS

POST MAINTENANCE

Temp, Pressure, Flow	BAM	Flow Standard	% Difference	Pass/Fail
Ambient Temperature	7.0	6.7	0.3	PASS
Barometric Pressure				
Volumetric Flow				

CALIBRATION TIME

From:	14:11	To:	15:15

ZERO/SPAN FOIL PROCEDURE

1. Turn heater off before performing calibration (yg 56).
2. Remove down tube from top of instrument. (Caution: Don't block the flow!) Wait 1 hour for T_1/T_4 to equilibriate.
3. Perform mass foil calibration (PS 65).

PRE-MAINTENANCE

	Expected Response	Actual Response	% Difference
Zero Foil			
Span Foil			

POST MAINTENANCE

	Expected Response	Actual Response	% Difference
Zero Foil			
Span Foil			

MAINTENANCE CHECKLIST

- ☐ Clean Inlet
- ☐ Clean Nozzle

	As Found	Actual
Time Reset		

Pre-Maint Comments:	Initial amplification is 7004
Post Maint Comments:	Final amplification was exactly as initial. JF

Air Resource Specialists, Inc.

GAS DILUTION CALIBRATOR CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/20/10	Date of Last Site Visit: 01/12/10
				Field Specialist: Faust, John

High Flow Standard Reference: BIOS, DC2	High Flow Standard Reference S/N: 1809	Calibration Date: 01/07/10
Low Flow Standard Reference: BIOS, DC2	Low Flow Standard Reference S/N: L 961	Calibration Date: 01/07/10

Mass Flow Device (Dilution Air)

Mfg:	S/N:	Range:
Calibration Gas:	This primary standard automatically corrects to standard flow.	

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1		
2		
3		
4		
5		
6		

Linear Regression		
Parameter	Air Flow Controller	Pass/Fail
Slope (m)		N/A
Y Intercept (b)		N/A
Correlation Coefficient (r)		

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts - b) / m

Mass Flow Device (Gas 1)

Mfg:	S/N:	Range:
Calibration Gas:	This primary standard automatically corrects to standard flow.	

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1		
2		
3		
4		
5		
6		

Linear Regression		
Parameter	Gas Flow Controller	Pass/Fail
Slope (m)		N/A
Y Intercept (b)		N/A
Correlation Coefficient (r)		

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts -b) / m

MFC/MFM Comments:	

Air Resource Specialists, Inc.

CARBON MONOXIDE ANALYZER CALIBRATION FORM

(146C Calculations)

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/20/10	Date of Last Site Visit: 01/12/10
				Field Specialist: Faust, John

EQUIPMENT IDENTIFICATION

	Transfer Standard	Analyzer	Station Reference
Mfg.		TECO	TECO
Model #		48C	146C
Serial #		48C-71377-368	146C-68497-360

FLOW METER DATA

	Dilution Air	Gas
Slope (m)		
Y Intercept (b)		
Correlation Coefficient (r)		

REFERENCE GAS

Tank S/N	CA 01538
Calibration Date	6/23/2009
Pressure Tank / Del.	1900/30
Tank Conc. (ppm)	3100

STATION TUBING

		CALCULATED FLOW 146C		FLOW METER		PRE-MAINTENANCE CO Bkg. (zero) = 2.522 CO Coef. (span) = 1.114					
Calibration Point	Conc. (ppm)	Dil. Air (cc/min)	Gas (cc/min)	Dil. Air Inst. Dis.	Gas Inst. Dis.	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference	Pass/ Fail
ZERO	0.000	3000	0.0			0.079	0.041				
1	17.960	4971	29.0			1.000	18.490		0.530	3.0%	PASS
2	15.550	4974	25.1			0.886	16.330		0.780	5.0%	FAIL
3	9.990	4983	16.1			0.590	10.260		0.270	2.7%	PASS
4	7.981	6981	18.0			0.479	8.104		0.123	1.5%	PASS
5	3.986	8489	10.9			0.269	3.665		-0.321	-8.1%	FAIL
ZERO	0.000	3000	0.0			0.079	0.040				
						Average ABS % Difference:				4.1%	PASS
						Maximum ABS % Difference:				8.1%	FAIL

