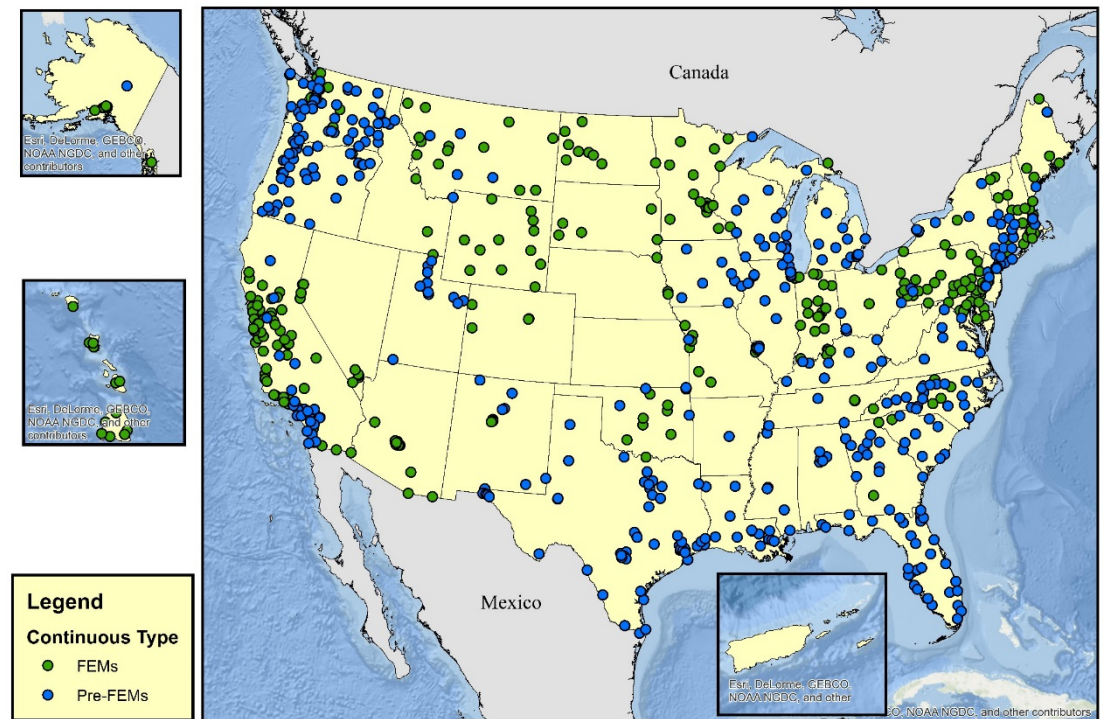


PM_{2.5} Continuous Monitoring Network and Method update with focus on data quality

National Ambient
Air Monitoring
Conference
St. Louis 2016

PM_{2.5} Continuous Monitors



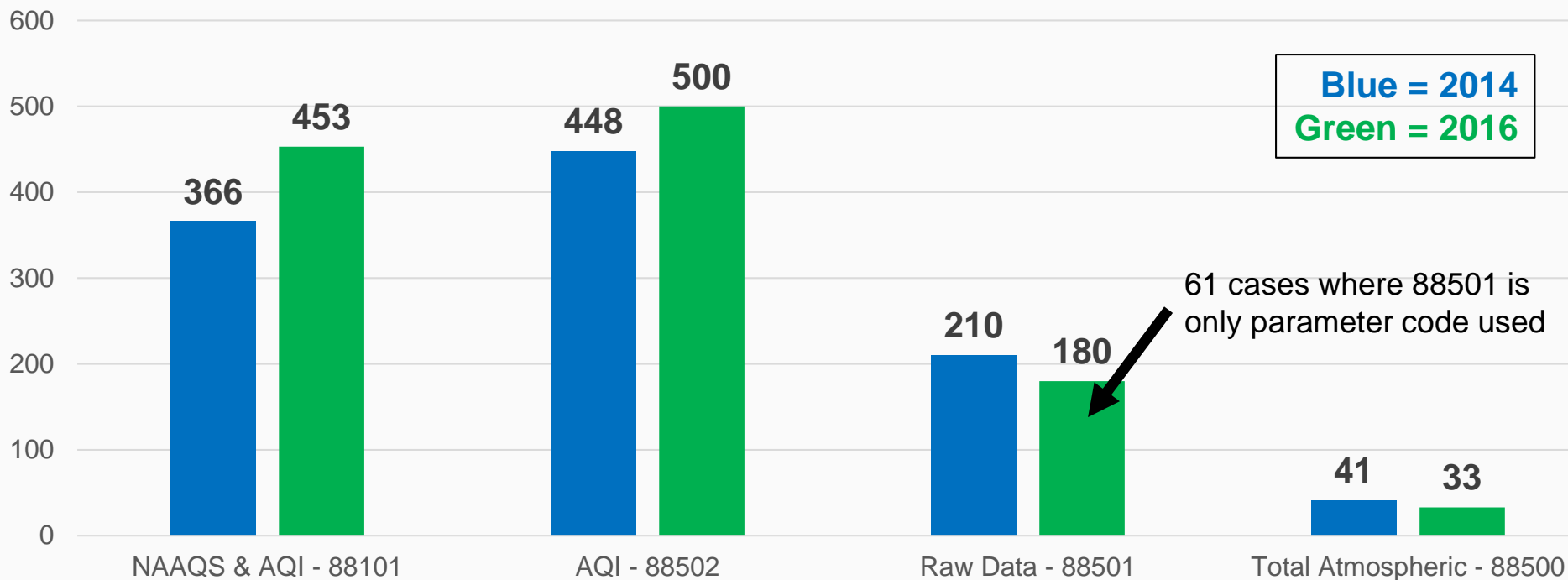


Summary

- Network and method update
- Actionable recommendations from Atlanta conference that should improve FRM to continuous FEM data comparability:
 - Utilize VSCCs on FRMs
 - Ensure data below zero is reported if in the noise of the instrument, where appropriate
- Additional items we are following up on:
 - Availability of instrument specific Auditor Checklists
 - Training opportunities
 - Development of FRM data quality visual Assessment

