QUALITY ASSURANCE PROJECT PLAN FOR THE CARBON MONOXIDE AMBIENT AIR MONITORING PROGRAM

December 1, 2011

The Department of Environmental Quality protects and enhances Virginia's environment, and promotes the health and well-being of the citizens of the Commonwealth.

Document Revision Record

Revision Number	Changes From Previous Version	Revision Date
Revision No. 0	Original Version	December 1, 2011

FOREWORD

This document has been reviewed either by the EPA Regional QA Manger or QA Officer, or both, and has been found to provide enough detail about the Commonwealth of Virginia carbon monoxide monitoring program to be considered acceptable. (See approval page.)

The following elements contain a description of the Quality Assurance Project Plan (QAPP) for the environmental data operations involved in monitoring for Carbon Monoxide as part of the ambient air monitoring program for the Commonwealth of Virginia. EPA regulation mandates the preparation of this QAPP; therefore, EPA approval must be obtained as a vital part of proper data collection quality assurance techniques.

The primary purpose of the QAPP is to provide an overview of the program, to describe the need for the measurement, and to characterize the QA/QC activities to be applied. Every aspect of the program is discussed in this report. In addition, the document identifies key personnel and provides an explanation of the tasks each will perform.

This QAPP was written in accordance with EPA regulations and guidance as described in the *EPA QA/R-5, EPA Requirements for Quality Assurance Project Plans, EPA QA/G-5, Guidance for Quality Assurance Project Plans,* and EPA's Model QAPP. All pertinent elements of the QAPP regulations and guidance are addressed herein.

ACKNOWLEDGMENTS

This QAPP is based closely on a QAPP produced by the Virginia DEQ for the PM2.5 Project. The PM2.5 QAPP was originally based on the Model QAPP that resulted from the combined efforts of staff members from the EPA Office of Air Quality Planning and Standards, the EPA National Exposure Research Laboratory, and the EPA Regional Offices, as well as by representatives from state and local organizations. The Virginia DEQ Carbon Monoxide QAPP Work Group developed and reviewed the material found in this QAPP. The Virginia DEQ Carbon Monoxide QAPP work group would also like to acknowledge the help of the Delaware Office of Air Monitoring for the use of their draft QAPP for continuous monitors and the National Park Service for the use of their draft QAPP for the continuous gas monitoring program. The work of these people as well as the entire DEQ Office of Air Quality Monitoring and EPA Region III is appreciated.

ACRONYMS AND ABBREVIATIONS

AQS	Air Quality System
ANSI	American National Standards Institute
APTI	Air Pollution Training Institute
ASTM	American Society for Testing and Materials
AWMA	Air and Waste Management Association
CAA	Clean Air Act
CFR	Code of Federal Regulations
COC	Chain of Custody
DAS	Data Acquisition System
DCLS	Division of Consolidated Laboratory Services
DCO	Document Control Officer
DEQ	Department of Environmental Quality
DQA	Data Quality Assessment
DQIs	Data Quality Indicators
DQOs	Data Quality Objectives
EDO	Environmental Data Operation
EMAD	Emissions, Monitoring, and Analysis Division
EPA	Environmental Protection Agency
FAR	Federal Acquisition Regulations
FEM	Federal Equivalent Method
FIPS	Federal Information Processing Standards
FRM	Federal Reference Method
GIS	Geographical Information Systems
GLP	Good Laboratory Practice
IMPROVE	Interagency Monitoring of Protected Visual Environments
LAN	Local Area Network

MPA	Monitoring Planning Area
MQAG	Monitoring Quality Assessment Group
MQOs	Measurement Quality Objectives
MSA	Metropolitan Statistical Area
MSR	Management System Review
NAAQS	National Ambient Air Quality Standards
NAMS	National Air Monitoring Station
NIST	National Institute of Standards and Technology
NPAP	National Performance Audit Program
OAQM	Office of Air Quality Monitoring
OAQPS	Office of Air Quality Planning and Standards
OARM	Office of Administration and Resources Management
ORD	Office of Research and Development
PAMS	Photochemical Assessment Monitoring Site
PC	Personal Computer
POC	Pollutant Occurrence Code
PD	Percent Difference
PE	Performance Evaluation
PM2.5	Particulate Matter $\leq$ 2.5 microns in diameter
PQAO	Primary Quality Assurance Organization
PTFE	Polytetrafluoroethylene
Q_a	Monitor flow rate at ambient (actual) conditions of temperature and pressure.
QA/QC	Quality Assurance/Quality Control
QA	Quality Assurance
QAAR	Quality Assurance Annual Report

QADD	Quality Assurance Division Director
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
SIPs	State Implementation Plans
SLAMS	State and Local Monitoring Stations
SOP	Standard Operating Procedure
SOW	Statement or Scope of Work
SPMS	Special Purpose Monitoring Stations
SYSOP	System Operator
T_a	Temperature, ambient or actual
TSA	Technical System Audit
TSP	Total Suspended Particulate
VA	Virginia
V_a	Air volume, at ambient or actual conditions
VOC	Volatile Organic Compound
VSLA	Virginia State Library and Archives
WAM	Work Assignment Manager

1.0 QA PROJECT PLAN IDENTIFICATION AND APPROVAL

Title: Virginia DEQ QA Project Plan for the Carbon Monoxide Ambient Air Monitoring Program.

The attached QAPP for the Carbon Monoxide Ambient Air Quality Monitoring Program is hereby recommended for approval and commits the Department to follow the elements described within.

Virginia DEQ/Air Division/Air Quality Monitoring Office

1) Signature: _____ Date:_____
Program Manager - Continuous Air Monitoring

2) Signature: _____ Date:_____
Data Quality Assurance Engineer

3) Signature: _____ Date:_____
Director, Office of Air Quality Monitoring

EPA Region 3

1) Signature: _____ Date:_____
Criteria Pollutants Program Manager

2) Signature: _____ Date:_____
QA Officer – Air Monitoring & Analysis Branch

3) Signature: _____ Date:_____
Technical Lead – Air Monitoring & Analysis Branch

2.0 TABLE OF CONTENTS

3.0 DISTRIBUTION

A copy of this document has been distributed to the persons whose names are listed below. The document also will be available generally in electronic format. Each regional office and each air satellite office will receive a copy which will be available for public inspection.

Michael G. Dowd	Air Division Director	DEQ – Air
Charles L. Turner	OAQM Director	Air Quality Monitoring
Thomas F. Jennings	Environmental Manager	Air Quality Monitoring
Anton Sorkin	Monitoring Engineer	Air Quality Monitoring
James Dinh	Environmental Manager	Air Quality Monitoring
Carolyn Stevens	Environmental Engineer	Air Quality Monitoring
Kara A. Jones	Monitoring Engineer	Air Quality Monitoring
Rudley Young	Chemist	Air Quality Monitoring
Denis Schmidt	Field Operations	Piedmont Reg. Office
Natalie Hirons	Field Operations	Tidewater Reg. Office
Katherine Evans	Field Operations	Northern Reg. Off.
Brandon Brumfield	Field Operations	Valley Reg. Off.
Blake Apo	Field Operations	Blue Ridge Reg. Off.
Reed Stanley	Field Operations	Southwest Reg. Off.
Liz Garcia	Environmental Specialist	National Park Service
Ken Hickman	Air Network Specialist	National Forest Ser.
Kia Hence	Project Officer	EPA Reg. Office
Andrew Hass	Project Officer	EPA Reg. Office

4.0 PROJECT/TASK ORGANIZATION

4. 1 ROLES AND RESPONSIBILITIES

Federal, state, tribal, and local agencies all have important roles in developing and implementing satisfactory air monitoring programs. As part of the planning effort, EPA is responsible for developing National Ambient Air Quality Standards (NAAQS) that define the quality of the data necessary to make comparisons to the NAAQS, and identify a minimum set of QC samples from which to judge data quality. The state and local organizations are charged with taking this information and developing and implementing a system that will meet the data quality requirements. When the system is in place and is producing reliable data, the EPA and the State and local organizations are responsible for assessing the quality of the data and taking corrective action when appropriate. The responsibilities of each organization follow.

4.1.1 OFFICE OF AIR QUALITY PLANNING AND STANDARDS (OAQPS)

Within EPA, OAQPS is the organization charged under the authority of the Clean Air Act (CAA) to protect and enhance the quality of the nation's air resources. OAQPS sets standards for pollutants considered harmful to public health or welfare and, in cooperation with EPA's Regional Offices and the States, enforces compliance with the standards through state implementation plans (SIPs) and regulations controlling emissions from stationary sources. The OAQPS evaluates the need to regulate potential air pollutants and develops national standards; works with State and local agencies to develop plans for meeting these standards; monitors national air quality trends and maintains a database of information on air pollution and controls; provides technical guidance and training on air pollution control strategies; and monitors compliance with air pollution standards.

Within the OAQPS Air Quality and Assessment Division, the Ambient Air Monitoring Group (AAMG) oversees the ambient air quality monitoring network. MQAG is responsible for the following:

- ensuring that the methods and procedures used in making air pollution measurements are adequate to meet the programs objectives, and that the resulting data are of satisfactory quality
- operating the national performance audit program (NPAP) and the Federal Reference Method/Federal Equivalent Method (FRM/FEM) performance evaluation program.
- evaluating the performance, through technical systems audits and management systems reviews, of organizations making air pollution measurements of importance to the regulatory process
- implementing satisfactory quality assurance programs over EPA's ambient air quality monitoring network
- ensuring that national regional laboratories are available to support chemical speciation and QA programs
- ensuring that guidance pertaining to the quality assurance aspects of the ambient air program are written and revised as necessary
- rendering technical assistance to the EPA Regional Offices and air pollution monitoring community

4.1.2 EPA REGION III OFFICE

Regional Offices have been developed to address environmental issues related to the states within their jurisdiction and to administer and oversee regulatory and congressionally mandated programs. The major quality assurance charge of EPA's Region III Office, with regard to the Ambient Air Quality Program, is coordinating quality assurance matters at the Regional level with the state and local agencies. This is accomplished by the appointing EPA Regional Project Officers who manage the technical aspects of the program, including the following:

- reviewing QAPPs by Regional QA Officers who are delegated the authority by the Regional Administrator to review and approve QAPPs for the Agency.
- supporting the FRM/FEM Performance Evaluation Program
- evaluating quality system performance, through technical systems audits and network reviews whose frequency is addressed in the Code of Federal Regulation
- acting as a liaison by making available the technical and quality assurance information developed by EPA Headquarters and the Region to the State and local agencies, and making EPA Headquarters aware of the unmet quality assurance needs of the state and local agencies

The Virginia DEQ will direct all technical and QA questions to Region III.

4.1.3 VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

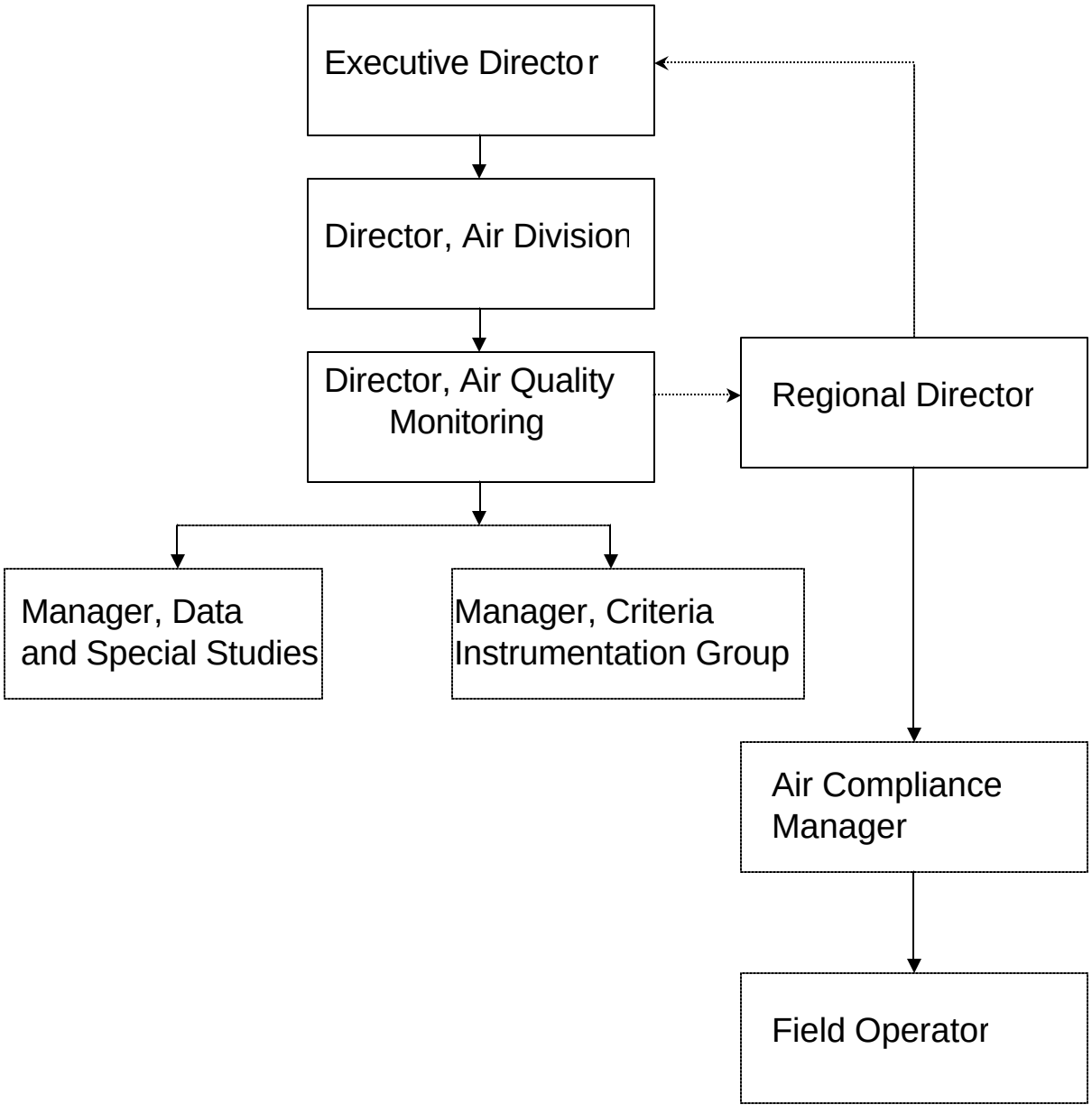
40 CFR Part 58 defines a State Agency as "the air pollution control agency primarily responsible for the development and implementation of a plan (SIP) under the Act (CAA)". Section 302 of the CAA provides a more detailed description of the air pollution control agency.

40 CFR Part 58 defines the Local Agency as "any local government agency, other than the state agency, which is charged with the responsibility for carrying out a portion of the plan (SIP)."

The major responsibility of state and local agencies is to implement a satisfactory monitoring program, which will include putting into action a meticulous quality assurance program. State and local agencies will perform quality assurance programs in all phases of the environmental data operation (EDO); including the field, their own laboratories, and in any consulting and contractor laboratories they may use to obtain data. An EDO is defined as work performed to obtain, use, or report information pertaining to environmental processes or conditions.

Figure 4.1 represents the organizational structure of the areas of the DEQ that carry out the activities of the carbon monoxide ambient air quality monitoring program.

