DATA TRANSMITTAL REPORT FOR THE YELLOWSTONE NATIONAL PARK WINTER USE AIR QUALITY STUDY DECEMBER 15, 2007 – MARCH 15, 2008

Prepared for

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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 2007-2008 season began December 15, 2007, and ran through March 15, 2008. 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 five (5) previous winter seasons.

This data report presents all data collected during the study period, December 15, 2007, through March 15, 2008. 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

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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 top of the monitoring shelter 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, 2007 - March 15, 2008

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 (Kodak)	HRDC-1	--	Every 15 minutes

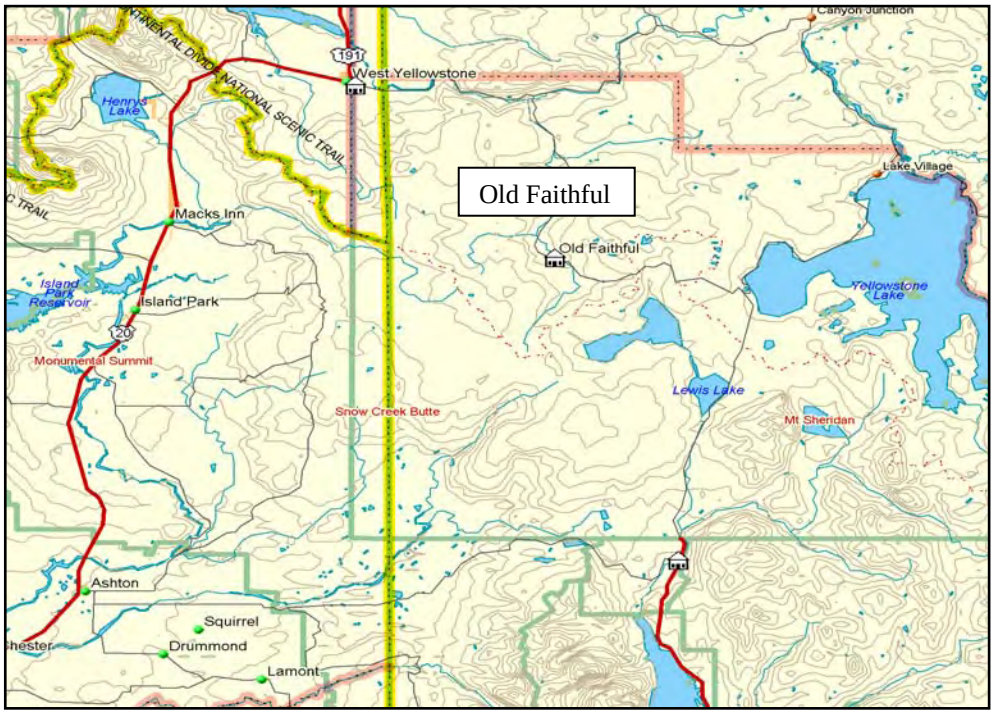

Figure 2-1. Monitoring Site Location.

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

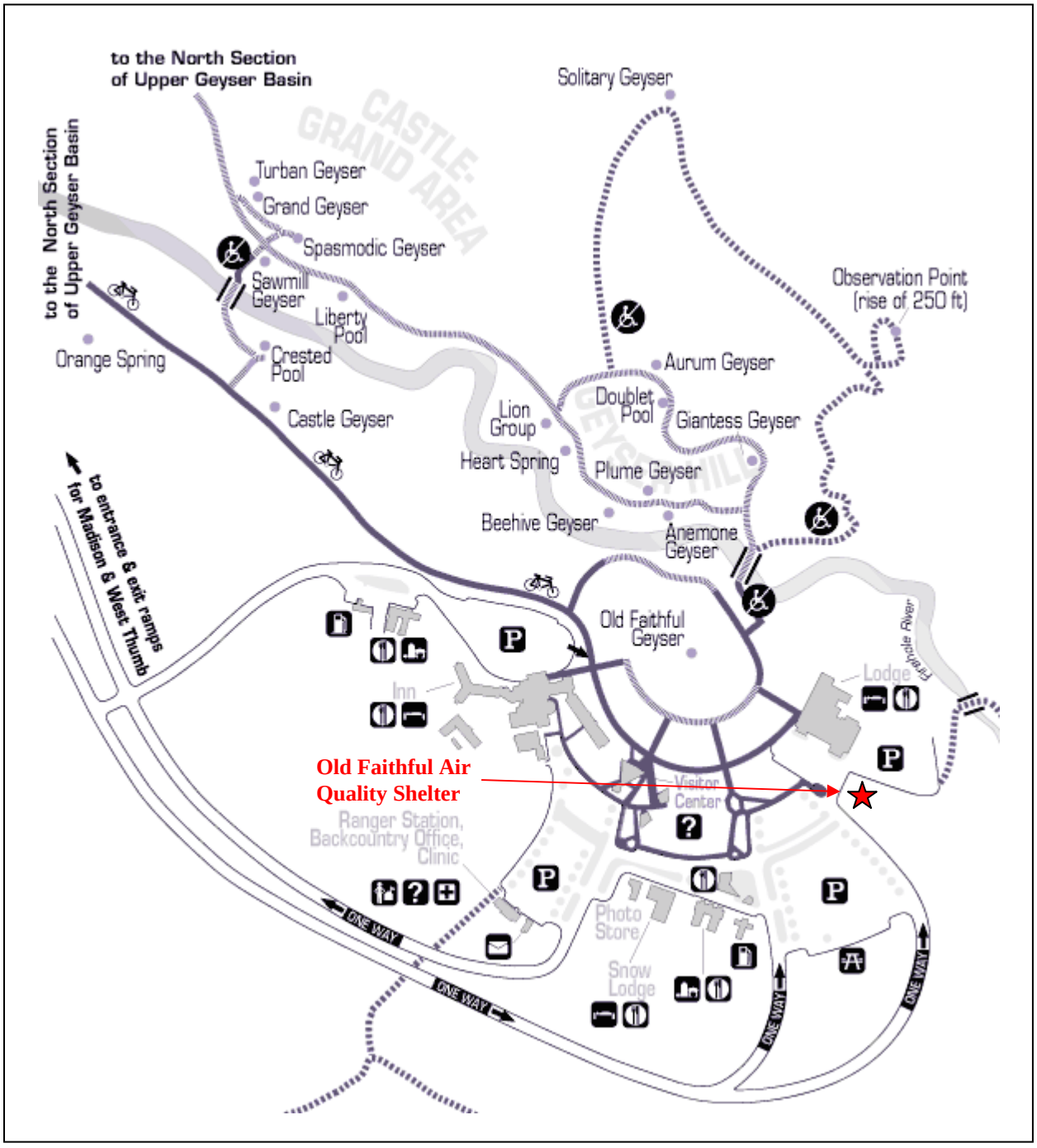


Figure 2-3. Old Faithful Area Map.

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 weekly 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 sensors were calibrated before the study began, once during the study, and again following project completion. All sensor calibrations performed in September 2007, prior to this study period, passed data validation acceptance criteria. The BAM and CO analyzer were calibrated in February 2008 before the end of the study period, and both instruments passed with the exception of one (1) point on the upper-end of the CO calibration. No ambient values occurred at this level during the study period. All equipment were again calibrated after the study in May 2008, and, once again, all instruments were within acceptable specifications accept for the high range of the CO analyzer. 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, 2007, through March 15, 2008.

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 except CO exceeded 99%. CO data validity was at 79% due to a suspected problem with the zero air system as well as a suspected analyzer problem from February 3 through 15, 2008. The problem corrected itself on February 15, 2008, and when ARS visited the station on February 20, 2008, no problems were discovered.

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

12/15/2007 - 03/15/2008

Parameter	Interval	Par Code	Data Recovery			Valid Data	
			No. Possible	No. Collected	% Collected	No. Valid	% Valid
Carbon Monoxide	hourly	CO	2904	2884	99.3	2302	79.3
Particulate Matter 2.5 Bam 1020	hourly	PM2.5B	2208	2202	99.7	2188	99.1
Relative Humidity	hourly	RH	2208	2208	100.0	2208	100.0
Standard Deviation for Wind Direction	hourly	SDWD	2904	2894	99.7	2894	99.7
Station Temperature	hourly	STP	2208	2208	100.0	2208	100.0
Scalar Wind Speed	hourly	SWS	2208	2203	99.8	2203	99.8
Ambient Temperature (aspirated)	hourly	TMP	2208	2208	100.0	2208	100.0
Vector Wind Direction	hourly	VWD	2208	2203	99.8	2203	99.8
Vector Wind Speed	hourly	VWS	2208	2203	99.8	2203	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

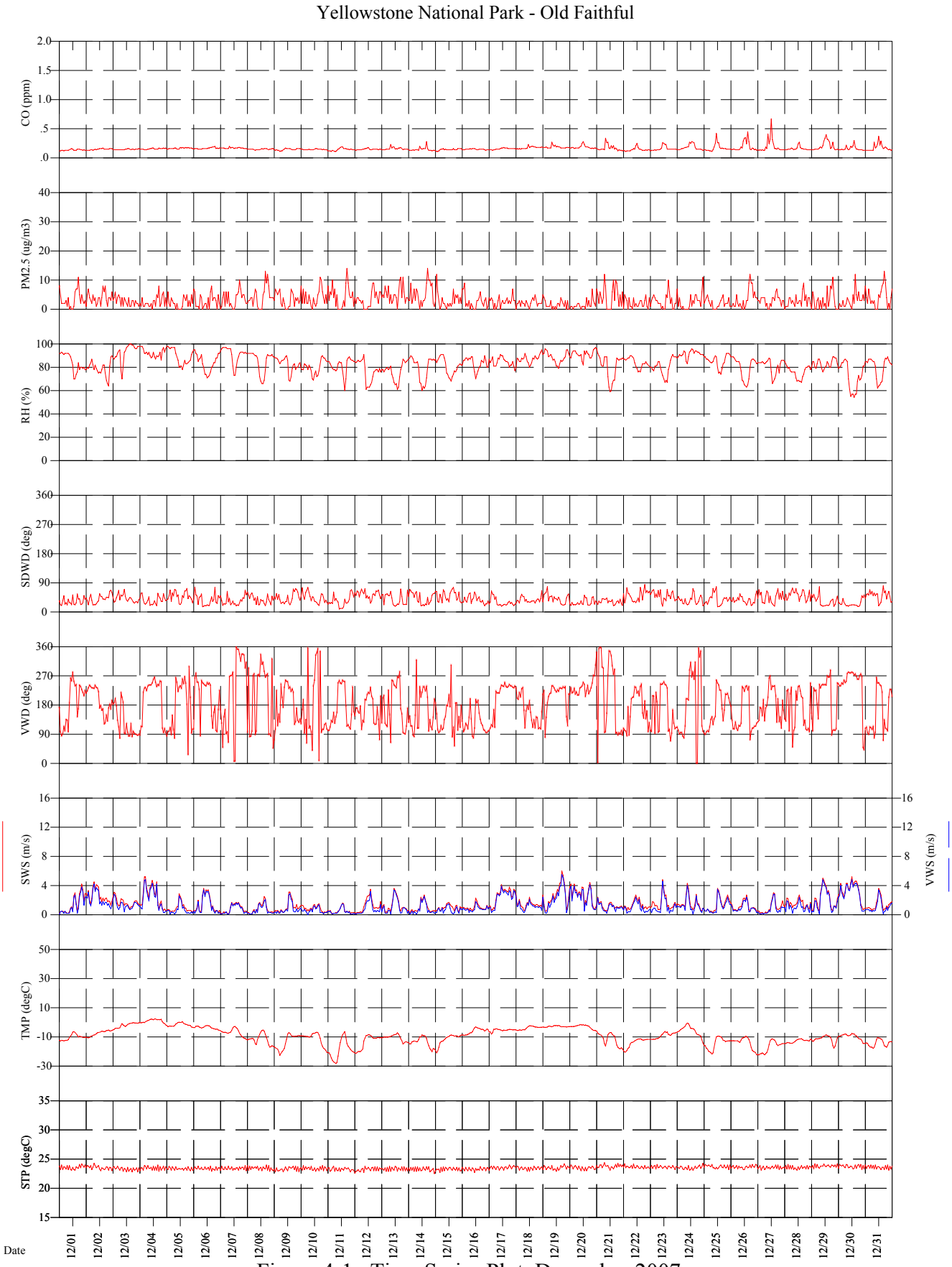


Figure 4-1. Time Series Plot, December 2007.