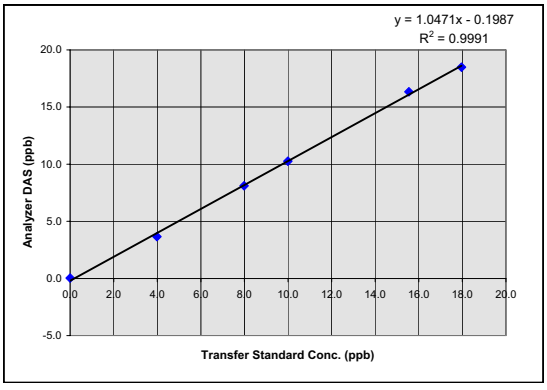
STATION TUBING

		POST MAINTENANCE CO Bkg. (zero) = 4.011 CO Coef. (span) = 1.123					
Calibration Point	Conc. (ppm)	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference	Pass/ Fail
ZERO	0.000	0.000	-0.014				
1	17.960	0.893	17.980		0.020	0.1%	PASS
2	15.550	0.773	15.430		-0.120	-0.8%	PASS
3	9.990	0.489	9.768		-0.222	-2.2%	PASS
4	7.981	0.386	7.899		-0.082	-1.0%	PASS
5	3.986	0.192	3.926		-0.060	-1.5%	PASS
ZERO	0.000	0.000	-0.014				
		Average ABS % Difference:				1.1%	PASS
		Maximum ABS % Difference:				2.2%	PASS

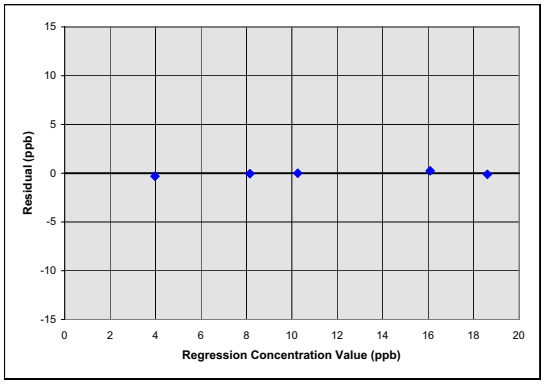
RESULTS

Linear Regression	PRE		POST	
Parameter	Analyzer	Pass/Fail	Analyzer	Pass/Fail
Slope	1.047	PASS	0.999	PASS
Y Intercept	-0.2	PASS	-0.1	PASS
Correlation Coefficient	0.9995	PASS	0.9999	PASS

LINEAR REGRESSION PLOT (PRE-MAINTENANCE)



RESIDUALS PLOT (PRE-MAINTENANCE)



CALIBRATION TIME

From:		To:	

EVENT RESPONSE

		Calculated Flow		Flow Meter		Analyzer Response				
Calibration Point	Conc. (ppm)	Dil. Air (cc/min)	Gas (cc/min)	Dil. Air (cc/min)	Gas (cc/min)	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference
ZERO	0.000									N/A
Precision										
Span										

Pre-Maint Carbon Monoxide Comments:	
Post Maint Carbon Monoxide Comments:	

Air Resource Specialists, Inc.

CARBON MONOXIDE ANALYZER CALIBRATION FORM

(146C Calculations)

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/20/10	Date of Last Site Visit: 01/12/10
				Field Specialist: Faust, John

EQUIPMENT IDENTIFICATION

	Transfer Standard	Analyzer	Station Reference
Mfg.		API	TECO
Model #		300EU2	146C
Serial #		224	146C-68497-360

FLOW METER DATA

	Dilution Air	Gas
Slope (m)		
Y Intercept (b)		
Correlation Coefficient (r)		

REFERENCE GAS

Tank S/N	CA 01538
Calibration Date	6/23/2009
Pressure Tank / Del.	1900/30
Tank Conc. (ppm)	3100

STATION TUBING

		CALCULATED FLOW 146C		FLOW METER		PRE-MAINTENANCE CO Bkg. (zero) = CO Coef. (span) =					
Calibration Point	Conc. (ppm)	Dil. Air (cc/min)	Gas (cc/min)	Dil. Air Inst. Dis.	Gas Inst. Dis.	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference	Pass/ Fail
ZERO	0.000	3000	0.0			-0.029	-0.120				
1	17.960	4971	29.0			4.483	17.940		-0.020	-0.1%	PASS
2	15.550	4974	25.1			3.875	15.500		-0.050	-0.3%	PASS
3	9.990	4983	16.1			2.431	9.722		-0.268	-2.7%	PASS
4	7.981	6981	18.0			1.924	7.693		-0.288	-3.6%	PASS
5	3.986	8489	10.9			0.917	3.665		-0.321	-8.1%	FAIL
ZERO	0.000	3000	0.0			0.004	0.013		0.013		
						Average ABS % Difference:				3.0%	PASS
						Maximum ABS % Difference:				8.1%	FAIL

