# $PM_{2.5}$ Quality Assurance

An important concern in any organization that is collecting and evaluating environmental data must be the quality of the results. The EPA has developed a quality system to ensure that the $PM_{2.5}$ monitoring results:

- Meet a well-defined need, use, or purpose;
- Satisfy the expectations of the network;
- Comply with applicable standards and specifications;
- Comply with statutory (and other) requirements of society, and
- Reflect consideration of cost and economics.

The reason for the development of the quality system is to ensure that $PM_{2.5}$ data are of the quality that a decision maker is willing to make decisions using the information. The data used in these decisions are never error free and always contain some level of uncertainty or error. Because of these uncertainties, there is a possibility that a decision maker will declare an area "nonattainment" when the area is actually in "attainment," or "attainment" when actually the area is in "nonattainment." Obviously, there are serious political, economic, and health consequences of making such decision errors. Therefore, decision makers need to understand the probabilities of making incorrect decisions with these data and set limits for an acceptable level of uncertainty.

To meet the objectives of $PM_{2.5}$ monitoring, the QA program should be organized in a manner that the factors affecting the data will be understood and controlled. These factors can be related to management, technology, the environment, and personnel. Therefore, the QA program must develop, document and implement a quality management system to control these influencing factors and meet the program's objectives.

The development of a quality system for $PM_{2.5}$ requires a coordinated effort between EPA and the State and local monitoring community. Elements of the quality system include planning, implementation and assessment. As part of the planning effort, EPA is responsible for developing National Ambient Air Quality Standards (NAAQS), defining the quality of the data necessary to make nonattainment /attainment decisions, with a reasonable level of confidence, and identifying a minimum set of QC samples from which to judge data quality. The State and local organizations are responsible for taking this information and developing and implementing a quality system that will meet the data quality requirements. Then, it is the responsibility of both EPA and the State and local organizations to assess the quality of the data and take corrective action when appropriate. The development of a quality system for the $PM_{2.5}$ monitoring program will be describe using the planning, implementation and assessment theme.

## Planning

The Office of Air Quality Planning and Standards used the DQO process to develop data collection efforts to support defensible decision making. DQOs are qualitative and quantitative statements derived from the DQO Process, that clarify the monitoring objectives, define the appropriate type of data, determine the most appropriate conditions from which to collect the data, and specify the tolerable levels of decision errors for the monitoring program.

Once it is known what uncertainty a decision maker can accept, a determination can be made of the degree of measurement uncertainty, in the form of precision and bias, that can be tolerated in the measurement system. The environmental data operation for $PM_{2.5}$ represents various data collection activities or phases including the initial equilibration and weighing of the filters, the transportation of the filters to and from the field, the calibration of the instrument and its maintenance, the handling and placement of the filters, the proper operation of the instrument, the storage and weighing of the sampled filter, and finally, the data reduction and reporting of the value. At each phase of this process, errors can occur, that in most cases are additive. This total measurement uncertainty must be understood and compared against the DQO.

OAQPS developed the $PM_{2.5}$ DQO during the spring of 1997. Since there are more than one objective for monitoring $PM_{2.5}$, the DQO Process was focused on the objective of making attainment/nonattainment decisions against the National Ambient Air Quality Standard. It was felt that the attainment/nonattainment DQO was the most important and would require the highest quality data. Therefore if this DQO were met, the other objectives (e.g. trends), would be met as well.

There are two National Ambient Air Quality Standards, the annual arithmetic mean and the 24-hour 98th percentile average standard. In running various statistical tests on $PM_{2.5}$ data in the AIRS database, it was concluded that the annual standard was more stringent and therefore was used in the development of the DQO.

Based upon the iterative DQO process, the decision maker felt comfortable making the correct decision 95% of the time when values (e.g., annual arithmetic mean) are close to the NAAQS, if precision and bias are maintained at the acceptable levels. For cases where values are farther from the standard, the decision maker will make the correct decision more often. Also, if precision and bias prove to be lower than the DQO, the decision maker can expect to make the correct decision more than 95% of the time.