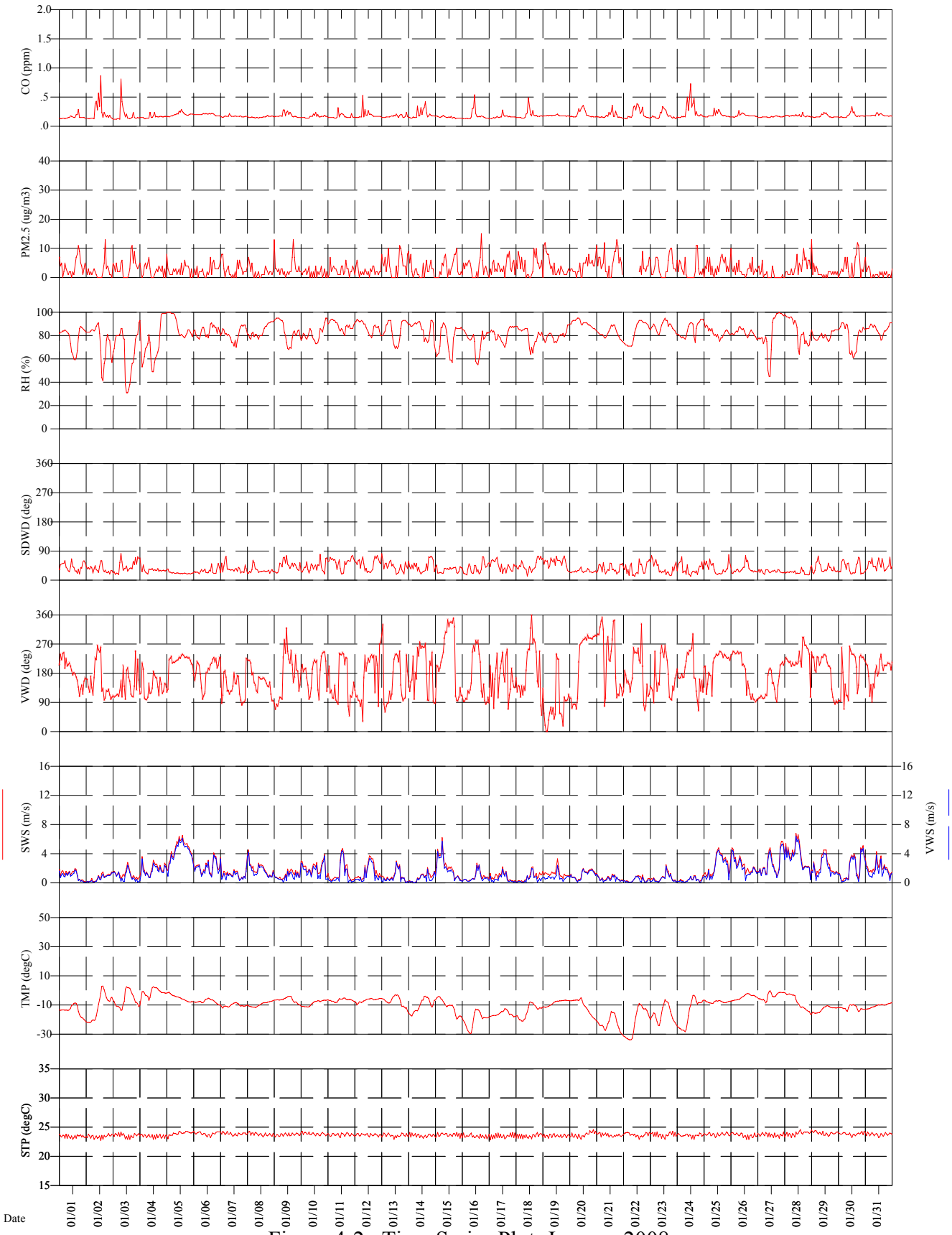


Figure 4-2. Time Series Plot, January 2008.

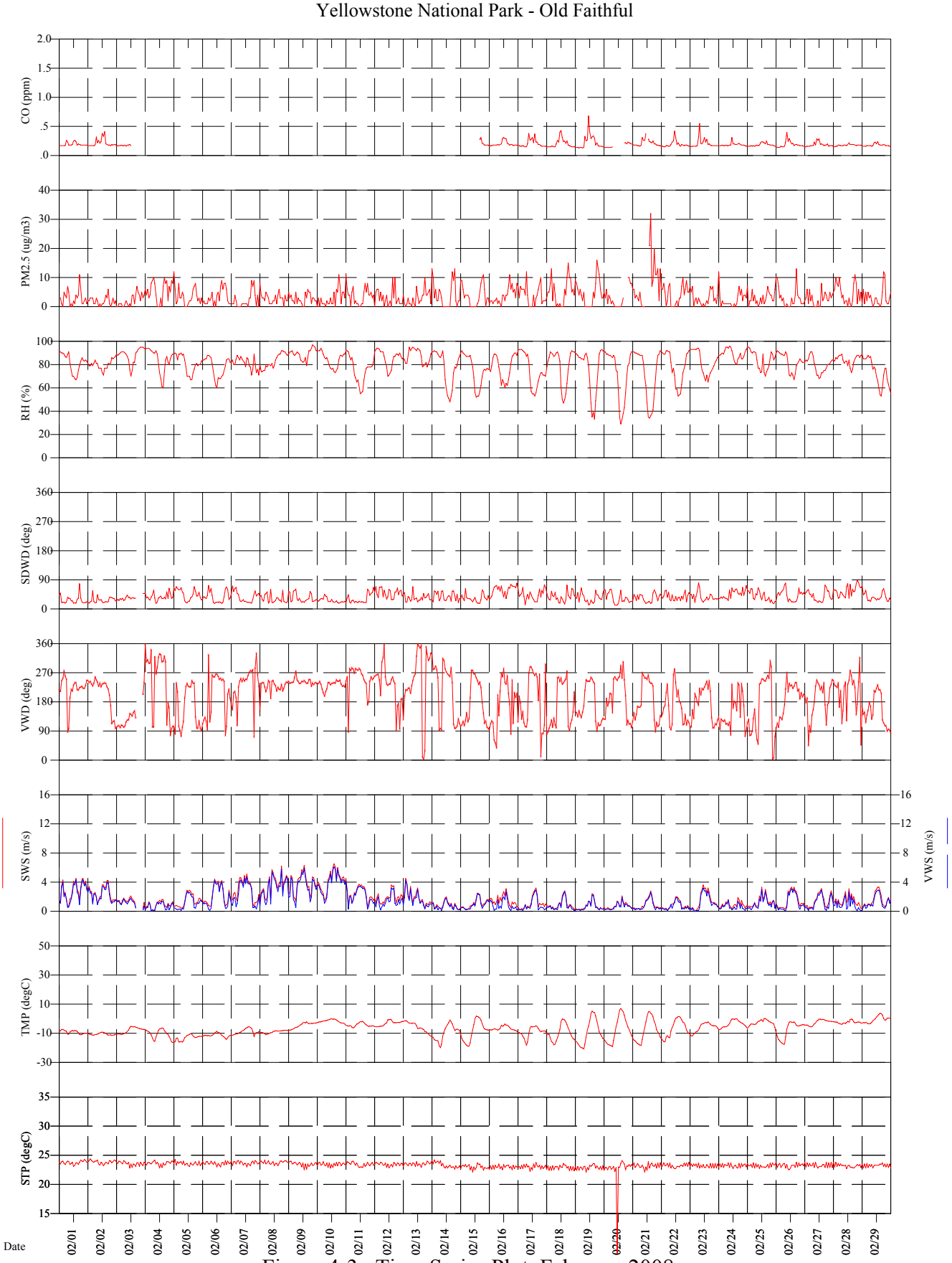


Figure 4-3. Time Series Plot, February 2008.

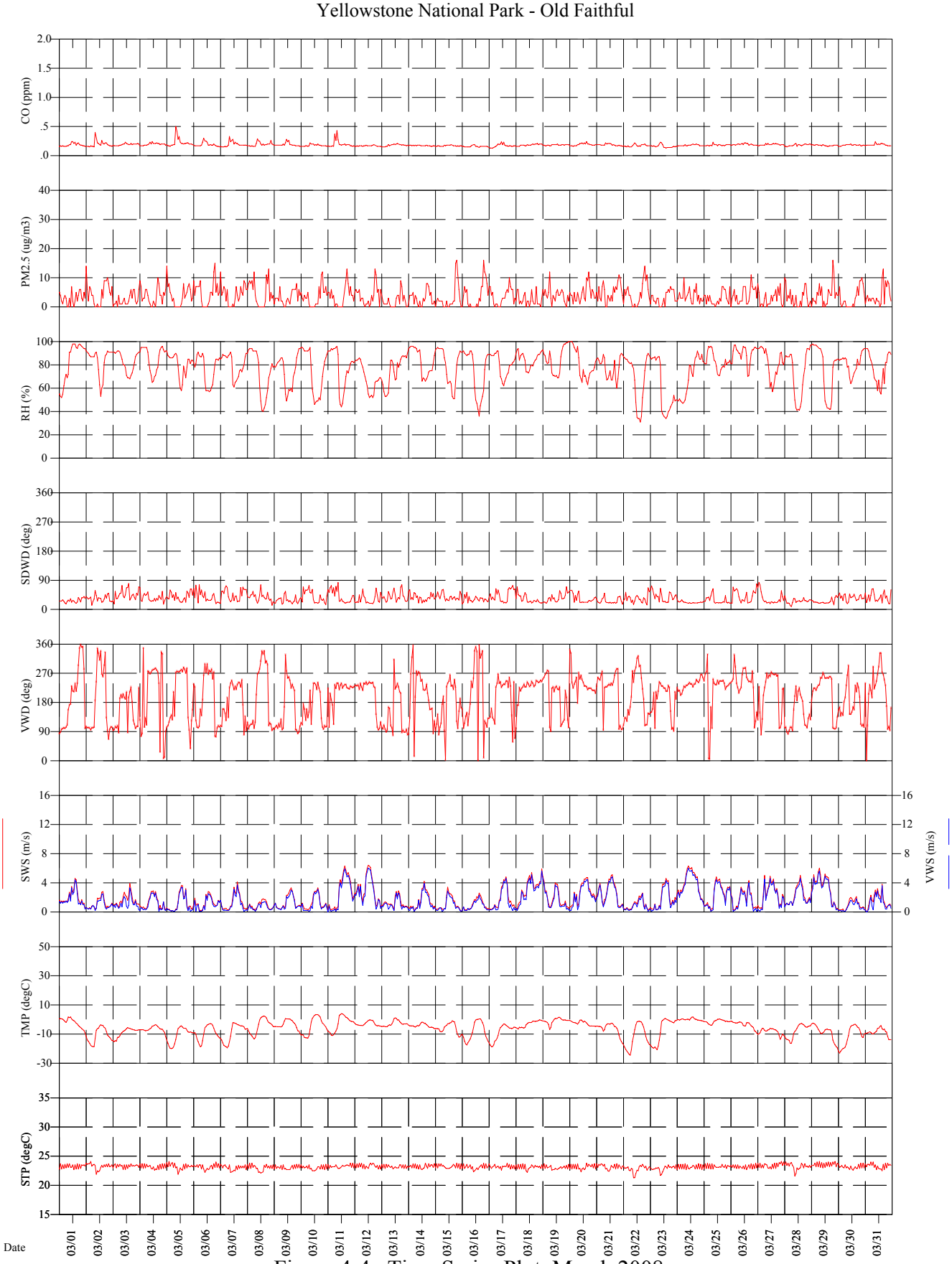


Figure 4-4. Time Series Plot, March 2008.

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 southwest and east-southeast. The highest wind speeds were seen when the winds were coming from the southwest.