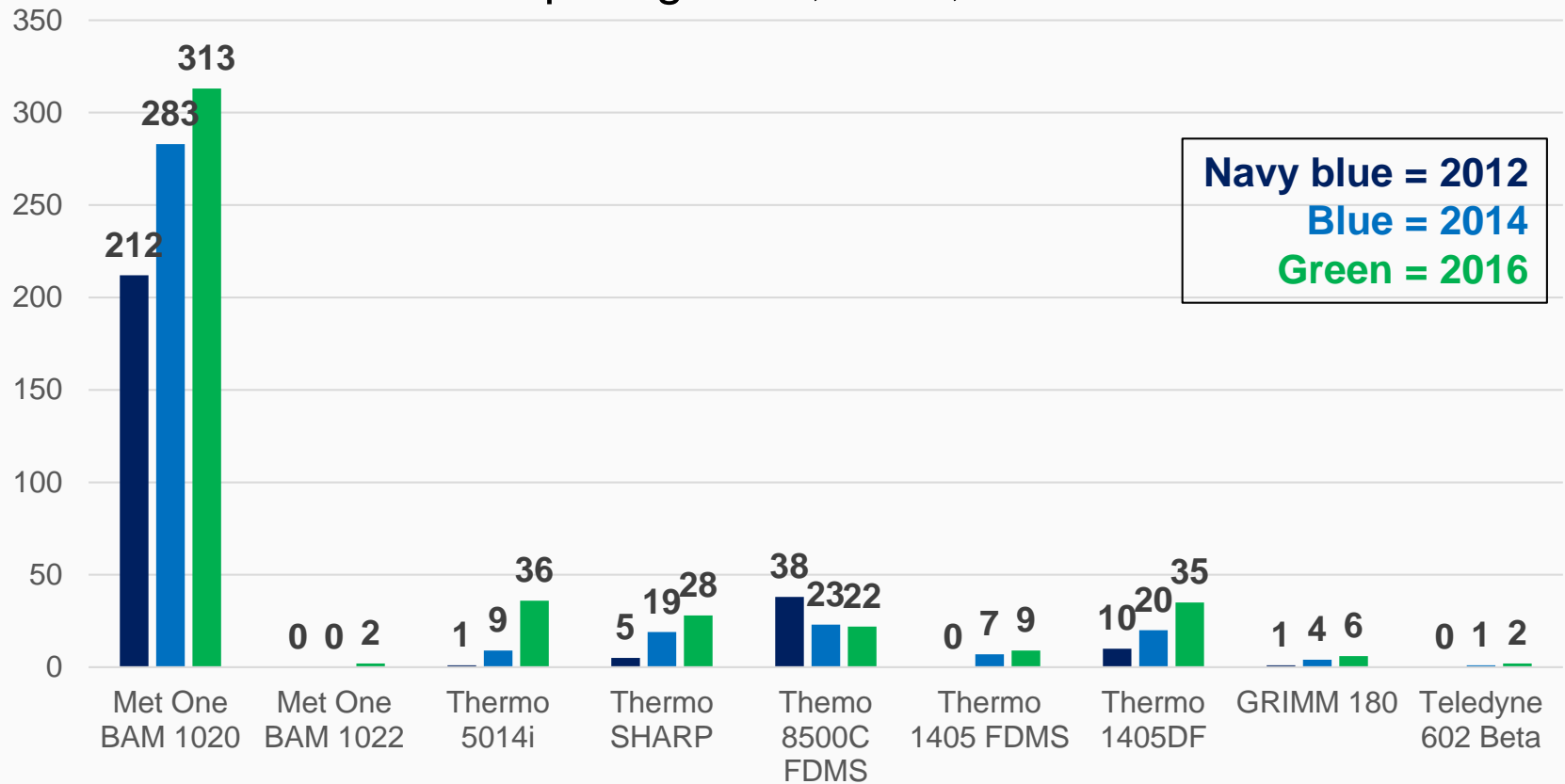


Number of PM_{2.5} Continuous Monitors Reporting to AQS by Parameter Code (comparing 2014 to 2016)





