Air Quality
ENVIRONMENTAL QUALITY

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Quality Assurance Project Plan for the North Carolina Division of Air Quality Criteria and NCore Ambient Air Quality Monitoring Programs

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DISCLAIMER

This Quality Assurance Project Plan (QAPP) covers the criteria-pollutant and NCore monitoring network for the North Carolina Department of Environmental Quality (DEQ) Division of Air Quality (DAQ) and the Western North Carolina Regional Air Quality Agency. Throughout this document where it states "DAQ" this local program is included by reference.

QUALITY ASSURANCE PROJECT PLAN ACRONYM GLOSSARY

ADQ - Audit of Data Quality
AQS - Air Quality System (EPA's Air database)
ARM – Approved regional method
BAM – Beta attenuation monitor
CFR – Code of Federal Regulations
CO – Carbon monoxide
COC – Chain of custody
CV – Coefficient of Variation
DAQ - North Carolina Division of Air Quality
DEQ – North Carolina Department of Environmental Quality
DQA - Data quality assessment
DQI - Data quality indicators
DQO - Data quality objectives
ECB – Electronics and Calibration Branch
e-log – electronic logbook
EPA – United States Environmental Protection Agency
FEM – Federal equivalent method
FRM – Federal reference method
IR – Infrared
km - kilometers
LDL – Lower detection limit
L/min – Liters per minute
m – meters
m^3/hour – Cubic meters per hour
MQO – Measurement quality objective
MSR - Management systems review
NAAQS - National Ambient Air Quality Standards
NCore- National Ambient Monitoring Strategy - National Core Monitoring
NCSOP - North Carolina standard ozone photometer
NIST - National Institute of Science and Technology
NO_2 – Nitrogen dioxide
NO_x – Nitrogen oxides
NO_y – Reactive oxides of nitrogen
NPAP - National performance audit program
O_3 – Ozone
PAMS - Photochemical assessment monitoring station
Pb – lead
PEP – Performance evaluation program
PFA – Perfluoroalkoxy
$PM_{2.5}$ – Particles with an average aerodynamic diameter of 2.5 microns or less, also known as fine particles
PM_{10} – Particles with an average aerodynamic diameter of 10 microns or less
ppb – parts per billion
ppm – parts per million

PQAO – Primary quality assurance organization
QA/QC - Quality assurance/quality control
QAPP - Quality assurance project plan
QC – Quality control
R & P - Rupprecht & Patashnick
RCO – Raleigh central office
RSD – Relative standard deviation
SD – Standard deviation
SLAMS - State and local air monitoring station
SO_2- Sulfur dioxide
SOP - Standard operating procedure
SPM - Special purpose monitor
SRP – EPA standard ozone reference photometer
STN – Speciation trends network
TEOM - Tapered elemental oscillating microbalance
TSA - Technical systems audit
VIP – Value in Performance
VOC – Volatile organic compounds
VSCC – Very sharp cut cyclone
WINS – Well-type impactor ninety-six
XRF – X-ray fluorescence

1.0 QUALITY ASSURANCE PROJECT PLAN IDENTIFICATION AND APPROVAL

Title: *Quality Assurance Project Plan for the State of North Carolina Division of Air Quality Ambient Air Quality Monitoring Program*

The attached Qu*ality Assurance Project Plan for the State of North Carolina Division of Air Quality Ambient Air Quality Monitoring Program* is hereby recommended for approval and commits the State of *North Carolina*, Department of Environmental Quality (Division of Air Quality) to follow the elements described within.

1) Signature: [signature] Date 9/12/2016
DEQ, Air Quality Division Director

2) Signature: [signature] Date 9/12/2016
DAQ Acting Quality Assurance Manager

3) Signature: ______________________ Date __________
EPA Region 4 Quality Assurance Officer

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3.0 DISTRIBUTION

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Table 3.1 DAQ Ambient Air Quality Monitoring Program Quality Assurance Project Plan Distribution List

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4.0 PROJECT/TASK ORGANIZATION

The DAQ Ambient Monitoring Section is organized into three main branches: The Projects and Procedures Branch, Laboratory Analysis Branch, and the Electronics and Calibration Branch. The chief of the Ambient Monitoring Section has responsibility for managing these branches according to stated policy. The chief delegates the responsibility and authority to develop, organize, and maintain and implement quality programs to the supervisors of each branch, in accordance with the quality management plan. These supervisors and the line managers under them have direct responsibility for assuring data quality.

The organizational structure for the implementation of the monitoring program is shown in Figure 4.1. The following information lists the specific responsibilities of each significant position within the DAQ Ambient Monitoring Section.

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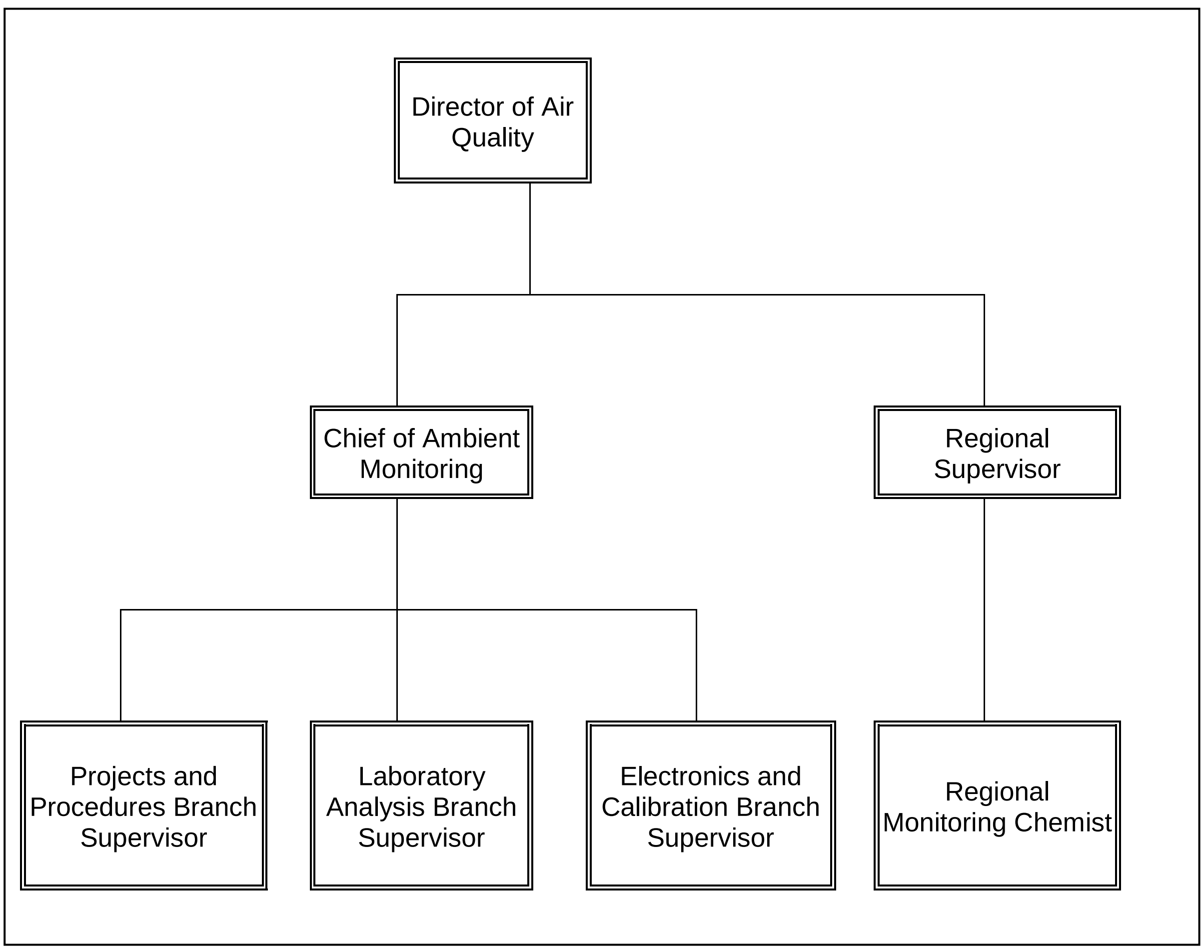
Figure 4-1. Ambient Air Quality Monitoring Program Organizational Structure



4.1. Ambient Monitoring Section

The Ambient Monitoring Section contains the Projects and Procedures, Lab Analysis, and Electronics and Calibration Branches and is responsible for coordinating all aspects (quality assurance, data collection, and data processing) of DAQ's criteria and National Core (NCore) ambient air quality monitoring program.

Chief: The chief of the Ambient Monitoring Section has direct access to the director of air quality on all matters relating to DAQ's criteria and NCore ambient monitoring operation. The chief's duties include, but are not limited to the following:

- Maintaining oversight of QA activities;
- Approving division standard operation procedures (SOPs) and quality assurance project plans (QAPPs);
- Developing, administering and maintaining the quality management plan;
- Assuring that QAPPs are established and effectively implemented for each project as applicable;
- Preparing budgets, contracts, and proposals; and
- Reviewing budgets, contracts, grants and proposals.

Database Manager: The database manager has direct access to the chief of ambient monitoring on all matters relating to DAQ's criteria and NCore ambient monitoring database management. The database manager's duties include, but are not limited to the following:

- Uploading environmental data to the Air Quality System (AQS) and AirNow Tech databases;
- Maintaining the central office data polling station, ensuring it polls hourly and minute data for each hour of every day; and
- Maintaining and updating the central office data polling software and AQS database when sites and monitors are established or shut down.

4.2. Projects and Procedures Branch

Project and Procedures Branch Supervisor: The Projects and Procedure Branch supervisor reports to the chief of the Ambient Monitoring Section. This supervisor's duties include the following:

- Maintaining oversight of all QA activities;
- Verifying implementation of all Ambient Monitoring Section QAPPs and procedures;
- Maintaining overall responsibility for the monitoring network design and review;
- Responding to public records requests and statistical consulting requests;
- Ensuring training availability and utilization; and
- Approving and implementing procedures.

Central Office Chemists. The central office chemists report to the Project and Procedure Branch supervisor and are responsible for coordinating the activities of the DAQ criteria and NCore monitoring program. The central office chemist's duties include the following:

- Organizing the collection, verification, and reporting of data
- Assessing the effectiveness of the network system
- Ensuring timely and appropriate SOP and QAPP updates
- Collecting, verifying, and reporting data
- Generating and evaluating air quality models
- Documenting position statements developed from modeling activities
- Verifying all required QA activities are performed and that measurement quality standards are met with annual system audits;
- Maintaining QA records, flagging suspect data, and assessing and reporting on laboratory data quality;
- Identifying quality problems and initiating action which results in solutions; and
- Providing training and certification to appropriate personnel.

Statistician. The statistician provides statistical programming support to the branch supervisor and other staff of the central and regional offices, including:

- Assisting the branch supervisor with responding to consulting and data requests;
- Uploading environmental data to the Air Quality System (AQS);
- Participating in training and certification programs to keep current on technology;
- Interpreting data and developing and maintaining statistical reports that include tabulations of data, statistical analysis and summaries of the data, graphs, maps, recommendations and conclusions;
- Planning and conducting statistical and scientific studies based on interpretation of data;
- Preparing and delivering data and statistical advice to the regional offices and DAQ; and
- Responding to public records requests and statistical consulting requests.

4.3. Regional Offices

Regional Supervisor. The regional supervisor has direct access to the chief on all matters relating to the DAQ criteria and NCore ambient air monitoring operation. The regional supervisor's duties include:

- Assuring that division policies are maintained at the regional office level;
- Verifying implementation of quality programs;
- Recommending changes when needed in the QA Program;

- Providing and approving regional input for the design and documentation of the monitoring network; and
- Supervising and delineating duties for the regional monitoring chemist.

Regional Monitoring Chemists. Regional chemists report directly to the regional supervisor. Regional chemists have the overall responsibility of ensuring the implementation of the QA program at the regional level. They direct the activities of the regional monitoring staff. Their responsibilities include:

- Coordinating and reviewing the collection of environmental data;
- Implementing the DAQ QA program within the region;
- Acting as conduits for information to regional monitoring staff;
- Training staff in the requirements of the QAPP and SOPs;
- Providing a backup to the regional monitoring staff;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Providing regional input on the design and documentation of the monitoring network; and
- Ensuring that monitoring personnel follow the QAPP and associated SOPs.

Regional Monitoring Staff. The regional monitoring staff's duties include:

- Ensuring that monitoring programs incorporate QA elements of SOPs and QAPPs;
- Reviewing environmental data prior to submittal;
- Assisting in the acquisition of resources, calibration and maintenance of equipment, and maintenance of inventories;
- Collecting, calculating, and reviewing environmental data;
- Participating in training and certification activities;
- Verifying that all required quality control (QC) activities are performed and that measurement quality objectives are met as prescribed in the QAPP and SOPs;
- Documenting deviations from established procedures and methods;
- Reporting nonconforming conditions and corrective actions to the regional chemist and the regional supervisor;
- Assessing data quality and flagging suspect data;
- Documenting on an annual basis that monitoring sites continue to meet 40 Code of Federal Regulations (CFR) Part 58 Appendix E requirements;
- Recommending changes, when needed, in the quality assurance program; and
- Preparing reports for the Ambient Monitoring Section.

4.4. Laboratory Analysis Branch.

Laboratory Analysis Branch Supervisor. The Laboratory Analysis Branch supervisor reports to the chief of the Ambient Monitoring Section. This supervisor's duties include the following:

- Maintaining oversight of all laboratory activities including QA;
- Directing the activities of laboratory personnel;
- Verifying implementation of all laboratory QAPPs and SOPs;
- Preparing and updating laboratory SOPs and good laboratory practices documents;
- Preparing budgets, contracts, and proposals;
- Ensuring training availability and utilization;
- Providing training and certification to laboratory personnel; and
- Approving and implementing procedures.

Laboratory Chemists. The laboratory chemists report to the Laboratory Analysis Branch supervisor. Their duties include the following:

- Organizing the collection, verification, and analyzing of air samples;
- Reporting laboratory analysis data;
- Preparing and updating laboratory SOPs and QAPPs;
- Ensuring the implementation of laboratory SOPs and sections of QAPPs as they pertain to filter processing, sample collection and sample analysis;
- Maintaining QA records, flagging suspect data, and assessing and reporting on laboratory data quality;
- Performing and documenting all maintenance of laboratory equipment;
- Identifying laboratory quality problems and initiating action which results in solutions.

Laboratory Technicians. The laboratory technicians report to the Laboratory Analysis Branch supervisor. Their duties include the following:

- Organizing the collection, verification, and tracking of air samples;
- Preparing, shipping, receiving, verifying, and tracking all air sampling media;
- Recommending timely and appropriate SOP and QAPP updates;
- Ensuring the implementation of laboratory SOPs and sections of QAPPs as they pertain to filter processing and sample analysis;
- Performing and documenting all maintenance of laboratory equipment; and
- Identifying laboratory quality problems and initiating action which results in solutions.

4.5 Electronics and Calibration Branch.

Electronics and Calibration Branch Supervisor. The Electronics and Calibration Branch supervisor has direct access to the chief and has the responsibility and authority to:

- Identify quality problems and initiate action which results in solutions and
- Provide training and certification to field personnel.

Electronics and Calibration Branch Staff. The electronics and calibration branch staff are responsible for:

- Providing performance audit services for the continuous gaseous and meteorological monitoring networks;
- Installing all field equipment and monitoring sites;
- Maintaining an inventory of spare parts, spare equipment, and cylinders to prevent unnecessary downtime;
- Calibrating and certifying all transfer standards and periodically checking calibration of primary standards to ensure quality calibrations;
- Assisting in prescribing corrective actions;
- Recommending changes, when needed, in the QA program; and
- Performing and documenting all maintenance of field equipment as described by the standard operating procedures (SOP).

5.0 PROBLEM DEFINITION AND BACKGROUND

In 1970 the Clean Air Act was signed into law. The Clean Air Act and its amendments provide the framework for protecting air quality. To protect air quality, active environmental data collection operations must be established and operated in a manner that assures the most applicable and highest quality data are collected. Ambient air quality monitoring programs monitor criteria pollutants (particulate matter [particles with an average aerodynamic diameter of 10 micrometers or less (PM_{10}) or 2.5 micrometers or less ($PM_{2.5}$)], sulfur dioxide [SO_2], carbon monoxide [CO], nitrogen dioxide [NO_2], ozone [O_3], and lead [Pb]). The National Ambient Air Quality Standards (NAAQS) establish limits for each of these pollutants, as shown in Table 5-1.

Table 5-1. National Ambient Air Quality Standards

Pollutant	Standard Value [a]		Standard Type
Carbon Monoxide (CO)			
8-hour average	9 ppm [b]	(10 mg/m^3)[c]	Primary
1-hour average	35 ppm	(40 mg/m^3)	Primary
Nitrogen Dioxide (NO_2)			
1-hour average	100 ppb [d]		Primary
Annual Arithmetic Mean	0.053 ppm	(100 $\mu g/m^3$)	Primary and Secondary
Ozone (O_3)			
8-hour average	0.070 ppm	(205 $\mu g/m^3$)[e]	Primary and Secondary
Lead (Pb)			
Rolling 3 month average	0.15 $\mu g/m^3$		Primary and Secondary
Particulate Matter (PM_{10}) *Particulates with diameters of 10 micrometers or less*			
24-hour Average	150 $\mu g/m^3$		Primary and Secondary
Particulate Matter ($PM_{2.5}$) *Particulates with diameters of 2.5 micrometers or less*			
Annual Arithmetic Mean	12 $\mu g/m^3$		Primary and Secondary
24-hour Average	35 $\mu g/m^3$		Primary and Secondary
Sulfur Dioxide (SO_2)			
1-hour Average	75 ppb	(196 $\mu g/m^3$)	Primary
3-hour Average	0.50 ppm	(1300 $\mu g/m^3$)	Secondary

[a] Parenthetical value is an approximately equivalent concentration.
[b] Parts per million
[c] Milligrams per cubic meter
[d] Parts per billion
[e] Micrograms per cubic meter

On October 17, 2006, as published in the Federal Register, the United States Environmental Protection Agency (EPA) provided final rule revisions to ambient monitoring regulations as contained in 40 CFR, Parts 53 and 58. Included in these revised rules are the requirements for establishing NCore sites. Each state is required to operate at least one NCore site beginning January 1, 2011. The NCore sites must measure, at a minimum, $PM_{2.5}$ particle mass (particles with an average aerodynamic diameter of 2.5 micrometers or less) using continuous and integrated/filter-based samplers, speciated $PM_{2.5}$, $PM_{10-2.5}$ particle mass, sulfur dioxide [SO2], CO, nitrogen oxide [NO], reactive oxides of nitrogen [NO_y], O_3, Pb, wind speed, wind direction, relativity humidity and ambient temperature.

In addition to the required NCore monitors listed above, the Millbrook NCore site also has the following monitors in operation: continuous PM2.5 nitrate, continuous PM2.5 sulfate, aethalometer for continuous OC/EC and a filter based monitor for OC/EC, $PM_{10-2.5}$ particulate mass will be determined by difference using the individual mass measurements. The SO2, CO and NO/NOy monitors are trace level monitors. Lead (Pb) will be determined by X-ray fluorescence analysis of the filter media associated with the PM_{10} monitor.

The EPA regulations require that all projects involving the generation, acquisition, and use of environmental data be planned, documented and have an approved QAPP. The QAPP is the critical planning document for any environmental data collection operation because it documents how QA and QC activities will be implemented during the project's life cycle.

This QAPP was developed to implement QA and QC policies and procedures for the DAQ criteria and NCore ambient monitoring programs. It is reviewed annually and revised as needed, subject to approval of the EPA's Region 4 QA Officer. Revision 1 of the DAQ's Criteria and NCore Ambient Air Monitoring QAPP, revised in 2015, is the latest revision to this document. The QAPP incorporates standard procedures to be followed in all air monitoring projects. DAQ's programs will adhere to the principles and procedures herein, unless a special project requires more stringent requirements.

The purpose of this QAPP is to prescribe requirements, procedures, and guidelines for the North Carolina Ambient Air Quality Monitoring Criteria Pollutant and NCore QA Program. It is intended to serve as a reference document for implementing and expanding the QA program and provides detailed operational procedures for measurement processes used by DAQ. The QAPP should be particularly beneficial to operators, project officers, and program managers responsible for implementing, designing, and coordinating air pollution monitoring projects. The QAPP is a compilation of QA requirements, procedures, and guidelines that are applicable to air pollution and meteorological measurements systems. They are designed to achieve a high percentage of valid data samples (>75 %) while maintaining integrity and accuracy. This QAPP clearly and thoroughly establishes QA protocols and QC criteria required to successfully implement and maintain the state of NC's ambient air quality criteria pollutant and NCore monitoring program. The monitoring program is administered by DAQ. It is the responsibility of DAQ to ensure that the quality assurance programs for the field, laboratory, and data processing phases of the monitoring program are implemented.

Quality assurance is a system of management activities designed to ensure that the data produced by the operation will be of the type and quality needed and expected by the data user. Quality control defines the procedures implemented to assure that acceptable precision, bias, completeness, representativeness, and comparability are obtained and maintained in the generated data set. Quality control procedures, when properly executed, provide data that meet or exceed the minimally acceptable quality criteria established to assist management in making confident decisions. It is the policy of DAQ to implement a QA program and QC procedures to assure that data of known and acceptable precision, bias, completeness, comparability, and representativeness are collected in all monitoring projects.

Precision, bias, completeness, comparability, and representativeness are the principle data quality indicators (DQI) that provide qualitative and quantitative descriptions used in interpreting the degree of acceptability of data. "Establishing acceptance criteria for these DQIs sets quantitative goals for the quality of data generated in the analytical measurement process. Of the five principal DQIs, precision and bias are the quantitative measures, representativeness and comparability are qualitative, and completeness is a combination of both qualitative and quantitative measures." (US EPA QA/G-5, Appendix D[1]) Definitions of the DQIs are provided in Section 7.2.

While most people are familiar with accuracy, accuracy is a combined metric that represents the closeness of an individual measurement, or the average of a number of measurements, to the true value. Components of accuracy are random error, represented by the metric precision, and systematic error, represented by the metric bias. These error components result from sampling and analytical operations.

The specific requirements of these five DQIs are established beforehand, on a project-by-project basis, so that the goals of each project are met. The goal is to locate and eliminate or minimize bias, so the data collected show the true conditions of the area being sampled. This includes consideration of siting criteria, spatial scales, monitoring objectives, climatic change, source configuration, and duration of study.

[1] http://www.epa.gov/quality/qs-docs/g5-final.pdf

6.0 PROJECT/TASK DESCRIPTION

6.1 Description of Work to be Performed

This QAPP was developed to ensure that DAQ's criteria pollutant and NCore air monitoring network collects ambient and meteorological data that meet or exceed EPA quality assurance requirements. These data are entered into the EPA AQS database.

The work required to collect, document, and report these data includes, but is not limited to:

- Establishing a monitoring network that has:
  - Appropriate density, location, and sampling frequency;
  - Applicable chemical species monitors;
  - Associated meteorological monitoring; and
  - Accurate and reliable data recording equipment, procedures, and software.
- Developing encompassing documentation for:
  - Data and report format, content, and schedules;
  - Quality objectives and criteria; and
  - SOPs providing activities and schedules for:
    - ✓ Equipment operation and preventative maintenance and
    - ✓ Instrument calibrations, zero, and span, and precision and accuracy evaluations.
- Establishing assessment criteria and schedules.

6.2 Field Activities

DAQ personnel will perform those activities that support continued successful operation and expansion of the statewide ambient air quality monitoring network. Personnel will perform field activities that include, but are not necessarily limited to, conducting periodic preventative maintenance and servicing equipment located at state and local air monitoring stations (SLAMS), NCore, special purpose monitoring station (SPM), and photochemical assessment monitoring stations (PAMS) sites located within North Carolina. Operational servicing activities may include, but may not be limited to, collecting samples, recording pertinent field data, and restocking consumables, such as silica gel and calibration gases, at the monitoring sites. Additional field activities include relocating sites and/or locating suitable monitoring sites for possible expansion of the network.

6.3 Laboratory Activities

Laboratory personnel will perform those activities that support continued successful operation of the statewide criteria pollutant and NCore ambient air quality monitoring network. Additionally, where analysis of samples is required, the laboratory personnel shall perform those duties such that the data quality provided meets or exceeds EPA QA requirements. Laboratory personnel shall be responsible for preparing consumables for field use. This may include, but not be limited to, performing assays on materials before and after exposure to the ambient atmosphere, preparing and analyzing control samples, maintaining consumable inventories, shipping and receiving activities, and performing instrument audits.

6.4 Project Assessment Techniques

An assessment is an evaluation process used to measure the performance or effectiveness of a system and its elements. As used here "assessment" is an all-inclusive term used to denote any of the following: audit, performance evaluation, management systems review (MSR), peer review, inspection, or surveillance. Section 20 discusses the details of assessments. Information on the parties implementing assessments and their frequency is provided in Table 6-1.

Table 6.1. Assessment Schedule

Assessment Type	Assessment Agency	Frequency
Technical System Audit	EPA Region 4 State	Every 3 years
Network Assessment	EPA Region 4 State	Every 5 years
Network Review	EPA Region 4 State	Annually
Data Qualifiers/Flags Review	State	Annually
Standard Operating Procedures Reviews	State	Annually
Data Quality Assessment	State	As needed
$PM_{2.5}$ Performance Evaluation Program	EPA designated contractor	8 valid audits per year/each monitor audited every 6 years
National Performance Audit Program	EPA designated contractor	20 % of sites per year/each site once every 5 years

6.5 Project Records

DAQ will establish and maintain procedures for the timely preparation, review, approval, issuance, use, control, revision, and maintenance of documents and records. The categories and types of records and documents that are applicable to document control for ambient air quality information are presented in Table 6-2. Information on key documents in each category is explained in more detail in Section 9.

Table 6.2. Critical Documents and Records

Categories	Record/Document Type
Site Information	Network Descriptions Site Files Site Maps Site Pictures
Environmental Data Operations	Quality Assurance Project Plans Standard Operating Procedures Field and Laboratory Notebooks Sample Handling/Custody Records Inspection/Maintenance Records
Raw Data	Any Original Data (routine and quality control) Including Data Entry Forms
Data Reporting	Air Quality Index Reports Annual SLAMS Report Data/Summary Reports
Data Management	Data Algorithms Data Management Plans/Flowcharts Data Management Systems
Quality Assurance	Good Laboratory Practices Network Reviews Control Charts Data Quality Assessments Quality Assurance Reports Technical System Audits Response/Corrective Action Reports Site Audits

7.0 DATA AND MEASUREMENT QUALITY OBJECTIVES AND CRITERIA

A special project may require different procedures depending on the purpose and scope of the project, resulting in a QAPP specific to that project that addresses the QA areas or elements as required. The NCore monitoring program has special requirements, which have been incorporated into this criteria pollutant monitoring QAPP.

However, the specific written procedures or methodologies for operating instruments and handling data must be adhered to by all individuals, firms, or agencies producing air quality data for enforcement purposes or under the terms of an air quality permit. Preferably, the designated methodologies shall comply with EPA approved federal reference methods (FRM), or equivalent methods (FEM).

7.1 Data Quality Objectives

This section provides a description of the data quality objectives (DQO) for the criteria pollutant and NCore ambient air quality monitoring programs for the state of North Carolina. Data quality objectives are qualitative and quantitative statements that:

- Clarify the intended use of the data,
- Define the type of data needed, and
- Specify the tolerable limits on the probability of making a decision error due to uncertainty in the data.

In general, the goal of the criteria pollutant ambient air quality monitoring program is to:

- Determine the highest concentrations expected to occur in the area covered by the network;
- Determine representative concentrations in areas of high population density;
- Determine the impact on ambient pollution levels of significant sources or source categories;
- Determine the general background concentration levels;
- Determine the extent of regional pollutant transport among populated areas, and in support of secondary standards; and
- Determine the welfare-related impacts in rural and remote areas (such as visibility impairment and effects on vegetation).

Whereas, the NCore network addresses the following objectives:

- Timely reporting of data to public by supporting AIRNow, air quality forecasting, and other public reporting mechanisms;
- Support for development of emission strategies through air quality model evaluation and other observational methods;
- Accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors;
- Support for long-term health assessments that contribute to ongoing reviews of the NAAQS;

- Compliance through establishing nonattainment/attainment areas through comparison with the NAAQS;
- Support to scientific studies ranging across technological, health, and atmospheric process disciplines; and
- Support to ecosystem assessments recognizing that national air quality networks benefit ecosystem assessments and, in turn, benefit from data specifically designed to address ecosystem analyses.

7.1.1 Intended Use of Data

These data will be used to:

- Evaluate compliance with the NAAQS,
- Establish an historical baseline concentration of natural and anthropogenic 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.

7.1.2. Type of Data Needed

The data compiled is a combination of meteorological and pollutant data. The criteria pollutants, established by EPA (particulate matter [$PM_{2.5}$ and PM_{10}], SO_2, CO, nitrogen oxides (NO_x), O_3, and Pb), are monitored at the designated SLAMS, NCORE, SPM, and PAMS sites. The pollutant concentrations to be measured and meteorological parameters to be monitored at NCore stations as required by EPA include PM2.5 particle mass using continuous and integrated/filter-based samplers, speciated $PM_{2.5}$, $PM_{10-2.5}$ particle mass, sulfur dioxide [SO2], CO, nitrogen oxide [NO], NO_y, O_3, Pb, wind speed, wind direction, relativity humidity and ambient temperature. Specific information on the sampling design, including how to identify monitoring locations, is presented in Section 10.

7.1.3. Tolerable Error Limits

In the development of the EPA model QAPP for $PM_{2.5}$, EPA utilized the formal DQO process (see: *Guidance on Systematic Planning using the Data Quality Objectives Process*[2]) to specify tolerable limits on the probability of making a decision error due to uncertainty in the data. That is, limits on the probability of coming up with false positive or false negative error. A false positive error is encountered when the data indicate that an emissions limit has been exceeded when in fact, due to random deviations in the data, it has not been exceeded. Alternately, a false negative error is encountered when the data indicate that no emissions limit has been exceeded

[2] http://www.epa.gov/quality/qs-docs/g4-final.pdf

when in fact, due to random deviations in the data, an emissions limit has been exceeded. Utilizing the DQO process, will determine the objectives regarding the quality of the ambient air measurement system to control precision and bias in order to reduce the probability of decision errors. The ambient air quality monitoring program has established the acceptable precision, as measured by coefficient of variation (CV), and acceptable bias for each pollutant as listed in Table 7.1. Attachment 1 (at the end of this document) provides the decision error probability limits for individual pollutants obtained by controlling precision and bias at these levels.

Table 7-1 Acceptable Precision as Measured by Coefficient of Variation (CV) and Bias for the Ambient Air Quality Monitoring Program

Pollutant	**Acceptable Precision**	**Acceptable Bias**
$PM_{2.5}$	≤10 % CV	Within ±10 %
Ozone	upper 90 percent confidence limit for the CV of ≤7 %	upper 95 percent confidence limit for the absolute bias of ≤7 %
$PM_{10-2.5}$	upper 90 % confidence limit for the CV of ≤15 %	upper 95 percent confidence limit for the absolute bias of ≤15 %
Pb	upper 90 % confidence limit for the CV of ≤20 %	upper 95 percent confidence limit for the absolute bias of ≤15 %
NO_2	upper 90 % confidence limit for the CV of ≤15 %	upper 95 percent confidence limit for the absolute bias of ≤15 %
SO_2	upper 90 % confidence limit for the CV of ≤10 %	upper 95 percent confidence limit for the absolute bias of ≤10 %
All others	≤15 % CV	Within ±20 %

Coefficient of variation and absolute bias are calculated using the procedures in 40 CFR 58 Appendix A Section 4.

7.2. Measurement Quality Objectives

As air pollution and meteorological measurement systems increase in both cost and complexity, it becomes essential to have a methodology that will, in a cost-effective manner, increase the completeness and precision and decrease the bias of the data produced by the air pollution and meteorological measurement systems.

Once 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 (MQOs) are designed to evaluate and control various phases (sampling, preparation, analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. The MQOs for North Carolina's criteria pollutant and NCore ambient air quality monitoring program will be defined in terms of the following DQIs:

- ***Precision -*** "Precision is a measure of agreement between two replicate measurements of the same property, under prescribed similar conditions. This agreement is calculated as either the range or as the standard deviation." (US EPA QA/G-5, Appendix D[3]) This is the random component of error.

- ***Bias*** **-** "Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction." (US EPA QA/G-5, Appendix D) Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.
- ***Comparability*** **-** "Comparability is the qualitative term that expresses the confidence that two data sets can contribute to a common analysis and interpolation. Comparability must be carefully evaluated to establish whether two data sets can be considered equivalent in regard to the measurement of a specific variable or groups of variables." (US EPA QA/G-5, Appendix D)
- ***Representativeness*** **-** "Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point or for a process condition or environmental condition. Representativeness is a qualitative term that should be evaluated to determine whether in situ or other measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the media and phenomenon measured or studied. "(US EPA QA/G-5, Appendix D)
- ***Completeness*** **-** Completeness is a metric quantifying the amount of valid data obtained from a measurement system compared to the amount that were expected to be obtained under correct, normal conditions. Completeness can be expressed as a ratio or a percentage. Data completeness requirements are included in the reference methods (40 CFR Part 50).

For each of these attributes, acceptance criteria have been developed using various parts of 40 CFR and EPA supplied guidance documents. The MQOs for North Carolina's criteria pollutant and NCore ambient air quality monitoring program are listed in Tables 7-2 through 7-7. More detailed descriptions of these MQOs and how they will be used to control and assess measurement uncertainty are described in other elements, as well as in the SOPs associated with this QAPP that are specific to each monitor type.

7.2.1. General Data Quality Objectives

- All data should be traceable to a National Institute of Science and Technology (NIST) primary standard.
- All data shall be of a known and documented quality. The level of quality required for each specific monitoring project shall be established during the initial planning stages of the project and will depend upon the data's intended use. Two major measurements used to define quality are precision and bias. Refer to Section 7.2 for definitions of the metrics precision and bias.

[3] http://www.epa.gov/quality/qs-docs/g5-final.pdf

Table 7-2a. Nitrogen Oxides Measurement Quality Objectives.
Measurement Quality Objective Parameter –Nitrogen Dioxide (NO_2) (Chemiluminescence).

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- NO_2			
One Point QC Check Single analyzer	***1/ 14 days***	Warning limit ≤ ±8% (percent difference) Control limit ≤ ±15% (percent difference)	1 and 2) 40 CFR Part 58 App A Sec 3.2 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.5 QC check concentration range 0.005 - 0.080 ppm Relative to routine concentrations
Zero/span check	1/ 14 days	Zero drift ≤ ± 1.0 ppb (24 hour) ≤ ± 5.0 ppb (>24hr-14 day) Span drift ≤ ± 10 %	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
Converter Efficiency	During multi-point calibrations, span and audit 1/ 14 days	***(≥96%)*** 96% – 104%	1) 40 CFR Part 50 App F Section 1.5.10 and 2.4.10 2) Recommendation 3) 40 CFR Part 50 App F Section 1.5.10 and 2.4.10 Regulation states ≥ 96%, 96 – 104% is a recommendation.
Shelter Temperature Range	Daily (hourly values)	20 to 30° C. (hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
OPERATIONAL CRITERIA- NO_2			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/180 days	± 2° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/365 days with an equal proportion of sites in each of the 4 quarters***	Percent difference of audit levels 3-10 ≤ ±10 % Audit levels 1&2 ± 1.5 ppb difference or ±15 %	1) 40 CFR Part 58 App A sec 3.2.2 2) 40 CFR Part 58 App A sec 3.2.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html
Federal Audits (NPAP)	100 percent of sites every 6 years; 20% of sites audited each year	Audit levels 1&2 ± 1.5 ppb difference all other levels percent difference ± 15 %	1) 40 CFR Part 58 App A sec 2.4 2) NPAP adequacy requirements on AMTIC 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving/failure of zero/span or 1-point QC check 1/365 days	> 10 % excess NO Span within ± 3 % of expected Precision point within ± 5 % of expected Zero within ± 1 ppb of expected	1) 40 CFR Part 50 App F 2 and 3) Recommendation based on instrument manual and experience Multi-point calibration (0 and 2 upscale points)

Table 7-2a. Nitrogen Oxides Measurement Quality Objectives.
Measurement Quality Objective Parameter – Nitrogen Dioxide (NO2) (Chemiluminescence) – Continued

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
Gaseous Standards	All gas cylinders	**NIST[a] Traceable** (e.g., EPA Protocol Gas) 10-25 ppm[b] of NO in Nitrogen with < 1 ppm NO_2	1) 40 CFR Part 50 App F Section 1.3.1 2) NA Green book 3) 40 CFR Part 50 App F Section 1.3.1 requires 50 -100 ppm but to successfully calibrate the photolytic monitor DAQ found using 10 to 25 ppm works better Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A sec 2.6.1
Zero Air/ Zero Air Check	1/365 days	Concentrations below LDL[c]	1) 40 CFR Part 50 App F Section 1.3.2 2 and 3) Recommendation
Gas Dilution Systems	1/365 days or after failure of 1-point QC check or performance evaluation	Accuracy ± 2 %	1,2 and 3) Recommendation based on SO2 requirement in 40 CFR Part 50 App A-1 Sec 4.1.2
Detection (FEM/FRMs)			
Noise	NA	***0.005 ppm***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) NA 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	Determined by manufacturer at purchase	***0.01 ppm***	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1
SYSTEMATIC CRITERIA- NO_2			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	***All data***	***ppb[d] (final units in AQS)***	1,2 and 3) 40 CFR Part 50 App S Sec 2 (c)
Rounding convention for data reported to AQ S	***All data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50 App S Sec 4.2 (a)
Completeness	***Annual Standard***	***≥ 75 % hours in year***	1) 40 CFR Part 50 App S sec 3.1(b) 2) 40 CFR Part 50 App S sec 3.1(a) 3) 40 CFR Part 50 App S sec 3.1(b)
	1-hour standard	***1) 3consecutive calendars years of complete data 2) 4 quarters complete in each year 3) ≥75 % sampling days in quarter 4) ≥ 75 % of hours in a day***	1) 40 CFR Part 50 App S sec 3.2(b) 2) 40 CFR Part 50 App S sec 3.2(a) 3) 40 CFR Part 50 App S sec 3.2(b) More details in 40 CFR Part 50 App S

Table 7-2a. Nitrogen Oxides Measurement Quality Objectives. Measurement Quality Objective Parameter – Nitrogen Dioxide (NO_2) (Chemiluminescence) – Continued			
1) Requirement (NO_2)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
Sample Residence Time Verification	1/365 days	***< 20 seconds***	1) 40 CFR Part 58 App E, section 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E, section 9 (c)
Sample Probe, Inlet, Sampling train	***All sites***	***Borosilicate glass (e.g., Pyrex®) or Teflon®***	1, 2 and 3) 40 CFR Part 58 App E sec 9 (a) FEP and PFA have been accepted as equivalent material to Teflon. Replacement or cleaning is suggested as 1/year and more frequent if pollutant load or contamination dictate
[a]-National Institute of Science and Technology [b]-parts per million [c]-Lower Detection Limit [d]-parts per billion			
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
Precision(using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***90% CL CV ≤ 15%***	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.2.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.2
Bias (using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***95% CL ≤ ± 15%***	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.2.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.3
Annual PE Primary QA Organization (PQAO) Evaluation	1/365 days	***95% of audit percent differences fall within the one point QC check 95% probability intervals at PQAO level of aggregation***	1) 40 CFR Part 58 App A Section 3.2.2 2) Recommendation 3) 40 CFR Part 58 App A sec 4.1.4 & 4.1.5

Table 7-2b. Nitrogen Oxides Measurement Quality Objectives.
Measurement Quality Objective Parameter –Reactive Oxides of Nitrogen (NO_y) (Chemiluminescence).

1) Requirement (NO_y)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- NO_y			
One Point QC Check Single analyzer	***1/ 14 days***	Warning limit ≤ ±10 % (percent difference) Control limit ≤ ±15 % (percent difference)	1 and 2) 40 CFR Part 58 App A Sec 3.2 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.5 QC check concentration range 0.005 - 0.080 ppm Relative to routine concentrations
Zero/span check	1/ 14 days	Zero drift ≤ ± 1.0 ppb (24-hour) ≤ ± 5.0 ppb (>24hr-14 day) Span drift ≤ ± 10 %	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
Converter Efficiency	During multi-point calibrations, span and audit 1/ 14 days	***(≥96%)*** 96% – 104%	1) 40 CFR Part 50 App F Section 1.5.10 and 2.4.10 2) Recommendation 3) 40 CFR Part 50 App F Section 1.5.10 and 2.4.10 Regulation states ≥ 96%, 96 – 104% is a recommendation.
OPERATIONAL CRITERIA- NO_y			
Shelter Temperature Range	Daily (hourly values)	20 to 30° C. (hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Control	Daily (hourly values)	≤ ± 2° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/180 days	± 2° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/365 days with an equal proportion of sites in each of the 4 quarters***	Percent difference of audit levels 3-10 ≤ ±10% Audit levels 1&2 ± 1.5 ppb difference or ±15%	1) 40 CFR Part 58 App A sec 3.2.2 2) 40 CFR Part 58 App A sec 3.2.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html
Federal Audits (NPAP)	100 percent of sites every 6 years; 20% of sites audited each year	Audit levels 1&2 ± 1.5 ppb difference all other levels percent difference ± 15%	1) 40 CFR Part 58 App A sec 2.4 2) NPAP adequacy requirements on AMTIC 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/180 days if manual zero/span performed biweekly 1/91 days for NCore	> 10 % excess NO Span within ± 3 % of expected Precision point within ± 5 % of expected Zero within ± 1 ppb of expected	1) 40 CFR Part 50 App F 2 and 3) Recommendation Multi-point calibration (0 and 3 upscale points)

Table 7-2b. Nitrogen Oxides Measurement Quality Objectives.
Measurement Quality Objective Parameter – Reactive Oxides of Nitrogen (NO_y) (Chemiluminescence) – Continued

1) Requirement (NO_y)	2) Frequency	3) Acceptance Criteria	Information /Action
Gaseous Standards	All gas cylinders	**NIST[a] Traceable** (e.g., EPA Protocol Gas) 10-25 ppm[b] of NO in Nitrogen with < 1 ppm NO_2	1) 40 CFR Part 50 App F Section 1.3.1 2) NA Green book 3) DAQ procedures Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A sec 2.6.1
Zero Air/ Zero Air Check	1/365 days	Concentrations below LDL[c]	1) 40 CFR Part 50 App F Section 1.3.2 2 and 3) Recommendation
Gas Dilution Systems	1/365 days or after failure of 1-point QC check or performance evaluation	Accuracy ± 2 %	1,2 and 3) Recommendation based on SO2 requirement in 40 CFR Part 50 App A-1 Sec 4.1.2
Detection			
Noise	NA	***0.05 ppb***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) NA 3) NCore Technical Assistance Document
Lower detectable level	Determined by manufacturer at purchase	***≤0.10 ppb***	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) NCore Technical Assistance Document
SYSTEMATIC CRITERIA- NO_y			
Sampler/Monitor	NA	***Meets requirements listed in NCore Technical Assistance Document***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	***All data***	***ppb[d] (final units in AQS)***	1,2 and 3) 40 CFR Part 50 App S Sec 2 (c)
Rounding convention for data reported to AQ S	***All data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50 App S Sec 4.2 (a)
Completeness	***All data***	***1) 4 quarters complete in each year 2) ≥75 % sampling days in quarter 3) ≥ 75 % of hours in a day***	1) 40 CFR Part 50 App S sec 3.2(b) 2) 40 CFR Part 50 App S sec 3.2(a) 3) 40 CFR Part 50 App S sec 3.2(b) More details in 40 CFR Part 50 App S
Sample Residence Time Verification	1/365 days	***< 20 seconds***	1) 40 CFR Part 58 App E, section 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E, section 9 (c)
Sample Probe, Inlet, Sampling train	***All sites***	***Borosilicate glass (e.g., Pyrex®) or Teflon®***	1, 2 and 3) 40 CFR Part 58 App E sec 9 (a) FEP and PFA have been accepted as equivalent material to Teflon. Replace probe line every other year and clean inlet filter holder every year and more frequently if pollutant load or contamination dictate

[a]-National Institute of Science and Technology [b]-parts per million [c]-Lower Detection Limit [d]-parts per billion

Table 7-2b. Nitrogen Oxides Measurement Quality Objectives.
Measurement Quality Objective Parameter – Reactive Oxides of Nitrogen (NO_y) (Chemiluminescence) – Continued

1) Requirement (NO_y)	2) Frequency	3) Acceptance Criteria	Information /Action
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
Precision(using 1-point QC checks)	***Calculated annually***	***90% CL CV ≤ 15%***	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.2.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.2
Bias (using 1-point QC checks)	***Calculated annually***	***95% CL ≤ ± 15%***	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.2.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.3
Annual PE Primary QA Organization (PQAO) Evaluation	1/365 days	***95% of audit percent differences fall within the one point QC check 95% probability intervals at PQAO level of aggregation***	1) 40 CFR Part 58 App A Section 3.2.2 2) Recommendation 3) 40 CFR Part 58 App A sec 4.1.4 & 4.1.5

Table 7-3. Ozone Measurement Quality Objectives.
Measurement Quality Objective Parameter – Ozone (O_3) (Ultraviolet Photometric).