Table 4-2

Summary of Selected Meteorological Data

Yellowstone National Park

Old Faithful

Final Validation

12/15/2007 - 03/15/2008

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	1.7	m/s	2203	1.3
Maximum	6.8	m/s		
Percent calm = 11.62				
AMBIENT TEMPERATURE				
Average	-8.6	degC	2208	6.0
Maximum	7.0	degC		
Minimum	-33.9	degC		
RELATIVE HUMIDITY				
Average	81	percent	2208	11
Maximum	100	percent		
Minimum	29	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	NA			
Maximum non-zero rate				
Minimum non-zero rate				
Accumulated during period				
SOLAR RADIATION				
Average Daily Total	NA			
Maximum Daily Total	NA			
Minimum Daily Total	NA			

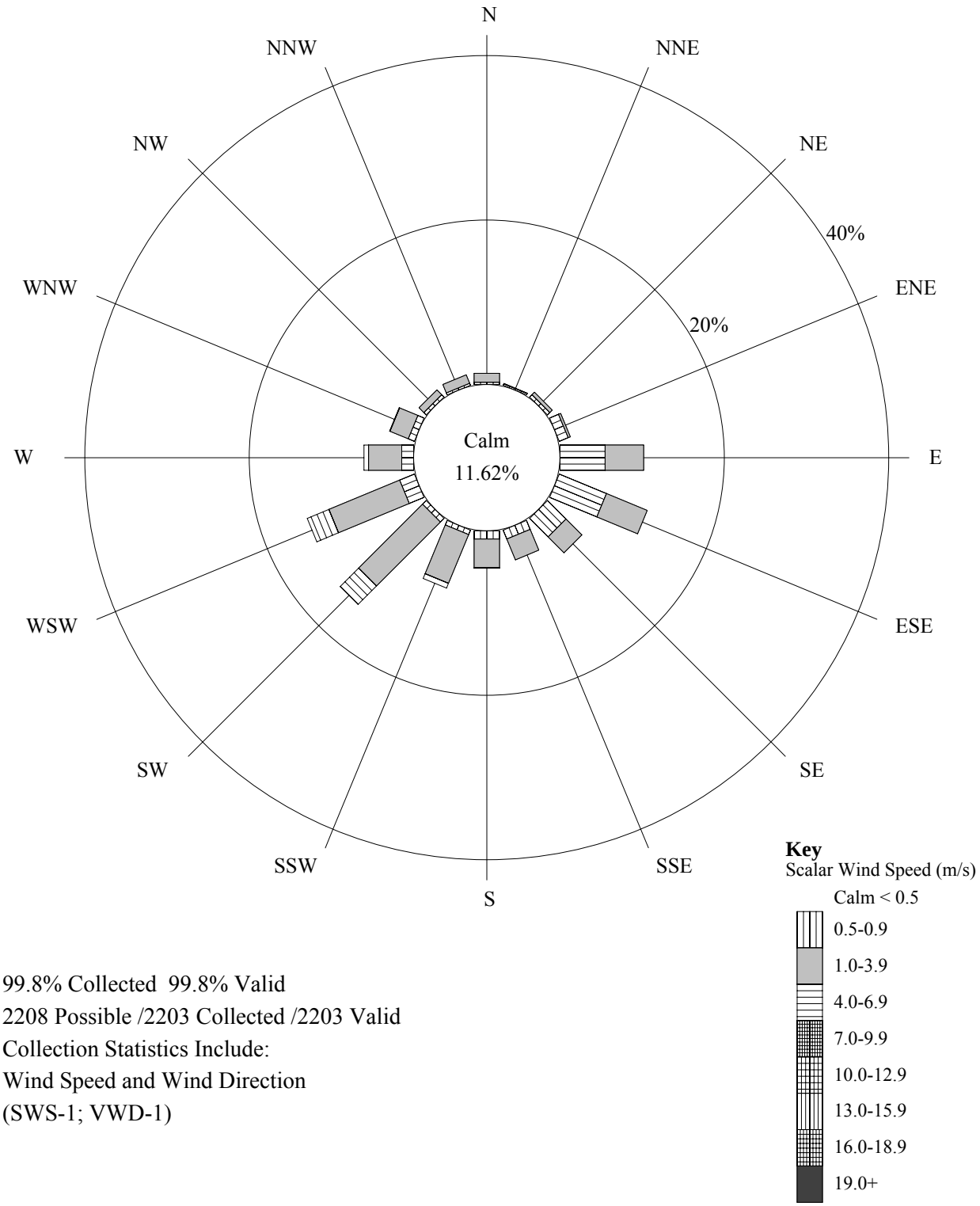
Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

NA indicates instrument not available.

Figure 4-5.

Yellowstone National Park Wind Rose 12/15/2007 - 03/15/2008
Old Faithful



99.8% Collected 99.8% Valid
2208 Possible /2203 Collected /2203 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

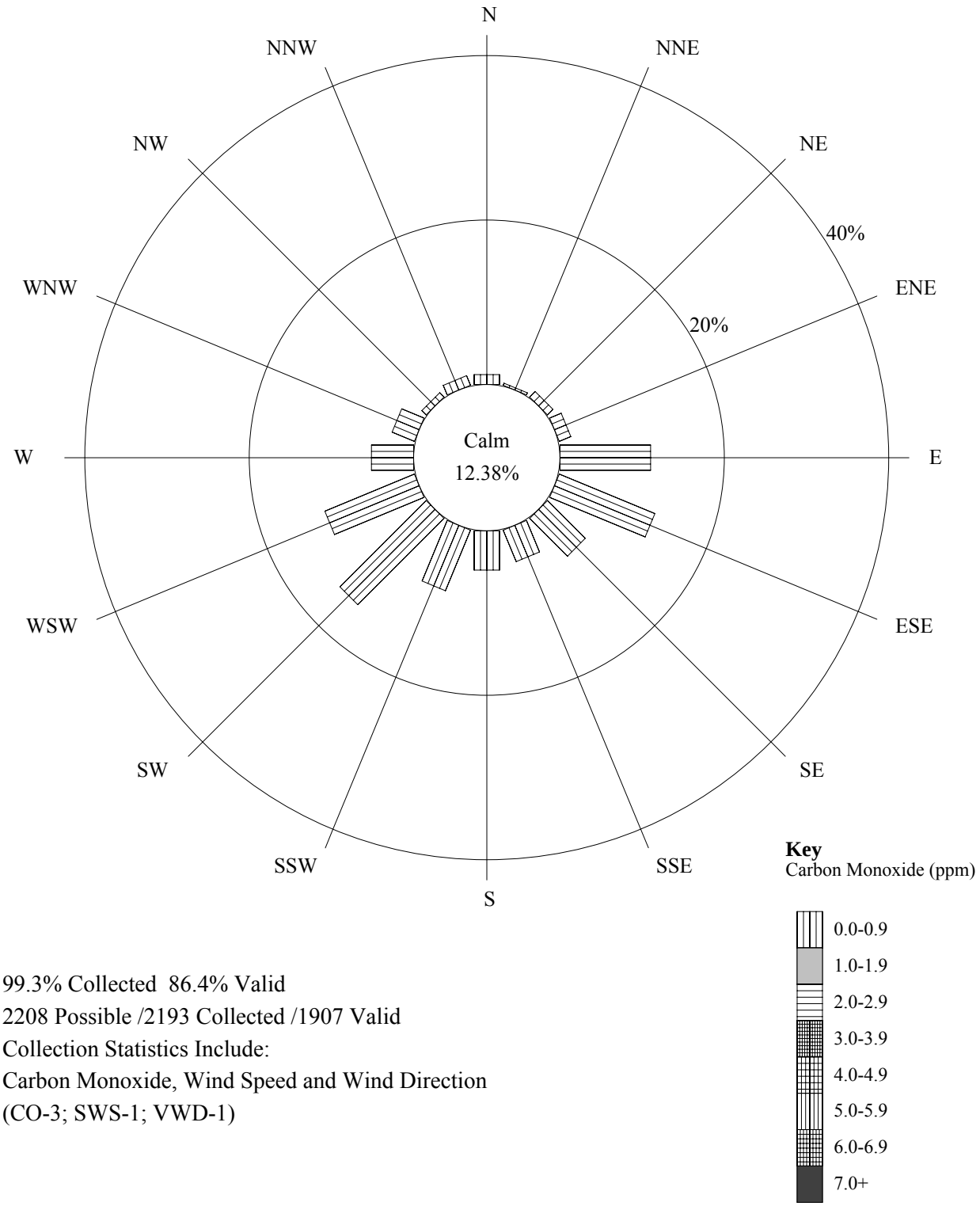
Table 4-3 lists the five (5) highest 1-hour average daily carbon monoxide maximums and the five (5) highest non-overlapping 8-hour running averages for the Old Faithful site. Table 4-4 lists the five (5) highest 1-hour average daily maximums and the five highest 24-hour averages recorded for $PM_{2.5}$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

Table 4-5 presents a comparison of the 2007-2008 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 3% of the 1-hour standard and 4% of the 8-hour standard. The highest 24-hour average recorded for $PM_{2.5}$ during the study period was 23% of the 24-hour standard.

Figure 4-6.

Yellowstone National Park | Pollutant Rose | 12/15/2007 - 03/15/2008

Old Faithful | Carbon Monoxide

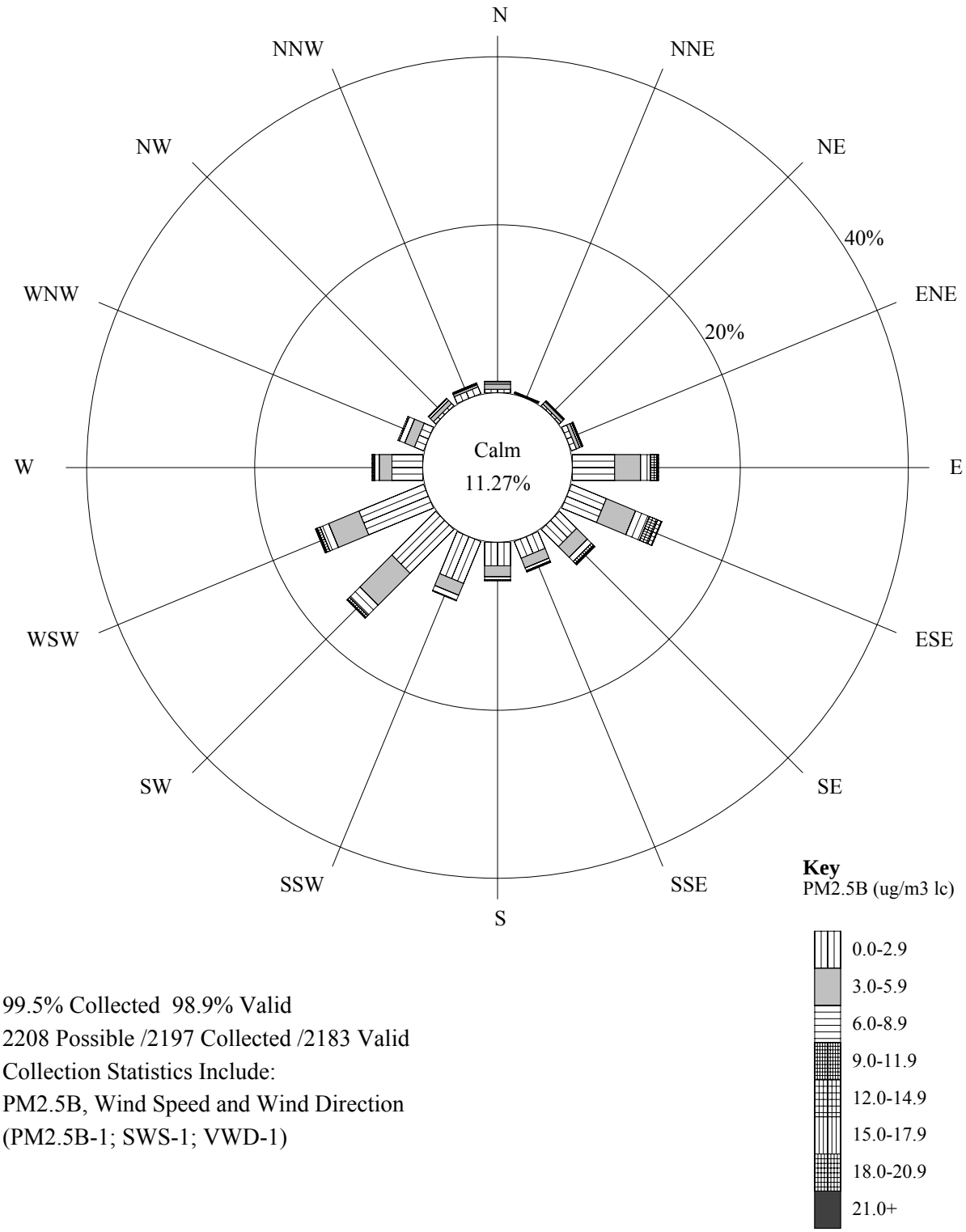


99.3% Collected 86.4% Valid
2208 Possible /2193 Collected /1907 Valid
Collection Statistics Include:
Carbon Monoxide, Wind Speed and Wind Direction
(CO-3; SWS-1; VWD-1)

Figure 4-7.