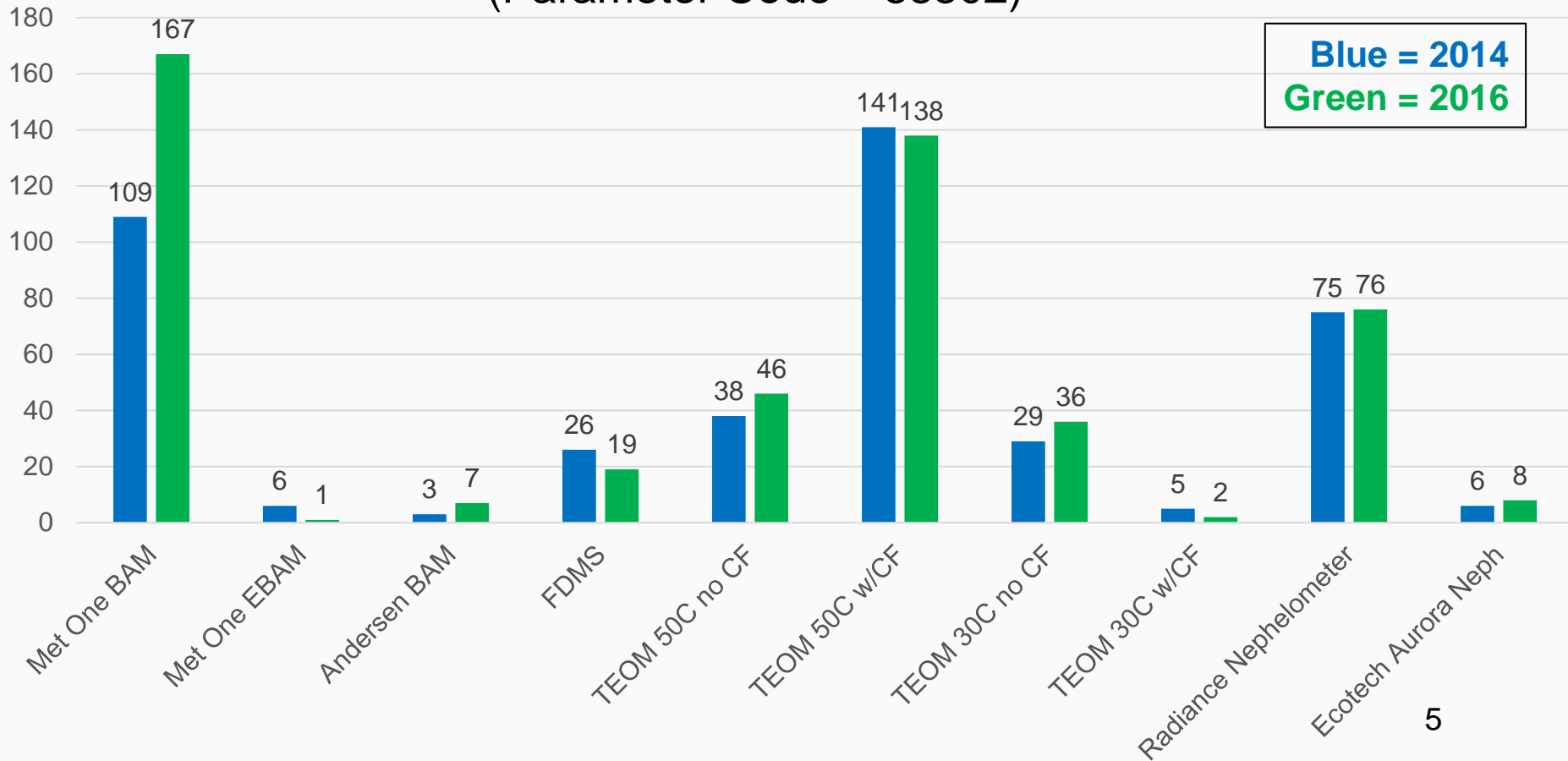
PM_{2.5} Continuous Methods Reporting to AQS for NAAQS and AQI; Parameter Code = 88101) Comparing 2012, 2014, and 2016.





PM_{2.5} Continuous Methods Reporting to AQS for AQI

(Parameter Code = 88502)

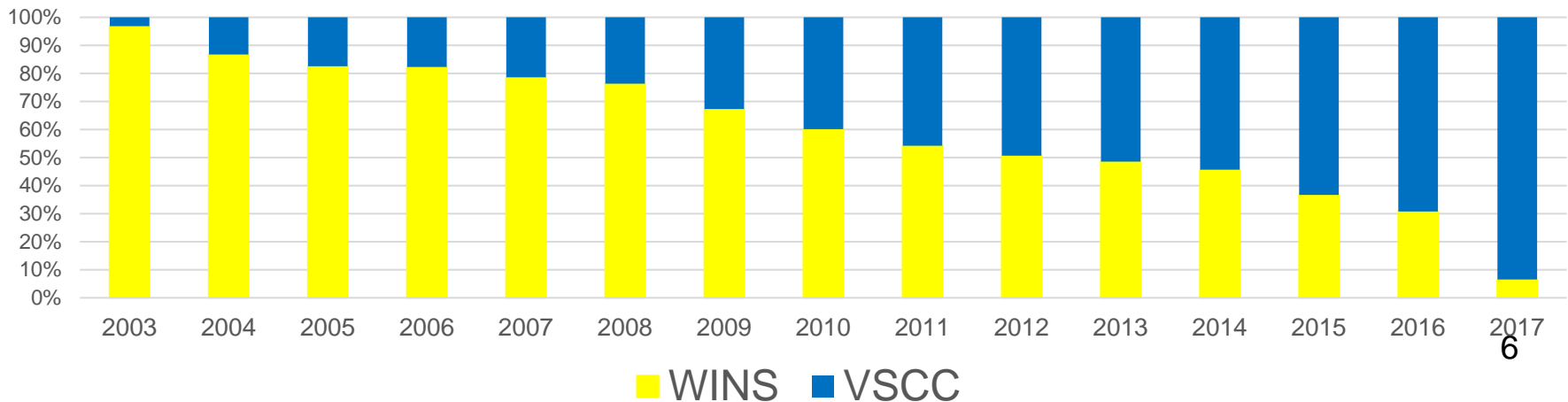


Migration to VSCCs for second stage separation on FRMs

- At Atlanta Conference we recommended utilizing VSCCs on FRMs.
 - WINS and VSCC are statistically the same when both are clean.
 - VSCC maintains a consistent cut-point over a longer period of time
 - VSCC requires less maintenance than a WINS
- Sensitivity test indicated that an FRM with a VSCC will read ~2% closer to a continuous FEM than an FRM with a WINS
- To expedite migration to VSCCs, EPA issued a national contract with for State, local and tribal agencies to receive VSCC's for their FRMs
- 64 cases where an FRM is still running a WINS and the agency has not received or requested a VSCC



Migration of PM_{2.5} FRM Network from WINS to VSCC





Reporting of slightly negative hourly data?

