1.0 Program Background

1.1 Ambient Air Quality Monitoring Network

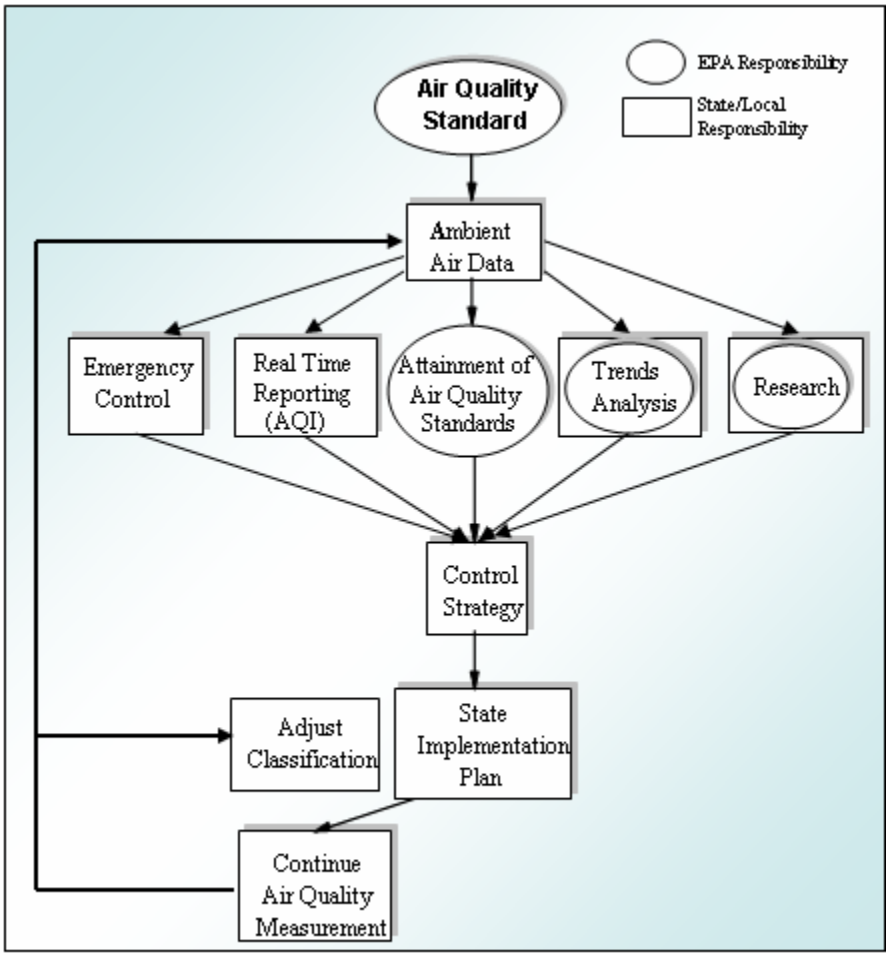


Figure 1.1 Ambient air quality monitoring process

The purpose of this section is to describe the general concepts for establishing the Ambient Air Quality Monitoring Network. The majority of this material, as well as additional details, can be found in the Clean Air Act (CAA)[1], 40 CFR Parts 50, 53 and 58[2], and their references.

Between the years 1900 and 1970, the emission of six principal pollutants increased significantly. The principal pollutants, also called criteria pollutants are: particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, and lead. In 1970 the CAA was signed into law. The CAA and its amendments provide the framework for all pertinent organizations to protect air quality.

40 CFR Part 58, Appendix D requires that monitoring networks be designed for three basic monitoring objectives:

- to provide air pollution data to the general public in a timely manner
- to support compliance with ambient air quality standards and emission strategy development
- to support air pollution research studies

In addition, these monitoring networks can also be developed:

- to activate emergency control procedures that prevent or alleviate air pollution episodes
- to observe pollution trends throughout the region, including non-urban areas

[1] http://epa.gov/air/caa/
[2] http://www.access.gpo.gov/nara/cfr/cfr-table-search.html

To meet these basic needs, networks are designed with a variety of types of monitoring sites located to:

- Determine the highest concentration expected to occur in the area covered by the network.
- Measure typical concentrations in areas of high population density.
- Determine the impact of significant sources or source categories on air quality.
- Determine background concentration levels.
- Determine the extent of regional pollutant transport among populated areas; and in support of secondary standards.
- Measure air pollution impacts on visibility, vegetation damage, or welfare-based impacts.