Figure 4.1 DEQ Organizational Structure



The DEQ will implement the carbon monoxide air monitoring program. The major responsibilities are divided between the Office of Air Quality Monitoring and the staff from the various DEQ regional offices. The Office of Air Quality Monitoring will perform major program tasks, including sample procurement, major monitor repair, site installations, supply, data handling, and training, as well as various quality assurance functions. Regional staff will operate the monitors and perform various field QA and maintenance functions. The Fairfax County Health Department, the Alexandria Health Department, the USDA Forest Service, and the National Park Service also will operate carbon monoxide monitors as part of the DEQ's air monitoring network.

Various persons have been assigned direct responsibility and accountability for program operations and quality assurance. The following listing describes the program's organizational structure for data collection and QA/QC activities. This listing is not inclusive because the carbon monoxide program is still being developed; therefore, certain personnel have not been identified, and certain duties have not been assigned. Information on additional personnel will be included in QAPP revisions.

MANAGEMENT

Name:	Mike Dowd
Title:	Director of Air Division
QA Responsibilities:	Senior Air Manager; program direction

OFFICE OF AIR QUALITY MONITORING

Name:	Chuck Turner
Title:	Environmental Manager II
QA Responsibilities:	Director, Office of Air Quality Monitoring

Name:	Thomas F. Jennings
Title:	Environmental Manager I
QA Responsibilities:	Continuous Monitoring and Criteria Pollutants Manager;

Name:	James Dinh
Title:	Environmental Manager I
QA Responsibilities:	Data Quality Assessment Section Manager - directs data QA and reporting activities; carbon monoxide QA manager
Name:	Anton Sorkin
Title:	Senior Monitoring Engineer
QA Responsibilities:	Instrument Operations Section Leader;
Name:	Hiep Nguyen
Title:	Monitoring technician
QA Responsibilities:	Monitor Installation, maintenance; calibrations
Name:	James Biggs
Title:	Electronic Technician
QA Responsibilities:	Monitor installation; supply; maintenance; training; calibration
Name:	Kara A. Jones
Title:	Environmental Engineer Senior
QA Responsibilities:	Performance Audits Leader; data QA
Name:	Carolyn Stevens
Title:	Environmental Engineer Senior
QA Responsibilities:	Data QA Review Leader
Name:	Crystal Sorensen
Title:	Statistical Analyst and Performance Audits
QA Responsibilities:	Data QA; data submittal

ALEXANDRIA HEALTH DEPARTMENT

Name:	Julius Holmes
Title:	Environmental Affairs Specialist
QA Responsibilities:	Alexandria Monitoring Sites

REGIONAL OFFICES

Name:	Frank Adams
Title:	Air Compliance Manager
QA Responsibilities:	Regional monitor operation oversight

Name:	Blake Apo
Title:	Enforcement/Compliance Specialist Senior
QA Responsibilities:	Monitor operations; field QA

Name:	Charles B. King
Title:	Air Compliance Manager
QA Responsibilities:	Regional Monitor operations oversight

Name:	Denis Schmidt
Title:	Regional Monitoring technician
QA Responsibilities:	Monitor operations, field QA

Name:	John Brandt
Title:	Air Compliance Manager
QA Responsibilities:	Regional monitor operations oversight

Name:	Natalie Hirons
Title:	Environmental Specialist-Field

QA Responsibilities:	Monitor operations; field QA
Name:	David Hartshorn
Title:	Air Compliance Manager
QA Responsibilities:	Regional monitor operations oversight
Name:	James LaFratta
Title:	Air Compliance Engineer, FSO
QA Responsibilities:	Regional monitor operations
Name:	Peter Thaler
Title:	Environmental Specialist Senior-Field
QA Responsibilities:	Regional Monitor operations oversight

4.2 COMMUNICATIONS

Formal lines for communicating information about the status of the quality assurance program and its needs are essential to ensure that an effective quality assurance program is put into action within the DEQ. Accordingly, the DEQ routinely will be provided with assessments of the quality assurance program status, its problems, if any, and its needs.

Communication amongst the project manager, the quality assurance officer, appropriate EPA staff, and DEQ is a key element in developing and implementing the DEQ's quality assurance program. The following organizational chart demonstrates the official and the unofficial lines of communication for this project (Figure 4-2).

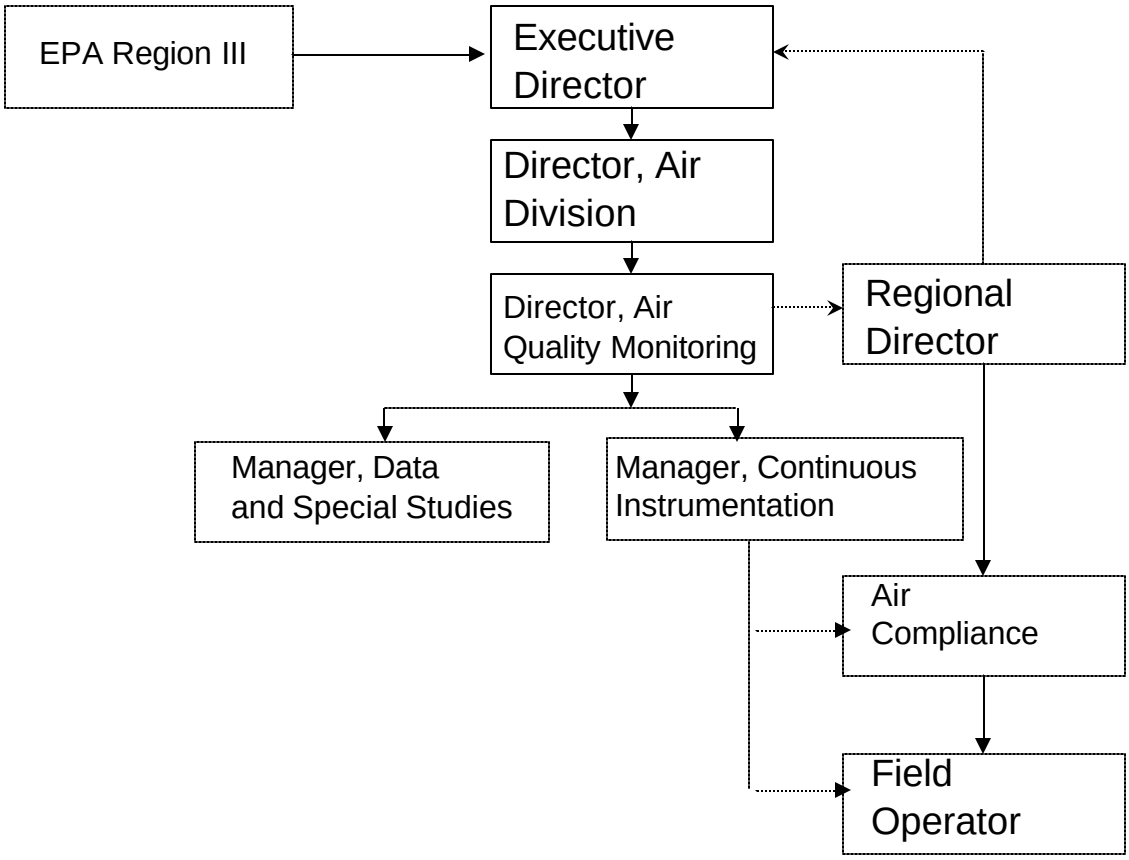


Figure 4-2 Lines of Communication

5.0 PROBLEM DEFINITION/BACKGROUND

5.1 PROBLEM STATEMENT AND BACKGROUND

Between the years 1900 and 1970, the amount of seven principal ambient-air pollutants increased significantly. The principal pollutants, also called *criteria pollutants,* are particulate matter (PM10, PM2.5); sulfur dioxide; ozone; nitrogen dioxide; carbon monoxide; and lead. In 1970, the Clean Air Act (CAA) was signed into law. The CAA and its amendments provide the framework on which all pertinent U.S. organizations build their air quality protection programs. This framework provides the guidelines for state/local organizations to monitor criteria pollutants through the Air Quality Monitoring Program (http://www.epa.gov/oar/caa).

Carbon monoxide (CO) is a colorless, odorless gas that is produced by incomplete burning of carbon compounds in fossil fuels (gasoline, natural gas, coal, oil, etc.). Over half of the CO emissions in the country come from motor vehicle exhaust. Other sources include construction equipment, boats, lawnmowers, woodstoves, forest fires, and industrial manufacturing processes. Carbon monoxide is harmful because it reacts in the bloodstream, reducing the amount of oxygen that is supplied to the heart and brain. CO can be harmful at lower levels to people who suffer from cardiovascular disease, like angina, arteriosclerosis, or congestive heart failure. At high levels, CO can impair brain function, causing vision problems, reduce manual dexterity, and reduce ability to perform complicated tasks. At very high levels, carbon monoxide can be deadly.

This QAPP focuses on the QA activities associated with monitoring carbon monoxide.

Air quality monitoring is performed generally for one or more of the following purposes:

- To judge compliance with and/or progress made towards meeting the National ambient air quality standards.

- To observe pollution trends throughout the region, including non-urban areas.
- To provide a data base for research and evaluation of effects

With the end use of the air quality samples as a prime consideration, various networks can be designed to meet one of six basic monitoring objectives listed below:

- To determine the highest concentrations to occur in the area covered by the network
- To determine representative concentrations in areas of high population density
- To determine the impact on ambient pollution levels of significant source or source categories
- To determine general background concentration levels
- To determine the extent of Regional pollutant transport among populated areas, and in support of secondary standards
- To determine the impact on health in more rural and remote areas

The monitoring network consists of four major categories of monitoring stations that measure the criteria pollutants. These stations are described as follows.

The **State and Local Air Monitoring Sites (SLAMS)** consist of a network of monitoring stations whose size and distribution is largely determined by the needs of state and local air pollution control agencies to meet their respective State implementation plan (SIP) requirements.

The **National Air Monitoring Sites (NAMS)** are a subset of the SLAMS network, with emphasis being given to urban and multi-source areas. In effect, they are key sites under SLAMS, with emphasis on areas of maximum concentrations and high population density.

The **Special Purpose Monitoring Stations (SPMs)** provide for special studies needed by the state and local agencies to support their State implementation plans (SIPs) and other air program activities. The SPMS are not permanently established and, thus, can be adjusted easily 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 and methodology requirements for SLAMS monitoring.

This QAPP focuses only on the QA activities of the SLAMS and NAMS network, and the objectives of this network, which include any monitor used for comparison to the NAAQS.

Throughout this document, the term "decision maker" will be used. Decision makers are the ultimate users of ambient air data and therefore may be responsible for such activities as setting and making comparisons to the NAAQS, and evaluating trends. Because there is more than one objective for this data, and more than one decision maker, the quality of the data will be based on the highest-priority objective to determine violations of the NAAQS. This QAPP will describe how the Virginia DEQ Carbon Monoxide Ambient Air Quality Monitoring Program proposes to control and evaluate data quality to meet the NAAQS data quality objectives.

6.0 PROJECT/TASK DESCRIPTION

6.1 DESCRIPTION OF WORK TO BE PERFORMED

In general, the measurement goal of the Ambient Air Quality Monitoring Program is to estimate the concentration of the criteria pollutants in units appropriate for determining compliance with the NAAQS. For the SLAMS network, which is what this QAPP describes, the primary goal is to compare the measured concentrations to National Ambient Air Quality Standards (NAAQS).

The following sections describe the requirements for the routine field and monitoring laboratory activities for the network.

6.2 FIELD ACTIVITIES

The performance requirements of the air monitors have been specified by EPA and can be found in 40 CFR Part 50. The design and performance specifications must be met before a specific monitor can receive official EPA designation as a FRM or FEM type monitor. Virginia will acquire and use only EPA approved monitors; therefore Virginia assumes that these monitoring instruments are adequate for the monitoring of gaseous ambient air pollutants.

6.3 MONITORING LABORATORY ACTIVITIES

Monitoring Laboratory personnel will perform those activities that support continued successful operation of the statewide ambient air-quality monitoring network. The monitoring laboratory personnel and field operators shall perform those duties such that the data quality provided meets or exceeds EPA QA requirements. Monitoring laboratory personnel shall be responsible for preparing consumables for field use. This may include, but not be limited to; maintaining standards, maintaining consumable inventories (e.g. silica gel, charcoal, Purafil, Monoxycon, probe lines, CO cylinders), shipping and receiving activities, and performing instrument audits (performance evaluations).

6.4 PROJECT ASSESSMENT TECHNIQUES

An assessment is an evaluation process used to measure the performance or effectiveness of a system and its elements. Table 6-4 provides information on the type of assessment and its frequency.

Table 6-4 Assessment Schedule

Assessment Type	Assessment Agency	Frequency
Technical Systems Audit	EPA Regional Office DEQ - Air Monitoring Office	1 every 3 years 1 every 3 years
Network Review	EPA Regional Office DEQ Air Monitoring Office and Regional Offices	Every year App B 1/year
FRM/FEM Performance Evaluation	DEQ – Air monitoring Office	Minimum of once per year
Data Quality Assessment	DEQ Air Monitoring Office	Every year
NPAP - Through the Probe (TTP) Audits	EPA – Region III	As funding allows

6.5 PROJECT RECORDS

The DEQ has a records retention schedule that is in conformance with the records retention regulations for the Commonwealth of Virginia and administered by the Virginia State Library and Archives. Additional information on the records retention program is provided in Section 9.

7.0 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

7.1 DATA QUALITY OBJECTIVES (DQOs)

Derived from the DQO Process, DQOs are qualitative and quantitative statements that clarify the monitoring objectives, define the appropriate type of data; and specify the tolerable levels of decision errors for the monitoring program. By applying the DQO Process to the development of a quality system for gaseous pollutants, the EPA, as well as states and localities, guard against committing resources to data collection efforts that do not support a defensible decision. The DQOs were based on the data requirements of the decision maker(s). Regarding the quality of the measurement system, the objective is to control precision and bias in order to reduce the probability of decision errors.

Utilizing the DQO process, the EPA will determine the specific objectives regarding the quality of the ambient air measurement system to control precision and bias in order to reduce the probability of decision errors. In addition, the VA Ambient Air Quality Monitoring Program has established an acceptable precision of ±10%, as measured by coefficient of variation, and an acceptable bias of ±10% for projects without EPA-established DQOs.

The DQOs are assessed using Data Quality Indicators (DQIs) which are the quantitative statistics and the qualitative descriptors used to interpret the degree of acceptability or utility of data to the user. The DQIs can then be used to establish the MQOs which will be discussed below. Once the Measurement Quality Objectives (MQOs) are established and monitoring is implemented, Data Quality Assessments (DQAs) are performed to determine whether the DQOs were achieved. If not, the monitoring program should take steps to identify the major sources of uncertainty and find ways to reduce these uncertainties to the acceptable levels.

The goals of the Virginia Ambient Air Quality Monitoring Program are to meet the six basic monitoring objectives listed in Section 5.

The data generated by the Virginia ambient air monitoring network will be used to:

- Evaluate compliance with the NAAQS,
- Establish an historical baseline concentration of air pollutants,
- Monitor the current dynamic concentrations of these air pollutants,
- Monitor progress made toward meeting ambient air quality standards,
- Activate emergency control procedures that prevent or alleviate air pollution episodes,
- Provide data upon which long term control strategies can be reliably developed,
- Observe pollution trends throughout the region, and
- Provide a database for researching and evaluating effects.

The criteria pollutants, established by EPA (particulate matter [$PM_{2.5}$ and PM_{10}], SO_2, CO, NO_2, O_3, and Pb), are monitored at the designated SLAMS and SPMS. Specific information on the sampling design, including how to identify monitoring locations, is presented in Section 10.