From Atlanta Conference:

- How to handle negative numbers?
 - Of course the atmosphere cannot have a negative amount of PM in it.
 - The regulation does not address negative numbers.
 - EPA has had a long standing convention of allowing negative data into AQS
 - If the atmosphere is very clean (approaching $0 \mu\text{g}/\text{m}^3$) and there is noise in the measurement, then a negative number may in fact be valid.
 - Invalidating data or correcting to 0 would lead to biasing data higher
 - How much is too negative?
 - Reference instrument manual, if addressed (e.g., Met One BAM allows up to $-15 \mu\text{g}/\text{m}^3$)
- Databases:
 - **AQS** - generally allows negative data for $\text{PM}_{2.5}$ continuous monitors up to a $-10 \mu\text{g}/\text{m}^3$
 - **AIRNow** – default flag of data less than $-4.99 \mu\text{g}/\text{m}^3$
- Valid negative numbers should be carried and included in reporting to data bases; however, public reports of data should not include negative numbers

Summary of Methods and Negative Data Submitted to AQS in 2013 and 2015
(Percent of monitors reporting with at least some negative data:
2013 = 73%; 2015 = 91%)

Method	Year	Total Number of Monitors Reporting	Number of Monitors Reporting with at least one Negative Hour	Percent of monitors reporting negative numbers	Total number of Hours Reported	Lowest Hourly data point Submitted	Highest Hourly data point Submitted
Met One BAM 1020	2013	258	194	75	1,948,125,	-10	593
	2015	293	273	93	2,219,974	-10	985
Met One BAM 1022	2015	2	2	100	1,280	-4	34
Thermo 5014i	2013	9	8	89	61,012	-10	131.3
	2015	23	21	91	158,371	-10	299.8
Thermo SHARP	2013	17	13	76	107,195	-7.5	320
	2015	23	11	48	162,792	-6.8	616.5
Thermo 8500C FDMS	2013	25	9	36	190,396	-9.5	914
	2015	24	21	88	177,211	-16.7	512.2
Thermo 1405DF	2013	22	21	95	144,941	-10	787
	2015	29	29	100	225,041	-10	297
Thermo 1405 FDMS	2013	5	1	20	29,594	-7.5	157.7
	2015	9	9	100	50,627	-10	164.4
GRIMM 180	2013	2	0	0	12,976	0	130.9
	2015	6	0	0	38,872	0.2	90.4
Teledyne 602 Beta	2013	1	1	100	1,747	-6.9	37
	2015	1	1	100	8,277	-9.9	49.8



Availability of PM continuous Technical System Audit (TSA) Checklists

- We have developed two TSA Checklists that cover the most widely used PM continuous methods

- Met One BAM
- Thermo TEOM and TEOM-FDMS

- Checklists cover four broad areas of operation

- Monitor
- Firmware and data logger
- Inlet and separator
- Maintenance and QC records

- Checklists will be/are available on AMTIC at:

<https://www3.epa.gov/ttn/amtic/contmont.html>

Met One BAM 1020

2. On-site Technical Systems Audit of Met One BAM 1020

Conducting the on-site audit of the Met One BAM 1020 involves evaluating several aspects of the set-up, operation, maintenance, and reporting of the monitor. For this checklist we have grouped the questions into four areas:

- Items to review at the monitor
- Items to review in the firmware and data logger
- Items to review at the inlet
- Maintenance and QC records to review

This checklist can be applied to either pre-FEM or FEM Met One BAM 1020 monitors. Pre-FEM Met One BAM 1020 monitors will be set up and operated nearly identical to an FEM, except that they may use a Sharp Cut Cyclone (SCC) rather than a VISC and that the version of firmware may be prior to version 3.2.A. There may be other engineering differences between a pre-FEM and FEM Met One BAM 1020; however, these will likely be unremediable to the user or auditor. To the extent that any differences exist, it does not necessarily mean that the pre-FEM version is not being run appropriately.

Typical Met One BAM 1020 Set-up:

Note: Dimensions are typical and not necessarily part of a requirement.

Table 2 – Audit Questions for the Met One BAM 1020 PM₁₀ Continuous Monitor:

Question #	Item	Response	Comments
Items to review of the Monitor:			
1	Confirm the make and model of the PM ₁₀ continuous monitor?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
2	Does this make and model match what is identified in the annual plan and reported to AQIS?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3	If expected, is there an FEM sticker on the PM ₁₀ continuous Monitor?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Aeromet Evaporator Method: EQPM-0200-170
4	Are there any concerns about the location of the monitor inside the shelter?	<input type="checkbox"/> Yes <input type="checkbox"/> No	This is largely professional judgement. Items of concern might include: substantial vibration where monitor is set-up; AC blowing directly on down tube; or poor access to monitor.
5	Is the latest SCF and instrument manual for the PM ₁₀ continuous monitor available at the station?	<input type="checkbox"/> Yes <input type="checkbox"/> No	The latest instrument manual version is Revision K.
6	Is the SDP current? Identify approval date.	<input type="checkbox"/> Yes <input type="checkbox"/> No	If practicable, look for approval before trip.
7	How far is the sampling pump placed away from the BAM? Is the pump isolated so as to minimize vibration to the monitor?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Distance between the BAM and pump will help to minimize vibration. If they have isolated down tube grounding, rubber mat will help.
8	Is the chassis of the monitor ground to an earth ground? How is this grounded?	<input type="checkbox"/> Yes <input type="checkbox"/> No	This is in addition to the ground associated with the electrical cord. Grounding of the pump is also recommended. Photo at right illustrates green/yellow ground line leading from back of chassis.
9	Is the inlet down tube grounded with two set screws at the necking collar of the monitor?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Ask operator if they have tested down tube grounding. While not required, this can be confirmed by testing continuity between the down tube and monitor chassis; however, a small

