Training Session - Best Practices for Operating PM$_{2.5}$ Continuous FEMs

Introductions, overview, web site references, and assessments

Tim Hanley – U.S. EPA - OAQPS
Monday May 14$^{th}$, 2012
National Air Quality Conference – Ambient Monitoring 2012
# Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:15 pm</td>
<td>Assemble in Room Colorado F</td>
<td></td>
</tr>
<tr>
<td>1:30 pm – 1:50 pm</td>
<td>Tim Hanley – U.S. EPA</td>
<td>Introductions, overview, web site references, assessments</td>
</tr>
<tr>
<td>1:50 pm – 2:30 pm</td>
<td>Dr. David Gobeli, Steve Wilson - Met One</td>
<td>BAM 1020</td>
</tr>
<tr>
<td>2:30 pm – 3:00 pm</td>
<td>Adam Blundell – Southwest Ohio Air Quality Agency</td>
<td>Operation of Continuous PM$_{2.5}$ Best Practices, One Agency’s Trials and Successes</td>
</tr>
<tr>
<td>3:00 pm – 3:15</td>
<td>Break</td>
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<tr>
<td>3:15 pm</td>
<td>Reassemble</td>
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<tr>
<td>3:20 pm – 4:20 pm</td>
<td>Jeff Ambs - Thermo Scientific</td>
<td>FDMS and SHARP</td>
</tr>
<tr>
<td>4:20 pm – 4:50 pm</td>
<td>Gil Cossett - GRIMM</td>
<td>The Use of Optical Technology for Continuous Mass Monitoring of Aerosol Particles</td>
</tr>
<tr>
<td>4:50 pm – 5:00 pm</td>
<td>Tim Hanley – U.S. EPA</td>
<td>Wrap-up and summary.</td>
</tr>
<tr>
<td>5:00 pm</td>
<td>Session Concludes</td>
<td></td>
</tr>
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</table>

6/5/2012  
U.S. Environmental Protection Agency  
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# Related Posters/Presentations this Week

<table>
<thead>
<tr>
<th>Title</th>
<th>Presenter</th>
<th>Organization</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermo pDR-1500 Personal Nephelometer</td>
<td>George Allen</td>
<td>NESCAUM</td>
<td>Poster</td>
</tr>
<tr>
<td>Evaluation of Teledyne API Model 602 BetaPLUS and PM10 &amp; PM2.5 FRM Measurements in Logan, UT and East St. Louis, IL During Wintertime Conditions</td>
<td>Stephen Toner</td>
<td>Teledyne</td>
<td>Poster</td>
</tr>
<tr>
<td>12 Year Data Quality Assessment of the PM$_{2.5}$ Monitoring Network</td>
<td>Shelly Eberly</td>
<td>STI Subcontractor</td>
<td>Wednesday 1pm. Quality Assurance Room - Colorado G</td>
</tr>
<tr>
<td>Continuous PM coarse Monitoring in Texas (Met One BAMs)</td>
<td>Bryan Lambeth</td>
<td>TCEQ</td>
<td>Wednesday 3 pm. Criteria Pollutant Methods, Issues, &amp; Updates Room – Colorado F</td>
</tr>
<tr>
<td>PM$_{2.5}$ Instrument comparison: FRM vs TEOM, BAM, &amp; GRIMM</td>
<td>Cary Gentry</td>
<td>Forsyth County, NC</td>
<td>Wednesday 3 pm. Criteria Pollutant Methods, Issues, &amp; Updates Room – Colorado F</td>
</tr>
<tr>
<td>PM$_{2.5}$ FEM Overview</td>
<td>Tim Hanley</td>
<td>EPA OAQPS</td>
<td>Thursday 8 am. Plenary Technical Program Updates</td>
</tr>
</tbody>
</table>
What Material/Information is available to support operation and evaluation of PM$_{2.5}$ Continuous Monitors?