7.2 MEASUREMENT QUALITY OBJECTIVES (MQOs)

After a DQO is established, the quality of the data must be evaluated and controlled to ensure that it is maintained within the established acceptance criteria. Measurement quality objectives are designed to evaluate and control various phases (monitoring, preparation, analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. MQOs can be defined in terms of the following data quality indicators:

Precision-a measure of mutual agreement among individual measurements of the same property usually under prescribed similar conditions. This is the random component of error. Precision is estimated by various statistical techniques using some derivation of the standard deviation.

Bias - the systematic or persistent distortion of a measurement process which causes error in one direction. Bias will be determined by estimating the positive and negative deviation from the true value as a percentage of the true value.

Representativeness - a measure of the degree to which data accurately and precisely represent parameter variations at a monitoring point, or a characteristic of a population, a process condition, or an environmental condition.

Detectability-The determination of the low-range critical value of a characteristic that a method-specific procedure can reliably discern.

Completeness-a measure of the amount of valid data obtained from a measurement system compared with the amount expected to be obtained under correct, normal conditions. Data completeness requirements are included in the reference methods (40 CFR Pt. 50).

Comparability-a measure of confidence with which one data set can be compared with another.

Accuracy has been a term frequently used to represent closeness to "truth" and includes a combination of precision and bias-error components. This term has been used throughout the CFR and in some of the sections of this document. If possible, the DEQ will distinguish measurement uncertainties into precision and bias components.

For each of these attributes, acceptance criteria can be developed for various phases of the EDO. Various parts of 40 CFR have identified acceptance criteria for some of these attributes. In theory, if these MQOs are met, measurement uncertainty should be controlled to the levels required by the DQO. More detailed descriptions of these MQOs and how they will be used to control and assess measurement uncertainty will be described in Appendix B.

8.0 TRAINING REQUIREMENTS/CERTIFICATION

8.1 TRAINING

Personnel assigned to the ambient air monitoring activities will meet all requirements for their positions, including education, special training, years of relevant work experience, level of responsibility, and personal attributes. Records documenting each employee's qualifications and training are maintained in personnel files, and will be accessible for review during audit activities, to the extent allowable under Virginia law and under the regulations of the Virginia Department of Human Resource Management.

The education and the training of each employee is a critical quality-control component of any monitoring program. To that end, senior staff has undergone special supervisory training on such topics as elements of performance evaluation. In addition, experienced air monitoring staff members train junior staff members on the job.

8.1.1 AMBIENT AIR MONITORING TRAINING

Pertinent training will be available to employees supporting the ambient air quality monitoring program, commensurate with their duties. Such training may consist of classroom lectures, workshops, teleconferences, and on-the-job training.

Over the years, a number of courses have been developed for personnel involved with ambient air monitoring and quality assurance aspects. Formal QA/QC training is offered through the following organizations:

- Air Pollution Training Institute (APTI)
  http://www.epa.gov/air/oaqps/eog/course_topic.html#ambient
- Air & Waste Management Association (A WMA)
  http://www.awma.org/enviro_edu/prof_dev/index.html
- American Society for Quality Control (ASQC)
  http://www.asq.org/education/training/overview.html
- EPA Quality Assurance Division (QAD)
  http://www.epa.gov/QUALITY/
- EPA Regional Offices

In Table 8-1 is shown a sequence of core ambient air monitoring and QA courses for ambient air monitoring staff, and QA managers. The suggested course sequences are based upon the assumption that a staff member will have little or no experience in QA/QC or air monitoring. Persons already knowledgeable about the subject matter should choose the course that is germane to his or her experience level and professional focus.

Courses not included in the core sequence may be selected according to available resources, and in keeping with individual responsibilities and preferences.

Table 8-1. Ambient Air Training Courses

Course Title (SI = self instructional)	Department Number	Source
Basic Math for Air Pollution Control	100	APTI
Air Pollution Control Orientation Course (Revised), SI:422	422	APTI
Principles and Practices of Air Pollution Control, 452	452	APTI
Introduction to Ambient Air Monitoring (Under Revision), SI:434	434	APTI
General Quality Assurance Considerations for Ambient Air Monitoring (Under Revision), SI:471	471	APTI
Quality Assurance for Air Pollution Measurement Systems (Under Revision), 470	470	APTI
Data Quality Objectives Workshop	QA2	QAD
Quality Assurance Project Plan	QA3	QAD
Atmospheric Sampling (Under Revision), 435	435	APTI
Analytical Methods for Air Quality Standards, 464	464	APTI
Chain-of-Custody Procedures for Samples and Data, SI:443	443	APTI
Data Quality Assessment	QA4	QAD
Management Systems Review	QA5	QAD
Beginning Environmental Statistical Techniques (Revised), SI:473A	473	APTI
Introduction to Environmental Statistics, SI:473B	473B	APTI
AQS Training	AQS	OAQPS

8.2 CERTIFICATION

For the ambient air monitoring program, the DEQ human resources office, in conjunction with the air monitoring office, will issue certifications to employees upon their successful completion of each training activity. Certification will be based upon the qualitative and the quantitative assessment of each person's adherence to the SOPs.

9.0 DOCUMENTATION AND RECORDS

A number of documents and records must be retained for the Ambient Air Monitoring Program. From a records management perspective a document is a volume that contains information that describes, defines, specifies reports, certifies, or provides data or results pertaining to environmental programs.

The DEQ maintains a records management program in compliance with the Virginia Public Records Act, Section 42.1-76, and et. Seq. of the *Code of Virginia,* "Appendix A." This records management program is a cooperative effort between the Virginia State Library Archives and Records Division, and state and local agencies of the Commonwealth of Virginia.

The following information describes the DEQ's document and records management procedures for carbon monoxide Program. In EPA's QAPP regulation and guidance, EPA uses the term reporting package. Although this is not a term currently used by the DEQ, it will be defined as follows: all the information required to support the concentration data reported to EPA, which includes all data required to be collected, as well as data deemed important by the DEQ under its policies and its records management procedures. Figure 9-1 contains a listing of these documents and records as they apply to the Air Quality Monitoring Program.

9.1 INFORMATION INCLUDED IN THE REPORTING PACKAGE

9.1.1 ROUTINE DATA ACTIVITIES

The DEQ has a structured records management retrieval system that allows for the efficient archive and retrieval of records. The carbon monoxide information will be included in this system.

Figure 9.1 includes a listing of the documents and records that will be filed according to the records retention and disposal schedule allowed by the Virginia State Library and DEQ filing practices.

FIG.9-1 CARBON MONOXIDE REPORTING PACKAGE INFORMATION

Commonwealth of Virginia

Virginia State Library and Archives

Records Management
(804) 692-3500

RECORDS RETENTION AND DISPOSITION SCHEDULE

SPECIFIC SCHEDULE NO. 422-019

AGENCY: Department of Environmental Quality

DIVISION: Air Division

SUBUNIT: Office of Air Quality Monitoring

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This schedule is continuing authority under the provisions of the Virginia Public Records Act, §§42.1-76 et. seq. Code of Virginia, for the retention and disposition of the records as stated. This schedule supersedes previously approved applicable schedules. Request approval on Form RM-3. Certificate of Records Disposal, for the destruction of record series noted in this schedule. Any records created prior to the Constitution of 1902 must first be offered to VSL&A before applying these disposition instructions.

EFFECTIVE SCHEDULE DATE:

RECORD SERIES NUMBER AND TITLE

DATA SECTION

1. Air quality data handling system in master file
2. Annual report- Virginia ambient air monitoring data
3. Downtime, analyses for criteria pollutants
4. Environmental systems corporation specifications for monthly polled data values
5. Exceeding of air quality standards

INSTRUMENT SECTION

6. Quality Assurance-Instrument Log Books
7. Quality Assurance-Calibration Sheets
8. Quality Assurance-drift control charts
9. Quality Assurance-operator daily check sheets
10. Quality Assurance-preventive maintenance
11. Quality Assurance-primary standard certification
12. Quality Assurance-station log books
13. Annual monitoring network review
14. Data assessment reporting forms for precision and accuracy

15. Exposed filer weights
16. Filter weights-quality control
17. Monitor calibrations
18. Monitor preventive maintenance schedule
19. Material Safety data sheets
20 Monitoring st e information
21. National performance audit program performance audit program records

22. Orifice-type flow-rate standard calibrations
23. Quality assurance checks
24. Quality assurance manual

9.1.2 ANNUAL SUMMARY REPORTS SUBMITTED TO EPA

As indicated in 40 CFR Part 58, the DEQ shall submit to the EPA Administrator, through the Region III Office, the AMP-450 Quick Look report which is an annual summary report of all the ambient air quality monitoring data from all monitoring stations designated as SLAMS. The report will be submitted by July 1 of each year for the data collected from January 1 to December 31 of the previous year. The report will contain the following information:

- City name (when applicable),
- County name and street address of site location.
- AQS site code.
- AQS monitoring method code.
- Monitoring schedule
- Summary Data

Michael Dowd, as the senior air pollution control official for the DEQ will certify that the annual summary is accurate to the best of his knowledge. This certification will be based on the various assessments and reports performed by the organization.

9.2 DATA REPORTING PACKAGE FORMAT AND DOCUMENTATION CONTROL

Figure 9-1 represents the documents and records that, at a minimum, must be filed into the reporting package. The details of these various documents and records will be discussed in the appropriate sections of this document.

All raw data required for the calculation of concentration, the submission to the AQS database, and the QA/QC data are collected electronically or on data forms that are included in the field and analytical methods sections. All hard-copy information will be filled out in indelible ink. Corrections will be made by inserting one line through the incorrect entry, and placing the correct entry alongside the incorrect entry, provided this can be done legibly, or, if not, by providing the information on a new line. The staff member making the correction will write the initial letters of his or her name next to the correction.

9.2.1 MONITOR NOTEBOOKS

Field Log Books-The DEQ will issue station log books to each Monitoring site housing 1 or more continuous analyzers. These log books will be uniquely numbered and associated with the individual site number. Although data-entry forms are associated with all routine environmental data operations, the log books will be used to record visits to the stations and additional information about these operations.

Field Notebooks- Notebooks will be issued for each monitoring site. These will be three-ring binders that will contain the appropriate data forms for routine operations as well as inspection and maintenance forms and SOPs.

Instrument Log Books–Monitoring Laboratory staff will use notebooks in accordance with internal procedures. These notebooks will be assigned to each instrument and the instruments model number, serial number and state ID number. Single log books will be used for the life of the instrument and will be archived for five years after the retirement of the instrument.

Ancillary Instrument Notebooks – Notebooks will be issued and maintained for ancillary instrumentation (strip chart recorders, calibrators, data loggers, etc), supporting the carbon monoxide monitoring network. These notebooks will be available at OAQM for pertinent entries for the life of the instrumentation. Upon retirement of the ancillary instrumentation, the notebooks will be archived for five years.

9.2.2 ELECTRONIC DATA COLLECTION

We anticipate that certain instruments will provide an automated means for collecting information that otherwise would be recorded on data-entry forms. Information on these systems is detailed elsewhere in this document.

9.3 DATA REPORTING PACKAGE ARCHIVING AND RETRIEVAL

In general all the information listed in Figure 9-1 will be retained for five years from the date the grantee submits the final expenditure report, unless otherwise noted in the funding agreement. Instrument raw data records will be retained at the Office of Air Quality Monitoring for 5 years. However, if any litigation, claim, negotiation, audit, or other action

involving the records has been started before the expiration of the five-year period, the records will be retained until the action is complete, until all issues which arise from it are resolved, or until the end of the regular five-year period, whichever is later. The Department will extend this regulation in order to store records for five full years past the year of collection.

10.0 MONITORING NETWORK DESCRIPTION

The purpose of this section is to describe all relevant components of the SLAMS carbon monoxide monitoring network operated by the Commonwealth of Virginia. This entails describing the rationale for the locations of the carbon monoxide monitors, the length of the monitoring season, the types of monitors used at each site, and the location and frequency of the FRM/FEM performance evaluations. The network design components comply with the regulations contained in 40 CFR Part 58, Section 58.12, Appendix A, and Appendix D.

The primary function of the Air Monitoring Program is to verify compliance with the NAAQS. Other purposes include but are not limited to determining trends over time, determining effects on air quality from adjustments to source emissions, developing algorithms based on historical air quality and other conditions which will forecast air quality, verifying air quality modeling programs, providing carbon monoxide data to the public, and correlating health effects to air quality.

Sampling network design and monitoring site selection comply with the following appendices of 40 CFR Part 58:

- 40 CFR Part 58, Appendix A: Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)
- 40 CFR Part 58, Appendix D: Network Design for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix E: Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

As stated in Section 5.0, the Ambient Air Quality Monitoring Network is designed to meet a minimum of one of six basic monitoring objectives:

- ***Maximum concentration:*** Determine the highest concentrations expected to occur in the area covered by the network,

- ***Population Exposure****:* Determine representative concentrations in areas of high population density, or
- ***Point Source Impact***: Determine the impact of significant sources or source categories on ambient pollution levels,
- ***Background:*** Determine general background concentration levels,
- ***Transport***: Determine the extent of regional pollutant transport among populated areas and in support of secondary standards, and
- ***Secondary Impacts****:* Determine the welfare-related impacts in rural and remote areas (such as visibility impairment and effects on vegetation).

The Ambient Air Quality Monitoring Network utilizes the network design criteria specified in 40 CFR Part 58, Appendix D, to establish the appropriate network configuration necessary to meet these objectives.

10.1 SCHEDULED PROJECT ACTIVITIES, INCLUDING MANAGEMENT ACTIVITIES

Selection of a site or sites must address EPA siting criteria and selection-specific considerations. The primary guidance for siting monitoring systems is to adhere to 40 CFR Part 58 Appendix E requirements. This is generally possible, but some locations present challenges due to availability of power, resource impacts, site access, logistics, and other considerations. The sites are also selected to be as representative as possible of overall air quality. In general, funding levels restrict selections to one site, which is chosen to be most representative of the locality, county or region. Some special studies that require additional and broad ranging information to support research and investigative functions may require more than one station.

10.2 RATIONALE FOR MONITORING NETWORK DESIGN

The primary purpose of the carbon monoxide ambient air monitoring program operated by Virginia is to measure compliance with the national standards for carbon monoxide as detailed in 40 CFR Part 50. To determine whether the chosen monitoring characteristics are quantified with sufficient confidence, Virginia must address monitor type, monitoring schedule, and monitor siting. The DEQ will use FRM/FEM monitors to evaluate

compliance with the carbon monoxide NAAQS. By complying with the requirements in 40 CFR Part 58, Appendix D, and the DEQ assumes its monitoring schedule is sufficient to properly characterize air quality in the vicinity of each monitor. The DEQ will select all monitoring sites in accordance with the siting regulations contained in 40 CFR Part 58, Appendix D. Monitor type, monitoring period, and siting are further described elsewhere in this document.

10.3 DESIGN ASSUMPTIONS

The monitoring design is based on the assumption that the rules and guidance provided in the CFR will result in data that can be used to measure compliance with the national standards. The only issue at Virginia's discretion is the monitor siting.

10.4 PROCEDURE FOR LOCATING AND SELECTING MONITOR SITES

10.4.1 CARBON MONOXIDE MONITORS

The design of the SLAMS carbon monoxide network must achieve one or more of the six basic monitoring objectives, as described in 40 CFR Part 58, Appendix D. These are:

1. To determine the highest concentration expected to occur in the area covered by the network.
2. To determine representative concentrations in areas of high population density.
3. To determine the impact on ambient pollution levels of significant sources.
4. To determine general background concentration levels.
5. To determine the extent of regional pollutant transport.
6. In support of secondary standards to determine welfare-related impacts.

