



*Florida Department of
Environmental Protection*

Practical Quality Control Training

National Air Monitoring Conference

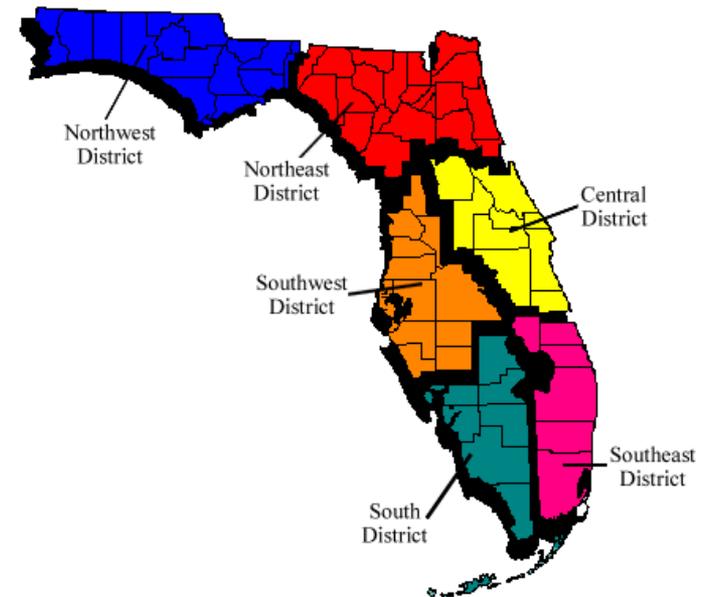
Nashville, TN

November 4, 2009



Purpose for Increased QC Training

- Florida has many agencies who supply air quality data
 - 6 state districts
 - 8 local programs
 - A few private contractors





Purpose for Increased QC Training



- In each agency there is someone responsible for the quality assurance/quality control of the data, the QA coordinator



Purpose for Increased QC Training

- Since many of the QA coordinators belong to the air monitoring AARP, they are retiring
- The average years experience for this group is over 20
- Often, there are not resources to allow cross-over training with their replacements





Purpose for Increased QC Training



- Without the cross over training, the new QA coordinator starts work without knowing what needs to be done starting on the first day
- Worse yet, they may start with a backlog of work



Purpose for Increased QC Training

- Results are often, disorganized system audits and potentially questionable data
- Particularly as the EPA has been changing the standards more frequently, and ambient data are being used more frequently for attainment determinations, we are trying to avoid not meeting the goal of legally defensible data





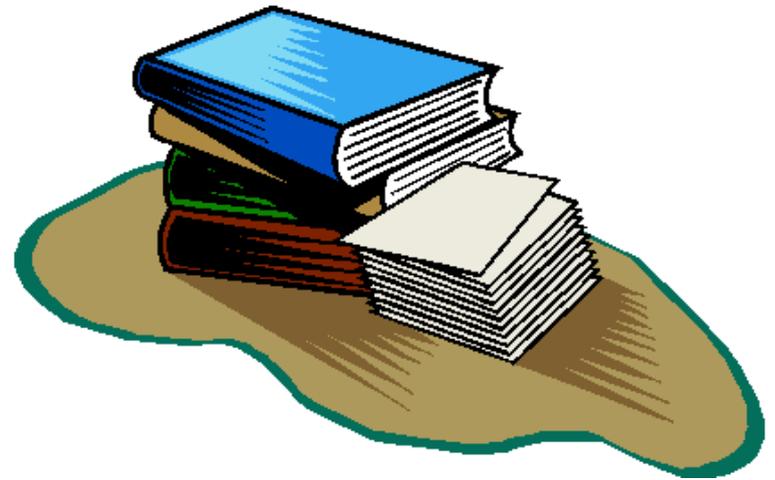
QA for Newbies

- My first attempt to address the shortfall was a document titled QA for Newbies
- It is a document that is short and highlights the activities for which the QA coordinator is responsible
- It was written with input from experienced QA coordinators and shared with all agencies in Florida and throughout the SE