1) Requirement (O_3)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-OZONE			
One Point QC Check Single analyzer	***1/ 14 days***	70 ppb +/- 3 ppb	1 and 2) 40 CFR Part 58 App A Sec 3.2 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.2. QC Check Concentration range 0.005 - 0.080 ppm, relative to routine concentrations
Zero/span check	1/ 14 days	0 ppb +/- 3 ppb 225 ppb +/- 5 ppb	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
Shelter Temperature Range	Daily (hourly values)	20 to 30° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
OPERATIONAL CRITERIA -OZONE			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/180 days	± 2° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single analyzer	***Every site 1/365 days within period of monitor operation, 25 % of sites quarterly***	Zero must be 0 ±3 ppb 100 ppb must be 100 ±6 ppb 70 ppb must be 70 ±4 ppb 7 ppb must be 7 ±2 ppb	1 and 2) 40 CFR Part 58 App A sec 3.2.2 3) Recommendation- 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html
Federal Audits (NPAP)	100 percent of sites every 6 years; 20% of sites audited each year	Audit levels 1&2 ± 1.5 ppb difference all other levels percent difference ± 10%	1) 40 CFR Part 58 App A sec 2.4 2) NPAP adequacy requirements on AMTIC 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving and repair and recalibration of standard of higher level 1/365 days if continuous zero/span performed daily	All points within ± 2 ppb of expected value	1) 40 CFR Part 50 App D 2) Recommendation 3) Recommendation- Linearity error 40 CFR Part 50 App D Multi-point calibration (0 and 3 upscale points) 40 CFR Part 50 App D sec 5.2.3
Zero Air/Zero Air Check	1/365 days	Concentrations below 1 ppb	1) 40 CFR Part 50 App D Section 4.1 2 and 3) Recommendation
Ozone Level 2 Standard			
Certification/recertification to Standard Reference Photometer (Level 1)	1/365 days	single point difference ≤ ± 3%	1) 40 CFR Part 50 App D Section 5.4 2 and 3) Transfer Standard Guidance EPA-454/B-10-001 Level 2 standard (formerly called primary standard) usually transported to EPA Regions SRP for comparison
Level 2 and Greater Transfer Standard Precision	1/365 days	***Standard Deviation less than 0.005 ppm or 3% whichever is greater***	1) 40 CFR Part 50 Appendix D Sec 3.1 2) Recommendation, part of reverification 3) 40 CFR Part 50 Appendix D Sec 3.1

Table 7-3. Ozone Measurement Quality Objectives.
Measurement Quality Objective Parameter – Ozone (O_3) (Ultraviolet Photometric) – Continued

1) Requirement (O_3)	2) Frequency	3) Acceptance Criteria	Information /Action
(if recertified via a transfer standard)	1/365 days	Regression slopes = 1.00 ± 0.03 and two intercepts are 0 ± 3 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001
Ozone Transfer standard (Level 3 and greater)			
Qualification	Upon receipt of transfer standard	±3 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001
Certification	After qualification and upon receipt/adjustment/repair	5 levels: 225 ±1 ppb 120 ±1 ppb 70 ±1 ppb 50 ±1 ppb 0 ±1 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001 1
Recertification to higher level standard	1/365 days	5 levels: 225 ±1 ppb 120 ±1 ppb 70 ±1 ppb 50 ±1 ppb 0 ±1 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001 recertification test that then gets added to most recent 5 tests. If does not meet acceptability certification fails
Detection (FEM/FRMs)			
Noise	Upon receipt/adjustment/repair/annual maintenance or 1/365 days	***≤ 5 hertz at 225 ppb*** ***≤ 2 hertz at 0 ppb***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) NA 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	Upon receipt	***0.01 ppm***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1
SYSTEMATIC CRITERIA-OZONE			
Sampler/Monitor/ Transfer and Calibration Standard	NA	*Meets requirements listed in FRM/FEM designation*	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	*All data*	*ppm (final units in AQS)*	1, 2 and 3) 40 CFR Part 50 App I sec 2.1.1
Rounding convention for data reported to AQS	*All data*	*3 places after decimal with digits to right truncated*	1, 2 and 3) 40 CFR Part 50 App I sec 2.1.1
Completeness (seasonal)	*3-Year Comparison*	*≥ 90% (average) daily max available in ozone season with min of 75% in any one year.*	1) 40 CFR Part 50 App I 2) 40 CFR Part 50 App I Section 2.3 3) 40 CFR Part 50 App I Section 2..3 (b)
	8- hour average	*≥75% of hourly averages for the 8-hour*	1) 40 CFR Part 50 App I 2 and 3) 40 CFR Part 50 App I Section 2.1.1

	Valid Daily Max	*≥ 75% of the 24, 8 hour averages (18 of 24 8-hour averages*	1) 40 CFR Part 50 App I 2) 40 CFR Part 50 App I Section 2.1.2 3) 40 CFR Part 50 App I Section 2.1.2(b)
Table 7-3. Ozone Measurement Quality Objectives. Measurement Quality Objective Parameter – Ozone (O_3) (Ultraviolet Photometric) – Continued			
1) Requirement (O_3)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
Sample Residence Time Verification	1/365 days	*< 20 seconds*	1) 40 CFR Part 58 App E, section 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E, section 9 (c)
Sample Probe, Inlet, Sampling train	*All sites*	*Borosilicate glass (e.g., Pyrex®) or Teflon®*	1) 40 CFR Part 58 App E, section sec 9 (a) 2) Recommendation 3) 40 CFR Part 58 App E, section sec 9 (a) FEP and PFA have been accepted as an equivalent material to Teflon. Replacement or cleaning is suggested as 1/year and more frequent if pollutant load or contamination dictate
Siting	1/365 days	*Meets siting criteria or waiver documented*	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
EPA Standard Ozone Reference Photometer (SRP) Recertification (Level 1)	1/365 days	Regression slope = 1.00 ± 0.01 and intercept < 3 ppb	1,2 and 3)) Transfer Standard Guidance EPA-454/B-10-001 This is usually at a Regional Office and is compared against the traveling SRP
Precision (using 1-point QC checks)	*Calculated annually and as appropriate for design value estimates*	**90% CL CV** ≤ 7%	1) 40 CFR Part 58 App A 2.3.1.2 & 3.2.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.2
Bias (using 1-point QC checks)	*Calculated annually and as appropriate for design value estimates*	**95% CL** ≤ ± 7%	1) 40 CFR Part 58 App A 2.3.1.2 & 3.2.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.3
Annual PE Primary QA Organization (PQAO) Evaluation	1/365 days	*95% of audit percent differences fall within the one point QC check 95% probability intervals at PQAO level of aggregation*	1) 40 CFR Part 58 App A Section 3.2.2 2) Recommendation 3) 40 CFR Part 58 App A sec 4.1.4 & 4.1.5

[a] - Relative Standard Deviation

Table 7-4a. PM_{10} Measurement Quality Objectives –
Measurement Quality Objectives - Parameter – PM_{10} (High Volume – Standard Conditions Gravimetric)

1) Criteria (PM_{10} Hi-Vol STP)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA-PM_{10} Filter Based Hi-Vol			
Field Activities			
Filter Holding Times			
Sample Recovery	*all filters*	***ASAP***	1,2 and 3) 40 CFR Part 50 App J sec 9.15
Sampling Period	**all filters**	**1440 minutes ± 60 minutes midnight to midnight local standard time**	1,2 and 3) 40 CFR Part 50 App J sec 7.1.5
Average Flow Rate	every 24 hours of operation	~1.13 m^3/min (varies with instrument)	1,2 and 3) Method 2.11
Verification/Calibration			
One-point Flow Rate Verification	***1/91 days***	± 7% of transfer standard and 10% from design	1 and 2) 40 CFR Part 58, App A, sec 3.2.3 3) Method 2.11 sec 3.5.1, Table 2-1
Lab Activities			
Filter			
Visual Defect Check (unexposed)	*all filters*	*see reference*	Method 2.11 sec 4.2
Collection efficiency	*all filters*	*99 %*	1,2 and 3) 40 CFR Part 50, App J sec 7.2.2
Alkalinity	*all filters*	*< 25.0 microequivalents/gram*	1,2 and 3) 40 CFR Part 50, App J sec 7.2.4
Filter Conditioning Environment			
Equilibration	*all filters*	*24 hours minimum*	1,2 and 3) 40 CFR Part 50, App. J sec 9.3
Temperature Range	*all filters*	*15-30° C*	1,2 and 3) 40 CFR Part 50, App. J sec 7.4.1
Temperature Control	*all filters*	*± 3°C SD* over 24 hours*	1,2 and 3) 40 CFR Part 50, App. J sec 7.4.2
Humidity Range	*all filters*	*20% - 45% RH*	1,2 and 3) 40 CFR Part 50, App. J sec 7.4.3
Humidity Control	*all filters*	*± 5% SD* over 24 hours*	1,2 and 3) 40 CFR Part 50, App. J sec 7.4.4
Pre/post Sampling RH	all filters	difference in 24-hour means ≤ ± 5% RH	1,2 and 3) Recommendation based on Part 50, App. L sec 8.3.3
Balance	all filters	located in filter conditioning environment	1,2 and 3) Recommendation based on Part 50, App. L sec 8.3.2
OPERATIONAL EVALUATIONS TABLE PM_{10} Filter Based Hi-Vol			
Field Activities			
Verification/Calibration			
System Leak Check	During precalibration check	Auditory inspection with faceplate blocked	1,2 and 3) Method 2.11 sec 2.3.2
Flow Rate Multi-point Verification/Calibration	1/365 days	3 of 4 calibration points within ± 10% of design	1, 2 and 3) Method 2.11 sec 2.3.2
Field Temp M-point Verification	on installation, then 1/365 days	± 2°C	1,2 and 3) Recommendation
Precision			
Collocated Samples	***every 12 days for 15% of sites***	CV ≤ 10% of samples > 15 µg/m^3	1) and 2) 40 CFR Part 58 App A sec 3.2.5 3) Recommendation

Table 7-4a. PM_{10} Measurement Quality Objectives –
Measurement Quality Objectives - Parameter – PM_{10} (High Volume – Standard Conditions Gravimetric)

1) Criteria (PM_{10} Hi-Vol STP)	2) Frequency	3) Acceptable Range	Information /Action
***SD= standard deviation CV= coefficient of variation**			
Semi Annual Flow Rate Audit	***1/182 days***	± 7% of transfer standard and 10% from design	1 and 2) 40 CFR Part 58, App A, sec 3.3.3 3) Method 2.11 sec 7 Table 7-1
Monitor Maintenance			
Inlet/downtube Cleaning	1/91 days	cleaned	1, 2 and 3) Method 2.11 sec 6
Motor/housing gaskets	1/91 days	Inspected replaced	1, 2 and 3) Method 2.11 sec 6
Blower motor brushes	600-1000 hours	Replace	1, 2 and 3) Method 2.11 sec 6
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	NA
Lab Activities			
Lab QC Checks			
Balance Check (Standard Weight Check and Calibration Check)	beginning, 15th sample, end	± 0.5 mg of true zero and ± 0.5 mg 1-5 g check weight	1,2, and 3) Method 2 .11 sec 4.5.1 and 4.5.2
"Routine" duplicate weighing	5-7 per weighing session	± 2.8 mg change from original value	1,2 and 3) Method 2.11 sec 4.5.3 From routine filter set
Integrity- Random sample of test field blank filters	10%	***± 5 µg/m3***	1) 40 CFR Part 50 App J sec 7.2.3 2) Recommendation 3) 40 CFR Part 50 App J sec 7.2.3
Lab Temperature Calibration	1/182 days	± 2°C	1,2 and 3) Recommendation related to 40 CFR Part 50, App. L
Lab Humidity Calibration	1/182 days	± 2%	1,2 and 3) Recommendation related to 40 CFR Part 50, App. L
Microbalance Calibration	1/365 days	Manufacturer's specification	
Audits			
Filter Weighing	1/365 days	± 5 mg change from original value	1) Method 2.11 Table 7-1 2) Recommendation 3) Method 2.11 Table 7-1
Balance Audit	1/365 days	Observe weighing technique and check balance with ASTM Class 1 standard	1) Method 2.11 Table 7-1 2) Recommendation 3) Method 2.11 Table 7-1
SYSTEMATIC CRITERIA - PM_{10} Filter Based Hi-Vol			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM/ARM designation***	1) 40 CFR Part 58 App C, Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5

Table 7-4a. PM_{10} Measurement Quality Objectives – Measurement Quality Objectives - Parameter – PM_{10} (High Volume – Standard Conditions Gravimetric)			
1) Criteria (PM_{10} Hi-Vol STP)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Data Completeness	quarterly	≥ 75%	1,2 and 3) 40 CFR Part 50 App. K, sec. 2.3b & c
Reporting Units	all filters	μg/m³ at standard temperature and pressure	1,2 and 3) 40 CFR Part 50 App K sec. 1
Rounding convention for data reported to AQS	***Each routine concentration***	***nearest 10 μg/m³ (≥ 5 round up)***	1,2 and 3) 40 CFR Part 50 App K sec 1
Precision			
Single analyzer	1/91 days	CV ≤ 10% > 15 μg/m³	1,2 and 3) Recommendation
Single analyzer	1/ 365 days	CV ≤ 10% > 15 μg/m³	1,2 and 3) Recommendation
Primary Quality Assurance Org.	Annual and 3 year estimates	90% CL of CV ≤ 10% > 15 μg/m³	1,2 and 3) Recommendation
Field Activities			
Verification/Calibration Standards and Recertifications - All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	1/365 days	+ 2% of NIST-traceable Std.	1) 40 CFR Part 50, App. J sec 7.3 2) Method 2.11 Sec 1.1.3 3) 40 CFR Part 50, App. J sec 7.3
Field Thermometer	1/365 days	+ 0.1° C resolution, + 0.5° C accuracy	1,2 and 3) Method 2.11 Sec 1.1.2
Field Barometer	1/365 days	+ 0.1° C resolution, + 0.5° C accuracy	1,2 and 3) Method 2.11 Sec 1.1.2
Clock/timer Verification	1/91 days	5 min/month	recommendation
Lab Activities			
Microbalance	***at purchase***	Readability 0.1 mg Repeatability0.5 mg (High Volume)	1 and 2) 40 CFR Part 50, App. J sec 7.5 3) Method 2.11 sec 4.4
Primary Mass Standards. (compare to NIST-traceable standards)	1/365 days	NIST traceable (e.g., ANSI/ASTM Class 1, 1.1 or 2)`	1,2 and 3) Method 2.11 sec 9
SD= standard deviation CV= coefficient of variation			

Table 7-4b. PM_{10} Measurement Quality Objectives –
Measurement Quality Objectives - Parameter – PM_{10} (Continuous)

1) Criteria (PM_{10} Cont)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA-PM_{10} Continuous			
Average Flow Rate	every 24 hours of operation	Average within ± 5% of design	recommendation
Verification/Calibration			
One-point Flow Rate Verification	***1/30 days***	± 7% of transfer standard	1 and 2) 40 CFR Part 58, App A, sec 3.2.3 3) Method 2.10 Table 3-1
OPERATIONAL EVALUATIONS TABLE PM_{10} Continuous			
Verification/Calibration			
System Leak Check	During precalibration check	Auditory inspection with faceplate blocked	1,2 and 3) Method 2.11 sec 2.3.2
Flow Rate Multi-point Verification/Calibration	1/365 days	3 of 4 calibration points within ± 10% of design	1) 40 CFR Part 50 App J sec 8.0 2 and 3) Method 2.10 Sec 2.2.4
Audits			
Semi Annual Flow Rate Audit	***1/182 days***	± 10% of audit standard	1,2) Part 58, App A, sec 3.2.4 3) Method 2.10 Sec 7.1.5
Monitor Maintenance			
Inlet/downtube Cleaning	1/91 days	cleaned	1,2 and 3) Method 2.10 sec 6.1.2
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
SYSTEMATIC CRITERIA -PM_{10} Continuous			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM/ARM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Data Completeness	24-hour quarterly	18 hours ≥ 75%	Based on 75 % of the hours in a day 40 CFR Part 50 App. K, sec. 2.3
Reporting Units	all filters	$\mu g/m^3$ at standard temperature and pressure (STP)	40 CFR Part 50 App K

Table 7-4b. PM_{10} Measurement Quality Objectives – Measurement Quality Objectives - Parameter – PM_{10} (Continuous) continued			
1) Criteria (PM_{10} Cont)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Rounding convention for data reported to AQS			
24-hour, 3-year average	quarterly	nearest 10 µg/m^3 (≥ 5 round up)	40 CFR Part 50 App K sec 1
Verification/Calibration Standards and Recertifications - All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	***1/365 days***	***± 2% of NIST-traceable Std.***	1,2 and 3) 40 CFR Part 50 App J sec 7.3
Field Thermometer	1/365 days	± 0.1° C resolution, ± 0.1° C accuracy	1,2 and 3) Method 2.10 section 1.1.2
Field Barometer	1/365 days	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1,2 and 3) Method 2.10 section 1.1.2
Clock/timer Verification	1/182 days	15 minutes/day	1,2 and 3) Method 2.10 sec 9

NOTE: There are a number of continuous PM_{10} monitors that are designated as FEM. These monitors may have different measurement or sampling attributes that cannot be identified in this validation template. Monitoring organizations should review specific instrument operating manuals and augment the validation template with QC information specific to their EPA FRM or FEM designation and instrument."
http://www.epa.gov/ttn/amtic/files/ambient/criteria/referenceequivalent-methods-list.pdf.
In general, 40 CFR Part 58 App A and 40 CFR Part 50 App J requirements apply to Continuous PM_{10}. Since a guidance document was never developed for continuous PM_{10}, many of the requirements reflect a combination of manual and continuous PM2.5 requirements and are therefore considered recommendations.

Table 7-4c. PM_{10} Measurement Quality Objectives. Parameter – PM_{10} (Low Volume – Local Conditions-STP Gravimetric)

Monitoring organizations can use low-volume PM instruments for PM_{10} monitoring. However, PM_{10} data collection for NAAQS purposes must be reported in standard temperature and pressure (STP). 40 CFR Part 50 App J describes the reference method for PM_{10} but this method was promulgated for dichot and high volume methods that have improved over the years. Since monitoring organization may be able to use the low volume methods for multiple uses (PM_{10c}, PM_{10}-Pb) it is suggested that the validation criteria for this method follow the method requirements associated with the $PM_{2.5}$ which is Appendix L. Where there are particular requirement directly related to the NAAQS evaluation App J will be used.

1) Criteria (PM_{10} LC)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA-$PM_{2.5}$ Filter Based Local Conditions			
Field Activities			
Filter Holding Times			
Pre-sampling	***all filters***	***< 30 days before sampling***	1,2 and 3) 40 CFR Part 50, App. L Sec 8.3.5
Sample Recovery	***all filters***	***≤7 days 9 hours from sample end date***	1, 2 and 3) 40 CFR Part 50 App L Sec 10.10
Sampling Period (including multiple power failures)	***all filters***	***1380-1500 minutes midnight to midnight local standard time***	1, 2 and 3) 40 CFR Part 50 App J sec 7.1.5
Sampling Instrument			
Average Flow Rate	***every 24 hours of op***	***average within 5% of 16.67 liters/minute***	1, 2 and 3) Part 50 App L Sec 7.4.3.1
Variability in Flow Rate	***every 24 hours of op***	***CV ≤ 2%***	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.2
One-point Flow Rate Verification	1/30 days	***± 4% of transfer standard*** ± 5% of flow rate design value	1) 40 CFR Part 50, App. L, Sec 9.2.5, 40 CFR Part 58, Appendix A Sec 3.2.3 & 3.3.2 2) Recommendation 3) 40 CFR Part 50, App. L, Sec 9.2.5 & 7.4.3.1
Laboratory Activities			
Post-sampling Weighing	***all filters***	***≤10 days from sample end date if shipped at ambient temp, or ≤30 days if shipped below average ambient (or 4° C or below for average sampling temps < 4° C) from sample end date***	1, 2 and 3) 40 CFR Part 50 App L Sec 8..3.6
Filter Visual Defect Check (unexposed)	***all filters***	***Correct type & size and for pinholes, particles or imperfections***	1, 2 and 3) 40 CFR Part 50, App. L Sec 10.2
Filter Integrity (exposed)	each filter	no visual defects	1,2 and 3) Method 2.12 Sec. 7.10, Region 4 guidance
Filter Conditioning Environment			
Equilibration	***all filters***	***24 hours minimum***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.5
Temperature Range	***all filters***	***24-hr mean 20-23° C***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.1
Temperature Control	***all filters***	***± 2° C SD* over 24 hours***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.2
Humidity Range	***all filters***	***24-hr mean 30% - 40% RH or ≤5% sampling RH but > 20%RH***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.3
Humidity Control	***all filters***	***± 5% SD* over 24 hr.***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.4
Pre/post Sampling RH	***all filters***	***difference in 24-hr means ≤ ± 5% RH***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.3.3
Balance	***all filters***	***located in filter conditioning environment***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.3.2

Table 7-4c. PM_{10} Measurement Quality Objectives – Measurement Quality Objectives - Parameter – PM_{10} (Low Volume – Local Conditions-STP Gravimetric) continued			
1) Criteria (PM_{10} Lo-Vol STP)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
OPERATIONAL EVALUATIONS TABLE PM_{10} Lo-Vol Filter Based STP			
Field Activities			
Sampling Instrument			
Individual Flow Rates	***every 24 hours of operation***	***no flow rate excursions > ±5% for > 5 minutes 1/***	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.1
Filter Temp Sensor	***every 24 hours of operation***	***no excursions of > 5° C lasting longer than 30minutes 1/***	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.11.4
Routine Verifications			
External Leak Check	1/30 days	***< 25 mm Hg*** (see comment #1)	1) 40 CFR Part 50 App L, Sec 7.4.6.1 2) Method 2-12 Table 8-1 3) 40 CFR Part 50, App. L, Sec 7.4.6.1
Internal Leak Check	when external leak check fails	***< 25 mm Hg***	1) 40 CFR Part 50, App. L, Sec 7.4.6.2 2) Method 2-12 Table 8-1 3) 40 CFR Part 50, App. L, Sec 7.4.6.2
One-point Temp Verification	1/30 days	± 2°C	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Table 6-1 3) Recommendation
Pressure Verification	1/30 days	± 10 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Table 6-1 3) Recommendation
Annual Multi-point Verifications/Calibrations			
Temperature multi-point Verification/Calibration	on installation, then 1/365 days	± 2°C	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.4
Pressure Verification/Calibration	on installation, then 1/365 days	± 10 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.5 Sampler BP verified against independent standard verified against a lab primary standard that is certified as NIST traceable 1/365 days
Flow Rate Multi-point Verification/ Calibration	***Electromechanical maintenance or transport or*** 1/365 days	***± 4% of transfer standard***	1) 40 CFR Part 50, App. L, Sec 9.2. 2) 40 CFR Part 50, App. L, Sec 9.1.3, Method 2.12 Table 6-1 3) 40 CFR Part 50, App. L, Sec 9.2.5
Design Flow Rate Adjustment	***at one-point or multi-point verification/calibration***	***± 2% of design flow rate***	1,2 and 3) 40 CFR Part 50, App. L, Sec 9.2.6
Other Monitor Calibrations	per manufacturers' op manual	per manufacturers' operating manual	1,2 and 3) Recommendation
Precision			

Table 7-4c. PM_{10} Measurement Quality Objectives – Measurement Quality Objectives - Parameter – PM_{10} (Low Volume – Local Conditions-STP Gravimetric) continued			
1) Criteria (PM_{10} Lo-Vol STP)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Collocated Samples	***every 12 days for 15% of sites***	CV ≤ 10% of samples > 3 µg/m^3	1) and 2) 40 CFR Part 58 App A Sec 3.2.5 3) Recommendation
Accuracy			
Temperature Audit	1/365 days	± 2°C	1, 2 and 3) Method 2.12 Sec. 10.2.2 & Table 3-1
Pressure Audit	1/365 days	±10 mm Hg	1, 2 and 3) Method 2.12 Sec. 10.2 & Table 3-1
Semi Annual Flow Rate Audit	***1/6 month***	± 4% of audit standard ± 5% of design flow rate	1 and 2) Part 58, App A, Sec 3.3.3 3) Method 2.12 Sec. 10.2.1 & Table 10-1
Monitor Maintenance			
Inlet/downtube Cleaning	every 15 sampling events	cleaned	1,2 and 3) Method 2.12 Sec 9.3 & 9.4.1
Filter Chamber Cleaning	1/month	cleaned	1, 2 and 3) Method 2.12 Sec 9.3
Circulating Fan Filter Cleaning	1/month	cleaned/changed	1, 2 and 3) Method 2.12 Sec 9.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
Laboratory Activities			
Filter Checks			
Lot Blanks	9 filters per lot	less than 15 µg change between weighings	1, 2, 3) Recommendation and used to determine filter stability of the lot of filters received from EPA or vendor.
Exposure Lot Blanks	3 filters per lot	less than 15 µg change between weighings	1,2 and 3) Method 2.12 Sec. 7.7 Used for preparing a subset of filters for equilibration
Lab QC Checks			
Field Filter Blank	10% or 1 per weighing session	± 30 µg change between weighings	1) 40 CFR Part 50, App. L Sec 8.3.7.1 2 and 3) Method 2.12 Sec. 7.7
Lab Filter Blank	10% or 1 per weighing session	± 15 µg change between weighings	1) 40 CFR Part 50, App. L Sec 8.3.7.2 2 and 3) Method 2.12 Sec. 7.7
Balance Check (working standards)	beginning, 10th sample, end	≤3 µg	1,2 and 3) Method 2.12 Sec. 7.9
Duplicate Filter Weighing	1 per weighing session	± 15 µg change between weighings	1,2 and 3) Method 2.12 Sec 7.11
Microbalance Audit	1/365 days	± 0.050 mg or manufacturers specs, whichever is tighter	1,2 and 3) Method 2.12 Sec. 10.2.6
Verification/Calibration			
Lab Temperature	1/6 months	± 2°C	1) Method 2.12 Table 3-2 2) Recommendation Table 3-2 suggests every 3 mo. 3) Method 2.12 Table 3-2
Lab Humidity	1/6 months	± 2%	1) Method 2.12 Table 3-2

Table 7-4c. PM_{10} Measurement Quality Objectives – Measurement Quality Objectives - Parameter – PM_{10} (Low Volume – Local Conditions-STP Gravimetric) continued

1) Criteria (PM_{10} Lo-Vol STP)	2) Frequency	3) Acceptable Range	Information /Action
			2) Recommendation Table 3-2 suggests every 3 mo. 3) Method 2.12 Table 3-2
Microbalance Calibration	***At installation and prior to each weighing session*** 1/365 days	Manufacturer's specification	1) 40 CFR Part 50, App. L, Sec 8.1 2) 40 CFR Part 50, App. L, Sec 8.1 and Method 2.12 Sec. 7.2 3) NA
Calibration & Check Standards			
Working Mass Standards. (compare to primary standards)	1/3 months	0.025 mg	1, 2 and 3) Method 2.12 Sec 4.3 and 7.3
SYSTEMATIC CRITERIA -PM_{10} Lo-Vol Filter Based STP			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM/ARM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Data Completeness	***24- Hour Standard***	***≥ 75% scheduled sampling days in each quarter***	1,2 and 3) 40 CFR Part 50 App. K, sec. 2.3b
Reporting Units	all filters	$\mu g/m^3$ at standard temperature and pressure	1,2 and 3) 40 CFR Part 50 App K sec. 1
Rounding convention for data reported to AQS	***Each routine concentration***	***nearest 10 $\mu g/m^3$ (≥ 5 round up)***	1,2 and 3) 40 CFR Part 50 App K sec 1
Detection Limit			
Lower DL	***all filters***	***≤ 2 $\mu g/m^3$***	1,2 and 3) 40 CFR Part 50, App. L Sec 3.1
Upper Concentration Limit	***all filters***	***≥ 200 $\mu g/m^3$***	1,2 and 3) 40 CFR Part 50, App. L Sec 3.2
Precision			
Single analyzer	1/3 months	Coefficient of variation (CV) ≤ 10% > 3 $\mu g/m^3$	1,2 and 3) Recommendation
Single analyzer	1/ 365 days	CV ≤ 10% > 3 $\mu g/m^3$	1,2 and 3) Recommendation
Primary Quality Assurance Org.	Annual and 3 year estimates	90% CL of CV ≤ 10% > 3 $\mu g/m^3$	1,2 and 3) Recommendation
Field Activities			
Verification/Calibration Standards Recertifications – All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	**1/365 days**	***± 2% of NIST Traceable Std.***	1) 40 CFR Part 50, App. L Sec 9.1 & 9.2 2) Method 2-12 Section 6.3.3 and Table 3-1 3) 40 CFR Part 50, App. L Sec 9.1 & 9.2
Field Thermometer	1/365 days	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2 & Table 3-1
Field Barometer	1/365 days	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2 & Table 3-1

Table 7-4c. PM_{10} Measurement Quality Objectives –
Measurement Quality Objectives - Parameter – PM_{10} (Low Volume – Local Conditions-STP Gravimetric) continued

1) Criteria (PM_{10} Lo-Vol STP)	2) Frequency	3) Acceptable Range	Information /Action
Clock/timer Verification	periodically, when in STOP mode	***1 minute/month***	1and 2) Method 2.12 Table 3-1 3) 40 CFR Part 50, App. L Sec 7.4.12
Laboratory Activities			
Microbalance Readability	***at purchase***	***1 µg***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.1
Microbalance Repeatability	1/365 days	1 µg	1) Method 2.12 Sec 4.3.6 2) Recommendation 3) Method 2.12 Sec 4.3.6
Primary Mass. Verification/Calibration Standards Recertifications	1/365 days	0.025 mg	1, 2 and 3) Method 2.12 Sec 4.3.7 & Table 3-2

Comment #1
The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.

Table 7-4d. PM_{10c} Measurement Quality Objectives - Measurement Quality Objectives PM_{10c} Measurement Quality Objectives -- (Gravimetric, Filter-Based Local Conditions)			
NOTE: The following validation template was constructed for use of PM_{10} at local conditions where PM10c is used in the calculation of the $PM_{10-2.5}$ measurement or for objectives other than comparison to the PM_{10} NAAQS. Although the $PM_{10-2.5}$ method is found in 40 CFR Part 50 Appendix O, Appendix O references Appendix L (the $PM_{2.5}$ Method) for the QC requirements listed below. Therefore, the information action column, in most cases, will reference 40 CFR Part 50 App L. Monitoring organizations using PM_{10} data for a NAAQS comparison purposes should refer to the PM_{10} validation template for STP (standard temperature and pressure correction). In addition, since the samplers are very similar to the $PM_{2.5}$ samplers, Guidance Document 2.12 Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class1 Equivalent Methods is referred to where appropriate.			
1) Criteria (PM_{10}c)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
CRITICAL CRITERIA-PM_{10}c Filter Based Local Conditions			
Field Activities			
Filter Holding Times			
Pre-sampling	***all filters***	***< 30 days before sampling***	1,2 and 3) 40 CFR Part 50, App. L Sec 8.3.5
Sample Recovery	***all filters***	***≤7 days 9 hours from sample end date***	1, 2 and 3) 40 CFR Part 50 App L Sec 10.10
Sampling Period (including multiple power failures)	***all filters***	***1380-1500 minutes, or value if < 1380 and exceedance of NAAQS[1/] midnight to midnight local standard time***	1, 2 and 3) 40 CFR Part 50 App L Sec 3.3 See details if less than 1380 min sampled
Sampling Instrument			
Average Flow Rate	***every 24 hours of operation***	***average within 5% of 16.67 liters/minute***	1, 2 and 3) Part 50 App L Sec 7.4.3.1
Variability in Flow Rate	***every 24 hours of operation***	***CV ≤ 2%***	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.2
One-point Flow Rate Verification	***1/month***	***± 4% of transfer standard*** ± 5% of flow rate design value	1, 2 and 3) 40 CFR Part 50, App. L, Sec 9.2.5, 40 CFR Part 58, Appendix A Sec 3.2.3 & 3.3.2
Laboratory Activities			
Post-sampling Weighing	***all filters***	***≤10 days from sample end date if shipped at ambient temp, or ≤30 days if shipped below average ambient (or 4° C or below for average sampling temps < 4° C) from sample end date***	1, 2 and 3) 40 CFR Part 50 App L Sec 8..3.6
Filter Visual Defect Check (unexposed)	***all filters***	***Correct type & size and for pinholes, particles or imperfections***	1, 2 and 3) 40 CFR Part 50, App. L Sec 10.2
Filter Integrity (exposed)	each filter	no visual defects	1,2 and 3) Method 2.12 Sec. 7.10, Region 4 guidance
Filter Conditioning Environment			
Equilibration	***all filters***	***24 hours minimum***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.5
Temperature Range	***all filters***	***24-hr mean 20-23° C***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.1
Temperature Control	***all filters***	***± 2° C SD* over 24 hour***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.2
Humidity Range	***all filters***	***24-hr mean 30% - 40% RH or ≤5% sampling RH but > 20%RH***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.3

Table 7-4d. PM_{10} Measurement Quality Objectives - Measurement Quality Objectives
$PM_{10}c$ Measurement Quality Objectives -- (Gravimetric, Filter-Based Local Conditions) continued

1) Criteria ($PM_{10}c$)	2) Frequency	3) Acceptable Range	Information /Action
Humidity Control	*all filters*	*± 5% SD* over 24 hours*	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.4
Pre/post Sampling RH	*all filters*	*difference in 24-hr means ≤ ± 5% RH*	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.3.3
Balance	*all filters*	*located in filter conditioning environment*	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.3.2
OPERATIONAL EVALUATIONS TABLE- $PM_{10}c$ Filter Based Local Conditions			
Field Activities			
Sampling Instrument			
Individual Flow Rates	*every 24 hours of operation*	***no flow rate excursions > ±5% for > 5 min.*** 1/	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.1
Filter Temp Sensor	*every 24 hours of operation*	***no excursions of > 5◦ C lasting longer than 30 min*** 1/	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.11.4
Routine Verifications			
External Leak Check	1/month	***< 25 mm Hg*** (see comment #1)	1) 40 CFR Part 50 App L, Sec 7.4.6.1 2) Method 2-12 Table 8-1 3) 40 CFR Part 50, App. L, Sec 7.4.6.1
Internal Leak Check	when external leak check fails	***< 25 mm Hg***	1) 40 CFR Part 50, App. L, Sec 7.4.6.2 2) Method 2-12 Table 8-1 3) 40 CFR Part 50, App. L, Sec 7.4.6.2
One-point Temp Verification	1/month	± 2°C	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Table 6-1 3) Recommendation
Pressure Verification	1/month	± 10 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Table 6-1 3) Recommendation
Annual Multi-point Verifications/Calibrations			
Temperature multi-point Verification/Calibration	on installation, then 1/365 days	± 2°C	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.4
Pressure Verification/Calibration	on installation, then 1/365 days	± 10 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.5 Sampler BP verified against independent standard verified against a lab primary standard that is certified as NIST traceable 1/365 days
Flow Rate Multi-point Verification/ Calibration	***Electromechanical maintenance or transport or*** 1/365 days	***± 4% of transfer standard***	1) 40 CFR Part 50, App. L, Sec 9.2. 2) 40 CFR Part 50, App. L, Sec 9.1.3, Method 2.12 Table 6-1 3) 40 CFR Part 50, App. L, Sec 9.2.5
Design Flow Rate Adjustment	***at one-point or multi-point verification/calibration***	***± 2% of design flow rate***	1,2 and 3) 40 CFR Part 50, App. L, Sec 9.2.6

Table 7-4d. PM_{10} Measurement Quality Objectives - Measurement Quality Objectives
$PM_{10}c$ Measurement Quality Objectives -- (Gravimetric, Filter-Based Local Conditions) continued

1) Criteria ($PM_{10}c$)	2) Frequency	3) Acceptable Range	Information /Action
Other Monitor Calibrations	per manufacturers' operating manual	per manufacturers' operating manual	1,2 and 3) Recommendation
Precision			
Collocated Samples	***every 12 days for 15% of sites in NCore network***	CV ≤ 15% of samples > 3 µg/m³	1) and 2) Part 58 App A Sec 3.2.5 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.3
Accuracy			
Temperature Audit	1/365 days	± 2°C	1, 2 and 3) Method 2.12 Sec. 10.2.2 & Table 3-1
Pressure Audit	1/365 days	±10 mm Hg	1, 2 and 3) Method 2.12 Sec. 10.2.3 & Table 3-1
Semi Annual Flow Rate Audit	***1/6 month***	± 4% of audit standard ± 5% of design flow rate	1 and 2) Part 58 App A, Sec 3.3.3 3) Method 2.12 Sec. 10.2.1 & Table 10-1
Monitor Maintenance			
Inlet/downtube Cleaning	every 15 sampling events	cleaned	1,2 and 3) Method 2.12 Sec 9.4.1
Filter Chamber Cleaning	1/month	cleaned	1, 2 and 3) Method 2.12 Sec 9.3
Circulating Fan Filter Cleaning	1/month	cleaned/changed	1, 2 and 3) Method 2.12 Sec 9.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
Laboratory Activities			
Filter Checks			
Lot Blanks	9 filters per lot	less than 15 µg change between weighings	1, 2 and 3) Recommendation and used to determine filter stability of the lot of filters
Exposure Lot Blanks	3 filters per lot	less than 15 µg change between weighings	1,2 and 3) Method 2.12 Sec. 7.7 Used for preparing a subset of filters for equilibration
Filter Integrity (exposed)	each filter	no visual defects	1,2 and 3) Method 2.12 Sec. 7.10
Lab QC Checks			
Field Filter Blank	10% or 1 per weighing session	± 30 µg change between weighings	1) 40 CFR Part 50, App. L Sec 8.3.7.1 2 and 3) Method 2.12 Sec. 7.7
Lab Filter Blank	10% or 1 per weighing session	± 15 µg change between weighings	1) 40 CFR Part 50, App. L Sec 8.3.7.2 2 and 3) Method 2.12 Sec. 7.7
Balance Check (working standards)	beginning, 10th sample, end	≤3 µg	1,2 and 3) Method 2.12 Sec. 7.9
Duplicate Filter Weighing	1 per weighing session	+ 15 µg change between weighings	1,2 and 3) Method 2.12 Sec 7.11
Microbalance Audit	1/365 days	± 0.050 mg or manufacturers specs, whichever is tighter	1,2 and 3) Method 2.12 Sec. 10.2.6
Verification/Calibration			

Table 7-4d. PM_{10} Measurement Quality Objectives - Measurement Quality Objectives $PM_{10}c$ Measurement Quality Objectives -- (Gravimetric, Filter-Based Local Conditions) continued			
1) Criteria ($PM_{10}c$)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Lab Temperature	1/6 months	± 2°C	1) Method 2.12 Table 3-2 2) Recommendation Table 3-2 suggests every 3 mo. 3) Method 2.12 Table 3-2
Lab Humidity	1/6 months	± 2%	1) Method 2.12 Table 3-2 2) Recommendation Table 3-2 suggests every 3 mo. 3) Method 2.12 Table 3-2
Microbalance Calibration	***At installation and prior to each weighing session*** 1/365 days	Manufacturer's specification	1) 40 CFR Part 50, App. L, Sec 8.1 2) 40 CFR Part 50, App. L, Sec 8.1 and Method 2.12 Sec. 7.2 3) NA
Calibration & Check Standards -			
Working Mass Standards. (compare to primary standards)	***1/3 month***	0.025 mg	1, 2 and 3) Method 2.12 Sec 4.3 and 7.3
SYSTEMATIC CRITERIA -$PM_{10}c$ Filter Based Local Conditions			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM/ARM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Data Completeness	NA	≥ 75% scheduled sampling days in each quarter	1, 2 and 3) Recommendation based on PM2.5 requirements in 40 CFR Part 50, App. N, Sec. 4.1 (b) 4.2 (a)
Reporting Units	***all filters***	***μg/m³ at ambient temp/pressure ($PM_{2.5}$)***	1. 2 and 3) 40 CFR Part 50 App N
Rounding convention for data reported to AQS	all concentrations	nearest 0.1 μg/m³ (≥ 0.05 round up)	1,2 and 3) Recommendation based on PM2.5 requirements 40 CFR Part 50 App N sect 4.3
Detection Limit			
Lower DL	***all filters***	***≤3 μg/m³***	1,2 and 3) 40 CFR Part 50, App O Sec 3.1
Upper Conc. Limit	***all filters***	***≥200 μg/m³***	1,2 and 3) 40 CFR Part 50, App. O Sec 3.2
Precision			
Single analyzer (collocated monitors)	1/3 month	Coefficient of variation (CV) ≤ 10% for values > 3 μg/m³	1, 2 and 3) Recommendation in order to provide early evaluation of achievement of DQOs.