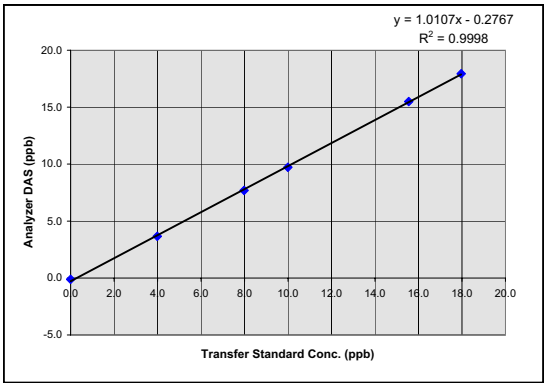
STATION TUBING

		POST MAINTENANCE CO Bkg. (zero) = -0.03093 CO Coef. (span) = 1.028					
Calibration Point	Conc. (ppm)	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference	Pass/ Fail
ZERO	0.000	0.000	0.019				
1	17.960	4.495	17.970		0.010	0.1%	PASS
2	15.550	3.889	15.560		0.010	0.1%	PASS
3	9.990	2.482	9.934		-0.056	-0.6%	PASS
4	7.981	1.973	7.901		-0.080	-1.0%	PASS
5	3.986	0.983	3.926		-0.060	-1.5%	PASS
ZERO	0.000	0.000	0.003				
		Average ABS % Difference:				0.6%	PASS
		Maximum ABS % Difference:				1.5%	PASS

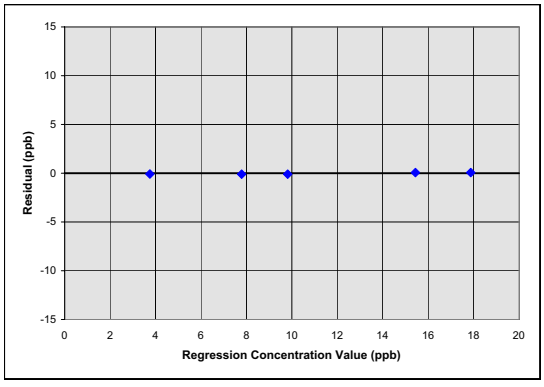
RESULTS

Linear Regression	PRE		POST	
Parameter	Analyzer	Pass/Fail	Analyzer	Pass/Fail
Slope	1.011	PASS	1.002	PASS
Y Intercept	-0.3	PASS	0.0	PASS
Correlation Coefficient	0.9999	PASS	1.0000	PASS

LINEAR REGRESSION PLOT (PRE-MAINTENANCE)



RESIDUALS PLOT (PRE-MAINTENANCE)



CALIBRATION TIME

From:		To:	

EVENT RESPONSE

		Calculated Flow		Flow Meter		Analyzer Response				
Calibration Point	Conc. (ppm)	Dil. Air (cc/min)	Gas (cc/min)	Dil. Air (cc/min)	Gas (cc/min)	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference
ZERO	0.000									N/A
Precision										
Span										

Pre-Maint Carbon Monoxide Comments:	Initial installation and calibration of instrument
Post Maint Carbon Monoxide Comments:	

Air Resource Specialists, Inc.

TEMPERATURE, DELTA TEMPERATURE AND RELATIVE HUMIDITY CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/20/10	Date of Last Site Visit: 01/12/10
				Field Specialist: Faust, John

Reference Thermometer S/N: 28052 058		Calibration Date: 03/11/09
Relative Humidity Reference S/N: Z3140005		Calibration Date: 08/14/09

TEMPERATURE / DELTA TEMPERATURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Vaisala	Vaisala
Model #	HMP45C	HMP45C
Temperature Serial #	Z1730047	A1040003
Delta Temp. Serial #		
Translator Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE DVM (volts)	TEMPERATURE DAS (° C)	Difference (° C)	Pass/Fail	Δ TEMPERATURE DVM (volts)	Δ TEMPERATURE DAS (° C)	Difference (° C)	Pass/Fail
4.0		4.0	0.0	PASS				
	Maximum Difference:		0.0	PASS	Maximum Difference:			

PRE- TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE DVM (volts)	TEMPERATURE DAS (° C)	Δ TEMPERATURE DVM (volts)	Δ TEMPERATURE DAS (° C)
Zero				
Span				