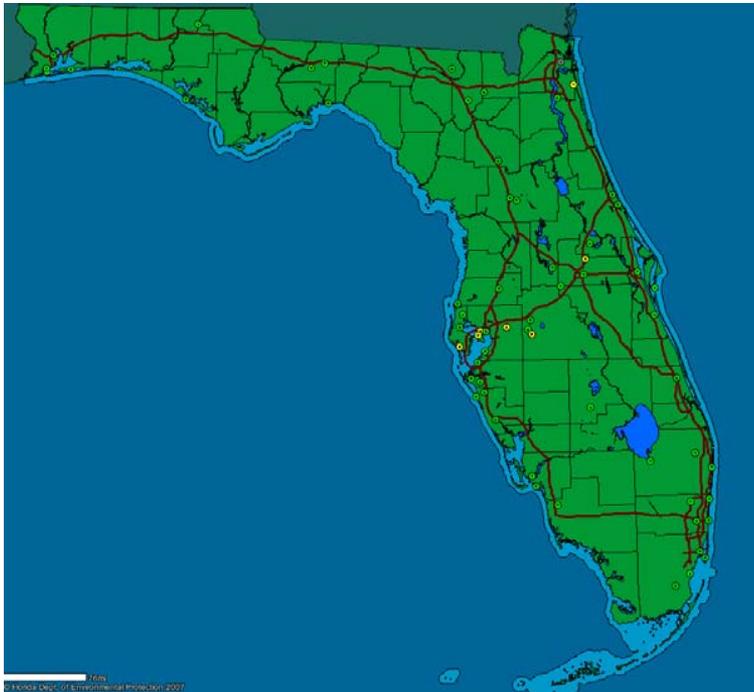
Format

- Introduction
- Daily Activities
- Weekly
- Monthly
- Quarterly
- Speciation
- Toxics
- Ongoing Work





Intention



- This booklet was primarily developed to assist the QA coordinators in Florida
- Some of the references are to Florida specific applications and practices



Thanks

- There are a few folks I would like to thank for their assistance in developing QA for Newbies:
- Melissa Smith, Hillsborough County
- Ken Colaw, Florida DEP
- Clay Wetherington, Florida DEP
- Mike Norcom, MS Air Division





Introduction

- In a time when many of the experienced air monitoring staff, those that grew-up with the science, are retiring, this document is intended to provide some quick assistance in quality activities. Every new Quality Assurance (QA) Coordinator is expected to read the Code of Federal Regulations (CFR) which apply to air monitoring, specifically 40 CFR Parts 50 and 58, the EPA Red Book, Volumes I and II, all standard Operating Procedures (SOPs), state regulations and Quality Assurance Project Plans (QAPPs) and other monitoring documentation. There is much to understand and digest to connect the requirements and activities. To help the new folks to get started, this document will cover some of the highlights of the work.
- *For general scientific inquiry, to show valid data, the results must be repeatable and legally defensible. To accomplish that, the data must be validated, i.e. shown to be complete and correct.*
- There are four important things to remember:
- The calibration equipment and gas standards, gases of known concentration, must be traceable to National Institute of Standards and Technology (NIST) and the traceability must be valid at the time of the calibrations, and this includes the standard reference photometer (SRP) certification for ozone. If you are calibrating for NO₂ with NO_x gas and do not account for the impurities, you will never get the right answer.



Introduction

- Precision, i.e. repeatability, must be demonstrated. Whenever you calibrate, you want repeatability. The precision check is also called a one-point quality control check.
- Accuracy, i.e. to measure how close you are to reality. The accuracy determination is based upon the calibration and the annual performance evaluation as defined in 40 CFR, Part 58, Appendix A, 3.2.2.
- According to the Red Book, the validation of the data is made on the basis of the zero and span checks. (In Precision, Bias and Accuracy, the “known” is the calibration standard being used in the checks, while the “measured” is the monitor’s response.)
- The Florida Air Monitoring and Assessment System (FAMAS) makes examination of data for concurrency very easy with the site comparison graphing. It would be helpful for QA coordinators to graph their data by pollutant to see any outliers that may need additional investigation. Keep in mind, there must be a defensible reason to invalidate data, not just that is “doesn’t fit”.



Daily Activities

- The summary print-out starts with the operator. It has the previous day's data for every parameter.
- The operator:
- Documents calibration and site activity and adds any invalid flagging, (including TEOM data for unstable readings with high noise or more than 6 hours of negative values).
- Annotates strip charts.
- Polls for any missing data as soon as possible.
- Files everything in the office.
- Works to discover problems by priority as indicated on the daily sheets.
- Polled data are reviewed daily and the following checks are recommended:
- Consistency and completeness
- Look for randomness – most pollution shows patterns
- Look for atypical data that is not flagged – investigate for cause through minute data, concurrency checks, calibration and site logs, use investigative tools (i.e. direct query of the instrument for status information), call the site directly for recent data and document results
- Flags
- Investigate and document any flags found on the data
- Specifications
- Verify that specifications for quality control are met, e.g. check internal trailer temperatures (i.e. 20 – 30 oC), verified with max/min thermometer, noise for TEOMs as diagnostic for problems, etc
- Calibration books are verified for data within specifications of nightly level one zero and span and bi-weekly (with concurrence check with one data logger where more than one is used).
- QA will then review and sign off on this documentation.
- Real-time data are corrected for erroneous data as soon as possible.