The procedure for siting the carbon monoxide monitors to achieve each one of these objectives is based on judgmental monitoring, as is the case for most ambient air monitoring networks. Judgmental monitoring uses data from existing monitoring

networks, knowledge of source emissions and population distribution, and inference from analyses of meteorology to select optimal monitor locations.

The number of SLAMS sites where carbon monoxide monitoring will occur and their locations were determined based upon the information contained in 40 CFR Part 58 Appendix D. Specifically, the following were used to define the Monitoring Planning Areas (MPAs) and to site monitors.

10.4.2 CARBON MONOXIDE MONITORS - DEFINING MPAs AND MSAs

The Commonwealth of Virginia contains 8 Metropolitan Statistical Areas (MSAs) or Primary Metropolitan Statistical Areas (PMSAs). Approximately 76% of Virginia's population resides within these MSAs (1990 census). Therefore, to the extent possible, the existing boundaries of the MSAs were used to identify the boundaries of the populated areas. Also considered in the determination of MPAs were terrain features, existing air quality monitoring sites, and existing planning areas.

Existing MSA boundaries were used, removing only those localities that have low populations and no significant sources.

As existing MSAs change with population growth, Virginia intends periodically to examine MSA boundaries as part of the annual review process, to determine if extra monitors are required. In addition, should any monitoring site show nonattainment with the NAAQS, Virginia will take appropriate actions to define the actual nonattainment area and will not necessarily use any designated MPA as the nonattainment area.

MPA	Cities/Counties	Population
Northern Virginia portion Washington, D.C.-Md-Va	Alexandria	139,966
	Arlington County	217,483
	Fairfax City	22,565
	Fairfax County	1,081,726
	Falls Church	12,332
	Loudoun County	312,311
	Manassas	37,821
	Manassas Park	14,273
	Prince William County	402,002
	Stafford County	128,961
	Total =	2,369,440
Norfolk-Va. Beach-Newport News	Chesapeake	222,455
	Hampton	137,436
	James City County	67,009
	Newport News	180,719
	Norfolk	242,803
	Poquoson	12,150
	Portsmouth	95,535
	Suffolk	84,585
	Virginia Beach	437,994
	York County	65,464
	Total =	1,546,150
Richmond-Petersburg	Charles City County	7,256
	Chesterfield County	316,236
	Colonial Heights	17,411
	Dinwiddie County	26,338
	Hanover County	99,863
	Henrico County	306,935
	Hopewell	22,591
	Petersburg	32,420
	Prince George County	35,725
	Richmond City	204,214
	Total =	1,068,989

MPA	Cities/Counties	Population
Bristol Va. Portion of Johnston City-Kingsport-Bristol	Bristol	17,835
	Scott County	23,177
	Washington County	54,876
	Total = 95,888	
Roanoke	Botetourt County	33,148
	Roanoke City	97,032
	Roanoke County	92,376
	Salem	24,802
	Total = 247,358	
Lynchburg	Amherst County	32,353
	Bedford City	6,222
	Bedford County	68,676
	Campbell County	54,842
	Lynchburg City	75,568
	Total = 237,661	
Charlottesville	Albemarle County	98,970
	Charlottesville	43,475
	Total = 142,445	
Danville	Danville	43,055
	Pittsylvania County	63,506
	Total = 106,561	

10.4.3 MONITORING THRESHOLDS

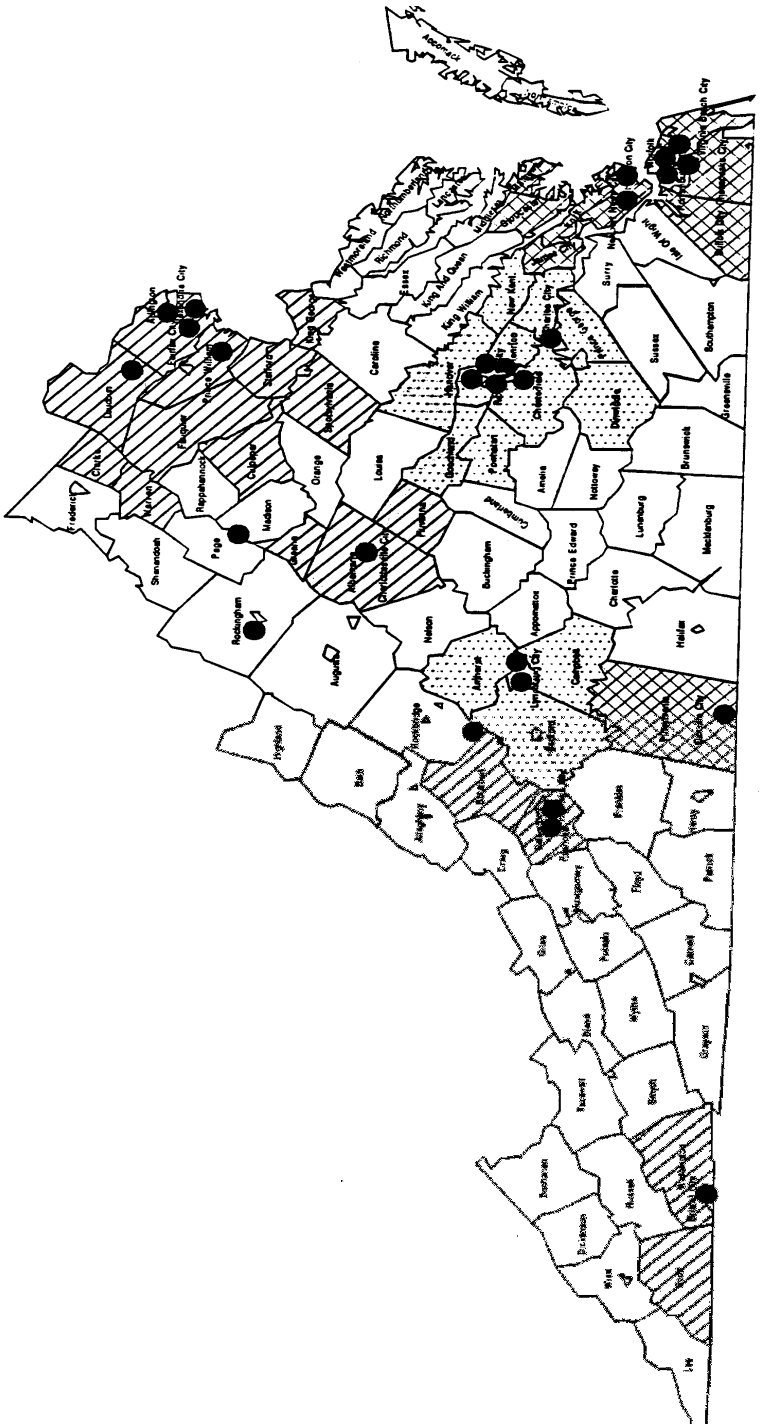
The minimum amount of monitored data required for appropriate summary statistics should be taken. At least 75% of the total possible monitoring operating time must be collected before summary statistics are calculated. The exact requirements appear in Table 10-2.

Table 10-2 Requirements for Calculating Summary Statistics

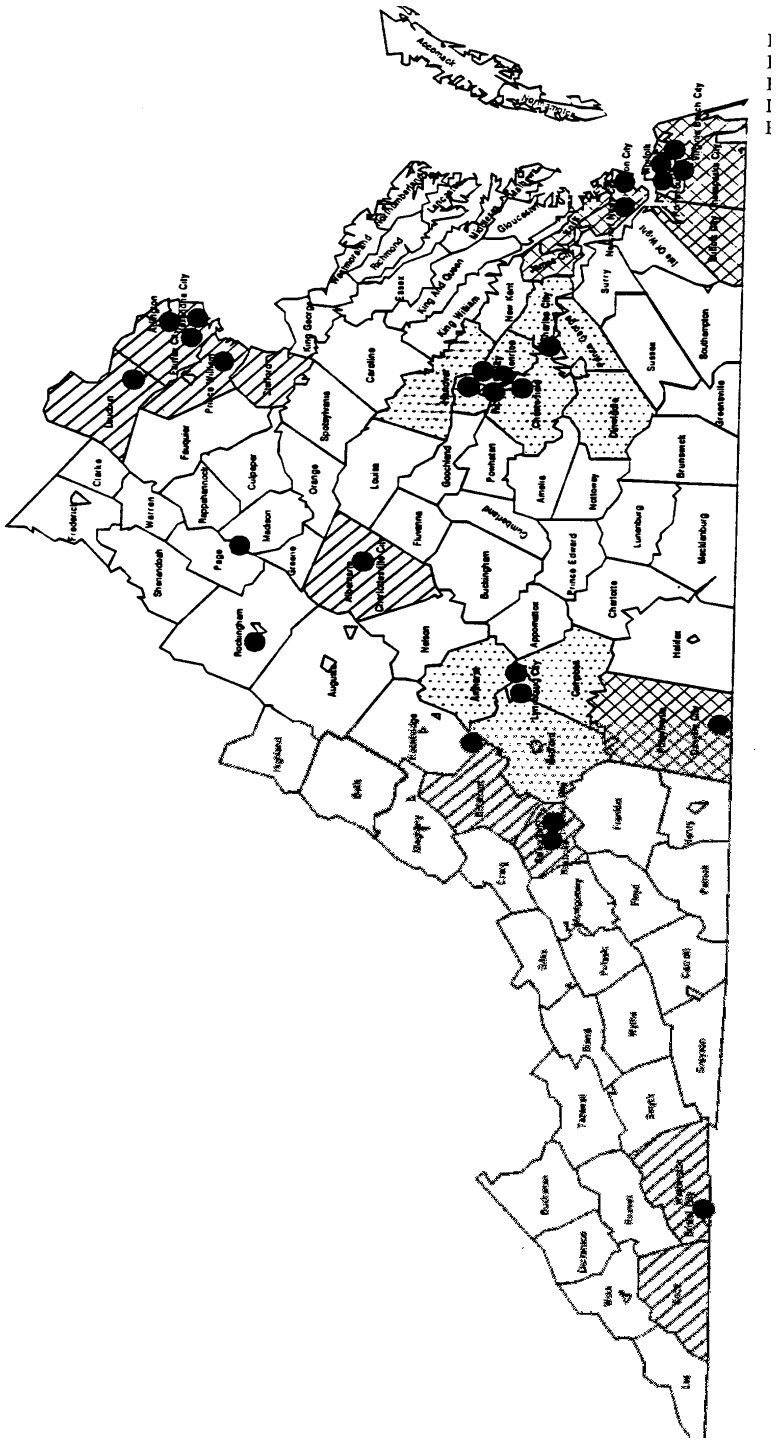
Pollutant	**Completeness Requirement** (%)	**Time Frame**
Carbon Monoxide	75%	Per Quarter
Nitrogen Dioxide	75%	Annual
Ozone	75% / 90%	Per Ozone season / Three Years
Sulfur Dioxide	75%	Per Quarter

COMMONWEALTH OF VIRGINIA

Metropolitan Statistical Areas



COMMONWEALTH OF VIRGINIA
Monitoring Planning Areas



10.4.4 CARBON MONOXIDE MONITORS - SITING MONITORS

The procedure for siting the carbon monoxide monitors is based on judgmental monitoring. A listing of monitoring locations by MSA is provided in the DEQ Annual Report and in the Annual DEQ Network Review.

10.4.5 CARBON MONOXIDE MONITORS - TYPES OF MONITORS

Virginia will operate only FRM/FEM analyzers in accordance with 40 CFR Part 58. These monitors will be operated in accordance all applicable SLAMS requirements and EPA guidance.

10.4.6 OTHER CARBON MONOXIDE MONITORING

For the purposes of this QAPP, special purpose monitoring will be accomplished with FRM/FEM monitors. These monitors will be operated in accordance with all applicable SLAMS requirements and EPA guidance.

11.0 MONITORING METHODS REQUIREMENTS

11.1 PURPOSE/BACKGROUND

The purpose of this section is to identify the sampling methods and the procedures for collecting the required environmental samples. Individual criteria pollutant SOPs contain more detailed descriptions of the equipment used in the data collection network; necessary support facilities; implementation requirements; required materials; and processes for preparing, calibrating and performing QA checks on monitoring equipment.

This section also identifies the corrective actions necessary to re-establish network data integrity, responsible parties to implement the corrective actions, and methods required to verify corrective action effectiveness.

11.2 MONITORING TECHNOLOGY/METHODOLOGY

11.2.1 CARBON MONOXIDE (NONDISPERSIVE INFRARED PHOTOMETRY)

Carbon monoxide is measured by infrared absorption photometry. Air is drawn continuously through a sample cell where infrared light passes through it. Carbon monoxide molecules in the air absorb part of the infrared light, reducing the intensity of the light reaching a light sensor. The light is converted into an electrical signal related to the concentration of carbon monoxide in the sample cell.

11.2.2 SULFUR DIOXIDE (FLUORESCENCE ANALYZER)

Sulfur dioxide is measured with a fluorescence analyzer. Air is drawn through a sample cell where it is subjected to high intensity ultraviolet light. This causes the sulfur dioxide molecules in the air to fluoresce and release light. The fluorescence is detected with a photo multiplier tube and converted to an electrical signal proportional to the SO_2 concentration.

11.2.3 NITROGEN OXIDES (CHEMILUMINESCENCE)

Nitrogen oxides are measured using the chemiluminescence reaction of nitric oxide (NO) with ozone (O_3). Air is drawn into a reaction chamber where it is mixed with a

high concentration of ozone from an internal ozone generator. Any NO in the air reacts with the carbon monoxide to produce NO_2. Light emitted from this reaction is detected with a photo multiplier tube and converted to an electrical signal proportional to the NO concentration. Nitrogen dioxide (NO_2) must be measured indirectly. Total nitrogen oxides (NO_X) are measured by passing the air through a converter where any NO_2 in the air is reduced to NO before the air is passed to the reaction chamber. By alternately passing the air directly to the reaction chamber, and through the converter before the reaction chamber, the analyzer alternately measures NO and NO_X. The NO_2 concentration is equal to the difference between NO and NO_X.

11.2.4 OZONE (ULTRAVIOLET PHOTOMETRY)

Ozone is measured by ultraviolet absorption photometry. Air is drawn through a sample cell where ultraviolet light (254 nm wavelength) passes through it. Ultraviolet light intensities are measured by detectors. The degree to which the ultraviolet light is absorbed is directly related to the ozone concentration.

11.3 DATA COLLECTION METHODOLOGY

Electronic data collection is possible through the network's data loggers and modems. This equipment is located in the shelters where the data loggers record the data history and the modems provide a path to download the data for analysis. The state's Data Acquisition System (DAS) is configured to automatically call the stations periodically to retrieve these data for analysis. Monitoring personnel can call the stations manually to retrieve data, or determine the status of the systems.

11.4 SUPPORT FACILITIES FOR MONITORING METHODS

11.4.1 MONITORING STATION DESCRIPTION

The monitoring station design must encompass the operational needs of the equipment, provide an environment that supports sample integrity, and allow the operator to safely and easily service and maintain the equipment. Winter weather

conditions must be considered during site selection in order to meet the station safety and serviceability requirements.