Yellowstone National Park | Pollutant Rose | 12/15/2007 - 03/15/2008

Old Faithful | PM2.5B



99.5% Collected 98.9% Valid
2208 Possible /2197 Collected /2183 Valid
Collection Statistics Include:
PM2.5B, 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 – 2007-2008 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	1/2/08	13	0.9	1/2/08	13	0.4
	2	1/3/08	7	0.8	1/24/08	12	0.4
	3	1/24/08	12	0.7	2/19/08	11	0.4
	4	2/19/08	11	0.7	12/24/07	14	0.3
	5	12/27/07	12	0.7	12/25/07	15	0.3

Table 4-4

$PM_{2.5}$ Five Highest 1-Hour and 24-Hour Average Concentrations
Yellowstone National Park – 2007-2008 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	2/21/08	15	32	1	2/21/08	8.1
	2	2/19/08	18	16	2	1/21/08	5.5
	3	3/15/08	19	16	3	2/4/08	5.4
	4	1/16/08	17	15	4	2/18/08	5.0
	5	2/18/08	18	15	5	3/6/08	4.9

Table 4-5

Comparison of CO and $PM_{2.5}$ Study Results to NAAQS
Yellowstone National Park – 2007-2008 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 8-hr avg (ppm)	Percent of Standard
Old Faithful	0.9	3%	0.4	4%	32	8.1	23%
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 11:45-14:00. Appendix B contains a full listing of images collected and their respective snowmobile codes.

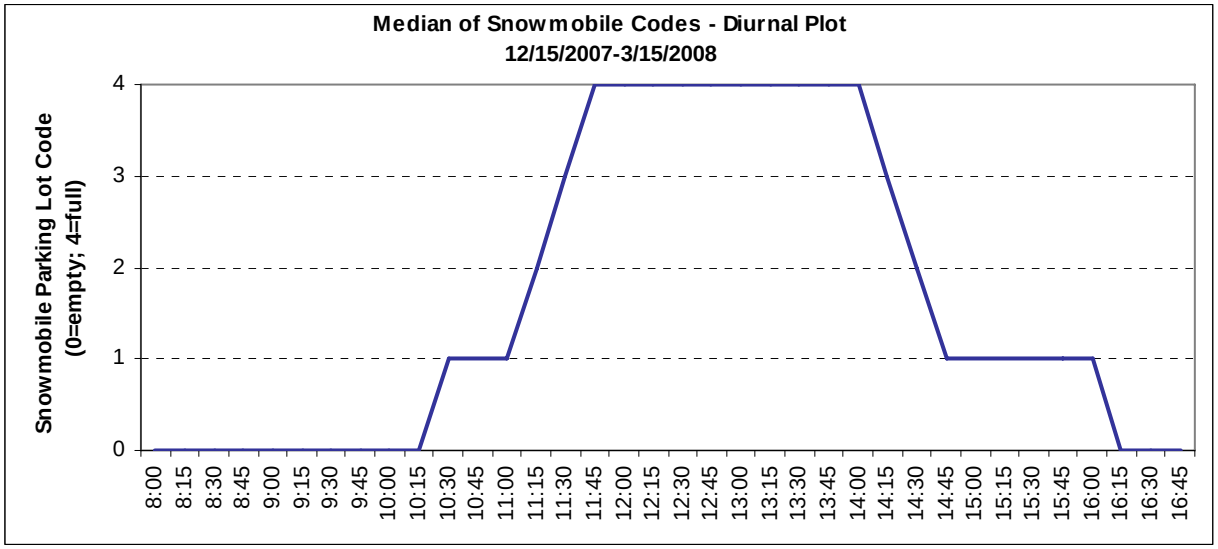


Figure 4-8. Diurnal Plot of Digital Image Codes.

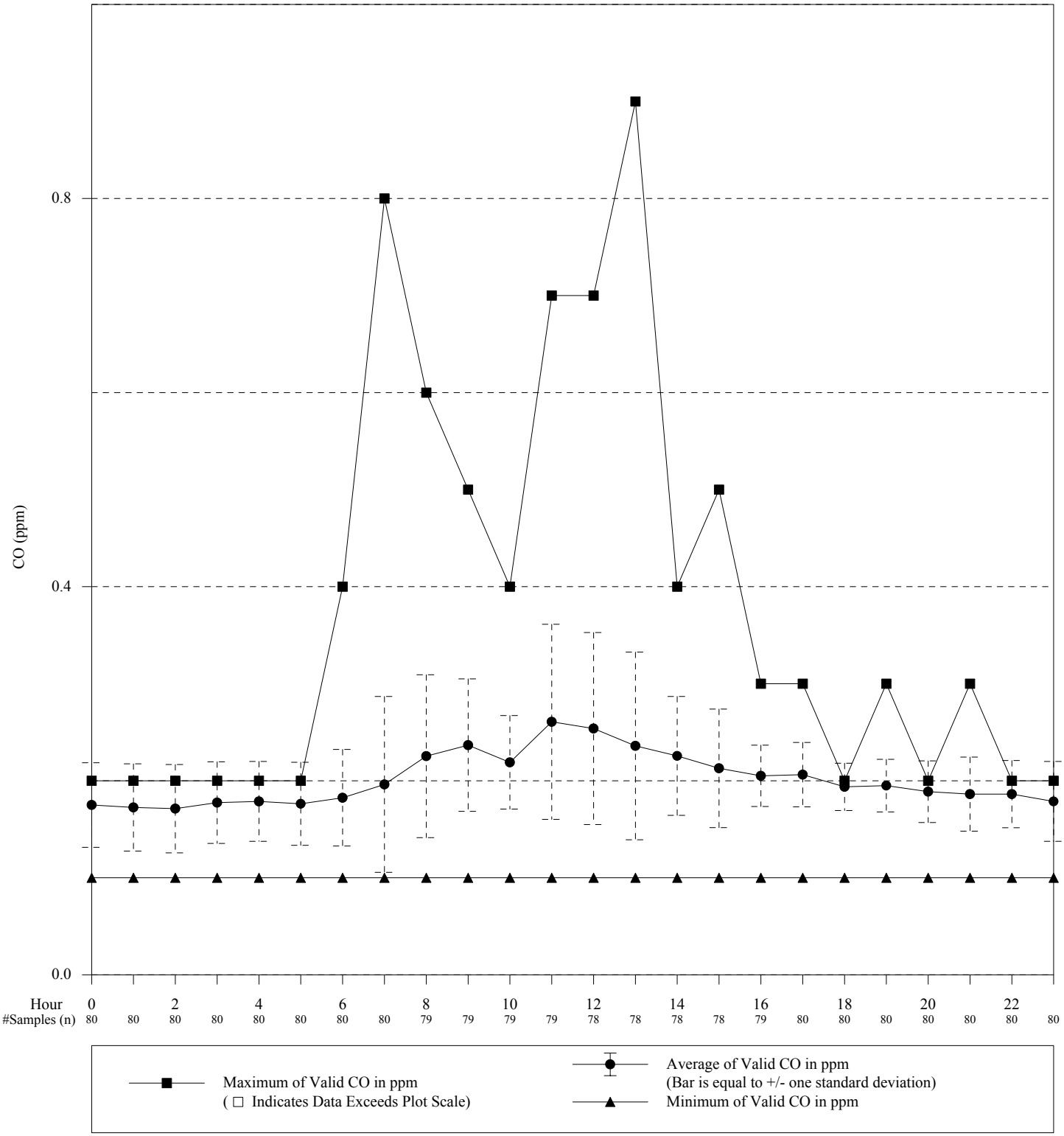
4.6 DIURNAL PATTERNS OF AIR QUALITY PARAMETERS

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 2007-2008 winter season. CO levels were highest during the daylight hours for the monitoring period. Figure 4-10 presents a diurnal pattern of $PM_{2.5}$ concentrations at the Old Faithful site. $PM_{2.5}$ levels were generally lowest in the late morning hours and highest in the late afternoon and early evening.

Yellowstone National Park
Old Faithful

Figure 4-9.
Diurnal Plot
Carbon Monoxide

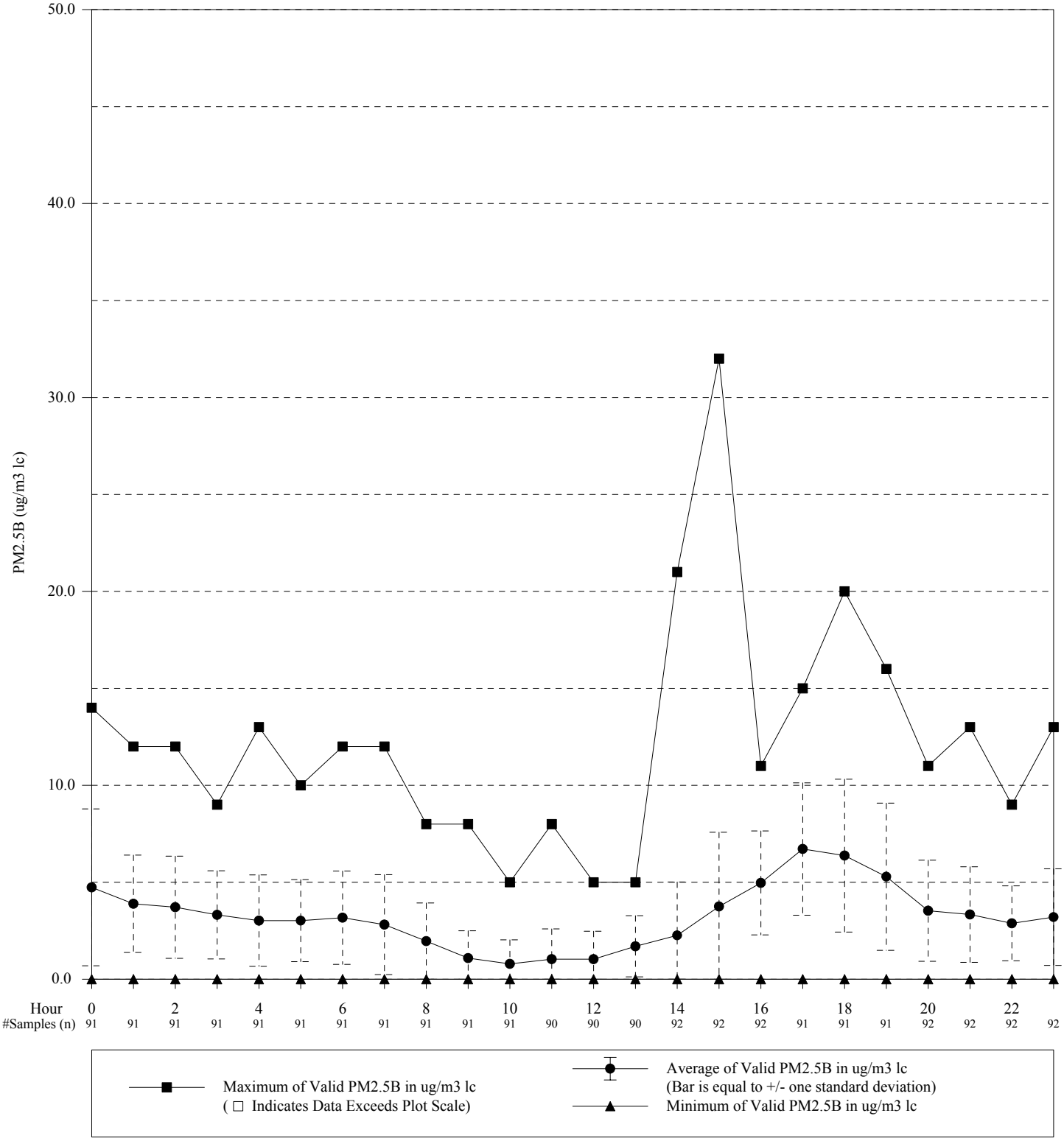
12/15/2007 - 03/15/2008



Yellowstone National Park
Old Faithful

Figure 4-10.
Diurnal Plot
PM2.5B

12/15/2007 - 03/15/2008



APPENDIX A

Maintenance and Calibration

Air Resource Specialists, Inc.