Weekly

- PM_{2.5} Field sheets are checked for completeness and quality assurance, (the data, dates and signatures).
- The QA coordinator signs off on them.
- Review for anything missed in the daily checks.
- Adjust Air Quality Index (AQI) and Clean Air Index Reporting (CLAIRE).



Monthly

- Monthly activities are due to be completed by the 30th of the month.
- Editing activities are conducted monthly.
- Invalidate anything that needs to be invalidated according to quality assurance documentation.
- Investigate any hours with more than 20 minutes missing.
- Recalculate any hours which were impacted by power failures, software errors, ramping, data not written to logger, etc.
- Best to validate someone else's work, i.e. double-check.
- Use monthly report to check against daily
- Load AQS data file
- Complete audit trail.
- Submit PM_{2.5} FRM F-files to the PM_{2.5} database.
- Check PM_{2.5} field sheets for the 10 parameters with data in the PM_{2.5} database and sign-off the sheets.
- Replace the collocated for designate when missing in the PM_{2.5} database





Monthly

- Make necessary changes in the PM_{2.5} database:
 - Concentration
 - Flow
 - Elapsed Time
 - Null codes
 - Qualifier flags
- Verify the AQS file – add validated flags or invalidate.
- Handle manual data when they are ready.
- Enter lead and PM₁₀ data from laboratory forms into the database.
- Print monthly report and compare to the laboratory report.
- The AQS file is created and submitted.
- Complete the monthly missing data form and e-mail.
- Missing data reports containing “voided by operator” and miscellaneous void null codes should require additional comments to be linked to the missing data report.
- Complete file comparison of submitted data.





Quarterly

- Quarterly activities are due to be completed by 50 days after the close of the quarter.
- Run verification utility
- Precision and Bias
 - Enter or compile precision and bias data
 - Submit AQS file



Speciation

- Website
 - save 4 or 5 files and use Speciation Data Validation Tool (SDVAT) to import
- Compare against field sheets:
 - dates
 - filters
 - flows
- Verify percentages of content
- Show all laboratory flags



Toxics

- Review field sheet review for:
 - Dates
 - Completeness
 - Anomalies to include problem resolution
 - Schedule observance



Ongoing Work

- Maintain and update SOPs
- Create an SOP for new equipment
 - a draft of the SOP should be submitted to DEP within 60 days of operating new equipment in the field
- Update the SOPs for changes in CFR and/or QAPP



Closing

- In all the work, keep in mind there are 5 measures in quality assurance:
- Comparability, being able to compare apples to apples, accomplished by using federal reference or equivalent equipment.
- Completeness, aiming for a minimum of 75% data completeness for most pollutants and 90% for ozone.
- Representativeness, accomplished by following the network design and siting guidelines in the CFR
- Precision, having repeatable results, accomplished through collocation, and precision level or one-point quality control checks. Bias, defined as the systemic or persistent distortion of a measurement in one direction is also determined through the precision level check.
- Accuracy, the closeness to reality, as determined by the degree of agreement between the observed value on the monitor and an acceptable reference value, determined through the use of traceable calibration gases and equipment
- Lastly, to try and keep straight the difference between quality assurance and quality control activities, remember that quality control activities are completed by the operator and quality assurance is the quality control of *the quality control.*





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QC Training for Data Handling

2009



Shelter Temperature

- Shelter Temperature should be between 20°C and 30°C, (+/- 2°C, so outside of 17.5 to 32.4°C)
- FAMAS will indicate in bright yellow temperatures out of specifications

FAMAS Daily Site Summary

Wednesday 6/11/2008

Hourly Foundation Averages with Flags

IINT deg C	O3PS ppb	PM25C_3 ug/m3
32.2	0	9.0
32.1	0	7.9
31.7	0	8.0
31.4	0	9.8
31.4	0	9.8
31.3	0	10.5
31.4	0	11.6
31.8	0	13.5
32.5	0	14.0
33.9	0	10.6
35.6	0	13.1
37.5	0	10.7
39.1	0	8.2
40.4	0	11.3
40.3	0	15.9
38.9	0	8.5
38.3	0	6.1
38.8	0	10.0
38.2	0	13.1
37.1	0	12.2
36.2	0	11.3
35.3	0	14.3
34.9	0 >C	10.0
34.8 >P	25 <P	8.5 >P
31.3	0	6.1
40.4	0	15.9
35.2	0	10.7
24	23	24