These six objectives will be used during the development of data quality objectives (Section 3). As one reviews the objectives, it becomes apparent that it will be rare that individual sites can be located to meet more than two or three objectives. Therefore, monitoring organizations need to choose the sites that are most representative of its priority objective(s).

Through the process of implementing the CAA, six major categories of monitoring stations or networks that measure the air pollutants have been developed. These networks are described below. In addition, a fact sheet on each network (with the exception of SPMs) can be found in Appendix A.

State and Local Air Monitoring Stations (SLAMS) including Tribal Monitoring Stations

The SLAMS consist of a network of monitoring stations whose size and distribution is largely determined by the monitoring requirements for NAAQS comparison and the needs of monitoring organizations to meet their respective tribal/state implementation plan (TIP/SIP) requirements. The TIP/SIPs provide for the implementation, maintenance, and enforcement of the national ambient air quality standards (NAAQS) in each air quality control region within a tribe/state. The Handbook is largely devoted to guidance related to the SLAMS network. SLAMS exclude special purpose monitor (SPM) stations and include NCore, PAMS, and all other State or locally operated stations that have not been designated as SPM stations.

Special Purpose Monitoring Stations (SPMs)

An SPM station means a monitor included in a monitoring organizations network has been designated as a special purpose monitor station in its monitoring network plan and in the Air Quality System (AQS), and which the agency does not count when showing compliance with the minimum monitoring requirements for the number and siting of monitors of various types. SPMs provide for special studies needed by the monitoring organizations to support TIPs/SIPs and other air program activities. These monitors are not counted towards the monitoring organization's minimum requirements established in CFR for monitoring certain pollutants. The SPMs are not permanently established and can be adjusted to accommodate changing needs and priorities. The SPMs are used to supplement the fixed monitoring network as circumstances require and resources permit. If the data from SPMs are used for SIP purposes, they must meet all QA, siting and methodology requirements for SLAMS monitoring. Any SPM data collected by an air monitoring agency using a Federal reference method (FRM), Federal equivalent method (FEM), or approved regional method (ARM) must meet the requirements of 40 CFR Part 58.11, 58.12, and the QA requirements in 40 CFR Part 58, Appendix A or an approved alternative to Appendix A to this part. Compliance with the probe and monitoring path siting criteria in 40 CFR Part 58, Appendix E is optional but encouraged except when the monitoring organization's data objectives are inconsistent with those requirements. Data collected at an SPM using a FRM, FEM, or ARM meeting the requirements of Appendix A must be submitted to AQS according to the requirements of 40 CFR Part

58.16. Data collected by other SPMs may be submitted. The monitoring agency must also submit to AQS an indication of whether each SPM reporting data to AQS meets the requirements of Appendices A and E.

$PM_{2.5}$ Chemical Speciation Network (CSN)[3]

As part of the effort to monitor particulate matter, EPA monitors and gathers data on the chemical makeup of these particles. EPA established a chemical speciation network consisting of approximately 300 monitoring sites. These sites are placed at various SLAMS across the Nation. Fifty-four of these CSN sites, the Speciation Trends Network (STN), will be used to determine, over a period of several years, trends in concentration levels of selected ions, metals, carbon species, and organic compounds in $PM_{2.5}$. Further breakdown on the location or placement of the trends sites requires that approximately 20 of the monitoring sites be placed at existing Photochemical Assessment Monitoring Stations (PAMS). The placement of the remaining trends sites will be coordinated by EPA, the regional offices, and the monitoring organizations. Locations will be primarily in or near larger Metropolitan Statistical Areas (MSAs). The remaining chemical speciation sites will be used to enhance the required trends network and to provide information for developing effective TIPs/SIPs.

The STN is a component of the National $PM_{2.5}$ SLAMS. Although the STN is intended to complement the SLAMS activities, STN data will not be used for attainment or nonattainment decisions. The programmatic objectives of the STN network are:

- annual and seasonal spatial characterization of aerosols;
- air quality trends analysis and tracking the progress of control programs;
- comparing, aggregating and evaluating the chemical speciation data set to the data collected from the IMPROVE network; and
- development of emission control strategies.

