UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711
OFFICE OF AIR QUALITY PLANNING AND STANDARDS

$PM_{2.5}$ Federal Reference Method (FRM) Data Quality Assessment Application

The $PM_{2.5}$ FRM Data Quality Assessment application is available at:
https://sti-r-shiny.shinyapps.io/QVA_Dashboard/

Summary:

This application provides visual assessments of $PM_{2.5}$ Federal Reference Method (FRM) data quality for each Primary Quality Assurance Organization (PQAO); selection by Monitoring Agency is also available. Assessments are generated for the latest available three-year period of certified data with an option for other time periods also available. The visual assessments are intended to assist agencies in understanding if the $PM_{2.5}$ FRM samplers operated in their networks are meeting goals for measurement quality objectives (MQOs). The assessments are expected to have three major advantages over existing assessments:

- Data are visualized allowing lots of information to be illustrated in a concise way;
- The assessment compares the PQAO of interest to all other PQAOs allowing agencies to understand if their program's data quality is similar to other agencies or perhaps an outlier; and
- The assessment application is expected to remain openly available so that users won't have to worry about tracking user IDs and passcodes. In this way we hope that users will efficiently find their programs $PM_{2.5}$ FRM data quality.

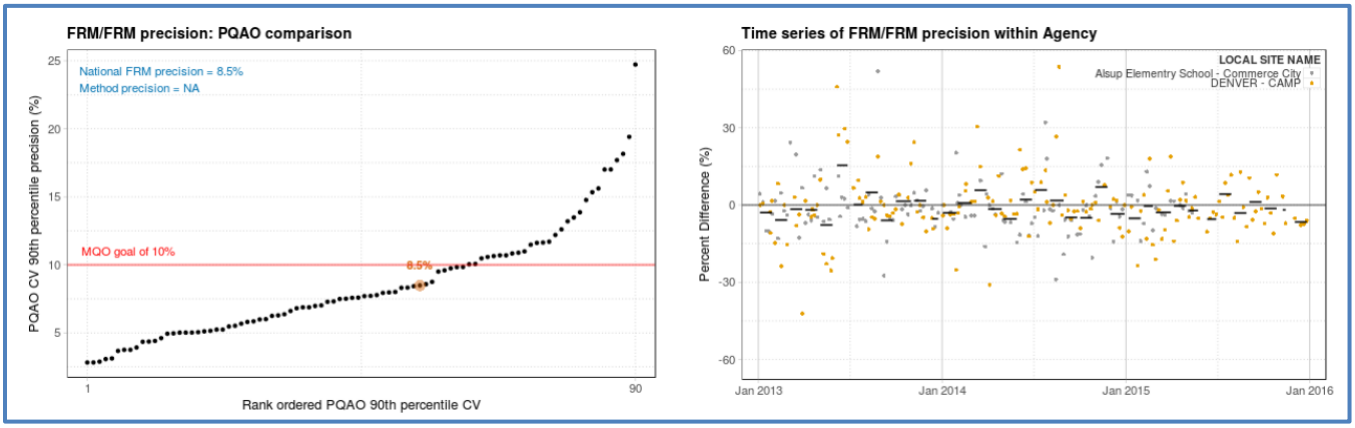
We took this project on as we continue to hear positive feedback on the one-page $PM_{2.5}$ Continuous Monitor Comparability Assessment (https://www.epa.gov/outdoor-air-quality-data/pm25-continuous-monitor-comparability-assessments). However, it's hard to know if you're getting good $PM_{2.5}$ continuous monitoring data without knowing the quality of your FRM data. This new assessment on the FRM data quality is an attempt to efficiently answer this question.

The $PM_{2.5}$ FRM Data Quality Assessment is designed to cover four indicators of $PM_{2.5}$ FRM data quality:

- Collocated Precision;
- Bias via the Performance Evaluation Program;
- Flow rate audits/flow rate verifications; and
- Field blanks.