Based upon these and a number of other technical assumptions, precision and bias requirements were generated that would control measurement uncertainty to meet the 95% acceptance rate. The precision requirement is 10% coefficient of variation and the bias is +/- 10%. These values were incorporated into the Federal Register.

The development of criteria for estimating both precision and bias is new to the ambient air monitoring program. Due to the accelerated time frame in which instruments will be manufactured and implemented in the field, EPA wanted to ensure that reference and equivalent instruments were comparable. The FRM audit, will help us determine comparability and bias.

Since DQOs have been established, the measurement system must now be controlled to those DQOs. The goal of a QA program is to control measurement uncertainty to an acceptable level through the use of various quality control and evaluation techniques. OAQPS, in cooperation with the EPA Regions , the National Exposure Research Laboratory, and State and locals are developing measurement quality objectives and criteria that will ensure the DQOs are met. These criteria are developed based upon a number of data quality indicators including precision, bias representativeness, completeness, detectability and comparability.

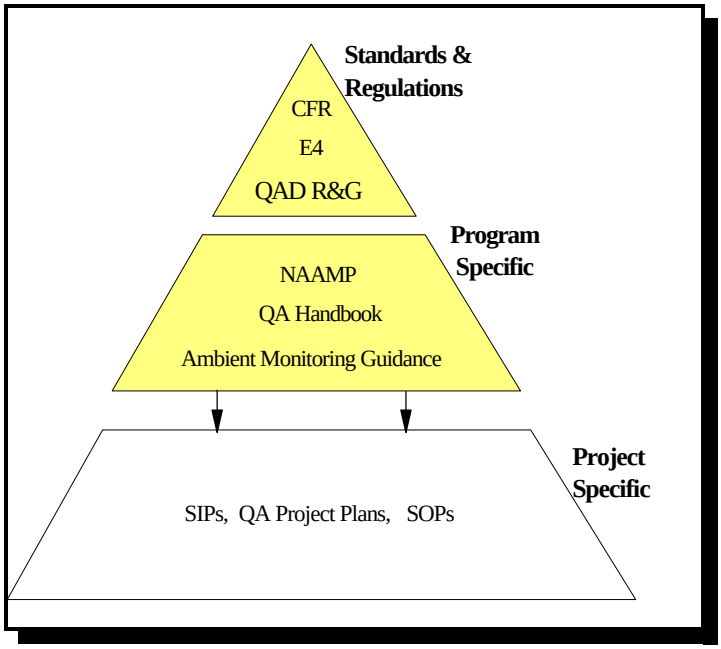


**Figure .1 Hierarchy of regulations and guidance**

Information on the proper implementation of the QA Program for the Ambient Air Quality Monitoring Program has been developed at three levels, as indicated in Figure.1. The top two levels (shaded) provide standards, regulations and guidance that form the basis for implementation documents for specific projects.

The Code of Federal Regulations provides the mandate for monitoring and the minimum requirements for the quality system. It also requires the development of QA project plans for any environmental data operation.

E4 refers to the document *American National Standard-Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs*. This document describes a basic set of mandatory specifications and non-mandatory guidelines by which a quality system for programs involving environmental data collection can be planned, implemented, and assessed. The EPA QA Order (5360.1) which mandates EPAs quality assurance program, adheres to E-4 under the authority of the Office of Management and Budget.

QAD refers to the EPA QA Division, the organization within the EPA that is responsible for the mandatory QA program. QAD is responsible for developing quality assurance and quality control requirements and for overseeing Agency-wide implementation of the EPA Quality System. QAD has developed a series of regulation and guidance documents that describe how to plan, implement and assess environmental data operations.