11.4.2 SHELTER CRITERIA

Continuous air pollution analyzers should be housed in a shelter capable of fulfilling the following requirements:

- The shelter temperature should be maintained between 20° and 30°C.
- The power supply voltage to the analyzers should not vary more than ±10% from available power supply.
- The shelter must protect the instrumentation from precipitation and excessive dust, dirt and trash; provide third wire grounding as in modern electrical codes; meet federal Occupational Safety and Health Administration regulations; and be cleaned regularly to prevent a buildup of dust.
- The shelter must protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light, or radiation.

A probe manifold or single sample lines can be used to provide sample air from the outside. AQM uses single sample lines for the majority of its analyzers. The analyzers draw samples from a Teflon tube that runs outside the shelter and is housed under a funnel with a shepherd's hook turn. The Teflon tube is surrounded by a metal pipe to prevent sunlight from reacting with any materials. Criteria pollutant analyzers require that the probe and any manifold material must be either stainless steel, borosilicate glass, or an acceptable inert plastic, such as polytetrafluoroethylene (PTFE or TFE), periluoroalkoxy (PFA), polyvinylidene fluoride (PVDF), or other Teflon®-type materials.

Any probe or manifold design used must ensure that the probe and manifold material is non-reactive with the pollutant of interest. The probe and any manifold, intake vent, and interconnecting tubing design must provide a minimum number of bends to avoid particles impacting onto surfaces. Impacted particles may provide

surfaces to which criteria pollutants may adsorb, or, if the impacted particle is metallic, catalyze to a non-criteria species.

Additionally, the probe and any manifold used must prevent rainwater from entering the analyzers. Any liquid water will absorb pollutants, impacting the criteria pollutant concentration by removing pollutants from the sample, and consequently, yielding inaccurate environmental data. All probe sample lines will be replaced at least every two years. All probe sample lines will be cleaned at least once every three months.

11.5 MONITORING/MEASUREMENT SYSTEM CORRECTIVE ACTION

Should problems occur in the carbon monoxide air quality monitoring network, corrective measures will be taken to ensure that the data quality objectives are attained. There is the potential for many types of sampling and measurement system corrective actions. Each approved standard operating procedure details some expected problems and corrective actions needed for a well-run monitoring network.

11.6 ANALYZER AUDITS/PERFORMANCE EVALUATIONS

Audits and/or performance evaluations are performed according to the methodology required by EPA. For each specific method and sampler type, the method followed is according to the procedures outlined in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II. Ambient Air Specific Methods* (EPA 1998). This handbook is commonly referred to as 'The Redbook." For each parameter and sampler type, audit procedures are performed following the procedures defined by the approved standard operating procedure.

12.0 SAMPLE CUSTODY

Since most criteria pollutant monitoring takes place *in situ* on a continuous basis, this section applies primarily to records associated with monitoring.

12.1 FIELD RECORDS

Station operators are responsible for maintenance of station log books and individual monitor monthly operational check sheets. The log books are kept at the monitoring site. The monthly operational check sheets (i.e. zero/span control charts) are returned to the Office of Air Quality Monitoring on a monthly basis.

12.2 MONITORING LABORATORY RECORDS

Certification/calibration records for the carbon monoxide monitors are maintained in the Office of Air Quality Monitoring.

13.0 ANALYTICAL METHODS REQUIREMENTS

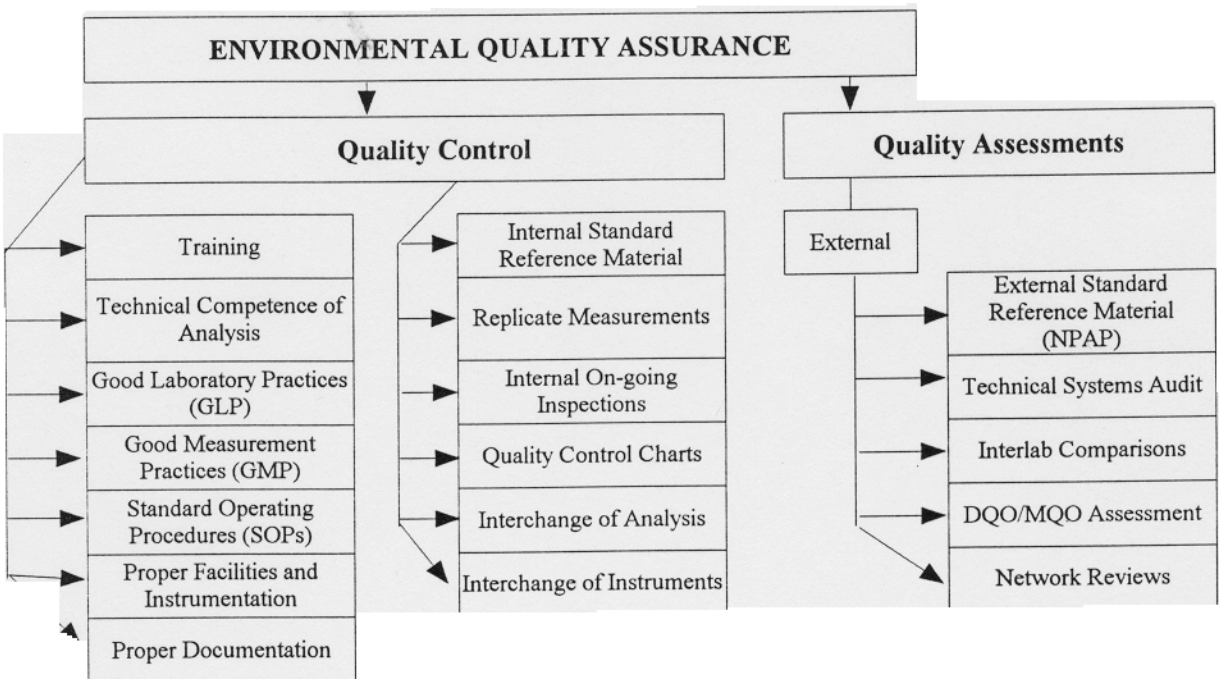
There are no analytical laboratory methods applied in the gaseous ambient air monitoring network. Certification of transfer standards and verification of primary standards used in the calibration of gaseous instruments are itemized in the SOPs. The analytical method employed for a specific criteria pollutant evaluation is dependant upon the monitoring technology utilized. For the criteria pollutants, SO_2, CO, NO_2, and O_3, the analyzers are designed as completely contained monitoring units that do not require additional analytical methods to establish the pollutants' environmental concentrations. The analytical instruments employed for sample analysis of the gaseous criteria pollutants have been identified and their specific technological methods detailed in Section 11.

14.0 QUALITY CONTROL REQUIREMENTS

To assure the quality of data from air monitoring measurements, two distinct and important interrelated functions must be performed. One function is to control the measurement process through broad quality assurance activities, such as establishing policies and procedures, developing data quality objectives, assigning roles and responsibilities, conducting oversight and reviews, and implementing corrective actions. The other function is to control the measurement process through the implementation of specific quality control procedures, such as audits, calibrations, checks, and routine self-assessments. In general, the greater the control of a given monitoring system, the better will be the resulting quality of the monitoring data.

Quality Control (QC) is the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the data user. In the ambient air quality monitoring network, QC activities ensure that measurement uncertainty is maintained within acceptance criteria for attaining the data quality objectives (DQOs). Figure 14.1 shows QC activities that help to evaluate and control data quality for the carbon monoxide program. Many of the activities in this figure are implemented by the VA DEQ and are discussed in this QAPP.

Figure 14.1 Quality Control and Quality Assessment Activities



14.1 QC PROCEDURES

Day-to-day quality control is implemented through the use of various check samples or instruments that are used for comparison. The measurement quality objectives in Appendix C contain a complete listing of these QC procedures as well as other requirements for the carbon monoxide Program. The procedures for implementing the QC procedures are included in the field and analytical methods section (Sections 11 and 13 respectively). Various types of QC procedures have been inserted at phases of the data operation to assess and control measurement uncertainties. The following information provides additional descriptions of these QC activities, how they will be used in the evaluation process, and what corrective actions will be taken when they do not meet acceptance criteria.

14.1.1 CALIBRATIONS

Calibration is the comparison of a measurement standard or instrument with another standard or instrument to report or eliminate by adjustment any variation (deviation) in the accuracy of the item being compared. The purpose of calibration is to minimize bias.

For carbon monoxide, calibration activities are performed in the following process:

First a flow check is performed on the multi-gas calibrator; the monitor is then compared to a standard CO gas cylinder mixed with zero air scrubbed of CO.

Calibration requirements for the critical field and monitor laboratory equipment are found in Appendix C; the details of the calibration methods are included in the calibration section (Section 16) and in the field and laboratory methods sections (11 and 13 respectively).

14.1.2 OPERATIONAL QUALITY CONTROL CHECKS

Various tools will be employed in evaluating the validity of air quality measurements. Periodically testing instruments with zero and span checks (generally 2 times/week), and tracking instrument performance with control charts can provide evidence that an instrument is operating within specifications. If a zero/span check is outside of the acceptable concentration range during a site visit, the site operator should notify appropriate personnel at OAQM as soon as possible, and appropriate action should be taken in accordance with instrument SOPs. If subsequent action reveals that the instrument was either out of calibration by more than 15%, or the instrument was malfunctioning, then the QA Coordinator must be notified so that data will be invalidated back to the last documented acceptable zero/span check.

Biweekly one-point QC checks are performed to assess precision and bias using a single point of known concentration. The results of these “precision” checks are reported to AQS concurrently with the monitored data, as a means of documenting data quality. Precision procedures and required concentration ranges for the

applicable instrumentation are found in the SOPs and in the specific instruments' operations manuals. The goal for each individual precision point check is < +/- 10% difference between the actual and indicated concentrations. When the percent difference is between 10 and 20%, the cause will be investigated and corrective action will be initiated. If the percent difference exceeds 20%, the QA Coordinator will be notified so that a decision can be made as to the validity of the data. Invalidation generally would apply to all data from the point where the problem is identified back to the last acceptable quality control or quality assurance check.

14.1.3 DATA QUALITY ASSESSMENT CALCULATIONS

Data quality assessment calculations of measurement uncertainty are carried out using one-point QC (precision) and performance audit checks. Annual assessments of data quality are computed by site and primary quality assurance organization (PQAO), and are included in the data certification package that is submitted to the EPA regional office each year.

Percent Difference. The percent difference (*di*) for each precision check is calculated using equation 1, where *meas* is the concentration indicated by the instrument and *audit* is the known concentration of the standard used in the QC check being measured.

Equation 1

$$d_i = \frac{meas - audit}{audit} \cdot 100$$

Precision estimate. The precision estimate is used to assess the one-point QC checks. The precision estimator is the coefficient of variation upper bound and is calculated using equation 2:

Equation 2

$$CV = \sqrt{\frac{n \cdot \sum_{i=1}^{n} d_i^2 - \left(\sum_{i=1}^{n} d_i\right)^2}{n(n-1)}} \cdot \sqrt{\frac{n-1}{\chi^2_{0.1,n-1}}}$$

Where $X^2_{0.1,n-1}$ is the 10th percentile of a chi-squared distribution with n-1 degrees of freedom.

Bias estimate. The bias estimate is calculated using the one-point QC checks. The bias estimator is an upper bound on the mean absolute value of the percent differences as described in equation 3:

Equation 3

$$|bias| = AB + t_{0.95,n-1} \cdot \frac{AS}{\sqrt{n}}$$

Where n is the number of single point checks being aggregated, $t_{.095,n-1}$ is the 95th quantile of a t-distribution with n-1 degrees of freedom; the quantity AB is the mean of the absolute values of the d_i's and is calculated using equation 4:

Equation 4

$$AB = \frac{1}{n} \cdot \sum_{i=1}^{n} |d_i|$$

The quantity *AS* is the standard deviation of the absolute value of the d_i's and is calculated using equation 5:

Equation 5

$$AS = \sqrt{\frac{n \cdot \sum_{i=1}^{n} |d_i|^2 - \left(\sum_{i=1}^{n} |d_i|\right)^2}{n(n-1)}}$$

Assigning a sign (positive/negative) to the bias estimate. Since the bias statistic as calculated in equation 3 uses absolute values, it does not have a tendency (negative or positive bias) associated with it. A sign will be designated by rank ordering the percent differences of the QC check samples from a given site for a particular assessment interval as follows.

Calculate the 25th and 75th percentiles of the percent differences for each site. The absolute bias upper bound should be flagged as positive if both percentiles are positive and negative if both percentiles are negative. The absolute bias upper bound would not be flagged if the 25th and 75th percentiles are of different signs.

Validation of bias using the one-point QC checks. The audits or performance evaluations are used to verify the results obtained from the one-point QC checks and to validate those results across a range of concentration levels. To quantify this annually at the site level and at the 3-year primary quality assurance organization level (PQAO), probability limits will be calculated from the one-point QC checks using equations 6 and 7:

Equation 6

$$\text{Upper Probability Limit} = m + 1.96 \cdot S$$

Equation 7

$$\text{Lower Probability Limit} = m - 1.96 \cdot S$$

Where m is the mean (equation 8):

Equation 8

$$m = \frac{1}{k} \cdot \sum_{i=1}^{k} d_i$$

Where k is the total number of one-point QC checks for the interval being evaluated and S is the standard deviation of the percent differences (equation 9):

Equation 9

$$S = \sqrt{\frac{k \cdot \sum_{i=1}^{k} d_i^2 - \left(\sum_{i=1}^{k} d_i\right)^2}{k(k-1)}}$$

Percent Difference. Percent differences for the performance audits, calculated using equation 1, can be compared to the probability intervals obtained at the site or PQAO level. Ninety-five percent of the individual percent differences (at all concentration levels) for the performance evaluations should be captured within the probability intervals for the PQAO.

Data Quality Objectives for Carbon Monoxide. The goal for acceptable measurement uncertainty for carbon monoxide is defined for precision as an upper 90 percent confidence limit for the coefficient of variation (CV) of 7 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 7 percent.

15.0 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

15.1 PURPOSE/BACKGROUND

This element is centered on the procedures used to confirm that the instruments and equipment used in the Virginia DEQ carbon monoxide ambient air quality monitoring network are maintained in sound operating condition, and are capable of producing consistently reliable data.

15.2 TESTING

The carbon monoxide monitors used in the Virginia DEQ carbon monoxide ambient air quality monitoring Network will be certified by EPA as designated federal reference methods (FRM) or federal equivalent methods (FEM). The EPA tests such equipment by means of the procedures described in 40 CFR Part 50. Accordingly, the monitors can be assumed to be of a quality adequate for the data- collection operation. Before installing the monitors at the field locations, the Virginia DEQ will assemble and subject them to a series of tests at the Office of Air Quality Monitoring. These tests are performed according to section 15.4 Maintenance (see Table 15-1). If any of these checks deviates from the specified standard, the OAQM will investigate to determine the needed repair and where appropriate ask the vendor to correct the deficiency. For the monitoring instrument to meet all acceptance criteria it will meet the specified standards and will calibrate properly. Complete records of the initial and all subsequent tests will be kept in the instrument log book.

15.3 INSPECTION

All instrumentation and equipment procured for the network undergo inspection and/or acceptance testing. Any noted inconsistencies related to the quality of manufacturing or system performance are resolved with the manufacturer. All systems must pass inspection and calibration before being implemented. An inventory of all procured capital equipment is maintained electronically in the Fixed Assets Accounting and Quality Control System

(FAAQS). All hard copy documentation is filed and maintained by instrument type and serial number. Instruments are accepted if they are fully operational, documentation of the calibration is received with the analyzer, and OAQM is able to perform successful calibration(s).