- Presentations from:
  - This Week
  - Previous Conferences
- Tools on the web and SOPs
- Assessments
  - Assessment (Spring 2011)
  - Comparability Assessment Tool
# Select Previous Conference Sessions on PM$_{2.5}$ Continuous Monitoring

<table>
<thead>
<tr>
<th>Conference</th>
<th>Session</th>
<th>Instruments Covered</th>
<th>Topics Addressed</th>
<th>URL</th>
</tr>
</thead>
</table>
| 2009 National Ambient Air Monitoring Conference – Nashville TN | Continuous PM Mass Instrument Training Session | Thermo:  
- TEOM 1405-DF,  
- TEOM 1400ab with 8500C,  
- SHARP (5030),  
- FH62C14-DHS Beta Monitor  
Met One:  
- BAM 1020  
Grimm:  
- Model 180 | Method Descriptions  
- FEM Field Testing  
- Development Status  
- Tips for operation and maintenance  
- Operational Key Points | http://www.epa.gov/ttn/amtic/2009present.html |
| 2008 National Air Quality Conference – Portland OR | Continuous PM$_{2.5}$ Monitoring Issues | FDMS  
Met One BAM 1020  
Nephelometers | Specific PM$_{2.5}$ continuous methods (tips on configuration, operation, maintenance, calibration and audit, data interpretation) | http://airnow.gov/index.cfm?action=naq_conf_2008.aq |
| 2006 National Air Monitoring Conference – Las Vegas TN | Air Monitoring Instrumentation – Continuous PM Monitors | TEOM FDMS  
Met One BAM 1020 | History, Regs., FEM/ARM performance criteria, Field testing requirements, parameter codes  
PM$_{2.5}$ Continuous Monitoring Website on AMTIC
(http://www.epa.gov/ttn/amtic/contmont.html)

- Guidance and supporting Documents:
  - Comparability assessment tool
  - FEM/ARM spreadsheet templates
- Policy and data management memos
- SOPs
- CASAC related files
- Assessments/verifications
- Presentations
Standard Operating Procedures (SOPs)

- Consensus SOPs are available for three PM\textsubscript{2.5} continuous FEMs:
  - DRAFT - Met One BAM-1020; Federal Equivalent Method EQPM-0308-170 for PM2.5 (111p) - 8/28/2009
  - DRAFT - Thermo Scientific FDMS\textsuperscript{®} 1405-DF; Federal Equivalent Method EQPM-0609-182 for PM2.5 (96pp) - 9/1/2009
  - DRAFT - Thermo Scientific 1400a Ambient Particulate Monitor with 8500C FDMS\textsuperscript{®}; Federal Equivalent Method EQPM-0609-181 for PM2.5 (101pp) - 3/1/2011

- SOPs were developed with input from monitoring agency stakeholders three years ago.

- Available at: http://www.epa.gov/ttn/amtic/contmont.html
Assessments

- An assessment of available PM_{2.5} FEMs operated by routine monitoring agencies was performed in Spring of 2011

- Assessment was referenced in the PM Policy Assessment (April, 2011) and is included in the PM NAAQS docket:
  - Assessment of PM_{2.5} FEMs Compared to Collocated FRMs; Tim Hanley and Adam Reff, OAQPS; PM NAAQS Docket, EPA - HQ - OAR - 2007 – 0492
  - Memo is available at: [http://www.epa.gov/ttn/naaqs/standards/pm/data/HanleyandReff040711.pdf](http://www.epa.gov/ttn/naaqs/standards/pm/data/HanleyandReff040711.pdf)

- Detailed one page assessments are available at: [http://www.epa.gov/ttn/analysis/pm.htm](http://www.epa.gov/ttn/analysis/pm.htm)
  - Met One BAM 1020 Assessments - 61 sites
  - Thermo Scientific Ambient Particulate Monitor with Series 8500C FDMS Assessments - 17 sites
  - Thermo Scientific Model 5030 SHARP Assessments - 2 sites
Met One BAM 1020 – PM$_{2.5}$ FEM

*National Assessment Summary can be very useful for comparison with your monitor*

**Slope**

- Average slope for all sites = 1.081
- Average slope for sites with an intercept within +/- 2 µg = 1.066

**Intercept (µg/m$^3$)**

- Average intercept for all sites = 1.12 µg/m$^3$
- Average intercept for sites with a slope within +/- 10% of 1 = 1.34 µg/m$^3$
Thermo 8500C FDMS - PM$_{2.5}$ FEM

**Slope**

Average slope for all sites = 0.937
Average slope for sites with an intercept within +/- 2 µg/m$^3$ = 0.926

**Intercept (µg/m$^3$)**

Average intercept for all sites = 1.40
Average intercept for sites with a slope within +/- 10% of 1 = 0.68