Based upon the standards and regulations, the Office of Air Quality Planning and Standards, the EPA National Exposure Research Laboratory, the EPA Regions, and other organizations implementing air monitoring have developed guidance specific to the Ambient Air Quality Monitoring Program. The *QA Handbook for Air Pollution Measurement Systems Vol II : Ambient Air Specific Methods*, provides the majority of the guidance necessary for the State and local agencies to develop QA project plans specific to their data collection needs. Other guidance has been developed specific to a part of the measurement system or to specific methods. A listing of this guidance is included in the QA Hand Book It is anticipated that the majority of these documents will be available through the Internet, most likely on the AMTIC bulletin board or the OAQPS QA Homepage

Based upon these standards, regulations and guidance from the Federal government, State and local organizations are expected to tailor and document their quality systems to meet the DQOs. These documents come in the form of State Implementation Plans, QA project plans, standard

operating procedures, and any other guidance or procedures that ensure the data quality of the $PM_{2.5}$ network.

## Implementation

The implementation process puts all our planning into action. Many of the same quality control techniques that we have previously used in the $PM_{10}$ program are being implemented for $PM_{2.5}$. However there are a few improvements.

Although all data are important to EPA, sites producing data close to the NAAQS would be the sites to focus limited QA resources. Therefore, the frequency of QA/QC (precision and bias) samples should be prioritized to sites in areas likely to be designated nonattainment, or at least to sites with higher concentrations. EPA recommends focusing 80% of the QA resources on sites with concentrations > 90% of the annual mean NAAQS (or 24-hour NAAQS if that is affecting the area), and each area determined to be in violation should be represented by at least one collocated monitor. The remaining 20% of the resources should be focused at sites with concentrations < 90% of the mean annual NAAQS. If an organization has no sites at concentration ranges > 90% of the mean annual NAAQS, 60% of the resources should be implemented at those sites with the annual mean concentrations among the highest 25% for all $PM_{2.5}$ sites in the network. Obviously, for a new network, the selection will be somewhat subjective and based upon the experience of State and local organizations.

Every Federal reference method (FRM) or Federal equivalent method (FEM) within a reporting organization MUST:

- Have 25% of the monitors collocated
- Have at least 1 collocated monitor and the first monitor must be collocated with a Federal reference method monitor. This allows for an estimate of bias as well as precision.
- Have 50% of the pairs be collocated with a Federal reference method monitor and the other 50% must be collocated with the exact same method designation. If there is an odd number of collocated monitors required, bias in favor of the Federal reference method monitor. This is implemented if more than 1 collocated monitoring pair is required.

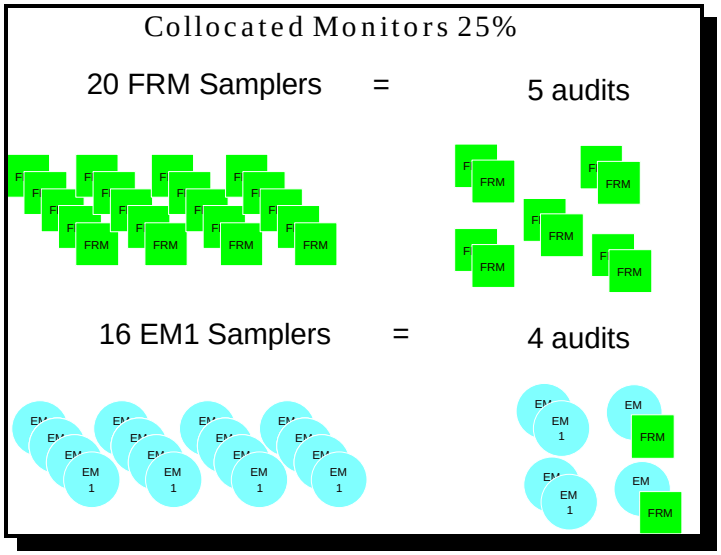


**Figure 2.**

The following diagrams, Figures 2 and 3, help explain how the 25% collocated monitoring requirement is implemented. In the first case (Figure 2), 20 Federal reference method monitors will be sited by a State or local organization; 25% of twenty monitors, or 5 collocated monitoring pairs will be required. In the second case 16 equivalent monitors of type EM1 will be sited. 25% of the 16 would require 4 collocated monitoring pairs. 50% or 2 would be paired with the Federal Reference Method monitor and the other 50% would be paired with