Thermo TEOM and TEOM-FDMS

NO2/0013 – Working Draft

Table 1 - Summary of TEOM Makes and Models:

Model Number	Key Feature(s) of Monitor	Illustration	Firmware	PM ₁₀ Designation	PM _{2.5} Designation	PM _{10/2.5} Designation
TEOM 1403a or 1403b	Original TEOM electronics and measurement are in separate units.		Not identified as part of designation (date is 3.03B)	NA	EQPM-1000-079	NA
TEOM 1403	Updated version of TEOM (with fast FDMS), one unit for electronics and measurement.		3.2C or later (date is 3.3)	NA	NA	NA
TEOM 1403a with Series 9000-1945	Original TEOM with FDMS unit on top of monitor. Measurement and electronics are separate.		3.2C or later (date is 3.3)	EQPM-0600-183	NA	NA
TEOM FDMS 1403-F	Latest model TEOM with one channel that is an all-in-one unit (electronics, monitor, and FDMS).		3.30 or later (date is 3.71)	NA	NA	NA
TEOM FDMS 1403-LF	Latest model TEOM that is an all-in-one unit set up with a virtual impactor. Two TEOM channels in one unit each measure PM allowing reporting of PM ₁₀ , PM _{2.5} , and PM _{10/2.5} .		3.50 or later (date is 3.71)	EQPM-0600-182	EQPM-1010-008	EQPM-1010-207

Note: the last three numbers of the method designation is the method code used in AQIS.

Question #	Item	Response	Comments
		<input type="checkbox"/> Air <input type="checkbox"/> C <input type="checkbox"/> CAP <input type="checkbox"/> N	4. Main O ₂ 3.00 is expected. 5. Auxiliary O ₂ 33.67 is expected.
14	If appropriate, have monitoring agency staff person open TEOM Filter. Inspect area: are there any issues?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
15	Are there spare TEOM filters equilibrating, but not in use in the filter area?	<input type="checkbox"/> Yes <input type="checkbox"/> No	 The two filters on the top side of the picture on the left are the active TEOM filters for a 1403-LF; the two filters on the bottom are TEOM filters that are equilibrating and are therefore not in use yet. On an older TEOM unit, up to two spares may be placed next to the active filter, which is centered in the TEOM housing.
16	Is one or more TEOM exchange tools available to change-out TEOM filters?	<input type="checkbox"/> Yes <input type="checkbox"/> No	While a maximum of one filter exchange tool is expected having two will allow using one to take off the exposed filter and one to install the new TEOM filter. The two TEOM exchange tools should each be identified so that the new TEOM filters are only handled with the appropriate exchange tool.
17	FDMS UNITS ONLY: If appropriate, have monitoring agency staff person open the FDMS unit purge filter(s) cassettes and inspect: are there any issues? - PM _{10/2.5} units have one purge filter. - PM ₁₀ units have two purge filters.	<input type="checkbox"/> Yes <input type="checkbox"/> No	

Training Opportunities

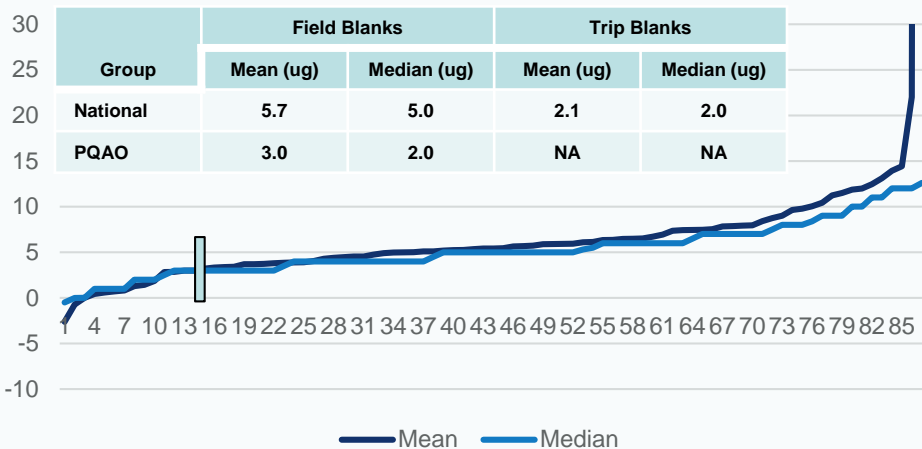
- We have invited instrument companies to provide hands on training at EPA Regional Offices
 - Many Regions have invited monitoring agencies to join them.
 - Goal is to get staff, managers, and auditors up to speed on the right things to look for to ensure methods are running appropriately.
- We have asked to have the applicable PM_{2.5} continuous monitoring Technical System Audit (TSA) Checklist covered as part of the training.
- What steps could we (or others) take to ensure training is available to those who need it?