Calibration Summary

Network: NPS	Location: Old Faithful	Site: YELL-OF
Date: 09/05/07	Last Site Visit: 10/26/06	Field Specialist: Meisters, Dave

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	Thermo TECO FH 62 C14 42545/40 0513			Thermo TECO FH 62 C14		
	Pressure	max error	<= ± 2.0%						
	Flow	max error	<= ± 5.0%						
	Leak Test	max error	<=1.5		0.0	PASS			
CO Analyzer - 146C	*Average Difference*	average error	<= ± 5.0%	TECO 48C 71377-368	1.6%	PASS	TECO 48C 71377-368		
	Maximum Difference	max error	<= ± 5.0%		3.5%	PASS			
	Correlation	actual	r > 0.9950		0.9997	PASS			
	Intercept	actual	<= ± 3.0 ppb		0.2	PASS			
	Slope	actual	0.950 <= m <= 1.050		0.970	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	0.9999	PASS
Relative Humidity	*PRE Sensor ID# Z1050068*	max error	<= ± 5.0%	Vaisala HMP45C Z1050068	0.0%	PASS	Vaisala HMP45C Z1730047		
Temperature		max error	Climatronics <= ± 0.2º C; RM Young <= ± 0.5º C; Rotronics <= ± 1.0º C	Vaisala HMP45C Z1050068	0.1º	PASS	Vaisala HMP45C z1730047		
Wind Direction	*Alignment*	max error	<= ± 5º	RM Young AQ 05305 50789			RM Young AQ 05305 50789	2º	PASS
	Linearity	max error	<= ± 3º					1º	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 50789			RM Young AQ 05305 50789	N/A	N/A
	max Wind Speed >= 5	max error	<= ± 5%					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:	Meisters, Dave	**Latitude:**	44 27 28
Operator:	Gary Nelson	**Longitude:**	110 49 45
Network:	NPS	**Elevation:**	
Location:	Old Faithful		
Site:	YELL-OF		
Date:	9/5/2007		
Last Site Visit:	10/26/2006		

Parameter	Device	Manufacturer	Model	S/N	Calibration Date
Voltage	DVM	Fluke	189	79390171	12/25/2006
	Voltage Source	Calib. Inc.	DVC-350A		
Ozone	Transfer Standard	TECO	49CPS	70761-366	6/16/2006
Gas Dilution	Mass flow	ERT	Gas Dil		
Barometric Pressure	Barometer/Altimeter	AIR	AIR-HB-1A	0725	8/12/2006
High Flow	Dry cal	BIOS	Definer 220-H	111450	6/15/2007
Low Flow	Dry cal	BIOS	Definer 220-L	111572	6/15/2007
Precipitation	PPT Calibrator			76	12/4/2006
	Volume (ml):	936			
Relative Humidity	RH Sensor	Rhotronics	MP100C	80041	4/10/2006
Solar Radiation	Thermopile	LiCor	Pyranometer	PY43595	5/20/2006
	Multiplier				
Temperature	Digital Thermometer	Eutechinics	4400	303083	2/15/2007
Wind Direction	Torque Gauge	RM Young	18331	76	
	Linearity Jig	RM Young	18212	76	
	Compass	Brunton	5006LM	5041192259	
Wind Speed	Torque Disk	RM Young	18310	76	
	Anemometer Drive	RM Young	18801	76	1/20/2006
Volumetric Flow					

Comments:

Air Resource Specialists, Inc.

MET ONE 1020 BETA ATTENUATION MONITOR CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 09/05/07	Date of Last Site Visit: 10/26/06
				Field Specialist: Meisters, Dave

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

EQUIPMENT IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Thermo TECO	Thermo TECO
Model #	FH 62 C14	FH 62 C14
Serial #	42545/40 0513	42545/40 0513
Version #	2.5	
Modem Serial #		
Flow Rate	1001 L/H	
C_v		
ABS		
K		
Flow Type		
Q_o		
M_{sw}		
BRGD		
RH Control		
RH Set Point		
Databg RH		
Delta-T Control		
Delta-T Setpoint		

MAINTENANCE CHECKLIST

- ☑ Record Errors
- ☑ Download Data
- ☐ Update Firmware
- ☑ Clean Inlet
- ☐ Clean Nozzle
- ☑ Reset Time

	As Found	Actual
Time Reset		

CALIBRATION TIME

From:		To:	

PRE-MAINTENANCE

Temp, Pressure, Flow	BAM	Critical Venturi Flow Meter	% Difference	Pass/Fail
Ambient Temperature				
Barometric Pressure				
Volumetric Flow				

LEAK TEST

	BAM	Pass/Fail
FLOW	0	PASS

Flow accuracy goal: <= 1.5 Lpm

POST MAINTENANCE

Temp, Pressure, Flow	BAM	Critical Venturi Flow Meter	% Difference	Pass/Fail
Ambient Temperature				
Barometric Pressure				
Volumetric Flow				

LEAK TEST

	BAM	Pass/Fail
FLOW		

Flow accuracy goal: <= 1.5 Lpm

Pre-Maint Beta Attenuation Monitor Comments:	
Post Maint Beta Attenuation Monitor Comments:	

Air Resource Specialists, Inc.

GAS DILUTION CALIBRATOR CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 09/05/07	Date of Last Site Visit: 10/26/06
				Field Specialist: Meisters, Dave

High Flow Standard Reference: BIOS, Definer 220-H	High Flow Standard Reference S/N: 111450	Calibration Date: 06/15/07
Low Flow Standard Reference: BIOS, Definer 220-L	Low Flow Standard Reference S/N: 111572	Calibration Date: 06/15/07

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	20	2.04
2	35	3.513
3	50	4.974
4	65	6.437
5	80	7.894
6	95	9.364

Linear Regression		
Parameter	Air Flow Controller	Pass/Fail
Slope (m)	10.248680	N/A
Y Intercept (b)	-0.955057	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: Millipore	S/N: AA00463029	Range: 0 -100cc
Calibration Gas:	This primary standard automatically corrects to standard flow.	

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1	20	20.12
2	35	35.21
3	50	50.15
4	65	64.96
5	80	79.44
6	95	93.19

Linear Regression		
Parameter	Gas Flow Controller	Pass/Fail
Slope (m)	1.023434	N/A
Y Intercept (b)	-1.018273	N/A
Correlation Coefficient (r)	0.999875	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: 09/05/07	Date of Last Site Visit: 10/26/06
				Field Specialist: Meisters, Dave

EQUIPMENT IDENTIFICATION

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

FLOW METER DATA

	Dilution Air	Gas
Slope (m)	10.249	1.023
Y Intercept (b)	-1.0	-1.0
Correlation Coefficient (r)	1.0000	0.9999

REFERENCE GAS

Tank S/N	CC677
Calibration Date	9/7/2008
Pressure Tank / Del.	1625 / 20
Tank Conc. (ppm)	3060

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	2999	0.0				0.040				
1	17.950	4983	29.4				17.610		-0.340	-1.9%	PASS
2	15.800	4981	25.9				15.250		-0.550	-3.5%	PASS
3	9.990	4992	16.4				9.970		-0.020	-0.2%	PASS
4	7.974	6989	18.3				8.110		0.136	1.7%	PASS
5	3.590	4992					3.610		0.020	0.6%	PASS
ZERO											
						Average ABS % Difference:				1.6%	PASS
						Maximum ABS % Difference:				3.5%	PASS

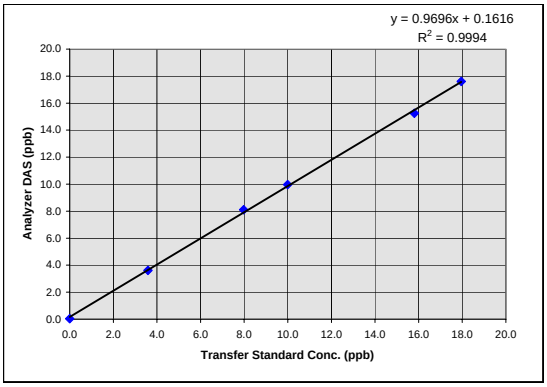
STATION TUBING

		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					
1	17.950						
2	15.800						
3	9.990						
4	7.974						
5	3.590						
ZERO	0.000	0.000					
		Average ABS % Difference:					
		Maximum ABS % Difference:					

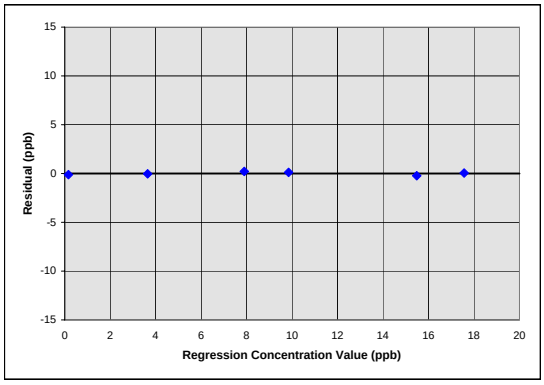
RESULTS

Linear Regression				
	PRE		POST	
Parameter	Analyzer	Pass/Fail	Analyzer	Pass/Fail
Slope	0.970	PASS		
Y Intercept	0.2	PASS		
Correlation Coefficient	0.9997	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:	Replaced noisy cooling fan in TECO 111.
Post Maint Carbon Monoxide Comments:	48C need a new gas filter correlation wheel and IR source.

Air Resource Specialists, Inc.

TEMPERATURE, DELTA TEMPERATURE AND RELATIVE HUMIDITY CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 09/05/07	Date of Last Site Visit: 10/26/06
				Field Specialist: Meisters, Dave

Reference Thermometer S/N: 303083		Calibration Date: 02/15/07
Relative Humidity Reference S/N: 80041		Calibration Date: 04/10/06

TEMPERATURE / DELTA TEMPERATURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Vaisala	Vaisala
Model #	HMP45C	HMP45C
Temperature Serial #	Z1050068	z1730047
Delta Temp. Serial #		
Translator Serial #	ESC 8816	ESC 8816

PRE-MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE		Difference (° C)	Pass/Fail	Δ TEMPERATURE		Difference (° C)	Pass/Fail
	DVM (volts)	DAS (° C)			DVM (volts)	DAS (° C)		
15.7		15.6	-0.1	PASS				
	Maximum Difference:		0.1	PASS	Maximum Difference:			

PRE- TRANSLATOR CARD RESPONSE

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

POST MAINTENANCE SENSOR RESPONSE

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

POST TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	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 #	Z1050068	Z1730047

PRE-MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00				
11:00	60.3	60.3	0.0%	PASS
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:			0.0%	PASS
Maximum % Difference:			0.0%	PASS

POST MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:				
Maximum % Difference:				

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: 09/05/07	Date of Last Site Visit: 10/26/06
				Field Specialist: Meisters, Dave

To Landmark #1:	180	Degrees True	From Landmark #1: 360	LM Description:	
To Landmark #2:	90	Degrees True	From Landmark #2: 270	LM Description:	
Declination:	11	Degrees			
Wind Direction Reference S/N: 5041192259				Calibration Date:	

WIND DIRECTION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	RM Young AQ	RM Young AQ
Model #	05305	05305
Serial #	50789	50789
Translator Serial #	ESC 8832	ESC 8832

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						182	2	PASS
From 1						1	1	PASS
To 2						91	1	PASS
From 2						270	0	PASS
	Average Difference:				Average Difference:		1	PASS
	Maximum Difference:				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						1	1	PASS
2						45	-1	PASS
3						91	1	PASS
4						135	-1	PASS
5						180	0	PASS
6						225	0	PASS
7						271	1	PASS
8						315	-1	PASS
	Average Difference:				Average Difference:		1	PASS
	Maximum Difference:				Maximum Difference:		1	PASS

Pre-Maint Wind Direction Comments:	Wind direction was working but the sensor was loosly attached and misoriented on the alignment ring
Post Maint Wind Direction Comments:	Fixed ws wire at sensor J box and reoriented the sensor on the alignment ring.

Air Resource Specialists, Inc.

WIND SPEED
CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 09/05/07	Date of Last Site Visit: 10/26/06
				Field Specialist: Meisters, Dave

Wind Speed Reference S/N: 76		Calibration Date: 01/20/06

WIND SPEED

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	RM Young AQ	RM Young AQ
Model #	05305	05305
Serial #	50789	50789
Translator Serial #	ESC 8816	ESC 8816

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
600	14.324	3.070	16.44							3.072	0.002		PASS
900	21.375	4.610	24.44							4.608	-0.002		PASS
1200	28.425	6.140	N/A							6.144	0.004	0.1%	PASS
1800	42.526	9.220	48.44							9.216	-0.004	0.0%	PASS
4000	N/A	20.480	N/A							20.480	0.000	0.0%	PASS
7000	N/A	35.840	N/A							35.840	0.000	0.0%	PASS
Maximum ABS Difference (use if Wind Speed <5):											0.004		
Maximum ABS % Difference (use if Wind Speed >=5):												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:	New sensor installed a week or so ago by operator. WS wire was found pulled out of Sensor j box and WD misalligned
Post Maint Wind Speed Comments:	Reoriented sensor on mast alignment ring and reattached WS wiring in sensor j box.

Air Resource Specialists, Inc.

Calibration Summary

Network: NPS	Location: Old Faithful	Site: YELL-OF
Date: 02/20/08	Last Site Visit: 09/06/07	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	*Temperature*	max error	<= ± 2.0º C	TECO FH62C-14 0513	-0.3	PASS	TECO FH62C-14		
	Pressure	max error	<= ± 2.0%		-0.9%	PASS			
	Flow	max error	<= ± 5.0%		0.8%	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 71377-368	1.7%	PASS	TECO 48C 71377-368	1.5%	PASS
	Maximum Difference	max error	<= ± 5.0%		2.4%	PASS		2.3%	PASS
	Correlation	actual	r > 0.9950		0.9999	PASS		0.9998	PASS
	Intercept	actual	<= ± 3.0 ppb		0.0	PASS		0.0	PASS
	Slope	actual	0.950 <= m <= 1.050		0.985	PASS		0.989	PASS
Mass Flow Correlation	*Low Cell (Dilution Air)*	correlation coefficient	r >= 0.9995	TECO 146C 146C-68497-360	N/A	N/A	TECO 146C 146C-68497-360	1.0000	PASS
	High Cell (Gas)	correlation coefficient	r >= 0.9995	TECO 146C 146C - 68497-360	N/A	N/A	TECO 146C 146C - 68497-360	0.9999	PASS

Air Resource Specialists, Inc.