Table 7-4d. PM_{10} Measurement Quality Objectives - Measurement Quality Objectives
$PM_{10}c$ Measurement Quality Objectives -- (Gravimetric, Filter-Based Local Conditions) continued

1) Criteria ($PM_{10}c$)	2) Frequency	3) Acceptable Range	Information /Action
Primary Quality Assurance Org.	***Annual and 3 year estimates***	***90% CL of CV ≤ 10% for values > 3 µg/m³***	1,2 and 3) 40 CFR Part 58, App A Sec 4.3.1 and 2.3.1.1
Bias			
Performance Evaluation Program (PEP)	***8 audits per year for the NCore network***	***±10% for values > 3 µg/m³***	1, 2 and 3) 40 CFR Part 58, App A, Sec 3.2.7, 4.3.2 and 2.3.1.1
Field Activities			
Verification/Calibration Standards Recertifications – All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	**1/365 days**	***± 2% of NIST-traceable Std.***	1) 40 CFR Part 50, App. L Sec 9.1 & 9.2 2) Method 2-12 Section 6.3.3 and Table 3-1 3) 40 CFR Part 50, App. L Sec 9.1 & 9.2
Field Thermometer	1/365 days	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2 & Table 3-1
Field Barometer	1/365 days	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2 & Table 3-1
Verification/Calibration Clock/timer Verification	1/month	***1 min/month***	1 and 2) Method 2.12 Table 3-1 3) 40 CFR Part 50, App. L, Sec 7.4.12
Laboratory Activities			
Microbalance Readability	***at purchase***	***1 µg***	1, 2 and 3)) 40 CFR Part 50, App. L, Sec 8.1
Microbalance Repeatability	1/365 days	1 µg	1) Method 2.12 Sec 4.3.6 2) Recommendation 3) Method 2.12 Sec 4.3.6
Primary Mass Standards.	1/365 days	0.025 mg	1, 2 and 3) Method 2.12 Sec 4.3.7 & Table 3-2
Comment #1 The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.			
1/ value must be flagged , SD= standard deviation, CV= coefficient of variation			

Table 7-5. Sulfur Dioxide Measurement Quality Objectives Parameter – Sulfur Dioxide (SO2) (Ultraviolet Fluorescence).			
1) Requirement (SO_2)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
CRITICAL CRITERIA- SO_2			
One Point QC Check Single analyzer	***1/ 14 days***	Warning limit: ≤ ±7% (percent difference) Control limit: ≤ ±10% (percent difference)	1 and 2) 40 CFR Part 58 App A Sec 3.1.1 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.5 QC Check Concentration range 0.005 and 0.08 ppm Relative to mean or median monitor concentrations
Zero/span check	1/ 14 days	Zero drift ≤ ± 1.5 ppb (24-hour) ≤ ± 2.5 ppb (>24hr-14 day) Span drift ≤ ± 10 %	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
Shelter Temperature Range	**Daily** (hourly values)	20 to 30° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
OPERATIONAL CRITERIA- SO_2			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/180 days	± 2° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/365 days with an equal proportion of sites in each of the 4 quarters***	Percent difference of audit levels 3-10 ≤ ±15% Audit levels 1&2 ± 1.5 ppb difference or ±15%	1 and 2) 40 CFR Part 58 App A sec 3.1.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html
Federal Audits (NPAP)	100 percent of sites every 6 years; 20% of sites audited each year	Audit levels 1&2 ± 1.5 ppb difference; all other levels percent difference ± 15%	1) 40 CFR Part 58 App A sec 3.1.3 2) 40 CFR Part 58 App A sec 3.1.3.1 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving; When one-point QC check is > 7 % difference; 1/365 days if continuous zero/span performed daily	Criteria: Span 1&2 within ± 5 % of expected Span 3 within ± 3 ppb of expected NCore: Span 1&2 within ± 3 ppb of expected Span 3 within ± 2 ppb of expected Both: Zero within ± 1 ppb of expected	1) 40 CFR Part 50 App A-1 Section 4 2 and 3) Recommendation Multi-point calibration (0 and 3 upscale points)
Gaseous Standards	***All gas cylinders***	***NIST Traceable*** ***(e.g., EPA Protocol Gas)***	1) 40 CFR Part 50 App A-1 Section 4.1.6.1 2) NA Green book 3) 40 CFR Part 50 App A-1 Section 4.1.6.1 Producers must participate in Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A sec 2.6.1
Zero Air/ Zero Air Check	Chemicals changed 1/365 days NCore – certified 1/365 days & verified 1/180 days	Concentrations below LDL < 0.1 ppm aromatic hydrocarbons	1) 40 CFR Part 50 App A-1 Section 4.1.6.2 2) Recommendation 3) Recommendation and 40 CFR Part 50 App A-1 Section 4.1.6.2

Table 7-5. Sulfur Dioxide Measurement Quality Objectives Parameter – Sulfur Dioxide (SO2) (Ultraviolet Fluorescence)– Continued			
1) Requirement (SO_2)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
Gas Dilution Systems	1/365 days or after failure of 1 point QC check or performance evaluation	***Accuracy ± 2 %***	1) 40 CFR Part 50 App A-1sec 4.1.2 2) Recommendation 3) 40 CFR Part 50 App A-1 sec 4.1.2
Detection (FEM/FRMs)			
Noise	NA	***0.001 ppm (standard range)*** ***0.0005 ppm (lower range)***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) NA 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	Verified by manufacturer at purchase	***0.002 ppm (standard range)*** ***0.001 ppm (lower range)***	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1
SYSTEMATIC CRITERIA- SO_2			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	***All data***	***ppb (final units in AQS)***	1, 2 and 3) 40 CFR Part 50 App T Sec 2 (c)
Rounding convention for data reported to AQS	***All data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50 App T Sec 2 (c)
Completeness	***1 hour standard***	***Hour – 75% of hour*** ***Day- 75% hourly concentrations*** ***Quarter- 75% complete days*** ***Years-4 complete quarters*** ***5-min value reported only for valid 5-min blocks***	1, 2 and 3) 40 CFR Part 50 App T Section 3 (b), (c) More details in CFR on acceptable completeness.
Sample Residence Time Verification	At installation	***< 20 seconds***	1) 40 CFR Part 58 App E, section 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E, section 9 (c)
Sample Probe, Inlet, Sampling train	***All sites***	***Borosilicate glass (e.g., Pyrex®) or Teflon®*** (FEP and PFA have been accepted as equivalent material to Teflon.)	1, 2 and 3) 40 CFR Part 58 App E sec 9 (a) Replace 1 / 2 years; more frequently if pollutant load or contamination dictate
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Precision(using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***90% CL CV ≤ 10%***	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.1.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.2
Bias (using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***95% CL ≤ ± 10%***	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.1.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.3

Table 7-6. Carbon Monoxide Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry)

1) Requirement (CO)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-CO			
One Point QC Check Single analyzer	***1/ 14 days***	Warning limit ≤ ±7 % (percent difference) Conttol limit ≤ ±10 % (percent difference)	1 and 2) 40 CFR Part 58 App A Sec 3.2 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1. QC Check Concentration range 0.5 - 5 ppm relative to routine concentrations
Zero/span check	1/ 14 days	Zero drift ≤ ± 0.4 ppm (24 hour) ≤ ± 0.6 ppm (>24hr-14 day) Span drift ≤ ± 10 %	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation
Shelter Temperature range	Daily (hourly values)	20 to 30° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
OPERATIONAL CRITERIA-CO			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/180 days	± 2° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/365 days with an equal proportion of sites in each of the 4 quarters***	0 ppb ± 35 ppb 190 ppb ± 10 % 1000 ppb ± 10 % 4000 ppb ± 10 %	1 and 2) 40 CFR Part 58 App A sec 3.2.2 3) Recommendation- 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html
Federal Audits (NPAP)	100 percent of sites every 6 years; 20% of sites audited each year	Audit levels 1&2 ± 0.03 ppm difference all other levels percent difference ± 15 %	1) 40 CFR Part 58 App A sec 2.4 2) NPAP adequacy requirements on AMTIC 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/91 days for NCore 1/180 days for near road	250 ppb ± 24 ppb 2000 ppb ± 100 ppb 4000 ppb ± 160 ppb	1) 40 CFR Part 50 Appendix C Section 4 2 and 3) Recommendation Multi-point calibration (0 and 3 upscale points)
Gaseous Standards	All gas cylinders	**NIST Traceable** (e.g., EPA Protocol Gas)	1) 40 CFR Part 50 Appendix C Section 4.3.1 2) NA Green book 3) 40 CFR Part 50 Appendix C Section 4.3.1 See details about CO2 sensitive instruments Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A sec 2.6.1
Zero Air/Zero Air Check	1/365 days	***< 0.1 ppm CO***	1) 40 CFR Part 50 App C Section 4.3.2 2) Recommendation 3) 40 CFR Part 50 App C Section 4.3.2

Table 7-6. Carbon Monoxide Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry) – Continued

1) Requirement (CO)	2) Frequency	3) Acceptance Criteria	Information /Action
Gas Dilution Systems	1/365 days or after failure of 1 point QC check or performance evaluation	Accuracy ± 2 %	1,2 and 3) Recommendation based on SO2 requirement in 40 CFR Part 50 App A-1 Sec 4.1.2
Detection (FEM/FRMs)			
Noise	1/365 days	***0.2 ppm (standard range)*** ***0.1 ppm (lower range)***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) Recommendation- info obtained from LDL 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	1/365 days	***0.4 ppm (standard range)*** ***0.2 ppm (lower range)***	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1
SYSTEMATIC CRITERIA-CO			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	***All data***	***ppm (final units in AQS)***	1, 2 and 3)) 40 CFR Part 50.8 (a)
Rounding convention for data reported to AQS	***All data***	***1 decimal place***	1, 2 and 3) 40 CFR Part 50.8 (d) (for averaging values for comparison to NAAQS not for reporting individual hourly values.)
Completeness	***8-hour standard***	***75% of hourly averages for the 8-hour period***	1) 40 CFR Part 50.8(c) 2) 40 CFR Part 50.8(a-2) 3) 40 CFR Part 50.8(c)
Sample Residence Time Verification	1/365 days	< 20 seconds	1, 2, and 3) Recommendation. CO not a reactive gas but suggest following same methods other gaseous criteria pollutants.
Sample Probe, Inlet, Sampling train	All Sites	Borosilicate glass (e.g., Pyrex®) or Teflon®	1, 2, and 3) Recommendation. CO not a reactive gas but suggest following same methods other gaseous criteria pollutants. FEP and PFA have been accepted as an equivalent material to Teflon. Replacement/cleaning is suggested as 1/year and more frequent if pollutant load dictate.
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
Precision(using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***90% CL CV ≤ 10%***	1) 40 CFR part 58 App A sec 3.2.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.2
Bias (using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***95 % CL ≤ ± 10%***	1) 40 CFR Part 58 App A sec 3.2.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.3
Annual PE Primary QA Organization (PQAO) Evaluation	1/365 days	***95 % of audit percent differences fall within the one point QC check 95 % probability intervals at PQAO level of aggregation***	1) 40 CFR Part 58 App A Section 3.2.2 2) Recommendation 3) 40 CFR Part 58 App A sec 4.1.4 & 4.1.5

Table 7-7a. PM$_{2.5}$ Measurement Quality Objectives. Parameter – PM2.5 (Gravimetric, Filter Based, Local Conditions)			
1) Criteria (PM$_{2.5}$ LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
CRITICAL CRITERIA-PM$_{2.5}$ Filter Based Local Conditions			
Field Activities			
Filter Holding Times			
Pre-sampling	***all filters***	***< 30 days before sampling***	1,2 and 3) 40 CFR Part 50, App. L Sec 8.3.5
Sample Recovery	***all filters***	***≤7 days 9 hours from sample end date***	1, 2 and 3) 40 CFR Part 50 App L Sec 10.10
Sampling Period (including multiple power failures)	***all filters***	***1380-1500 minutes, or value if < 1380 and exceedance of NAAQS [1/] midnight to midnight local standard time***	1, 2 and 3) 40 CFR Part 50 App L Sec 3.3 See details if less than 1380 min sampled
Sampling Instrument			
Average Flow Rate	***every 24 hours of op***	***average within 5% of 16.67 liters/minute***	1, 2 and 3) Part 50 App L Sec 7.4.3.1
Variability in Flow Rate	***every 24 hours of op***	***CV ≤ 2%***	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.2
One-point Flow Rate Verification	***1/30 days***	***± 4% of transfer standard*** ± 5% of flow rate design value	1, 2 and 3) 40 CFR Part 50, App. L, Sec 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix A Sec 3.2.3 & 3.3.2
Laboratory Activities			
Post-sampling Weighing	***all filters***	***≤10 days from sample end date if shipped at ambient temp, or ≤30 days if shipped below average ambient (or 4° C or below for average sampling temps < 4° C) from sample end date***	1, 2 and 3) 40 CFR Part 50 App L Sec 8..3.6
Filter Visual Defect Check (unexposed)	***all filters***	***Correct type & size and for pinholes, particles or imperfections***	1, 2 and 3) 40 CFR Part 50, App. L Sec 10.2
Filter Integrity (exposed)	each filter	no visual defects	1,2 and 3) Method 2.12 Sec. 7.10, Region 4 guidance
Filter Conditioning Environment			
Equilibration	***all filters***	***24 hours minimum***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.5
Temperature Range	***all filters***	***24-hr mean 20-23° C***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.1
Temperature Control	***all filters***	***± 2° C SD* over 24 hours***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.2
Humidity Range	***all filters***	***24-hr mean 30% - 40% RH or ≤5% sampling RH but > 20%RH***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.3
Humidity Control	***all filters***	***± 5% SD* over 24 hr.***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.2.4
Pre/post Sampling RH	***all filters***	***difference in 24-hr means ≤ ± 5% RH***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.3.3
Balance	***all filters***	***located in filter conditioning environment***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.3.2
OPERATIONAL EVALUATIONS TABLE PM$_{2.5}$ Filter Based Local Conditions			
Field Activities			
Sampling Instrument			

Individual Flow Rates	***every 24 hours of op***	***no flow rate excursions > ±5% for > 5 min.*** 1/	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.1

Table 7-7a. PM2.5 Measurement Quality Objectives. Parameter – PM2.5 (Gravimetric, Filter Based, Local Conditions) continued

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Filter Temp Sensor	***every 24 hours of op***	***no excursions of > 5°C lasting longer than 30 min*** 1/	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.11.4
Routine Verifications			
External Leak Check	every 5 sampling events	***< 80 mL/min*** (see comment #1)	1) 40 CFR Part 50 App L, Sec 7.4.6.1 2) Method 2-12 Table 8-1 3) 40 CFR Part 50, App. L, Sec 7.4.6.1
Internal Leak Check	every 5 sampling events	***< 80 mL/min***	1) 40 CFR Part 50, App. L, Sec 7.4.6.2 2) Method 2-12 Table 8-1 3) 40 CFR Part 50, App. L, Sec 7.4.6.2
One-point Temp Verification	1/30 days	± 2°C	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Table 6-1 3) Recommendation
Pressure Verification	1/30 days	± 10 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Table 6-1 3) Recommendation
Annual Multi-point Verifications/Calibrations			
Temperature multi-point Verification/Calibration	on installation, then 1/365 days	± 2°C	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.4
Pressure Verification/Calibration	on installation, then 1/365 days	± 10 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.5 Sampler BP verified against independent standard verified against a lab primary standard that is certified as NIST traceable 1/365 days
Flow Rate Multi-point Verification/ Calibration	***Electromechanical maintenance or transport or*** 1/365 days	***± 4% of transfer standard***	1) 40 CFR Part 50, App. L, Sec 9.2. 2) 40 CFR Part 50, App. L, Sec 9.1.3, Method 2.12 Table 6-1 3) 40 CFR Part 50, App. L, Sec 9.2.5
Design Flow Rate Adjustment	***at one-point or multi-point verification/calibration***	***± 2% of design flow rate***	1,2 and 3) 40 CFR Part 50, App. L, Sec 9.2.6
Other Monitor Calibrations	per manufacturers' op manual	per manufacturers' operating manual	1,2 and 3) Recommendation
Precision			
Collocated Samples	***every 12 days for 15% of sites by method designation***	CV ≤ 10% of samples > 3 μg/m^3	1) and 2) Part 58 App A Sec 3.2.5 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.1
Accuracy			
Temperature Audit	1/365 days	± 2°C	1, 2 and 3) Method 2.12 Sec. 10.2.2 & Table 3-1
Pressure Audit	1/365 days	±10 mm Hg	1, 2 and 3) Method 2.12 Sec. 10.2.3 & Table 3-1

Table 7-7a. PM2.5 Measurement Quality Objectives. Parameter – PM2.5 (Gravimetric, Filter Based, Local Conditions) continued			
1) Criteria ($PM_{2.5}$ LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Semi Annual Flow Rate Audit	***1/182 days***	± 4% of audit standard ± 5% of design flow rate	1 and 2) Part 58, App A, Sec 3.3.3 3) Method 2.12 Sec. 10.2.1 & Table 10-1
Monitor Maintenance			
Impactor (WINs)	every 5 sampling events	cleaned/changed	1, 2,and 3) Method 2.12 Sec 8.3.1
Very Sharp Cut Cyclone	every 30 days	cleaned/changed	1,2 and 3) Recommendation
Inlet/downtube Cleaning	every 15 sampling events	cleaned	1,2 and 3) Method 2.12 Sec 9.3
Filter Chamber Cleaning	1/30 days	cleaned	1, 2 and 3) Method 2.12 Sec 9.3 and 9.4.1
Circulating Fan Filter Cleaning	1/30 days	cleaned/changed	1, 2 and 3) Method 2.12 Sec 9.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
Laboratory Activities			
Filter Checks			
Lot Blanks	9 filters per lot	less than 15 µg change between weighings	1, 2, 3) Recommendation and used to determine filter stability of the lot of filters received from EPA or vendor.
Exposure Lot Blanks	3 filters per lot	less than 15 µg change between weighings	1,2 and 3) Method 2.12 Sec. 7.7 Used for preparing a subset of filters for equilibration
Lab QC Checks			
Field Filter Blank	10% or 1 per weighing session	± 30 µg change between weighings	1) 40 CFR Part 50, App. L Sec 8.3.7.1 2 and 3) Method 2.12 Sec. 7.7
Lab Filter Blank	10% or 1 per weighing session	± 15 µg change between weighings	1) 40 CFR Part 50, App. L Sec 8.3.7.2 2 and 3) Method 2.12 Sec. 7.7
Balance Check (working standards)	beginning, 10th sample, end	≤ ± 3 µg	1,2 and 3) Method 2.12 Sec. 7.9
Duplicate Filter Weighing	1 per weighing session	± 15 µg change between weighings	1,2 and 3) Method 2.12 Sec 7.11
Microbalance Audit	1/365 days	± 0.050 mg or manufacturers specs, whichever is tighter	1,2 and 3) Method 2.12 Sec. 10.2.6
Verification/Calibration			
Lab Temperature	1/182 days	± 2°C	1) Method 2.12 Table 3-2 2) Recommendation. Table 3-2 suggests every 3 mo. 3) Method 2.12 Table 3-2
Lab Humidity	1/182 days	± 2%	1) Method 2.12 Table 3-2 2) Recommendation Table 3-2 suggests every 3 mo. 3) Method 2.12 Table 3-2
Microbalance Calibration	***At installation and prior to each weighing session*** 1/365 days	Manufacturer's specification	1) 40 CFR Part 50, App. L, Sec 8.1 2) 40 CFR Part 50, App. L, Sec 8.1 and Method 2.12 Sec. 7.2 3) NA
Calibration & Check Standards			

Table 7-7a. PM2.5 Measurement Quality Objectives. Parameter – PM2.5 (Gravimetric, Filter Based, Local Conditions) continued			
1) Criteria ($PM_{2.5}$ LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Working Mass Standards. (compare to primary standards) Primary standards	1/91 days. 1/365 days	0.025 mg 0.025 mg	1, 2 and 3) Method 2.12 Sec 4.3 and 7.3
SYSTEMATIC CRITERIA -$PM_{2.5}$ Filter Based Local Conditions			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM/ARM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Data Completeness	***Annual Standard***	***≥ 75% scheduled sampling days in each quarter***	1, 2 and 3) 40 CFR Part 50, App. N, Sec. 4.1 (b) 4.2 (a)
	24- Hour Standard	***≥ 75% scheduled sampling days in each quarter***	1, 2 and 3) 40 CFR Part 50, App. N, Sec. 4.1 (b) 4.2 (a)
Reporting Units	***all filters***	***$\mu g/m^3$ at ambient temp/pressure ($PM_{2.5}$)***	1. 2 and 3) 40 CFR Part 50 App N Sec 3.0 (b)
Rounding convention for data reported to AQS	***all filters***	***to one decimal place, with additional digits to the right being truncated***	1. 2 and 3) 40 CFR Part 50 App N Sec 3.0 (b)
Annual 3-yr average	***all concentrations***	***nearest 0.1 $\mu g/m^3$*** (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, App. N Sec 3 and 4 Rounding convention for data reported to AQS is a recommendation
24-hour, 3-year average	***all concentrations***	***nearest 1 $\mu g/m^3$*** (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, App. N Sec 3 and 4 Rounding convention for data reported to AQS is a recommendation
Detection Limit			
Lower DL	***all filters***	***≤ 2 $\mu g/m^3$***	1,2 and 3) 40 CFR Part 50, App. L Sec 3.1
Upper Conc. Limit	***all filters***	***≥ 200 $\mu g/m^3$***	1,2 and 3) 40 CFR Part 50, App. L Sec 3.2
Precision			
Single analyzer (collocated monitors)	1/91 days.	Coefficient of variation (CV) ≤ 10% for values > 3 $\mu g/m^3$	1, 2 and 3) Recommendation in order to provide early (quarterly) evaluation of achievement of DQOs.
Primary Quality Assurance Org.	***Annual and 3 year estimates***	***90% CL of CV ≤ 10% for values > 3 $\mu g/m^3$***	1, 2 and 3) 40 CFR Part 58, App A, Sec 4.3.1 and 2.3.1.1.
Bias			
Performance Evaluation Program (PEP)	***8 valid audits per year/each monitor audited every 6 years***	***±10% for values > 3 $\mu g/m^3$***	1,2 and 3) 40 CFR Part 58, App A, Sec 3.2.7, 4.3.2 and 2.3.1.1
Field Activities			
Verification/Calibration Standards Recertifications – All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	1/365 days	± ***2% of NIST Traceable Std.***	1) 40 CFR Part 50, App. L Sec 9.1 & 9.2 2) Method 2-12 Section 6.3.3 and Table 3-1 3) 40 CFR Part 50, App. L Sec 9.1 & 9.2

Table 7-7a. PM2.5 Measurement Quality Objectives. Parameter – PM2.5 (Gravimetric, Filter Based, Local Conditions) continued			
1) Criteria ($PM_{2.5}$ LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Field Thermometer	1/365 days	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2 & Table 3-1
Field Barometer	1/365 days	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2 & Table 3-1
Clock/timer Verification	1/30 days	***1 min/month***	1and 2) Method 2.12 Table 3-1 3) 40 CFR Part 50, App. L Sec 7.4.12
Laboratory Activities			
Microbalance Readability	***at purchase***	***1 µg***	1, 2 and 3) 40 CFR Part 50, App. L Sec 8.1
Microbalance Repeatability	1/365 days	1 µg	1) Method 2.12 Sec 4.3.6 2) Recommendation 3) Method 2.12 Sec 4.3.6
Primary Mass. Verification/Calibration Standards Recertifications	1/365 days	0.025 mg	1, 2 and 3) Method 2.12 Sec 4.3.7 & Table 3-2
Comment #1 The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.			
1/ value must be flagged SD * = standard deviation CV= coefficient of variation			

Table 7-7b. PM2.5 Measurement Quality Objectives. Parameter – PM2.5 (Continuous, Local Conditions)			
1) Criteria (PM2.5 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
CRITICAL CRITERIA- PM2.5 Continuous, Local Conditions			
Field Activities			
Sampling Period 24 hour estimate	***every sample period***	***≥ 75% (18) of hourly averages***	1,2and 3) 40 CFR Part 50 App N Sec 3 (c) See additional details for sample periods less than 18 hours.
Hourly estimates	Every hour	Instrument dependent	See operators manual
Sampling Instrument			
Average Flow Rate	***every 24 hours of operation***	***average within 5% of 16.67 liters/minute***	1, 2 and 3) Part 50 App L Sec 7.4.3.1
Variability in Flow Rate	***every 24 hours of operation***	***CV ≤ 2%***	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.2
One-point Flow Rate Verification	***1/30 days***	***± 4% of transfer standard*** ± 5% of flow rate design value	1, 2 and 3) 40 CFR Part 50, App. L, Sec 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix A Sec 3.2.3 & 3.3.2
BAM Specific Critical Criteria			
Reference Membrane Span Foil Verification (BAM)	Hourly	+ 4% of ABS Value	1,2 and 3) BAM 1020 Operation Manual
OPERATIONAL CRITERIA - PM2.5 Continuous, Local Conditions			
Annual Multi-point Verifications/Calibrations			
Leak Check	every 30 days	**< 1.0 lpm BAM + 0.15 lpm TEOM**	1) 40 CFR Part 50 App L, Sec 7.4.6.1 2) Recommendation 3) BAM SOP Sec 10.1.2 TEOM SOP Sec 10.1.6
Temperature multi-point Verification/Calibration	on installation, then 1/365 days	+ 2oC	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.4
One-point Temp Verification	1/30 days	+ 2oC	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Table 6-1 3) Recommendation
Pressure Verification/Calibration	on installation, then 1/365 days	+ 10 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.5 BP verified against independent standard verified against a lab primary standard that is certified NIST traceable 1/365 days
Flow Rate Multi-point Verification/ Calibration	***Electromechanical maintenance or transport or*** 1/365 days	***+ 4% of transfer standard***	1) 40 CFR Part 50, App. L, Sec 9.2. 2) 40 CFR Part 50, App. L, Sec 9.1.3, Method 2.12 Table 6-1 3) 40 CFR Part 50, App. L, Sec 9.2.5

Table 7-7b. PM2.5 Measurement Quality Objectives. Parameter – PM2.5 (Continuous, Local Conditions) continued			
1) Criteria (PM2.5 Cont)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Design Flow Rate Adjustment	***at one-point or multi-point verification/calibration***	***± 2% of design flow rate***	1,2 and 3) 40 CFR Part 50, App. L, Sec 9.2.6
Other Monitor Calibrations	per manufacturers' op manual	per manufacturers' operating manual	
Precision			
Collocated Samples	***every 12 days for 15% of sites by method designation***	CV ≤ 10% of samples > 3 µg/m^3	1) and 2) Part 58 App A Sec 3.2.5 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.3
Accuracy			
Temperature Audit	1/365 days	± 2°C	1, 2 and 3) Method 2.12 Sec. 10.2.2 & Table 3-1
Pressure Audit	1/365 days	±10 mm Hg	1, 2 and 3) Method 2.12 Sec. 10.2.3 & Table 3-1
Semi Annual Flow Rate Audit	***1/182 days***	± 4% of audit standard ± 5% of design flow rate	1 and 2) Part 58, App A, Sec 3.3.3 3) Method 2.12 Sec. 10.2.1 & Table 10-1
Shelter Temperature			
Temperature range	**Daily** (hourly values)	28 to 32° C. (Hourly average) (BAM) or per manufacturers specifications (TEOM)	
Temperature Control	Daily (hourly values)	≤ ± 2° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Temperature Device Check	1/182 days	± 2° C	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Monitor Maintenance			
Virtual Impactor (VSCC/SCC)	Every 30 days	cleaned/changed	1,2 and 3) Recommendation
Inlet Cleaning	Every 30 days	cleaned	1,2 and 3) Method 2.12 Sec 9.3
Filter Chamber Cleaning	Every 30 days	cleaned	1,2 and 3) Method 2.12 Sec 9.3
Circulating Fan Filter Cleaning	1/30 days	cleaned/changed	1,2 and 3) Method 2.12 Sec 9.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
TEOM Specific Operational Criteria			
Total Flow Verification	every 30 days	Sum of flow rates from 3 paths equal design flow rate ± 5%	1,2 and 3) TEOM SOP Sec 10.1.2
Leak check (TEOM)	every 30 days	< 4 inches of Hg per 2 minutes and the flow readings are zero	1,2 and 3) DAQ TEOM SOP and TEOM Operating Manual Sec 5-4
Replace TEOM filters	every 30 days	As filter loading approached 60%	1 and 2) TEOM SOP Sec 10.1.8 3) DAQ practice
Replace the 47-mm FDMS (Purge) filters	every 30 days or any time TEOM filters are replaced	replaced	1,2 and 3) TEOM SOP Sec 10.1.10
Internal/External Data Logger Data	Every month 2 highest values on three	agree exactly (digital) and ± 1 µg/m^3 (analog)	1 and 3) TEOM SOP Sec 10.1.24 2) DAQ practice

Table 7-7b. PM2.5 Measurement Quality Objectives. Parameter – PM2.5 (Continuous, Local Conditions) continued			
1) Criteria (PM2.5 Cont)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
	randomly selected days		
Replace In-line filters	1/182 days	replaced	1, 2 and 3) TEOM SOP Sec 10.2
Clean cooler assembly	1/365 days	cleaned	1, 2 and 3) TEOM SOP Sec 10.3.1
Clean/Maintain switching valve	1/365 days	cleaned	1, 2 and 3) TEOM SOP Sec 10.3.2
Clean air inlet system of mass transducer enclosure	1/365 days	cleaned	1, 2 and 3) TEOM SOP Sec 10.3.3
Replace the dryers	1/365 days or due to poor performance	replaced	1, 2 and 3) TEOM SOP Sec 10.3.4
Calibration (KO) constant verification	1/365 days	Pass or Fail (≤ 2.5%)	1, 2 TEOM SOP Sec 10.3.6 3) 1405-DF operating guide. Verification software either passes or fails the verification. Acceptance criteria is ≤ 2.5 %
Rebuild sampling pump	Every 18 months	< 66% of local pressure	1, 2 and 3) TEOM SOP Sec 10.4
BAM Specific Operational Criteria			
Cleaning Nozzle and Vane (BAM)	Every 30 days	cleaned	1, 2 and 3) BAM SOP Sec 10.1.3
Replace or Clean pump Muffler	1/182 days	Cleaned or changed	
Internal/External Data Logger Data (BAM)	Every month 2 highest values on three randomly selected days	agree exactly (digital) and ± 1 µg/m^3 (analog)	1 and 3) BAM SOP Sec 10.1.9 2) DAQ practice
Capstan shaft and pinch roller cleaning (BAM)	Every 30 days	cleaned	1, 2 and 3) BAM SOP Sec 10.1.3
Smart Heater Test	1/182 days	Heater turns when forced off	1, 2 and 3) BAM SOP Sec 10.3.3
Clean/replace internal debris filter	1/365 days		
72-Hour zero filter test	At installation and 1/365 days		1, 2 and 3) BAM SOP Sec 9.6.10
Check of membrane span foil	1/365 days	Avg. < ± 5% of ABS	1, 2 and 3) BAM SOP Sec 10.4.3
Beta detector count rate	1/365 days	Between 600,00 and 1,000,000	1, 2 and 3) BAM SOP Sec 10.4.4
SYSTEMATIC CRITERIA- PM$_{2.5}$ Continuous, Local Conditions			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM/ARM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Data Completeness	quarterly	≥ 75%	Part 50, App. N, Sec. 4.1 (b) 4.2 (a)
Reporting Units	***all hourly and 24-hour values***	***µg/m^3 at ambient temp/pressure (PM$_{2.5}$)***	1. 2 and 3) 40 CFR Part 50 App N Sec 3.0 (b)

Table 7-7b. PM2.5 Measurement Quality Objectives. Parameter – PM2.5 (Continuous, Local Conditions) continued			
1) Criteria (PM2.5 Cont)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Rounding convention for data reported to AQS	***all 24-hour averages***	***to one decimal place, with additional digits to the right being truncated***	1. 2 and 3) 40 CFR Part 50 App N Sec 3.0 (b)

Table 7-8. PM_{10}-Pb Low Volume Filter-Based Local Conditions Measurement Quality Objectives

NOTE: The following validation template was constructed for PM_{10}-Pb at local conditions where PM_{10c} method in 40 CFR Part 50 Appendix O is referenced. Although the PM $_{10-2.5}$ method is found in 40 CFR Part 50 Appendix O, Appendix O also references Appendix L (the $PM_{2.5}$ Method) for the QC requirements listed below. Therefore, the information action column, in most cases, will reference 40 CFR Part 50 App L. In addition, since the PM10 samplers are very similar to the PM2.5 samplers, Guidance Document 2.12 *Monitoring PM2.5 in Ambient Air Using Designated Reference or Class 1 Equivalent Methods* is referred to where appropriate. DAQ uses XRF as the analytical FRM so quality control criteria are for the XRF method which is promulgated in 40 CFR Part 50 Appendix Q.

1) Criteria (PM_{10}-Pb Lo-Vol LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
CRITICAL CRITERIA-PM_{10}–Pb Low Volume Filter-Based Local Conditions			
Field Activities			
Filter Holding Times			
Pre-sampling	***all filters***	***< 30 days before sampling***	1,2 and 3) 40 CFR Part 50, App. L Sec 8.3.5 Required only if filters will be used for PM10c mass as well as Pb. If only used for Pb then 30 day pre-sampling holding time not required
Sample Recovery	***all filters***	***ASAP***	1, 2 and 3) 40 CFR part 50 App B sec 6.3 If filters are used for more than one purpose (i.e., Pb and PM10) the sample recovery is dictated by the most stringent requirement.
Sampling Period (including multiple power failures	***all filters***	***1440 minutes ±60 minutes midnight to midnight local standard time***	1,2 and 3) 40 CFR Part 50 App B sec 8.15 If filters are used for more than one purpose (i.e., Pb and PM10) the sample recovery is dictated by the most stringent requirement.
Sampling Instrument			
Average Flow Rate	***every 24 hours of operation***	***average within 5% of 16.67 liters/minute***	1, 2 and 3) Part 50 App L Sec 7.4.3.1
Variability in Flow Rate	***every 24 hours of operation***	***CV ≤ 2%***	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.2
One-point Flow Rate Verification	***1/30 days***	***± 4% of transfer standard*** ± 5% of flow rate design value	1) 40 CFR Part 50, App. L, Sec 9.2.5, 40 CFR Part 58, Appendix A Sec 3.2.3 & 3.3.2 2) Recommendation 3) 40 CFR Part 50, App. L, Sec 9.2.5 & 7.4.3.1

Laboratory Activities			
Filter Visual Defect Check (unexposed and exposed)	*all filters*	*Correct type & size and for pinholes, particles or imperfections*	1, 2 and 3) 40 CFR Part 50, App. L Sec 10.2
Pb blank filter Acceptance Testing	*~ 20 test filters per lot*	*90% of filters < 4.8 ng Pb/cm2*	1, 2 and 3) 40 CFR Part 50 App Q Sec 6.1.2

Table 7-8. PM_{10}-Pb Low Volume Filter-Based Local Conditions Measurement Quality Objectives continued

1) Criteria (PM_{10}-Pb)	2) Frequency	3) Acceptable Range	Information /Action
OPERATIONAL EVALUATIONS TABLE- PM_{10}-Pb Low Volume Filter Based Local Conditions			
Field Activities			
Sampling Instrument			
Individual Flow Rates	***every 24 hours of operation***	***no flow rate excursions > ±5% for > 5 min.*** 1/	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.1
Filter Temp Sensor	***every 24 hours of operation***	***no excursions of > 5° C lasting longer than 30 min*** 1/	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.11.4
Routine Verifications			
External Leak Check	1/30 days	***< 25 mm Hg*** (see comment #1)	1) 40 CFR Part 50 App L, Sec 7.4.6.1 2) Method 2-12 Table 8-1 3) 40 CFR Part 50, App. L, Sec 7.4.6.1
Internal Leak Check	when external leak check fails	***< 25 mm Hg***	1) 40 CFR Part 50, App. L, Sec 7.4.6.2 2) Method 2-12 Table 8-1 3) 40 CFR Part 50, App. L, Sec 7.4.6.2
One-point Temp Verification	1/30 days	± 2°C	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Table 6-1 3) Recommendation
Pressure Verification	1/30 days	± 10 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2) Method 2.12 Table 6-1 3) Recommendation
Annual Multi-point Verifications/Calibrations			
Temperature multi-point Verification/Calibration	on installation, then 1/365 days	± 2°C	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.4
Pressure Verification/Calibration	on installation, then 1/365 days	± 10 mm Hg	1) 40 CFR Part 50, App. L, Sec 9.3 2 and 3) Method 2.12 sec 6.5 Sampler BP verified against independent standard verified against a lab primary standard that is certified as NIST traceable 1/365 days
Flow Rate Multi-point Verification/ Calibration	***Electromechanical maintenance or transport or*** 1/365 days	***± 4% of transfer standard***	1) 40 CFR Part 50, App. L, Sec 9.2. 2) 40 CFR Part 50, App. L, Sec 9.1.3, Method 2.12 Table 6-1 3) 40 CFR Part 50, App. L, Sec 9.2.5

Table 7-8. PM_{10}-Pb Low Volume Filter-Based Local Conditions Measurement Quality Objectives continued

1) Criteria (PM_{10}-Pb)	2) Frequency	3) Acceptable Range	Information /Action
Design Flow Rate Adjustment	***at one-point or multi-point verification/calibration***	***± 2% of design flow rate***	1,2 and 3) 40 CFR Part 50, App. L, Sec 9.2.6
Other Monitor Calibrations	per manufacturers' operating manual	per manufacturers' operating manual	1,2 and 3) Recommendation
Precision			
Collocated Samples	***every 12 days for 15% of NCore sites by method designation***	CV ≤ 20% of samples > 0.02 µg/m3 (cutoff value)	1 and 2) 40 CFR Part 58 App A sec 3.3.4.3 3) Recommendation for early evaluation of DQOs
Accuracy			
Temperature Audit	1/365 days	± 2°C	1, 2 and 3) Method 2.12 Sec. 10.2.2 & Table 3-1
Pressure Audit	1/365 days	±10 mm Hg	1, 2 and 3) Method 2.12 Sec. 10.2.3 & Table 3-1
Semi Annual Flow Rate Audit	***1/182 days***	± 4% of audit standard ± 5% of design flow rate	1 and 2) Part 58 App A, Sec 3.3.3 3) Method 2.12 Sec. 10.2.1 & Table 10-1
Monitor Maintenance			
Inlet/downtube Cleaning	every 15 sampling events	cleaned	1,2 and 3) Method 2.12 Sec 9.3 & 9.4.1
Filter Chamber Cleaning	1/30 days	cleaned	1, 2 and 3) Method 2.12 Sec 9.3
Circulating Fan Filter Cleaning	1/30 days	cleaned/changed	1, 2 and 3) Method 2.12 Sec 9.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
Laboratory Activities (XRF Analysis)			
Analysis Audits	***6 filters/quarter 3 at each concentration range***	10% (percent difference)	1 and 2) 40 CFR Part 58, App A, sec 3.3.4.2 3) Recommendation
Field Filter Blank	1/quarter	< 0.01 µg/m3	1) 40 CFR Part 50 App Q sec 6.1.2.1 2 and 3) Recommendation
Lab Filter Blank	1/ sample run	<.003 µg/m3	1 40 CFR part 50 App Q sec 6.1.2.1 2 and 3) Recommendation
Thin Film Standards (standard reference materials)	Beginning and end of each analytical run	XRF conc. + 3x the 1 sigma uncertainty overlaps the NIST certified conc. + 1x its reported uncertainty.	1) 40 CFR Part 50 App Q sec 6.2.3 2 and 3) recommendation
Run time quality control standards Checking peak areas, background areas, centroid and FWHM	Beginning and end of each analytical run	Target value + 3 SD	1,2, and 3) Recommendation Target values and SD of QC samples established prior to analysis.
XRF analyzer calibration	***1/365 days or when significant repairs*** or changes occur or QC limits exceeded	XRF conc. + 3x the 1 sigma uncertainty overlaps the NIST certified conc. + 1x its reported uncertainty.	1 and 2) 40 CFR Part 50 App Q sec 6.2.4 3) Recommendation
Background Measurement and Correction	***20 clean blank filters for each filter lot used***	NA	1 and 2) 40 CFR Part 50 App Q sec 6.2.4.2

Table 7-8. PM_{10}-Pb Low Volume Filter-Based Local Conditions Measurement Quality Objectives continued

1) Criteria (PM_{10}-Pb)	2) Frequency	3) Acceptable Range	Information /Action
Calibration & Check Standards -			
Working Mass Standards. (compare to primary standards)	1/91 days	0.025 mg	1, 2 and 3) Method 2.12 Sec 4.3 and 7.3
SYSTEMATIC CRITERIA -PM_{10}-Pb Filter-Based Local Conditions			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Data Completeness	***3-year standard***	***average of the 3 constituent monthly means > 75%***	1, 2 and 3) 40 CFR Part 50 App. R, sec. 4. In addition there are substitution tests that can be used for data not meeting completeness criteria.
Reporting Units	***all filters***	***µg/m3 at local temperature and pressure***	1,2 and 3) 40 CFR Part 50 App R sec 3 (b)
Rounding convention for data reported to AQS (3-monthmean)	***quarterly***	***Report data to 3 decimal places (data after 3 are truncated.***	1,2 and 3) 40 CFR Part 50 App R sec 3 (b)
Detection Limit			
Lower DL	***all filters***	***<0.001 µg/m3***	1,2 and 3) 40 CFR Part 50 App Q Sec 2.2
Upper Conc. Limit	***all filters***	***≥200 µg/m³***	1,2 and 3) 40 CFR Part 50, App. Q Sec 3.1
Precision			
Single analyzer	1/91 days	Coefficient of variation (CV) ≤ 20% for values > 0.02 µg/m³	1 and 2) 40 CFR Part 58 App A sec 3.3.4.3 3) Recommendation related to DQO
Primary Quality Assurance Org.	***Annual and 3 year estimates***	***90% CL of CV ≤ 20% for values > 0.02 µg/m³***	1, 2 and 3) 40 CFR Part 58 App A sec 3.3.4.3 and sec 2.3.1.4
Bias			
Performance Evaluation Program (PEP)	***8 audits per year for NCore network***	***95% CL Absolute bias +15% > 0.02 µg/m3***	1, 2 and 3) 40 CFR Part 58 App A sec 3.3.4.4 and sec 2.3.1.4 The PEP includes 1 or 2 independent collocated audits and 4 or 6 samples from the monitoring organizations collocated monitor sent to the independent National PEP Laboratory.
Field Activities			
Verification/Calibration Standards Re-certifications – All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	**1/365 days**	***± 2% of NIST-traceable Std.***	1) 40 CFR Part 50, App. L Sec 9.1 & 9.2 2) Method 2-12 Section 6.3.3 and Table 3-1 3) 40 CFR Part 50, App. L Sec 9.1 & 9.2

Table 7-8. PM_{10}-Pb Low Volume Filter-Based Local Conditions Measurement Quality Objectives continued

1) Criteria (PM_{10}-Pb)	2) Frequency	3) Acceptable Range	Information /Action
Field Thermometer	1/365 days	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2 & Table 3-1
Field Barometer	1/365 days	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1, 2 and 3) Method 2.12 Sec 4.2.2 & Table 3-1
Verification/Calibration Clock/timer Verification	1/30 days	***1 minute/month***	1 and 2) Method 2.12 Table 3-1 3) 40 CFR Part 50, App. L, Sec 7.4.12
Comment #1 The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.			
1/ value must be flagged , SD= standard deviation, CV= coefficient of variation			

Table 7-9. PM2.5 Measurement Quality Objectives. Parameter – PM2.5 Speciation (Gravimetric, Filter Based, Local Conditions)			
1) Criteria (PM2.5 Spec LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
CRITICAL CRITERIA-PM$_{2.5}$ Speciation Filter Based Local Conditions			
Field Activities			
Filter Holding Times			
Pre-sampling	***PTFE filters only***	***≤ 30 days before sampling***	1,2 and 3) EPA Quality Assurance Guidance Document Table 6-4
Sample Recovery	***all filters***	***retrieve and ship within 48 hours of sample completion or 110 hours for samples collected on Thursday and Friday.***	1, 2 and 3) EPA Quality Assurance Guidance Document Table 6-4
Nitric acid denuder (magnesium oxide)	***Met One SASS sampler ion sampling module***	***Replace each denuder after 3 months use***.	1, 2 and 3) EPA Quality Assurance Guidance Document Table 6-4
Sampling Period (including multiple power failures)	***all filters***	***1380-1500 minutes midnight to midnight local standard time***	1, 2 and 3) EPA Quality Assurance Guidance Document Table 11-2
Sampling Instrument			
Average Flow Rate	***every 24 hours of op***	***average within 10% of 6.7 liters/minute for Met One Super SASS and 22.0 liters/minute for URG***	1, 2 and 3) EPA Quality Assurance Guidance Document Table 22-6
Variability in Flow Rate	***every 24 hours of op***	***CV ≤ 4%***	1, 2 and 3) EPA Quality Assurance Guidance Document Section 24.2.1
One-point Flow Rate Verification	***1/30 days***	***± 10 % of transfer standard*** ± 10 % of flow rate design value	1, 2 and 3) EPA Quality Assurance Guidance Document Table 11-2
Laboratory Activities			
Post-sampling Weighing and Analysis	***PTFE filters*** ***Quartz and nylon filters***	***Reweigh ≤ 10 business days from sample receipt*** ***Analyze ≤20 business days from sample receipt***	1, 2 and 3) EPA Quality Assurance Guidance Document Table 6-4
Filter Visual Defect Check (unexposed)	***all filters***	***Correct type & size and for pinholes, particles or imperfections***	1, 2 and 3) EPA Quality Assurance Guidance Document Table 14-1
OPERATIONAL EVALUATIONS TABLE PM$_{2.5}$ Speciation Filter-Based Local Conditions			
Field Activities			
Sampling Instrument			
Individual Flow Rates	***every 24 hours of operation***	***no flow rate excursions > ±5% for > 5 min.*** [1/]	1, 2 and 3) 40 CFR Part 50, App. L Sec 7.4.3.1
Filter Temperature Sensor	***every 24 hours of operation***	***For Met One, no excursions of > 5°C lasting longer than 30 min*** [1/]	1, 2 and 3) EPA Quality Assurance Guidance Document Table 11-2
Routine Verifications			
External Leak Check	1/30 days	Met One: ≤ 0.1 L/min URG < 0.55 L/min	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1

Table 7-9. PM2.5 Speciation Measurement Quality Objectives. Parameter – PM2.5 (Speciation, Filter Based, Local Conditions) continued

1) Criteria (PM2.5 Speciation LC)	2) Frequency	3) Acceptable Range	Information /Action
Internal Leak Check	If external leak check fails	Met One: ≤ 0.1 L/min URG < 0.55 L/min	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
One-point Temp Verification	1/30 days	± 2°C	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Pressure Verification	1/30 days	± 10 mm Hg	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Annual Multi-point Verifications/Calibrations			
Temperature multi-point Verification/Calibration	on installation, then 1/365 days or if verification/audit indicates drift or failure	± 2°C	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Pressure Verification/Calibration	on installation, then 1/365 days or if verification/audit indicates drift or failure	± 10 mm Hg	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Flow Rate Multi-point Verification/ Calibration	***Electromechanical maintenance or transport or 1/365 days or if verification/audit indicates drift or failure***	***± 2 % of transfer standard at each flow rate***	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Design Flow Rate Adjustment	***at one-point or multi-point verification/calibration***	***± 2 % of design flow rate***	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Other Monitor Calibrations	per manufacturers' operating manual	per manufacturers' operating manual	1,2 and 3) Recommendation
Precision			
Collocated Samples	***every 12 days for 15 % of sites in the chemical speciation network***	CV ≤ 10 % of samples > 3 µg/m^3	1) and 2) Part 58 App A Sec 3.2.5 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.[1]
Accuracy			
External Leak Check	1/182 days, if failed, 1/91 days until passes twice	Met One: ≤ 0.1 L/min URG < 0.55 L/min	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Internal Leak Check	If external leak check fails	Met One: ≤ 0.1 L/min URG < 0.55 L/min	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Temperature Audit	1/182 days, if failed, 1/91 days until passes twice	± 2°C	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Pressure Audit	1/182 days, if failed, 1/91 days until passes twice	±10 mm Hg	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Semi Annual Flow Rate Audit	***1/182 days, if failed, 1/91 days until passes twice***	± 10 % of audit standard ± 10 % of design flow rate	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Monitor Maintenance			

Table 7-9. PM2.5 Speciation Measurement Quality Objectives. Parameter – PM2.5 (Speciation, Filter Based, Local Conditions) continued			
1) Criteria (PM2.5 Speciation LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Cyclone and manifold cleaning	every 30 days	cleaned/changed	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Inlet/downtube Cleaning	every 15 sampling events	cleaned	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Filter Chamber Cleaning	1/30 days	cleaned	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Circulating Fan Filter Cleaning	1/30 days	cleaned/changed	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
Laboratory Activities			
Filter Checks			
Filter Integrity (exposed)	each filter	no visual defects	1, 2 and 3) EPA Quality Assurance Guidance Document Table 14-1
Lab QC Checks			
Field Filter Blank			
Met One Mass, elements & ions	3% or one set every 10 sampling days	30 µg mass per filter; other limits apply to chemical species concentrations (refer to lab QAPP)	1, 2 and 3) EPA Quality Assurance Guidance Document Table 14-1
Carbon (URG 3000 N)	10% 10% backup filters	6.0 µg/filter (g)	1, 2 and 3) EPA Quality Assurance Guidance Document Table 14-1
Trip Filter Blank	2% for Carbon (URG)	< 5.64 µg	1, 2 and 3) EPA Quality Assurance Guidance Document Table 14-1
SYSTEMATIC CRITERIA -PM2.5 Filter Based Local Conditions			
Sampler/Monitor	NA	***Meets requirements in EPA Quality Assurance Guidance Document***	1, 2 and 3) EPA Quality Assurance Guidance Document Section 5.3
Siting	1/365 days	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Data Completeness	***Annual***	***≥ 75 % scheduled sampling days in each year***	1, 2 and 3) EPA Quality Assurance Guidance Document 14.4.4
	Quarterly	***≥ 75 % scheduled sampling days in each quarter***	1, 2 and 3) EPA Quality Assurance Guidance Document 14.4.4
Reporting Units	***all filters***	***µg/m³ at ambient temp/pressure (PM2.5)***	1. 2 and 3) 40 CFR Part 50 App N Sec 3.0 (b)
Precision			

Table 7-9. PM2.5 Speciation Measurement Quality Objectives. Parameter – PM2.5 (Speciation, Filter Based, Local Conditions) continued			
1) Criteria (PM2.5 Speciation LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Single analyzer (collocated monitors)	4% of Chemical Speciation Network, sampling on a 1-in-6-day basis	Total Carbon 15 % Sulfate ion 10 % Nitrate ions 10 % Trace elements 20 %	1, 2 and 3) EPA Quality Assurance Guidance Document Table 14-1
Bias			
Performance Evaluation Program (PEP)	***8 audits for NCore Network***	***±10% for values > 3 µg/m³***	1,2 and 3) 40 CFR Part 58, App A, Sec 3.2.7, 4.3.2 and 2.3.1.1
Field Activities			
Verification/Calibration Standards Re-certifications – All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	1/365 days	***± 2% of NIST Traceable Std.***	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Field Thermometer	1/365 days	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Field Barometer	1/365 days	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Clock/timer Verification	1/30 days	***1 minute/month***	1, 2 and 3) EPA Quality Assurance Guidance Document Table 16-1
Comment #1 The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.			
1/ value must be flagged SD * = standard deviation CV= coefficient of variation The EPA Quality Assurance Guidance Document for speciation measurements is available at http://www.epa.gov/ttn/amtic/files/ambient/pm25/spec/CSN_QAPP_v120_05-2012.pdf.			