Data Completeness

Ambient Reading Counts

	O3	WDA	WSA	INT	O3PS	PM25C_3	FILT_3	NOISE_3	WDV	WSV
1 Minute Readings	*1336	*1336	*1336	*1336	*1336	*1336	*1336	*1336	*1336	*1336
5 Minute Readings	----	----	----	----	----	----	----	----	----	----
1 Hour Readings	24	24	24	24	24	24	24	24	24	24

* Reading count is less than expected. Verify that the site is not experiencing communication problems (click [here](#) to view the site's polling log) and that no power failures have occurred. If the site is functioning properly have an administrator check the FAMAS Executive logs for possible database related errors.

- FAMAS shows the data capture. If there are less than 24 hours or 1440 minutes, they are indicated in red. If there was not a power failure to account for the missing minutes, use FAMAS to poll the missing data.





Maintenance

Hourly Foundation Averages with Flags

PM10C_3 ug/m3	FILT_3 %	NOISE_3 hz
27.4	29.2	0.023
124.5	30.2	0.029
152.0	32.1	0.031
89.3	33.4	0.030
98.8	34.4	0.029
48.7	35.1	0.027
30.7	35.3	0.023
60.0	34.5	0.025
35.4	33.9	0.023
12.8	33.8	0.021
14.9	33.5	0.021
40.9	33.5	0.026
27.1 <B	20.5 <B	0.009 <B
-40.9 <B	0.4 <B	0.004 <B
-65.8 <B	0.9 <B	0.008 <B
*-62.1	0.9	0.008
*-63.7	0.8	0.008
*-62.2	0.9	0.008
*-64.3	0.9	0.008
*-64.2	0.9	0.008
*-63.0	0.9	0.008
*-63.8	0.9	0.008
*-62.9	0.9	0.008
*-62.4	0.8	0.008
-64.3	0.8	0.008
152.0	35.3	0.031
7.9	19.4	0.018
21	21	21

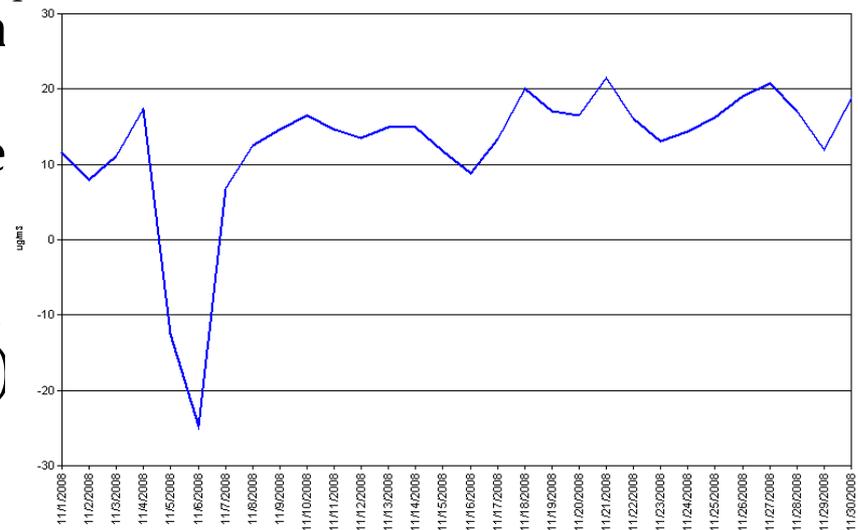
- Here, the TEOM was having trouble. If the data logger channel had been left in maintenance, no additional data handling would be required. Since PM₁₀ values more negative than 50, (-10 for PM_{2.5}), are not accepted by AQS, they must be changed. Since a negative 24 hour value is not valid, it must be made null. Noting the nature of the failure in the comments, is a good practice.





Continuous Particulate

- Individual hours of PM are allowed to be negative, up to $-50 \mu\text{g}/\text{m}^3$ for PM_{10} . A 24 hour average must be positive or the day is invalid
- Any day with more than hours of negatives, (25%) should be examined for cause.
- Fires are known to create many hours of negative values.