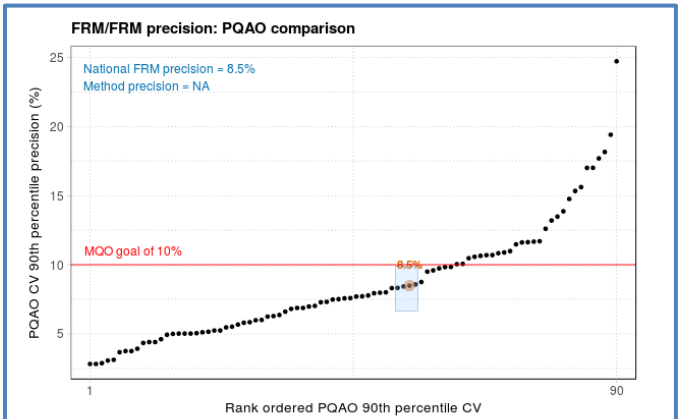
Assessment Design:

Each of the four indicators of data quality are illustrated with two charts. On the left side of the page is a ranking of all PQAOs from low to high for the indicator of data quality. On the right side of the page is a time series of the data within the PQAO of interest. For example, in the collocated precision statistics below, the agency selected has a calculated precision of 8.5% for the three-year period of 2013–2015 and thus meets the Measurement Quality Objective (MQO) for this indicator of data quality. The time series on the right shows data from two sites with each site having a collocated pair of FRMs for the selected PQAO. Each site is color coded with the calculated paired difference on the y axis and the date on the x axis. Monthly means are displayed as black horizontal bars. The three other indicators of data quality (i.e., PEP bias, flow rate audits/verifications, and field blanks) follow the same approach with PQAOs ranked from low to high on the left and the PQAOs selected data displayed on the right in a time series.



Collocated Precision:

Precision is the measure of mutual agreement among individual measurements of the same property. For purposes of the precision assessment in this application, we are looking at FRM to FRM collocated precision (i.e., FRM to continuous FEM collocated precision information is not included). Each PQAO operating an FRM as a primary monitor will have at least one site with FRM to FRM collocation. PQAOs that utilize continuous FEMs for all of their primary monitors are not expected to have collocated FRMs, and thus there may not be any data in this part of the assessment.



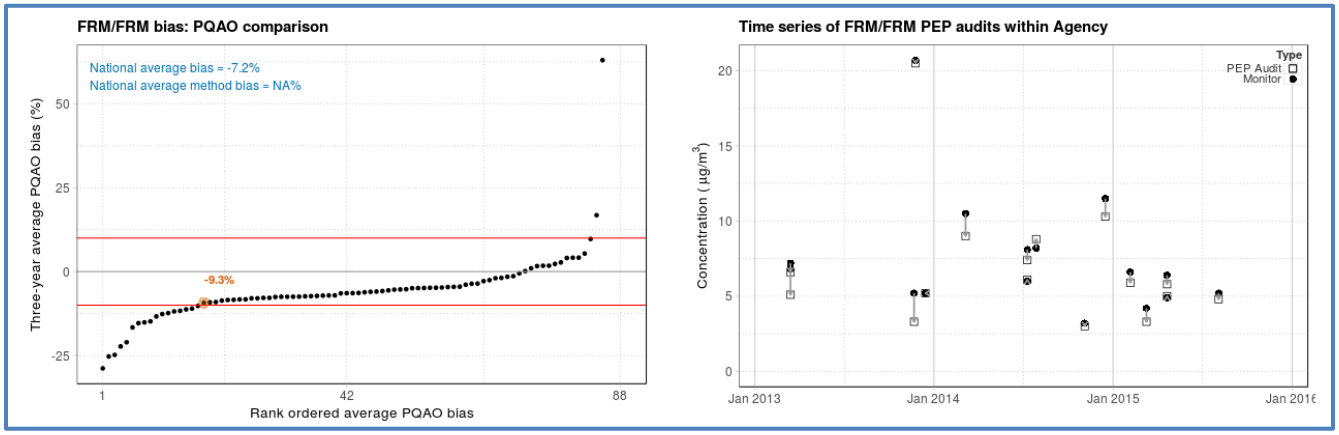
PQAO_CODE	PQAO	n	CV_90th
1175	Wisconsin Dept Of Natural Resources, Air Monitoring Section	299	8.33
0511	Idaho Department Of Health And Welfare-Environment Division	42	8.43
0240	Colorado Department of Public Health And Environment	294	8.49
0350	Department of Energy & Environment, District of Columbia	313	8.58