Table 7-10. Ambient Temperature Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Ambient Temperature (AT) (Thermistor)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-AT			
Accuracy	At purchase Every 182 days	± 0.5°C	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C
Time Constant	At purchase	≤ 1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C
Operating Range	At purchase	-30 – 50	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Resolution	At purchase	0.1	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/182 days	3 pt. Water Bath with NIST traceable thermistor or thermometer. All points within ± 0.5 ºC of standard.	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final) Table 0-4 NCore Calibration & Accuracy Criteria
OPERATIONAL CRITERIA-AT			
Calibration and audit standards	Purchase, recertify 1/365 days or per NIST/ASTM certification frequency	Thermistor with measurement range -50°C to + 40°C; Accuracy ≤±0.2°C NIST traceable certified over -30°C to +30°C; and Resolution ≤±0.1°C	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final) Table 0-4 NCore Calibration & Accuracy Criteria
Annual Accuracy Evaluation	Every site 1/365 days	3 pt. Water Bath with NIST traceable thermistor or thermometer. All points within ± 0.5 ºC of standard.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Minimum Sample Frequency	Every site Every work day	Hourly	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Raw Data Collection Frequency	Every site Every work day	1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Hourly Recorded Ambient Temperature	1/30 days	Local record low ≤ Temp ≤ local record high; Temp ≤ 5°C from previous hourly record; Temp varies ≥ 0.5°C/12 consecutive hours, or per site specific climatology criteria	1, 2 and 3) EPA -454/R-99-005 Feb 2000, Chapter 8,Table 8-4
Appropriate radiation shield	1/182 days	Free from dirt, no surface damage	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver.

Table 7-10. Ambient Temperature Measurement Quality Objectives. Measurement Quality Objectives Parameter – Ambient Temperature (AT) (Thermistor)			
1) Requirement (AT)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
			2.0 (Final)
DAS Clock/timer Verification	1/7 days (or every site visit if site visited less than weekly)	< ± 1 minute NIST EST.	1, 2 and 3) Recommendation
Data Acquisition System (internal battery back-up)	1/182 days	Check Battery Back-up, Replace as needed	1, 2 and 3) Recommendation
SYSTEMATIC CRITERIA-AT			
Sensor/Monitor	At purchase/installation	Meets requirements listed in QA Handbook	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Standard Reporting Units	All data	ºC (final units in AQS)	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Rounding convention for data reported to AQS	All data	1 decimal place	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Completeness	Quarterly Hourly	75 % of hourly averages for the quarter 75 % of minute averages for the hour	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Siting	1/365 days	Meets siting criteria or waiver documented	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
Distance from Obstruction	At installation/moving 1/365 days	1.5x the tower diameter from tower support & at least 4x height from ground (i.e., 8 m for a sensor located at 2 m above ground) from trees & buildings	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Distance Above Ground	At installation/moving 1/365 days	1.25 to 2 meters	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Recommended Ground Cover	At installation/moving 1/365 days	Non-irrigated or un-watered short grass, or natural earth at least 9 m in diameter. The surface should not be concrete, asphalt or oil-soaked. Reflection from these surfaces may affect sensor performance.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Technical Systems Audit	1/3 years	Data meets acceptance criteria in validation table	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 10 & Appendix A

Table 7-12. NCore Wind Speed Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Speed (WS) (Cup, prop or sonic anemometer)

1) Requirement (WS)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-WS			
Accuracy	At purchase 1/182 days	± 0.2 m/s	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C
Starting Threshold	At purchase 1/182 days	≤ 0.5 meters per second	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final)
Operating Range	At purchase	0.5 – 50.0 meters per second	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Resolution	At purchase	0.1 meters per second	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/182 days	NIST-traceable Synchronous Motor, CTS method. Zero plus 4 to 5 evenly spaced points between 0.5 and 50 m/s. ±0.25m/s ≤5m/s; 5 %>2m/s not to exceed 2.5m/s.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
OPERATIONAL CRITERIA-WS			
Calibration and audit standards	Purchase, recalibrate 1/365 days or at frequency dependent upon use	NIST Traceable Synchronous motor, or Series of NIST Traceable constant speed motors to generate WS in range of 2 m/s thru 50 m/s	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Annual Accuracy / Performance Evaluation	Every site 1/365 days	NIST-traceable Synchronous Motor. At least 4 to 5 points between 0.5 and 50 m/s. ±0.25 m/s ≤ 5m/s; 5 % > 2m/s not to exceed 2.5 m/s.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Minimum Sample Frequency	Every site Every day	Hourly	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Raw Data Collection Frequency	Every site Every day	1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Hourly Recorded WS	Every workday 1/30 days	0 m/s ≥ WS ≤ 25 m/s0, WS varies ≥ 0.1 m/s/3 consecutive hours, WS varies ≥ 0.5 m/s/12 consecutive hours, or	1, 2 and 3) EPA -454/R-99-005 Feb 2000, Chapter 8,Table 8-4

Table 7-12. NCore Wind Speed Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Speed (WS) (Cup, prop or sonic anemometer)

1) Requirement (WS)	2) Frequency	3) Acceptance Criteria	Information /Action
		per site specific climatology criteria	
Preventative maintenance	1/182 days	Follow manufacturer's instructions; replace sensor bearings	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Routine maintenance	1/182 days	Application of cleaning and protective lubricants to mounting hardware	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Visual Inspection	1/7 days (or every site visit if site visited less than weekly)	Moving freely, no visual damage	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.1
DAS Clock/timer Verification	1/7 days (or every site visit if site visited less than weekly)	< ± 1 minute NIST EST	1, 2 and 3) Recommendation
Data Acquisition System (internal battery back-up)	1/182 days	Check Battery Back-up, Replace as needed	1, 2 and 3) Recommendation
SYSTEMATIC CRITERIA-WS			
Sensor/Monitor	At purchase/installation	Meets requirements listed in QA Handbook	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Standard Reporting Units	All data	Meters per second (final units in AQS)	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Rounding convention for data reported to AQS	All data	1 decimal place	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Completeness	Quarterly Hourly	75 % of hourly averages for the quarter 75 % of minute averages for the hour	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Siting	1/365 days	Meets siting criteria or waiver documented	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
Distance from Obstruction	At installation/moving 1/365 days	10x the height of the obstruction	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Distance Above Ground	At installation/moving 1/365 days	10 meters	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological

Table 7-12. NCore Wind Speed Measurement Quality Objectives. Measurement Quality Objectives Parameter – NCore Wind Speed (WS) (Cup, prop or sonic anemometer)			
1) Requirement (WS)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
			Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Recommended Ground Cover	At installation/moving 1/365 days	Grass or gravel	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Technical Systems Audit	1/3 years	Data meets acceptance criteria in validation table	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 10 & Appendix A

Table 7-13. NCore Wind Direction Measurement Quality Objectives. Measurement Quality Objectives Parameter – NCore Wind Direction (WD) (Vane or sonic anemometer)			
1) Requirement (WD)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
CRITICAL CRITERIA-WD			
Data Validity	Every 182 days	Data set bracketed between two valid calibration checks, “as-left” and “as-found”, readings should be the same within ±2 degrees	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.5.2.5
Orientation	1/182 days	True north location must be determined accurate to <1 degree, and wind vane “reference position” must be fixed to true north accurate to <2 degrees	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.5.2.1
Starting Threshold	1/182 days	≤ 0.5 meters per second at 10 degrees	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final)
Operating Range	At purchase	0 – 360 (or 540) degrees	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Resolution	At purchase	1.0 degrees	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/182 days	Solar Noon, GPS, Magnetic Compass, CTS method. Points every 45 º between 0 and 360 (540) º. ±5 degrees; includes orientation error.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
OPERATIONAL CRITERIA-WD			
Calibration and audit standards	Purchase, recalibrate 1/365 days or at frequency dependent upon use	**Alignment to True North:** Solar Noon method, and or Transit & Compass, map, and site magnetic declination, or GPS accuracy ≤3 meters with lock on minimum 3 satellite signals **Linearity:** Linearity wheel with evenly spaced preset markings, e.g., 0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°, 360°	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Annual Accuracy Evaluation	Every site 1/365 days	Solar Noon, GPS, or Magnetic Compass. At least 4 to 5 between 0 and 360 (540) degrees. ±5 degrees; includes orientation error.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Minimum Sample Frequency	Every site Every work day	Hourly	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore

Table 7-13. NCore Wind Direction Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Direction (WD) (Vane or sonic anemometer)

1) Requirement (WD)	2) Frequency	3) Acceptance Criteria	Information /Action
			Meteorological Measurement Quality Objectives
Raw Data Collection Frequency	Every site Every work day	1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Hourly Recorded WD	Every workday 1/30 days	0°≥ WD ≤ 360°, WD varies ≥ 1°/3 consecutive hours, or per site specific climatology criteria	1, 2 and 3) EPA -454/R-99-005 Feb 2000, Chapter 8,Table 8-4
Preventative maintenance	1/182 days	Follow manufacturer's instructions; replace sensor bearings	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Routine maintenance	1/182 days	Application of cleaning and protective lubricants to mounting hardware	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Visual Inspection	1/7 days (or every site visit if site visited less than weekly)	Moving freely, no visual damage	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.1
DAS Clock/timer Verification	1/7 days (or every site visit if site visited less than weekly)	< ± 1 minute NIST EST	1, 2 and 3) Recommendation
Data Acquisition System (internal battery back-up)	1/182 days	Check Battery Back-up, Replace as needed	1, 2 and 3) Recommendation
SYSTEMATIC CRITERIA-WD			
Sensor/Monitor	At purchase/installation	Meets requirements listed in QA Handbook	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Standard Reporting Units	All data	Degrees (final units in AQS)	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Rounding convention for data reported to AQS	All data	1 decimal place	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Completeness	Quarterly Hourly	75 % of hourly averages for the quarter 75 % of minute averages for the hour	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Siting	1/365 days	Meets siting criteria or waiver documented	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6

Table 7-13. NCore Wind Direction Measurement Quality Objectives.

Measurement Quality Objectives Parameter – NCore Wind Direction (WD) (Vane or sonic anemometer)

1) Requirement (WD)	2) Frequency	3) Acceptance Criteria	Information /Action
Distance from Obstruction	At installation/moving 1/365 days	10x the height of the obstruction	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Distance Above Ground	At installation/moving 1/365 days	10 meters	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Recommended Ground Cover	At installation/moving 1/365 days	Grass or gravel	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Technical Systems Audit	1/3 years	Data meets acceptance criteria in validation table	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 10 & Appendix A

- All data shall be comparable. This means all data shall be produced in a similar and scientific manner. The use of the standard methodologies for sampling, calibration, auditing, etc. referenced in the QAPP should achieve this goal.
- All data shall be representative of the parameters being measured with respect to time, location, and the conditions from which the data are obtained. The use of approved standard methodologies should ensure that the data generated are representative.
- The QAPP must be dynamic to continue to achieve its stated goals as techniques, systems, concepts, and project goals change.

7.2.2. Specific Data Quality Objectives (NAAQS)

The purposes of ambient pollutant monitoring in North Carolina are to:

- Determine whether or not the primary and secondary 24-hour NAAQS for particulate matter (measured as PM_{10}) of 150 micrograms per cubic meter ($\mu g/m^3$) are exceeded.
- Determine whether or not the primary and secondary 24-hour NAAQS for particulate matter (measured as $PM_{2.5}$) of 35 $\mu g/m^3$ (98^{th} percentile 24-hour average averaged over 3 years) are exceeded.
- Determine whether or not the primary and secondary NAAQS for particulate matter (measured as $PM_{2.5}$) of 12 and 15 $\mu g/m^3$ (annual arithmetic mean, averaged over 3 years) are exceeded.
- Determine whether or not the 8-hour average NAAQS for CO of 9 parts per million (ppm) is exceeded.
- Determine whether or not the hourly average NAAQS for CO of 35 ppm is exceeded.
- Determine whether or not the 8-hour average NAAQS for O_3 of 0.070 ppm (annual 4^{th} highest daily maximum 8-hour concentration, averaged over 3 years) is exceeded.
- Determine whether or not the daily maximum hourly average NAAQS for SO_2 of 75 parts per billion (ppb) (99^{th} percentile of 1-hour daily maximum concentration, averaged over 3 years) is exceeded.
- Determine whether or not the 3-hour average NAAQS for SO_2 of 0.5 ppm (maximum 3-hour average for the year) is exceeded.
- Determine whether or not the daily maximum hourly average NAAQS for NO_2 of 100 ppb (98^{th} percentile of 1-hour daily maximum concentrations averaged over 3 years) is exceeded.
- Determine whether or not the annual average (annual arithmetic mean) NAAQS for NO_2 of 0.053 ppm is exceeded.

7.3. Network Scale

Representativeness is defined as a measure of the degree to which data accurately and precisely represent a selected characteristic of a monitored system. Support in achieving representativeness is provided through adhering to the requirements provided in:

- 40 CFR Part 58, Appendix D (Network Design Criteria for Ambient Air Quality Monitoring); and
- 40 CFR Part 58, Appendix E (Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring).

Each monitor operated is assigned a scale of representativeness based on the definitions of 40 CFR Part 58, Appendix D.

- ***Micro Scale -*** describes air volumes associated with area dimensions ranging from several meters up to about 100 meters (m).
- ***Middle Scale -*** describes air volumes associated with area dimensions up to several city blocks in size with dimensions ranging from about 100 m to 500 m (0.5 kilometer [km]).
- ***Neighborhood Scale -*** describes air volumes associated with an area of a city that has relatively uniform land use with dimensions in the 500 m to 4,000 m (0.5 to 4.0 km) range.
- ***Urban Scale -*** describes air volumes within cities with dimensions on the order of 4,000 m to 50,000 m (4.0 km to 50 km). This scale would usually require more than one site for definition.
- ***Regional Scale -*** describes air volumes associated with rural areas of reasonably homogeneous geography that extends for tens to hundreds of kilometers.

8.0 TRAINING REQUIREMENTS

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. Training is aimed at increasing the effectiveness of employees and their organization. As part of a QA program, 40 CFR Part 58, Appendix A requires the development of operational procedures for training. These procedures should include information on:

- Personnel qualifications – general and position-specific
- Training requirements – by position
- Training frequency

Air monitoring personnel training consists of required reading prior to implementing the requirements of this QAPP. Documents required to be read shall include this QAPP, and the operational procedures specific to the equipment personnel will be working with or servicing. Required reading shall be documented on a form indicating that the person has read and understood the QAPP or SOP or in the NC Learning Management System for DAQ employees. For DAQ employees reading of the QAPPs and SOPs are also documented in the employee Value in Performance, VIP, performance management system. Training for each WNC employee is recorded annually as part of the annual performance evaluation WNC submits for the air planning agreement. This training record is kept for each employee and stored on the WNC server. Each Duke Energy technician has to be trained on each procedure. Duke Energy has an in house system that documents and tracks all training.

All employees are actively encouraged to pursue training opportunities whenever possible and as needed. Because DAQ's ambient air monitoring network is continually undergoing evaluation and modification, new equipment, procedures, and personnel are added periodically. DAQ provides vendor based training for its personnel when new equipment is obtained. Additionally, personnel are encouraged to periodically identify, request, and attend pertinent courses and seminars. These courses and seminars may be provided as videotapes, closed circuit transmission, web based real-time interactive formats, and/or live instruction. Organizations that provide these training opportunities include local and regional universities, the Air and Waste Management Association, the Mid Atlantic Regional Air Management Association, and EPA. This training is tracked for each individual in the NC Learning Management System. Air monitoring personnel have sufficient training to currently perform necessary functions at an acceptable level. This training is tracked and documented in both the Learning Management System and VIP.

Monitoring staff provides new monitoring personnel and local station operators the necessary on the job training for their individual monitoring tasks.

DEQ - DAQ Training Links:

Training Syllabus:	http://DAQ.state.nc.us/employee/training/
Air Monitoring:	http://www.epa.gov/ttn/amtic/training.html
Professional Skills:	http://oshr.nc.gov/state-employee-resources/training

9.0 DOCUMENTATION AND RECORDS

The following information describes DAQ's document and records procedures for the criteria pollutant and NCore ambient air quality monitoring program. The documents and records pertaining to all data required to be collected and all other data deemed important by its policies and records management procedures, including documents and records required to support the concentration data reported to EPA, are listed in Table 9-1.

Table 9-1. Reporting Package Information

Categories	Record/Document Type	File Locations
Management and Organization	State Implementation Plan Reporting Agency Information Organizational Structure Personnel Qualifications and Training Training Certification Quality Management Plan EPA Directives Grant Allocations Support Contracts	Raleigh, NC – Central Office
Site Information	Network Descriptions Site Files Site Maps Site Pictures	Raleigh, NC – Central Office and Regional Offices
Environmental Data Operations	Quality Assurance Project Plans Standard Operating Procedures Field and Laboratory Notebooks Sample Handling/Custody Records Inspection/Maintenance Records	Raleigh, NC – Central Office and Regional Offices
Raw Data	Any Original Data (routine and quality control) Including Data Entry Forms	Raleigh, NC – Central Office
Data Reporting	Air Quality Index Reports Annual SLAMS Report Data/Summary Reports Journals/Articles/Papers/Presentations	Raleigh, NC – Central Office
Data Management	Data Algorithms Data Management Plans/Flowcharts Data Management Systems Pollutant Data Meteorological Data	Raleigh, NC – Central Office

Table 9-1. Reporting Package Information

Categories	Record/Document Type	File Locations
Quality Assurance	Network Reviews Control Charts Data Quality Assessments Quality Assurance Reports Technical System Audits Response/Corrective Action Reports Site Audits	Raleigh, NC – Central Office and Regional Offices

9.1. Information Included in the Reporting Package

9.1.1. Routine Data Activities

DAQ maintains records in appropriate files that allow for the efficient archival and retrieval of records. Ambient air quality information is included in this system. Table 9-1 includes the documents and records that are filed according to the statute of limitations discussed in Section 9.3.

9.1.2. Quarterly Data Submittal to EPA

DAQ shall submit quarterly data, as specified in 40 CFR Part 58, to EPA, either directly via AQS data entry or through the Region 4 office. These data shall be submitted no later than 90 days following the close of each calendar quarter, as specified in 40 CFR Section 58.16, and shall be certified accurate, to the best of his/her knowledge, by DAQ’s Ambient Monitoring Section chief. The quarterly data submittal shall contain the following summary data:

- the city name (if applicable), county name, site location street address of each criteria pollutant and NCore monitoring station;
- the measurement scale associated with the parameter occurrence code (POC);
- the AQS site code, monitoring method code, and POC;
- the results of all valid precision, bias, and accuracy tests performed during the quarter;
- all ambient air quality data obtained on SO_2, NO_x, NO, NO_y, CO, O_3, Pb, $PM_{10,}$ $PM_{2.5;}$ $PM_{10-2.5,}$ speciated $PM_{2.5,}$ wind speed, wind direction, ambient air temperature, relative humidity and any other information specified by the *AQS User Guide*, and *AQS Data Coding Manual*, and
- the location, date, pollution source, and duration of incidents of ambient level exceedances.

9.1.3. Annual Summary Reports Submitted to EPA

DAQ shall submit to the EPA an annual summary report of all the ambient air quality monitoring data from all criteria pollutant and NCore monitoring stations designated as SLAMS and from all FRM, FEM, and approved regional method (ARM) SPM stations that meet criteria in appendix A, in accordance with 40 CFR Section 58.15. The report will be submitted by May 1 of each year for the data collected from January 1 through December 31 of the previous year. DAQ's Ambient Monitoring Section chief, or designee, must certify the report to be accurate to the best of his/her knowledge. This certification will be based on the various assessments and reports performed by the organization, in particular, the annual QA report discussed in Section 21 that documents the quality of the ambient air quality data and the effectiveness of the quality system. The report will contain the following information:

- the city name (if applicable), county name, site location street address, and measurement scale of each criteria pollutant and NCore monitoring station;
- the AQS site code, monitoring method code, and POC;
- a list, by pollutant, of all criteria pollutant and NCore monitoring sites in the reporting organization;
- the information specified in 40 CFR Part 58, Appendix F (air quality index data); and
- the location, date, pollution source, and duration of each incident of air pollution during which ambient levels of a pollutant reached or exceeded the level specified by 40 CFR Section 51.16(a) as a level which could cause significant harm to the health of persons.

9.2. Data Reporting Package Format and Documentation Control

Table 9-1 lists the documents and records that must be included in 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 calculations, the submissions to the AQS database, and quality assurance/quality control (QA/QC) data shall be collected electronically or on data forms that are included in the field and analytical methods, see Section 11. **All hardcopy information shall be filled out in indelible ink. Corrections shall be made by inserting one line through the incorrect entry, initialing and dating this correction, and placing the correct entry alongside the incorrect entry, if this can be accomplished legibly, or by providing the information on a new line if the above is not possible.**

9.2.1. Logbooks

Each field and laboratory technician will be responsible for obtaining appropriate logbooks. Each monitor type (SO2, CO, PM, Etc.) has an electronic logbook (e-log) that has been created for that specific monitor type. After each use, these e-logs are uniquely numbered by being given a specific file name before saving to a storage device such as a laptop computer. The e-logs will be used to record information about the site and laboratory operations, as well as document routine operations.

Completion of data entry forms, associated with all routine environmental data operations, are required even when the field logbooks contain all appropriate and associated information required for the routine operation being performed.

- ***Field Logbooks*** – A combination of bound paper and/or e-logs will be used for record keeping for each sampling site, sampling instrument, specific program, or individual. Each notebook should be hardbound and paginated. Appropriate data entry forms may be used instead of logbooks; however, these forms are not required for routine operations, inspection and maintenance operations, or SOP activities as long as the information is contained in a notebook.

- ***Lab Logbooks*** – A combination of paper data sheets, bound paper logbooks, electronic databases, and electronic logbooks exist in which the state laboratory retains all records pertaining to equipment calibrations and materials tracking, preparation, storage, and disposal, as well as general comments and notations and other pertinent information required for support of the ambient air quality network data integrity activities.

9.2.2 Electronic Data Collection

Certain instruments can provide an automated means for collecting information that would otherwise be recorded on data entry forms. Information on these systems is detailed in Section 18. To reduce the potential for data entry errors, automated systems will be used where appropriate and will record the same information that would be recorded on data entry forms. To provide a backup, electronic copies of the automated data collection information (daily poll) will be stored for an appropriate time frame by the Project and Procedures Branch staff on the group drive. Electronic backup copies of automated data collection information will also be stored on the site computers, in the regional offices and in the central office.

9.3 Data Reporting Package Archiving and Retrieval

All the information listed in Table 9-1 will be retained for four complete calendar years from the date of collection in accordance with 40 CFR Section 31.42. However, if any litigation, claim, negotiation, audit, or other action involving the records has been started before the expiration of the four-year period, the records will be retained until completion of the action and resolution of all issues that arise from it, or until the end of the regular four-year period, whichever is later.

10. NETWORK DESCRIPTION

The purpose of this section is to:

- Identify the functions associated with DAQ's criteria pollutant and NCore ambient air quality monitoring network.
- Outline the objectives of the two networks.
- Establish the criteria for:
  - Monitoring activities,
  - Sampling network design and
  - Monitoring site selection.
- Identify the intended sampling frequency.

The primary function of both the criteria pollutant and NCore air monitoring programs is to verify compliance with the NAAQS. Other purposes for both programs include (1) determining trends over time, (2) determining effects on air quality from adjustments to source emissions, (3) developing algorithms based on historical air quality and other conditions which will forecast air quality, (4) verifying air quality modeling programs, (5) providing real-time O_3 data to the public, and (6) correlating health effects to air quality. In addition, the NCore air monitoring program supports scientific studies ranging across technological, health and atmospheric process disciplines as well as ecosystem assessments.

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 SLAMS, SPM and PSD Air Quality Monitoring
- 40 CFR Part 58, Appendix D - Network Design Criteria for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

10.1. Network Objectives

The criteria pollutant ambient air quality monitoring network is designed to meet a minimum of six basic monitoring objectives. These basic monitoring objectives are to:

- Determine the highest concentrations expected to occur in the area covered by the network,
- Determine representative concentrations in areas of high population density,
- Determine the impact of significant sources or source categories on ambient pollution levels,
- Determine general background concentration levels,
- Determine the extent of regional pollutant transport among populated areas and in support of secondary standards, and

- Determine the welfare-related impacts in rural and remote areas (such as visibility impairment and effects on vegetation).

While the NCore network shares these objectives, it is primarily focused on determining representative concentrations in areas of high population density and general background concentration levels.

The criteria pollutant and NCore ambient air quality monitoring networks use the network design criteria specified in 40 CFR Part 58, Appendix D, to establish the appropriate network configuration necessary to meet these objectives.

Each monitor within DAQ’s criteria pollutant and NCore ambient air quality monitoring networks is assigned one or more of the following monitoring objective designations:

- ***Population exposure*** **-** the monitor is located in an area associated with high population density.
- ***Background*** **-** the monitor is located where manmade pollutant emissions are minimal.
- ***Transport*** **-** the monitor is located to measure pollutants transported from other areas.
- ***Comparison study*** **-** the monitor is located adjacent to other instrumentation measuring the same pollutant to compare different sampling/monitoring methodologies.
- ***Air Quality Index*** **-** the monitor provides data primarily for reporting to the Air Quality Index (previously called the Pollutant Standards Index).

In addition, the NCore ambient air quality monitoring network may also include the objectives of:

- ***Trends*** **–** track trends in air pollution.
- ***Modeling*** **–** the monitor data will be used to evaluate air quality modeling.

The criteria pollutant ambient air quality monitoring network may include the additional objective of:

- ***Maximum concentration*** **-** the monitor is located where a high concentration of the pollutant is expected (often based on results of receptor models).

Data collected within the network must be representative of the spatial area under study. The goal in siting a monitoring station is to match the spatial scale represented by the samples obtained with the spatial scale most appropriate for the monitoring objective of the station. Table 10.1 summarizes appropriate measurement scales for different pollutants. For a description of representative measurement scales, see Section 7.3.

Table 10.1 Summary of Spatial Scales for State and Local Air Monitoring Stations (SLAMS) and Required Scales for National Core Monitoring Stations (NCore).

Scales Applicable for SLAMS								Scales Required for NCore						
	SO_2	CO	O_3	NO_2	Pb	PM_{10}	PM2.5	SO_2	CO	O_3	NO_y	Pb	$PM_{10-2.5}$	$PM_{2.5}$
Micro	**X**	**X**			**X**	**X**	**X**							

Table 10.1 Summary of Spatial Scales for State and Local Air Monitoring Stations (SLAMS) and Required Scales for National Core Monitoring Stations (NCore).

Scales Applicable for SLAMS								Scales Required for NCore						
Middle	X	X	X	X	X	X	X							
Neighborhood	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Urban	X		X	X	X	X	X							
Regional	X		X		X	X	X							

10.2 Site Selection

The selection of a specific monitoring site includes the following activities:

- Developing and understanding the monitoring objective and appropriate DQOs,
- Identifying the spatial scale most appropriate for the monitoring objective of the site,
- Identifying potential locations where the monitoring site could be placed, and
- Identifying the specific monitoring site.

Each monitoring site is evaluated to assure it adheres to the site selection criteria specified in 40 CFR Part 58, Appendix E.

10.2.1 Site Location

Four criteria should be considered when evaluating potential sites. Monitoring sites should be oriented to measure the following (singly or in combination as appropriate for the sampling objective):

1. Impacts of known pollutant emission categories on air quality,
2. Population density relative to receptor-dose levels, both short- and long-term,
3. Impacts of known pollutant emission sources (area and point) on air quality, and
4. Representative air quality.

Selection according to these criteria requires detailed information concerning the location of sources, geographic variability of ambient pollutant concentrations, meteorological conditions, and population density. Selection of the number, geographic locations, and types of sampling stations is, therefore, a complex process.

The sampling site selection process also involves consideration of the following factors:

- ***Economics*** **-** The quantity of resources required to accomplish all data collection activities, including instrumentation, installation, maintenance, data retrieval, data analysis, QA, and data interpretation, must be established
- ***Security*** **-** In some cases, a preferred location may have associated problems that compromise the security of monitoring equipment (i.e., high risk of theft, vandalism, etc.). If such problems cannot be remedied through the use of standard measures such as additional lighting, fencing, etc., then an attempt to locate the site as near to the preferred location as possible shall be made.

- ***Logistics*** **-** This process includes procurement, maintenance, and transportation of material and personnel for the monitoring operation. The logistics process requires full knowledge of all aspects of the data collection operation: planning, reconnaissance, training, scheduling, safety, staffing, procuring goods and services, communications, and inventory management.

- ***Atmospheric Considerations*** **-** These considerations may include spatial and temporal variability of pollutants and their transport. Effects of buildings, terrain, and heat sources or sinks on air trajectories can produce localized anomalies of pollutant concentrations. Meteorology must be considered in determining the geographic location of a site as well as the height, direction, and extension of sampling probes. Evaluation of a local wind rose is essential to properly locate many monitoring sites (e.g., siting either to detect or avoid emissions from specific sources).

- ***Topography*** **-** Evaluation of the local topography based upon land use maps, U.S. Geological Survey topographic maps, and other available resources must be completed. Minor and major topological features that impact both the transport and diffusion of air pollutants must be identified and evaluated. Minor features may include an adjacent tree lined stream or tall structures either upwind or downwind of a point source, each of which may exert small influences on pollutant dispersion patterns. Major features include river canyons or deep valleys, mountain ranges, and large lakes. Major features significantly impact the prevailing wind patterns or create their own local weather such as katabatic or anabatic winds.

- ***Pollutant Considerations*** **-** The monitoring site location for a specific pollutant may or may not be appropriate for another pollutant. Evaluation of the changes that pollutants undergo temporally and spatially must be considered in order to determine the applicability of each particular site for a specific pollutant. An example would be the temporal delay in peak concentrations of NO_y and volatile organic compounds (VOCs), compared to the peak concentration of resulting O_3. A micro scale site used to monitor CO may be appropriate for measuring O_3 precursors, such as VOCs and NO_y, but entirely inappropriate for measuring O_3 itself. Due to the time delay in the creation of the secondary pollutant, O_3, a more distant neighborhood- or urban-scale monitoring site may be appropriate for directly monitoring O_3.

An interdependence exists between all of the factors listed above. Consequently, an iterative procedure must be employed to successfully select appropriate sites that can provide the data necessary to accomplish the project's stated objectives. In situations where the sites do not specifically meet the requirements necessary to obtain the project objectives, reevaluation of the project operation of air quality measurement systems; estimates of air quality, field, and theoretical studies of air diffusion; and considerations of atmospheric chemistry and air pollution effects make up the required expertise needed to select the optimum sampling site for obtaining data necessary to fulfill the monitoring objectives.

10.2.2. Monitor Placement

The placement of each monitor is generally determined by the defined monitoring objective. Monitors are thus usually placed according to potential exposure to pollution. Due to the various factors discussed above, tradeoffs are often necessary to locate a site for collection of optimally representative data. Final placement of a particular monitor at a selected site is dependent on physical obstructions and activities in the immediate area. Monitors must be placed away from obstructions such as trees and fences to avoid their effects on airflow. To prevent sampling bias, airflow around monitor sampling probes must be representative of the general airflow in the area. In addition, the availability of utilities (i.e., electricity and telephone services) is critical.

10.3. Probe Siting Criteria for Pollutant Sampler/Analyzer

General probe and monitoring path siting criteria for criteria pollutants shall adhere to the requirements listed in 40 CFR58, Appendix E, and the instructions outlined below.

10.3.1. Sulfur Dioxide (SO_2 criteria and NCore trace level)

The SO_2 intake probe must be 2 to 15 m above the ground. The probe must be at least one meter away, both vertically and horizontally, from any supporting structure. The probe must be at least 2 m away from any small local obstruction, such as a pipe, pole, etc., and at least 2 m from any other sampler probe intakes. The probe should be at least 20 m from any trees or shrubs extending higher than the sampler intake. The distance shall be measured from the drip-line or outside edge of the crown, not the trunk. For monitors to be operated at the same site for several years, it is best to allow some additional space for vegetation growth. Because of their ability to alter normal wind flows and provide surfaces for SO_2 deposition or absorption, trees and shrubs shall not be located between a source and the sampler. In situations where trees or shrubs could be considered an obstruction (this is particularly true of large coniferous trees), the distance between the trees or shrubs and the sampler shall be either at least 10 meters or the height the tree protrudes above the sampler intake, whichever is greater. The distance between the probe and any large obstruction (such as buildings) higher than the probe must be more than twice the height that the obstruction extends above the probe. There should be no minor sources of SO_2 (coal or oil fired stoves or furnaces) within 100 m of the probe intake that could have a significant impact.

The sampler must have an unrestricted airflow in at least a 270° arc around the sampler. The arc must include the predominant wind directions and any major sources in the area. An exception is made for probes located on the sides of buildings for measuring street canyon pollution in urban areas. In these cases, the probe must have an unrestricted airflow of 180°. See 40 CFR Part 58, Appendix E, for an explanation of these and other siting criteria.

10.3.2. Carbon Monoxide (CO)

If the site is a city street canyon and the desired measurement scale is micro scale, the probe intake must be located 3±0.5 m above the ground. Micro-scale near road monitoring stations require the probe intake to be located 2 to 7 meters above the ground. Other measurement scales, including NCore, require the probe to be 2 to 15 m above the ground. In all cases the probe inlet must be at least one meter horizontally or vertically away from any supporting structures. The major concern with trees and shrubs is their ability to alter normal wind flow patterns. Thus, for micro scale stations, no trees or shrubs should be located between the probe inlet and the road. For middle and neighborhood scale stations, including NCore, trees and shrubs shall not be located between the major sources of CO, usually vehicles on a heavily traveled road, and the sampler. In addition, the sampler shall be located at least 10 m from all trees. The distance must be measured from the dripline or outside edge of the crown, and not the trunk. For monitors to be located at the same site for several years, additional space must be provided when siting monitors adjacent to trees or shrubs to accommodate vegetation growth. In situations where trees or shrubs could be considered an obstruction (this is particularly true of large coniferous trees), the distance between the trees or shrubs should be either at least 20 meters or the height the tree protrudes above the sampler intake. The distance between the probe and any large obstruction (such as buildings) higher than the probe must be more than twice the height that the obstruction extends above the probe.

The sampler must have an unrestricted airflow in at least a 270° arc around the sampler, unless the probe is in an urban street canyon. The arc must include the predominant wind directions for the season of maximum concentration. If the probe is used in an urban street canyon and is attached to the side of a building, it must have an unrestricted airflow of 180°. For street traffic micro scale monitoring, the probe must be 2 to 10 m from the roadway and at least 10 m from an intersection. A mid-block location is preferred. For microscale near road monitoring, the probe should be between 20 and 50 meters from the nearest traffic lane. For neighborhood or larger scales use the data in 40 CFR Part 58, Appendix E to calculate the required separation distance from the nearest traffic lane.

10.3.3. Ozone (O3)

The probe intake is to be located from 2 to 15 m above the ground. The probe is to be more than 1 meter horizontally or vertically away from any supporting structures. It should be at least 20 m away from any trees or shrubs. Because of their ability to alter normal wind flow patterns and provide surfaces for absorption or reactions (the scavenging effect of vegetation is greater for O_3 than for the other criteria pollutants), trees and shrubs shall not be located between a nearby source and the sampler. Samplers monitoring O_3 transported over a long distance, such as from an urban city core area, should be sited so that no trees are within 20 m of the sampler along the predominant summer daytime wind direction. The distance shall be measured from the drip-line or outside edge of the crown, not the trunk. For monitors to be operated at the same site for several years, it is best to allow some additional space for vegetation growth. In situations where trees or shrubs could be considered an obstruction, the trees or shrubs must be at least 10 meters from the probe and should be at least 20 meters. The distance between the probe and any obstruction must be at least twice the height that the obstruction extends above the probe.

The sampler must have unrestricted airflow in at least a 270° arc around the sampler. The arc must include the predominant wind direction for the season of maximum concentration. 40 CFR Part 58, Appendix E gives the required separation distance from the nearest traffic lane.

10.3.4 Nitrogen Dioxide (NO_2) and Reactive Oxides of Nitrogen (NO_y)

The siting criteria for micro-scale near road NO_2 monitors is the same as for micro-scale near road CO monitors. The siting criteria for other NO_2 and NO_y analyzers is the same as for O_3 analyzers, except the inlet for the NO_y monitor must be 10 meters above grade.

10.3.5 Visibility Sensors

The siting criteria for visibility monitors must allow for the considerable differences among the monitors themselves (e.g., integrating nephelometer vs. contrasting telephotometer). The siting criteria listed below are the general siting criteria. When a specific monitor is to be installed, DAQ personnel shall be contacted to review the proposed site, instrument specifications, and monitoring objectives to ensure that the monitoring objectives will be met.

When siting a visibility monitor that uses a probe, the probe should be located from 2 to 15 m above the ground. The probe is to be more than 1 m vertically and horizontally away from any supporting structure, and at least 2 m from any nearby small obstructions (poles, pipes, cables, etc.) or other sampler or probe intakes. The probe should be located a minimum of 20 m from any shrubs or trees. This distance shall be measured from the dripline or edge of the crown and not the trunk. If the monitors are to be retained at the site for multiple years, additional space should be provided when siting monitors adjacent to trees or shrubs to accommodate vegetation growth. In situations where trees or shrubs could be considered an obstruction (this is particularly true of coniferous trees), the distance between the trees or shrubs and the probe should be either at least 20 m or twice the height that the trees or shrubs protrude above the probe intake, whichever is greater. The probe must have an unrestricted airflow of at least 270° and this arc should include the predominant wind directions. There should be no micro scale sources of any pollutant within 100 m of the probe.

Visibility monitors requiring clear lines of sight (telephotometers) should have several targets (mountains or other permanent landmarks) visible from the same vantage point (site) and at varying distances (3 to 50 km) from the site. This condition requires an open field of view in at least one direction. There should be no micro scale sources of any pollutant within 100 m of the monitor and no sources of any visible pollutant within 100 m (on either side) of a centerline running from the monitor to the target.

10.3.6. Meteorological Sensors

The siting criteria for meteorological sensors vary greatly from parameter to parameter. Because of the variations, the siting criteria are discussed below on a parameter-by-parameter basis.

Instruments shall be mounted on booms at the top of, or projecting horizontally from, the tower. The booms shall be securely fastened to the tower and shall be strong enough so that they will not sway or vibrate in strong winds. Wind instruments shall be mounted on a boom so that the sensors are twice the maximum diameter or diagonal of the tower away from the tower. The boom shall project into the prevailing winds. Wind sensors shall be mounted on booms or cross arms so that a sensor's wake does not impact adjacent sensors. Usually, this means mounting the sensors a minimum of 0.6 meters apart. If the wind sensors are to be mounted on top of a tower, they shall be mounted at a height and distance from the tower so that the diagonal distance between the sensor and the tower is equal to twice the maximum diameter or diagonal of the tower.

Temperature sensors and solar radiation sensors that are to be mounted on a boom shall be mounted on a boom with a length that is greater than the diameter of the tower at the height at which the boom is mounted. The temperature and solar radiation sensors shall always be mounted on the south side of a tower. Temperature sensors that are mechanically aspirated shall have a downward-facing shielding.

10.3.6.1. Towers

The sensor should be securely mounted on a mast (tower or pole) that will not twist, rotate, or sway.

The towers shall be of an open grid-type construction and designed so that they either tilt or can be cranked into place so that the sensors can be installed, serviced and audited from the ground so that the operator will not need to climb the tower. A tower must be rigid enough to maintain all mounted instruments in proper alignment and orientation in high winds.

When instruments are located on a cross arm projecting out from the tower, the cross arms shall be securely fastened to the tower and shall be strong enough so that the sensors do not sway or vibrate in high winds. The sensors shall be securely fastened to the cross arm at a distance of two tower diameters or widths, measured from the edge of the tower to the sensor, to avoid any influence of tower-induced turbulence on the sensors. The cross arm shall be installed so that it is horizontally level and the sensors shall be installed so that they are vertical. The cross arm shall be mounted and aligned so that the wind direction sensor is correctly aligned. (The correct alignment varies on a sensor-by-sensor basis. Consult the appropriate section of manufacturer's operator's manual for the correct alignment.)

10.3.6.2. Wind Velocity Sensors

If the wind sensors are to measure surface level winds, the sensors should be located on a 10-m tower in open terrain. Open terrain is defined as an area where the distance between the tower base and any obstruction is at least ten times the height of that obstruction above the instrument. This applies to manmade (buildings) and natural (trees, rocks, or hills) obstructions. All distances are to be measured from the edge of the obstruction nearest the tower. Trees and shrubs shall be measured from the outside edge of the crown or drip-line, and not the trunk.

If the sensors (and tower) are to be located in areas of uneven terrain or terrain containing obstacles, refer to Table 10-2 for the limits for terrain variation and obstacle height near the tower.

Table 10-2. Limits on Terrain and Obstacles near Towers.

Distance from Tower (m)	Slope, not Greater Than (%)	Maximum Obstruction or Vegetation Height (m)
0 – 15	± 2	0.3
15 – 30	± 3	0.5 – 1.0 (most vegetation <0.3)
30 – 100	± 7	3.0
100 – 300	± 11	10 x height *

10.3.6.3. Temperature and Humidity Sensors

Temperature and humidity sensors shall be mounted over an open plot of short grass or natural earth (not concrete or asphalt) at least 9 m in diameter. A height of 1.25 to 2 m above the ground surface is the standard height for mounting temperature and humidity sensors, but tower mounting, as is the case in most air pollution/meteorological monitoring applications, is also acceptable. For the NCore site, the sensors will be mounted on a tower at 2 to 5 m above the ground surface. Wherever the sensor is mounted, the height of the sensor should be measured and recorded.

The sensors shall be no nearer any obstructions than a distance of four times the height differential between the height of the sensor and the height of the obstruction. This applies to both manmade and natural obstructions.

The distance shall be measured from the edge of the crown or drip-line of the vegetation, not the trunk. The sensors shall be positioned at a minimum of 30 m from large paved areas (streets, parking lots, etc.), steep slopes, ridges, hollows, or bodies of standing water. Temperature probes shall be located so that they are not influenced by heat leakage from the shelter containing the electronics and recorders for the meteorological equipment.

10.3.6.4 Barometric Pressure Sensors

Barometric pressure sensors are usually mounted inside the shelter housing meteorological instruments and recorders since barometric pressure is not affected by indoor installations. The installation of the barometric pressure sensors inside the stable shelter environment protects the instruments from exposure to extreme climatological events that may impact the sensors or recorders. However, when a sensor is mounted inside a shelter, it should be placed inside the building on an interior wall, and removed from drafts from the heating/ventilating/air conditioning system, doors, and windows. The instrument should be mounted to minimize vibration and be vented to eliminate shelter interior pressurization.

10.3.6.5 Solar Radiation Sensors

All solar or net radiation sensors must be positioned so they are horizontal. These sensors must have an unobstructed view of the sun during the entire year, from sunrise to sunset. They should not be positioned within 50 m of any light colored walls or sources of artificial light.

If net radiation is to be measured, the sensors shall be sited according to the siting criteria for temperature sensors unless a specific application is desired.

10.3.6.6 Precipitation Sensors

A rain gauge should be positioned so that it is horizontal. The gauge’s opening must be at least 3 m above the ground, but greater mounting heights are acceptable to prevent the gauge from becoming buried in snow. The gauge should be shielded from the wind, but not oriented such that excessive turbulence from the windshield would impact the collection of precipitation. In open areas, windshields such as those used by the U.S. National Weather Service should be used. The distance between obstructions, either natural or manmade, and the gauge shall be at least four times the height difference between the height of the sensor’s opening and the height of the obstruction. The ground surface around the rain gauge may be either natural vegetation (grass) or gravel. Paved surfaces are not acceptable because splashing may bias the readings.

10.3.7 Acid Deposition Sensors

The siting criteria for acid deposition monitoring sites have been updated to enhance comparability of data between sites. Any acid deposition monitors installed in North Carolina shall be installed using the current siting criteria used by the National Atmospheric Deposition Program (NADP). For a copy of the current siting criteria, contact:

Research and Monitoring Evaluation Branch

Quality Assurance Division (MD-77B)
Atmospheric Research and Exposure Assessment Lab
Research Triangle Park, NC 27711

10.3.8. PM10 and Lead Monitoring

When monitoring $PM_{10,}$ it is important to select a site or sites where the collected particulate mass is representative of the monitored area.

Optimum placement of the sampling inlet for PM_{10} is at breathing height level. However, practical factors such as prevention of vandalism, security, and safety precautions must also be considered. Given these considerations, the sampler inlet for micro scale PM_{10} monitors must be between 2 and 7 m above the ground. For middle or larger spatial scales, the inlet must be 2 to 15 m above the ground. Thus, for neighborhood scale NCore sites the inlet must be 2 to 15 m above the ground.

If the sampler is located on a roof or other structure, there must be 2 m separation from walls, parapets, penthouses, etc. No furnace or incineration flues should be nearby. Collocated high volume samplers must be at least 2 m, but not greater than 4 m, away from each other. For low volume samplers, including NCore, collocated samplers must be at least 1 m, but not greater than 4 m, away from each other.

Samplers should be located at least 20 m from the drip-line of the nearest trees, but must be 10 m from the drip-line.

The sampler must be located away from obstacles such as buildings, so that the distance between the obstacle and the sampler is at least two times the height that the obstacle protrudes above the sampler.

There must be unrestricted airflow in an arc of at least 270° around the sampler. The predominant wind direction for the season with the greatest pollutant concentration potential must be included in the 270° unrestricted arc. If the sampler is to measure concentrations from a road or point source, there must be no obstructions between the road or point source even when other spacing from obstruction criteria are met.