POST MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE DVM (volts)	TEMPERATURE DAS (° C)	Difference (° C)	Pass/Fail	Δ TEMPERATURE DVM (volts)	Δ TEMPERATURE DAS (° C)	Difference (° C)	Pass/Fail
6.0		5.9	-0.1	PASS				
	Maximum Difference:		0.1	PASS	Maximum Difference:			

POST TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE DVM (volts)	TEMPERATURE DAS (° C)	Δ TEMPERATURE DVM (volts)	Δ TEMPERATURE DAS (° C)
Zero				
Span				

Pre-Maint Temperature Comments:	
Post Maint Temperature Comments:	

RELATIVE HUMIDITY

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Vaisala	Vaisala
Model #	HMP45C	HMP45C
Serial #	Z1730047	A1040003

PRE-MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00	88.0	85.0	3.0%	PASS
11:00	78.0	75.0	3.0%	PASS
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:			3.0%	PASS
Maximum % Difference:			3.0%	PASS

POST MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
12:00	55.0	59.0	-4.0%	PASS
13:00				
14:00				
15:00				
16:00				
17:00				
Average ABS % Difference:			4.0%	PASS
Maximum % Difference:			4.0%	PASS

Screen dirty/clogged on RH pre-maintenance sensor? (check one):	☐ Yes ☐ No

Pre-Maint Relative Humidity Comments:	
Post Maint Relative Humidity Comments:	

Air Resource Specialists, Inc.

WIND DIRECTION CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/20/10	Date of Last Site Visit: 01/12/10
				Field Specialist: Faust, John

To Landmark #1: 272 Degrees True	From Landmark #1: 92	LM Description: Parking Lot Lamp Post
To Landmark #2: Degrees True	From Landmark #2:	LM Description:
Declination: Degrees		
Wind Direction Reference S/N: 5040392346		Calibration Date: 01/07/10

WIND DIRECTION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	RM Young AQ	RM Young AQ
Model #	05305	05305
Serial #	55389	54746
Translator Serial #		

WIND DIRECTION TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
360				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND DIRECTION STARTING THRESHOLD

PRE		POST	
Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail

Wind direction starting threshold accuracy goal:
RM Young AQ <= 9 g-cm

WIND DIRECTION ALIGNMENT

Land Mark Reference	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
To 1		274	2	PASS		274	2	PASS
From 1		94	2	PASS		94	2	PASS
To 2								
From 2								
	Average Difference:		2	PASS	Average Difference:		2	PASS
	Maximum Difference:		2	PASS	Maximum Difference:		2	PASS

WIND DIRECTION LINEARITY

Check Point	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
1		355	1	PASS		2	2	PASS
2		38	-2	PASS		45	-2	PASS
3		82	-1	PASS		91	1	PASS
4		130	3	PASS		137	1	PASS
5		177	2	PASS		181	-1	PASS
6		223	1	PASS		225	-1	PASS
7		266	-2	PASS		270	0	PASS
8		309	-2	PASS		315	0	PASS
	Average Difference:		2	PASS	Average Difference:		1	PASS
	Maximum Difference:		3	PASS	Maximum Difference:		2	PASS

Pre-Maint Wind Direction Comments:	
Post Maint Wind Direction Comments:	

Air Resource Specialists, Inc.

WIND SPEED CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/20/10	Date of Last Site Visit: 01/12/10
				Field Specialist: Faust, John

Wind Speed Reference S/N: CA 02241		Calibration Date: 12/21/09

WIND SPEED

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	RM Young AQ	RM Young AQ
Model #	05305	05305
Serial #	55389	54746
Translator Serial #		

WIND SPEED TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND SPEED STARTING THRESHOLD

PRE		POST	
Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail

Wind speed starting threshold accuracy goal:
RM Young AQ <= 0.3 g-cm

Motor Speed (rpm)				WIND SPEED PRE-MAINTENANCE					WIND SPEED POST MAINTENANCE				
	Climatronics (m/s)	RM Young (m/s)	Met One	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail
100	2.574	0.510	0.45										
300	7.274	1.540	8.45		1.536	-0.004		PASS		1.536	-0.004		PASS
600	14.324	3.070	16.44										
900	21.375	4.610	24.44		4.608	-0.002		PASS		4.608	-0.002		PASS
1200	28.425	6.140	N/A		6.144	0.004	0.1%	PASS		6.144	0.004	0.1%	PASS
1800	42.526	9.220	48.44		9.216	-0.004	0.0%	PASS		9.216	-0.004	0.0%	PASS
4000	N/A	20.480	N/A										
7000	N/A	35.840	N/A										
Maximum ABS Difference (use if Wind Speed <5):						0.004					0.004		
Maximum ABS % Difference (use if Wind Speed >=5):							0.1%	PASS				0.1%	PASS