15.4 MAINTENANCE

There are a number of items that need maintenance attention in the monitoring network. The individual SOPs/Check sheet has more detail about the appropriate procedures and schedules. Table 15-1 lists the annual maintenance criteria for TEI 49C instruments.

Table 15-1

	CARBON MONOXIDE TEI 48 (c or i) ANNUAL MAINTENANCE		
	Reference	Test/Action	
1		Visually Inspected	
2	5,2	Clean Optical components	
3	5,2	IR Source Replacement	
4		Fan Filter inspection and cleaning	
5		Leak test	
6		Pump inspection/Re-build	
7		Leak test the zero/span and solenoid valves	

16.0 INSTRUMENT CALIBRATION

16.1 INSTRUMENTS REQUIRING CALIBRATION

The purpose of calibration is to establish a relationship between the ambient conditions and an instrument's response. Challenging the instrument with known values and adjusting the instrument to respond properly to those values constitutes a calibration. Routine calibrations of air quality instruments are performed upon initial installation and quarterly thereafter. Additional calibrations are performed on an as-needed basis, such as in the event of equipment repair or replacement. Each calibration will be documented in the instrument log book and the calibration report should be reviewed and filed by OAQM assigned personnel.

16.2 CALIBRATION STANDARDS

16.2.1 FLOW RATE

The flow rate standard apparatus that will be used for flow rate calibration has its own certification and is traceable to other standards for volume or flow rate that are themselves NIST -traceable. The manufacturer will establish and verify if necessary a calibration relationship for the flow-rate standard that is accurate to within 2% over the expected range of ambient temperatures and pressures at which the flow rate standard is used. The flow rate standard will be recalibrated and recertified annually.

16.2.2 TEMPERATURE

The field temperature transfer standards used for calibration of temperature sensors will be thermometers that have their own certification. They will be re-verified or recertified at least annually against the local primary temperature standard, or auditor's transfer standard, to within 2 °C over the expected range of ambient temperatures at which the temperature standard is to be used.

16.2.3 PRESSURE

The Fortin mercury barometer works on fundamental principles of length and mass and therefore is more accurate but is also more difficult to read and correct than other types. By comparison, the precision aneroid barometer is an evacuated capsule with a flexible bellows coupled through mechanical, electrical, or optical linkage to an indicator. The precision aneroid barometer is potentially less accurate than the Fortin type, but it can be transported with less danger of impairing the reliability of its measurements. What is more, it presents no danger from possible mercury spills. Therefore, a Fortin type of barometer will be used as a higher-quality laboratory standard for adjusting and certifying an aneroid barometer in the OAQM. The OAQM pressure standard will be a Fisher Scientific National Weather Service type Fortin mercury barometer. The field working standard will be an Airguide Dual Scale aneroid barometer.

16.2.4 GAS CYLINDERS

Carbon monoxide monitors are calibrated using a standardized protocol CO cylinder and zero air gas scrubbed of carbon monoxide. The zero air used for the calibrations is generated using a series of sequential scrubbing steps involving activated carbon, Purafil, Monoxycon and a desiccant.

16.3 CALIBRATION FREQUENCY DOCUMENTATION

Carbon monoxide instrument calibration parameters are documented quarterly. Carbon monoxide instrument diagnostic parameters are subject to quarterly calibration reporting and are documented in instrument notebooks (log books).

17.0 INSPECTION/ACCEPTANCE FOR SUPPLIES AND CONSUMABLES

17.1 PURPOSE

This element establishes and documents the system for inspecting and accepting all supplies and consumables that may directly or indirectly affect the quality of the carbon monoxide program. Various supplies and consumables are critical to the effective operation of the Virginia DEQ carbon monoxide monitoring network. By having meticulously documented inspection and acceptance criteria, consistent quality of the supplies can be assured. This section is centered on a description of the supplies and consumables, the criteria for their acceptance, and the required tracking documentation.

17.2 CRITICAL SUPPLIES AND CONSUMABLES

Consumables include various supplies such as inlet filters, Teflon tubing, and various replacement parts. Reference is made to the monitor operator's manual for lists of monitor-specific supplies and consumables.

17.3 ACCEPTANCE CRITERIA

Acceptance criteria must be consistent with the overall technical and quality standards for the project. Some of the acceptance criteria are delineated in 40 CFR Parts 50. Others, such as observation of damage due to shipping, can be performed only after the equipment has arrived at AQM.

17.4 TRACKING AND QUALITY VERIFICATION OF SUPPLIES AND CONSUMABLES

The tracking and quality verification of supplies and consumables has two main goals: (1) for the end user to have an item of the required quality; and (2) for the purchasing department to have a faithful record of goods received so that payment or credit of invoices can be approved. In order to address these two issues, the following procedures outline the proper tracking and documentation procedures to follow:

Receiving personnel will do the following:

1. Perform a rudimentary inspection of the packages as they are received from the supplier, noting obvious problems, such as crushed or wet cardboard box.
2. Open and inspect each package, comparing the contents against the packing slip.
3. Compare supplies and consumables with the acceptance criteria.
4. Note any problem with the equipment/supplies on the packing list, and notify the appropriate supervisor to call the vendor.
5. If the equipment/supplies appear to be complete and in good condition, sign and date the packing list and give it to the purchasing coordinator so that payment can be made in a timely manner.
6. Notify appropriate personnel that equipment/supplies are available.
7. Stock equipment/supplies in the designated area in the Office of Air Quality Monitoring Warehouse area.
8. For supplies, consumables, and equipment used throughout the carbon monoxide program, document when these items are changed out. Provided the information is available, include all relevant facts such as model number, lot number, and serial number.

18.0 DATA ACQUISITION REQUIREMENTS

18.1 ACQUISITION OF NON-DIRECT MEASUREMENT DATA

In this section we address data not obtained by direct measurement from the carbon monoxide ambient air quality monitoring program. This includes data from outside sources, and historical data related to monitoring. Such data are used by the DEQ in a variety of ways. For instance, data may be used to draw comparisons. The policies and procedures described in this section apply not only to data acquired through the DEQ monitoring program, but also to information previously acquired, and to that acquired from outside sources.

The carbon monoxide ambient air quality monitoring program relies on data that are generated through field and monitor operations; however, other significant data are obtained from sources outside the DEQ or from historical records. In this section we list these data and address quality-control issues related to the carbon monoxide ambient air quality monitoring program.

18.1.1 CHEMICAL AND PHYSICAL PROPERTIES DATA

Physical and chemical properties data and conversion constants often are required in the processing of raw data into reporting units. Such information as has not already been specified in the monitoring regulations will be obtained from nationally and internationally recognized sources. Other data sources may be used with approval of the director of the Office of Air Quality Monitoring. The following sources may be used in the carbon monoxide ambient air quality monitoring program without prior approval:

- National Institute of Standards and Technology (NIST)
- ISO, IUPAC, ANSI, and other widely-recognized national and international standards organizations
- U.S. EPA

- The current edition of certain standard handbooks, for example, CRC Press' *Handbook of Chemistry and Physics,* and *Lange's Handbook.*

18.1.2 MONITOR OPERATION AND MANUFACTURERS' LITERATURE

Another important source of information needed for monitor operation is manufacturers' literature. Operations manuals and users' manuals frequently provide numerical information and equations pertaining to specific equipment. DEQ personnel are cautioned that such information sometimes is in error, and appropriate cross-checks will be made to verify the reasonableness and accuracy of information contained in manuals. Whenever possible, the field operators will compare physical and chemical constants in the operator's manuals to those given in the sources listed above. If discrepancies are found, we will determine the correct value by contacting the manufacturer. The instrumentation technicians will correct all the operators' manuals and ask the vendor to issue an errata sheet discussing the changes. The DEQ also will inform the staff of the Region Ill Office of such errors, if necessary. The following kinds of errors are commonly found in such manuals:

- insufficient precision
- outdated values for physical constants
- typographical errors
- incorrectly specified units
- inconsistent values within a manual
- use of different reference conditions than those called for in EPA regulations

18.1.3 GEOGRAPHIC LOCATION

Another type of data that will commonly be used in conjunction with the carbon monoxide ambient air quality monitoring program is geographic information. The DEQ has located current sites using global positioning systems (GPS) that meet EPA

Locational Data Policy of 25-meters accuracy.

18.1.4 HISTORICAL MONITORING INFORMATION

The DEQ has operated a network of ambient air monitoring stations since the late 1960s. Historical monitoring data, and summary information derived from those data, may be used in conjunction with current monitoring results to calculate and report trends in pollutant concentrations. In calculating historical trends, it is important to verify that the historical data are fully comparable to current monitoring data. If different methodologies were used to gather the historical data, the biases and other inaccuracies must be described in trends reports based on that data. Direct comparisons of Carbon Monoxide with historical data will not be reported or used to estimate trends. Trends reports comparing carbon monoxide data with historical data must be approved by the director of the Office of Air Quality Monitoring prior to release.

18.1.5 EXTERNAL MONITORING QUALITY DATABASES

As a matter of policy, the Office of Air Quality Monitoring does not use, without prior approval, data obtained from the internet, from computer bulletin boards, or from data bases from outside organizations to create reportable data or published reports. This policy is intended to ensure the use of high quality data in DEQ publications.

Data from the EPA AQS data base may be used in published reports with appropriate caution. Care must be taken in reviewing/using any data that contain flags or data qualifiers. If data is flagged, such data will not be used unless it is clear that the data still meets critical *QA/QC* requirements. It is impossible to assure that a data base such as AQS is completely free from errors, including outliers and biases, so caution and skepticism is called for in comparing Virginia data from other reporting agencies as reported in AQS. Users should review available *QA/QC* information to assure that the external data are comparable with DEQ measurements and that the original data generator had an acceptable QA program in place.

18.1.6 U.S. WEATHER SERVICE DATA

Meteorological information is gathered from the U.S. Weather Service stations throughout the Commonwealth. Parameters can include temperature, relative humidity, barometric pressure, rainfall, wind speed, wind direction, cloud type/layers, percentage cloud cover, and visibility range. NWS data are occasionally included in summary reports.

19.0 DATA MANAGEMENT

19.1 BACKGROUND AND OVERVIEW

This section is devoted to a description of the data management operations applicable to carbon monoxide measurements for the NAMS/SLAMS stations operated by the Virginia DEQ. The scope of these operations encompasses all aspects of data management - recording, validating, transforming, transmitting, performing reduction analyses, managing, storing, and retrieving. Contained here is an overview of the mathematical operations and analyses to be performed on raw (as-collected) carbon monoxide data.

19.2 DATA RECORDING

The majority of data collected in VA AQM's network is recorded electronically. To accomplish this, each gaseous monitoring site is equipped with data loggers. A data logger is set up to record each gaseous monitor's output, perform specific data manipulations, and format the resulting data in preparation for downloading to a database or spreadsheet. Activities such as operational checks, leak check results, audit results, and calibrations are kept on separate logsheets maintained by the operators.

19.3 DATA VALIDATION

Data validation is a combination of checking that data processing operations have been carried out correctly and of monitoring the quality of the field operations. Data validation can identify problems in either of these areas. Once problems are identified, the data can be corrected or invalidated, and corrective actions can be taken for field or monitoring laboratory operations.

The following validation functions are used by the Office of Air Quality Monitoring to ensure quality of data entry and data processing operations:

- **Record review** - the following data records are subjected to monthly review by designated OAQM personnel: zero/span field sheets, operator check sheets, drift

control charts, missing data reports, and other gas analyzer forms. Questionable entries are discussed with the field operator and resolved by designated OAQM personnel.

- **Range Checks** – Some monitored parameters have simple range checks that are pre-programmed. This information is reviewed as part of the monthly QA review by the Data QA leader. All flagged values i.e. high values are investigated to ensure the monitor is operating properly. This information is checked against other monitors located in the same area.
- **Completeness Checks** - When the data are processed certain completeness criteria must be met. For example, for an hourly average to be considered valid there must be valid data collected for 75% of that hour. Less than 75% valid data results in a flag being added to the record for that hour and no valid hourly average is generated.
- **Data Retention** – Monthly raw data reports are retained on file in Air Quality Monitoring consistent with the records retention policy described in Chapter 9.
- **Statistical Data Checks** - These checks are run when data are submitted to AQS. All sample values that are flagged during the screening process are investigated before submittal is completed.
- **Data Validation**- Data validation is performed monthly. During this process, which is discussed in Section 23, flags that are generated by QC values outside of acceptance criteria are associated with the data.
- **Precision and Accuracy (Bias) Reporting**- Two key operational criteria for ambient air pollution monitoring are bias and precision. As defined in 40CFR Part 58, these are based on differences between sampler results and known test concentrations or conditions. The Virginia Office of Air Quality Monitoring reviews the results of each month's data quality assessment activity. The objective will be to optimize the performance of its monitoring equipment by minimizing bias in the monitored data. Multiple bias and precision results must be accumulated to assess data quality with confidence. At a minimum, all instruments undergo an every two week precision check as well as regular zero/span checks to provide sufficient information to verify

data accuracy and precision.

19.4 DATA TRANSFORMATION

The inherent accuracy of an instrument is incorporated into the system accuracy when the instrument is calibrated. Each criteria pollutant-monitoring direct-measurement instrument has its own internal potentiometers, whether digital or analog, which are adjusted to accurately reflect the concentration at which the instrument is tested. Each instrument is assumed to be linear within the range of 10% to 90% of full scale. As long as the background concentrations do not violate this range, the accuracy of the instrument is not questioned. Each time the instrument is calibrated the data logger is adjusted to reflect the revised monitor correction/correlation equation.

Additional information is available in the pollutant specific SOPs and the individual analyzer's operations manuals.

19.5 DATA TRANSMITTAL

1. The Virginia DEQ will report all carbon monoxide ambient air quality data and information specified by the AQS Data coding manual www.epa.gov/ttn/airs/airsaqs/manuals. Such air quality data and information will be fully screened and validated, and will be submitted directly to AQS via electronic transmission, in the format of AQS, and in accordance with the quarterly schedule. A data flow diagram outlining this procedure is included as Table 19-1. The specific quarterly reporting periods and due dates are shown in Table 19-2.