U.S. Environmental Protection Agency
Comparability Assessment Tool

- Available at: http://www.epa.gov/airquality/airdata/ad_rep_frmv fem.html
- Provides one-page assessment
- Data is from AQS Data Mart where there is a collocated PM$_{2.5}$ FRM and PM$_{2.5}$ continuous monitor.
- Includes PM$_{2.5}$ continuous data submitted to any of the following parameter codes:
  - 88101, 88500, 88502, 88501
- Technical note explaining tool is available at:
Title, Site, Methods, and Difference Trend

PM 2.5 Continuous Monitor Comparability Assessment
Site 37-183-0014: Raleigh, NC

FRM: R & P Model 2025 PM2.5 Sequential w/WINS-GRAVIMETRIC (118), PM2.5 - Local Conditions (88101), POC=1
Cont: Met One BAM-1020 Mass Monitor w/VSCC-Beta Attenuation (170), PM2.5 - Local Conditions (88101), POC=3

Recently added POC
Regression Equations

One regression equation is displayed; however, several regression equation outputs are illustrated below.

Line in regression figure is a 1:1 line

Slope from regression equation is displayed as multiplicative bias along x-axis

Intercept from regression equation is displayed as additive bias along y-axis
Correlation Criteria

Part 53 performance criteria for acceptance of a method includes a statistic for correlation.

Appendix A and DQO’s do not include a correlation goal.

Note: (r), not (r²)

Interpreting correlation can be challenging, especially at sites with low concentrations.

X-axis is CCV which describes the spread of the sample population; the higher the CCV the higher r (on y-axis) we should expect.
### Means for each Method & Ratio of Cont/FRM

<table>
<thead>
<tr>
<th>Dataset</th>
<th>N</th>
<th>FRM</th>
<th>Cont</th>
<th>Ratio (Cont/FRM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AllData</td>
<td>530</td>
<td>9.9</td>
<td>10.8</td>
<td>1.09</td>
</tr>
<tr>
<td>Winter</td>
<td>121</td>
<td>8.7</td>
<td>11.4</td>
<td>1.30</td>
</tr>
<tr>
<td>Spring</td>
<td>116</td>
<td>10.9</td>
<td>11.6</td>
<td>1.07</td>
</tr>
<tr>
<td>Summer</td>
<td>142</td>
<td>12.2</td>
<td>11.4</td>
<td>0.93</td>
</tr>
<tr>
<td>Fall</td>
<td>151</td>
<td>8.0</td>
<td>9.2</td>
<td>1.16</td>
</tr>
<tr>
<td>2009</td>
<td>169</td>
<td>10.0</td>
<td>10.5</td>
<td>1.05</td>
</tr>
<tr>
<td>2010</td>
<td>317</td>
<td>10.1</td>
<td>11.1</td>
<td>1.10</td>
</tr>
<tr>
<td>2011</td>
<td>44</td>
<td>8.2</td>
<td>9.8</td>
<td>1.19</td>
</tr>
</tbody>
</table>

Data Source: EPA AQS Data Mart

### Appendix A Statistics for Bias

<table>
<thead>
<tr>
<th>Dataset</th>
<th>N</th>
<th>Bias (all observations)</th>
<th>N</th>
<th>Bias (only &gt;= 3 µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AllData</td>
<td>530</td>
<td>11.7</td>
<td>517</td>
<td>12.3</td>
</tr>
<tr>
<td>Winter</td>
<td>121</td>
<td>33.9</td>
<td>118</td>
<td>33.8</td>
</tr>
<tr>
<td>Spring</td>
<td>116</td>
<td>6.6</td>
<td>113</td>
<td>8.6</td>
</tr>
<tr>
<td>Summer</td>
<td>142</td>
<td>-7.9</td>
<td>142</td>
<td>-7.9</td>
</tr>
<tr>
<td>Fall</td>
<td>151</td>
<td>16.5</td>
<td>144</td>
<td>17.5</td>
</tr>
<tr>
<td>2009</td>
<td>169</td>
<td>7.1</td>
<td>166</td>
<td>7.0</td>
</tr>
<tr>
<td>2010</td>
<td>317</td>
<td>12.8</td>
<td>309</td>
<td>13.5</td>
</tr>
<tr>
<td>2011</td>
<td>44</td>
<td>21.6</td>
<td>42</td>
<td>24.5</td>
</tr>
</tbody>
</table>

Appendix A calls for calculating bias when both methods are >= 3 µg/m³. This is presented in the column on the right.