TEOM Noise

- A noise level of 0.1 hz or higher has been identified by the manufacturer as a level that requires attention
- FAMAS highlights these values in yellow
- This level does not automatically require that data be void
- Smoke commonly creates a noisy response
- Elevated noise may indicate a filter that is not well seated

NOISE_3

hz

0.074
0.077
0.082
0.085
0.081
0.073
0.086
0.097
0.104
0.091
0.107
0.101
0.110
0.100
0.103
0.104
0.096
0.094
0.088
0.080
0.081
0.089
0.084
0.086

0.073
0.110
0.091





Calibration

Hourly Foundation Averages with Flags													
Hour	SDD	WDA	WSA	WFT	PHYSIC_3		PHYSIC_2		PHYSIC	PK_170	NCS214	NDV	WST
					deg	mph	deg C	mph					
0	1	202	13.0	26.1	7.1	48.9	0.006	16.7	38.9	0.045	252	12.6	
1	1	206	13.2	26.2	7.1	49.0	0.007	16.8	39.0	0.045	253	12.4	
2	1	249	14.0	26.2	7.5	49.7	0.040	16.1	39.1	0.039	249	12.3	
3	1	244	16.7	26.1	8.1	49.2	0.038	17.2	38.2	0.038	244	16.2	
4	1	248	16.8	26.1	8.5	49.2	0.032	17.6	38.2	0.042	248	16.2	
5	1	257	14.7	25.8	8.1	49.3	0.038	16.8	38.4	0.040	251	13.9	
6	1	253	14.8	25.8	8.5	49.2	0.032	16.7	38.4	0.040	253	14.3	
7	1	251	15.5	25.8	8.2	49.3	0.038	17.8	38.3	0.040	251	14.9	
8	1	262	16.9	26.4	10.0	49.0	0.036	20.2	38.1	0.037	262	16.5	
9	1	238	16.7	26.3	11.5	48.8	0.023	24.7	38.7	0.038	238	16.5	
10	1-C	287	17.7	24.9	12.1-10	48.9	0.021	27.2	34.0	0.038	287	16.6	
11	1	274	16.0	26.1	12.1	48.9	0.028	26.7	38.7	0.032	274	16.4	
12	1	29	41.9	26.4	12.1	34.9	0.030	26.7	38.7	0.038	29	31.8	
13	1	374	42.8	26.4	-1.5	37.8	0.027	42.2	26.9	0.036	374	36.8	
14	1	15	29.4	26.3	8.7	37.8	0.028	18.0	27.4	0.034	6	24.9	
15	1	335	14.1	26.4	2.7	37.8	0.030	16.9	27.6	0.032	335	11.2	
16	1	305	13.8	26.3	5.8	37.8	0.028	8.9	27.6	0.037	301	11.7	
17	1	264	13.0	26.4	2.4	38.0	0.030	9.0	27.6	0.036	265	11.2	
18	1	302	11.9	26.4	-1.8	38.2	0.028	4.9	28.1	0.040	303	10.4	
19	2	296	12.0	26.9	3.9	38.7	0.027	6.8	28.4	0.036	296	10.5	
20	1	286	11.3	26.9	3.8	38.7	0.028	9.8	28.8	0.038	286	9.8	
21	2-C	287	11.2	26.9	1.1	38.9	0.026	5.9	28.9	0.038	288	10.3	
22	1-C	288	11.6	26.9	3.8	39.2	0.028	8.8	29.2	0.038	289	10.5	
23	1	114	11.4	26.8	4.4	39.1	0.031	9.4	28.9	0.038	117	10.4	
24	1	15	11.2	24.9	20.1	28.7	0.027	21.7	14.0	0.038	6	9.9	
25	1	304	14.0	26.5	12.8	48.4	0.029	21.6	38.4	0.032	304	16.6	
Average	1		18.2	26.0	4.7	42.8	0.041	4.8	31.8	0.037		18.2	
Valid Hours	22	24	24	24	23	24	24	23	24	24	24	24	24

Invalid or invalid hour Invalid hourly average is outside of the EPA's acceptable margin range

Flag Legend:
 C - Low Flow Warning
 W - Wind Warning
 H - Humidity Error
 L - Low Water Alarm
 V - Vertical Flag
 F - Floor Sensor

Data Logger Flag Descriptions:
 D - Disabled
 W - Watchdog Error
 A - Alarm
 L - Low Water
 P - Power Supply Error

Calibration Results:

Parameter	Sequence	Phase	Start Time	End Time	Indicated Value	Theoretical	% Error	Flag
SDD	SDD_A_A	DRD	21:41:00	21:53:00	1.024	0	102.4%	
SDD	SDD_A_A	DRD	21:41:00	22:14:00	886.972	800	110.87%	
SDD	SDD_ZSP_A	DRD	18:53:24	11:25:41	0.964	0	96.4%	
SDD	SDD_ZSP_A	DRD	18:53:24	12:11:41	886.190	800	110.76%	
SDD	SDD_ZSP_A	PHC	18:53:24	12:28:14	14.210	0	1421.0%	

- When a manual calibration is completed and the nightlies drop to warning levels, corrective action must be taken





Calibration History

The calibration history shows the instrument stayed well away from the target values (about mid-month)





Troubleshooting

FAMAS Daily Site Summary - Windows Internet Explorer

http://10.10.10.10:8080/.../reports/06/06SiteSummary.asp

16	17	18	19	20	21	22	23	24
41	81	26.4	26.1	0	02	26.9		
37	81	48.9	26.2	0	02	48.9		
29	82	53.2	26.9	0	03	53.9		
22	82	52.6	26.7	0	02	52.6		
21	82	53.1	26.9	0	02	52.9		
21	82	52.6	26.3	0	02	52.7		
21	HC	53.1	26.3	0	HC	52.9		
22	HC	53.1	26.3	0	HC	52.9		
Max	20	89	22.9	0	81	21.4		
Min	41	82	52.7	0	82	53.4		
Average	38	82	47.4	20.9	0	47.9		
Compliance								
Valid Hours	24	24	24	24	24	24		

Indicates an invalid hour. Indicates the hourly average is outside of the EPA's acceptable normal limits.

Site Upper Flag Descriptors

<input type="checkbox"/> - Power Fail	<input type="checkbox"/> - Disabled	<input type="checkbox"/> - Data Control	<input type="checkbox"/> - Slave Off-Line
<input type="checkbox"/> - Bad Status	<input type="checkbox"/> - Calibration	<input type="checkbox"/> - Maintenance	<input type="checkbox"/> - Analog Overrange
<input type="checkbox"/> - Address Error	<input type="checkbox"/> - Alarm	<input type="checkbox"/> - Alarm Change	<input type="checkbox"/> - Analog Alarm
<input type="checkbox"/> - Low-Low Alarm	<input type="checkbox"/> - High Alarm	<input type="checkbox"/> - Low Alarm	<input type="checkbox"/> - Low Rate of Change
<input type="checkbox"/> - High Alarm	<input type="checkbox"/> - Low Rate of Change	<input type="checkbox"/> - High Rate of Change	<input type="checkbox"/> - Low Rate of Change
<input type="checkbox"/> - Power Switched	<input type="checkbox"/> - Data Switched	<input type="checkbox"/> - Failed Setting Limit	<input type="checkbox"/> - 0.0 M Dia

Calibration Results

Parameter	Sequence	Phase	Start Time	End Time	Indicated Value	Theoretical	Drift %	Flag
03	03_P_A	ZNO	22:41:00	22:51:00	0.186	0		
03	03_P_A	SPH	22:41:00	22:51:00	431.270	425	1.48%	
03	03_P_A	REC	22:00:00	23:18:00	28.534	75	-61.96%	
03PS	03_P_A	ZNO	22:41:00	22:51:00	0.307	0		
03PS	03_P_A	SPH	22:41:00	22:51:00	426.506	425	0.36%	
03PS	03_P_A	REC	22:00:00	23:18:00	0.338	75	-99.55%	

- If the PS span is zero and the analyzer precision is at the same level as the ambient concentration, (about 27 ppb), it indicates a likely problem with the PS

Indicated Value	Theoretical	Drift %
0.186	0	
431.270	425	1.48%
28.534	75	-61.96%
0.307	0	
426.509	425	0.36%
0.338	75	-99.55%





PS Operation

- Generally, the PS is expected to be quiet, reading 0. When the values skyrocket, find the problem and take action.