FOR REFERENCE

	ESC Met Card				ESC Analog Input Card				CSI 23X Instruction P3 M/S Output		
	WSP High Input	WSP Low Input	WSP High Output (E.U.'s)	WSP Low Output (E.U.'s)	WSP High Input	WSP Low Input	WSP High Output (E.U.'s)	WSP Low Output (E.U.'s)	Config.	Multiplier	Offset
RMY Gray Prop	488.3	0 Hz	50 m/s	0 m/s	1V	0V	50 m/s	0 m/s	21	0.1024	0
RMY Black Prop	510 Hz	0 Hz	50 m/s	0 m/s	1V	0V	47.8 m/s	0 m/s	21	0.980	0
Aluminum Cups Lexan Cups	1059.2	-4.76	50 m/s	0 m/s	1(or 5)V	0V	50 m/s	0 m/s	20	0.04699	0.134

Pre-Maint Wind Speed Comments:	
Post Maint Wind Speed Comments:	

APPENDIX B

Snowmobile Codes

Date	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45	10:00	10:15	10:30	10:45	11:00	11:15	11:30	11:45	12:00	12:15
12/15/09	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	2
12/16/09	0	1	0	1	0	1	1	1	0	0	0	1	1	1	1	1	2	2
12/17/09	1	1	1	1	1	1	1	0	0	0	0	0	0	1	2	2	1	1
12/18/09	1	1	0	0	0	0	0	1	0	0	0	0	1	2	3	3	3	3
12/19/09	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3	3	3	3
12/20/09	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3
12/21/09	1	1	0	0	0	0	0	0	0	0	0	1	3	2	2	2	4	4
12/22/09	1	0	0	0	0	1	0	1	1	1	0	0	0	2	3	3	4	4
12/23/09	1	1	1	1	1	1	1	1	1	1	1	1	3	3	3	3	3	4
12/24/09	0	1	0	0	0	0	0	0	0	0	0	1	2	2	2	3	3	4
12/25/09	0	0	0	0	0	0	0	1	0	0	0	0	0	2	2	3	3	3
12/26/09	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	3	4
12/27/09	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	3	3
12/28/09	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	3	3
12/29/09	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	4
12/30/09	0	0	0	0	0	1	0	0	0	0	0	1	2	2	2	3	3	3
12/31/09	1	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	4	4
1/1/10	1	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	4
1/2/10	1	1	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	3
1/3/10	1	1	0	0	0	0	0	0	0	0	0	0	2	2	2	3	3	3
1/4/10	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	2	2
1/5/10	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	3	3
1/6/10	1	1	1	1	0	0	0	0	0	0	0	0	0	1	2	2	2	3
1/7/10	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	2	2
1/8/10	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	2	3
1/9/10	0	0	0	0	1	0	0	0	0	0	0	1	1	2	2	2	2	2
1/10/10	0	0	0	0	1	0	0	0	0	0	2	2	2	2	3	2	2	2
1/11/10	0	0	0	1	1	1	0	0	0	0	1	0	1	1	2	3	3	3
1/12/10	0	0	1	1	1	1	1	1	0	0	0	1	1	2	2	2	3	3
1/13/10	1	0	1	1	1	1	1	1	0	0	0	1	2	2	2	2	3	3
1/14/10	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	3	3
1/15/10	0	0	0	0	0	0	0	1	0	0	1	1	1	2	2	2	2	2
1/16/10	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	2	3
1/17/10	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3	3	3
1/18/10	0	0	0	0	0	0	0	0	0	1	1	2	2	2	2	2	3	3
1/19/10	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	3	3
1/20/10	1	1	1	1	1	0	0	0	0	1	1	1	1	2	2	2	2	3
1/21/10	1	1	1	1	0	1	0	0	0	0	1	1	2	2	2	2	3	3
1/22/10	1	1	1	1	1	1	1	0	0	1	0	1	1	2	3	3	3	3
1/23/10	0	0	0	0	1	1	0	1	1	1	0	1	1	2	2	2	3	3
1/24/10	0	0	0	0	0	0	1	1	0	0	0	2	2	2	3	3	3	3
1/25/10	0	0	0	0	1	1	1	1	0	0	0	1	1	2	2	2	2	3
1/26/10	0	1	1	1	1	1	1	1	1	1	1	2	2	3	3	3	3	4
1/27/10	1	1	1	1	0	0	0	0	0	0	1	1	2	2	2	3	3	3
1/28/10	1	0	0	0	0	0	1	1	1	1	1	0	2	3	3	4	4	4
1/29/10	0	0	0	0	1	0	0	0	0	1	1	1	2	3	3	3	4	4
1/30/10	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	3	4	4
1/31/10	0	0	0	0	0	0	1	1	0	1	1	0	0	2	2	3	3	4