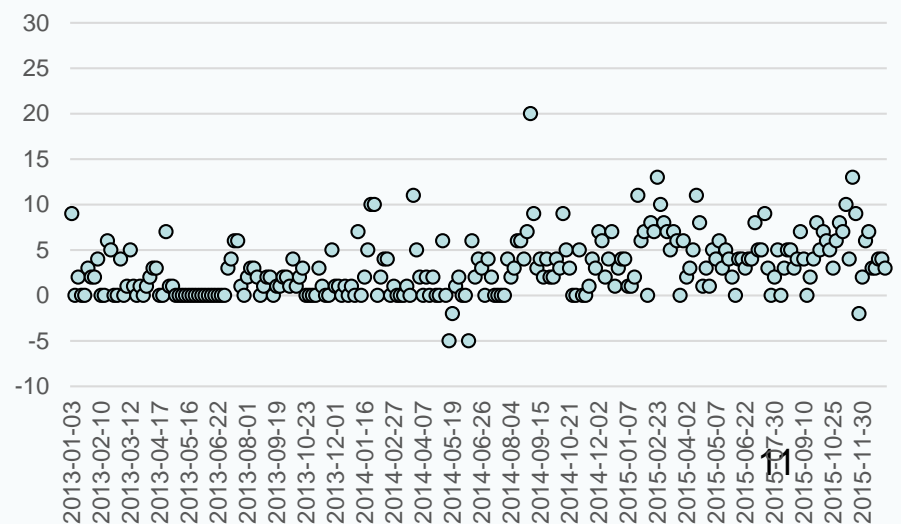
We are developing an automated PM_{2.5} FRM Visual Assessment

- In order to know if we are getting good PM_{2.5} continuous monitoring data we need to know if we are getting good FRM data.
- Similar to the PM_{2.5} continuous monitoring one page assessment, we are developing a one-page visual assessment of a PQA's PM_{2.5} FRM data quality
- Will include up to 3 years of data for four indicators of PM_{2.5} data quality:
 - Collocated precision
 - Bias via Performance Evaluation Program
 - Flow Rate Audits/Verifications
 - **Field Blanks**