Photochemical Assessment Monitoring Stations (PAMS)[4]

Section 182(c)(1) of the 1990 CAA required the Administrator to promulgate rules for the enhanced monitoring of ozone, oxides of nitrogen (NOx), and volatile organic compounds (VOC) to obtain more comprehensive and representative data on ozone air pollution. Immediately following the promulgation of such rules, the affected states/tribes were to commence such actions as were necessary to adopt and implement a program to improve ambient monitoring activities and the monitoring of emissions of NOx and VOC. Each TIP/SIP for the affected areas must contain measures to implement the ambient monitoring of such air pollutants. The subsequent revisions to 40 CFR 58 required states to establish Photochemical Assessment Monitoring Stations (PAMS) as part of their SIP monitoring networks in ozone nonattainment areas classified as serious, severe, or extreme.

The chief objective of the enhanced ozone monitoring revisions is to provide an air quality database that will assist air pollution control agencies in evaluating, tracking the progress of, and, if necessary, refining control strategies for attaining the ozone NAAQS. Ambient concentrations of ozone and ozone precursors will be used to make attainment/nonattainment decisions, aid in tracking VOC and NOx emission inventory reductions, better characterize the nature and extent of the ozone problem, and to evaluate air quality trends. In addition, data from the PAMS will provide an improved database for evaluating photochemical model performance, especially for future control strategy mid-course corrections as part of

[3] http://www.epa.gov/ttn/amtic/speciepg.html
[4] http://www.epa.gov/ttn/amtic/pamsmain.html

the continuing air quality management process. The data will help to ensure the implementation of the most cost-effective regulatory controls.

National Air Toxic Trends Stations (NATTS)[5]

There are currently 188 hazardous air pollutants (HAPs) or Air Toxics (AT) regulated under the CAA. These pollutants have been associated with a wide variety of adverse health and ecosystem effects. In 1999, EPA finalized the Urban Air Toxics Strategy (UATS). The UATS states that emissions data are needed to quantify the sources of air toxics impacts and aid in the development of control strategies, while ambient monitoring data are needed to understand the behavior of air toxics in the atmosphere after they are emitted. Part of this strategy included the development of the National Air Toxics Trends Stations (NATTS). Specifically, it is anticipated that the NATTS data will be used for:

- tracking trends in ambient levels to evaluate progress toward emission and risk reduction goals;
- directly evaluating public exposure & environmental impacts in the vicinity of monitors;
- providing quality assured data for risk characterization;
- assessing the effectiveness of specific emission reduction activities; and
- evaluating and subsequently improving air toxics emission inventories and model performance.

Currently the NATTS program is made up of 22 monitoring sites; 15 representing urban communities and 7 representing rural communities.

National Core Monitoring Network (NCore)[6]

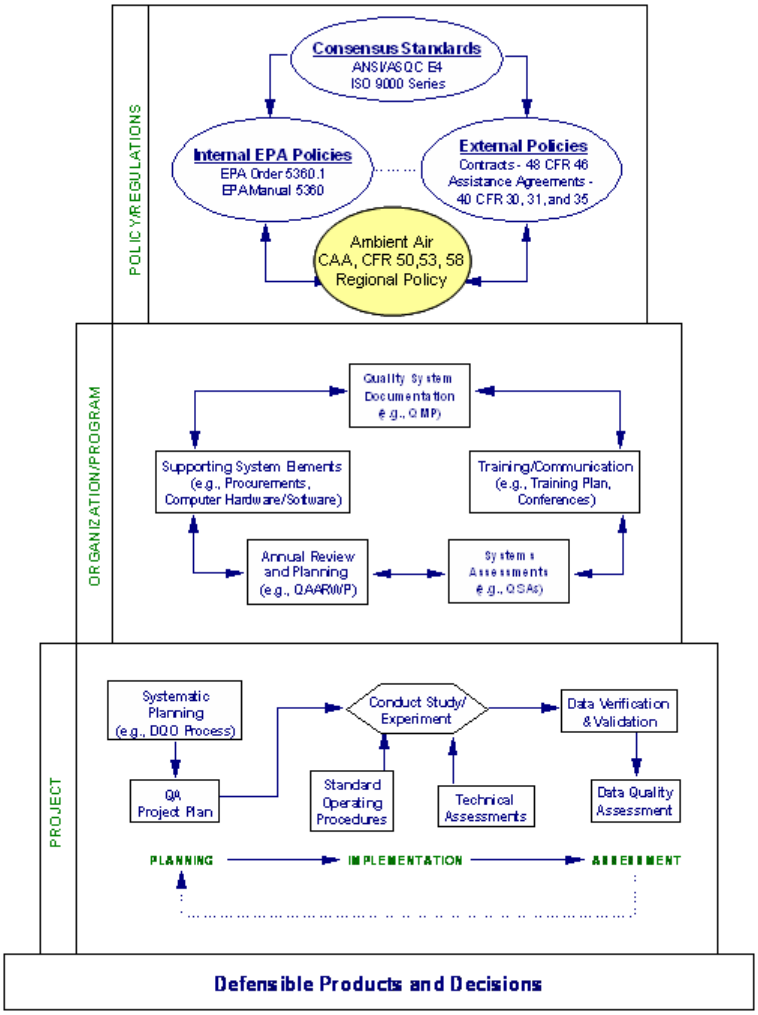
The NCore multi-pollutant stations are part of an overall strategy to integrate multiple monitoring networks and measurements. Each state (i.e., the fifty states, District of Columbia, Puerto Rico, and the Virgin Islands) is required to operate at least one NCore site. Monitors at NCore multi-pollutant sites will measure particles ($PM_{2.5}$, speciated $PM_{2.5}$, $PM_{10\text{-}2.5,}$ speciated $PM_{10\text{-}2.5}$), O_3, SO_2, CO, nitrogen oxides ($NO/NO_2/NO_y$), and basic meteorology. In addition a number of NCore sites will be selected to measure lead (Pb).