Calibration Standards

Field Specialist:	Faust, John	**Latitude:**	
Operator:	Gary Nelson	**Longitude:**	
Network:	NPS	**Elevation:**	
Location:	Old Faithful		
Site:	YELL-OF		
Date:	2/20/2008		
Last Site Visit:	9/6/2007		

Parameter	Device	Manufacturer	Model	S/N	Calibration Date
Voltage	DVM	Fluke			
	Voltage Source	Calib. Inc.			
Ozone	Transfer Standard	TECO			
Gas Dilution	Mass flow	ERT			
Barometric Pressure	Barometer/Altimeter	AIR			
High Flow	Dry cal	BIOS	DC - HC -1	740	10/29/2007
Low Flow	Dry cal	BIOS	DC - LC- 1	L 1646	1/16/2008
Precipitation	PPT Calibrator				
	Volume (ml):	900			
Relative Humidity	RH Sensor	Visala			
Solar Radiation	Thermopile	LiCor			
	Multiplier	95.64			
Temperature	Digital Thermometer	Eutechinics			
Wind Direction	Torque Gauge	RM Young			
	Linearity Jig	RM Young			
	Compass	Brunton			
Wind Speed	Torque Disk	RM Young			
	Anemometer Drive	RM Young			
Volumetric Flow					

Comments:

Air Resource Specialists, Inc.

TECO BAM (BETA ATTENUATION MONITOR) CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 02/20/08	Date of Last Site Visit: 09/06/07
				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 #	0513	
Version #	NA	
Diagnostics	NA	
Air Flow Vol. Head	1000	
Air Flow Norm	1000	
T_1	4	
T_2	20	
T_3	20	
T_4	17	
Status Code	10	
Error Codes	0	
RH Control	Heater Temp 0	
RH Set Point	NA	
Databg RH	NA	
Delta-T Control	NA	
Delta-T Setpoint	NA	NA

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	4.0	4.3	-0.3	PASS
Barometric Pressure (hPa)	756	763	-0.9%	PASS
Volumetric Flow	1000.0	992.0	0.8%	PASS

1mmHg = 1.333 hPa

POST MAINTENANCE

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

CALIBRATION TIME

From:		To:	

	Old	New	accept?
Aplification	7118	7024	Yes

ZERO/SPAN FOIL PROCEDURE

1. **Turn heater off before performing calibration (pg 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.** Only T2 and T3 need to equilibrate
3. **Perform mass foil calibration (pg 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:	
Post Maint Comments:	

Air Resource Specialists, Inc.

GAS DILUTION CALIBRATOR CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 02/20/08	Date of Last Site Visit: 09/06/07
				Field Specialist: Faust, John

High Flow Standard Reference: BIOS, DC - HC -1	High Flow Standard Reference S/N: 740	Calibration Date: 10/29/07
Low Flow Standard Reference: BIOS, DC - LC- 1	Low Flow Standard Reference S/N: L 1646	Calibration Date: 01/16/08

Mass Flow Device (Dilution Air)

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

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1	1498	1470
2	2500	2449
3	3500	3427
4	4500	4430
5	5500	5415
6	7000	6902

Linear Regression		
Parameter	Air Flow Controller	Pass/Fail
Slope (m)	1.011991	N/A
Y Intercept (b)	19.351000	N/A
Correlation Coefficient (r)	0.999993	PASS

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts - b) / m

Mass Flow Device (Gas 1)

Mfg: TECO 146C	S/N: 146C - 68497-360	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	7.97	7.83
2	14.97	14.59
3	29.99	30.51
4	50.00	50.00
5	70.05	69.32
6	89.96	90.04

Linear Regression		
Parameter	Gas Flow Controller	Pass/Fail
Slope (m)	1.001118	N/A
Y Intercept (b)	0.059447	N/A
Correlation Coefficient (r)	0.999913	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: 02/20/08	Date of Last Site Visit: 09/06/07
				Field Specialist: Faust, John

High Flow Standard Reference: BIOS, DC - HC -1	High Flow Standard Reference S/N: 740	Calibration Date: 10/29/07
Low Flow Standard Reference: BIOS, DC - LC- 1	Low Flow Standard Reference S/N: L 1646	Calibration Date: 01/16/08

Mass Flow Device (Dilution Air)

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

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1	1498	1470
2	2500	2449
3	3500	3427
4	4500	4430
5	5500	5415
6	7000	6902

Linear Regression		
Parameter	Air Flow Controller	Pass/Fail
Slope (m)	1.011991	N/A
Y Intercept (b)	19.351000	N/A
Correlation Coefficient (r)	0.999993	PASS

Display Volts = (Flow SCCPM * m) + b

Flow SCCPM = (Display Volts - b) / m

Mass Flow Device (Gas 1)

Mfg: TECO 146C	S/N: 146C - 68497-360	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	8	7.125
2	15	13.97
3	30	29.56
4	50	48.73
5	70	69.37
6	90	89.44

Linear Regression		
Parameter	Gas Flow Controller	Pass/Fail
Slope (m)	0.996638	N/A
Y Intercept (b)	0.945494	N/A
Correlation Coefficient (r)	0.999958	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: 02/20/08	Date of Last Site Visit: 09/06/07
				Field Specialist: Faust, John

EQUIPMENT IDENTIFICATION

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

FLOW METER DATA

	Dilution Air	Gas
Slope (m)	1.012	1.001
Y Intercept (b)	19.4	0.1
Correlation Coefficient (r)	1.0000	0.9999

REFERENCE GAS

Tank S/N	CC677
Calibration Date	9/7/2008
Pressure Tank / Del.	1600/20
Tank Conc. (ppm)	3060

STATION TUBING

		CALCULATED FLOW 146C		FLOW METER		PRE-MAINTENANCE CO Bkg. (zero) = 11.627 CO Coef. (span) = 1.053					
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				0.040				
1											
2	15.490	4975	25.3			0.882	15.360		-0.130	-0.8%	PASS
3	9.987	4984	16.4			0.605	9.806		-0.181	-1.8%	PASS
4	7.977	6982	18.3			0.503	7.788		-0.189	-2.4%	PASS
5	4.280	4993	7.0			0.333	4.354		0.074	1.7%	PASS
ZERO	0.000	3000	0.0			0.116	0.060		0.060		
						Average ABS % Difference:				1.7%	PASS
						Maximum ABS % Difference:				2.4%	PASS

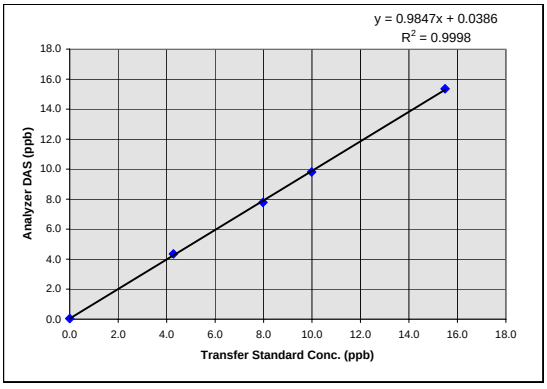
STATION TUBING

		POST MAINTENANCE CO Bkg. (zero) = 11.627 CO Coef. (span) = 1.053					
Calibration Point	Conc. (ppm)	DVM (volts)	DAS (ppm)	Recorder (%)	Difference (ppm)	% Difference	Pass/ Fail
ZERO	0.000	0.000					
1							
2	15.490		15.380		-0.110	-0.7%	PASS
3	9.987		9.767		-0.220	-2.2%	PASS
4	7.977		7.791		-0.186	-2.3%	PASS
5	4.280		4.314		0.034	0.8%	PASS
ZERO	0.000	0.000	0.020				
		Average ABS % Difference:				1.5%	PASS
		Maximum ABS % Difference:				2.3%	PASS

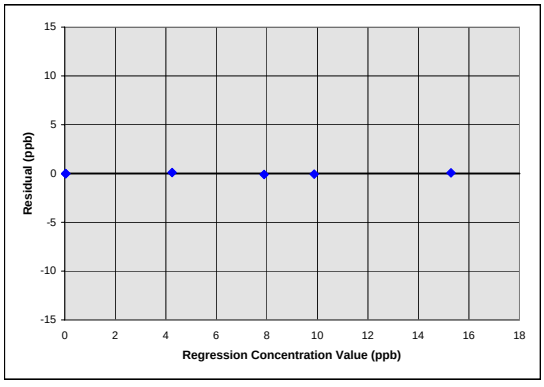
RESULTS

Linear Regression				
	PRE		POST	
Parameter	Analyzer	Pass/Fail	Analyzer	Pass/Fail
Slope	0.985	PASS	0.989	PASS
Y Intercept	0.0	PASS	0.0	PASS
Correlation Coefficient	0.9999	PASS	0.9998	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:	Could not adjust zero, too far out of range. This instrument will need optics cleaning in the lab. JF

Air Resource Specialists, Inc.

Calibration Summary

Network: NPS	Location: Old Faithful	Site: YELL-OF
Date: 05/21/08	Last Site Visit: 02/20/08	Field Specialist: Meisters, Dave

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 42545/40	0.3	PASS	TECO FH62C-14	0.3	PASS
	Pressure	max error	<= ± 2.0%		0.0%	PASS		0.0%	PASS
	Flow	max error	<= ± 5.0%		0.7%	PASS		0.6%	PASS
	Zero Foil	N/A	N/A		N/A	N/A		N/A	N/A
	Span Foil	N/A	N/A		-4.9%	N/A		0.7%	N/A
CO Analyzer - 146C	*Average Difference*	average error	<= ± 5.0%	TECO 48C 71377-368	1.6%	PASS	TECO 48C 71377-368	4.5%	PASS
	Maximum Difference	max error	<= ± 5.0%		3.3%	PASS		12.5%	FAIL
	Correlation	actual	r > 0.9950		0.9998	PASS		0.9895	FAIL
	Intercept	actual	<= ± 3.0 ppb		-0.1	PASS		-0.9	PASS
	Slope	actual	0.950 <= m <= 1.050		1.012	PASS		1.106	FAIL
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	0.9997	PASS
Relative Humidity	*PRE Sensor ID# Z1730047*	max error	<= ± 5.0%	Vaisala HMP45C Z1730047	0.0%	PASS	Vaisala HMP45C Xo810149	1.0%	PASS
Temperature		max error	Climatronics <= ± 0.2º C; RM Young <= ± 0.5º C; Rotronics <= ± 1.0º C	Vaisala HMP45C Z17330047			Vaisala HMP45C X0810149		
Wind Direction	*Alignment*	max error	<= ± 5º	RM Young AQ 05305			RM Young AQ 05305		
	Linearity	max error	<= ± 3º						
	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			RM Young AQ 05305		
	max Wind Speed >= 5	max error	<= ± 5%						
	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:	Meisters, Dave	**Latitude:**	
Operator:	Gary Nelson	**Longitude:**	
Network:	NPS	**Elevation:**	
Location:	Old Faithful		
Site:	YELL-OF		
Date:	5/21/2008		
Last Site Visit:	2/20/2008		

Parameter	Device	Manufacturer	Model	S/N	Calibration Date
Voltage	DVM	Fluke	189	79390171	
	Voltage Source	Calib. Inc.	DVC-350A		
Ozone	Transfer Standard	TECO	49i	721223194	10/3/2008
Gas Dilution	Mass flow	ERT	Gas Dil		
Barometric Pressure	Barometer/Altimeter	AIR	AIR-HB-1A	0725	8/12/2008
High Flow	Dry cal	BIOS	Definer 220-H	111450	6/15/2008
Low Flow	Dry cal	BIOS	Definer 220-L	111572	6/15/2008
Precipitation	PPT Calibrator			76	12/4/2008
	Volume (ml):	936			
Relative Humidity	RH Sensor	Rhotronics	MP100C	32736	12/6/2008
Solar Radiation	Thermopile	LiCor	Pyranometer	PY43595	5/20/2008
	Multiplier				
Temperature	Digital Thermometer	Eutechinics	4400	303083	9/20/2008
Wind Direction	Torque Gauge	RM Young	18331	76	
	Linearity Jig	RM Young	18212	76	
	Compass	Brunton	5006LM	5041192259	
Wind Speed	Torque Disk	RM Young	18310	76	
	Anemometer Drive	RM Young	18801	76	
Volumetric Flow					

Comments:

Air Resource Specialists, Inc.