Field Blank Summary by PQA
2013 - 2015



Field Blank Time Series within PQA
2013 - 2015





PM_{2.5} FRM Visual Assessment

- Development is underway
- Working with STI on this project

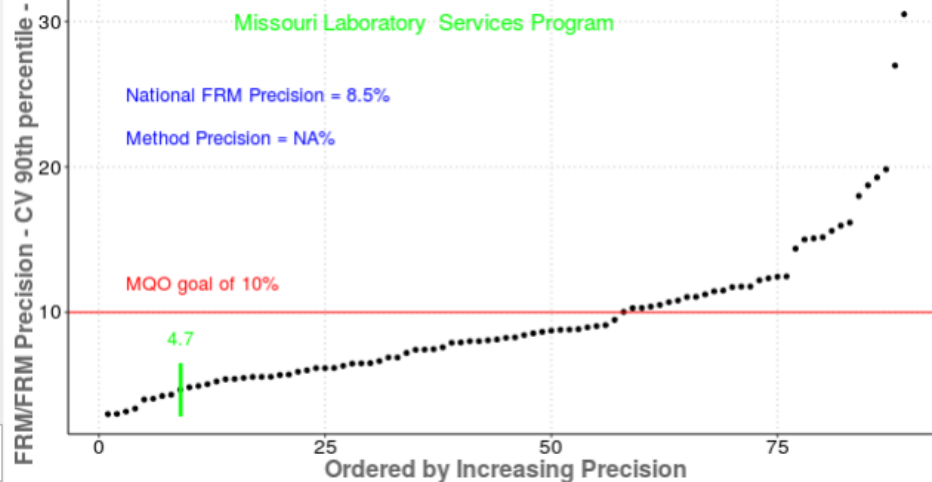
PM_{2.5} Data Quality Assessment

Choose a PQAO

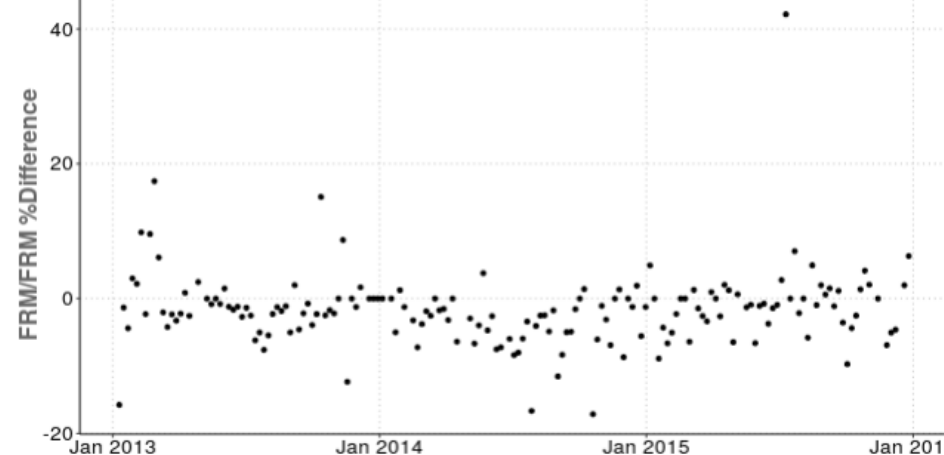
Missouri Laboratory Services Program ▼

Select a Method

FRM/FRM Precision: PQAO compared to all other PQAO's



Time Series of Precision in PQAO



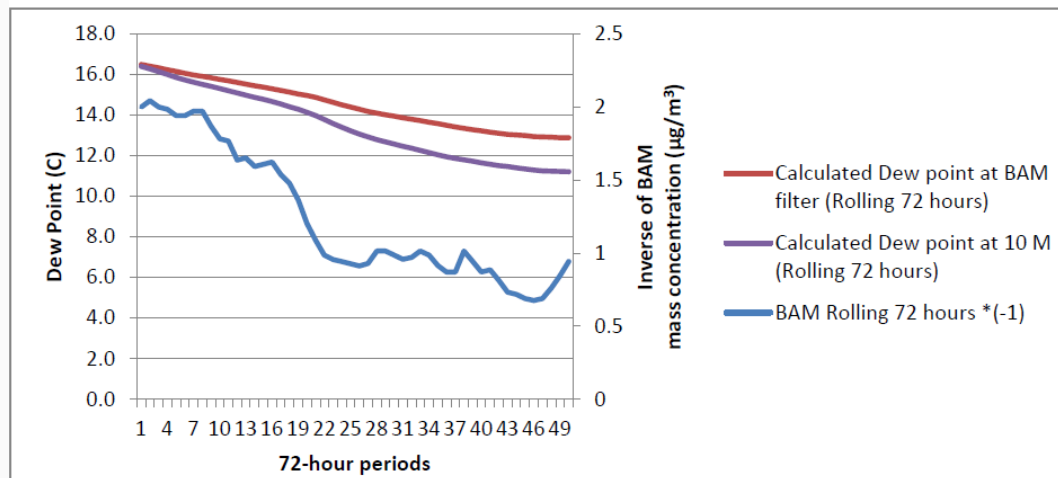


Method Specific Topic

Met One BAM Zero Test

- After Denver Conference, several agencies shared their zero test data (IN, MD, NC, NH, Albuquerque NM, BAAQMD, Cherokee, Hamilton County OH)
- A relationship between ambient dew point and the zero test results of the Met One BAM was identified at most, but not all sites

Met One BAM zero data in RTP, NC from September 7th to 12th, 2012

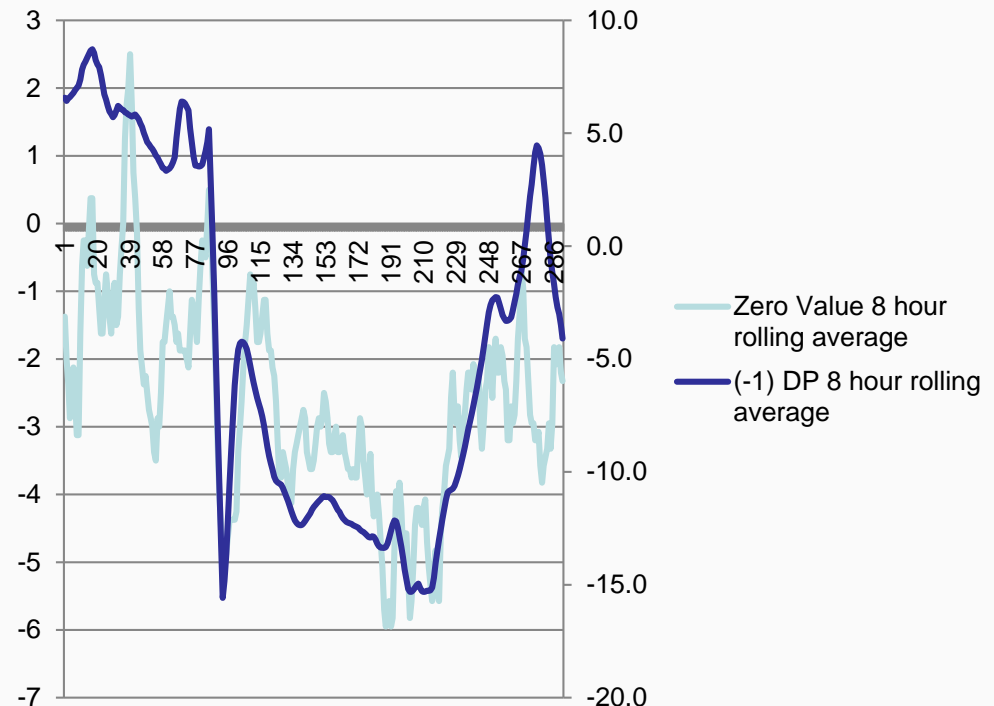




Met One BAM Zero Test

- Relationship between ambient Dewpoint and zero test results:
 - When dew point goes down the BAM zero test data goes up.
 - The magnitude of the BAM 1020 zero response is somewhat variable; however, data indicate that a 5 to 10 C drop in dew point corresponds to a 1 to 3 $\mu\text{g}/\text{m}^3$ increase in the mass concentration.

RTP, NC Met One BAM Zero Tests
Rolling 8-hour averages





Met One BAM Zero Test

- Recommendations:
 - Perform zero tests at the beginning of a season when the dewpoint will be representative of that season.
 - Enter the negative of the zero test results in the Met One BAM in the field “BKGD”. For example, an average from the sample period of $-3.0 \mu\text{g}/\text{m}^3$ is entered as 0.0030
 - **Delta-T.** Log this channel in the BAM 1020 settings. See: Met One Presentation at the Denver 2012 National Monitoring Conference (<http://www.epa.gov/ttn/amtic/files/2012conference/1B02BAM.pdf>), page 9; set the Datalog Delta-T: to “YES”.
 - Log Met One BAM temperatures and RH data to your data logger

```
CALIBRATE SETUP
CONC TYPE: ACTUAL      FLOW RATE: 16.7
                       FLOW TYPE: ACTUAL
      Cv: 1.047         Qo: 0.000
      ABS: 0.822       μsw: 0.306
      K: 1.005         BKGD: -0.0030
STD TEMP: 25C         HEATER: AUTO
SAVE                 EXIT
```

```
Heater Setup
RH Control: YES
RH Setpoint: 35%
Datalog RH: YES (Chan 4)
Delta-T Control: NO
Delta-T Setpoint: 99 C
Datalog Delta-T: YES (Chan 5)
SAVE                 EXIT
```