The objective is to locate sites in broadly representative urban (about 55 sites) and rural (about 20 sites) locations throughout the country to help characterize regional and urban patterns of air pollution. The NCore network should be fully operational by 2011.

In many cases, monitoring organizations will collocate these new stations with STN sites measuring speciated $PM_{2.5}$ components, PAMS sites already measuring O_3 precursors, and/or NATTS sites measuring air toxics. By combining these monitoring programs at a single location, EPA and its partners will maximize the multi-pollutant information available. This greatly enhances the foundation for future health studies, NAAQS revisions, validation of air quality models, assessment of emission reduction programs, and studies of ecosystem impacts of air pollution.

[5] http://www.epa.gov/ttn/amtic/airtoxpg.html
[6] http://www.epa.gov/ttn/amtic/ncore/index.html

1.2 The EPA Quality System Requirements



A quality system is the "blueprint" or framework by which an organization applies sufficient quality control (QC) and quality assurance (QA) practices to ensure that the results of its environmental programs meet or exceed expectations. It is based upon the model of planning the work, implementing what is planned, assessing the results against the performance criteria, reporting on data quality and making improvements if necessary. Figure 1.2 provides an illustration of the pertinent regulations and policy that drive the development of a quality system. Some important aspects of this figure are explained below.

1.2.1 Policy and Regulations

At the highest level, standards and regulations determine what QA is required for the monitoring program and, therefore, set the stage for program and project specific guidance. The standards and regulations pertinent to the Ambient Air Quality Monitoring Program include:

Figure 1.2. Hierarchy of quality system development

- **ANSI/ASQ E4** – EPA's quality system is based on the document: *American National Standard-Quality Systems for Environmental Data and Technology Programs-Requirements with Guidance for use (ANSI/ASQ E4-2004)*[7]. 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.

- **Internal Policies**- EPA Order 5360.1[8] expresses the EPA policy in regards to the quality system development for all EPA organizations and by non-EPA organizations performing work on behalf of EPA through extramural agreements. The EPA QA Orders adhere to E4 under the authority of the Office of Management and Budget. Section 1.2.5 below provides more specifics on this Order.

[7] http://webstore.ansi.org/default.aspx
[8] http://www.epa.gov/quality1/.

NOTE: During development of this document EPA Order 5360.1 was under revision and its new reference may be changed to CIO 2105.0. This Handbook will continue to use 5360.1 as the current reference.

- **External Policies** - Refers to the Code of Federal Regulation (CFR). The references to the external regulations are those that apply to the quality system requirements for external funding. Those most important to the monitoring community are 40 CFR Parts 30, 31 and 35 but are not specific to ambient air monitoring.

- **Ambient Air -**The consensus standards (E4) and internal and external requirements then funnel to the Headquarters and Regional programs (yellow circle) where additional QA requirements, specific to a particular monitoring program, are included. Ambient air requirements include documents like the Clean Air Act (CAA) and 40 CFR Parts 50, 53 and 58 which are specific to ambient air monitoring.