Hourly Foundation Averages with Flags

O3 ppb	WDA deg	WSA mph	INT deg C	O3PS ppb
19	27	3.1	22.7	0
13	68	2.4	22.5	0
11	38	2.9	22.3	0
13	30	3.3	22.4	0
13	83	3.2	22.6	0
10	34	3.0	22.5	0
7	76	2.4	22.3	0
6	188	3.7	22.5	0
12	198	5.9	22.6	0
89 <C	276	5.4	23.3	84 <C
16 >C	306	5.3	24.3	0 >C
17	313	6.5	24.4	0
16	325	8.7	24.4	0
11	314	8.1	24.2	0
9	305	8.0	24.1	0
300	309	12.0	23.7	300 >O
416	312	11.1	23.2	426
416	318	8.9	22.6	426
416	319	10.4	22.5	426
417	316	11.8	22.3	426
417	326	9.3	22.4	426
417	347	10.0	22.3	426
417 >C	5	19.3	22.1	426 >C
416 >C	340	19.8	22.3	426 >C
—	—	—	—	—
6	5	2.4	22.1	0
417	347	19.8	24.4	426
165	—	7.7	22.9	161
23	24	24	24	23





More Troubleshooting

- Look for high concentrations and understand their genesis. In this case, the calibration gas was included, by malfunction, in the ambient reading.

Hour	O3 ppb	WDA deg	WSA mph	INT deg C	O3PS ppb
0	34	333	12.2	23.7	0
1	34	332	13.7	23.4	0
2	33	332	12.9	23.2	0
3	31	332	12.9	22.9	0
4	29	332	10.6	22.6	0
5	33	331	12.7	22.4	0
6	33	332	12.5	22.4	0
7	31	332	13.6	22.5	0
8	34	331	16.2	23.7	0
9	38	331	17.8	25.5	0
10	41	330	19.5	25.5	3
11	98 <C	332	18.1	25.6	-3 <C
12	85 >C	331	19.3	25.6	29 >C
13	44	329	20.7	25.6	0





High Concentrations

PM25C
ug/m3
77.9
84.1
87.8
85.2
92.2
100.1
100.0
99.3
103.7
37.7
19.4
21.1
25.5
21.5
16.8
18.3
21.8
24.0
16.0
19.6
21.1
27.4
23.9
21.9
—
16.0
103.7
48.6

24

- In this case, the high concentrations of PM_{2.5} were from fires in Georgia.
- This day was a run day for the FRM, so keep in mind that two exceedance reports should be completed.
- Comments should be added to these data in FAMAS detailing the fires.



High Concentrations

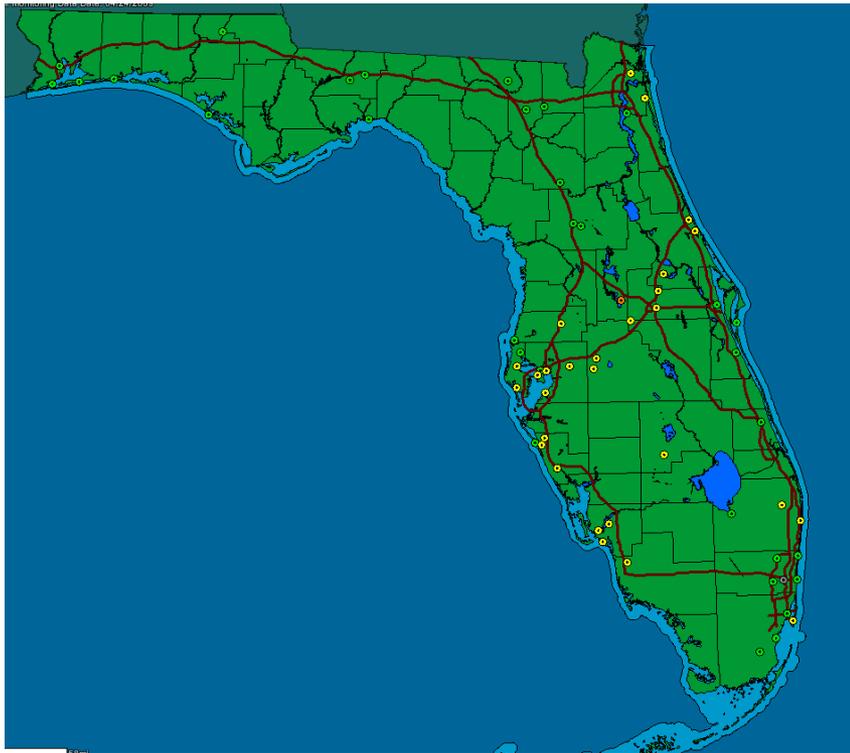
- For ozone, if the hourly values are over the standard, 75 ppb, then look at another report to determine if the highest eight-hours exceeded the standard. SAQS and the rolling average report will both work.