Notes on PM_{2.5} Continuous FEMs

- **Good comparability with filter-based methods can be achieved**
- There are several reasons why a PM_{2.5} continuous method may not meet the desired comparability with a collocated filter-based method
 - Filter-based methods are known to have their own biases
 - e.g., In filter-based methods, the sample is often left in the sampler for several hours to days after the end of the collection period
 - Continuous methods need to account for varying levels of moisture in the atmosphere; however, heating of the sample stream can lead to significant loss of PM
 - Different measurement principles can lead to different results
 - We are still learning how to fully optimize the use of PM continuous methods
- No method is perfect, but many can be sufficient to meet the monitoring objectives



Summary of Best Practices

- ✓ Ensure your getting good FRM data
- ✓ For most methods, slightly negative numbers can be valid and are to be reported
- ✓ Align your second stage separators (i.e., VSCC to VSCC)
- ✓ Site and Method Set-up
- ✓ Firmware updates?
- ✓ Leak Tests?
- ✓ Quality Assurance/Quality Control
- ✓ Utilize QC checks in your own data system and/or AIRNowTech.
- ✓ Data Transfer and Reporting
- ✓ Method Specific Topics
- ✓ Assessments – you need to look at your data and compare to other methods and sites.

- AMTIC Home
- Basic Information
- SLAMS Networks
- Training & Conferences
- Air Monitoring Methods
- Quality Assurance
- Regulations & Guidance
- Program Review & Oversight
- Other Networks & Partners
- Related Links
- Ambient Monitoring Mailing List

You are here: EPA Home » TTN Home » Ambient Monitoring Technology Information Center » SLAMS Networks » PM 2.5 » Continuous Monitoring

PM 2.5 - Continuous Monitoring

You will need Adobe Acrobat Reader to view the Adobe PDF files on this page. See EPA's PDF page for more information about getting and using the free Acrobat Reader.

Guidance Documents and Supporting Tools

- PM2.5 continuous monitor comparability assessment tool
 - Technical Note - PM2.5 Continuous Monitor Comparability Assessment (PDF) (4pp, 150K) - 2/22/12
- Spreadsheet Template for Candidate FEMs for PM2.5 and PM10-2.5
 - Spreadsheet without example data (xls file) (878K)
 - Spreadsheet with example data included (xls file) (410K)
- This spreadsheet can be used for assessing collocated FRM and continuous data at sites with up to 366 data pairs (XLT file) (918K)
- This spreadsheet can be used for assessing collocated FRM and continuous data at sites with up to 122 data pairs (XLT file) (448K)
- Data Quality Objectives (DQOs) for Relating Federal Reference Method (FRM) and Continuous PM2.5 Measurements to Report an Air Quality Index (AQI), EPA-454/B-02-002, November 2002 (PDF) (102pp, 1.9 MB) - 12/19/02
- "Guidance for Using Continuous Monitors in PM2.5 Monitoring Networks," EPA-454/R-98-012, May 1998 (PDF) (178pp, 1.4 MB) - 6/5/98

PM 2.5 Navigation

- PM 2.5 Home
- **Continuous Monitoring**
- Data Management and AQS Reporting
- Federal Reference Method (FRM)
- Regulations (Federal Register)
- Implementation
- National Monitoring Procurement
- Network Design
- Policy and Guidance
- Quality Assurance
- Meetings, Conferences, Workshops
- Visibility (IMPROVE)
- Wildfire/Smoke Monitoring

Policy and Data Management

- Instructions and Template for Requesting that data from PM2.5 Continuous FEMs are not compared to the NAAQS (Microsoft Word) (17pp, 1.2 MB) - 10/28/2013
 - Memo (PDF) (1pp, 402K)
- Implementing Continuous PM2.5 Federal Equivalent Methods (FEMs) and Approved Regional Methods (ARMs) in State or Local Air Monitoring Station (SLAMS) Networks (PDF) (6pp, 416K) - 7/24/2008
- Parameter Codes Used to Report PM2.5 Continuous Monitor and Speciation Sampler Data to AQS (PDF) (6pp, 29 kb) - 6/2/2006

Standard Operating Procedures

- DRAFT SOP for the Met One BAM-1020; Federal Equivalent Method EQPM-0308-170 for PM2.5 (PDF) (111pp, 1.1 MB) - 8/28/2009
 - Technical Note - Met One BAM Zero Tests (PDF) (8pp, 280K) - 10/05/2012
- DRAFT SOP for the Thermo Scientific FDMS* 1405-DF; Federal Equivalent Method EQPM-0609-182 for PM2.5 (PDF) (96pp, 1.4 MB) - 9/1/2009
- DRAFT SOP for the Thermo Scientific 1400a Ambient Particulate Monitor with 8500C FDMS*; Federal Equivalent Method EQPM-0609-181 for PM2.5 (PDF) (101pp, 2.5 MB) - 8/1/2011

Technical Systems Audit Checklists

- PM continuous TSA checklist - Met One BAM - Draft (PDF) (14pp, 886K) - May 12, 2015
- PM continuous TSA checklist - Thermo TEOM-FDMS - Draft (PDF) (18pp, 586K) - September 22, 2015

CASAC

- CASAC PM2.5 continuous files

Assessments and Verifications

- Environmental Verification statements and Reports for Ambient Fine Particulate Monitors
- Assessment of PM2.5 FEMs Compared to Collocated FRMs (PDF) (10pp, 114K) - April 7, 2011

Presentations

- National Air Quality Conference - Ambient Air Monitoring 2012: Best Practices for Operating PM2.5 Continuous FEMs
- Continuous PM Presentations from the 2009 National Air Monitoring Conference
- Continuous PM Presentations from the 2006 National Air Monitoring Conference

AMTIC Web Site at <https://www3.epa.gov/ttn/amtic/contmont.html>

Provides detailed information on:

- Guidance Documents and Tools
- Policies and Data Management
- Available SOPs
- **Technical Systems Audit checklists**
- CASAC files
- Assessments and Verifications
- Presentations