1.2.2 Organization/Program

This area in Figure 1.2 refers to the monitoring organization and is used to describe its overall quality system, usually in the form of a **quality management plan (QMP)**[9]. Many monitoring organizations perform a multitude of data collection activities for different media (e.g., air, water, solid waste) where ambient air monitoring might be only one branch in a large organization. It is the responsibility of each organization to have a QMP that demonstrates an acceptable quality system. QMPs are approved by the EPA Regions.

1.2.3 Project

The term "project" refers to the specific environmental data operation (EDO) that occurs at the monitoring organization. An environmental data operation refers to the work performed to obtain, use, or report information pertaining to environmental processes and conditions. This handbook provides the majority of the guidance necessary for the monitoring organizations to develop QA project plans specific to its data collection needs. Other guidance has been developed specific to a part of the measurement system (i.e., calibration techniques) or to specific methods. A listing of this guidance is included in Appendix B. It is anticipated that the majority of these documents will be available on the AMTIC bulletin board.

1.2.4 Quality System Requirements for EPA Funded Programs

EPA's national quality system requirements can be found in EPA QA Policy 5360.1[10]. Any organization using EPA funds for the collection of environmental data are covered under 5360.1 and must develop, implement, and maintain a quality system that demonstrates conformance to the minimum specifications of ANSI/ASQC E4-1994 and that additionally provides for the following (excerpt from 5360.1):

1. A quality assurance manager (QAM), or person/persons assigned to an equivalent position, who functions independently of direct environmental data generation, model development, or technology development responsibility; who reports on quality issues to the senior manager

[9] http://www.epa.gov/quality1/qs-docs/r2-final.pdf
[10] http://www.epa.gov/irmpoli8/ciopolicy/2105-0.pdf

having executive leadership authority for the organization; and who has sufficient technical and management expertise and authority to conduct independent oversight of and assure the implementation of the organization's quality system in the environmental programs of the organization.

2. A Quality Management Plan (QMP), which documents the organization's quality policy, describes its quality system, identifies the environmental programs to which the quality system applies, and which is implemented following approval by the organization's executive leadership.
3. Sufficient resources to implement the quality system defined in the approved QMP.
4. Assessments of the effectiveness of the quality system at least annually.
5. Submittal to the Office of Environmental Information (OEI) of the Quality Assurance Annual Report and Work Plan (QAARWP) for the organization that summarizes the previous years QA and QC activities and outlines the work proposed for the current year (not applicable to air monitoring organizations)
6. Use of a systematic planning approach to develop acceptance or performance criteria for all work covered by this Order.
7. Approved Quality Assurance Project Plans (QAPPs), or equivalent documents defined by the QMP, for all applicable projects and tasks involving environmental data with review and approval having been made by the EPA QAM (or authorized representative defined in the QMP). QAPPs must be approved prior to any data gathering work or use, except under circumstances requiring immediate action to protect human health and the environment or operations conducted under police powers.
8. Assessment of existing data, when used to support Agency decisions or other secondary purposes, to verify that they are of sufficient quantity and adequate quality for their intended use.
9. Implementation of Agency-wide Quality System requirements in all applicable EPA-funded extramural agreements
10. Implementation of corrective actions based on assessment results.
11. Appropriate training, for all levels of management and staff, to assure that QA and QC responsibilities and requirements are understood at every stage of project implementation.