There are many factors to be considered in establishing a particulate sampling location. These include accessibility under all weather conditions, availability of adequate electricity, and the security of the monitoring personnel and equipment. The sampler must be situated where the operator can reach it safely despite adverse weather conditions. If the sampler is located on a rooftop, care should be taken that the operator's personal safety is not jeopardized by a slippery roof surface. Consideration should also be given to the fact that routine operational procedures such as calibration, maintenance, and filter installation and recovery involve transporting supplies and equipment to and from the monitoring site.

The lack of a suitable power source can often result in the loss of many samples because of power interruptions or fluctuations. To ensure that adequate power is available consult the manufacturer's instruction manual for the sampler's minimum voltage and power requirements.

The security of the sampler depends mostly on the location. Rooftop sites with locked access and ground level sites with fences are common. In all cases, the security of the operating personnel as well as the sampler should be considered.

When siting monitors for monitoring Pb, the same criteria as siting PM_{10} particulate samplers should be followed. For the DAQ NCore monitoring site, all PM monitors are located on a dedicated 16 foot by 16-foot wooden deck that is secured by a chain linked fence.

10.3.9. $PM_{2.5}$

When monitoring for $PM_{2.5}$, it is important to select a site or sites where the collected particulate mass is representative of the monitored area.

Optimum placement of the sampling inlet for $PM_{2.5}$ is at breathing height level. However, practical factors such as prevention of vandalism, security, and safety precautions must also be considered. Given these considerations, the sampler inlet for micro scale $PM_{2.5}$ monitors must be between 2 and 7 m above the ground. For middle or larger spatial scales, including NCore sites, the inlet must be 2 to 15 m above the ground.

If the sampler is located on a roof or other structure, there must be 2 meters separation from walls, parapets, penthouses, etc. No furnace or incineration flues should be nearby. Collocated samplers must be at least 1 m, but not greater than 4 m, away from each other.

Samplers should be located at least 20 m from the drip-line of the nearest trees, but must be 10 meters from the drip-line.

The sampler must be located away from obstacles such as buildings, so that the distance between the obstacle and the sampler is at least two times the height that the obstacle protrudes above the sampler.

There must be unrestricted airflow in an arc of at least 270° around the sampler. The predominant wind direction for the season with the greatest pollutant concentration potential must be included in the 270° unrestricted arc. If the sampler is to measure concentrations from a road or point source, there must be no obstructions between the road or point source and the sampler, even when other spacing from obstruction criteria are met.

There are many factors to be considered in establishing a particle sampling location. These include accessibility under all weather conditions, availability of adequate electricity, and the security of the monitoring personnel and equipment. The sampler must be situated where the operator can reach it safely despite adverse weather conditions. If the sampler is located on a rooftop, care should be taken that the operator's personal safety is not jeopardized by a slippery roof surface. Consideration should also be given to the fact that routine operational procedures such as calibration, maintenance, and filter installation and recovery involve transporting supplies and equipment to and from the monitoring site.

The lack of suitable power source can often result in the loss of many samples because of power interruptions or fluctuations. To ensure that adequate power is available, consult the manufacturer's instruction manual for the sampler's minimum voltage and power requirements.

The security of the sampler depends mostly on the location. Rooftop sites with locked access and ground level sites with fences are common. In all cases, the security of the operating personnel as well as the sampler should be considered.

10.4. Sampling Frequency

Minimum sampling frequencies are established by EPA and followed accordingly. The sampling frequencies of monitors are based on EPA's requirements. In instances requiring every third and sixth day sampling, specific days must be sampled in order that the entire nation is sampling on the same day. This intermittent sampling is accomplished in accordance with a national sampling schedule published annually by EPA.

The minimum number of samples required for appropriate summary statistics should be taken. At least 75 percent of the total possible observations must be present before summary statistics are calculated. The exact requirements appear in Table 10-3. For filter-based PM 2.5 monitoring, DAQ follows EPA guidance for collecting makeup samples. Makeup samples can be collected either before the next scheduled sample or one week later. The sampling schedule and frequency for each criteria and NCore pollutant is provided in Table 10-4.

Table 10-3. Requirements for Calculating Summary Statistics.

Pollutant	Completeness Requirement (%)	Time Frame
Carbon monoxide	75 %	Per hour and quarter
Nitrogen dioxide	75 %	Per hour, day, quarter and year
Reactive oxides of nitrogen	75 %	Per hour and quarter
Ozone	75 % / 90 %	Per hour, 8-hour, and season / per three years
PM 10	75 %	Per quarter
PM 2.5	75 %	Per quarter
Sulfur dioxide	75 %	Per hour and quarter
Lead	75 %	Per month and average of the 3 constituent monthly means
Wind speed	75 %	Per hour and quarter
Wind direction	75 %	Per hour and quarter
Ambient temperature	75 %	Per hour and quarter
Relative humidity	75 %	Per hour and quarter

Table 10-4. Criteria Pollutant and NCore Sampling Schedule and Frequency

Pollutant	Time Frame	Frequency	Monitor Type
PM_{10}	Midnight to midnight	24/7	continuous
PM_{10}	Midnight to midnight	1 in 6	Filter based
Carbon monoxide	Midnight to midnight	24/7	continuous
Nitrogen dioxide	Midnight to midnight	24/7	continuous
Reactive oxides of nitrogen	Midnight to midnight	24/7	continuous

Table 10-4. Criteria Pollutant and NCore Sampling Schedule and Frequency

Pollutant	Time Frame	Frequency	Monitor Type
Ozone	Midnight to midnight	24/7	continuous
PM_{10} Pb	Midnight to midnight	1 in 6	Filter based
$PM_{2.5}$	Midnight to midnight	24/7	continuous
$PM_{2.5}$	Midnight to midnight	1 in 3	Filter based
$PM_{10-2.5}$	Midnight to midnight	1 in 3	Filter based
Sulfur dioxide	Midnight to midnight	24/7	continuous
Speciated $PM_{2.5}$	Midnight to midnight	1 in 3	Filter based
Wind Speed	Midnight to midnight	24/7	continuous
Wind Direction	Midnight to midnight	24/7	continuous
Ambient Temperature	Midnight to midnight	24/7	continuous
Relative Humidity	Midnight to midnight	24/7	continuous

10.5. Rationale for DAQ's Criteria Pollutant and NCore Ambient Air Quality Monitoring Networks

The primary rationale for the operation of the DAQ criteria pollutant and NCore ambient air quality monitoring networks is to determine compliance with the NAAQS and provide the public with information on current air quality. The emphasis of DAQ's criteria pollutant ambient air quality monitoring network is three-fold. First, DAQ focuses on measuring pollutant levels in areas where elevated pollutant concentrations are known or suspected. Second, DAQ collects monitoring data to evaluate EPA models and emission inventories. Third, DAQ collects data to assist industry to meet prevention of significant deterioration requirements when expanding or building a new facility. In addition, expanded monitoring (i.e., additional sites, increased sampling frequency, or addition of supporting monitors) may occur in areas where a previous exceedance of a standard has been recorded. In addition, the NCore ambient air quality monitoring network provides monitoring data to evaluate EPA models, to assess air pollution trends, and for health studies.

11.0 SAMPLING METHODS REQUIREMENTS

11.1. Purpose

The purpose of this section is to:

- Identify the sampling methods.
- Identify the procedures for collecting the required environmental samples.
- Describe the:
  - Equipment used in the data collection network.
  - Necessary support facilities.
  - Sample preservation requirements.
  - Implementation requirements.
  - Required materials.
  - Processes for preparing and decontaminating sampling equipment.
- Identify the:
  - Corrective actions necessary to reestablish network data integrity.
  - Responsible parties to implement the corrective actions.
  - Methods required to verify corrective action effectiveness.

11.2. Monitoring Technology/Methodology

This subsection describes the sampling methods used in the DAQ criteria and NCore pollutant network.

11.2.1. Carbon Monoxide (Trace Level Nondispersive Infrared Analyzer)

The detection and measurement of CO is based on the absorption of infrared (IR) radiation. Broadband IR radiation is generated using a high-energy heated element. The IR radiation is modulated using gas filter correlation technology. Gas filter correlation uses a rotating wheel containing two gas filled cells that selectively modulate the IR radiation. One cell contains nitrogen (the measure cell), while the other contains CO (the reference cell). This configuration modulates the IR radiation into reference and measure pulses.

During the reference pulse, the CO in the gas filter wheel effectively strips the beam of all IR energy at wavelengths susceptible to CO absorption, resulting in a beam that is unaffected by any CO in the sample cell being evaluated.

During the measure pulse, the nitrogen in the filter wheel does not affect the IR radiation beam. The CO subsequently absorbs the IR radiation in the sample cell. The attenuation of the IR radiation is directly proportional to the quantity of CO present in the sample being evaluated.

The IR beam enters the multi-pass sample cell after the gas filter wheel. This sample cell uses folding optics to extend the absorption path through the sample, by making the reference and measure beams pass multiple times through the sample in the cell. The length of the absorption path is directly related to the sensitivity of the instrument in measuring CO concentrations.

Upon exiting the sample cell, the beam passes through a band-pass interference filter to limit the light to the wavelength of interest. Finally, the beam strikes a thermoelectrically cooled, solid-state photo-conductor. This solid-state device, coupled with its support circuitry, amplifies the signal generated by the modulated IR radiation beam, and outputs a modulated voltage. This voltage is de-modulated resulting in two voltage signals associated with the reference and measurement pulses. The ratio of the de-modulated voltage signals is indirectly proportional to the concentration of CO in the sample being evaluated.

11.2.2. Sulfur Dioxide (Fluorescence Analyzer and Trace-level Fluorescence Analyzer)

The physical principle used in SO_2 measurement relies on exciting an electron shell of a SO_2 molecule, which occurs in the presence of a specific wavelength (214 nanometers [nm]) of ultraviolet (UV) radiation, and the subsequent relaxation, which produces a photon of light. A photo multiplier tube allows the light emissions to be measured as the SO_2 molecule returns to the ground state. The intensity of this light is proportional to the quantity of SO_2 present in the sample. A reference detector continuously monitors the intensity of the UV lamp, used to excite the SO_2, and allows use of a ratiometric measurement technique that compensates for lamp degradation. A hydrocarbon scrubbing system, containing no consumable material, removes interfering hydrocarbons prior to the ambient sample entering the measurement chamber.

11.2.3. Nitrogen Oxides and Reactive Oxides of Nitrogen (Chemiluminescence)

Nitrogen oxides (NO_x) is the sum of nitric oxide (NO) and NO_2. Reactive oxides of nitrogen (NO_y) includes all of the nitrogen oxide compounds that are emitted to the atmosphere or that are formed in the lower atmosphere. The NO_y compounds include, NO, NO_2, and other organic and inorganic nitrogen containing species. Both NO_x and NO_y are measured using the same measurement principle.

The principle of measurement is based upon the reaction of a NO molecule with an internal source of O_3 in an evacuated reaction cell that results in the emission of light. Single channel instruments divide the sample into two streams. The first stream passes the sample directly to the evacuated reaction cell. A reaction between the NO present in the sample and the analyzer supplied O_3 occurs. The resulting light emitted by the reaction is monitored and correlated to the concentration of NO in the sample.

The second stream of sample gas is passed through a converter. For NO_x, a photolytic converter is used to selectively reduce the NO_2 to NO. This second stream, now containing NO from both the reduction of NO_2 and the original NO, is cycled through the evacuated reaction cell where the new augmented concentration of NO is measured. The measurement of the untreated sample provides an NO concentration, while the measurement of the converted sample provides a measurement of the NO_x concentration. Subtracting the NO concentration from the NO_x concentration yields the NO_2 concentration. Periodically, a background measurement is taken to correct the zero offset of the instrument to maintain zero stability.

For NO_y, a catalytic converter is used reduce the NO_y components to NO. The catalytic converter is positioned at the extreme sample inlet 10 meters above grade and has an enhanced sample flow rate of approximately 10 liters per minute to minimize any reactions in the sample line. This second stream, now containing NO from both the reduction of NO_y and the original NO, is cycled through the evacuated reaction cell where the new augmented concentration of NO is measured. The measurement of the untreated sample provides an NO concentration, while the measurement of the converted sample provides a measurement of the NO_y concentration.

11.2.4. Ozone (Ultraviolet Photometry)

The physical principle used to measure O_3 relies on the absorption of UV radiation by the O_3 molecule. The O_3 molecule has an affinity for specific wavelengths between 240 nm and 320 nm. The affinity peaks in the UV range at approximately 254 nm. Utilizing this phenomenon, and employing the Beer-Lambert relationship (see Equations 11-1 and 11-2), one can measure the quantity of O_3 present in a sample by determining the quantity of UV radiation absorbed along a specified path length.

To employ these concepts, a UV photometer splits the sample stream. The first stream is directed into a measurement cell, while the second stream is passed through a catalytic converter to remove all traces of O_3. The measurement cell has a specified length, a UV source at one end, and a photometer at the other end. The analyzer allows a specified time to pass, determined by the cell volume and the sample flow rate, to insure that a clean, uniform sample is present in the cell. A measurement is taken of this sample over the subsequent, equal time span. Next, the instrument cycles the catalyzed sample into the cell, utilizing the same time spans to insure a clean, O_3-free sample exists in the cell, prior to measuring the O_3-free UV attenuation level. The cycle is then repeated with a new O_3 containing sample.

11.2.5. Particulate Matter (Intermittent filter-based operation)

This methodology uses precisely weighed filters that are placed in a carefully controlled volumetric flow for a specified period of time. The combination of flow and duration identify a controlled volume that has passed through the clean filter. The mass added to the filter has been applied during the period when the flow was present. Determining the amount of mass added, and dividing by the volume of air filtered, yields a particulate matter concentration that is an average of the time the flow occurred.

These intermittent operating filter monitors require that the filters be changed between each sampling period, which usually occurs once every three or six days, but can be scheduled more frequently. The filters are precisely weighed in a lab before field installation. They are once again precisely weighed, at the same humidity level as at the initial weighing, after the filtering operation. The resulting difference yields the mass trapped during filtering.

Trapped particulate matter can be separated into finer grades of matter than was originally mandated under federal total suspended particulates regulations using an inertial separator on the inlet stream. These inertial separators selectively pass particulate matter classified as either PM_{10} or $PM_{2.5.}$ $PM_{10-2.5}$ is measured using identical monitors operated identically except one monitor uses an inertial separator that selectively passes PM_{10} and the other uses an inertial separator that selectively passes $PM_{2.5}$.

11.2.6. Particulate Matter (Continuous Operation, TEOM)

A Tapered Element Oscillating Microbalance (TEOM) is composed of sensing and control units. At the heart of the sensing unit is the tapered element oscillating micro-balance, which is a patented inertial mass measurement technique for making real time direct measurement of particle mass collected on a filter. This measuring equipment can determine the fine changes in mass that accumulate on the filter as a constant stream of air passes through it. The combination of the rate at which mass is accumulated on the filter and a near real-time measurement (10 minutes), coupled with the air's known volumetric flow rate, yields an accurate method of determining the concentration of particulate matter in the air. The equipment can calculate the 30-minute, 1-hour, 8-hour, and 24-hour averages and the total mass accumulation on the filter from the raw data. Utilizing hydrophobic-filter material and collecting the sample at above ambient temperatures (50°C) minimizes humidity effects. The control unit employs an industrial microprocessor system, flow control hardware, transformers and power supplies, and a gauge to determine filter lifetime.

Initially, the air stream is filtered through an inertial separator. An inertial separator is specifically designed to eliminate particles with aerodynamic diameters either greater than 10 micrometers, or greater than 2.5 micrometers, depending upon the desired data to be collected. This equipment draws in 16.7 liters/minute (L/min) (1.0 m^3/hour) of air. After the air stream exits the inertial separator the stream is split into a 3-L/min sample that is sent to the mass transducer and a 13.7 L/min exhaust stream. The mass transducer assembly filters the sample air stream using a Teflon®-coated borosilicate glass filter. The system measures the accumulated mass every two seconds. Information required for installing and maintaining the TEOM particulate monitor is available in the NC SOP Section 2.27.1 and the Rupprecht & Patashnick TEOM Sampler manual.

11.2.7 Particulate Matter (Continuous Operation, BAM)

A Beta attenuation monitor (BAM) is composed of sensing and control units. At the heart of the sensing unit is the carbon 14 beta radiation source and glass fiber filter tape, which combine in a measurement technique for making near-real-time direct measurement of particle mass collected on the filter tape. This measuring equipment can determine the fine changes in mass that accumulate on the filter tape as a constant stream of air passes through it. The BAM is configured to operate on 1-hour cycles. During this one-hour cycle, the unit makes two 8-minute beta measurements (one for the background or blank and one for the sample) and collects one 42-minute sample for a combined total of 58 minutes. The remaining 2-minutes of each hour are used for filter tape and nozzle movements. The combination of the difference between blank and sample radiation counts, coupled with the air's known volumetric flow rate, yields an accurate method of determining the concentration of particulate matter in the air. The equipment can calculate the 1-hour, 8-hour, and 24-hour averages. The control unit employs a microprocessor system, flow control hardware, temperature and humidity sensors, transformers and power supplies, and a software algorithm to determine when to advance the filter tape.

Initially, the air stream is filtered through an inertial separator. An inertial separator is specifically designed to eliminate particles with aerodynamic diameters either greater than 10 micrometers, or greater than 2.5 micrometers, depending upon the desired data to be collected. This equipment draws in 16.7 liters/minute (L/min) (1.0 m^3/hour) of air. After the air stream exits the inertial separator the stream passes through a defined spot on the filter tape. The mass transducer is a radiation scintillation counter. The system measures the accumulated mass every hour. Information required for installing and maintaining the BAM particulate monitor is available in the NC SOP Section 2.37.1 and the Met One BAM 1020 Continuous Particulate Monitor manual.

11.3. Sample Collection Methodology

The specific SOP titles used in the network are listed in Table 11-1.

11.3.1. Physical Collection

The physical collection of particulate filter samples, sample transport, and sample preservation techniques adhere to the requirements of 40 CFR Part 50, Appendix J, L, O and Q, and *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume II, Ambient Air Quality Program.[4]

11.3.2. Electronic Data Collection

Electronic data collection is possible through the network's data loggers and wireless 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. Computers in the state's central office are configured to automatically connect to the stations periodically to retrieve these data for analysis. Monitoring personnel can contact the stations manually to retrieve data, or determine the status of the systems.

11.4. Support Facilities

11.4.1. Monitoring Station Design

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

Air pollution analyzers, with the exception of high volume samplers, dichotomous sampler heads (pump housing should be sheltered whenever practical), and meteorological sensors must be housed in a shelter capable of fulfilling the following requirements:

- The shelter temperature must be maintained between 20° and 30°C for gaseous monitors and 28 and 32°C for BAM 1020 monitors.
- The power supply should not vary more than ±10% from 117 alternating current voltage. It is best to provide some type of voltage regulation to accomplish this.
- The shelter must protect the instrumentation from precipitation and excessive dust and dirt, 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.

[4] http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf

Table 11-1. List of SOPs Associated with this Quality Assurance Project Plan

Section 2.3.2.1 Procedures for Rootsmeter Calibration and Maintenance, Revision 2, Oct. 1, 1996
Section 2.3.2.2 Calibration of Orifice Flow Device, Revision 8, Sept. 1, 1998
Section 2.3.3 Certification and Accuracy Check of Field Barometers and Thermometers, Revision 7, Nov. 1, 2011
Section 2.3.4 Thermo Environmental Model 146C Calibrator Certification, Revision 12.2, Sept. 17, 2014
Section 2.3.6 Protocol Gas Verification for Compressed Gas Cylinders Containing Either SO2, NO or CO, Revision 0, Nov. 30, 2009
Section 2.4 Total Suspended Particulate Standard Operating Procedure, Revision 9, July 1, 2003
Section 2.5 Particulate Matter 10 Microns, PM 10 Wedding Samplers, Revision 4, Oct. 1, 2001
Section 2.7.2 Procedures for Ozone Monitoring Site Calibration and Operation, Revision 6, Oct. 29, 2004
Section 2.8.1 Sulfur Dioxide Standard Operating Procedures for the Electronics and Calibration Branch, Revision 9, April 27, 2007
Section 2.8.2 Sulfur Dioxide Standard Operating Procedures for Operator Responsibilities, Revision 10, Dec. 1, 2012
Section 2.8.3 Regional Office Polling and Data Review: E-DAS set-up; Retrieval, Review, Correction and Storage of Data; Report Submission; QA Standard Operating Procedures, Revision 0, Oct. 26, 2006
Section 2.12.1 National Core (NCore) and State and Local Air Monitoring Station (SLAMS) Meteorological Monitoring Standard Operating Procedures, Electronics and Calibration Branch Responsibilities, Revision 1.5, July 1, 2015
Section 2.24.1 Particulate Matter 2.5 Standard Operating Procedures for the Electronics and Calibration Branch, Revision 2011, Jan. 1, 2011
Section 2.24.2 Particulate Matter 2.5 Standard Operating Procedures for Operators, Revision 2014, Jan. 1, 2014
Section 2.24.3 Particulate Matter 2.5 Standard Operating Procedures for Laboratory Responsibilities, Revision 2014, Aug. 8, 2014
Section 2.24.4 Particulate Matter 2.5 Standard Operating Procedures for Raleigh Central Office, Revision 1, Sept. 1, 2002
Section 2.27.1 Electronics and Calibration Branch Installation and Maintenance Responsibilities for the TEOM Continuous PM 2.5 and PM 10 Monitors, Revision 3, May 25, 2006
Section 2.27.2 Tapered Element Oscillating Microbalance (TEOM) Site Operator's Standard Operating Procedure, Revision 6, Sept. 1, 2011
Section 2.27.3 Lab Responsibilities for the TEOM Continuous Monitor Standard Operating Procedure, Revision 2, Mar. 10, 2006
Section 2.27.4 Raleigh Central Office Responsibilities for the TEOM Continuous Monitor Standard Operating Procedure, Revision 2, Mar. 10, 2006
Section 2.37.1 Installation, Calibration and Maintenance Responsibilities of the Electronics and Calibration Branch for the Met One Instruments Beta Attenuation Monitor, Revision 0, Oct. 8, 2008

Table 11-1. List of SOPs Associated with this Quality Assurance Project Plan

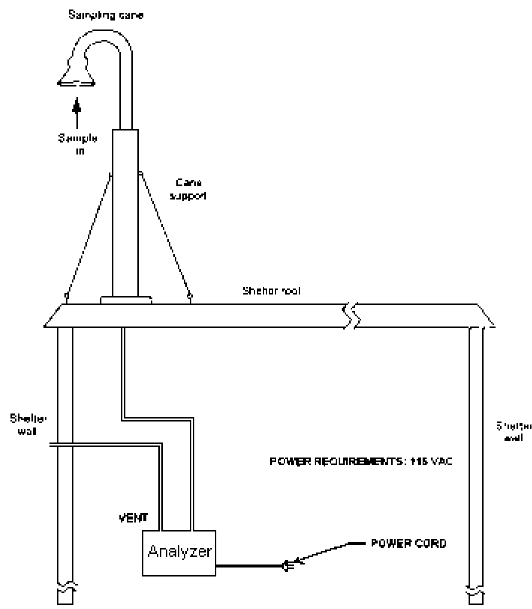
Section 2.37.2 Site Operator's Responsibilities for the Operation of the Met One Instruments Beta Attenuation Monitor (BAM 1020) and BAM 1020 with Touch Screen Option, Revision 4, Jan. 1, 2015
Section 2.39 SOP for Preparing SOPs for the DAQ, Revision 0, Nov. 1, 2010
Section 2.41.4 Data Review & Validation for Continuous Gaseous & Non-speciated Particulate Monitors, Raleigh Central Office Responsibilities, Revision 1.6, Oct. 15, 2014
Section 2.43 SOP for Completing the Annual Network Review for the DAQ, Revision 1, Aug. 7, 2015

Additional SOPs for NCore:

Section 2.3.5 Zero Air Pack Certification and Auditing, Revision 13, July 27, 2015
Section 2.34.1 Trace Level Sulfur Dioxide Standard Operating Procedures for the Electronics and Calibration Branch, Revision 1, Nov. 14, 2007
Section 2.34.2 Trace Level Sulfur Dioxide Standard Operating Procedures for Operator Responsibilities, Revision 1, Jan. 1, 2014
Section 2.36.1 Trace Level Carbon Monoxide Standard Operating Procedures for the Electronics and Calibration Branch, Revision 10.2, Oct. 12, 2011
Section 2.36.2 Trace Level Carbon Monoxide Standard Operating Procedures for Operator Responsibilities, Revision 4.4, Nov. 10, 2011
Section 2.38.1 Trace Level Reactive Oxides of Nitrogen Standard Operating Procedures for the Electronics and Calibration Branch, Revision 1.5, Aug. 17, 2014
Section 2.38.2 Trace Level Reactive Oxides of Nitrogen Standard Operating Procedures for Operator Responsibilities, Revision 5.4, Nov. 10, 2011
Section 2.44.1 Installation, Calibration and Maintenance Responsibilities of the Electronics and Calibration Branch for the URG Instruments 3000 N Monitor, Revision 0, Oct. 1, 2013
Section 2.45.1 Installation, Calibration and Maintenance Responsibilities of the Electronics and Calibration Branch for the Met One Instruments Super SASS Monitor, Revision 1, Aug. 1, 2013
Section 2.45.2 Site Operator's Responsibilities for the Operation of the Met One Instruments Super SASS Monitor, Revision 1, July 1, 2013

Single sample lines are used to provide sample air from the outside. The DAQ uses single sample lines for all of its analyzers as shown in Figure 11-1. The analyzers draw samples from the probe inlet. Criteria pollutant analyzers require that the probe material must be either borosilicate glass, or an acceptable inert plastic, such as polytetrafluoroethylene (PTFE or TFE), perfluoroalkoxy (PFA), or other Teflon®-type materials.

Figure 11-1. Teflon® Sampling Configuration.



Any probe design used must ensure that the probe material is non-reactive with the pollutant of interest. The probe, 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 or NCore pollutants may adsorb, or, if the impacted particle is metallic, catalyze to a non-criteria species. Additionally, the probe 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.

The residence time in the probe must be 20 seconds or less. If the physical configuration of the probe restricts the flow such that both of these constraints cannot be simultaneously met, then modify the physical configuration to rectify this deficiency. This may be accomplished by reducing the length of interconnecting tubing, increasing the tubing and/or decreasing the number of tube bends between the probe and the analyzer, or other alterations that allow the system to meet the residence time constraints.

All probe sample lines used should be replaced or cleaned at least once every 2 years or when the line is dirty or contaminated.

11.5 DAQ Ambient Air Monitoring Network Samplers

The analyzers used in the DAQ criteria pollutant and NCore ambient air monitoring network are listed in Table 11-2.

Table 11-2. DAQ Criteria Pollutant and NCore Ambient Air Monitoring Network Analyzers

Pollutant	Analyzer	EPA Reference/Equivalence
Ozone	Thermo Electron/ Thermo Environmental Instruments Model 49 i	EQOA-0880-047
Carbon Monoxide	Thermo Electron/ Thermo Environmental Instruments Model 48 i	RFCA-0981-054
Nitrogen Dioxide	Teledyne-Advanced Pollution Inst. 200EUP, T200UP	EQNA-0512-200
Reactive Oxides of Nitrogen (Trace Level)	Thermo Electron/ Thermo Environmental Instruments Model 42 i - y	Not applicable
Sulfur Dioxide	Thermo Environmental Instruments, Inc. Model 43C	EQSA-0486-060
Sulfur Dioxide (Trace Level)	Thermo Electron Model 43C TLE	EQSA-0486-060
PM_{10} filter based	Wedding & Associates Model 600 PM 10 High Volume Sampler Rupprecht and Patashnick Partisol®-Plus 2025 PM_{10} Sequential Air Sampler (with PM_{10} head & down tube)	RFPS-1087-062 RFPS-1298-127
PM_{10} continuous	Met One Instruments BAM 1020 (with PM_{10} head & down tube)	EQPM-0798-122
$PM_{2.5}$ filter based	Rupprecht & Patashnick Partisol®-Plus Model 2025 Sequential Air Sampler (with PM10 head and WINS or VSCC)	RFPS-0498-118
$PM_{2.5}$ continuous	Rupprecht & Patashnick TEOM 1400A (with PM10 head and SCC or VSCC) Met One BAM 1020 (with PM10 head and VSCC)	Not applicable EQPM-0798-122
$PM_{10-2.5}$ filter based	Rupprecht & Patashnick Partisol®-Plus Model 2025 Sequential Air Sampler	RFPS-0509-176
$PM_{2.5}$ speciated	Met One Super SASS URG 3000 N	Not applicable Not applicable
PM_{10} Lead	Rupprecht & Patashnick Partisol®-Plus Model 2025 Sequential Air Sampler (with PM_{10} head and downtube)	RFPS-1298-127

11.6. Sample Collection

All samples for criteria pollutants will be collected using FRMs or FEMs. For NCore pollutants, which lack FRMs or FEMs, other methods specified by the EPA will be followed. Procedures prepared by DAQ and set forth in the EPA approved QAPP and SOPs will be used.

11.7. Sampling / Measurement System Corrective Action

Corrective action measures in the ambient air quality monitoring network will be taken to ensure the DQOs are attained. There is the potential for many types of sampling and measurement system corrective actions. Each approved SOP details some expected problems and corrective actions needed for a well-run monitoring network.

11.8. Analyzer Audits

Audits 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 *QA Handbook for Air Pollution Measurement Systems: Volume II. Ambient Air Quality Monitoring Program* (EPA-454/B-13-003, May 2013)[5]. 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 SOP.

[5] http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf

12.0 SAMPLE CUSTODY PROCEDURE

Due to the potential use of data for comparison to the NAAQS and the requirement for extreme care in sample collection, sample custody procedures must be followed. An example of the chain of custody (COC) record form that will be used to track the stages of filter handling throughout the data collection operation is presented in Figure 12-1. These forms shall be supplied to site operators when necessary. Custody procedures are detailed in the individual approved SOPs.

Figure 12-1 Chain of Custody (COC) Record Form for High Volume Particle Samples

NORTH CAROLINA DIVISION OF AIR QUALITY
PARTICULATE MONITORING DATA SHEET (24 HOURS)

Office__________ AIRS Code 37-______-________

Site Name__________ AQCR __ __ __

Lab No. __A________
~ Void Filter ~ Radiation ~ Metals ~ Enforcement ~ Emergency Episode
~ Special Study ~ Microscopy ~ Collocated ~ Data Validation
Regional

T One	Pollutant	Method	Unit	Dec	YY	MM	DD	ST HR	µg/m³
	TP 11101	091	001	0					
	APM 81102	063	001	0					
	WPM 81102	062	001	0					

PM Only
Ps= mmHg
TS= K

PRESAMPLING CHAIN-OF-CUSTODY THAT LAB COMPLETES FOR ENFORCEMENT SAMPLES ONLY

Init Weighing Date	Lab Tech	Storage Location	Date/Time removed	Locked, Sealed & Relinquished by	Courier
Date	Sign	Date	From Storage/ Initials	to Courier	Type
1.2.1			1.2.2		

CHAIN-OF-CUSTODY THAT REGION COMPLETES FOR ENFORCEMENT SAMPLES ONLY

Locked/sealed (L/S) (1)	Signature or Status (2)	Date/Time (3)	Relinquished By (4)	Disposition
L / S Yes No	Box Opened By @ Region 1.2.3			Region Storage
Locked Yes No	Storage opened by 1.2.4		1.2.5	To Technician=s Container
Locked Yes No	From Technician=s Container 1.2.6			To Sampler
Locked Yes No	From Sampler 1.2.7			To Technician=s Container
Locked Yes No	From Technician=s Container 1.2.8			To Region Storage
Locked Yes No	From Region Storage 1.2.9			To Region Storage
Locked Yes No	From Region Storage 1.2.10			To Shipping Container
L / S Yes No	Anticipated date Container Shipped to Lab			Courier(type)

FIELD INFORMATION OPERATOR COMPLETES FOR ALL SAMPLES

Installed By	Removed By
Date/Time	Date/Time
Remarks	Remarks

Please Staple Recorder Chart
To White Sheet Only
Here

VFC Sampling Rate			Total Volume Sampled, M³	Elapsed Time (Minutes)		
Start	End	Qstd CFM		Final	- Initial	= Total
X	X	X		X	X	X
RO Reviewed By:				Date	Remarks	

Mass Flow Sampling Rate (OLD TSP)			Total Volume Sampled, M³	Elapsed Time (Minutes)		
Start	End	Avg CFM		Final	- Initial	= Total
X	X	X		X	X	X
RO Reviewed By:				Date	Remarks	

POSTSAMPLING CHAIN-OF-CUSTODY THAT LAB COMPLETES FOR ENFORCEMENT SAMPLES ONLY

Security Condition	Unlocked/Unsealed By	Date/Time Opened	Lab CoC Initiated By
L / S Yes No			
1.2.11			

PARTICULATE LABORATORY ANALYSIS COMPLETED FOR ALL SAMPLES

Filter No.	Final Wt.	Initial Wt.	Total Particulate	Other
	X	X	X	X
Reweighs	Final	Initial	Date of Analysis	
	X	X	Data Entry By:	Checked By:
Laboratory Remarks				
HQ Review By: Date:		HQ Process:	Remarks	

AQ-41 Revised 4-01-87 White, Yellow, and Pink AQ-41\WPFILES\QAPLANS

13.0 ANALYTICAL METHODS REQUIREMENTS

This section will identify the equipment and analytical methods required to complete the analyses of the samples provided from the criteria pollutant and NCore monitoring network. Where appropriate, the analytical methods will be identified by the regulatory citation, number, and date.

13.1. Purpose/Background

The analytical method employed for a specific criteria or NCore pollutant evaluation is dependent upon the monitoring technology utilized. For the gaseous criteria pollutants, SO_2, CO, NO, NO_2, NO_x, and O_3, as well as the gaseous NCore pollutants, SO_2, CO, NO, NO_y, 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 particulate matter criteria pollutants, PM_{10}, and $PM_{2.5}$, and the particulate matter NCore pollutants, $PM_{2.5}$, speciated $PM_{2.5}$, $PM_{10-2.5}$, and PM_{10} Pb, do require analytical methods to evaluate the captured sample in order to establish the pollutant concentrations present in the environment.

The Wedding PM_{10} monitor and the low volume PM_{10}, $PM_{2.5}$ and $PM_{10-2.5}$ FRM monitors employed for particulate matter monitoring utilize gravimetric analyses. The Green Square laboratory will conduct these analyses. A filter's net weight gain identifies the sample characteristic of interest, captured particulate mass. This net weight gain is obtained by subtracting the initial filter weight from the final weight of the exposed filter. Once calculated, the net weight gain can be used with the total filter flow to calculate the concentration for comparison to the daily and annual NAAQS. Since the method is non-destructive, and due to possible interest in sample composition (e.g., subsequent chemical analyses), the filters will be archived for a minimum of five years, after final gravimetric analyses has occurred.

The PM_{10} Pb and $PM_{2.5}$ speciation samples for NCore will be sent to the EPA contractor for analysis. The EPA contractor has an approved SOP that is followed for the sample analysis.

13.2. Preparation of Samples

The laboratory PM_{10} and PM2.5 filter processing SOPs, outlining activities associated with preparing pre-sample batches, will be followed. In addition to the primary and collocated sampler filters, field blanks, lab blanks, and flow check filters will also be prepared.

Upon delivery of EPA approved quartz and Teflon filters, their receipt will be documented and the filters stored in the conditioning/weighing room. Each box of filters will be labeled with the date of receipt, opened one at a time, and used completely before another is opened. All filters in a lot will be used before a case containing another lot is opened. Filters will be visually inspected according to the PM_{10} and $PM_{2.5}$ inspection criteria.

13.3. Analysis Method for Gravimetric Samples

13.3.1. Analytical Equipment and Method

The analytical instruments employed for sample analysis of the gaseous criteria pollutants have been identified and their specific technological methods detailed in Section 11.

The analytical instrument (analytical balance and microbalance) that will be used for analysis sampler method will be setup and calibrated yearly under contract to an outside vendor.

13.3.2. Conditioning and Weighing Room

The primary support facility for the PM_{10} and NC PM Network is the filter conditioning and weighing room at the Green Square laboratory. This laboratory is used to conduct pre-exposure weighing and post-exposure weighing of each PM_{10} and NCore PM filter sample. The laboratory is an environmentally controlled room with temperature and humidity controls. The temperature is kept between 20 and 23 °C. The relative humidity is controlled at between 35 and 40%. The temperature and relative humidity are measured and recorded every 5 minutes. The balance is located on a marble slab and is protected from or located out of the path of any sources of drafts.

13.4. Internal Quality Control and Corrective Actions for Measurement Systems

A QC notebook or database (with backups) will be maintained which will contain QC data, including the microbalance calibration and maintenance information, routine internal QC checks of mass reference standards and laboratory and field filter blanks, and external QA audits. These data will duplicate data recorded on laboratory data forms but will consolidate them so long-term trends can be identified. A QC chart will be maintained on each microbalance and included in this notebook/database.

At the beginning of each weighing session the analyst will zero and calibrate the analytical balance and weigh the working standards before the filters. One lab blank and one field blank will be weighed for every 10 samples weighed. A minimum of one lab and one field blank will be weighed per each weighing session. The balance will be re-zeroed between each weighing. After every tenth filter weighing the smaller working standard will be reweighed. The analyst will record the zero, working standard, and blank measurements in the laboratory data form and the laboratory QC notebook or database. If the working standard measurements differ from the certified values or the pre-exposure values by more than 3 µg, the analyst will repeat the working standard measurements. If the blank measurements differ from the pre-exposure values by more than 15 µg, the analyst will repeat the blank measurements. If the two measurements still disagree, the analyst will contact the Lab Analysis Branch supervisor, who may direct the analyst to:

1. Reweigh some or all of the previously weighed filters,
2. Recertify the working standard against the laboratory primary standard,
3. Conduct diagnostic troubleshooting, and/or
4. Arrange to have the original vendor or an independent, authorized service technician troubleshoot or repair the analytical balance or microbalance.

Corrective action measures in the PM_{10} and $PM_{2.5}$ systems will be taken to ensure good quality data. Filter weighing will be delayed until corrective actions are satisfactorily implemented.

14.0 QUALITY CONTROL REQUIREMENTS AND PROCEDURES

To assure the quality of data from air monitoring measurements, two distinct and important interrelated functions must be performed. One function is the control of the measurement process through broad QA activities, such as establishing policies and procedures, developing DQOs, assigning roles and responsibilities, conducting oversight and reviews, and implementing corrective actions. The other function is the control of the measurement process through the implementation of specific quality control procedures, such as audits, calibrations, checks, replicates, routine self-assessments, etc.

Quality control is the overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify they meet the stated requirements established by the end user. For the criteria pollutant and NCore ambient air quality monitoring networks, QC activities are used to ensure measurement uncertainty, as discussed in Section 7, is maintained within acceptance criteria for the attainment of the DQOs. Lists of pertinent QC checks are provided in the SOPs and instrument manuals.

Quality control is achieved through periodic maintenance; flow rate audits; acceptance test procedures; accuracy, bias, and precision checks; and collocated instruments, control charts, and other verification techniques. Specific quality control procedures are found in Tables 7.2 thru 7.9

14.1. Calibrations

Calibration is the process used to verify and rectify an instrument's measurements to minimize deviation from a standard. This multiphase process begins with certifying a calibration or transfer standard against an authoritative standard. The sampling or analytical instrument's measurements are compared to this calibration/transfer standard. If significant deviations exist between the instrument's measurements and the calibration/transfer standard's measurements, corrective action is implemented to rectify the analytical instrument's measurements.

Calibration requirements for the critical field and laboratory equipment are found in the SOPs and in the specific instruments' operations manuals.

14.2. Precision Checks

Precision is the measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. In order to meet the DQOs for precision, DAQ will ensure the entire measurement process is within statistical control. Various tools will be employed in evaluating and monitoring precision measurements. Periodically exercising instruments with zero and span checks, employing collocated monitoring, and monitoring data integrity with control charts will provide evidence of deviations from the required precision measurement. Fifteen percent of all manual PM_{10} network sites and the NCore $PM_{2.5}$ monitor will be outfitted with collocated monitors to actively support precision checks. Precision requirements for the applicable instrumentation are found in the SOPs and in the specific instruments' operations manuals.

14.3. Accuracy or Bias Checks

Accuracy is defined as the degree of agreement between an observed value and an accepted reference value. Accuracy is a combination of random error (precision), and systematic error (bias). Although collocated monitors are primarily used for evaluating and controlling precision, they can also be used to determine accuracy or bias. By employing percent difference calculations and plotting the results on control charts, trends can be observed that indicate bias occurring within the measurements. In addition to collocated monitors, daily zero and span checks can also provide data capable of identifying bias. Accuracy or bias requirements for various types of instrumentation are found in the SOPs and in the specific instruments' operations manuals.

14.4. Flow Rate Audits

For instruments that monitor flow, a flow rate audit will be performed at least every 6 months and preferably every quarter. The audit is made by measuring the analyzer's normal operating flow rate using a certified flow rate transfer standard. The flow rate standard used for auditing may not be the same flow rate standard used to calibrate the analyzer. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate or volume standard. Document the audit (actual) flow rate and the corresponding flow rate measured by the sampler in the calibration worksheet associated with the equipment undergoing calibration. Details for implementing flow audits may be found in the applicable instruments' operations manuals, and in the appropriate SOPs.

14.5. Balance Checks

Balance checks are frequent checks of the balance working standards (5 and 50 g standards for the analytical balance and 100 and 200 mg standards for the microbalance) against the laboratory balance to ensure that it is within acceptance criteria throughout weighing sessions. The laboratory will use ASTM class 1 weights for its primary and secondary (working) standards. Both working standards will be measured at the beginning of each weighing session. Additionally, the 5 g and 200 mg weights will be weighed after every 10 filters and at the end of each weighing session.

15.0 EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

15.1. Purpose/Background

This section discusses the procedures used to verify that all instruments and equipment are maintained in sound operating condition and are capable of operating at acceptable performance levels. All instrument inspection and maintenance activities must be documented and filed. See Section 9 for document and record details.

15.2. Testing

All gaseous criteria and particulate matter pollutant monitors used in the criteria pollutant and NCore ambient air quality monitoring network shall be certified to adhere to EPA equivalent or reference methods, where such methods exist. For NCore measurements where EPA equivalent or reference methods are not available, DAQ will follow EPA guidance. Therefore, the monitors and procedures used are assumed to be of sufficient quality for the data collection operation. The model designations are identified in Table 11-1.

Prior to field installation, the particulate samplers are assembled and operated at the Electronic and Calibration Branch (ECB). The ECB technicians will perform external and internal leak checks and temperature, pressure, and flow rate multi-point verification checks. If any of these checks are out of specification, the ECB will contact the vendor for initial corrective action. Once installed at the site, the field operators will again run the tests mentioned above. If the sampling instrument meets the acceptance criteria, it will be assumed to be operating properly.

Prior to field installation of the gaseous criteria pollutant monitors, the analyzers shall successfully undergo zero/span and multi-point calibrations. Following site installation, the field operators will initiate, observe, and document the successful completion of a zero/span cycle. If the analyzers meet the acceptance criteria, they will be assumed to be operating properly. These tests will be properly documented and filed as indicated in Section 9.

15.3. Inspection

A discussion of the necessary inspections of various equipment and components is provided here. Inspections are subdivided into two sections: one pertaining to conditioning/weighing room issues and one associated with field activities.

15.3.1. Inspections in Conditioning/Weighing Room

There are several items that need routine inspection in the weighing room laboratory. The SOP details the items to inspect and how to appropriately document the inspections.

15.3.2. Inspections of Field Items

There are several items that periodically require field inspection. These items are identified and procedures are presented in the applicable equipment SOPs and operations manuals.

16.0 INSTRUMENT CALIBRATION AND FREQUENCY

The ECB of the DAQ is responsible for procuring and maintaining dedicated traceable standards and gasses for the certification of the ambient air quality monitoring systems. These standards provide a direct link to established national standards (i.e. NIST) and are the foundation for the collection of the highest quality ambient air pollution data possible in accordance with current procedures and existing federal regulations and guidelines.

16.1. Calibration of Local Primary Standards

16.1.1. ASTM Class 1 Weights

The ASTM class 1 weights that will be used to calibrate the laboratory analytical and microbalances will be recertified annually. During the annual visit by the service technician, the in-house primary standard weights will be checked against the service technician's standards to ensure acceptability. These actions will be documented in the service technician's report, a copy of which will be provided to the Lab Analysis Branch supervisor, which after review, will be appropriately filed (see Section 9).

16.1.2. Local Primary Flow Rate Standard

The local primary flow rate standard used to calibrate the field flow rate transfer standards will be maintained and recertified against a NIST-traceable flow rate standard by the manufacturer every 365 days.

16.1.3. Local Primary Temperature Standard

The local primary temperature standard used to verify the accuracy of the field temperature transfer standards will be an Omega Digital Thermometer DPT-1 with a bridge sensor and will be recertified against a NIST primary standard every 365 days.

16.1.4. Local Primary Pressure Standard

The local primary pressure standard used to verify the accuracy of the field barometer transfer standards will be a Mensor Model # 2500. It will be recertified every 365 days.

16.1.5 Calibration Gases

All zero air and calibration gasses should be NIST traceable and include but not limited to the following information:

Cylinder serial number
Recertification status
Gas type (e.g. NO, CO, SO_2, etc.)
PSI (double-checked upon receipt)
Impurity
Expiration date

16.1.6 Ozone Primary Standard

At least once every 365 days, the North Carolina standard ozone photometer (NCSOP) is compared to an SRP. The EPA maintains SRPs to set the standard for all ambient air O_3 measurements made nationwide. The NCSOP serves as the reference standard for all ambient air O_3 measurements made by DAQ.

16.1.7 Alicat Mass Flow Controllers

The Alicat Mass Flow Controllers will have their own certification and will be re-verified or recertified at least annually.