Hour	O3 ppb
0	46
1	43
2	41
3	42
4	35
5	30
6	26
7	30
8	34
9	49
10	65
11	69
12	74
13	85
14	87
15	81
16	76
17	71
18	63
19	57
20	54
21	50
22	47 >C
23	42 >C
<hr/>	
Min	26
Max	87
Average	54
Cumulative	
Valid Hours	24





Finding the Daily 8-hour Max

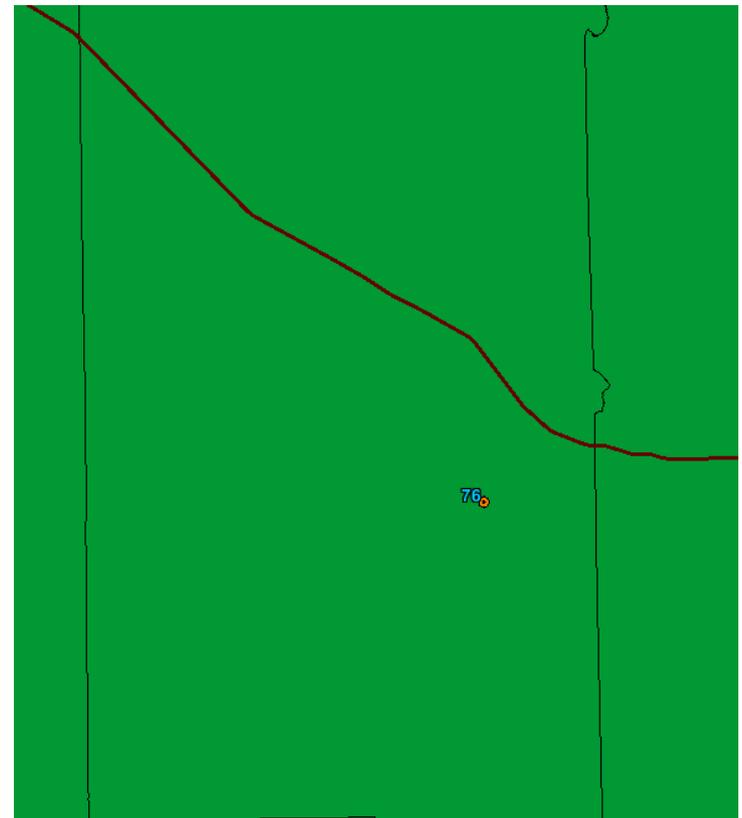


- SAQS is easy, since it will color the site markers in the color of the AQI
- If you want to see the level of the concentration, you can plot it on the map.



Zoom in to Read

- The values that are displayed in SAQS may be small.
- If they are difficult to read, zoom into the area
 - With the zoom or
 - Select your county





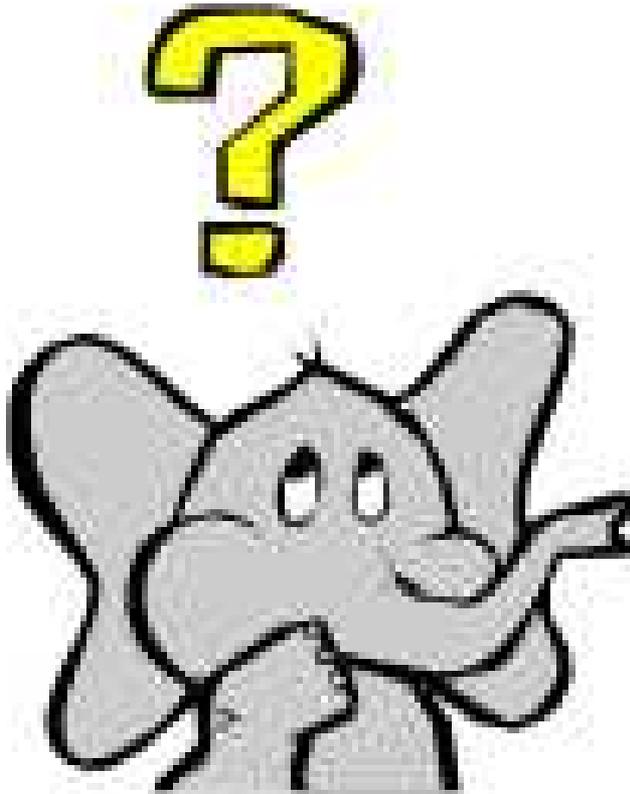
Exceedance Report for Ozone

- For ozone only, make comments in FAMAS acknowledging the valid exceedance,
- Record the value of the exceedance on the eight hours of max concentration used for the calculations





Comments or Questions



- Tammy Eagan
- 850/921-9567
- SC 291-9567
- e-mail:
Tammy.Eagan@dep.state.fl.us