TECO BAM (BETA ATTENUATION MONITOR) CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/21/08	Date of Last Site Visit: 02/20/08
				Field Specialist: Meisters, Dave

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

EQUIPMENT IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	TECO	TECO
Model #	FH62C-14	FH62C-14
Serial #	42545/40	
Version #	513	
Diagnostics		
Air Flow Vol. Head	16.56	
Air Flow Norm		
T_1	1	
T_2	19	
T_3	19	
T_4	17	
Status Code	0	
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	1.0	0.7	0.3	PASS
Barometric Pressure	751	751	0.0%	PASS
Volumetric Flow	16.7	16.6	0.7%	PASS

POST MAINTENANCE

Temp, Pressure, Flow	BAM	Flow Standard	% Difference	Pass/Fail
Ambient Temperature	1.0	0.7	0.3	PASS
Barometric Pressure	751	751	0.0%	PASS
Volumetric Flow	16.7	16.6	0.6%	PASS

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	4	N/A
Span Foil	1347	1281	-4.9%

POST MAINTENANCE

	Expected Response	Actual Response	% Difference
Zero Foil	0	2	N/A
Span Foil	1347	1356	0.7%

MAINTENANCE CHECKLIST

- ☑ Clean Inlet
- ☑ Clean Nozzle

	As Found	Actual
Time Reset		

Pre-Maint Comments:	
Post Maint Comments:	

Air Resource Specialists, Inc.

GAS DILUTION CALIBRATOR CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/21/08	Date of Last Site Visit: 02/20/08
				Field Specialist: Meisters, Dave

High Flow Standard Reference: BIOS, Definer 220-H	High Flow Standard Reference S/N: 111450	Calibration Date: 06/15/08
Low Flow Standard Reference: BIOS, Definer 220-L	Low Flow Standard Reference S/N: 111572	Calibration Date: 06/15/08

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	499	479.9
2	1998	1949
3	3499	3416
4	4999	4885
5	6500	6357
6	7997	7858

Linear Regression		
Parameter	Air Flow Controller	Pass/Fail
Slope (m)	1.017674	N/A
Y Intercept (b)	17.703879	N/A
Correlation Coefficient (r)	0.999992	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	11.98	12.18
2	15	15.07
3	35	35.7
4	49.99	50.88
5	59.97	59.96
6	85.05	83.42

Linear Regression		
Parameter	Gas Flow Controller	Pass/Fail
Slope (m)	1.019179	N/A
Y Intercept (b)	-0.858843	N/A
Correlation Coefficient (r)	0.999669	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: 05/21/08	Date of Last Site Visit: 02/20/08
				Field Specialist: Meisters, Dave

EQUIPMENT IDENTIFICATION

	Transfer Standard	Analyzer	Station Reference
Mfg.		TECO	TECO
Model #		48C	146C
Serial #		71377-368	68947-360

FLOW METER DATA

	Dilution Air	Gas
Slope (m)	1.018	1.019
Y Intercept (b)	17.7	-0.9
Correlation Coefficient (r)	1.0000	0.9997

REFERENCE GAS

Tank S/N	CC677
Calibration Date	9/7/2008
Pressure Tank / Del.	1600 / 20
Tank Conc. (ppm)	3060

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				0.000				
1	15.960	4979	26.1				16.120		0.160	1.0%	PASS
2	15.490	4978	25.3				15.560		0.070	0.5%	PASS
3	9.985	4988	16.3				9.990		0.005	0.1%	PASS
4	7.978	6989	18.3				7.731		-0.247	-3.1%	PASS
5	3.968	6994	9.1				3.838		-0.130	-3.3%	PASS
ZERO											
						Average ABS % Difference:				1.6%	PASS
						Maximum ABS % Difference:				3.3%	PASS

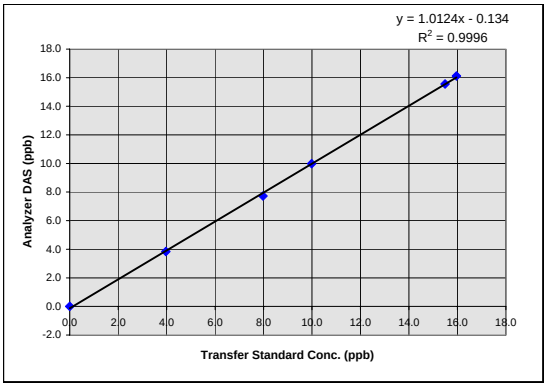
STATION TUBING

		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					
1	17.960		17.950		1.990	12.5%	FAIL
2	15.480		15.210		-0.280	-1.8%	PASS
3	9.979		9.870		-0.115	-1.2%	PASS
4	7.975		7.700		-0.278	-3.5%	PASS
5	3.963		3.820		-0.148	-3.7%	PASS
ZERO	0.000	0.000					
		Average ABS % Difference:				4.5%	PASS
		Maximum ABS % Difference:				12.5%	FAIL

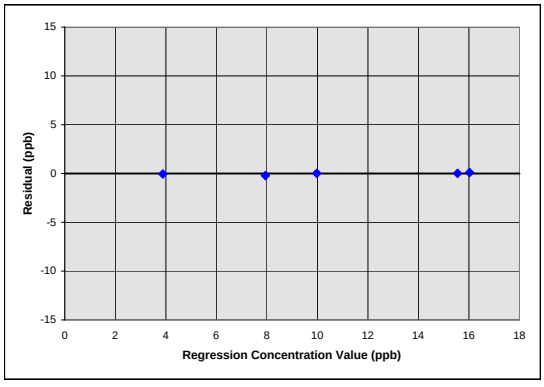
RESULTS

Linear Regression	PRE		POST	
Parameter	Analyzer	Pass/Fail	Analyzer	Pass/Fail
Slope	1.012	PASS	1.106	FAIL
Y Intercept	-0.1	PASS	-0.9	PASS
Correlation Coefficient	0.9998	PASS	0.9895	FAIL

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.

TEMPERATURE, DELTA TEMPERATURE AND RELATIVE HUMIDITY CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/21/08	Date of Last Site Visit: 02/20/08
				Field Specialist: Meisters, Dave

Reference Thermometer S/N: 303083		Calibration Date: 09/20/08
Relative Humidity Reference S/N: 32736		Calibration Date: 12/06/08

TEMPERATURE / DELTA TEMPERATURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Vaisala	Vaisala
Model #	HMP45C	HMP45C
Temperature Serial #	Z17330047	X0810149
Delta Temp. Serial #	N/A	
Translator Serial #	N/A	N/A

PRE-MAINTENANCE SENSOR RESPONSE

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

PRE- TRANSLATOR CARD RESPONSE

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

POST MAINTENANCE SENSOR RESPONSE

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

POST TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	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	Xo810149

PRE-MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00	94.0	94.0	0.0%	PASS
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:			0.0%	PASS
Maximum % Difference:			0.0%	PASS

POST MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00				
11:00	92.0	93.0	-1.0%	PASS
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:			1.0%	PASS
Maximum % Difference:			1.0%	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: 05/21/08	Date of Last Site Visit: 02/20/08
				Field Specialist: Meisters, Dave

To Landmark #1:	Degrees True	From Landmark #1:	LM Description:
To Landmark #2:	Degrees True	From Landmark #2:	LM Description:
Declination:	Degrees		
Wind Direction Reference S/N: 5041192259			Calibration Date:

WIND DIRECTION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	RM Young AQ	RM Young AQ
Model #	05305	05305
Serial #		
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								
From 1								
To 2								
From 2								
	Average Difference:				Average Difference:			
	Maximum Difference:				Maximum Difference:			

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								
2								
3								
4								
5								
6								
7								
8								
	Average Difference:				Average Difference:			
	Maximum Difference:				Maximum Difference:			

Pre-Maint Wind Direction Comments:	No checks or maintnance was performed due to heavey, wet snow.
Post Maint Wind Direction Comments:	

Air Resource Specialists, Inc.

WIND SPEED
CALIBRATION FORM

Network: NPS	Location: Old Faithful	Site: YELL-OF	Date: 05/21/08	Date of Last Site Visit: 02/20/08
				Field Specialist: Meisters, Dave

Wind Speed Reference S/N: 76		Calibration Date:

WIND SPEED

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	RM Young AQ	RM Young AQ
Model #	05305	05305
Serial #		
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										
600	14.324	3.070	16.44										
900	21.375	4.610	24.44										
1200	28.425	6.140	N/A										
1800	42.526	9.220	48.44										
4000	N/A	20.480	N/A										
7000	N/A	35.840	N/A										
Maximum ABS Difference (use if Wind Speed <5):													
Maximum ABS % Difference (use if Wind Speed >=5):													

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:	No checks or maintenance was performed due to heavy, wet snow fall.
Post Maint Wind Speed Comments:	

APPENDIX B

Snowmobile Codes

Date	0800	0815	0830	0845	0900	0915	0930	0945	1000	1015	1030	1045	1100	1115	1130	1145	1200	1215
12/15/07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/16/07	0	1	1	1	0	0	0	0	0	0	0	0	2	2	3	3	3	2
12/17/07	0	0	0	1	1	1	0	0	0	0	0	ICE	0	0	0	0	ICE	ICE
12/18/07	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1
12/19/07	1	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	4
12/20/07	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	3	3	4
12/21/07	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3
12/22/07	0	0	0	0	0	0	1	0	0	0	0	0	0	2	2	3	4	4
12/23/07	0	0	0	0	0	0	0	0	1	1	1	1	2	3	3	4	4	4
12/24/07	1	1	1	0	0	0	0	0	0	0	0	1	2	3	3	4	4	4
12/25/07	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3	4	4
12/26/07	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3	4	4	4
12/27/07	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	4
12/28/07	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	4	4	4
12/29/07	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	4	4
12/30/07	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	4	4	4
12/31/07	0	0	0	0	0	0	0	0	0	0	0	1	1	2	4	4	4	4
1/1/08	0	0	0	0	0	0	0	0	0	0	0	1	3	3	4	4	4	4
1/2/08	0	0	0	0	WEATHER	0	0	0	0	0	0	1	1	2	3	4	4	4
1/3/08	0	0	0	0	0	0	0	0	0	0	0	2	2	3	3	4	4	4
1/4/08	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	4	4
1/5/08	1	1	1	1	0	0	0	0	0	0	0	0	1	1	2	4	4	4
1/6/08	1	1	1	1	1	1	1	1	1	0	0	1	2	3	3	3	4	4
1/7/08	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	NO IMAGE	NO IMAGE
1/8/08	0	0	0	1	1	1	1	1	1	1	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	4	4
1/9/08	0	0	0	0	0	0	0	1	0	1	1	1	1	2	3	4	4	4
1/10/08	0	0	0	0	0	0	0	0	0	0	1	2	2	2	4	4	4	4
1/11/08	0	0	0	NO IMAGE	0	0	0	0	0	1	1	1	1	0	1	2	3	4
1/12/08	0	0	0	0	0	0	0	0	0	0	0	2	2	3	3	4	4	4
1/13/08	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	4
1/14/08	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	3	4
1/15/08	ICE	ICE	ICE	0	0	0	0	NO IMAGE	0	0	0	0	1	1	2	3	3	4
1/16/08	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	3	4	4
1/17/08	0	0	0	0	0	0	1	0	0	0	0	2	2	2	3	4	4	4
1/18/08	0	0	0	0	0	0	0	0	1	1	1	0	1	2	3	4	4	4
1/19/08	0	1	0	1	1	1	1	1	1	1	1	1	1	2	3	4	4	4
1/20/08	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	4	4	4
1/21/08	0	1	1	1	1	1	1	1	1	1	1	1	1	2	3	3	4	4
1/22/08	0	0	0	WEATHER	WEATHER	0	WEATHER	1	0	0	0	1	1	1	1	2	2	3
1/23/08	0 - MOON	0	0	0	0	0	0	0	0	0	0	1	1	3	3	4	4	4
1/24/08	0 - MOON	0	WEATHER	0	0	WEATHER	WEATHER	WEATHER	0	0	0	0	14	2	2	2	3	4
1/25/08	0 - MOON	0 - MOON	0	0	0	0	0	0	0	0	0	0	1	2	3	4	4	4
1/26/08	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	4	4	4
1/27/08	0	0	0	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4
1/28/08	1	1	1	1	1	1	0	0	0	1	0	0	0	0	0	2	2	3
1/29/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3
1/30/08	0	0	0	0	0	1	0	0	1	1	1	1	2	2	3	4	4	4
1/31/08	0	0	0	0	1	0	0	0	0	0	0	1	2	3	4	4	4	4