Date	12:30	12:45	13:00	13:15	13:30	13:45	14:00	14:15	14:30	14:45	15:00	15:15	15:30	15:45	16:00	16:15	16:30	16:45
12/15/09	2	2	3	3	3	3	2	2	1	1	0	1	1	0	0	0	0	0
12/16/09	3	4	3	3	3	3	3	1	0	0	0	0	0	1	0	1	0	0
12/17/09	2	3	3	3	3	3	1	2	1	1	1	1	0	0	1	1	0	0
12/18/09	3	3	3	3	3	0	0	0	0	0	0	1	1	0	1	0	0	0
12/19/09	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	0	0
12/20/09	3	3	3	3	3	3	1	1	0	1	1	0	0	1	0	0	1	1
12/21/09	4	4	4	4	4	3	3	3	2	2	0	0	0	0	0	0	0	0
12/22/09	4	4	4	4	3	3	1	0	0	0	1	1	0	0	0	0	1	0
12/23/09	4	4	4	4	4	3	3	1	0	0	0	0	1	1	1	1	1	1
12/24/09	4	4	4	4	4	4	4	3	3	2	1	0	0	1	1	0	1	0
12/25/09	3	3	3	3	2	2	1	0	1	1	1	0	1	1	1	0	0	0
12/26/09	4	4	4	4	4	3	3	3	2	2	0	1	2	1	1	0	0	0
12/27/09	4	4	4	4	4	4	4	3	2	1	0	0	1	1	1	0	1	0
12/28/09	4	4	4	4	4	4	3	3	3	2	1	0	1	1	1	0	0	0
12/29/09	4	4	4	4	4	4	3	2	2	2	1	1	0	0	0	0	0	0
12/30/09	4	4	4	4	3	3	3	3	3	1	2	2	2	2	0	0	1	1
12/31/09	4	4	4	4	4	2	2	1	1	1	1	1	1	1	1	1	1	0
1/1/10	4	4	4	4	3	2	2	2	2	1	1	1	0	0	1	0	0	0
1/2/10	4	4	4	4	4	3	2	2	1	1	1	0	0	0	0	0	0	0
1/3/10	3	4	3	3	3	3	2	1	1	2	2	1	1	1	1	0	0	0
1/4/10	3	3	3	3	3	3	2	2	2	1	0	0	0	0	0	1	0	0
1/5/10	3	4	3	3	3	2	2	1	1	2	1	0	0	1	1	0	0	0
1/6/10	3	2	2	2	2	2	2	1	1	0	0	0	0	1	0	0	0	0
1/7/10	3	3	3	3	3	2	3	2	2	2	2	1	1	1	1	0	0	0
1/8/10	4	4	4	4	4	4	3	2	2	2	2	1	1	1	1	0	0	1
1/9/10	2	2	3	2	1	1	1	0	0	0	0	0	1	1	0	0	1	1
1/10/10	2	2	2	2	2	2	1	1	1	1	1	0	0	1	1	0	0	0
1/11/10	3	3	3	2	3	2	1	1	1	1	1	1	1	1	1	1	1	1
1/12/10	3	3	3	3	3	2	0	0	0	0	0	0	0	1	0	0	0	0
1/13/10	3	3	3	3	2	2	2	0	0	0	1	0	1	1	1	1	0	0
1/14/10	3	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1
1/15/10	2	3	3	3	2	1	1	1	1	0	1	1	1	0	1	0	0	0
1/16/10	3	3	3	3	3	3	3	2	1	2	1	1	0	0	1	1	0	0
1/17/10	3	4	3	3	3	3	3	2	1	1	1	0	0	1	1	1	0	0
1/18/10	4	4	4	4	4	4	3	1	1	1	1	1	0	1	1	1	1	1
1/19/10	3	3	3	3	3	3	3	2	1	1	0	1	1	1	1	0	0	0
1/20/10	3	3	3	3	2	2	1	1	1	1	1	0	0	0	0	1	1	1
1/21/10	3	3	3	3	3	3	2	1	1	0	1	1	1	1	1	0	0	1
1/22/10	3	4	4	3	3	3	3	3	3	1	0	0	0	1	1	1	1	1
1/23/10	3	3	3	3	3	2	2	1	1	1	1	0	0	1	1	1	1	1
1/24/10	3	2	2	2	1	1	1	0	1	0	0	0	0	1	1	0	0	0
1/25/10	3	3	3	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1
1/26/10	4	4	4	4	2	3	3	2	2	2	1	1	1	1	1	1	1	1
1/27/10	3	3	3	3	3	3	3	3	3	1	0	0	0	0	1	0	0	0
1/28/10	4	3	3	2	2	1	1	0	0	0	0	0	1	1	0	0	0	0
1/29/10	4	4	4	4	3	2	2	2	1	1	1	0	0	1	1	0	0	1
1/30/10	4	4	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1
1/31/10	3	3	3	3	2	1	I	0	0	0	1	1	1	1	1	0	0	0