Table 19-1
Data Flow for Virginia Gaseous Monitors

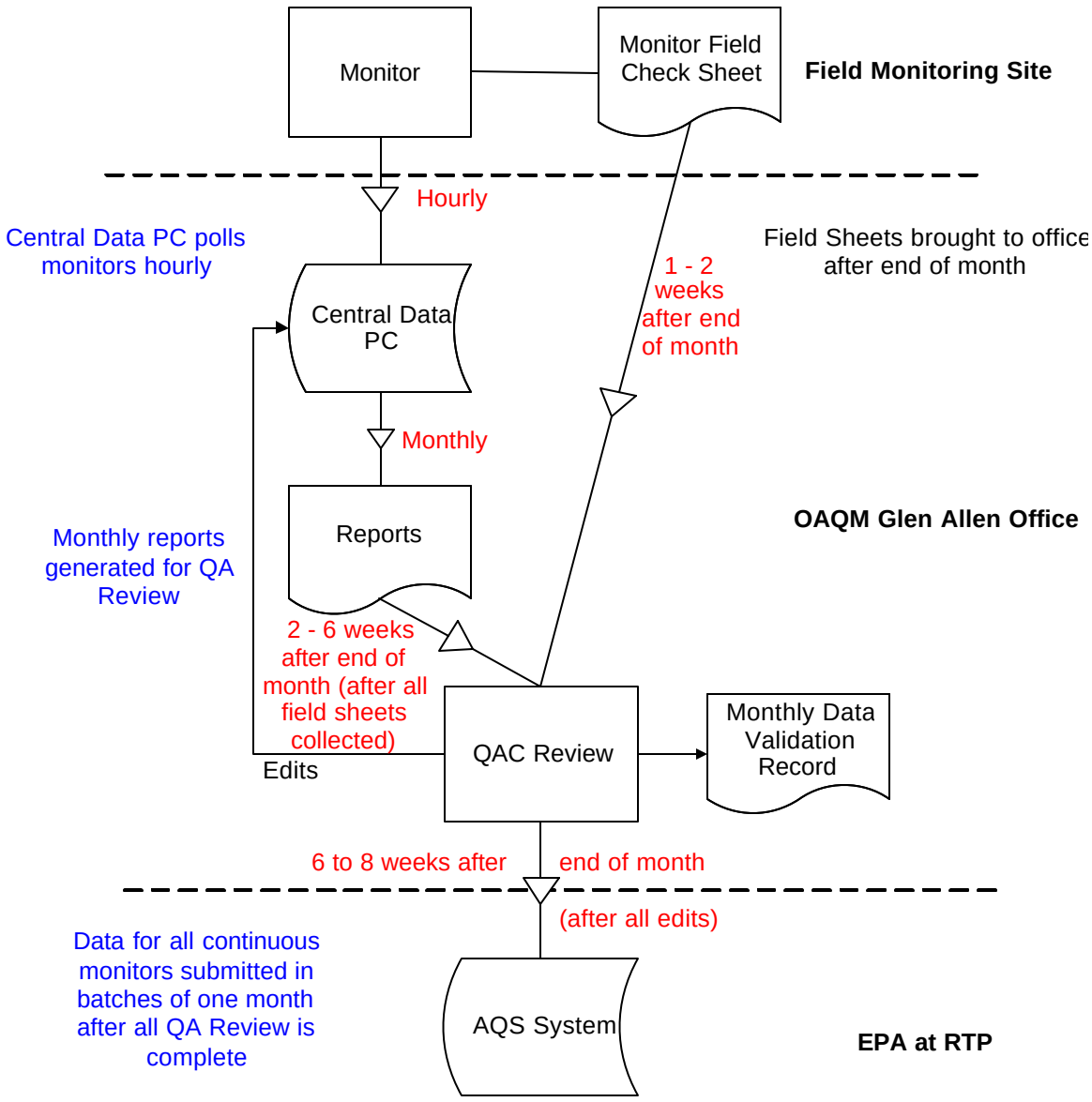


Table 19-2 Gaseous Pollutant Data Reporting Schedule

Reporting Period	AQS Due Date
January 1-March 31	June 30
April 1-June 30	September 30
July 1-September 30	December 31
October 1-December 31	March 31

19.6 DATA ANALYSIS

The Virginia DEQ will implement the data summary and analysis requirements contained in 40 CFR Part 58. The following specific summary statistics will be tracked and reported for the carbon monoxide network:

- Single monitor bias or accuracy (based on FRM/FEM performance evaluations)
- Single monitor precision
- Network-wide bias and precision (based on FRM/FEM data and performance evaluations)
- Data completeness

Equations used in these reports are found in 40 CFR Part 58, Appendix A.

19.7 DATA FLAGGING - SAMPLE QUALIFIERS

A sample qualifier or result qualifier consists of alphanumeric characters that act as an indicator of the fact and the reason that the data value (a) did not produce a numeric result; (b) produced a numeric result but it is qualified in some respect relating to the type or validity of the result; or (c) produced a numeric result but for administrative reasons it is not to be reported outside of the DEQ.

Some flags will be generated by the monitor equipment. During the monitoring validation process, the flags will be used to decide whether to validate or invalidate data.

19.8 DATA STORAGE AND RETRIEVAL

Data archival policies for the carbon monoxide monitoring program are shown in Table 19-3.

Table 19-3 Data Archive Policies

Data Type	Medium	Location	Retention Time	Final Disposition
Paperwork from Field Notebooks /Site Log books	Hardcopy	Virginia Office of Air Quality Monitoring	5 years	May be recycled after 5 years
Carbon Monoxide database (included in DEQ Air continuous monitor database)	Electronic (on-line) and hardcopy	Virginia Office of Air Quality Monitoring	moved to backup media each year AQS is the official record	Backup media may be retained indefinitely Hardcopy retained for 5 years
Carbon Monoxide Precision and Accuracy records	Hardcopy	Virginia Office of Air Quality Monitoring	5 years	recycled after 5 years

20.0 ASSESSMENTS AND RESPONSE ACTIONS

An assessment, for this QAPP, is defined as an evaluation process used to measure the performance or effectiveness of the quality system, the establishment of the monitoring network and sites and various measurement phases of the data operation.

The results of quality assurance assessments indicate whether the control efforts are adequate or need to be improved. Documentation of all quality assurance and quality control efforts implemented during the data collection, analysis, and reporting phases is important to data users, who can then consider the impact of these control efforts on the data quality. Both qualitative and quantitative assessments of the effectiveness of these control efforts will identify those areas most likely to impact the data quality and to what extent. Periodic assessments of SLAMS data quality are required to be reported to EPA. The selection and extent of the QA and QC activities used by a monitoring agency depend on a number of local factors, such as the field and laboratory conditions, the objectives for monitoring, the level of the data quality needed, the expertise of assigned personnel, the cost of control procedures, and pollutant concentration levels.

To ensure the adequate performance of the quality system, the VA DEQ-OAQM will perform the following assessments:

- Management Systems Reviews
- Network Reviews
- Audits of Data Quality
- Data Quality Assessments

20.1 ASSESSMENT ACTIVITIES AND PROJECT PLANNING

20.1.1 MANAGEMENT SYSTEMS REVIEW

Management Systems Reviews (MSR) are qualitative assessments of a data collection operation or organization to establish whether the prevailing quality management structure, policies, practices, and procedures are adequate for ensuring that the type and quality of data needed are obtained. Management systems reviews of the ambient air monitoring program are conducted periodically by the OAQM. The quality assurance activities of all criteria pollutants, including carbon monoxide, will be part of these reviews. Follow-up and progress on corrective action(s) will be determined based on the need and severity of the action.

20.1.2 NETWORK REVIEWS

Conformance with requirements set forth in 40 CFR Part 58 Appendices D and E is determined through annual network reviews of the ambient air quality monitoring system. The network review determines how well an air monitoring network achieves its required objective, and how it should be modified to continue to meet its objective. The DEQ-OAQM will be responsible for performing a carbon monoxide network review every year. The OAQM will coordinate its activities with the EPA Region III office, which is also required to perform an annual network review.

The following criteria will be considered during the review:

- date of last review,
- areas where attainment/non attainment re-designations are taking place or are likely,
- results of special studies, saturation monitoring, point source oriented ambient monitoring,
- proposed network modifications since the last review.

In addition, pollutant-specific priorities may be considered.

Prior to implementing the network review, the OAQM will compile and evaluate data and information significant to the review. Such information might include the following

- network files, including updated site information and photographs,
- AQS reports,
- air quality summaries for the past five years for the monitors in the network,
- emissions trends reports for the major metropolitan area,
- emission density maps for the region in which the monitor is located,
- maps showing the major sources of emissions,
- National Weather Service summaries for the monitoring network area.

The information will be checked to make sure it is the most current. Discrepancies will be noted on the checklist and resolved during the review. Files or photographs that need to be updated will be identified. The following categories will be emphasized during network reviews:

Number of Monitors:

For SLAMS, the number of monitors required for carbon monoxide depends on the measurement objectives. This is discussed in *40 CFR Part* 58. Section 10 of this QAPP discusses the carbon monoxide network. The following information will be used to determine the adequacy of the network:

- maps of historical monitoring data,
- maps of emission densities,
- dispersion modeling,
- special studies and saturation monitoring,
- best professional judgments,
- SIP requirements,
- revised monitoring strategies, e.g. lead strategy, reengineering the air monitoring network.

For NAMS, selection of areas to be monitored must be based on urbanized population and pollutant concentration levels. To determine whether the number of NAMS is adequate, the number operating will be compared to the number specified in 40 CFR 58 Appendix D. The number of NAMS operating can be determined from the AIRS summary reports. The number of monitors required, based on concentration levels and population, can be determined from the AIRS reports and the latest official census population data.

Location of Monitors:

For SLAMS, the regulations do not specify the location of monitors; rather, location is determined by the EPA Regional Office and State agencies on a case-by-case basis in consideration of the monitoring objectives specified in *40 CFR Part* 58 *Appendix D.* Adequacy of the location of monitors can only be determined on the basis of stated objectives. Maps, graphical overlays, and GIS-based information will be helpful in assessing the adequacy of monitor locations. Plots of potential emissions and historical monitoring data versus monitor locations will also be used.

During the network review, the stated objective for each monitoring location or site (see section 10) will be "re-confirmed" and the spatial scale "re-verified" and then compared to each location to determine whether these objectives can still be attained at the present location.

Conformance to *40 CFR Part* 58 *Appendix E,* Probe Siting Requirements:

Siting criteria applicable to SLAMS and NAMS are specified in *40 CFR* 58 *Appendix E.* The on-site visit will include physical measurements and observations to determine compliance with Appendix E requirements, such as height above ground level, distance from trees, and paved or vegetative ground cover. Since many of the Appendix E requirements will not change within one year, this check at each site will be performed every three years.

Prior to the site visit, the reviewer will review the following:

- most recent copy of site description, including any photographs

- data on the seasons with the greatest potential for high concentrations of specified pollutants
- predominant wind direction by season

The OAQM will use a checklist similar to the one used by the EPA Regional offices during their scheduled network reviews. This checklist, which is intended to assist the reviewers in determining conformance with Appendix E, can be found in NAMS/SLAMS Network Review Guidance. The reviewer will perform the following tasks in addition to those on the checklist:

- check equipment for frayed cords, loose parts and other damage,
- record findings in field notebook and checklist,
- take photographs or videotape and when needed in the eight directions,
- document site conditions, with additional photographs or videotape.

Other Discussion Topics:

In addition to the items included in the checklists, subjects for discussion as part of the network review and in determining adequacy of the monitoring program will include:

- installation of new monitors
- relocation of existing monitors.
- siting criteria problems and suggested solutions
- problems with data submittals and data completeness
- maintenance and replacement of existing monitors and related equipment
- quality assurance problems
- air quality studies and special monitoring programs
- other issues such as proposed regulations and funding

A network review report will be written within two months of the review.

20.1.3 DATA QUALITY ASSESSMENTS

A Data Quality Assessment (DQA) is the statistical analysis of environmental data to determine whether the quality of data is adequate to support the decisions which are based on the data quality objectives (DQOs). Data are appropriate if the level of uncertainty in a decision based on the data is acceptable. The DQA process is described in detail in Guidance for the Data Quality Assessment Process, EPA QA/G-9 and is summarized below.

1. Review the data quality objectives (DQOs) and monitoring design of the program. Define statistical hypothesis, tolerance limits, and confidence intervals.
2. Conduct preliminary data review; review Precision & Accuracy (P & A) and other available QA reports; calculate summary statistics, plots and graphs. Look for patterns, relationships, or anomalies.
3. Select the statistical test; select the best test for analysis based on the preliminary review, and identify underlying assumptions about the data for that test.
4. Verify test assumptions; decide whether the underlying assumptions made by the selected test hold true for the data and the consequences.
5. Perform the statistical test and document interferences. Evaluate the performance for future use.

Data quality assessment will be included in the *Annual Carbon Monoxide Q.A. Report.*

Measurement uncertainty will be estimated for both automated (monitors) and data manipulations. Terms associated with measurement uncertainty are found within *40 CFR Part* 58 *Appendix A* and include:

- Precision: a measurement of mutual agreement among individual measurements of the same property usually under prescribed similar conditions, expressed generally in terms of the standard deviation.

- Accuracy: the degree of agreement between an observed value and an accepted reference value; accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to monitoring and analytical operations.
- Bias: the systematic or persistent distortion of a measurement process which causes errors in one direction.

The individual results of these tests for each method or analyzer shall be reported to EPA. Estimates of the data quality will be calculated on the basis of single monitors and aggregated to all monitors.

20.2 DOCUMENTATION OF ASSESSMENTS

Table 20-1 summarized each of the assessments discussed above.

Table 20-1 Assessment Summary

Assessment Activity	Frequency	Personnel Responsible	Report Completion
Management Systems Reviews	1 per 3 years	OAQM	30 days after inactivity
Network Reviews App D App E	 1 per year 1 per 3 years	OAQM	30 days after inactivity
Technical Systems Audits	1 per 3 years	EPA	30 days after inactivity
Audits of Data Quality	1 per year	OAQM	30 days after inactivity
Data Quality Assessment	1 per year	OAQM	120 days after end of calendar year

21.0 REPORTS TO MANAGEMENT

This section describes the quality-related reports and communications to management necessary to support NAMS/SLAMS carbon monoxide network operations, and the associated data acquisition, validation, assessment, and reporting. Unless otherwise indicated, data pertaining to carbon monoxide will be included in reports containing monitoring data for other pollutants.

Important benefits of submitting regular QA reports to management include the opportunity to alert the management to data-quality problems, to propose viable solutions to problems, and to procure necessary additional resources. Quality assessment, including the evaluation of the technical systems, the measurement of performance, and the assessment of data, will be conducted to help ensure that measurement results meet program objectives, and to ensure that necessary corrective actions are taken early, when they will be most effective. This is particularly important with respect to the new carbon monoxide network, as new equipment and procedures are being implemented.

Effective communication among all personnel is an integral part of a quality system. Regular, planned quality reporting will provide a means for tracking the following:

- adherence to scheduled delivery of data and reports,
- documentation of deviations from approved QA and test plans, and the impact of these deviations on data quality,
- analysis of the potential uncertainties in decisions based on the data.

21.1 FREQUENCY, CONTENT, AND DISTRIBUTION OF REPORTS

Required reports to management for carbon monoxide monitoring and the SLAMS program in general are discussed in various sections of 40 CFR Parts 50, 53, and 58. Guidance for management report format and content are provided in guidance developed by EPA's

Quality Assurance Division (QAD) and the Office of Air Quality Planning and Standards (OAQPS). These reports are described in the following subsections.

21.1.1 NETWORK REVIEWS

The DEQ will prepare annual network reviews in accord with requirements in 40 CFR Part 58.20(d). The purpose of the annual network reviews will be to determine if the system meets the monitoring objectives defined in 40 CFR Part 58 Appendix D. The review will identify needed modifications to the network including the termination or relocation of unnecessary stations or the establishment of new stations. Information gathering for these reviews will be coordinated through the Director, Office of Air Quality Monitoring. Supervisors and other personnel will assist as necessary to provide information and support. The DEQ Air Operations Director will assure that such changes are included in future planning. The Director, Office of Air Quality Monitoring, also will implement other review findings that affect data quality.

As required by 40 CFR Part 58 Appendix Z, Section 4(a), revised July 18, 1997, the DEQ will submit a list of all monitoring sites and their AQS site identification codes to the EPA Regional Office each year. Whenever there is a change in this list of monitoring sites in a reporting organization, the DEQ, Office of Air Quality Monitoring, will report this change to the EPA Regional Office and to AQS.

21.1.2 QUARTERLY REPORTS

Each quarter, the DEQ Office of Air Quality Monitoring will report to AQS the results of all precision, bias, and accuracy tests it has carried out during the quarter. The quarterly reports will be submitted, in compliance with the data-reporting requirements specified for air quality data as set forth in 40 CFR Parts 58.26, 58.35 and 40 CFR Part 58 Appendix A, Section 4.