Collocated precision requirements are described in Appendix A to 40 CFR, Part 58. Collocated FRM samplers are required to operate on at least a 1-in-12 day sample schedule, but are often operated more frequently. The goal for acceptable measurement uncertainty for precision is defined as an upper 90 percent confidence limit for the coefficient of variation (CV) of 10 percent. Precision calculations for $PM_{2.5}$ are described in section 4 of Appendix A to Part 58; see equations 6 and 7. These calculate result the relative percent difference for each collocated pair (equation 6) and the coefficient of variation upper bound (equation 7). In the displayed outputs, the upper left chart provides an illustration of each PQAO's 90th percent confidence limit. PQAOs are sorted from low to high with the selected PQAOs precision calculation illustrated in the chart. A national FRM precision statistic is also provided (i.e., 8.5% for years 2013–2015). Additionally, the MQO goal (i.e., 10%) is identified with a red horizontal line.

A mouse or touchpad can be used to "box in" any of the selected data on any chart for displaying more detailed information. Results for what has been boxed in are presented below the chart with details on the agencies and/or data.

Bias via the Performance Evaluation Program:

Bias is defined as the systematic or persistent distortion of a measurement process which causes errors in one direction. Bias is estimated using collocated instruments that are set up by a group independent of the monitoring organization. The program we utilize to provide independent $PM_{2.5}$ FRM audits is called the Performance Evaluation Program (PEP). The measurement bias goal is +/-10% aggregated over a 3-year period for each PQAO. A paired difference calculation is performed using equation 1 from Appendix A to Part 58. The data pair would only be considered valid if both the audit and primary sampler concentration are greater than 3 $\mu g/m^3$. An average of the bias is calculated using equation 12 from Appendix A to Part 58 for the time period selected. A few agencies that meet the requirement for independence in their quality assurance program perform their own audits, and those results are included in the assessments provided.