Date	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45	10:00	10:15	10:30	10:45	11:00	11:15	11:30	11:45	12:00	12:15
2/1/10	1	0	0	0	0	0	0	1	0	0	0	0	1	1	2	2	3	3
2/2/10	0	1	1	1	1	1	1	1	1	1	1	1	2	2	3	3	4	4
2/3/10	0	1	1	1	0	0	0	0	0	1	2	2	2	2	3	3	4	4
2/4/10	0	0	0	0	0	0	0	1	1	1	1	1	1	2	3	3	3	4
2/5/10	0	0	0	0	0	0	0	0	0	1	2	2	2	2	3	3	3	4
2/6/10	1	0	0	0	0	0	0	0	0	1	0	1	0	1	2	3	3	3
2/7/10	0	0	1	1	1	1	1	1	0	1	2	2	3	3	3	3	3	3
2/8/10	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	3	3
2/9/10	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3	4	4
2/10/10	0	0	1	1	1	1	1	1	0	0	2	2	2	2	3	4	4	4
2/11/10	1	0	0	0	0	1	1	1	0	0	1	2	3	3	3	3	3	3
2/12/10	0	0	0	0	0	0	0	0	0	1	0	0	1	2	3	3	4	4
2/13/10	0	0	0	0	0	0	0	0	1	0	1	1	2	3	3	3	3	4
2/14/10	0	0	0	0	0	0	0	0	0	1	1	2	2	2	3	3	3	4
2/15/10	0	0	0	0	0	0	0	1	0	0	1	2	2	3	3	3	4	4
2/16/10	0	0	0	0	1	1	1	1	1	1	2	2	3	3	3	4	4	4
2/17/10	1	1	1	1	1	1	1	1	0	0	0	1	2	3	3	3	4	4
2/18/10	1	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	3	3
2/19/10	0	0	0	0	0	0	0	0	0	0	1	2	1	2	3	3	4	4
2/20/10	1	1	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3	3
2/21/10	0	0	0	1	0	0	0	0	0	2	1	1	1	2	2	3	3	3
2/22/10	0	0	0	0	0	0	0	0	1	0	1	1	1	2	2	3	3	3
2/23/10	0	0	0	0	0	1	0	1	0	0	0	1	1	1	2	2	3	3
2/24/10	1	1	1	0	0	0	0	0	0	0	0	0	2	2	2	3	3	3
2/25/10	1	0	0	0	1	0	0	0	0	0	1	1	1	2	2	3	4	4
2/26/10	1	0	0	0	0	0	0	0	1	1	1	2	2	3	3	3	3	3
2/27/10	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	3	3
2/28/10	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	3
3/1/10	0	0	0	0	0	0	0	0	0	0	2	2	2	2	3	3	2	2
3/2/10	1	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3	3	3
3/3/10	1	1	1	1	1	1	1	1	0	0	2	2	2	3	3	3	4	4
3/4/10	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	3	3
3/5/10	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3	3	3
3/6/10	1	0	0	0	0	0	0	0	0	0	0	1	2	1	1	2	2	2
3/7/10	0	0	0	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1
3/8/10	0	1	1	1	1	1	1	1	0	0	0	0	0	1	2	3	3	3
3/9/10	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	2	2	2
3/10/10	0	0	0	0	1	1	1	1	1	1	1	0	2	2	3	3	3	3
3/11/10	1	1	1	1	1	1	1	1	0	1	1	1	1	1	2	2	2	2
3/12/10	1	1	0	0	0	0	0	0	0	0	0	2	2	2	2	3	3	3
3/13/10	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2
3/14/10	0	1	1	1	1	1	0	2	2	3	3	3	3	3	3	3	3	2
3/15/10	0	0	1	0	0	0	0	0	1	2	3	3	3	4	3	3	3	3