The data-reporting requirements of 40 CFR Part 58.35 apply to those stations designated SLAMS or NAMS. Required accuracy and precision data will be reported on the same schedule as quarterly monitoring data submittals. The required

reporting periods and due dates are listed in Chapter 6.

In accordance with the Federal Register Notice of July 18, 1997, all QA/QC data collected will be reported and will be flagged appropriately. This data includes: "results from invalid tests, from tests carried out during a time period for which ambient data immediately prior or subsequent to the tests were invalidated for appropriate reasons, and from tests of methods or analyzers not approved for use in SLAMS monitoring networks. . ." (40 CFR Part 58 Appendix A, Section 4, revised July 18, 1997).

Air quality data submitted for each reporting period will be edited, validated, and entered into the AQS using the procedures described in the *AIRS Users Guide,* Volume II**,** Air Quality Data Coding*.* The DEQ Office of Air Quality Monitoring, Data Processing and Special Studies Section will be responsible for preparing the data reports, which will be reviewed by the data QA manager before they are transmitted to EPA.

21.1.3TECHNICAL SYSTEM AUDIT REPORTS

External system audits are conducted at least every three years by the EPA Regional Office as required by 40 CFR Part 58, Appendix A, Section 2.5. Further instructions are available from the EPA Regional QA Coordinator or the Systems Audit QA Coordinator, Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division (MD-14), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

21.1.4 RESPONSE/CORRECTIVE ACTION REPORTS

The Response/Corrective Action Report procedure will be followed whenever a problem is found such as a safety defect, an operational problem, or a failure to comply with procedures. The Response/Corrective Action Report is one of the most important ongoing reports to management because it documents primary QA

activities and provides valuable records of QA activities that can be used in preparing other summary reports.

The Response/Corrective Action Report procedure is designed as a closed-loop system. The Response/Corrective Action Report form identifies the originator who reported and identified the problem, states the problem, and may suggest a solution. The form also indicates the name of the person or persons who are assigned to correct the problem. The assignment of personnel to address the problem and the schedule for completion will be filled in by the appropriate supervisor. The Response/Corrective Action Report procedure closes the loop by requiring that the recipient state on the form how the problem was resolved, and to what extent the solution was effective. Supervisors and managers, as well as the originator, also will be included in the distribution.

21.1.5 CONTROL CHARTS WITH SUMMARY

Gas Analyzer Forms, i.e. zero span drift, check sheets, and QA set point sheets for instruments will be updated after every new calibration or standardization as defined in the relevant SOP. Field operators and analysts will review each control chart immediately after it is updated, and will take corrective actions whenever an out-of-control condition exists. Control charts will be reviewed at least monthly by the monitoring Data QA team leader. Control charts also will be subject to inspection during audits. Monitoring laboratory personnel will maintain a readily accessible file of control charts for each instrument.

21.2 RESPONSIBLE ORGANIZATIONS

This section outlines the responsibilities of persons within the monitoring organization for preparing quality reports, evaluating their impact, and implementing follow-up actions. Changes made in one area or procedure may affect another part of the project. Only by defining clear-cut lines of communication and responsibility can all the affected elements of the monitoring network remain current with such changes. The documentation for all changes will be maintained and included in the reports to management. The following

paragraphs describe key personnel involved with QA reporting.

Air Division Director, DEQ-The ultimate responsibility for the quality of the data and the technical operation of the carbon monoxide network rests with the Executive Director, DEQ. The Director's responsibilities with respect to air quality reporting will be delegated through the Air Division Director, to the Director, Office of Air Quality Monitoring. These responsibilities include defining and implementing the document-management and quality assurance systems for the carbon monoxide monitoring network.

Director, Office of Air Quality Monitoring-The Director, OAQM will direct the operations of the air quality network. The Director will be specifically responsible for assuring the timely submittal of quarterly and annual data summary reports.

QA Data Quality Engineer – The QA Engineer will be responsible for the management and administrative aspects of the carbon monoxide QA program, including coordinating audits and preparing required reports. The Carbon Monoxide QA Officer's responsibilities for QA reports to management include the following:

- assessing data quality and performing other internal audits ,
- reviewing control charts and other QC materials ,
- monitoring Response/Corrective Action Reports,
- ensuring access to data for timely reporting and interpretation,
- ensuring timely delivery of all required data to AQS.

Continuous Monitoring Group Manager-The Manager will identify problems and issue appropriate Response/Corrective Action Reports related to carbon monoxide Network/monitor activities. He or she also will review QC data, such as control charts, and assure that repairs and preventive maintenance are completed and effective. The Manager also will assure that analysts under his or her supervision maintain their documentation files

as defined in the relevant SOPs. The Manager will provide information to assist the QA engineer in preparing QA reports and summaries.

Instrumentation Team Leader - The Continuous Instrumentation Team Leader will identify problems and issue appropriate Response/Corrective Action Reports. He or she also will assign Response/Corrective Action Reports to specific personnel and assure that the work is completed and that the corrections are effective. The Team Leader will assure that technicians and site operators maintain their documentation files as defined in the network design. Supervisors will disseminate information appearing in audit reports and other quality-related documents to operations personnel.

Field and Laboratory Technicians-Individual technicians and analysts normally will not write reports to management. However, they will participate in the process by generating control charts, identifying the need for new Response/Corrective Action Reports, and maintaining other quality-related information used to prepare QA reports.

22.0 DATA REVIEW, VALIDATION AND VERIFICATION REQUIREMENTS

In this section we will describe how the DEQ will verify and validate the data collection operations associated with the carbon monoxide ambient air monitoring network. For the purpose of this program "verification" will be defined as confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. "Validation" will be defined as confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Although there are a number of objectives for collecting ambient air monitoring data, the major objective for the DEQ carbon monoxide network is to compare the data collected with the NAAQS.

This section is focused upon the verification and validation activities that occur at a number of the important data collection phases. Earlier elements of this QAPP contain detailed descriptions of how the activities in each data collection phase will be set in motion to meet the data quality objectives of the program. Review and approval of this QAPP by the DEQ and EPA provide initial agreement that the processes described in the QAPP, if implemented, will provide data of adequate quality. In order to verify and validate the phases of the data collection operation, the DEQ will use various qualitative assessments to verify that the QAPP is being followed, and will rely on the various quality control processes, inserted at various phases of the data collection operation, to validate that the data will meet the DQOs.

22.1 MONITORING DESIGN

The objective of the monitoring design is to represent the population of interest at adequate levels of spatial and temporal resolution. Most of these requirements have been described in the Code of Federal Regulations. DEQ is responsible for ensuring that the intent of the regulations are properly administered and carried out.

22.1.1 MONITORING DESIGN VERIFICATION

Verification of the monitoring design will occur through three processes:

(1) Network Design Plan Confirmation-the Network Design Plan that covers the initial deployment of the network must be submitted, reviewed, and approved by EPA prior to implementation. This process verifies the initial monitoring design.

(2) Internal Network Reviews-Once a year, the OAQM will perform a network review to determine whether the network objectives, as described in the Network Design Plan, are still being met, and that the sites are meeting the CFR siting criteria.

(3) External Network Reviews-Every three years the EPA Region III Office will conduct a network review to determine whether the network objectives, as described in the Network Design Plan, are still being met, and whether the sites are meeting the CFR siting criteria.

22.1.2 MONITORING DESIGN VALIDATION

The ambient air data derived from the sites will be used to validate the monitoring design. The processes described in Section 10 will be used to confirm the network design.

22.1.3 SAMPLE COLLECTION VERIFICATION

Sample-collection procedures are described in detail in Section 11 and are developed to ensure proper monitoring and to maintain sample integrity. The following process will be used to verify the monitoring collection activities:

External Technical System Audits will be conducted by the EPA Region III Office every three years.

Technical-systems audits will be used to verify that the sample collection activity is being performed as described in this QAPP and the SOPs. Deviations from the sample collection activity will be noted in the audit report, and corrected using the procedures described in Section 20.

22.2 QUALITY CONTROL

Sections 14 and 16 of this QAPP specify the QC checks that are to be performed during monitor operation and analysis. These checks include analyses of standards which provide indications of the quality of data being produced by specified components of the measurement process. For each specified QC check, the procedure, the acceptance criteria, and the corrective action are specified.

22.2.1 VERIFICATION OF QUALITY CONTROL PROCEDURES

As described above, external technical-systems audits will be performed to ensure adherence to the quality-control method specifications set forth in the QAPP.

22.2.2 VALIDATION OF QUALITY CONTROL PROCEDURES

Validation activities of many of the other data-collection phases mentioned in this subsection use the quality-control data to validate the proper and adequate implementation of the quality-control phase. Section 14 describes the techniques used to document QC review/corrective action activities.

22.3 CALIBRATION

Section 16, as well as the field (Section 11) and the analytical sections (Section 13), detail the calibration activities and requirements for the critical pieces of equipment for the carbon monoxide network.

22.3.1 VERIFICATION OF CALIBRATION PROCEDURES

External technical-systems audits will be performed to ensure the calibration specifications and corrective actions mentioned in the QAPP are being followed. Deviations from the calibration procedures will be noted in the audit report and corrected using the procedures described in Section 20.

22.3.2 VALIDATION OF CALIBRATION PROCEDURES

As with the validation of monitoring activities, the review of calibration data described in section 14 and 16, can be used to validate calibration procedures.

Calibration data within the acceptance requirements verify that the monitoring devices are operating properly. Any data that indicate unacceptable levels of bias or precision, or a tendency (trend on a control chart) will be flagged and investigated. This investigation could lead to a discovery of inappropriate calibration procedures, or to equipment problems requiring corrective action. Validation will include the review of the documentation to ensure corrective action was taken as prescribed in the QAPP.

22.4 DATA REDUCTION AND PROCESSING

As mentioned in the above sections, external technical systems audits will be performed to ensure the data reduction and processing activities mentioned in the QAPP are being followed. These raw data will be reviewed to determine whether the final values submitted to AQS compare with the independent calculations. The data also will be reviewed to ensure that associated flags and other data qualifiers have been appropriately associated with the data, and that corrective actions were taken when necessary.

23.0 VALIDATION AND VERIFICATION METHODS

The purpose of this element is to identify the procedures and responsible parties who will perform data validation and verification. Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. Data validation is an analyte and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e. data verification) to determine the analytical quality of a specific data set.

Many of the processes for verifying and validating the measurement phases of the NAMS/ SLAMS data collection operation have been discussed in Section 22. If these processes, as written in the QAPP, are followed, and the sites are representative of the conditions for which they were selected, one would expect to achieve the DQOs. However, exceptional field events may occur, and field and laboratory activities may negatively affect the validity of monitored results. In addition, it is expected that some of the QC checks will fail to meet the acceptance criteria. Information on problems that affect the integrity of data is identified in the form of flags. It is important to determine how these failures affect the routine data. The review of this routine data and the associated QC data will be verified and validated on a monthly basis. It is assumed that if measurement uncertainty can be controlled within acceptance criteria, then the overall measurement uncertainty will be maintained within the precision and bias DQOs.

23.1 DATA VERIFICATION

On a monthly basis, a thorough review of the data will be conducted for completeness and data entry accuracy. All raw data that are hand entered from data sheets will be checked prior to entry to the appropriate database. Once the data are entered, the data will be reviewed for routine data outliers and conformance to acceptance criteria. Unacceptable or questionable data will be flagged appropriately. All flagged data will be re-verified to ensure

that the values were entered correctly.

23.2 DATA VALIDATION

The data validation process will consist of review of hourly data and monitor quality control records. Records of all invalid data will be filed in the monthly validation files in the OAQM office. Information will include a brief summary of why the data was invalidated along with any associated flags. Additional flags may be associated with the null data code that would help describe the reason for these flags, as well as free form notes from the field operator or technician. Explanations for significant amounts of missing data will also be recorded in the monthly validation files in the OAQM office.

24.0 RECONCILIATION WITH DATA QUALITY OBJECTIVES

This section of the QAPP outlines the procedures that the DEQ Office of Air Quality Monitoring will follow to determine whether the monitors and laboratory analyses are producing data that comply with the DQOs and what action will be taken as a result of the assessment process. Such an assessment is termed a Data Quality Assessment (DQA) and is thoroughly described *in EPA QA/G-9: Guidance for Data Quality Assessment.*

24.1 FIVE STEPS OF DQA PROCESS

The DQA process is comprised of five steps which are detailed below.

1. Review the DQOs and the monitoring network design. Ascertain that the DQOs are still valid and that the monitoring network is providing the necessary data with which to make attainment decisions.

2. Conduct a preliminary data review. This review is performed to uncover potential limitation to the use of the data, to reveal outliers, and for general data review. During data review, summary statistics, quality assurance reports, and some graphical representations of the data will be generated. Particular attention will be directed to the detection of anomalies in the data, missing values, and any deviations from standard operating procedures. The summary statistics will be generated for each monitoring site.

3. Select the statistical test. The primary objective for the monitoring of carbon monoxide is for the determination of compliance with the carbon monoxide NAAQS. These calculations are specified in 40 CFR Part 50. Virginia will utilize these calculations in the determination of NAAQS attainment/non-attainment determinations.

4. Verify assumptions of statistical test. EPA has already verified the assumptions of the statistical test prior to their inclusion in the regulations. To the extent possible, Virginia will use full years of data for NAAQS determinations, but as much data as is available will be

used if there is less than three years. Acceptable measurement and decision error limits have been specified by EPA, and these limits will be applied during DEQ's DQO review. The review will identify any monitoring sites that violate the standard, have apparent non-normal measurement errors or have less that the required data capture rate. Bias and precision limits will be estimated and compared to the established three year limit of +/- 10% (bias) and less than 10% (precision). Quarterly and annual bias and precision estimates will be calculated.

5. Draw conclusions from the data. The DEQ will determine if any of the assumptions upon which the statistical tests are based have been violated. This determination will be made prior to any determinations of compliance with the carbon monoxide NAAQS. If the tests indicate that the assumptions are valid, the DEQ will proceed with the calculations for determination of NAAQS attainment as described in 40 CFR Part 50. If not, further investigation will be needed before any attainment/nonattainment decisions can be made.

24.2 ACTION PLAN RESULTING FROM DATA QUALITY ASSESSMENT

The DEQ will conduct a DQA each year. In addition, quarterly determinations of precision and bias will be made to check for any changes in field or laboratory operations that need to be addressed before the annual review. Based upon the results of the DQA, the DEQ may take one or more of the following actions:

1. Modify the monitoring network. Virginia will operate monitors in accordance with 40 CFR Part 58, Appendix A, at a minimum. The number of monitors may be increased if additional data is necessary to characterize the precision and bias of the carbon monoxide monitoring network.

2. Modify other *QA/QC* activities. At a minimum, Virginia will perform all *QA/QC* operations in accordance with federal regulations and Guidance. These operations include field and laboratory activities, equipment malfunctions, site problems, and operator training.

3. Determine level of aggregation at which DQOs are violated. Specific problem monitors may be identified as part of the DQA process. Should this occur, it will be determined if

the problem is unique to a specific site(s) or whether there is a broader problem. If an investigation cannot determine a specific site problem, national reports will be reviewed for specific type monitor problems. In addition, neighboring reporting organizations' precision and bias reports will be reviewed.

4. Communication with the EPA Regional Office. The DEQ will maintain close contact with the EPA Region III Office concerning any problems with achieving bias and precision DQOs.

5. Review of quarterly data. The DEQ will review the quarterly QA reports and the QC summaries to ensure attainment of bias and precision limits.