Date	1230	1245	1300	1315	1330	1345	1400	1415	1430	1445	1500	1515	1530	1545	1600	1615	1630	1645
12/15/07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
12/16/07	2	2	2	1	2	1	1	0	0	0	0	0	1	0	0	0	0	0
12/17/07	ICE	ICE	ICE	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0
12/18/07	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
12/19/07	4	4	4	4	4	4	4	4	2	3	3	1	0	0	1	1	1	0
12/20/07	4	4	4	4	4	3	2	2	1	1	1	1	0	0	0	0	0	0
12/21/07	4	4	4	4	4	4	3	1	1	1	1	1	1	0	0	0	0	0
12/22/07	4	4	4	4	4	4	4	4	4	3	2	1	0	1	0	0	0	1
12/23/07	4	4	4	4	4	4	4	4	2	1	1	1	1	0	0	0	0	0
12/24/07	4	4	4	4	4	3	3	3	3	2	2	1	1	1	1	1	1	0
12/25/07	4	4	4	4	4	3	3	3	1	1	0	0	0	0	0	0	0	0
12/26/07	4	4	4	4	4	4	4	3	2	2	1	1	0	0	0	1	1	1
12/27/07	4	4	4	4	4	4	4	4	2	1	0	0	0	0	1	0	0	0
12/28/07	4	4	4	4	4	4	4	4	4	2	2	1	1	1	1	0	0	0
12/29/07	4	4	4	4	4	4	4	4	4	3	3	1	1	1	1	1	1	1
12/30/07	4	4	4	4	4	4	4	4	4	4	4	4	3	2	2	0	0	0
12/31/07	4	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	0	0
1/1/08	4	4	4	4	4	4	4	4	3	2	2	1	0	0	1	1	0	0
1/2/08	4	4	4	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1
1/3/08	4	4	4	4	4	4	4	4	3	2	2	2	2	1	1	0	0	1
1/4/08	4	4	4	4	3	3	3	3	3	3	2	1	0	0	1	1	0	0
1/5/08	NO IMAGE	4	4	4	4	4	3	3	3	2	1	1	0	1	0	0	0	0
1/6/08	4	4	4	4	4	3	3	2	1	1	0	0	0	0	1	1	0	0
1/7/08	4	4	4	4	1	1	1	1	1	1	0	0	0	0	0	0	1	0
1/8/08	4	4	4	4	4	4	2	2	2	2	NO IMAGE	2	1	0	0	1	0	0
1/9/08	4	4	4	4	4	4	4	3	2	1	1	0	0	0	0	0	0	0
1/10/08	4	4	4	4	4	3	2	2	2	2	2	0	0	0	1	0	1	0
1/11/08	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1	1	1	0
1/12/08	4	4	4	4	4	4	4	3	3	3	2	1	0	0	0	0	0	0
1/13/08	4	4	4	4	4	2	1	1	1	2	2	0	0	1	NO IMAGE	0	1	0
1/14/08	4	4	4	4	3	3	3	2	2	2	2	2	2	0	0	0	0	1
1/15/08	4	4	4	4	4	3	3	2	2	2	1	1	1	1	0	0	0	0
1/16/08	4	4	4	4	2	2	2	1	0	0	0	0	0	0	0	0	1	1
1/17/08	4	4	4	4	3	3	3	3	2	0	0	0	0	0	1	1	0	1
1/18/08	4	4	4	4	4	3	2	1	2	0	0	0	0	2	2	0	1	0
1/19/08	4	4	4	4	4	4	4	4	3	2	0	0	0	0	0	0	1	0
1/20/08	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1	1	0
1/21/08	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	2	1
1/22/08	4	4	4	4	4	4	4	4	4	3	3	0	0	0	0	0	0	0
1/23/08	4	4	4	4	4	4	3	2	1	1	1	1	NO IMAGE	1	1	0	0	0
1/24/08	4	NO IMAGE	4	4	4	4	4	4	4	4	1	1	2	2	2	NO IMAGE	0	NO IMAGE
1/25/08	4	4	4	4	4	4	4	3	1	1	2	2	1	1	1	NO IMAGE	1	1
1/26/08	4	4	4	4	4	4	4	2	2	1	0	1	1	1	1	1	1	1
1/27/08	4	4	4	4	4	2	NO IMAGE	2	2	2	0	0	0	0	0	0	0	0
1/28/08	3	3	2	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0
1/29/08	3	4	4	4	4	4	3	3	2	2	2	1	2	2	2	2	2	0
1/30/08	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	NO IMAGE	1	0
1/31/08	4	4	4	4	4	4	4	2	1	0	0	1	2	2	2	0	0	0

Date	0800	0815	0830	0845	0900	0915	0930	0945	1000	1015	1030	1045	1100	1115	1130	1145	1200	1215
2/1/08	0	0	0	0	0	0	0	1	1	1	1	0	1	NO IMAGE	3	4	4	4
2/2/08	0	1	0	0	0	0 - BUFFALO	1	1	0	0	0	0	1	2	3	3	3	4
2/3/08	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4	4
2/4/08	0	0	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	0	1	1	2	3	3	4	4
2/5/08	0	0	0	0	0	0	0	0	0	0	0	1	1	2	4	4	4	4
2/6/08	0	1	1	0	0	0	0	0	0	1	1	1	2	2	3	4	4	4
2/7/08	0	0	0	0	0	0	1	0	0	0	0	1	2	2	3	4	4	4
2/8/08	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	4	4	4
2/9/08	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	3	4	4
2/10/08	0	0	0	0	1	1	0	0	1	2	2	2	3	3	3	4	4	4
2/11/08	1	1	1	1	1	1	1	1	1	1	1	1	2	3	4	4	4	4
2/12/08	0	0	1	1	1	1	1	1	1	1	2	2	3	3	4	4	4	4
2/13/08	0	0	0	0	0	1	0	0	1	0	1	1	2 - WIPEOUT	1	2	3	3	4
2/14/08	0	0	0	0	0	0	0	0	0	0	1	1	12	2	3	3	3	4
2/15/08	0	0	0	0	0	0	NO IMAGE	1	1	1	1	2	2	3	4	4	4	4
2/16/08	0	1	1	1	1	1	1	1	1	1	1	1	1	2	3	4	4	4
2/17/08	1	1	1	1	1	1	1	1	1	1	2	2	2	3	4	4	4	4
2/18/08	0	0	1	1	1	1	1	1	1	1	1	1	1	2	3	4	4	4
2/19/08	0	0	0	1	1	1	1	1	1	1	1	1	2	2	4	4	4	4
2/20/08	0	1	1	1	0	0	0	0	0	0	1	1	2	2	3	3	4	4
2/21/08	1	1	0	0	0	0	0	0	0	0	1	1	1	2	3	3	4	4
2/22/08	0	1	1	1	1	1	1	1	1	1	1	2	2	3	4	4	4	4
2/23/08	1	1	1	1	1	1	1	1	1	1	1	2	3	4	4	4	4	4
2/24/08	0	1	1	1	1	1	1	1	1	1	1	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE
2/25/08	0	0	1	1	1	1	1	1	1	1	1	1	1	2	3	4	4	4
2/26/08	0	0	1	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4
2/27/08	0	0	NO IMAGE	1	1	1	1	1	1	1	2	2	4	4	4	4	4	4
2/28/08	0	1	1	1	1	1	1	1	1	1	1	1	2	3	4	4	4	4
2/29/08	1	1	1	1	1	1	NO IMAGE	1	1	1	2	2	2	3	4	4	4	4
3/1/08	1	0	0	0	0	0	0	1	2	3	2	2	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE
3/2/08	1	1	1	1	1	1	1	1	1	1	1	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE
3/3/08	0	0	0	0	0	0	0	0	0	1	1	2	3	4	4	4	4	4
3/4/08	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	4	4	NO IMAGE
3/5/08	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	4	4
3/6/08	0	0	0	0	0	0	0	1	0	0	1	2	2	3	3	4	4	4
3/7/08	WEATHER	WEATHER	WEATHER	0	0	0	0	0	0	1	2	2	3	4	4	4	4	4
3/8/08	0	0	0	0	0	0	0	0	0	0	1	2	2	3	3	4	4	4
3/9/08	0	0	1	0	0	0	0	2	3	4	4	4	4	4	4	4	4	4
3/10/08	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
3/11/08	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
3/12/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/13/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3/14/08	0	0	0	0	0	0	0	0	0	0	0	0	0	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	0
3/15/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	1230	1245	1300	1315	1330	1345	1400	1415	1430	1445	1500	1515	1530	1545	1600	1615	1630	1645
2/1/08	4	4	4	4	4	3	3	3	2	2	2	1	1	1	0	0	0	0
2/2/08	4	4	4	4	4	4	4	4	4	0	0	0	NO IMAGE	0	0	0	0	0
2/3/08	4	4	4	4	3	NO IMAGE	2	0	0	0	0	0	0	1	1	0	0	0
2/4/08	4	4	4	4	4	4	4	4	4	4	1	1	1	1	1	0	0	0
2/5/08	4	4	4	4	4	4	4	4	4	4	4	0	0	0	0	0	0	0
2/6/08	4	4	4	4	4	4	4	3	2	2	2	0	0	0	NO IMAGE	1	1	1
2/7/08	4	4	4	4	4	2	2	2	2	2	2	2	2	2	2	2	0	0
2/8/08	4	4	4	4	4	3	3	1	1	2	2	0	1	0	0	0	0	0
2/9/08	4	4	4	4	4	4	1	1	1	1	0	0	1	1	1	1	1	1
2/10/08	4	4	4	4	4	3	3	3	3	2	1	1	1	1	1	1	1	1
2/11/08	4	4	4	4	4	4	3	2	2	2	2	1	1	1	1	0	0	0
2/12/08	4	4	4	4	4	3	2	1	1	1	1	1	1	1	1	1	1	1
2/13/08	4	4	4	4	4	4	4	4	1	1	1	0	0	1	1	0	0	0
2/14/08	4	4	4	4	4	4	4	2	1	0	0	0	0	0	0	0	0	0
2/15/08	4	4	4	4	4	4 - BUFFALO	4	2	2	2	1	1	0 - PRISTINE	0	0	0	0	0
2/16/08	4	4	4	4	4	4	4	4	4	4	3	1	1	1	1	1	1	1
2/17/08	4	4	4 - PRES DAY	4	4	4	4	4	NO IMAGE	2	1	1	1	1	1	1	1	1
2/18/08	4	4	4	4	4	4	4	3	3	2	2	2	2	1	1	1	1	1
2/19/08	4	4	4	4	4	4	4	2	1	0	1	1	1	1	1	1	1	1
2/20/08	4	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1	1
2/21/08	4	4	4	4	4	4	4	4	3	2	2	0	1	1	1	1	1	1
2/22/08	4	4	4	4	4	4	4	3	2	2	2	1	1	1	1	1	1	1
2/23/08	4	4	4	4	4	4	4	4	3	1	1	1	1	1	1	1	1	1
2/24/08	NO IMAGE	4	4	4	4	4	4	2	2	2	1	1	1	1	1	1	1	1
2/25/08	4	4	4	4	4	4	3	2	1	1	1	1	1	1	1	1	1	1
2/26/08	4	4	4	4	4	4	4	2	1	1	1	1	1	1	1	1	1	1
2/27/08	4	4	4	4	4	4	4	3	3	1	1	1	1	1	1	1	1	1
2/28/08	4	4	4	4	4	4	3	2	1	1	1	1	1	1	1	1	1	1
2/29/08	4	4	4	4	4	3	2	NO IMAGE	2	1	1	1	1	1	1	1	1	1
3/1/08	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	NO IMAGE	2	2	2	1	1	1	1	1	1	1
3/2/08	NO IMAGE	4	4	4	4	4	4	3	2	2	2	2	2	1	1	1	1	1
3/3/08	4	4	4	4	4	4	4	3	2	1	0	0	0	1	1	0	0	0
3/4/08	4	4 - BUFFALO	4	4	3	1	0	1	1	1	1	1	1	1	1	0	0	0
3/5/08	4	4	4	4	4	2	3	2	2	2	2	2	1	0	0	0	0	0
3/6/08	4	4 - BUFFALO	4	4	4	4	4	4	1	1	1	0	0	0	0	0	0	0
3/7/08	4	4	4	4	4	3	3	3	3	3	0	1	1	1	1	1	0	0
3/8/08	4	4	4	4	4	4	4	4	2	1	1	1	1	0	0	0	0	0
3/9/08	4	4	4	4	4	1	1	1	1	1	1	0	0	0	0	0	1	1
3/10/08	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
3/11/08	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3/12/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/13/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/14/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/15/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0