16.2. Calibration of Transfer Standards

16.2.1. Flow Transfer Standards

The field flow transfer standards used for flow rate calibration will have their own certifications and will be traceable to the factory primary flow rate standard. The ECB will employ either an automatic dry-piston flow meter or the manufacturer provided streamline flow transfer standard for field calibrations and flow rate verifications of the flow rates of the network samplers. Both devices have the advantage of providing volumetric flow rate values directly, without requiring conversion for mass flow measurements, temperature, pressure, or water vapor content. The manufacturer establishes (and verifies as needed) a calibration relationship for the flow rate standard, such as an equation, curve, or family of curves, as accurate to within 2% over the expected range of ambient temperatures and pressures at which the flow rate standard is used. The flow rate standards shall be recalibrated and recertified at least annually.

16.2.2. Temperature Transfer Standards

The field temperature transfer standards used for calibration of temperature sensors will be mineral thermometers that have their own certification. They will be re-verified/recertified at least annually against the local primary temperature standard, or auditor’s transfer standard, to within 1 °C, over the expected range of ambient temperatures at which the temperature standard is to be used.

16.2.3. Pressure Transfer Standards

The field pressure transfer standards will be handheld digital barometers that will have their own certification and will be re-verified or recertified at least annually against the local primary pressure standard.

16.2.4 Calibration Gasses

The calibration gas standards will have their own certifications and will be re-verified or recertified after 4 years for 1 to 50 ppm SO2 in nitrogen standards, after 3 years for 0.5 to 50 ppm NO in oxygen-free nitrogen standards and after 8 years for 500 ppb to 10 percent CO in air standards.

16.2.5 Calibrators

The Thermo Environmental 146C and 146i calibrators are used as field calibration devices and audit devices for O_3, CO, NO_y, sulfur dioxide, and ammonia continuous monitoring. Teledyne API T700U calibrators are used as field calibration devices and audit devices for NO_2 monitoring. Field calibrators are certified every 12 months and audit calibrators every one and one half quarters (18 weeks, not to exceed 126 days between consecutive certifications) by Alicat flow measurement units.

16.2.6 Site Primary Ozone Standard

The site primary ozone standard is compared to the NCSOP each year by the ECB to establish a direct response data link to the SRP. During the yearly certification of the site primary ozone standard the ECB performs all necessary response adjustments to the site primary ozone standard to duplicate the concentration response of the North Carolina ozone primary photometer.

The certified site primary ozone standard is the source of known concentration of O_3 utilized in the calibration of the site ambient air ozone monitor. During the calibration procedure the site ambient air ozone monitor is adjusted to duplicate the concentration of O_3 produced by the site primary ozone standard. This monitor calibration procedure establishes a direct link to the NCSOP and the EPA SRP

The calibration will have its own certification and will be re-verified or recertified at least annually.

16.3. Calibration of Laboratory/Field Equipment

The specific calibration procedures for the laboratory and field equipment can be found in the applicable SOPs or operation manuals.

16.4. Document Calibration Frequency

See the appropriate SOP for field QC checks that include frequency and acceptance criteria and references for calibration and verification tests of single and sequential sampler flow rates, temperature, pressure, and time. See the laboratory SOP for a similar summary of laboratory QC checks, including the frequency of primary and working mass standards and conditioning/weigh room temperature and relative humidity.

The field sampler flow rate, temperature, and pressure sensor verification checks include one-point checks at least monthly and multipoint checks (calibration without adjustment unless needed as determined independently and then performed by the vendor’s authorized service representative) at least annually, as documented by tracking on control charts.

All of these events, as well as sampler and calibration equipment maintenance, will be documented in field data records and logbooks and annotated with the flags required in Appendix L of 40 CFR Part 50 and the manufacturer’s operating instruction manuals. Laboratory and field activities associated with equipment used by the technical staff will be kept in record logbooks as well. The records will normally be controlled by the laboratory and/or regional chemists and located in the laboratories or field sites when in use or at regional offices when being reviewed or used for data validation.

17.0 NON-DIRECT MEASUREMENTS

This section addresses data not obtained by direct measurement from the criteria pollutant and NCore ambient air quality monitoring programs. This includes data from outside sources and historical monitoring data. At this time, DAQ has not formally determined the types of additional data that may be needed in support of these monitoring programs. Possible databases and types of data and information that might be used include:

- Chemical and physical properties data
- Sampler manufacturers' operational literature
- Geographic location data
- Historical monitoring information
- External monitoring databases
- Lead and speciated particulate data
- National Weather Service data and
- Traffic count data from the North Carolina Department of Transportation

Any use of outside data will be quality controlled to the extent possible following QA procedures outlined in this document and in applicable EPA guidance documents.

18.0 DATA MANAGEMENT

18.1. Purpose/Background

The following section identifies the processes and procedures to follow to acquire, transmit, transform, reduce, analyze, store, and retrieve data. These processes and procedures maintain the data integrity and validity through application of the identified data custody protocols.

18.2. Data Recording

The majority of run-data collected in DAQ's network is recorded electronically. To accomplish this, each monitoring site is equipped with Environmental Systems Corporation data loggers (model 8816 and/or 8832). A data logger is set up to record each monitor's output, perform specific data manipulations, and format the resulting data in preparation for downloading to a database or spreadsheet. Electronic logs are kept for most parameters, documenting the operators' actions in running the sampling systems (Figures 18-1 through 18-16). Activities such as operational checks, leak check results, flow check results, audit results, filter changes, and calibrations are kept on spreadsheets maintained by the operators.

Data that require manual entry are recorded onto the appropriate data sheets (Figures 18-17 through 18-36). For filter-based data collections such as FRM $PM_{2.5}$ and the Speciation Trends Network (STN), filter weights are entered onto individual filter tracking sheets generated by the weighing labs and completed in the field by the regional operators. Sampler runtime data are transferred to the sheets and recorded in spreadsheets directly from the sampling instrument download histories. The exposed filters are returned to the respective laboratories for post-sampling analysis according to protocols. The final results are extracted and recorded to a database to complete the manual data recording effort.

18.3. Data Validation

Each of the network's analytical instruments employed to measure meteorological conditions and the ambient concentrations of the criteria and NCore pollutants undergoes periodic audits, one-point quality control checks and calibrations. These procedures are outlined in the appropriate SOPs. Performance audits and one-point quality control checks ascertain the accuracy, precision and repeatability of each instrument in performing its required function.

The instrument-generated data are stored on site in the data logger. When the data are accessed through the wireless modems, they are downloaded to a database where they undergo verification, reduction and analysis. Data verification is performed electronically by searching the data for status flags and comparing reported values to acceptable range criteria. After data are flagged as questionable, regional and central office chemists evaluate the flagged data to identify underlying causes and decide whether the data are valid. If the data are invalid, they are not used in calculations. If the data are valid, but flagged due to some extenuating circumstance, then the data will be used in calculations, accompanied by a comment documenting the situation.

Figure 18-1 Sample Data Entry Form – Ozone calibration

Date	6/3/2016
Site	Purchase Knob
Operator	SE
Ambient Air Ozone ppb	0

Ozone Monitor Calibration

EPA Temperature Requirement for Calibration is 20-30° C

Site Temperature	25
Adjusted Site Temp If Applicable	0

Step One

Site Documentation Must be Completed prior to starting the Calibration Procedure

Step Two

Particulate Filter Change and Conditioning - Immediately Prior to All Calibrations

New Filter Y/N		Leak Checked Y/N	

Acceptance Criteria	*i*PS	O3
*i*PS Compared to Theoretical	225 ≤ ± 2 ppb	≤ *i*PS ± 5 ppb
O3 Compared to *i*PS	0 ≤ ± 2 ppb	≤ *i*PS ± 3 ppb

Calibration Filter Conditioning: Filter is Conditioned for a minimum of 10 minutes after values stabilize. Then Record 5 x 1 minute values below.

Level 4 Event 225 ppb		
Time		
Reading	*i*PS	O3
1		
2		
3		
4		
5		
Avg.	0.0	0.0

Zero Event 0 ppb		
Time		
Reading	*i*PS	O3
1		
2		
3		
4		
5		
Avg.	0.0	0.0

Filter Conditioning Evaluation

UNACCEPTABLE

Action

Check for Leaks and Recondition the Filter a Second Time or Replace with a New filter and Re-Run Conditioning Procedure

If 2nd Filter Conditioning FAILS Notify PPB and ECB.

Step Three

Ozone Monitor Calibration Data

Zero Event 0 ppb		
Time		
Reading	*i*PS	O3
1		
2		
3		
4		
5		
Avg	0.0	0.0

Level 4 Event 225 ppb		
Time		
Reading	*i*PS	O3
1		
2		
3		
4		
5		
Avg	0.0	0.0

Level 3 Event 120 ppb		
Time		
Reading	*i*PS	O3
1		
2		
3		
4		
5		
Avg	0.0	0.0

Level 2 Event 70 ppb		
Time		
Reading	*i*PS	O3
1		
2		
3		
4		
5		
Avg	0.0	0.0

Step Four

Calibration Evaluation

*i*PS Values are compared to Theoretical Values	Acceptance Criteria		O3 values are compared to *i*PS values
	***i*PS**	**O3**	
	0 ppb ± 2	≤ *i*PS ± 2	
	70 ppb ± 2	≤ *i*PS ± 2	
	120 ppb ± 2	≤ *i*PS ± 2	
	225 ppb ± 2	≤ *i*PS ± 2	

Site Transfer Standard	Unacceptable Performance
Monitor	Acceptable Performance

Calibration Invalid -- Site Transfer Standard Exceeds Limits Notify PPB and ECB

Step Five

Calibration Factor Evaluation

Background Factor	> -3 & < +3
Ozone Coefficient	>0.95 & < 1.05

Enter Monitor Background Factor	
Enter Monitor Ozone Coefficient Factor	

Unacceptable

Cal Factor Evaluation Actions: Check for Leaks and Perform Calibration Procedure a Second Time, If Second Calibration Fails Calibration Factor Evaluation Notify PPB and ECB

Step Six	Has the 49i Ozone Monitor been returned to the Lock Mode ?	Yes/No/NA	

Operator Comments	Regional Chemist Review Comments

Figure 18-2 Sample Data Entry Form – Ozone On-site Check

Date	6/3/16
Site	Purchase Knob
Operator	SE

Initial Site Temperature	25
Site Temperature Criteria 20 - 30 °	
Adjusted Site Temperature if Applicable	0

On-Site Calibration-Check

Required Following
Failed Daily Auto-Calibration Checks
Failed Office Actuated Calibration Checks

Version 3.42 2016

Site Documentation must be Completed First during Each Site Visit

Time	0:00

Step One

Ambient Air Ozone Concentration Evaluation Prior to Start of the Calibration Check	0	PROCEED if the Daily Auto-Calibration Check FAILED. If possble perform this monitor evaluation step using the 9:12 Rule.

Step Two

On-Site Calibration Check

Acceptance Criteria

iPS values are compared to Theoretical Values	iPS	O3	O3 Values are Compared to iPS Values
	0 ppb ± 2 ppb	≤ iPS ± 2 ppb	
	70 ppb ± 2 ppb	≤ iPS ± 3 ppb	
	225 ppb ± 2 ppb	≤ iPS ± 5 ppb	

Zero Event		0 ppb	Level 2 Event		70 ppb	Level 4 Event		225 ppb
TIME			TIME			TIME		
Reading	iPS	O3	Reading	iPS	O3	Reading	iPS	O3
1			1			1		
2			2			2		
3			3			3		
4			4			4		
5			5			5		
Avg	0.0	0.0	Avg	0.0	0.0	Avg	0.0	0.0

Step Three

On-Site Calibration Check Evaluation

Site Transfer Standard	Unacceptable Performance
Ozone Monitor	Acceptable Performance
Action	Site Transfer Standard Exceeds Limits, Do Not Proceed Contact PPB and ECB

Step Four

If the Ozone Monitor PASSES the On-Site Calibration Check Acceptance Criteria

Ambient Air Ozone Conc.	Performing a Particulate Filter Change is Conditional
0	If the site operator has time is available, the changing and conditioning of a new sample line particulate filter is recommended only if such time will not result in the loss of an hour of monitoring data when the ambient air ozone is ≥ 60 ppb which will result in a falsely high 8-Hour average ozone concentration and potentially even a false exceedance being reported.

Operator Comments	Regional Chemist Review Comments
3	

Figure 18-3 Sample Data Entry Form – Criteria SO2 1-Pt QC Check / Calibration

SO_2 MANUAL CALIBRATION CHECK (Version 5, December, 2012)

Site: 0 | Date: 1/0/1900 | Operator: 0

Analyzer Range (ppb): 0

Cylinder Conc., ppm: 0.00

From 146C Readings

Span	Flow Rate (Gas, sccm)	Flow Rate (Air, sccm)	146C (SO2, ppb)	Target Value Nominal ppb
0			#DIV/0!	0.00
1			#DIV/0!	400
2			#DIV/0!	100
4			#DIV/0!	70

CALIBRATION CHECK

(record 5 consecutive 1-minute average values from the Datalogger)

SO2	ZERO			SPAN 1 (70-90%)			SPAN 2 (40-60%)			SPAN 4 (10 - 100 ppb)		
	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb
	1			1			1			1		
	2			2			2			2		
	3			3			3			3		
	4			4			4			4		
	5			5			5			5		
	Avg ppb		#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!	Avg ppb		#DIV/0!
	Difference, ppb		#DIV/0!		% Difference	#DIV/0!		% Difference	#DIV/0!	Difference, ppb		#DIV/0!
Acceptable (Yes/No):			#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!
Acceptable Range:	Difference ± 3 ppb			% Difference ± 5			% Difference ± 5			Difference ± 3 ppb		

SO_2 MANUAL CALIBRATION (Version 5, December, 2012)

Site: 0 | Date: 01/00/00 | Operator: 0

Analyzer Range (ppb): 0

Cylinder Conc., ppm: 0.0

From 146C Readings

Span	Flow Rate (Gas, sccm)	Flow Rate (Air, sccm)	146C (SO2, ppb)	Target Value Nominal ppb
0			#DIV/0!	0.00
1			#DIV/0!	400
2			#DIV/0!	100
3			#DIV/0!	45

Calibration Factor Information

	Before Calibration	After Calibration	Expected Range
SO2 Background			0-50 ppb
SO2 Coefficient			0.900-1.100

CALIBRATION

(record 5 consecutive 1-minute average values from the data logger)

SO2	Attempt One						Attempt Two, If Needed					
	ZERO			SPAN 1 (70-90%)			ZERO			SPAN 1 (70-90%)		
	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb
	1			1			1			1		
	2			2			2			2		
	3			3			3			3		
	4			4			4			4		
	5			5			5			5		
	Avg ppb		#DIV/0!		Avg ppb	#DIV/0!	Avg ppb		#DIV/0!		Avg ppb	#DIV/0!
	Difference, ppb		#DIV/0!		% Difference	#DIV/0!	Difference, ppb		#DIV/0!		% Difference	#DIV/0!
Acceptable (Yes/No):			#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!
Acceptable Range:	Difference ± 2 ppb			% Difference ± 5			Difference ± 2 ppb			% Difference ± 5		

CALIBRATION VERIFICATION

[record 5 consecutive 1-minute average values from the Datalogger]

SO2	ZERO			SPAN 1 (70-90%)			SPAN 2 (40-60%)			SPAN 3 (10-100 ppb)		
	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb
	1			1			1			1		
	2			2			2			2		
	3			3			3			3		
	4			4			4			4		
	5			5			5			5		
	Avg ppb		#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!	Avg ppb		#DIV/0!
	Difference, ppb		#DIV/0!		% Difference	#DIV/0!		% Difference	#DIV/0!	Difference, ppb		#DIV/0!
Acceptable (Yes/No):			#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!
Acceptable Range:	Difference ± 2 ppb			% Difference ± 5			% Difference ± 5			Difference ± 3 ppb		

Figure 18-4 Sample Data Entry Form – Criteria SO2 site visit

SO_2 SITE INFORMATION (Version 5, December, 2012)

Site: ____ **Time:** ____ (hh:mm) **Date:** ____ (mm/dd/yy) **Operator:** ____

Routine Site Inspection

Bldg Secure ? (Y/N):
Sample Line Inlet in Place? (Y/N):
Bldg Power On (Y/N):
Sample Line OK? (Y/N):

Bldg Temp (Deg. C): **Sensor** ____ **NIST** ____ OK
(+/- 2 degrees C)

SO_2 Analyzer

Model Type: ____ (43C/43C-TLE) Serial No. ____ Range: ____ (ppb)

Cooling Fan/Filter OK? (Y/N)):
Date Fan Filter Cleaned:
Date Particulate Filter Changed:
Internal Temp.(15-35C)
Chamber Temp.(43-47C)
Pressure (650-800mmHg)
Flow (0.35-0.65 Lpm)

Date of Most Recent Calibration (mm/dd/yy)
Sample Port Leak Check OK ? (<180mmHg and 0.0 lpm) (Y/N):
Span Port Leak Check OK ? (<180mmHg and 0.0 lpm) (Y/N):
Alarms?

146C Calibrator Information

Serial No.:
Expiration Date: (mm/dd/yy)
Days Left: -42241
Cooling Fan/Filter OK? (Y/N):
Date Fan Filter Cleaned:

Cylinder Information

Cylinder No.:
Expiration Date:
Days Left: -42241
Concentration: (ppm)
Alarms?:

Cylinder Press. (>500 psig):
Delivery Press.(30 psig):

Zero Air Pack

Serial No.:
Expiration Date: (mm/dd/yy)
Days Left: -42241
Silica Gel Checked (Y/N):
Date Silica Gel Changed:

Delivery Air Pressure (30 +/- 2 psig)
Compressor Pressure (40 to 45 psig):
Air Compressor drained ? (Y/N):

Site computer/Data Logger Information

	Date (mm/dd/yy)		Time (hh:mm)	
Site Computer:		Warning		Warning
Data Logger :		Warning		
NIST:		Warning		

(Site Computer Must Agree With Data Logger Retarded By 5 Min)
(Data Logger Must Be Within ± 1 Minute of NIST Time)

Notes

Figure 18-5 Sample Data Entry Form – NCore SO2 1-Pt QC Check / Calibration

SO_2T MANUAL CALIBRATION

Version 6, March 2016

Site Code: MQ   Date: 04/25/16   Operator: TTSkelding

Analyzer Range (ppb): 100

Cylinder Conc. (ppb): 10.7

Calibrator Readings

Span	Flow Rate	Flow Rate	Expected	Target Value
	(Gas, sccm)	(Air, sccm)	(SO2, ppb)	Nominal ppb
0			#DIV/0!	0.00
1			#DIV/0!	85
2			#DIV/0!	45
3			#DIV/0!	7

Calibration Factor Information

	Before Calibration	After Calibration	Expected Range
SO2 Background			0-50 ppb
SO2 Coefficient			0.900-1.100

CALIBRATION

(record 5 consecutive 1-minute average values from the Datalogger)

Attempt One						Attempt Two, If Needed					
ZERO			SPAN 1			ZERO			SPAN 1		
Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
	Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!
	Difference (ppb)	#DIV/0!		Difference (ppb)	#DIV/0!		Difference (ppb)	#DIV/0!		Difference (ppb)	#DIV/0!
Acceptable (Yes/No):		#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!

CALIBRATION VERIFICATION

(record 5 consecutive 1-minute average values from the Datalogger)

ZERO			SPAN 1			SPAN 2			SPAN 3		
Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
	Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!
	Difference (ppb)	#DIV/0!		% Difference	#DIV/0!		% Difference	#DIV/0!		Difference (ppb)	#DIV/0!
Acceptable (Yes/No):		#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!

SO_2T MANUAL CALIBRATION CHECK

Version 6, March 2016

Site: MQ   Date: 4/25/2016   Operator: TTSkelding

Analyzer Range (ppb): 100

Cylinder Conc. (ppm): 10.70

Calibrator Readings

Span	Flow Rate	Flow Rate	Expected	Target Value
	(Gas, sccm)	(Air, sccm)	(SO2, ppb)	Nominal ppb
0			#DIV/0!	0.00
1			#DIV/0!	85
2			#DIV/0!	45
4			#DIV/0!	10

ZERO			SPAN 1 (70-90%)			SPAN 2 (40-60%)			SPAN 4 (10 - 100 pbb)		
Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
	Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!
	Difference (ppb)	#DIV/0!		% Difference	#DIV/0!		% Difference	#DIV/0!		Difference (ppb)	#DIV/0!
Acceptable (Yes/No):		#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!
Acceptable Range:	Difference ± 2 ppb			Difference ± 3 ppb			Difference ± 3 ppb			Difference ± 3 ppb	

Figure 18-6 Sample Data Entry Form – NCore SO2 site visit

SO_2T SITE INFORMATION

Version 6, March 2016

Site: ______ **Time:** ______ (hh:mm) **Date:** ______ (mm/dd/yy) **Operator:** ______

Routine Site Inspection

				Data Logger	NIST	
Bldg Secure ? (Y/N):						
Sample Line Inlet in Place? (Y/N):			Bldg Temp (Deg. C):			OK
Bldg Power On (Y/N):				(+/- 2 degrees C)		
Sample Line OK? (Y/N):						

SO_2 Analyzer

Model Type: ______ Serial No. ______ Range (ppb): ______

Cooling Fan/Filter OK? (Y/N):		Date Particulate Filter Changed:	
Date Fan Filter Cleaned:		Pre-filter Change Sample Port Leak Check OK? (Y/N):	
Date of Most Recent Calibration:		Pre-filter Change Span Port Leak Check OK? (Y/N):	
Internal Temp. (C: 15-35C, i: 15-45C):		Post-filter Change Sample Port Leak Check OK? (Y/N):	
Chamber Temp. (all models: 43-47C):		Post-filter Change Span Port Leak Check OK? (Y/N):	
Pressure (C: 650-800mmHg):		Alarms?	
(i: 400-1000mmHg)			
Flow (C: 0.35-0.65 lpm, 0.35-0.75 lpm):			

Calibrator Information		**Cylinder Information**	
Serial No.:		Cylinder No.:	
Expiration Date: (mm/dd/yy)		Expiration Date:	
Days Left:	-42556	Days Left:	-42556
Cooling Fan/Filter OK? (Y/N):		Concentration: (ppm)	
Date Fan Filter Cleaned:		Cylinder Press. (>500 psig):	
Recorded Cylinder Conc. (ppm):		Delivery Press. (30 psig):	
		Alarms?:	

Zero Air Pack

Serial No.:		Delivery Air Pressure (30 +/- 2 psig)	
Expiration Date: (mm/dd/yy)		Air Compressor drained ? (Y/N):	
Days Left:	-42556		

Site computer/Data Logger Information

	Date (mm/dd/yy)	Time (hh:mm)	
Site Computer:			
Data Logger :			
NIST:			(Data Logger Must Be Within ± 1 Minute of NIST Time)

Notes

Figure 18-7 Sample Data Entry Form – NO-NO2-NOx check / calibration

CALIBRATION GAS (NO2 E-LOG)

Site: 0 | Date: 1/0/00 | Time: 0:00 | Operator: 0

Cylinder NO Conc. = 0

Span	Flow Rate (sccm)	Flow Rate (sccm)	T700U	T700U	T700U
	(CAL)	(DIL)	NO ppb	NO2 ppb	NOx ppb
0			#DIV/0!	#DIV/0!	#DIV/0!
1			#DIV/0!	#DIV/0!	#DIV/0!
2			#DIV/0!	#DIV/0!	#DIV/0!
3			#DIV/0!	#DIV/0!	#DIV/0!

ZERO	Data Logger		
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!

	diff ± 1 ppb		
Acceptable:	#DIV/0!	#DIV/0!	#DIV/0!

SPAN 2	Data Logger		
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	#DIV/0!		#DIV/0!

	[diff ± 4%]		[diff ± 4%]
Acceptable:	#DIV/0!		#DIV/0!

SPAN 1	Data Logger		
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	#DIV/0!		#DIV/0!

	[diff ± 3%]		[diff ± 3%]
Acceptable:	#DIV/0!		#DIV/0!

SPAN 3	Data Logger		
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	#DIV/0!		#DIV/0!

	[diff ± 5%]		[diff ± 5%]
Acceptable:	#DIV/0!		#DIV/0!

Comments/Notes:

Figure 18-8 Sample Data Entry Form – NO-NO2-NOx check / calibration

CAL GAS PHASE TITRATION (NO2 E-LOG)

Site: 0 | Date: 1/0/00 | Time: 0:00 | Operator: 0

GPTZ Settings Entered		
NO		ppb
O3		ppb
Ftotal		sccm

T700U DISPLAY GPTZ		
NO		ppb
CAL		sccm
DIL		sccm

80-90% FS GPTZ Titration "CALB"

Data Logger			
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!

80-90% FS GPTPS / GPT "CALB"

Data Logger			
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!

80-90% FS Calibration "CALB"

Data Logger			
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!

GPTZ (NO)	#DIV/0!	ppb
GPT (NO)	#DIV/0!	ppb
→ NO2B (O3)	#DIV/0!	ppb

After Adj. Converter Efficiency

SETB Gain	

GPTZ Settings Entered		
NO		ppb
O3		ppb
Ftotal		sccm

T700U DISPLAY GPTZ		
NO		ppb
CAL		sccm
DIL		sccm

10-20% FS GPTZ Titration "CALA"

Data Logger			
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!

10-20% FS GPTPS / GPT "CALA"

Data Logger			
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!

10-20% FS Calibration "CALA"

Data Logger			
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!

GPTZ (NO)	#DIV/0!	ppb
GPT (NO)	#DIV/0!	ppb
→ NO2A (O3)	#DIV/0!	ppb

After Adj. Converter Efficiency

SETA Gain	

Comments/Notes:

Figure 18-9 Sample Data Entry Form – NO-NO2-NOx check / calibration

GAS CALIBRATION CHECK (NO2 E-LOG)

Site:	0	Date:	1/0/00	Time:	0:00	Operator:	0

Cylinder NO conc. = 0

Span	Flow Rate (sccm)	Flow Rate (sccm)	T700U	T700U	T700U
	(CAL)	(DIL)	NO ppb	NO2 ppb	NOx ppb
0			#DIV/0!	#DIV/0!	#DIV/0!
1			#DIV/0!	#DIV/0!	#DIV/0!
2			#DIV/0!	#DIV/0!	#DIV/0!
3			#DIV/0!	#DIV/0!	#DIV/0!

ZERO	Data Logger		
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!
	diff ± 1ppb		
Acceptable:	#DIV/0!	#DIV/0!	#DIV/0!

SPAN 2	Data Logger		
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	#DIV/0!		#DIV/0!
	[% diff ± 8%]		[% diff ± 8%]
Acceptable:	#DIV/0!		#DIV/0!

SPAN 1	Data Logger		
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	#DIV/0!		#DIV/0!
	[% diff ± 8%]		[% diff ± 8%]
Acceptable:	#DIV/0!		#DIV/0!

SPAN 3	Data Logger		
Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	#DIV/0!		#DIV/0!
	[% diff ± 8%]		[% diff ± 8%]
Acceptable:	#DIV/0!		#DIV/0!

Comments/Notes:

Figure 18-10 Sample Data Entry Form – NO-NO2-NOx check / calibration

CHECK GAS PHASE TITRATION (NO2 E-LOG)

Site: 0 | Date: 1/0/00 | Time: 0:00 | Operator: 0

Span	Flow Rate (sccm)	Flow Rate (sccm)
	(CAL)	(DIL)
CALB		

80-90% FS Calibration "CALB"
(copy/paste from latest calibration)

NO ppb	NO2 ppb	NOx ppb
#DIV/0!	#DIV/0!	#DIV/0!

Cal Check GPT 80-90% FS Titration

Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!
		#DIV/0!	

Cal Check NO2 ± 8%
#DIV/0!

Span	Flow Rate (sccm)	Flow Rate (sccm)
	(CAL)	(DIL)
CALA		

10-20% FS Calibration "CALA"
(copy/paste from latest calibration)

NO ppb	NO2 ppb	NOx ppb
#DIV/0!	#DIV/0!	#DIV/0!

Cal Check GPT 10-20% FS Titration

Hrs:min	NO ppb	NO2 ppb	NOx ppb
Avg ppb	#DIV/0!	#DIV/0!	#DIV/0!
		#DIV/0!	

Cal Check NO2 ± 10%
#DIV/0!

Comments/Notes:

Figure 18-11 Sample Data Entry Form – NO-NOy check / calibration

CALIBRATION (NOYT E-LOG)

Site: MQ Date: 8/11/15 Operator: TTS

Cylinder conc. NO=	23.7	ppb
Cylinder conc. NO2=	0.3	ppb
Cylinder conc. NOY=	24	ppb
Instrument Scale :	200	

Span	Flow Rate (Gas)	Flow Rate (Air)	146C NO ppb	146C NOY ppb
0			#DIV/0!	#DIV/0!
1			#DIV/0!	#DIV/0!
2			#DIV/0!	#DIV/0!
3			#DIV/0!	#DIV/0!

ZERO	Primary	Backup	Primary	Backup
Time Hrs:min	NOT ppb	NOYT ppb	NOT ppb	NOYT ppb
			NA	NA
			NA	NA
			NA	NA
			NA	NA
			NA	NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	[diff +/-1ppb]			
Acceptable:	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

SPAN 2	Primary	Backup	Primary	Backup
Time Hrs:min	NOT ppb	NOYT ppb	NOT ppb	NOYT ppb
			NA	NA
			NA	NA
			NA	NA
			NA	NA
			NA	NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	[% diff +/- 3.0%]			
Acceptable:	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

SPAN 1	Primary	Backup	Primary	Backup
Time Hrs:min	NOT ppb	NOYT ppb	NOT ppb	NOYT ppb
			NA	NA
			NA	NA
			NA	NA
			NA	NA
			NA	NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	[diff +/- 3.0%]			
Acceptable:	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

SPAN 3	Primary	Backup	Primary	Backup
Time Hrs:min	NOT ppb	NOYT ppb	NOT ppb	NOYT ppb
			NA	NA
			NA	NA
			NA	NA
			NA	NA
			NA	NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	[diff +/- 10.0%]			
Acceptable:	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Figure 18-12 Sample Data Entry Form – NO-NOy check / calibration

GAS PHASE TITRATION (NOYT E-LOG)

Site: MQ

Operator: TTS

Cylinder conc. NO=	23.7
Cylinder conc. NO2=	0.3
Cylinder conc. NOY=	24
Instrument Scale :	200

Converter Efficiency	
NO2 Ca =	#DIV/0!
NO2 conv	#DIV/0!
C.E.=	**#DIV/0!**

Span (ppb)	Flow Rate (Gas)	Flow Rate (Air)	146C NO ppb	146C NOY ppb
0			#DIV/0!	#DIV/0!
1			#DIV/0!	#DIV/0!

Original	Primary		Backup	
Time Hrs:min	NOT ppb	NOYT ppb	NOT ppb	NOYT ppb
			NA	NA
			NA	NA
			NA	NA
			NA	NA
			NA	NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**
	[diff +/- 6.0%]			
Acceptable:	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**

Remainde	Primary			Backup		
Time Hrs:min	NOT ppb	NOYT ppb	NO2T ppb	NOT ppb	NOYT ppb	NO2T ppb
				NA	NA	NA
				NA	NA	NA
				NA	NA	NA
				NA	NA	NA
				NA	NA	NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			#DIV/0!			**#DIV/0!**
				NO2 Tolerance: 5%		
Acceptable:			**#DIV/0!**			**#DIV/0!**

42S Range	O_3 Level	NO_{rem}		NOY_{rem}		NO2	$NO2_{Ca}$	$NO2_{Cm}$		% Difference	
50/100/200	%	PDL	BUDL	PDL	BUDL	Impurities		PDL	BUDL	PDL	BUDL
200	32.9	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

9/1/2015
MQ NOY 20150811 BF
GPT POST CAL

Figure 18-13 Sample Data Entry Form – NO-NOy check / calibration

CALIBRATION CHECK (NOYT E-LOG)

Site: 0 | Date: 1/0/00 | Operator: 0

NO Cylinder conc. = 0 ppb
NO2 Cylinder conc. = 0 ppb
NOY Cylinder conc. = 0 ppb

Instrument Scale : 0

Span	Flow Rate (Gas)	Flow Rate (Air)	146C NOT ppb	146C NOYT ppb
0			#DIV/0!	#DIV/0!
1			#DIV/0!	#DIV/0!
2			#DIV/0!	#DIV/0!
3			#DIV/0!	#DIV/0!

ZERO	Primary	
Time Hrs:min	NOT ppb	NOYT ppb
Avg ppb	#DIV/0!	#DIV/0!

[diff ±1 ppb]

Acceptable	#DIV/0!	#DIV/0!

SPAN 2	Primary	
Time Hrs:min	NOT ppb	NOYT ppb
Avg ppb	#DIV/0!	#DIV/0!
% Diff	#DIV/0!	#DIV/0!

[% diff ± 8.0%]

Acceptable	#DIV/0!	#DIV/0!

SPAN 1	Primary	
Time Hrs:min	NOT ppb	NOYT ppb
Avg ppb	#DIV/0!	#DIV/0!
% Diff	#DIV/0!	#DIV/0!

[diff ± 8.0%]

Acceptable	#DIV/0!	#DIV/0!

SPAN 3	Primary	
Time Hrs:min	NOT ppb	NOYT ppb
Avg ppb	#DIV/0!	#DIV/0!
% Diff	#DIV/0!	#DIV/0!

[% diff ± 15.0%]

Acceptable	#DIV/0!	#DIV/0!

Figure 18-14 Sample Data Entry Form – NO-NOy check / calibration

GAS PHASE TITRATION (NOYT E-LOG)

Site: MQ

Operator: TTS

Cylinder conc. NO=	23.7
Cylinder conc. NO2=	0.3
Cylinder conc. NOY=	24
Instrument Scale :	200

Converter Efficiency	
NO2 Ca =	#DIV/0!
NO2 conv	#DIV/0!
C.E.=	**#DIV/0!**

Span (ppb)	Flow Rate (Gas)	Flow Rate (Air)	146C NO ppb	146C NOY ppb
0			#DIV/0!	#DIV/0!
1			#DIV/0!	#DIV/0!

Original	Primary		Backup	
Time Hrs:min	NOT ppb	NOYT ppb	NOT ppb	NOYT ppb
			NA	NA
			NA	NA
			NA	NA
			NA	NA
			NA	NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
% Diff	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**
	[diff +/- 6.0%]			
Acceptable:	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**

Remainde	Primary			Backup		
Time Hrs:min	NOT ppb	NOYT ppb	NO2T ppb	NOT ppb	NOYT ppb	NO2T ppb
				NA	NA	NA
				NA	NA	NA
				NA	NA	NA
				NA	NA	NA
				NA	NA	NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			#DIV/0!			**#DIV/0!**
				NO2 Tolerance: 5%		
Acceptable:			**#DIV/0!**			**#DIV/0!**

42S Range	O_3 Level	NO_{rem}		NOY_{rem}		NO2	$NO2_{Ca}$	$NO2_{Cm}$		% Difference	
50/100/200	%	PDL	BUDL	PDL	BUDL	Impurities		PDL	BUDL	PDL	BUDL
200	33	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Figure 18-15 Sample Data Entry Form – CO Check / Visit

HSCO-TLE LOGBOOK

Site: ______ Time: ______ Date: ______ Operator: ______

Routine Site Inspection

Building Secure		Bldg. Power On	
Sampling Probe Intact		Bldg. Temperature (ºC)	

	Date	Time
Computer :		
PDL :		
BUDL :		

(± 1 min. on dataloggers)

TEI Model 48i-TLE HSCO Analyzer

Serial No. ______
Cal Date ______ Days Remaining 90

Filters:

Date Particulate Filter changed	
Cooling Fan Filter Cleaned	
Leak Check (Pass / Fail)	

Alarms? ______

STATS:

Range @ 0-5 ppm? (Y/N)	
Instrument Temp - Internal (°C):	
Instrument Temp - Bench (°C):	
Instrument Pressure (mm Hg):	
Flow Setting (LPM):	
Sample/Ref Ratio:	
AGC Intensity (Hz):	

TEI Model 146C Calibrator

Serial No. ______
Exp. Date ______ Days Remaining 0

Cylinder CHECK: (>500psi)

Cylinder #	
Cylinder Exp. Date	
Cylinder Conc.	

Cylinder Press. (psig)	
Delivery Press. (30 psig)	

Days Remaining 0

Filters:
Cooling Fan Filter Cleaned ______ Alarms? ______

Zero Air

Serial No. :	
Exp Date:	
Silica Gel Checked (y/n):	
Date Silica Gel Changed:	

Days Remaining 0

Delivery Air Pressure (30 psig):	
Compressor Pressure (40 psig):	
Air Compressor Drained (y/n):	

Data Loggers

Primary Data Logger OK?		Data Backed-up? (y/n):	
Backup Data Logger OK?		Date of last back-up:	

Notes/Comments

Figure 18-16 Sample Data Entry Form – CO calibration

HSCO-TLE CALIBRATION

Site:	0	Time:	12:00 AM	Date:	01/00/00	Operator:	0

Cylinder Conc.	0.0

Calibration Zero/Span Criteria
Span 1 = 4%
Span 2, Span 4 = 5%

Span (ppb)	Flow Rate (Gas)	Flow Rate (Air)	146C (CO)
0			#DIV/0!
4000/5000			#DIV/0!
2000/2500			#DIV/0!
250/500			#DIV/0!

Calibration Factors	
As Found	
Background PPM	
Span Gas	0
CO Coeffecient	
After Calibration	
Background PPM	
Span Gas	0
CO Coeffecient	

ZERO		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!

SPAN 2		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!
% Diff		#DIV/0!	#DIV/0!

[diff ± 100 ppb]

Acceptable:	#DIV/0!	#DIV/0!

SPAN 1		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!
% Diff		#DIV/0!	#DIV/0!

[diff ± 160 ppb]

Acceptable:	#DIV/0!	#DIV/0!

SPAN 4		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!
% Diff		#DIV/0!	#DIV/0!

[diff ± 25 ppb]

Acceptable:	#DIV/0!	#DIV/0!

Figure 18-17 Sample Particulate Intermittent Low-Volume Data Entry Form and Chain of Custody Form.

PM 2.5 Filter/Sampler Run Data Sheet

Sample Information

Filter ID:

Filter Weigh Date:

Site ID:

Site Name:

Actual Start Date:

Sample Status

Status Code:

WINS Run # (≤12):

Sampler ran according to schedule?

Data Download?

Operator Information

Date of Setup Visit:

Time of Setup Visit:

Setup Operator:

Setup Operator Signature:

____

Days from Initial Weight to Sample:

Date of Post Sample Visit:

Time of Post Sample Visit:

End Operator:

End Operator Signature:

____

Hours from Sample Date to Pickup:

Field Comments (Site Conditions, Missed Sample Reasons, etc.)

PM Laboratory/RCO QA Comments

____

____

Shipping Information

Sample Ship Date: ________________

Relinquished by: ____________________________ Signature: ____________________________

Lab Receipt Date: ____________________________

Received by: ______________________________ Signature: ____________________________

Sample Receipt Temperature: ____________°C

Version 20150903

Figure 18-18 Sample Particulate Data FRM Logbook.

VISIT INFORMATION				
Site Name	Corey's Site			
AQS ID	44-123-4567			
Visit Type	Calibration			
FRM Serial Number				
Date of Visit				
Time of Visit				
Operator				
THERMOMETER INFORMATION				
Thermometer ID				
Therm. Calibration Date				
Therm. Expiration Date				
Therm. Certification Pass/Fail				
MANOMETER INFORMATION				
Manometer ID				
Manometer Certification Date				
Manometer Expiration Date				
Manometer Certification Pass/Fail				
BAROMETER INFORMATION				
Barometer ID				
Barometer Calibration Date				
Barometer Expiration Date				
Barometer Calibration Pass/Fail				
FTS INFORMATION				
FTS ID				
FTS Certification Date				
FTS Expiration Date				
FTS Certification Pass/Fail				
FTS Slope (M)				
FTS Intercept (b)				
AS FOUND LEAK CHECK				
As Found Leak Check (mm Hg)				
As Found Leak Check Pass/Fail				
AMBIENT TEMPERATURE CHECK				
FRM Ambient Temperature (°C)				
NIST Ambient Temperature (°C)				
Temperature Difference (°C)				
CABINET TEMPERATURE CHECK				
FRM Cabinet Temperature (°C)				
NIST Cabinet Temperature (°C)				
Temperature Difference (°C)				
FILTER TEMPERATURE CHECK				
FRM Filter Temperature (°C)				
NIST Filter Temperature (°C)				
Filter Temperature Difference (°C)				
PRESSURE CHECK				
FRM Barometric Pressure (mm Hg)				
NIST Barometric Pressure (mm Hg)				
Pressure Difference (mm Hg)				
15.0 L/Min FLOW CALIBRATION				
15.0 L/Min Sampler Value				
15.0 L/Min Manometer Delta H (in H2O)				
15.0 L/Min Actual FTS Calculated Flow				
16.7 L/Min FLOW CALIBRATION				
16.7 L/Min Sampler Value				
16.7 L/Min Manometer Delta H (in H2O)				
16.7 L/Min Actual FTS Calculated Flow				
18.3 L/Min FLOW CALIBRATION				
18.3 L/Min Sampler Value				
18.3 L/Min Manometer Delta H (in H2O)				
18.3 L/Min Actual FTS Calculated Flow				
POST-CAL FLOW VERIFICATION				
FRM Sampler Flow Reading (LPM)				
Manometer Delta H (in H2O)				
Actual FTS Calculated Flow				
Flow Rate Accuracy (%A)				
Flow Rate Accuracy vs Design (%AD)				
Post-Cal Flow Check Pass/Fail				
AS LEFT LEAK CHECK				
As Left Leak Check (mm Hg)				
As Left Leak Check Pass/Fail				
ADDITIONAL INFORMATION				
Notes regarding the site activity, if necessary				
Regional Office Review				
Initial and Date				

Figure 18-19 Sample Particulate Data FRM Logbook

VISIT INFORMATION	
Site Name	Corey's Site
AQS ID	44-123-4567
Date of Visit	
Time of Visit	
Operator	
Maintenance Activity	
12 RUN MAINTENANCE	
Service water collection bottle	
Clean impactor housing	
Inspect O-Rings	
Replace WINS filter and oil	
MONTHLY MAINTENANCE	
External leak check	
Check sampler clock	
Inspect cassette tubes	
Wipe down interior/exterior of sampler	
Inspect air intake fan filters (clean if dirty)	
QUARTERLY MAINTENANCE	
Clean PM10 head and tube	
Inspect inlet tube water seal gasket	
Clean air intake fan filters	
Inspect o-rings (grease if necessary)	
PERIODIC MAINTENANCE	
Data purge	
Check clock time	
ANNUAL MAINTENANCE	
Replace batteries	
ADDITIONAL INFORMATION	
Add notes regarding the site activity, if necessary	
Regional Office Review	
Initial and Date	

Figure 18-20 Sample Particulate Data FRM Logbook.

VISIT INFORMATION				
Site Name	Corey's Site			
AQS ID	44 123 4567			
FRM Serial Number				
Visit Type				
Date of Visit				
Time of Visit				
Operator				
THERMOMETER INFORMATION				
Thermometer ID				
Therm. Certification Date				
Therm. Expiration Date				
Therm. Certification Pass/Fail				
MANOMETER INFORMATION				
Manometer ID				
Manometer Certification Date				
Manometer Expiration Date				
Manometer Certification Pass/Fail				
BAROMETER INFORMATION				
Barometer ID				
Barometer Certification Date				
Barometer Expiration Date				
Barometer Certification Pass/Fail				
FTS INFORMATION				
FTS ID				
FTS Certification Date				
FTS Expiration Date				
FTS Certification Pass/Fail				
FTS Slope (M)				
FTS Intercept (b)				
AS FOUND LEAK CHECK				
As Found Leak Check (mm Hg)				
As Found Leak Check Pass/Fail				
AMBIENT TEMPERATURE CHECK				
Sampler Ambient Temperature (°C)				
NIST Ambient Temperature (°C)				
Temperature Difference (°C)				
Ambient Temp. Difference Pass/Fail				
CABINET TEMPERATURE CHECK				
Sampler Cabinet Temperature (°C)				
NIST Cabinet Temperature (°C)				
Temperature Difference (°C)				
Cabinet Temp. Difference Pass/Fail				
FILTER TEMPERATURE CHECK				
Sampler Filter Temperature (°C)				
NIST Filter Temperature (°C)				
Filter Temperature Difference (°C)				
Filter Temp. Difference Pass/Fail				
PRESSURE CHECK				
Sampler Barometric Pressure (mm Hg)				
NIST Barometric Pressure (mm Hg)				
Pressure Difference (mm Hg)				
Pressure Difference Pass/Fail				
FLOW CALCULATIONS				
Sampler Flow Reading (LPM)				
Manometer Delta H (in H2O)				
Actual FTS Calculated Flow				
Flow Rate Accuracy (%A)				
Flow Rate Accuracy vs Design (%AD)				
Flow Check Pass/Fail				
AS LEFT LEAK CHECK				
As Left Leak Check (mm Hg)				
As Left Leak Check Pass/Fail				
VISIT INFORMATION				
Add notes regarding the site activity, if necessary				
Regional Office Review				
Initial and Date				

Figure 18-21 Sample Particulate Data SASS SPECIATION Logbook

NC DAQ AMS
SASS SPECIATED PM2.5 SAMPLER

Date RAMC Review:

RAMC Initials:

This TAB is for calibrations with an FTS. Write only in the Yellow boxes.

Findings:

Cal Worsheet Info:	
Revision	1.1
last update:	1/16/2013
by:	PJ Chappin
created:	1/16/2013

Comments

REGION
STATION

AQS#:
POC:
Run Schedule:
Next Run Date:
Site Operator:
Visitor:

Current Date: mm/dd/yy
Current Time: hh:mm (AM/PM)
Last Calibration date: mm/dd/yy
Current Calibration Type
Further explain calibration

Sampler S/N
Head S/N
Pump S/N

FTS for Calibration: S/N: Cal Date:
NIST Temperature Device: S/N: Cal Date:
NIST Barometer Device: S/N: Cal Date:
Manometer S/N: S/N: Cal Date:
DO NOT ATTEMPT QA PROCEEDURES WITH EXPIRED EQUIPMENT.