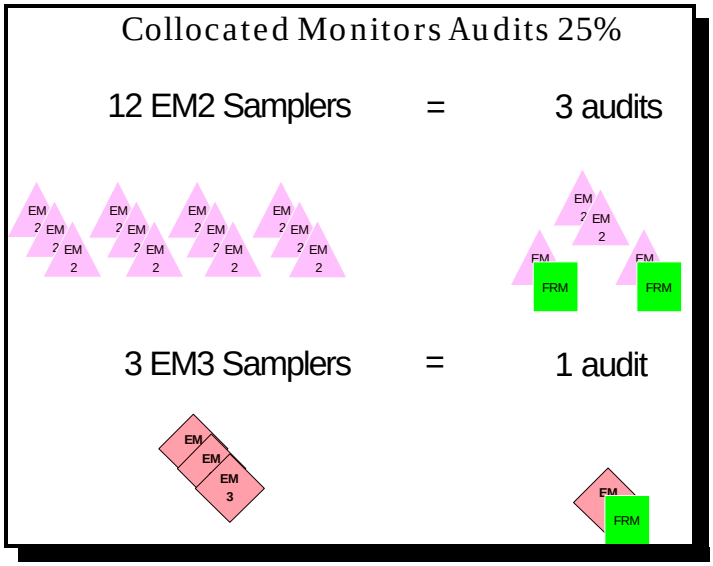


**Figure 3**.

the exact same method designation, meaning the exact same make and model of equivalent monitor .

The next two cases (Figure 3) show other scenarios, the first representing an odd number of collocated pairs where the bias is toward siting with the Federal reference method monitor, and the last case illustrating that each method designation must have a collocated pair and the first collocated pair must be sited with a Federal reference method monitor.

One of the major issues, relative to quality assurance, is the implementation of the independent FRM performance audit procedures as discussed in 40 CFR, Part 58, Appendix A, Section 3.5.3. These audits provide estimates of sampler bias, which will be a very critical estimate for the program, especially during the initial implementation phase. Based upon review comments on the December 13 $PM_{2.5}$ NAAQS Proposal, the Agency assessed the audit program and consequently made the following revisions:

- modified the system to include an independent FRM audit;
- reduced the burden of this program by changing the audit frequency from all sites to 25% of all $PM_{2.5}$ sites;
- reduced the burden of this program by reducing the audit frequency from six times a year to four times a year; and

- made allowances to shift the audit responsibility from the State and local agencies to the federal government

Although the FRM audits remain a State and local responsibility, due to the need for independent information, and the burden that this audit would place on State and local resources the EPA is offering State and local agencies opportunity to shift the responsibility of implementing the audit to EPA or to access a Federal vehicle to perform the audit. The EPA is currently working on the advantages and disadvantages of a number of scenarios and it is the intent of EPA to work with the State and local agencies to determine how best to implement this program.

## Assessment

A data quality assessment (DQA) is the scientific and statistical evaluation of data to determine if data from environmental data operations are of the right type, quality, and quantity to support their intended use. Since DQOs have been developed for the $PM_{2.5}$ attainment/nonattainment objective,

the quality assurance and quality control data can be statistically assessed at various levels of aggregation to determine whether the DQOs have been attained. Data quality assessments of precision and bias will be aggregated at the monitor level, the reporting organization level, and at the national level.

The statistical calculations for these assessments are found in Appendix A. It is anticipated that these calculations will be performed on the data in the Aerometric Information Retrieval System (AIRS) which will allow for the generation of reports at the levels specified above. A discussion on the implementation of the DQA activities will be included in the *QA Hand Book for Air Pollution Measurement Systems- Volume II Ambient Air Specific Methods* .

Technical systems audits will be performed by the EPA Regions of each State and local agency every three years. These audits will be similar to the ones implemented in the past. There is presently an effort to combine the long and short audit forms found in the current QA Handbook into one form.

Network reviews will also be conducted similar to the current requirement. There is also a draft network review guidance document that will be finalized in 1998