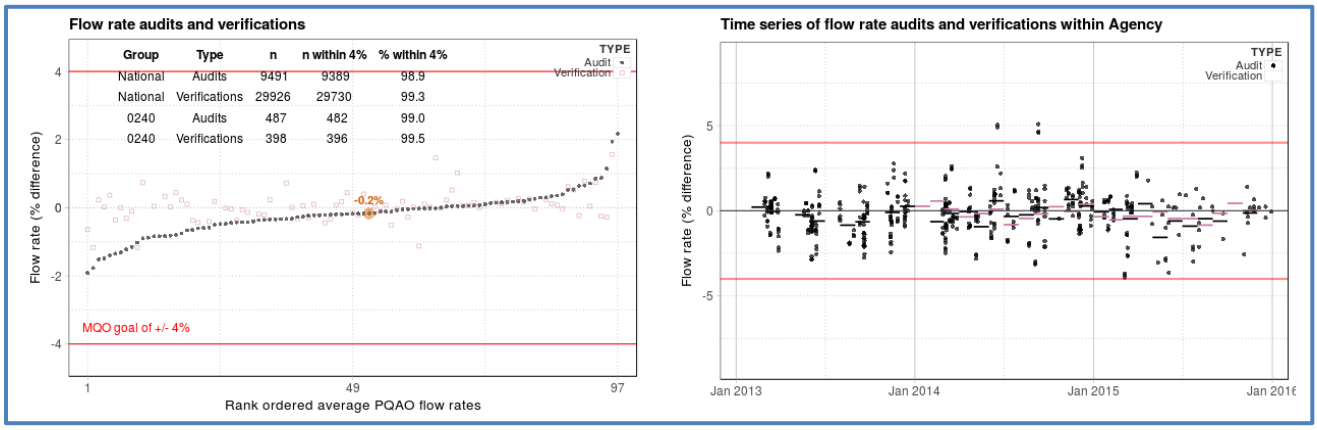


PQAOs with five or less sites are required to have at least five valid audits per year; PQAOs with greater than five sites are required to have at least eight valid audits per year. Due to the typical low number of performance audits conducted each year for a PQAO, a three-year period of data is used to aggregate and compute the bias by PQAO. MQOs are presented with the two red horizontal lines in the chart on the left side of this page. A national average bias calculation is presented on the left side (i.e., -7.2% for years 2013–2015). The chart on the right side of this page presents the individual audits conducted in the PQAO selected. The black point represents the PEP audit concentration with the arrow pointing to the PQAO's primary sampler concentration, which is a box. Data may be boxed in with a mouse or touchpad for more details.

Flow Rate Audits/Flow Rate Verifications:

An audit of the flow rate of each $PM_{2.5}$ FRM is performed at least twice each year. The audit should be conducted by a technician other the routine site operator. The audit is made by measuring the monitor's normal operating flow rate (i.e., 16.67 LPM) using a certified flow rate transfer standard that is different than the transfer standard used for the verifications described below.

A one-point flow rate verification check is performed at least once every month on each $PM_{2.5}$ FRM. The verification is made by checking the normal operational flow rate of the monitor with a certified flow rate transfer standard. Flow rate verifications are typically performed by the routine operator of a monitoring station. A percent difference between the FRMs reported flow and the verification device is reported for each flow rate verification check using equation 1 from Appendix A to Part 58.



On the left side of this page is a chart illustrating the mean of all flow rate audits and verifications by PQAO, ranked from low to high. Not surprising, all PQAOs are shown as within the ±4% MQO goal since positive and negative data will cancel each other out. However, by comparing all PQAO's from low to high, agencies can consider if their program's flow audits and verifications look similar to others, or perhaps are at the beginning or end of the data set. Also, on the chart on the left side of this page, the percent of checks for both audits and verifications that meet the ±4% MQO goal are presented in the summary table for the PQAO selected and the national estimates. On the chart on the right side of this page, the individual flow audits and flow verifications for the selected PQAO are presented. Monthly means for audits are displayed as black horizontal bars, while monthly means for verifications are displayed as magenta horizontal bars. The red lines representing the acceptable MQO goal of ±4% are also presented. There is no distinction in the chart for which FRM sampler is audited; however, "mousing in" the data will provide additional details of the data.