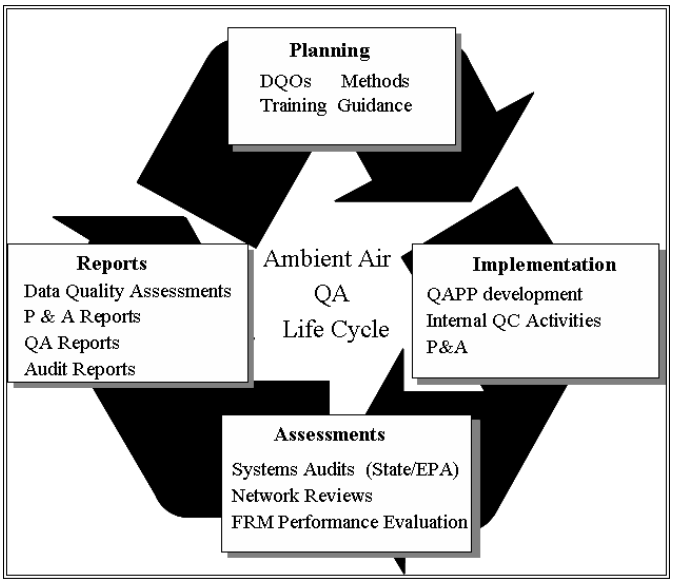


Figure 1.3 Ambient Monitoring Quality Monitoring QA Program

1.3 The Ambient Air Monitoring Program Quality System

Figure 1.3 represents the stages of the Ambient Air Quality Monitoring QA Program. OAQPS modified EPA 5360.1 as appropriate in order to provide data of the quality needed to meet the Ambient Air Monitoring Program objectives. The planning, implementation, assessment and reporting tools will be briefly discussed below.

1.3.1 Planning

Planning activities include:

Data Quality Objectives (DQOs) - DQOs are qualitative and quantitative statements derived from the outputs of the DQO Process that: (1) clarify the study objective; (2) define the most appropriate

type of data to collect; (3) determine the most appropriate conditions from which to collect the data; and (4) specify tolerable limits on decision errors which will be used as the basis for establishing the quantity and quality of data needed to support the decision. Section 3 will provide more information on the DQO Process.

Methods- Reference methods and measurement principles have been written for each criteria pollutant. For monitoring for comparison to the NAAQS, monitoring organizations must use methods that are designated as Federal Reference (FRM) Federal Equivalent (FEM)[11] or approved regional monitor (ARM)[12] for $PM_{2.5}$. ORD NERL implements the FRM/FEM designation program and provides technical assistance in the $PM_{2.5}$ ARM process. Approved FRM/FEM methods refer to individual monitoring instruments that either provide a pollutant concentration or provide a sample for further laboratory analysis and must be operated minimally as required in 40 CFR Part 50. Since these methods cannot be applied to the actual instruments acquired by each monitoring organization, they should be considered as guidance for detailed standard operating procedures that would be developed by monitoring organizations as part of an acceptable QAPP.

Training - Training is an essential part of any good monitoring program. Training activities are discussed in Section 4.

Guidance - This QA Handbook as well as many other guidance documents have been developed for the Ambient Air Quality Monitoring Program. Many of the monitoring networks listed above have developed technical assistance documents and generic QAPPs to help guide personnel in the important aspects of these programs. A list of these documents is included in Appendix B.

1.3.2 Implementation

Implementation activities include:

QMP/QAPP Development - Each state, local, and tribal organization must develop a QMP and QAPP.

- **QMP** - describes the quality system in terms of the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, and assessing activities involving environmental data collection. The QMP is not specific to any particular project, but related to how the monitoring organization implements its quality system.

- **QAPP**- is a formal document describing, in comprehensive detail, the necessary QA/QC and other technical activities that must be implemented to ensure that the results of work performed will satisfy the stated performance criteria, which may be in the form of a data quality objective (DQO). The QAPP is specific to a particular monitoring project. Standard operating procedures (SOPs) are part of the QAPP development process and are vital to the quality of any monitoring program. The QAPP should be detailed enough to provide a clear description of every aspect of the project and include information for every member of the project staff, including samplers, lab staff, and data reviewers. The QAPP facilitates communication among clients, data users, project staff, management, and external reviewers.

[11] http://www.epa.gov/ttn/amtic/criteria.html
[12] 40 CFR Part 58 Appendix C Section 2.4

Guidance for the development of both QMPs and QAPPs can be found on the EPA Quality Staff's website[13]. In addition, EPA has provided flexibility on how EPA organizations implement this policy, allowing for use of a graded approach. Since EPA funds the collection and use of data for a number of monitoring objectives and for organizations with a broad range of capabilities, flexibility in the QMP and QAPP requirements is necessary. For example, data collection for the purpose of comparison to the National Ambient Air Quality Standards (NAAQS) will require more stringent requirements, while monitoring programs for special purposes may not require the same level of quality assurance. The level of detail of QMPs and QAPPs, as explained by the EPA Quality Staff in the EPA Quality Manual, "should be based on a common sense, graded approach that establishes the QA and QC requirements commensurate with the importance of the work, available resources, and the unique needs of the organization." The ambient air program has developed a graded approach that will help tribes and smaller monitoring organizations develop both a QMP and QAPPs. Appendix C provides information on this approach.