Clock Check (Enter in indicated format; Ref. Std is one hour ahead during DST)

hh:mm (AM/PM)

SASS	Ref.		Diff.		5 min or less? Pass	Fail
2:45 AM	2:46 AM	as found		As Found		
		as reset		As Left		

Temperature Calibration

	Ref.	SASS	Diff.	Post Cal.
Ambient				
Ch. 1				
Ch. 2				
Ch. 3				
Ch. 4				
Ch. 5				
Ch. 6				
Ch. 7				
Ch. 8				

Pressure Calibration

	Ref.	SASS	Diff.	Post Cal.
Ambient				

Leak Check

	Pass	Fail
Ch. 1		
Ch. 2		
Ch. 3		
Ch. 4		
Ch. 5		
Ch. 6		
Ch. 7		
Ch. 8		

Flow Calibration

FTS Info
slope(m_{fto}) 4.9793
intercept(b_{fto}) -0.2333

FTS Pressure Unit ***Must match FTS pressure units.***
◉ mm Hg
○ atmospheres

Ambient Temperture (°C) 25
Ambient Pressure 725

Flowrate calibration using FTS (make sure pump is in open position before beginning).

	SASS	ΔH in H_2O	FTS	D_1	D_2	Post Cal
Ch. 1						
Ch. 2						
Ch. 3						
Ch. 4						

D_1 = (URG - Ref)*100/Ref
D_2 = (Ref - Design)*100/Design

Operator Initials
Date

If calibration does not pass, calibrate again with a different set of standards. If calibration fails again, contact ECB.

Figure 18-22 Sample Particulate SASS Data SPECIATION Calibration Logbook

NC DAQ AMS
SASS SPECIATED PM2.5 SAMPLER

Date RAMC Review:

RAMC Initials:

This TAB is for calibrations with an Tetracal. Write only in the Yellow boxes.

Findings:

Cal Worsheet Info:

Revision	1.1
last update:	1/16/2013
by:	PJ Chappin
created:	1/16/2013

Comments

REGION
STATION

AQS#:
POC:

Current Date:
Current Time:
Last Calibration date:
Current Calibration Type
Further explain calibration

Run Schedule:
Next Run Date:
Site Operator:
Visitor:

Sampler S/N
Head S/N
Pump S/N

Tetra-cal used for calibration:	S/N:		Cal Date:	
NIST Temperature Device:	S/N:		Cal Date:	
NIST Barometer Device:	S/N:		Cal Date:	
Manometer S/N:	S/N:		Cal Date:	

DO NOT ATTEMPT QA PROCEEDURES WITH EXPIRED EQUIPMENT.

Clock Check (Enter in indicated format; Ref. Std is one hour ahead during DST)

hh:mm (AM/PM)

SASS	Ref.	Diff.		5 min or less? Pass	Fail
2:45 AM	2:46 AM		As Found		
			As Left		

Temperature Calibration

	Ref.	SASS	Diff.	Post Cal.
Ambient				
Ch. 1				
Ch. 2				
Ch. 3				
Ch. 4				
Ch. 5				
Ch. 6				
Ch. 7				
Ch. 8				

Pressure Calibration

	Ref.	SASS	Diff.	Post Cal.
Ambient				

Leak Check

	Pass	Fail
Ch. 1		
Ch. 2		
Ch. 3		
Ch. 4		
Ch. 5		
Ch. 6		
Ch. 7		
Ch. 8		

Flow Calibration

Pre Calibration

		L/Min.			Less than 10%	
	Lower Lt.	Ref Std.	SASS	% Diff.	Pass	Fail
Ch. 1	NA					
Ch. 2	NA					
Ch. 3	NA					
Ch. 4	NA					

Post Calibration Verification

		L/Min.			Less than 10%	
	Lower Lt.	Ref Std.	SASS	% Diff.	Pass	Fail
Ch. 1	NA					
Ch. 2	NA					
Ch. 3	NA					
Ch. 4	NA					
Ch. 5	NA					
Ch. 6	NA					
Ch. 7	NA					
Ch. 8	NA					

If cal. does not pass, cal. again with a different set of standards. If cal. fails again, contact ECB.

Figure 18-23 Sample Particulate Data URG SPECIATION FTS Calibration Logbook

NC DAQ AMS
URG 3000N CARBON SAMPLER

Note that Yellow Cells should not have prior data.

3-POINT CAL with FTS

Write only in the Yellow boxes.

This TAB is for calibrations with an FTS.

Date of RAMC review:

RAMC Initials:

Cal Worsheet Info:

Revision	14.0
last update:	7/11/2012
by:	JP Chauhan
created:	9/15/2009

Findings:

REGION
STATION

AQS#
POC: 5

Comments
Mismatch Error in AQS# (NC DAC
Be accurate with box entries (rc

Current Date:		mm/dd/yy	Run Schedule:	
Current Time:		hh:mm (AM/PM)	Next Run Date:	
Last Calibration date:		mm/dd/yy	Site Operator:	
Current Calibration Type			Visitor	
further explain calibration				

	Controller	Sampler	Pump Box	
Module S/N				last 3 digits
New module installed?				
Date of Install				

Flow Transfer Standard Model for Calibration:		S/N:		Cal Date:	
Flow Transfer Standard Model for Verification:		S/N:		Cal Date:	
Temperature Transfer Standard Model:		S/N:		Cal Date:	
Barometric Pressure Transfer Std. Model:		S/N:		Cal Date:	
Manometer Model		S/N:		Cal Date:	

(DO NOT ATTEMPT CONTROL CHECKS WITH EXPIRED CHECK/AUDIT/CALIBRATION EQUIPMENT.)

Clock Check (Enter time as indicated in format; Ref. Std (cellphone) runs one-hour ahead during DST: April - October)

hh:mm (AM/PM) URG	Ref.		Difference (Minutes)		5 min or less? Pass	Fail
		as found		as found		
		as reset		as left		

Temperature Calibration (Raw value should correspond to URG temperature at *moment* of reading)

Raw	Offset	Degrees C URG	Reference		Difference (degrees C)		Less than 2? Pass	Fail
				as found		as found		
				as left		as left		

Save results to memory

Pressure Calibration (Raw value should correspond to URG pressure at *moment* of reading)

Raw	Offset	mmHg URG	Reference		Difference (mm HG)		Less than 10? Pass	Fail
				as found		as found		
				as left		as left		

Save ALL results to memory.

Leak Check Results (Warning: Re-insert temperature probe into URG prior to leak check)

Max	Min	Difference				225 drop or higher fails Pass	Fail
			mm Hg		seconds		

After leak check, turn pump shut off value to open position.

Flow FTS information

Gain = 6.000 Offset = 0.00 Factory Defaults

FTS Info
slope(m_{flo})
intercept(b_{flo})

FTS Pressure Unit
(selected) mm Hg
atmospheres

Ambient Temperture (°C)
Ambient Pressure — must match FTS pressure units

Flow rate calibration using FTS.

Set Point	Raw (mv)	Vacuum	URG	ΔH, in H_20	FTS	D_1	D_2	
19.80								New Gain
22.00								New Offset
24.20								

Watch for Negative v

SAVE RESULTS TO MEMORY.

Post-calibration verification. Flow Verification device SHOULD be different from the flow calibration devic

	Raw (mv)	Vacuum	URG	ΔH, in H_20	Flow	D_1	D_2	less than 10%? Pass	Fail
FTS									
TetraCaL				XXXXXXX					

D_1= (URG - Ref)*100/Ref
D_2 = (Ref - Design)*100/Design

Calibration Passed? (selected) YES NO

Operator Initials
Date

If calibration does not pass, calibrate again with a different set of standards. If calibration fails again, contact ECB.

Figure 18-24 Sample Particulate Data URG SPECIATION Tetra-Cal Calibration Logbook

NC DAQ AMS
URG 3000N CARBON SAMPLER

Note that Yellow cells should not have prior data.

3-POINT CAL with TETRA CAL

Write only in the Yellow boxes.

This TAB is for calibrations with a Tetra-Cal.

Date of RAMC review:

RAMC Initials:

Cal Worsheet Info:	
Revision	14.0
last update:	7/11/2012
by:	JP Chauhan
created:	9/15/2009

Findings:

REGION				
STATION			AQS#	
URG Time:		hh:mm (AM/PM)	POC:	5
Current Date:		mm/dd/yy	Run Schedule:	
Arrival Time:		hh:mm (AM/PM)	Next Run Date:	
Last Calibration date:		mm/dd/yy	Site Operator:	
Current Calibration Type			Visitor:	
further explain calibration				

Comments
Mismatch Error in AQS# (
Be accurate with box en

	Controller	Sampler	Pump Box	
Module S/N				last 3 digits
New module installed?				
Date of Install				

		S/N:		Cal Date:	
Flow Transfer Standard Model for Calibration:		S/N:		Cal Date:	
Flow Transfer Standard Model for Verification:		S/N:		Cal Date:	
Temperature Transfer Standard Model:		S/N:		Cal Date:	
Barometric Pressure Transfer Std. Model:		S/N:		Cal Date:	
Manometer Model		S/N:		Cal Date:	

(DO NOT ATTEMPT CONTROL CHECKS WITH EXPIRED CHECK/AUDIT/CALIBRATION EQUIPMENT.)

Clock Check (Enter time as indicated in format. Ref. Std (cellphone) will be ahead by one hour during DST)

URG (hh:mm (AM/PM))	Ref.		Difference (Minutes)	5 min or less? Pass	Fail
		as found			
		as reset			

Temperature Calibration (Raw value should correspond to URG temperature at *moment* of reading)

Raw	Offset	URG (Degrees C)	Reference		Difference (degrees C)		Less than 2? Pass	Fail
				as found		as found		
				as left		as left		

Save results to memory

Pressure Calibration (Raw value should correspond to URG pressure at *moment* of reading)

Raw	Offset	URG (mmHg)	Reference		Difference (degrees C)		Less than 10? Pass	Fail
				as found		as found		
				as left		as left		

Save ALL results to memory

Leak Check Results (Warning: Re-insert temperature probe into URG prior to leak check)

Max	Min	Difference				≥ 225 mm Hg fails Pass	Fail
			mm Hg	35	seconds		

After leak check, turn pump shut off value to open position.

Flow FTS information

Gain = 6.000 Offset = 0.00 Factory Defaults

FTS Info

slope(m_{flo})	
intercept(b_{flo})	
ECG TC ID	
Ambient Temperture (°C)	
Ambient Pressure	must match FTS pressure units

FTS Pressure Unit
○ mm Hg
○ atmospheres

Flow rate calibration using Tetra-Cal.

Set Point	Raw (mv)	Vacuum	URG	TetraCal	D_1	D_2	New Gain
19.80							
22.00							New Offset
24.20							

SAVE RESULTS TO MEMORY.

Watch for Nec

Post-Calibration Flow rate verification: Verification device SHOULD be different from the Flow Calibrator.

	Raw (mv)	Vacuum	URG	ΔH, in H_20	Flow verifier	D_1	D_2	less than 10%? Pass	Fail
FTS									
TetraCaL				XXXXXXX					

D_1 = (URG - (TC or FTS))*100/(TC or FTS)

D_2 = ((TC or FTS) - Design Flow)*100/Design Flow

Calibration Passed?
○ YES ◉ NO

Operator Initials

Date

If calibration does not pass, calibrate again with a different set of standards. If calibration fails again, contact ECB.

Figure 18-25 Sample Particulate Data SASS SPECIATION Flow Rate Audit Log Page 1

MetOne SASS - Primary Sampler 9/1/2015 Page 1 of 4

Chemical Speciation Network
Performance Audit Worksheet
MetOne SASS - Primary Sampler

Note - Cyan fields are entered from TSA worksheet or calculated - yellow fields are to be filled in here

Location		Date	
AQS Site ID		**Missing Date, Site Name, Site Code, or POC**	
AQS Sampler POC	5		

Audit Information

Sampler Type (Model)	Select From Dropdown List		
Auditor(s)		Affiliation	
Audit Type	Select From Dropdown List	**Missing Audit Agency Type!**	
		Sampler S/N	
		Head S/N	
		Pump S/N	
Last Calibration Date			

Audit Reference Standards

Flow Reference Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
Temperature Ref Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
BP Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	

Significant Findings:	
General Findings:	

Figure 18-26 Sample Particulate Data SASS SPECIATION Flow Rate Audit Log Page 2

MetOne SASS - Primary Sampler 9/1/2015 Page 2 of 4

MetOne SASS - Primary Sampler

Clock Audit

If Local Time is under daylight savings, convert Ref Std to Local Standard Time. Daylight Saving Time begins for most of the United States at 2:00 a.m. on the first Sunday of April. Time reverts to standard time at 2:00 a.m. on the last Sunday of Octobe

	Time (hh:mm)				Difference		5 minutes or less?	
	Ref Std		SASS		Minutes		Pass	Fail
Audit Time								
Date	1/0/1900			**Missing Sampler Date!**				
Recalib Time								
Date	1/0/1900							

Leak Test

	Initial Audit A L/min		After Correction B L/min		Greater than 0.10 L/min fails		
					Pass	Fail A	Fail B
Channel 1		Channel 1					
Channel 2		Channel 2					
Channel 3		Channel 3					
Channel 4		Channel 4					
Channel 5		Channel 5					
Channel 6		Channel 6					
Channel 7		Channel 7					
Channel 8		Channel 8					

Flow Audit

For the reference standard, enter "UR" for under range and "OR" for over range flow readings.

	L/min				% Difference		Within ± 10%?	
	Lower Limit	Ref Std	Upper Limit	SASS	SASS - Ref		Pass	Fail
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					

Retest after Calibration

	L/min				% Difference		Within ± 10%?	
	Lower Limit	Ref Std	Upper Limit	SASS	SASS - Ref		Pass	Fail
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					

Figure 18-27 Sample Particulate Data SASS SPECIATION Flow Rate Audit Log Page 3

MetOne SASS - Primary Sampler 9/1/2015 Page 3 of 4

MetOne SASS - Primary Sampler								
Reference Standard vs Design Flow								
	L/min				% Difference		Within ± 10%?	
	Lower Limit	SASS	Upper Limit	Ref Std	Ref-Design		Pass	Fail
Channel 1	6.03	6.7	7.37					
Channel 2	6.03	6.7	7.37					
Channel 3	6.03	6.7	7.37					
Channel 4	6.03	6.7	7.37					
Channel 5	6.03	6.7	7.37					
Channel 6	6.03	6.7	7.37					
Channel 7	6.03	6.7	7.37					
Channel 8	6.03	6.7	7.37					
Retest after Calibration								
	L/min				% Difference		Within ± 10%?	
	Lower Limit	SASS	Upper Limit	Ref Std	Ref-Design		Pass	Fail
Channel 1	6.03	6.7	7.37					
Channel 2	6.03	6.7	7.37					
Channel 3	6.03	6.7	7.37					
Channel 4	6.03	6.7	7.37					
Channel 5	6.03	6.7	7.37					
Channel 6	6.03	6.7	7.37					
Channel 7	6.03	6.7	7.37					
Channel 8	6.03	6.7	7.37					
Ambient Temperature Audit								
	Degrees C						Within ± 2 degrees?	
	Lower Limit	Ref Std	Upper Limit	SASS	Difference		Pass	Fail
	NA		NA					
Retest After Recalibration								
	NA		NA					

Figure 18-28 Sample Particulate Data SASS SPECIATION Flow Rate Audit Log Page 4

MetOne SASS - Primary Sampler 9/1/2015 Page 4 of 4

MetOne SASS - Primary Sampler

Filter Temperature Audit

	Degrees C						Within ± 2 degrees?	
	Lower Limit	Ref Std	Upper Limit	SASS	Difference		Pass	Fail
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					
Retest After Recalibration								
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					

Pressure Audit

	mm Hg						Within ± 10 mm?	
	Lower Limit	Ref Std	Upper Limit	SASS	Difference		Pass	Fail
	NA		NA					
Retest after recalibration								
	NA		NA					

Figure 18-29 Sample Particulate Data URG SPECIATION Flow Rate Audit Log Page 1

URG 3000 N - Primary Sampler 9/1/2015 Page 1 of 2

Chemical Speciation Network Performance Audit Worksheet URG 3000N - Primary Sampler			
Note - Cyan fields are entered from TSA worksheet or calculated - yellow fields are to be filled in here			
Location		Date	
AQS Site ID		**Missing Date, Site Name, Site Code, or POC**	
AQS Sampler POC	5		
Audit Information			
Auditor(s)		Affiliation	
Audit Type	Select From Dropdown List	**Missing Audit Agency Type!**	
Sampler Model	URG 3000 N	Controller S/N	
		Pump S/N	
		Sampler S/N	
Last Calibration Date			
Audit Reference Standards			
Flow Reference Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
Temperature Ref Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
BP Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
Significant Findings:			
General Findings:			

Figure 18-30 Sample Particulate Data URG SPECIATION Flow Rate Audit Log Page 2

URG 3000 N - Primary Sampler 9/1/2015 Page 2 of 2

URG 3000N - Primary Sampler

Clock Audit

If Local Time is under daylight savings, convert Ref Std to Local Standard Time. Daylight Saving Time begins for most of the United States at 2:00 a.m. on the first Sunday of April. Time reverts to standard time at 2:00 a.m. on the last Sunday of Octobe

	Time (hh:mm)				Difference		5 minutes or less?	
	Ref Std		URG		Minutes		Pass	Fail
Audit Time								
Date	1/0/1900			**Missing Sampler Date!**				
Recalib Time								
Date	1/0/1900							

Leak Test

	Initial Audit		After Correction		225 mm Hg drop or higher fails		
	A mm Hg		B mm Hg		Pass	Fail A	Fail B
Channel 1		Channel 1					

Flow Audit

For the reference standard, enter "UR" for under range and "OR" for over range flow readings.

	L/min						Less than 10%?	
	Lower Limit	Ref Std	Upper Limit	URG	% Difference		Pass	Fail
Channel 1	NA		NA					

Retest after Calibration

	L/min						Less than 10%?	
	Lower Limit	Ref Std	Upper Limit	URG	% Difference		Pass	Fail
Channel 1	NA		NA					

Reference Standard vs Design Flow

		L/min					Less than 10%?	
	Lower Limit	URG	Upper Limit	Ref Std	% Difference		Pass	Fail
Channel 1	19.8	22.0	24.2					

Retest after Calibration

		L/min					Less than 10%?	
	Lower Limit	URG	Upper Limit	Ref Std	% Difference		Pass	Fail
Channel 1	19.8	22.0	24.2					

Ambient Temperature Audit

	Degrees C						Less than 2 degrees?	
	Lower Limit	Ref Std	Upper Limit	URG	Difference		Pass	Fail
	NA		NA					
Retest After Recalibration								
	NA		NA					

Pressure Audit

	mm Hg						Less than 10 mm Hg?	
	Lower Limit	Ref Std	Upper Limit	URG	Difference		Pass	Fail
	NA		NA					
Retest after recalibration								
	NA		NA					

Figure 18-31 Sample Particulate Data SASS SPECIATION Flow Verification Log Page 1

MetOne SASS - Primary Sampler 9/1/2015 Page 1 of 4

Chemical Speciation Network
Flow Check Worksheet
MetOne SASS - Primary Sampler **version** 25

Note - Cyan fields are entered from URG worksheet or calculated - yellow fields are to be filled in here

Location		Date	
AQS Site ID		**Missing Date, Site Name, Site Code, or POC**	
AQS Sampler POC	5		

Site Information

Sampler Type (Model)	Select From Dropdown List		
Operator(s)		Affiliation	
Check Type	Flow Verification by Site Operator		
		Sampler S/N	
		Head S/N	
		Pump S/N	
Last Calibration Date			

Reference Standards

Flow Reference Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
Temperature Ref Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
BP Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	

Significant Findings:	
General Findings:	

Figure 18-32 Sample Particulate Data SASS SPECIATION Flow Verification Log Page 2

MetOne SASS - Primary Sampler 9/1/2015 Page 2 of 4

MetOne SASS - Primary Sampler

Clock Check

If Local Time is under daylight savings, convert Ref Std to Local Standard Time. Daylight Saving Time begins for most of the United States at 2:00 a.m. on the first Sunday of April. Time reverts to standard time at 2:00 a.m. on the last Sunday of Octobe

	Time (hh:mm)				Difference		5 minutes or less?	
	Ref Std		SASS		Minutes		Pass	Fail
Check Time								
Date	1/0/1900			**Missing Sampler Date!**				
Recalib Time								
Date	1/0/1900							

Leak Test

	Initial Check A L/min		After Correction B L/min		Greater than 0.10 L/min fails		
					Pass	Fail A	Fail B
Channel 1		Channel 1					
Channel 2		Channel 2					
Channel 3		Channel 3					
Channel 4		Channel 4					
Channel 5		Channel 5					
Channel 6		Channel 6					
Channel 7		Channel 7					
Channel 8		Channel 8					

Flow Check

For the reference standard, enter "UR" for under range and "OR" for over range flow readings.

	L/min				% Difference		Within ± 10%?	
	Lower Limit	Ref Std	Upper Limit	SASS	SASS - Ref		Pass	Fail
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					

Retest after Calibration

	L/min				% Difference		Within ± 10%?	
	Lower Limit	Ref Std	Upper Limit	SASS	SASS - Ref		Pass	Fail
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					

Figure 18-33 Sample Particulate Data SASS SPECIATION Flow Verification Log Page 3

MetOne SASS - Primary Sampler 9/1/2015 Page 3 of 4

MetOne SASS - Primary Sampler

Reference Standard vs Design Flow

	L/min				% Difference		Within ± 10%?	
	Lower Limit	SASS	Upper Limit	Ref Std	Ref-Design		Pass	Fail
Channel 1	6.03	6.7	7.37					
Channel 2	6.03	6.7	7.37					
Channel 3	6.03	6.7	7.37					
Channel 4	6.03	6.7	7.37					
Channel 5	6.03	6.7	7.37					
Channel 6	6.03	6.7	7.37					
Channel 7	6.03	6.7	7.37					
Channel 8	6.03	6.7	7.37					

Retest after Calibration

	L/min				% Difference		Within ± 10%?	
	Lower Limit	SASS	Upper Limit	Ref Std	Ref-Design		Pass	Fail
Channel 1	6.03	6.7	7.37					
Channel 2	6.03	6.7	7.37					
Channel 3	6.03	6.7	7.37					
Channel 4	6.03	6.7	7.37					
Channel 5	6.03	6.7	7.37					
Channel 6	6.03	6.7	7.37					
Channel 7	6.03	6.7	7.37					
Channel 8	6.03	6.7	7.37					

Ambient Temperature Check

	Degrees C						Within ± 2 degrees?	
	Lower Limit	Ref Std	Upper Limit	SASS	Difference		Pass	Fail
	NA		NA					
Retest After Recalibration								
	NA		NA					

Figure 18-34 Sample Particulate Data SASS SPECIATION Flow Verification Log Page 4

MetOne SASS - Primary Sampler								
Filter Temperature Check								
	Degrees C						Within ± 2 degrees?	
	Lower Limit	Ref Std	Upper Limit	SASS	Difference		Pass	Fail
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					
Retest After Recalibration								
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					
Pressure Check								
	mm Hg						Within ± 10 mm?	
	Lower Limit	Ref Std	Upper Limit	SASS	Difference		Pass	Fail
	NA		NA					
Retest after recalibration								
	NA		NA					

Figure 18-35 Sample Particulate Data URG SPECIATION Flow Verification Log Page 1

URG 3000 N - Primary Sampler 9/1/2015 Page 1 of 2

Chemical Speciation Network
Flow Check Worksheet
URG 3000N - Primary Sampler

Note - Cyan fields are entered from URG worksheet or calculated - yellow fields are to be filled in here

Location		Date	
AQS Site ID		**Missing Date, Site Name, Site Code, or POC**	
AQS Sampler POC	5		

Site Information

Auditor(s)		Affiliation	
Audit Type	Flow Verification by Site Operator		
Sampler Model	URG 3000 N	Controller S/N	
		Pump S/N	
		Sampler S/N	
Last Calibration Date			

Reference Standards

Flow Reference Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
Temperature Ref Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
BP Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	

Significant Findings:	
General Findings:	

Figure 18-36 Sample Particulate Data URG SPECIATION Flow Verification Log Page 2

URG 3000 N - Primary Sampler 9/1/2015 Page 2 of 2

URG 3000N - Primary Sampler

Clock Check

If Local Time is under daylight savings, convert Ref Std to Local Standard Time. Daylight Saving Time begins for most of the United States at 2:00 a.m. on the first Sunday of April. Time reverts to standard time at 2:00 a.m. on the last Sunday of Octobe

	Time (hh:mm)				Difference		5 minutes or less?	
	Ref Std		URG		Minutes		Pass	Fail
Check Time								
Date	1/0/1900			**Missing Sampler Date!**				
Recalib Time								
Date	1/0/1900							

Leak Test

	Initial Check		After Correction		225 mm Hg drop or higher fails		
	A mm Hg		B mm Hg		Pass	Fail A	Fail B
Channel 1		Channel 1					

Flow Check

For the reference standard, enter "UR" for under range and "OR" for over range flow readings.

	L/min						Less than 10%?	
	Lower Limit	Ref Std	Upper Limit	URG	% Difference		Pass	Fail
Channel 1	NA		NA					

Retest after Calibration

	L/min						Less than 10%?	
	Lower Limit	Ref Std	Upper Limit	URG	% Difference		Pass	Fail
Channel 1	NA		NA					

Reference Standard vs Design Flow

	L/min						Less than 10%?	
	Lower Limit	URG	Upper Limit	Ref Std	% Difference		Pass	Fail
Channel 1	19.8	22.0	24.2					

Retest after Calibration

	L/min						Less than 10%?	
	Lower Limit	URG	Upper Limit	Ref Std	% Difference		Pass	Fail
Channel 1	19.8	22.0	24.2					

Ambient Temperature Check

	Degrees C						Less than 2 degrees?	
	Lower Limit	Ref Std	Upper Limit	URG	Difference		Pass	Fail
	NA		NA					
Retest After Recalibration								
	NA		NA					

Pressure Check

	mm Hg						Less than 10 mm Hg?	
	Lower Limit	Ref Std	Upper Limit	URG	Difference		Pass	Fail
	NA		NA					
Retest after recalibration								
	NA		NA					

18.4. Data Transformation

The inherent accuracy of an instrument is incorporated into the system accuracy when the instrument is calibrated. Each continuous monitor has its own internal potentiometers, whether digital or analog, 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. At a minimum, all instruments measuring gaseous pollutants undergo a 14-day one-point quality control check to maintain accuracy. All PM monitors (continuous and intermittent) undergo a 30-day flow verification check to maintain accuracy. All gaseous monitors run nightly automated zero-precision-span sequences that can be remotely viewed to ensure correct operation.

The network's CO analyzers are equipped with zero and span concentration potentiometers that are adjusted during the calibration operation to coordinate the magnitude of the electronic output to match the actual gas concentrations present in the analysis cell. Additional information is available in the trace-level CO SOP and the analyzer's operations manual.

The NO_x and NO_y analyzers are equipped with zero and span concentration potentiometers that are adjusted during the calibration operation to coordinate the magnitude of the electronic output to match the actual gas concentrations present in the analysis cell. Additional information is available in the NO_x and NO_y SOPs and the individual analyzer's operations manuals.

The network's SO_2 analyzers are equipped with zero and span concentration potentiometers. Additionally, the high voltage to the photomultiplier tube (PMT) or the gain on the final amplifier can be adjusted to make the analyzer agree with known SO_2 concentrations. Signals resulting from scattered UV light inside the sample cell, background radiation detected by the PMT when no SO_2 is present, are suppressed using the zero potentiometer. Additional information is available in the SO_2 SOP and the individual analyzer's operations manuals.

The network's O_3 analyzers are equipped with span and zero potentiometers that can be operator adjusted during the calibration operation if needed. The analyzers run automated zero-precision-span points every night that are closely tracked to ensure reliable operation.

DAQ utilizes a photometric O_3 calibrator for generating the necessary O_3 gas concentrations required to calibrate the O_3 analyzers. Each calibrator installed at a monitoring site is calibrated against a calibrator that is annually certified against the EPA primary standard. Descriptions of the O_3 calibrator functions and step-by-step calibration procedures can be found in the Ozone SOP and instrument operations manual.

At the NCore site, meteorological instruments are audited semiannually and calibrated annually. At all other sites audits and calibrations occur annually. Calibration information is available in the meteorological SOP and the individual instruments' operations manuals.

Mass flow controller calibration information is available in each instrument's operations manual.

18.5. Data Transmittal

Data transmittal is usually accomplished using wireless communication to access the sites' modems, which are linked to the data logger. Downloading collected data does not delete data from the data logger. Data are removed from the data logger by overwriting data on a first-in, first-out basis. This configuration requires the data be extracted from the data logger on a regular basis to prevent any data loss. If communications problems arise, data are retrieved from the site computer or from the data logger. A site visit is mandatory if the communications problems are not expected to be corrected in time to prevent data from being overwritten.

Data download directly from instruments to laptops in the field is required for some methods (continuous $PM_{2.5}$ / PM_{10}, $PM_{2.5}$ FRM and $PM_{2.5}$ STN). For the filter-based methods, these data, used to manually determine values associated with the remote measurement of the particulate filter's mass increase, are transferred via FTP. After the used filters are returned to the laboratory and processed, the data are combined from the FTP transfer and values are calculated.

All raw data sets (both direct measurement and particulate) are stored electronically. These data sets are retained intact by archiving the raw data. Data reduction operations can be performed repeatedly without violating the integrity of the original raw data set.

18.6. Data Reduction

Data reduction activities aggregate raw data into averages that are required to compare against the NAAQS criteria pollutant limits. These values obtained from reducing these data sets establish whether or not the NAAQS have been exceeded.

The state's regional air quality chemists are provided the raw data sets from the instrument downloads for their region's monitoring sites. These data sets are verified, corrected, flagged by the regional operator and reviewed by the regional chemist for correctness indicating the validity of the data. The data sets are returned to the Project and Procedures Branch for additional review, updating and archiving.

The Raleigh central office (RCO) air quality chemists monitor and review the data sets for invalid flags. If the data are deemed invalid, they are disqualified from the data set, and consequently, not used. Annually, the regions' collection process is audited. Criteria for the quantity of valid data points required within a data set is defined in 40 CFR Part 50. These criteria are adhered to when performing the data reduction operations.

Retaining copies of all data sets electronically recorded provides a data audit trail. These data sets are archived on backup systems in addition to being retained on computers.

18.7. Data Analysis

The network-provided raw data sets are reduced, yielding the appropriate averaging period values. These results are compared to the NAAQS for the specific criteria pollutants under consideration. All validated data are reviewed looking for trends, outliers, etc. to establish the reasonableness of the data sets.

18.8. Data Storage and Retrieval

DAQ's archiving system makes possible the storage and retrieval of the air quality monitoring data. The data are stored for a minimum period of four years, unless any litigation, claim, negotiation, audit, or other action involving the records has been started before the expiration of the four-year period. When this type of situation occurs, the records will be retained until completion of the action and resolution of all issues that arise from it, or until the end of the regular four-year period, whichever is later.

The data shall be stored on electronic media or in hard copy, whichever format proves most advantageous. After the storage period has passed, the storage media may be disposed of or recycled.

19.0 ASSESSMENTS AND RESPONSE ACTIONS

An assessment is the process used to measure the performance or effectiveness of the quality system, the criteria pollutant and NCore ambient air quality monitoring networks and their sites, and various measurement phases of the data operation. In order to ensure the adequate performance of the quality system, DAQ will perform

- Management systems reviews
- Network reviews and assessments
- Technical systems audits
- Data quality audits
- Data quality assessments
- Assessment activities and project planning

19.1. Management Systems Review

A MSR is a qualitative assessment of a data collection operation or organization. A MSR is employed to establish whether the prevailing quality management structure, policies, practices and procedures are adequate to ensure data obtained are of the necessary type and quality to support the decision process.

A MSR of the criteria pollutant and NCore ambient air quality monitoring programs will be conducted every three years by EPA Region 4 quality assurance staff. The MSR will use appropriate federal regulations and this QAPP to determine the adequate operation of the ambient air monitoring programs and their related quality systems. The EPA will report its findings to senior management. The report will be filed appropriately. The DAQ Ambient Monitoring Section chief or a duly appointed representative will regularly monitor progress on corrective action(s).

19.2. Network Reviews/Assessments

Conformance with network requirements of the criteria and NCore ambient air quality monitoring networks as set forth in 40 CFR Part 58, Appendices D and E are determined through annual network reviews of the ambient air quality monitoring systems, as required by 40 CFR Section 58.10(a). The network review is used to determine if a particular air-monitoring network is collecting adequate, representative and useful data in pursuit of its air monitoring objectives. Additionally, the network review may identify possible network modifications to enhance the system or correct deficiencies in attaining network objectives.

Prior to implementing a network review, significant data and information pertaining to the network will be compiled and evaluated. Such information might include:

- Network files (including updated site information and site photographs);
- AQS reports;
- Network monitors’ five-year air quality summaries;

- Major metropolitan area emissions trends reports;
- Emissions information, such as a monitor's emission density maps and maps delineating an area's major emissions sources; and
- National Weather Service summaries for the monitoring network area.

Upon receiving the information, it will be checked to ensure it is current. Discrepancies will be noted and resolved during the review. Files and/or photographs that need to be updated will also be identified during the review. The following categories will be emphasized during network reviews:

State and Local Air Monitoring Stations. Adequacy of the network will be determined using the following information:

- Appendix D to 40 CFR Part 58;
- The most current design values,
- The most recent census or population estimates,
- Maps of historical monitoring data,
- Maps of emission densities,
- Dispersion modeling,
- Special studies/saturation sampling,
- Best professional judgment,
- State implementation plan requirements, and
- Revised monitoring strategies (e.g., Pb strategy, reengineering air monitoring network).

National Core Monitoring Stations. Urban NCore stations are to be generally located at urban or neighborhood scale to provide representative concentrations of exposure expected throughout the metropolitan area; however, a middle-scale site may be acceptable in cases where the site can represent many such locations throughout a metropolitan area. Rural NCore stations are to be located to the maximum extent practicable at a regional or larger scale away from any large local emission source, so that they represent ambient concentrations over an extensive area. To determine whether the number of NCore sites is adequate, the number of NCore sites operating will be compared to the number of Ncore sites specified in 40 CFR Part 58 Appendix D.

Monitor Locations. For SLAMS, the geographical location of monitors is not specified in the regulations, but is determined on a case-by-case basis to meet the monitoring objectives specified in 40 CFR Part 58, Appendix D. Suitable monitor locations can only be determined on the basis of stated objectives. Maps, graphical overlays and GIS-based information will be helpful in visualizing or assessing the adequacy of monitor locations. Plots of potential emissions, historical monitoring data and/or saturation study findings versus monitor locations will also be used.

During the network review, the stated objective for each monitoring site will be reconfirmed and the location's spatial scale will be re-verified. If the site location does not support the stated objectives, or the designated spatial scale, changes will be proposed to rectify the discrepancy.

Probe Siting Requirements. Applicable siting criteria for SLAMS and NCORE are specified in 40 CFR Part 58, Appendix E. The on-site visit will consist of physical measurements and observations to determine compliance with the 40 CFR Part 58, Appendix E requirements, such as height above ground level, distance from trees, appropriate ground cover, etc. This check at each site is performed every year.

The annual network review and probe site check will also:

- Review the most recent hard copy of site description (including any photographs) for any updates needed for the RCO;
- Report on any new industries in the area and review their emission impacts based on the site of the facility and predominant wind directions; and
- Determine conformance with 40 CFR Part 58 Appendix E.

The checklist used is found on pages 169 through 174 and is used to determine conformance with 40 CFR Part 58, Appendix E. In addition to the items on the checklist, the reviewer will also perform the following tasks:

- Ensure that the inlet is clean and the funnel is whole and functions properly;
- Perform annual site safety check, including checking equipment for missing parts, frayed cords, damage, etc.;
- Record findings on the site safety audit form and the annual network review checklist, as appropriate, to be turned in to the RCO;
- Take photographs/videotape in the eight directions (east, southeast, south, southwest, west, northwest, north and northeast) when significant changes are observed in vegetation, trees, or roadways, or every five years; and
- Document any significant changes in site conditions on the network review checklist.

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Site Information

Region ____	**Site Name** ____	**AQS Site # 37-**____-____
Street Address-____		**City** ____
Urban Area Choose an item.		**Core-based Statistical Area** Choose an item.

Enter Exact		
Longitude ____	**Latitude** ____	**Method of Measuring**
In Decimal Degrees	In Decimal Degrees	__ **Explanation:** ____
Elevation Above/below Mean Sea Level (in meters) ____		

Name of nearest road to inlet probe ____ ADT ____ Year latest available ____

Comments: ____

Distance of site to nearest major road (m) ____ Direction from site to nearest major road __

Name of nearest major road ____ ADT ____ Year ____

Comments: ____

Site located near electrical substation/high voltage power lines? Yes ☐ No ☐

Distance of site to nearest railroad track (m) ________Direction to RR __ ☐NA

Distance of site to nearest power pole w/transformer (m) ____ Direction N

Distance between site and drip line of water tower (m) ______Direction from site to water tower ____________☐**NA**

Explain any sources of potential bias; include cultivated fields, loose bulk storage, stacks, vents, railroad tracks, construction activities, fast food restaurants, and swimming pools.

____

ANSWER ALL APPLICABLE QUESTIONS:

Parameters	**Monitoring Objective**	**Scale**	**Monitor Type**
☐ NA ☐ SO_2 (NAAQS) ☐ SO_2 (trace-level) ☐ NO_x (NAAQS) ☐ $HSNO_y$ ☐ O_3 ☐ NH_3 ☐ Hydrocarbon ☐ Air Toxics ☐ HSCO (Not Micro) ☐ CO (trace-level)	☐General/Background____ ☐Highest Concentration____ ☐Max O3 Concentration____ ☐Population Exposure____ ☐Source Oriented____ ☐Transport____ ☐Upwind Background____ ☐Welfare Related Impacts ____	☐Micro____ ☐Middle____ ☐Neighborhood____ ☐Urban____ ☐Regional____	☐SLAMS ____ ☐SPM____ **Monitor Network Affiliation** ☐NCORE____ ☐Unofficial PAMS____

Probe inlet height (from ground) 2-15 m? Yes ☐ No ☐ Give actual measured height from ground (meters) ____

Distance of outer edge of probe inlet from horizontal (wall) and/or vertical (roof) supporting structure > 1 m? Yes ☐ No ☐

Actual measured distance from outer edge of probe to supporting structure (meters) ____

Distance of outer edge of probe inlet from other monitoring probe inlets > 1 m? Yes ☐ No ☐ NA ☐

Is probe > 20 m from the nearest tree drip line? Yes ☐ *No ☐ (answer *'d questions)

*Is probe > 10 m from the nearest tree drip line? Yes ☐ *No ☐

*Distance from probe to tree (m) ____ Direction from probe to tree __ *Height of tree (m) ____

Are there any obstacles to air flow? *Yes ☐ (answer *'d questions) No ☐

*Identify obstacle ____ Distance from probe inlet (m) ____Direction from probe inlet to obstacle __

*Is distance from inlet probe to obstacle at least twice the height that the obstacle protrudes above the probe? Yes ☐ No ☐

Distance of probe to nearest traffic lane (m) ____ Direction from probe to nearest traffic lane __

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Instructions:

Address: Sometimes local addresses change. Confirm the local address of the site using a 911 locator or the address used by the local utility company, community or county to identify the site location.

Urban Area: If the monitor is located within the bounds of an urban area (an incorporated area with a population of 10,000 or more people), select the appropriate urban area from the list. Otherwise select "Not in an Urban Area".

Core-Based Statistical Area (CBSA): If the monitor is located within a county that is part of a metropolitan statistical area (MSA) or a micropolitan statistical area (MiSA), then it is located within a core-based statistical area. If the monitoring station is located in a county included in a MSA or MiSA, select the appropriate CBSA from the list. Otherwise select "None".

Longitude and Latitude: The longitude and latitude should be entered in decimal degrees. Use a conversion program, such as http://transition.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html, to convert to decimal degrees.

Road Information: For the nearest road to the inlet probe, list whatever roadway that carries vehicles that is closest to the probe, whether or not it is a named or public road and even if the road has very little traffic. Use the comments space if necessary to describe the road or the source of the annual average daily traffic (AADT) counts. If the monitor is located near an unnamed, little used, private road, use the nearest major road space to list the closest named public road to the site. Include the distance and direction of the nearest major road from the site as well as the AADT if it is available. If the closest road is a small public road but there is a large major roadway such as an interstate highway, divided highway, major thoroughfare, etc., near the monitoring station use the nearest major road space to list the information about this major roadway. Include the distance and direction of the major road from the site as well as the AADT. The AADT for state roads can be obtained from the North Carolina Division of Transportation at http://www.ncdot.gov/travel/statemapping/trafficvolumemaps/default.html. For AADT values for local roadways contact the appropriate local governments.

Any Sources of Potential Bias: Use this space to record any information about the site that is not requested elsewhere. Especially note any changes to the site that occurred near the site in the past year, such as road construction, building construction, new businesses, businesses closing, or changes in traffic patterns, crops or other agricultural activities.

Monitoring Objective: Why is this monitor here? What purpose does it serve? Monitoring objectives include: (a) Highest Concentration, which determine the highest concentrations of pollutant expected to occur in the area covered by the network; (b) Population Exposure, which measure typical concentrations of pollutant in areas of high population density; (c) Source Oriented, which determine the impact of significant sources or source categories of pollutant or precursors on air quality; (d) General/Background, which determine general background pollutant concentrations; (e) Transport, which determine the extent of regional pollutant transport among populated areas and in support of secondary standards; and (f) Welfare Related Impacts, which measure pollutant impacts on visibility, vegetation damage, or other welfare-based impacts. Sites established with the objective of studying ozone and its precursors may also be Maximum Ozone Concentration or Upwind Background sites. A monitor may have multiple objectives.

Scale: The scale of representativeness is determined by how close the monitor is located to a potential source or by the local terrain or urban development. For most monitors the scale of representativeness is determined by how close the monitor is to the roadway and how much traffic is present on the roadway.

Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood_and Urban_Scale Ozone and Oxides of Nitrogen (NO, NO_2, NO_x, NO_y)

Roadway average daily traffic, vehicles per day	Minimum separation distance,[1] meters	Minimum separation distance,[1, 2] meters
≤1,000	10	10
10,000	10	20
15,000	20	30
20,000	30	40
40,000	50	60
70,000	100	100
>=110,000	250	250

[1]Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.
[2] Applicable for ozone monitors whose placement has not already been approved as of December 18, 2006.

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Parameters	Monitoring Objective	Scale	Monitor Type
☐ NA ☐ NO_y (trace-level)	☐General/Background_____ ☐Highest Concentration_____ ☐Max O3 Concentration_____ ☐Population Exposure_____ ☐Source Oriented_____ ☐Transport_____ ☐Upwind Background_____ ☐Welfare Related Impacts _____	☐Micro_________ ☐Middle_________ ☐Neighborhood_____ ☐Urban_________ ☐Regional_____	☐SLAMS _________ ☐SPM_________ **Monitor Network Affiliation** ☐ NCORE_____

Probe inlet height (from ground) 10-15 m? Yes ☐ No ☐
Actual measured distance from probe inlet to ground (meters) _____

Distance of outer edge of probe inlet from horizontal and/or vertical supporting structure > 1 m? Yes ☐ No ☐
Actual measured distance from outer edge of probe inlet to supporting structure (meters) _____

Distance of outer edge of probe inlet from other monitoring probe inlets > 1 m? Yes ☐ No ☐ NA ☐

Is probe > 20 m from the nearest tree drip line? Yes ☐ *No ☐ (answer *'d questions)

*Is probe > 10 m from the nearest tree drip line? Yes ☐ *No ☐
*Distance from probe to tree (m) _____ Direction from probe to tree ___ *Height of tree (m) _____

Are there any obstacles to air flow? *Yes ☐ (answer *'d questions) No ☐

*Identify obstacle _____ Distance from probe inlet (m) _____Direction from probe inlet to obstacle ___
*Is distance from inlet probe to obstacle at least twice the height that the obstacle protrudes above the probe? Yes ☐ No ☐

Distance of probe to nearest traffic lane (m) _____ Direction from probe to nearest traffic lane ___

Parameters	Monitoring Objective	Scale	Monitor Type
☐ NA Air flow > 200 L/min ☐ PM10 ☐ TSP ☐ TSP Pb	☐Highest Concentration_____ ☐Population Exposure_____ ☐Source Oriented_____ ☐Background_____ ☐Transport_____ ☐Welfare Related Impacts _____	☐Micro_____ ☐Middle_____ ☐Neighborhood_____ ☐Urban_____ ☐Regional_____	☐SLAMS _____ ☐SPM_____ **Monitor Network Affiliation** ☐ NCORE_____

Probe inlet height (from ground) ☐ < 2 m _____ ☐ 2-7m _____ ☐ 7-15 m _____ ☐ > 15 m_____

Actual measured distance from probe inlet to ground (meters) _____

Distance of outer edge of probe inlet from horizontal (wall) and/or vertical (platform or roof) supporting structure > 2 m?
Actual measured distance from probe to supporting structure (meters) _____ Yes ☐ No ☐

Entire inlet opening of collocated PM-10, TSP or TSP Pb Samplers (X) within 2 to 4 m of each other? Yes ☐ No ☐ NA ☐

Actual measured distance (X) including entire inlet openings of both (all) collocated probe inlets (meters) _____

Distance (Y) between outer edge of any high volume inlet and any other high or low volume inlet ≥ 2 m? Yes☐ No☐ NA☐

Is probe > 20 m from the nearest tree drip line? Yes ☐ *No ☐ (answer *'d questions)

*Is probe > 10 m from the nearest tree drip line? Yes ☐ *No ☐
*Distance from probe to tree (m) _____ Direction from probe to tree ___ *Height of tree (m) _____

Are there any obstacles to air flow? *Yes ☐ (answer *'d questions) No ☐

*Identify obstacle _____ Distance from probe inlet (m) _____Direction from probe inlet to obstacle ___
*Is distance from inlet probe to obstacle at least twice the height that the obstacle protrudes above the probe? Yes ☐ No ☐

Distance of probe to nearest traffic lane (m) _____ Direction from probe to nearest traffic lane ___

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Instructions (continued):

Table E–2 to Appendix E of Part 58—Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood Scale Carbon Monoxide

Roadway average daily traffic, vehicles per day	Minimum distance[1] (meters)
≤10,000	10
15,000	25
20,000	45
30,000	80
40,000	115
50,000	135
≥60,000	150

[1]Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

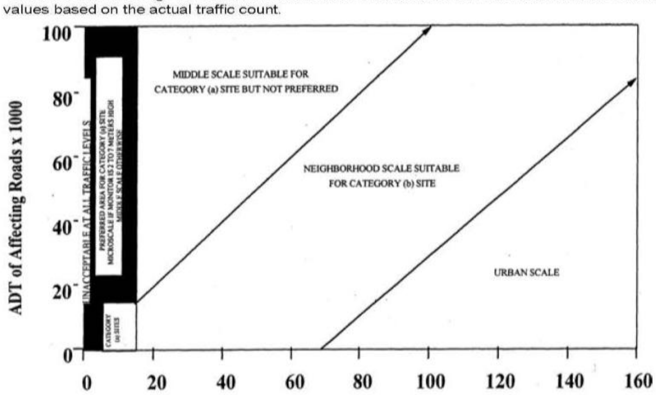

Figure E-1. Distance of PM samplers to nearest traffic lane (meters)

Probe Location: The probe must be located between 2 and 15 meters above ground level for all O_3 monitoring sites. Gaseous pollutant probes must be at least 1 meter vertically or horizontally away from any supporting structure, walls, parapets, penthouses, *etc.,* and away from dusty or dirty areas. If the probe is located near the side of a building or wall, then it should be located on the southwest side of the building.