Evaluating the means and ratio of means provides a quick way to assess the comparability of the methods.
Comparability Assessment Tool Summary

• Tool provides quick and valuable assessment
  – However, some runs may take several minutes
• The assessment assumes the FRM represents the true value, even though the FRM will have its own uncertainty
• Assessments should be used as a guide and not a bright line

*From Section 2.3.1.1 of Appendix A to Part 58:
Measurement Uncertainty for Automated and Manual PM$_{2.5}$ Methods.*

The goal for acceptable measurement uncertainty is defined as 10 percent coefficient of variation (CV) for total precision and plus or minus 10 percent for total bias

Bias is calculated from samples collected in PEP program.
PM$_{2.5}$ Continuous FEM QA Requirements

Collocated Sampling Procedures for PM$_{2.5}$ - Section 3.2.5 (a). Have 15 percent of the monitors collocated (values of 0.5 and greater round up)

<table>
<thead>
<tr>
<th>Number of Continuous PM$_{2.5}$ FEMs (same make and model) in PQAO network</th>
<th>Minimally Required Collocated FRM(s)</th>
<th>Minimally Required Collocated FEM(s) of the same make and model as primary monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>10 – 16</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>17 – 23</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>24 - 29</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Flow Rate Verifications – Section 3.2.3. A one-point flow rate verification check must be performed at least once every month on each automated analyzer used to measure PM$_{10}$, PM$_{10-2.5}$ and PM$_{2.5}$.

Flow Rate Audits – Section 3.2.4. Every 6 months, audit the flow rate of the PM$_{10}$, PM$_{10-2.5}$ and PM$_{2.5}$ particulate analyzers.
PM$_{2.5}$ Continuous Monitoring Data Reporting Summary

- **General**
  - Report hourly data, make sure flow system is operating on local conditions, ensure data for a given hour is placed as the “Start Hour”.

- **Two related policy Memo’s addressing this data reporting to AQS:**
  - Implementing Continuous PM$_{2.5}$ Federal Equivalent Methods (FEMs) and Approved Regional Methods (ARMs) in State or Local Air Monitoring Station (SLAMS) Networks, 7/24/2008
  - Parameter Codes Used to Report PM$_{2.5}$ Continuous Monitor and Speciation Sampler Data to AQS, 6/2/2006

- **Monitoring Agency decision to use FEM continuous PM$_{2.5}$ data for comparison to the NAAQS:**
  - Generally “SLAMS” and “Primary monitor” to use data, or
  - “SPM” and “Non-regulatory” to not use it; however, other FRM/FEM must be operating as primary monitor.
  - Recommend your agency state intentions in Annual Network Plan
### AQS Parameter Codes for PM$_{2.5}$ Continuous Monitoring Data Reporting

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Parameter Code</th>
<th>Purpose</th>
<th>Data uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM2.5 LOCAL CONDITIONS</td>
<td>88101</td>
<td>Appropriate code for all FRM/FEM/ARMs</td>
<td>- AirData AQI calculations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- NAAQS (unless coded with “non-regulatory”)</td>
</tr>
<tr>
<td>PM2.5 TOTAL ATMOSPHERIC</td>
<td>88500</td>
<td>Valid data from methods measuring total PM$_{2.5}$ aerosols in the atmosphere, including those that can be volatilized from the FRM</td>
<td>- AirData AQI calculations</td>
</tr>
<tr>
<td>PM2.5 RAW DATA</td>
<td>88501</td>
<td>Valid uncorrected data that does not reasonably match the FRM</td>
<td></td>
</tr>
<tr>
<td>ACCEPTABLE PM2.5 AQI &amp; SPECIATION MASS</td>
<td>88502</td>
<td>Valid data that does reasonably match the FRM with or without correction, but not to be used in NAAQS decisions</td>
<td>- AirData AQI calculations</td>
</tr>
<tr>
<td>PM2.5 VOLATILE CHANNEL</td>
<td>88503</td>
<td>Store important related data such as the FDMS reference channel</td>
<td></td>
</tr>
</tbody>
</table>

Technical Note covering codes available at [http://www.epa.gov/ttn/amtic/cpreldoc.html](http://www.epa.gov/ttn/amtic/cpreldoc.html)

88101 is only parameter code eligible for NAAQS decision-making

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