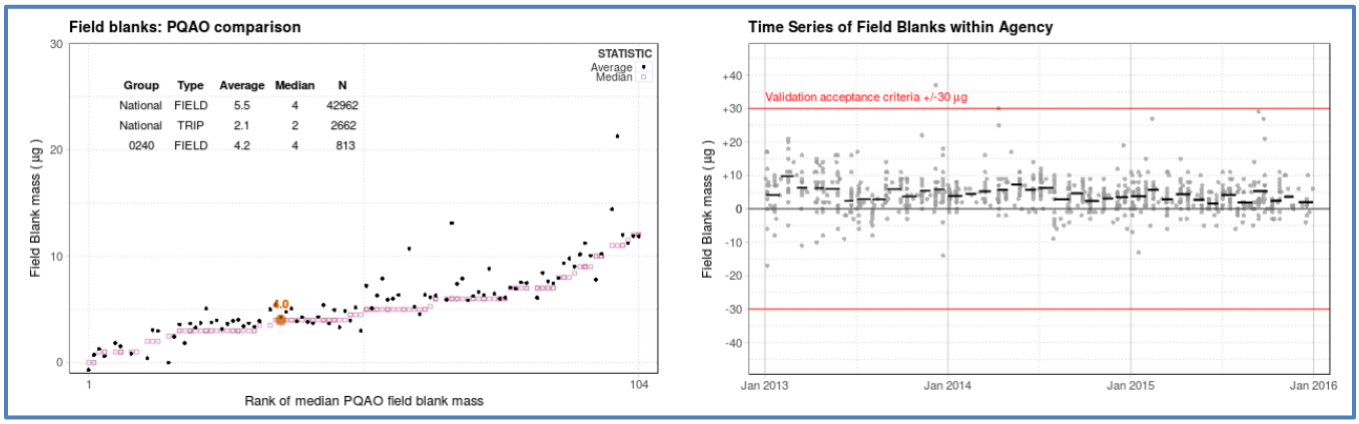
Data are compared using the actual (as read from the audit device) and indicated (as read from the FRM sampler) values rather than the design value (i.e., 16.67 LPM). Also, while all agencies should have a complete record of flow rate audits reported to AQS, flow rate verifications were not required to be reported to AQS until a monitoring rule change in March 2016; therefore, some agencies may not have this data reported to AQS before 2016 and subsequently, these data would not be available in the assessment.

Field Blanks:

A field blank is a filter that is pre-weighed with routine samples, installed in the field sampler without any flow passing through the filter, and re-weighed with routine samples; after this process, the initial/final weights are compared. The purpose of field blanks is to provide an estimate of total measurement system contamination, including laboratory and field activities. Through a comparison of laboratory blanks against field blanks, contamination from field activities can be assessed. The validation acceptance criterion for field blanks is ±30 µg between weighings.

Field blanks should be collected at a frequency of 10% of the sampling runs scheduled per site. For example, a monitor operating on a 1-in-6 day schedule would be expected to have six blanks in a year, while a monitor operating every day would be expected to have 36 blanks. Field blanks should be taken throughout the duration of the sampling schedule (spaced evenly across the year) and not concentrated in a short period of time. Collecting field blanks is required under 40 CFR Part 50, Appendix L, Section 8.3.7.1.

On the left bottom portion of the screen (left image, shown on the next page), each PQAO's 3-year mean and median field blank contamination is calculated. Field blanks are ranked from lowest to highest by PQAO using the median contamination. The corresponding field blank mean for each PQAO is then also illustrated. The national calculated values (4 µg median and 5.5 µg mean for years 2013–2015) are provided in the top left hand portion of the graphic. Although not required to be reported, trip blank data is summarized nationally, and where available, within the PQAO. However, trip blank data is not illustrated on either chart on the following page.



On the right side of the page, a time-series chart of field blanks within the selected PQAO is presented. Monthly means are displayed as black horizontal bars. The MQO ±30 µg acceptance criterion for field blanks is displayed with two red horizontal bars. As with all the charts, one or more data points can be selected by "mousing in" the data of interest.

Additional Notes:

- The data source for the $PM_{2.5}$ FRM is EPA's Air Quality System (AQS), which provides updated data files for use in the application each night.
- The AMP 256 report can be used to review this same information updated immediately in AQS for collocated precision, PEP bias, and flow rate verifications and audits. At this time, field blank data is not available in the AMP256 report; however, field blank data is available from AQS.
- While the focus of this assessment is the $PM_{2.5}$ FRM, we do include filter-based FEMs (e.g., dichots) as a couple agencies use these methods as their primary sampler, and they would not be covered in other visual assessments.
- We welcome any comments on this work. Please email any comments to Tim Hanley in EPA's Ambient Air Monitoring Group (hanley.tim@epa.gov).