Date	12:30	12:45	13:00	13:15	13:30	13:45	14:00	14:15	14:30	14:45	15:00	15:15	15:30	15:45	16:00	16:15	16:30	16:45
2/1/10	3	3	3	2	2	2	1	1	2	2	1	1	1	1	1	1	0	0
2/2/10	4	4	3	3	3	3	1	0	0	1	1	1	1	1	1	1	1	1
2/3/10	4	4	4	4	3	4	2	1	1	1	2	2	2	1	1	1	1	0
2/4/10	4	4	4	4	4	3	3	2	1	2	2	0	0	1	1	0	0	0
2/5/10	4	4	4	4	3	2	1	2	1	0	0	0	0	1	0	0	0	0
2/6/10	3	3	3	3	3	3	3	3	3	1	1	2	0	1	1	0	1	1
2/7/10	4	4	3	4	3	3	2	2	1	0	0	0	0	1	1	0	0	0
2/8/10	4	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2	0	0
2/9/10	4	4	4	4	3	2	2	2	1	2	2	2	1	1	1	0	0	0
2/10/10	4	4	4	3	3	2	2	2	1	0	NA	1	1	1	1	1	1	1
2/11/10	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
2/12/10	3	3	4	3	3	3	1	1	1	1	0	1	1	1	1	1	1	0
2/13/10	4	4	4	4	3	3	2	2	2	1	0	0	0	0	0	1	0	0
2/14/10	4	4	4	4	3	3	3	2	1	1	2	1	1	1	1	1	0	0
2/15/10	4	4	4	4	3	3	3	3	2	2	0	0	0	0	1	1	0	0
2/16/10	4	4	4	3	3	3	0	0	1	1	1	1	0	0	1	0	1	0
2/17/10	4	4	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1
2/18/10	4	3	4	4	3	3	3	3	0	0	0	0	0	1	1	0	0	0
2/19/10	4	4	4	4	3	3	3	3	2	2	1	1	0	1	1	0	0	0
2/20/10	3	4	3	3	3	3	3	3	3	2	1	1	1	1	1	0	1	1
2/21/10	3	4	4	4	4	3	2	2	1	1	1	0	0	1	1	1	1	0
2/22/10	3	3	4	3	3	2	2	2	2	2	2	2	2	2	2	1	0	0
2/23/10	3	3	3	4	3	2	2	2	2	2	2	2	1	1	1	1	1	1
2/24/10	4	4	4	4	3	3	3	3	2	2	1	1	1	1	1	1	1	1
2/25/10	4	3	4	3	3	3	3	1	2	2	2	1	2	1	1	0	0	0
2/26/10	3	3	2	2	2	1	2	2	0	0	0	0	0	0	1	1	0	0
2/27/10	3	4	4	4	4	4	2	2	2	2	1	1	1	1	1	1	1	1
2/28/10	3	3	3	3	3	3	1	1	1	1	1	1	0	0	1	0	0	0
3/1/10	3	3	3	3	3	3	2	0	0	0	1	1	1	0	1	0	0	0
3/2/10	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1
3/3/10	4	4	3	4	3	3	2	1	1	1	1	1	1	1	1	1	1	1
3/4/10	3	3	3	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
3/5/10	3	2	2	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0
3/6/10	2	2	1	1	1	1	1	0	0	0	0	0	0	0	1	1	0	1
3/7/10	2	2	2	2	2	1	0	0	0	0	0	0	1	1	1	0	0	0
3/8/10	3	3	3	2	1	1	0	0	0	0	0	0	1	1	1	1	1	1
3/9/10	3	3	1	1	1	1	0	1	0	1	0	0	0	1	1	0	0	0
3/10/10	2	2	2	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0
3/11/10	2	2	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
3/12/10	3	2	2	2	1	1	1	1	0	0	0	0	0	0	1	0	0	0
3/13/10	2	1	2	2	2	2	1	1	1	0	0	0	1	1	1	1	0	0
3/14/10	0	0	0	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0
3/15/10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0