Internal QC Activities - The quality control (QC) system is used to fulfill requirements for quality. It is the overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer. In the case of the Ambient Air Quality Monitoring Network, QC activities are used to ensure that measurement uncertainty is maintained within established acceptance criteria for the attainment of the DQOs.

Federal regulation provides for the implementation of a number of qualitative and quantitative checks to ensure that the data will meet the DQOs. Each of the checks attempt to evaluate phases of measurement uncertainty. Some of these checks are discussed below and in Section 10.

- **Precision and Bias (P & B) Checks** - These checks are described in the 40 CFR Part 58, Appendix A. These checks can be used to provide an overall assessment of measurement uncertainty.
- **Zero/Span Checks** - These checks provide an internal quality control check of proper operation of the measurement system.
- **Annual Certifications** - A certification is the process which ensures the traceability and viability of various QC standards. Standard traceability is the process of transferring the accuracy or authority of a primary standard to a field-usable standard. Traceability protocols are available for certifying a working standard by direct comparison to a NIST-SRM[14, 15].
- **Calibrations** - Calibrations should be carried out at the field monitoring site by allowing the analyzer to sample test atmospheres containing known pollutant concentrations. Calibrations are discussed in Section 12.

1.3.3 Assessments

Assessments, as defined in *ANSI/ASQC-E4* and EPA's document, *Guidance on Technical Audits and Related Assessments for Environmental Data Operations* (QA/G-7)[16], are evaluation processes used to measure the performance or effectiveness of a system and its elements. It is an all inclusive term used to denote any of the following: audit, performance evaluation, management systems review, peer review,

[13] (http://www.epa.gov/quality1/)
[14] http://www.epa.gov/ttn/amtic/files/ambient/criteria/reldocs/4-79-056.pdf
[15] http://www.epa.gov/appcdwww/pubs/600r97121/600r97121.htm
[16] http://www.epa.gov/quality1/qs-docs/g7-final.pdf

inspection, or surveillance. Assessments for the Ambient Air Quality Monitoring Program, as discussed in Section 15, include:

Technical Systems Audits (TSA) -A TSA is an on-site review and inspection of a State or local agency's ambient air monitoring program to assess its compliance with established regulations governing the collection, analysis, validation, and reporting of ambient air quality data. Both EPA and State organizations perform TSAs. Procedures for this audit are discussed in general terms in Section 15.

Network Reviews - The network review is used to determine how well a particular air monitoring network is achieving its required air monitoring objective(s) and how it should be modified to continue to meet its objective(s). Network reviews are discussed in Section 15.

Performance Evaluations- Performance evaluations are a type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of an analyst, laboratory, or measurement system. The following performance evaluations, discussed in further detail in Section 15, are included in the Ambient Air Quality Monitoring Program:

- **Monitoring Organization Performance Evaluations (Audits)** - These performance evaluation audits are used to provide an independent assessment of the measurement operations of each instrument being audited. This is accomplished by comparing performance samples or devices of "known" concentrations or values to the values measured by the instruments being audited.

- **National Performance Evaluation Program (NPEP) –** These performance evaluation audits are implemented at the federal level although some programs may be implemented by the monitoring organizations if certain requirements are met.

1.3.4 Reports

All concentration data should be assessed in order to evaluate the attainment of the DQOs or the monitoring objectives. These assessments can be documented using the following types of reports:

- **Data quality assessment (DQA)** is the scientific and statistical evaluation to determine if data are of the right type, quality, and quantity to support their intended use (DQOs). QA/QC data can be statistically assessed at various levels of aggregation to determine whether the DQOs have been attained. Data quality assessments of precision, bias, and accuracy can be aggregated at the following three levels.
    - **Monitor**- monitor/method designation
    - **PQAO** - monitors in a method designation, all monitors
    - **National** - monitors in a method designation, all monitors
- **P & B reports** are generated annually and evaluate the precision and bias of data against the acceptance criteria discussed in Section 3.
- **QA reports** provide an evaluation of QA/QC data for a given time period to determine whether the data quality objectives were met. Discussions of QA reports can be found in Sections 16 and 18.
- **Meetings and Calls** at various national meetings and conference calls can be used as assessment tools for improving the network. It is important that information derived from the avenues of communication is appropriately documented.