Instructions for Measuring Distances between Inlets of Collocated Monitors

Diagram provided by Paul Chappin 8/4/2015

X is the distance allowed between collocated monitors. All collocated monitor inlets must be within 2 to 4 meters of one another. To be conservative, this distance should be measured so that the entire inlet opening of Monitor 1 and Monitor 2 are within 2 to 4 meters of each other, i.e., X = 2 to 4 meters. The purpose for this measurement is to ensure that the collocated monitors are measuring the same air mass.

Y is the minimum distance between collocated monitors. The minimum distance a low volume monitor must be from another low volume monitor is 1 meter. The minimum distance any monitor must be from a high volume monitor (Wedding PM 10 or TSP) is 2 meters. To be conservative this distance should be measured so that the entire inlet opening of Monitor 1 and Monitor 2 are more than either 1 meter or 2 meters from each other, i.e., Y = 1 or 2 meters. The purpose of this measurement is to ensure that neither monitor is being impacted by the turbulence created by the adjacent monitor, i.e., that both monitors are sampling air masses that are not impacted by nearby monitors.

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Parameters	Monitoring Objective	Scale	Site Type
☐ NA Air flow < 200 L/min ☐ PM2.5 FRM ☐ PM10 FRM ☐ PM10 Cont. (BAM) ☐ PM10-2.5 FRM ☐ PM10-2.5 BAM ☐ PM10 Lead (PB) ☐ PM2.5 Cont. (TEOM) ☐ PM2.5 Cont. (BAM) ☐ PM2.5 Spec. (SASS) ☐ PM2.5 Spec. (URG) ☐ PM2.5 Cont. Spec.	☐ General/Background _____ ☐ Highest Concentration _____ ☐ Population Exposure _____ ☐ Source Oriented _____ ☐ Transport _____ ☐ Welfare Related Impacts _____	☐ Micro _____ ☐ Middle _____ ☐ Neighborhood _____ ☐ Urban _____ ☐ Regional _____	☐ SLAMS _____ ☐ SPM_____ **Monitor Network Affiliation** ☐ NCORE _____ ☐ SUPPLEMENTAL SPECIATION _____ **Monitor NAAQS Exclusion** ☐ NONREGULATORY_____

Probe inlet height (from ground) ☐ < 2 m _____ ☐ 2-7m _____ ☐ 7-15 m _____ ☐ > 15 m _____
Actual measured distance from probe inlet to ground (meters) _____

Distance of outer edge of probe inlet from horizontal (wall) and/or vertical (platform or roof) supporting structure > 2 m?
Actual measured distance from outer edge of probe inlet to supporting structure (meters) _____ Yes ☐ No ☐

Distance (Y) between outer edge of probe inlets of any low volume monitor and any other low volume monitor at the site = 1 m or greater? Yes ☐ No ☐ NA ☐
Distance (Y) between outer edge of all low volume monitor inlets and any Hi-Volume PM-10 or TSP inlet = 2 m or greater? Yes ☐ No ☐ NA ☐

Are collocated PM2.5 Monitors (Two FRMs, FRM & BAM, FRM & TEOM, BAM & TEOM) Located at Site? *Yes ☐ (answer *'d questions) No ☐ NA ☐
* Entire inlet opening of collocated PM 2.5 samplers (X) within 2 to 4 m of each other? Yes ☐ No ☐ Give actual (meters) _____
*Are collocated PM2.5 sampler inlets within 1 m vertically of each other? Yes ☐ No ☐ Give actual (meters) _____

Is an URG 3000 monitor collocated with a SASS monitor at the site? *Yes ☐ (answer *'d questions) No ☐ NA ☐
* Entire inlet opening of collocated speciation samplers inlets (X) within 2 to 4 m of each other? Yes ☐ No ☐
Give actual (meters) _____
* Are collocated speciation sampler inlets within 1 m vertically of each other? Yes ☐ No ☐ Give actual (meters) _____

Is a low-volume PM10 monitor collocated with a PM2.5 monitor at the site to measure PM10-2.5? *Yes ☐ (answer *'d questions) No ☐ NA ☐
* Entire inlet opening of collocated PM10 and PM2.5samplers for PM10-2.5 (X) within 2 to 4 m of each other? Yes ☐ No ☐
*Are collocated PM10 and PM2.5 sampler inlets within 1 m vertically of each other? Yes ☐ No ☐

Is probe > 20 m from the nearest tree drip line? Yes ☐ *No ☐ (answer *'d questions)
*Is probe > 10 m from the nearest tree drip line? Yes ☐ *No ☐
*Distance from probe to tree (m) _____ Direction from probe to tree ___ *Height of tree (m) _____

Are there any obstacles to air flow? *Yes ☐ (answer *'d questions) No ☐
*Identify obstacle ____ Distance from probe inlet (m) ______Direction from probe inlet to obstacle ___
*Is distance from inlet probe to obstacle at least twice the height that the obstacle protrudes above the probe? Yes ☐ No ☐

Distance of probe to nearest traffic lane (m) _____ Direction from probe to nearest traffic lane ___

RECOMMENDATIONS:

1) Maintain current site status? Yes ☐ *No ☐ (answer *'d questions)

*2) Change monitoring objective? Yes ☐ (enter new objective ______) No ☐-

*3) Change scale of representativeness? Yes ☐ (enter new scale) No ☐

*4) Relocate site? Yes ☐ No ☐

Comments:

Date of Last Site Pictures _____ New Pictures Submitted? Yes ☐ No ☐

Reviewer ____Date _____

Ambient Monitoring Coordinator ______________________________Date___________

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Instructions (continued)**:**

Trees: The probe or inlet must be at least 10 meters or further from the drip line of trees. A distance of at least 20 meters between the probe and any tree or trees is preferred.

Obstacles: An obstacle is anything that restricts air flow. A tree can be an obstacle because it has branches and leaves that restrict the flow of air but a pole is not considered to be an obstacle. To avoid interference from obstacles, the probe or inlet must have unrestricted airflow and be located away from obstacles. The distance from the obstacle to the probe or inlet must be at least twice the height that the obstacle protrudes above the probe, inlet, or monitoring path.

If the annual network review has indicated that the monitoring objectives and scale of representativeness for the site have not changed and the siting criteria still meets those monitoring objectives and that scale of representativeness and there are no other reasons to modify the site in any way, check “Yes” to the question “Maintain current site status?” and skip the rest of the recommendations section.

If the annual network review has indicated that the monitoring objectives, scale of representativeness, or siting criteria have changed for some reason or there is another reason to modify the site in some way, check “No” to the question “Maintain current site status?” and complete the rest of the recommendations section. If the monitoring objective or scale of representativeness needs to be changed, check the “Yes” box and write in the new monitoring objective or scale of representativeness on the line. Otherwise check the “No” box. If the site needs to be relocated, check the “Yes” box. If the site needs to be shut down, write “Shut down” in the comments line. Also use the comments line to explain any change requested.

Check the site picture archive to find out when the last set of site pictures were taken and write the date down on the line. If the pictures are more than five years old or if something at the site has changed in the past year, take new site pictures. Changes that require new site pictures include additions, removals, or movement of monitors at the site, growth or removal of trees and other shrubs at the site, and construction of roads or buildings at or in the vicinity of the site.

Pictures of the site should at a minimum include at least one picture showing the site itself and pictures standing at the probe or inlet or as close as possible to the probe or inlet looking in the four compass directions (north, east, south, and west). If meteorological data are collected at the site, pictures standing at the meteorological tower looking southwest and northeast should also be included. Sometimes pictures looking at the site from the four compass directions are also helpful.

Be sure to correctly identify the pictures as to which compass direction they show. This documentation may be achieved by using good notes when taking the pictures, holding a compass in front of the camera, or placing a sign with the appropriate direction indicated somewhere in the picture. Label the pictures with the name of the site using the two digit logger ID (HC, JW, *etc.*), the direction (N, NE, E, SE, S, SW, W, NW), and the date taken (YYYYMMDD) and transfer the pictures to the group drive in the appropriate Incoming/Regional Office directory.

In addition to the items included in the checklists, other subjects for discussion as part of the network review and overall 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, and
- Other issues such as proposed regulations and funding.

The network review will be documented in a report within two months of completion. This report will be distributed to the appropriate senior staff and EPA.

19.2.1. Particulate Matter Network Reviews

A particulate matter (PM_{10} and $PM_{2.5)}$ network review will be completed every year. EPA regions are also required to perform these reviews. The following criteria will be considered:

- Date of last review;
- Areas where attainment/non-attainment re-designations are likely to take place, or did take place;
- Results of special studies, saturation sampling, point source oriented ambient monitoring, etc.; and
- Proposed network modifications since the last network review.

The number of particulate matter monitors required, depending upon the measurement objectives, is discussed in 40 CFR Part 58 Appendix D. Additional details exist in the *Guidance for Network Design and Optimum Exposure for $PM_{2.5}$ and PM_{10}.*

19.2.2. Technical Systems Audits

A technical systems audit (TSA) is a thorough and systematic qualitative audit, where facilities, equipment, personnel, training procedures, protocols and record keeping are examined for conformance with the QAPP. A TSA will be performed on-site during the early stage of the project, and anytime senior staff feels it is appropriate, to assist in identifying deficiencies and providing timely corrective actions. Annual TSA's will take place at the conclusion of each calendar year's collection of data to maintain high quality data collection and reporting.

A TSA team or an individual TSA auditor may segregate TSA activities into three categories. The categories may be audited independently or they may be combined. The TSA categories are:

- Field activities - Handling, sampling and shipping.

- Laboratory activities - Pre-sampling weighing, shipping, receiving, post-sampling weighing, archiving and associated QA/QC activities.
- Data management activities – Collecting, flagging, editing, and uploading data; providing data security.

Key personnel to be interviewed during the audit are those individuals with responsibilities for planning, field operations, laboratory operations, QA/QC, data management and reporting.

The audit team will prepare a brief written report summarizing the findings. The following areas may be included but all reports will include items d, e and f:

a. Planning,
b. Field operations,
c. Laboratory operations,
d. QA/QC,
e. Data management, and
f. Reporting.

Problems with specific areas will be documented and corrective actions will be implemented.

19.2.3. Post-Audit Activities

The major post-audit activity is the preparation of the systems audit report. The report will include:

- Audit title, identification number, date of report and any other identifying information;
- Audit team leaders, audit team participants and audited participants;
- Background information about the project, purpose of the audit, dates of the audit, particular measurement phase or parameters that were audited and a brief description of the audit process;
- Summary and conclusions of the audit and corrective action required; and
- Attachments or appendices that include all audit evaluations and audit finding forms.

To prepare the report, the audit team will meet and compare observations with collected documents and results of interviews with key personnel. Expected QAPP implementation is compared with observed accomplishments and deficiencies. The audit findings are reviewed in detail and, within 30 calendar days of the completion of the audit, a comprehensive audit report will be generated and distributed to senior staff for comment.

If the affected parties have written comments or questions concerning the audit report, the audit team will review and incorporate them as appropriate. Subsequently, a modified report will be prepared and resubmitted in final form within 30 days of receipt of the written comments. The report will include an agreed-upon schedule for corrective action implementation.

19.2.4. Follow-up and Corrective Action Requirements

As part of corrective action and follow-up, an audit finding response form will be generated by the audited organization for each finding in the TSA report. The audit finding response form is signed by the respective regional chemist(s) and sent to the TSA team, which reviews and accepts or rejects the corrective action. The audit response form will be completed within 30 days of acceptance of the audit report.

19.2.5. Performance Evaluation

Performance evaluation activities are addressed by DAQ (and any of its contractors) participating in the EPA's National Performance Audit Program (NPAP) and Performance Evaluation Program (PEP). Only qualified and authorized personnel execute performance audits.

19.2.6. Audit of Data Quality

An audit of data quality (ADQ) reveals how data are handled, what judgments were made and whether uncorrected mistakes were made. An ADQ can often identify the means to correct systematic data reduction errors. An ADQ shall be included as part of the annual systems audit. Sufficient time and effort will be devoted to this activity so that the auditors have a clear understanding and complete documentation of data flow. Pertinent ADQ questions appear on the TSA check sheets, which shall be used in executing an ADQ. The TSA check sheets shall be used to ensure that the data collection and handling integrity is maintained. The ADQ will serve as an effective framework for organizing the extensive amount of information gathered during the audit of laboratory, field monitoring and support functions within the agency.

19.2.7. Data Quality Assessments

A data quality assessment (DQA) is the statistical analysis of environmental data to determine whether the data meet the assumptions that the DQOs and data collection design were developed under and whether the total error in the data is tolerable. Calculations for DQA activities shall follow the requirements and equations identified in 40 CFR Part 58, Appendix A, Section 4 and reiterated in Section 14 of this QAPP. The DQA process is described in detail in t *Data Quality Assessment - A Reviewer's Guide* (EPA QA/G-9R)[6]

Measurement uncertainty will be estimated for both automated and manual data recording methods. Terminology associated with measurement uncertainty is found within 40 CFR Part 58, Appendix A.

Estimates of the data quality will be calculated on the basis of single monitors and aggregated to all monitors. The individual results of these tests for each method or analyzer shall be reported to EPA. Data quality assessment findings will be included in DAQ's QA annual report.

[6] Available at http://www.epa.gov/QUALITY/qs-docs/g9r-final.pdf.

19.3. Assessment Documentation

19.3.1. Number, Frequency and Types of Assessments

Audits shall be executed during the course of this project at the frequency and quantity indicated. Network reviews shall be conducted by the regional site operators every year that the ambient air quality monitoring network is operational. MSRs shall be conducted by Region 4 once during every three-year period that the criteria pollutant and NCore ambient air quality monitoring networks collect data verifying compliance with the NAAQS. TSAs shall be performed by Region 4 once during every three-year period that the criteria pollutant and NCore ambient air quality monitoring networks collect data verifying compliance with the NAAQS. Application of additional TSAs shall be at the discretion of the DAQ's Ambient Monitoring Section chief. Performance evaluation audits shall be performed in accordance with the schedule established by EPA's NPAP and PEP. An ADQ shall be performed every year that the criteria pollutant and NCore ambient air quality monitoring networks are operational.

19.3.2. Assessment Personnel

The following sections identify the responsibilities of individuals within the monitoring organization. These individuals are responsible for executing audits, assessing findings, developing and implementing necessary corrective actions, preparing QA reports, evaluating their impact and implementing follow-up actions.

19.3.2.1. Ambient Monitoring Section Chief

The section chief administers and maintains overall responsibility for management and administrative aspects of the QA program.

19.3.2.2. Regional Chemist

The regional chemists are responsible for assessing audit findings, issuing appropriate response/corrective actions, assigning response/corrective actions to specific personnel and assuring the completeness and efficacy of the work. The regional chemists are also responsible for assuring that the site operators, auditors and ECB technicians maintain their documentation as defined in the network design (40 CFR Part 58, Appendix D) and for disseminating information appearing in audit reports and other quality-related documents to operations personnel.

19.3.2.3. Data Polling and Database Manager

The data polling and database manager is responsible for coordinating the information management activities for SLAMS/SPM data collection and dissemination to AirNow and AQS. Specific activities related to audit execution include ensuring access to data for DQA and ADQ activities.

19.3.2.4. Projects and Procedures Branch Chemists, Regional Chemists and Regional Site Operators

The Projects and Procedures Branch chemists, regional chemists and regional site operators are responsible for implementing day-to-day QA activities for the criteria pollutant and NCore ambient air quality monitoring programs, generating control charts, assisting with DQAs and other internal audits and calculating and/or reviewing precision and bias data generated by the collocated $PM_{2.5}$ monitors. They are also responsible for documenting the response to required corrective actions in response/corrective action reports (see section 20.1.5).

19.3.2.5. Projects and Procedures Branch Supervisor

The Projects and Procedures Branch supervisor is responsible for identifying problems, overseeing the corrective action and assuring that the appropriate documentation is generated, distributed and filed. The Project and Procedures Branch supervisor will assist the Project and Procedures Branch chemists in preparing QA reports and summaries.

19.3.2.6. Lab Analysis Branch Supervisor

The Lab Analysis Branch supervisor is responsible for reviewing laboratory QC data such as control charts, assuring that repairs and preventive maintenance are completed and that the maintenance is effective and assuring that analysts under his or her supervision maintain their documentation files as defined in the relevant SOPs.

19.3.2.6. Electronics and Calibration Branch Supervisor and Technicians

The Electronic and Calibration Branch supervisor and technicians are responsible for completing repairs and preventive maintenance on all field equipment, conducting annual performance evaluations on all of the gaseous monitors, and maintaining documentation as required in the relevant SOPs.

19.3.3. Reporting and Resolution of Issues

To address the findings from audits, peer reviews and other assessments, the following structure and associated protocols shall be employed to identify and implement corrective actions.

Any participant in the collection, analysis, audit/assessment and report generating activities affiliated with the criteria pollutant and NCore ambient air quality monitoring networks is responsible for identifying the need for corrective actions. Identifying the need for corrective actions can occur during site visits, audits, data analysis operations, or other monitoring network activities. This shared responsibility, coupled with diligent attention to detail and accuracy, will assure that the criteria pollutant and NCore ambient air quality monitoring networks consistently collects quality data, and that these data are reduced, analyzed, and presented in an accurate and representative manner. Any participant that perceives a need for corrective action(s) shall present the situation to their supervisor and the appropriate regional chemist(s) within 30 days of perceiving the need.

The regional chemist(s) will assess the need for a corrective action. If one is deemed necessary, a suitable corrective action will be selected and disseminated to the Project and Procedures Branch chemist(s) and the originator within 60 days.

Regional site operators are responsible for implementing corrective actions. An implementation notice will be supplied to the regional chemist(s) upon completion of the corrective action. The corrective action must be implemented within 30 days notwithstanding extenuating circumstances.

Following implementation of a corrective action, the section chief may, at his or her discretion, require a TSA to verify the efficacy of the corrective action. Both the action of implementing the corrective action and the influence of the corrective action on the operations of the criteria pollutant and NCore ambient air quality monitoring network must be appraised. Any deficiencies in the correction must be noted and the procedure updated to completely correct the discrepancy.

20. REPORTS TO MANAGEMENT

This section describes the quality-related reports and communications to management necessary to support criteria pollutant and NCore SLAMS/SPM network operations and the associated data acquisition, validation, assessment, and reporting. Unless otherwise indicated, all reports will contain monitoring data for criteria and NCore pollutants, including $PM_{2.5}$.

20.1. Frequency, Content, and Distribution of Reports

Reports to management required for the criteria pollutant SLAMS and NCore programs in general are discussed in various sections of 40 CFR Parts 50, 53, and 58. Guidance for management report format and content is provided in reports developed by EPA's Quality Assurance Division and Office of Air Quality Planning and Standards. These reports are described in the following subsections.

20.2. Quality Assurance Annual Report

Periodic assessments of SLAMS data quality for the criteria pollutant and NCore networks are required to be reported to EPA (40 CFR Part 58, Appendix A, Section 1.4). DAQ's QA annual report is issued to meet this requirement. This document describes the quality objectives for measurement data and how those objectives have been met. The QA annual report also reviews the SLAMS air quality criteria pollutant and NCore surveillance systems on an annual basis to determine if the systems meet the monitoring objectives defined in 40 CFR Part 58, Appendix D. Such review identifies needed modifications to the network such as termination or relocation of unnecessary stations or establishment of new stations.

20.3. Network Reviews Network Plan, and 5-Year Assessments

Following the requirements in 40 CFR Section 58.10(a) the State agency prepares and submits to the regional administrator an annual monitoring network plan. The plan provides for the establishment and maintenance of an air quality surveillance system consisting of a network of SLAMS monitoring stations including FRM, FEM, and ARM monitors that are part of SLAMS, NCore, STN, state speciation, SPM and PAMS monitoring stations. The plan includes: (1) a statement of purpose for each monitor and (2) evidence that siting and operation of each monitor meets the requirements of appendices A, C, D, and E of 40 CFR 58, where applicable. The annual monitoring network plan is made available for public inspection for at least 30 days before submission to EPA. As part of the network plan, annual network reviews of each site are conducted by the site operators. The network review determines if a system meets the siting requirements and monitoring objectives defined in 40 CFR Part 58, Appendix D. The review identifies needed modifications to the site and network including termination or relocation of unnecessary stations or establishment of new stations.

DAQ conducts and submits to the EPA regional administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network. The network assessment considers the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma), and, for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby states and tribes or health effects studies. For $PM_{2.5}$, the assessment also identifies needed changes to population-oriented sites. The state agency submits a copy of this 5-year assessment, along with a revised annual network plan, to the regional administrator.

As required by 40 CFR Part 58, Appendix A, Section 5.1, DAQ provides a list of all monitoring sites and their AQS site identification codes to EPA Region 4 each year in the network plan. DAQ keeps AQS up-to-date by creating site data records with the date a site was established and other pertinent info. DAQ also sends any appropriate data to AIRNow Tech. Whenever there is a change in this list of monitoring sites or in a reporting organization between network plans, DAQ reports this change to EPA Region 4 via electronic mail and to AQS and AirNow Tech by updating the appropriate site records.

20.4. Quarterly Reports

Each quarter, DAQ reports to AQS the results of all precision, bias, and accuracy tests it carried out during the previous quarter. The quarterly reports are submitted consistent with the data reporting requirements specified for air quality data as set forth in 40 CFR Part 58, Appendix A, Section 5. The data reporting requirements of 40 CFR Section 58.16 apply to those stations designated SLAMS or SPM in the criteria pollutant and NCore networks. Required accuracy and precision data are reported on the same schedule as quarterly monitoring data submittals.

Air quality data submitted for each reporting period will be edited, validated, and entered into the AQS using the procedures described in the *AQS Data Coding Manual*[7]. A Project and Procedures Branch staff member will be responsible for preparing the data reports, which will be reviewed by the chief of the Ambient Monitoring Section before they are transmitted to EPA.

20.5. Technical System Audit Reports

Project and Procedures Branch chemists perform TSAs of the criteria pollutant and NCore monitoring systems. These reports are issued by the DAQ RCO and are reviewed by the regional chemists. These reports will be filed and made available to EPA personnel during their TSAs. External systems audits are conducted at least every three years by EPA Region 4 as required by 40 CFR Part 58, Appendix A, Section 2.5.

20.6. 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. A separate report will be required for each problem identified. 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. Copies of response/corrective action reports will be distributed twice: first when the problem has been identified and the action has been scheduled, and second when the correction has been completed. The regional chemist or

[7] Available at http://www.epa.gov/ttn/airs/airsaqs/manuals/AQS%20Data%20Coding%20Manual.pdf.

technician assigned will generate the response/corrective action reports. The report will be distributed to the regional supervisor and the Ambient Monitoring Section Chief.

21.0 DATA VALIDATION AND USABILITY

The purpose of this element is to state the criteria for deciding the degree to which each data item has met its quality specifications. Investigators should estimate the potential effect that each deviation from the QAPP may have on the usability of the associated data item, its contribution to the quality of the reduced and analyzed data, and its effect on decisions.

21.1. Sampling Design

Sampling network design and monitoring site selection must comply with:

- 40 CFR Part 58, Appendix A - Quality Assurance Requirements for SLAMS, SPM, and PSD Air Monitoring
- 40 CFR Part 58, Appendix D - Network Design Criteria for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring.

Additional guidance is provided in *Guidance for Choosing a Sampling Design for Environmental Data Collection,* (EPA QA/G-5S).

Any deviations from the minimum siting criteria (e.g., shelter location, probe placement, and/or monitor sight path requirements) shall be thoroughly documented in the site's QC documentation. Examples of deviations include, but are not limited to, insufficient distance from roadways (i.e., marginal terrain criteria) and insufficient distance from influencing objects (e.g., dripline of an adjacent tree or a cell phone tower that was installed after the monitoring site was established). The impact of the deviations should be evaluated and appropriate adjustments to the confidence intervals should be determined.

21.2. Sample Collection Procedures

Sample collection procedures are outlined in Section 11 of this QAPP. Potentially unacceptable data points are routinely identified in the database through electronic application of error flags. Each instrument-specific flag is associated with a unique error. These error flags are routinely reviewed as part of the data validation process. This activity assists in identifying suspect (potentially bad) data points that could invalidate the resulting averaging periods. A compilation of the error flags is presented in Table 21-1.

Any deviation from the established sample collection plan must be documented in the appropriate logbook and on the field sample data sheet. Accurate and complete documentation of any sample collection deviations will assist in any subsequent investigations or evaluations. Investigations and evaluations may be necessary to determine whether the data obtained from a particular site may qualify as a baseline or indicator for other sites.

Table 21-1. Qualifier Code Description and Type.

Flag	Flag Description	Flag Qualifier Type	Purpose
IA	African Dust	Informational Only	To provide information on events that influenced the measured values
IB	Asian Dust	Informational Only	
IC	Chem. Spills & Indust Accidents	Informational Only	
ID	Cleanup After a Major Disaster	Informational Only	
IE	Demolition	Informational Only	
IF	Fire - Canadian	Informational Only	
IG	Fire - Mexico/Central America	Informational Only	
IH	Fireworks	Informational Only	
II	High Pollen Count	Informational Only	
IJ	High Winds	Informational Only	
IK	Infrequent Large Gatherings	Informational Only	
IL	Other	Informational Only	
IM	Prescribed Fire	Informational Only	
IN	Seismic Activity	Informational Only	
IO	Stratospheric Ozone Intrusion	Informational Only	
IP	Structural Fire	Informational Only	
IQ	Terrorist Act	Informational Only	
IR	Unique Traffic Disruption	Informational Only	
IS	Volcanic Eruptions	Informational Only	
IT	Wildfire-U. S.	Informational Only	
J	Construction	Informational Only	
AA	Sample Pressure out of Limits	Null Data Qualifier	Void the data and submit the code in its place.
AB	Technician Unavailable	Null Data Qualifier	
AC	Construction/Repairs in Area	Null Data Qualifier	
AD	Shelter Storm Damage	Null Data Qualifier	
AE	Shelter Temperature Outside	Null Data Qualifier	
AF	Scheduled but not Collected	Null Data Qualifier	
AG	Sample Time out of Limits	Null Data Qualifier	
AH	Sample Flow Rate out of Limits	Null Data Qualifier	
AI	Insufficient Data (cannot	Null Data Qualifier	
AJ	Filter Damage	Null Data Qualifier	
AK	Filter Leak	Null Data Qualifier	
AL	Voided by Operator	Null Data Qualifier	
AM	Miscellaneous Void	Null Data Qualifier	
AN	Machine Malfunction	Null Data Qualifier	
AO	Bad Weather	Null Data Qualifier	
AP	Vandalism	Null Data Qualifier	
AQ	Collection Error	Null Data Qualifier	
AR	Lab Error	Null Data Qualifier	
AS	Poor Quality Assurance Results	Null Data Qualifier	
AT	Calibration	Null Data Qualifier	

Table 21-1. Qualifier Code Description and Type. (continued)			
Flag	**Flag Description**	**Flag Qualifier Type**	**Purpose**
AU	Monitoring Waived	Null Data Qualifier	Void the data and submit the code in its place.
AV	Power Failure	Null Data Qualifier	
AW	Wildlife Damage	Null Data Qualifier	
AX	Precision Check	Null Data Qualifier	
AY	Q C Control Points (zero/span)	Null Data Qualifier	
AZ	Q C Audit	Null Data Qualifier	
BA	Maintenance/Routine Repairs	Null Data Qualifier	
BB	Unable to Reach Site	Null Data Qualifier	
BC	Multi-point Calibration	Null Data Qualifier	
BD	Auto Calibration	Null Data Qualifier	
BE	Building/Site Repair	Null Data Qualifier	
BF	Precision/Zero/Span	Null Data Qualifier	
BG	Missing ozone data not likely to exceed level of standard	Null Data Qualifier	
BH	Interference/co-elution/misidentification	Null Data Qualifier	
BI	Lost or damaged in transit	Null Data Qualifier	
BJ	Operator Error	Null Data Qualifier	
BK	Site computer/data logger down	Null Data Qualifier	
BL	QA Audit	Null Data Qualifier	
BM	Accuracy check	Null Data Qualifier	
BN	Sample Value Exceeds Media Limit	Null Data Qualifier	
BR	Sample Value Below Acceptable Range	Null Data Qualifier	
CS	Laboratory Calibration Standard	Null Data Qualifier	
DA	Aberrant Data (Corrupt Files, Aberrant Chromatography, Spikes, Shifts)	Null Data Qualifier	
DL	Detection Limit Analyses	Null Data Qualifier	
FI	Filter Inspection Flag	Null Data Qualifier	
MB	Method Blank (Analytical)	Null Data Qualifier	
MC	Module End Cap Missing	Null Data Qualifier	
SA	Storm Approaching	Null Data Qualifier	
SC	Sampler Contamination	Null Data Qualifier	
ST	Calibration Verification Standard	Null Data Qualifier	
TC	Component Check & Retention Time Standard	Null Data Qualifier	
TS	Holding Time or Transport Temperature Is Out of Specs.	Null Data Qualifier	
XX	Experimental Data	Null Data Qualifier	
1	Deviation from a CFR/Critical Criteria	Quality Assurance Qualifier	Flag indicating the quality of the data
2	Operational Deviation	Quality Assurance Qualifier	
3	Field Issue	Quality Assurance Qualifier	
4	Lab Issue	Quality Assurance Qualifier	
5	Outlier	Quality Assurance Qualifier	
6	QAPP Issue	Quality Assurance Qualifier	

Table 21-1. Qualifier Code Description and Type. (continued)			
Flag	**Flag Description**	**Flag Qualifier Type**	**Purpose**
7	Below Lowest Calibration Level	Quality Assurance Qualifier	Flag indicating the quality of the data. In some cases the data may not meet all of the criteria but is still valid.
9	Negative value detected - zero reported	Quality Assurance Qualifier	
CB	Values have been Blank Corrected	Quality Assurance Qualifier	
CC	Clean Canister Residue	Quality Assurance Qualifier	
CL	Surrogate Recoveries Outside Control Limits	Quality Assurance Qualifier	
DI	Sample was diluted for analysis	Quality Assurance Qualifier	
EH	Estimated; Exceeds Upper Range	Quality Assurance Qualifier	
FB	Field Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
FX	Filter Integrity Issue	Quality Assurance Qualifier	
HT	Sample pick-up hold time exceeded	Quality Assurance Qualifier	
LB	Lab blank value above acceptable limit	Quality Assurance Qualifier	
LJ	Identification Of Analyte Is Acceptable; Reported Value Is An Estimate	Quality Assurance Qualifier	
LK	Analyte Identified; Reported Value May Be Biased High	Quality Assurance Qualifier	
LL	Analyte Identified; Reported Value May Be Biased Low	Quality Assurance Qualifier	
MD	Value less than MDL	Quality Assurance Qualifier	
MS	Value reported is 1/2 MDL substituted.	Quality Assurance Qualifier	
MX	Matrix Effect	Quality Assurance Qualifier	
ND	No Value Detected	Quality Assurance Qualifier	
NS	Influenced by nearby source	Quality Assurance Qualifier	
QX	Does not meet QC criteria	Quality Assurance Qualifier	
SQ	Values Between SQL and MDL	Quality Assurance Qualifier	
SS	Value substituted from secondary monitor	Quality Assurance Qualifier	
SX	Does Not Meet Siting Criteria	Quality Assurance Qualifier	
TB	Trip Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
TT	Transport Temperature is Out of Specs.	Quality Assurance Qualifier	
V	Validated Value	Quality Assurance Qualifier	
VB	Value below normal; no reason to invalidate	Quality Assurance Qualifier	
W	Flow Rate Average out of Spec.	Quality Assurance Qualifier	
X	Filter Temperature Difference out of Spec.	Quality Assurance Qualifier	
Y	Elapsed Sample Time out of Spec.	Quality Assurance Qualifier	
RA	African Dust	Request Exclusion	Flags data influ-enced by an excep-tional event that will be excluded
RB	Asian Dust	Request Exclusion	
RC	Chem. Spills & Indust. Accidents	Request Exclusion	
RD	Cleanup After a Major Disaster	Request Exclusion	
RE	Demolition	Request Exclusion	
RF	Fire - Canadian	Request Exclusion	
RG	Fire - Mexico/Central America	Request Exclusion	
RH	Fireworks	Request Exclusion	
RI	High Pollen Count	Request Exclusion	

Table 21-1. Qualifier Code Description and Type. (continued)

Flag	Flag Description	Flag Qualifier Type	Purpose
RJ	High Winds	Request Exclusion	Flags data influenced by an exceptional event that will be excluded
RK	Infrequent Large Gatherings	Request Exclusion	
RL	Other	Request Exclusion	
RM	Prescribed Fire	Request Exclusion	
RN	Seismic Activity	Request Exclusion	
RO	Stratospheric Ozone Intrusion	Request Exclusion	
RP	Structural Fire	Request Exclusion	
RQ	Terrorist Act	Request Exclusion	
RR	Unique Traffic Disruption	Request Exclusion	
RS	Volcanic Eruptions	Request Exclusion	
RT	Wildfire-U. S.	Request Exclusion	

21.3. Sample Handling

Record pertinent deviations from established sample-handling protocols for each sample physically retrieved for monitoring sites and equipment. These deviations shall be recorded on the sample custody sheet assigned to each filter for particulate matter and recorded in the applicable electronic database for all other criteria pollutants.

21.4. Analytical Procedures

The data obtained from the electronic evaluation of criteria pollutant concentrations shall be validated and verified utilizing both manual and electronic methods. Specific criteria are employed that identify the range of acceptable data, the minimum and maximum acceptable values, the rate of change of specific values, and other criteria that are indicative of valid qualifying data. Suspect data are flagged utilizing the list provided in Table 21-1.

21.5. Quality Control

Section 14 specifies the QC checks that are to be performed during sample collection, handling, and analysis. These include analyses of check standards, blanks, replicates and collocated monitoring, which provide indications of the quality of data being produced by specified components of the measurement process. For each specified QC check, the procedure, acceptance criteria, and corrective action (and changes) should be specified. Data validation should document the corrective actions that were taken, which samples were affected, and the potential effect of the actions on the validity of the data.

21.6. Calibration

Section 16 addresses the calibration of instruments and equipment and the information that should be presented to ensure that the calibrations are performed correctly, and the results are acceptable. When calibration problems are identified, any data produced between the suspect calibration event and any subsequent recalibration should be flagged to alert data users.

21.7. Data Reduction and Processing

As mentioned in the above sections, both internal and external TSAs will be performed to ensure the data reduction and processing activities mentioned in the QAPP are being followed. Periodically, raw data will be reviewed and final concentrations will be calculated by hand. The final values submitted to AQS should match the hand calculations. The data will also be reviewed to ensure that associated flags or any other data qualifiers have been appropriately associated with the data and that appropriate corrective actions were taken.

22.0 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.

22.1. Validating and Verifying Data

The validation and verification procedures that will be employed for this operation shall conform to Sections 2.24 *Particulate Matter 2.5 QA Plan Section IV RCO Responsibilities*, 2.5 *Particulate Matter 10 Microns PM 10 Wedding Samplers*, and 2.8.3 *Section III: Regional Office Polling and Data Review*. Verification and validation issues are also discussed at length in *Guidance on Environmental Verification and Validation*, (EPA QA/G-8). The regions and their designated support staff shall perform all validation and verification activities. The central office shall provide additional support through a final review of all data reconciling any anomalies through discussions with the regional offices. The central office will also provide other QC/QA support.

The data under evaluation should be compared to actual events as specified in Sections 2.24 *Particulate Matter 2.5 QA Plan Section IV RCO Responsibilities*, 2.5 *Particulate Matter 10 Microns PM 10 Wedding Samplers*, and 2.8.3 *Section III: Regional Office Polling and Data Review*. However, exceptional field events may occur, and field and laboratory activities may negatively affect the integrity of samples. In addition, it is expected that some of the QC checks will indicate that the data fail to meet the acceptance criteria. Data identified as suspect, or does not meet the acceptance criteria, shall be flagged as indicated in Table 21-1.

The review of the routine and the associated QC data will be verified and validated on a sample batch basis. The sample batch is the most efficient entity for verification/validation activities. The hypothesis is that if measurement uncertainty can be controlled at a batch level, then the overall measurement uncertainty will be maintained within the precision and bias DQIs.

22.2. Verification

After a sample batch is compiled, 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 verified again to ensure that the values were entered correctly.

22.3. Validation

Validation of measurement data requires two stages, one at the measurement value level and another at the batch level. Records of all invalid samples shall be retained in the appropriate database. Information shall include a brief summary of why the sample was invalidated along with the associated flags. Logbook notes and field data sheets shall have more detailed information regarding the reason a sample was flagged. These documents shall remain with the field operators and/or at the monitoring site.

Certain criteria based upon federal requirements, and field operator and laboratory personnel judgment have been developed that will be used to invalidate a sample or measurement. The flags listed in Table 21-1 shall be used to indicate that individual samples, or samples from a particular instrument, have been invalidated. Filter-based samples shall be returned to the laboratory for further examination. Filters that have flags related to contamination, damage, or field complications shall be immediately examined. Upon concurrence of the laboratory technician and Projects and Procedures Branch chemist, these samples shall be invalidated.

23.0 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Section 23 identifies the acceptable methods for evaluating the project results and provides an outline for the report required to document the findings. The DQOs for the criteria pollutant and NCore ambient air quality monitoring networks were established in Section 7. The resulting DQOs are for sampling or monitoring precision and relative bias. Section 19 discusses assessment and response actions. This section of the QAPP outlines the procedures to follow to determine whether the monitors and laboratory analyses are producing data that comply with the DQOs, what actions will be taken as a result of the assessment process, who will perform, review, and approve this assessment, and who will generate the report to document the findings.

23.1. Reconciling Results with Data Quality Objectives

This element includes scientific and statistical evaluations of data to determine if the data are of the right type, quantity, and quality to support their intended use. The EPA document *Guidance for Data Quality Assessment - A Reviewer's Guide* (EPA QA/G-9R)[8] focuses on evaluating data for fitness in decision-making and also provides many graphical and statistical tools.

As described in *Guidance for Data Quality Assessment*, the DQA process is comprised of five steps. The steps are outlined below. Refer to *Guidance for Data Quality Assessment* for a detailed description of each step.

Five Steps of the Data Quality Assessment Process

As described in *Guidance for Data Quality Assessment – A Reviewer's Guide* (EPA QA/G-9R), the DQA process is comprised of five steps. The steps are outlined below. Refer to *Guidance for Data Quality Assessment* for a detailed description of each step.

Step 1. Review Data Quality Objectives and Sampling Design. Data and modeling analysts, and the chief of ambient monitoring shall review the project's sampling design, DQIs (precision, bias, comparability, representativeness, and completeness), and DQOs to verify that they are still applicable. Section 7 of this QAPP contains details for DQO development. Additional information contained in Section 7 includes methods for:

- Defining the primary objectives of the criteria pollutant and NCore ambient air quality monitoring network (e.g., NAAQS comparison, model verification, etc.).
- Translating the objectives into a statistical hypothesis (e.g., the three-year average of annual mean $PM_{2.5}$ concentrations is less than or equal to 12 µg/m^3).
- Developing limits on decision errors (e.g., incorrectly conclude an area is non-attainment when it truly is attainment no more than 5 percent of the time, and incorrectly conclude an area is attainment when it truly is in non-attainment no more than 5 percent of the time).

Section 10 of this QAPP contains the details of the criteria pollutant and NCore ambient air quality monitoring network design, including the rationale for the design, the design assumptions, and the sampling locations and frequency. If any deviations from the sampling

[8] Available at http://www.epa.gov/QUALITY/qs-docs/g9r-final.pdf.

design have occurred, these shall be documented for the DQA, and their potential effect carefully considered throughout the entire DQA.

Step 2. Conduct Preliminary Data Review. Data and modeling analysts, and the statistician shall perform a preliminary data review to uncover potential limits on using the data, and evaluate the various submitted QA reports to identify any corresponding anomalous conditions. The first phase of the preliminary data review is to review the QA reports. The second phase of the preliminary data review is to calculate basic summary statistics, generate graphical presentations of the data, and review these summary statistics and graphs.

- **Review Quality Assurance Reports –** Project and Procedures Branch Chemists will write all QA reports that describe the data collection and reporting process. Particular attention will be directed to looking for anomalies in recorded data, missing values, and any deviations from SOPs. This is a quality review. Any concerns will be further investigated in the next two steps.
- **Calculate Summary Statistics and Generate Graphical Presentations –** the statistician will generate summary statistics (via AQS) for each primary and QA sampler. The summary statistics will be calculated at the quarterly, annual, and three-year levels and will include only valid samples. Standard summary statistics include:
    - Effective number of samples
    - Mean concentrations
    - Median concentrations
    - Standard deviations
    - Coefficient of variation
    - Maximum concentrations
    - Minimum concentrations
    - Inter-quartile range

These statistics will also be calculated for percent differences at collocated sites. The results will be summarized in a table. Particular attention will be given to the impact on the statistics caused by abnormalities noted in the QA review. The statistician may evaluate the influence of a potential outlier by evaluating the change in the summary statistics resulting from exclusion of the outlier.

Additionally, basic histograms or other appropriate graphs, such as boxplots or CDF plots, may be created for each of the primary and QA samplers and for the percent difference at the collocated sites. These graphs will be useful in identifying anomalies and evaluating the normality assumption in the measurement errors.

Step 3. Select the Statistical Test. The data analyst will determine whether the primary objectives of DAQ’s criteria pollutant and NCore ambient air quality monitoring networks, which are compliance to the NAAQS established by the EPA for criteria pollutant concentrations, has been attained for the prior monitoring period. This goal will be accomplished by employing statistical testing to validate that the ambient data can be properly used for determining attainment status.

Step 4. Verify the Assumptions of the Statistical Test. The statistician and the Ambient Monitoring Section chief shall evaluate the assumptions upon which the DQOs, and the bias and precision (measurement error) assumptions are based. These assumptions are foundational to the statistical test. The method of verification will be addressed in this step. Note that when less than three years of data are available, this verification will be based on as much data as are available.

Data Quality Objective Assumptions. The DQOs are based on the annual arithmetic mean NAAQS. In the DQO development, it is assumed that the annual standards are more restrictive than the 24-hour, 8-hour, 3-hour, and 1-hour standards. Conceptually, DQOs can be developed for shorter averaging periods and more restrictive bias and precision limits selected. However, DAQ will assume the annual standard is more restrictive, until proven otherwise.

Measurement Error Assumptions. It is commonly assumed that measurement errors are distributed normally in environmental monitoring. *Normality of measurement errors should be verified by use of an appropriate statistical test, such as the Shapiro-Wilk*[9] *test or the probability plot correlation test*[10]. *Attachment 2 to this section* provides a procedure using Excel for creating normal probability plots and testing a data set for normal distribution. If a plot indicates possible violations of normality, the statistician may need to determine the sensitivity of the DQOs to departures in normality.

Data error can occur when the estimated one- or three-year average differs from the actual or true one- or three-year average. This is not really an assumption as much as a statement that the data collected by an ambient air monitor is stochastic, meaning that there are errors in the measurement process.

The limits on precision and bias are based on the smallest number of required sample values in a one- or three-year period. In developing DQOs, the smallest number of required samples is used to ensure that the confidence is sufficient in the minimal case. If more samples are collected, then the confidence in the resulting decision will be even higher. Data completeness evaluations will be performed each quarter to ensure that this DQO requirement is upheld.

Measurement imprecision is established at 10% CV. For each monitor, the statistician will review the CV. If any exceed 10%, the statistician may need to determine the sensitivity of the DQOs to larger levels of imprecision.

Before determining whether the monitored data indicate compliance with a NAAQS, it must first be determined if any of the assumptions upon which the statistical test is based are violated. If any of the assumptions have been violated, then the level of confidence associated with the test is suspect and must be investigated further.

Step 5. Draw Conclusions from the Data. Perform the calculations required for the statistical test and document the inferences drawn as a result of these calculations. If the design is to be used again, evaluate the performance of the sampling design.

[9] *Shapiro, S.S., M.B. Wilk, and H.J. Chen, 1968. A comparative study of various tests for normality. J. Amer. Statistical Assoc. 63:1343-1372.*

[10] *Looney, S.W. and T.R. Gulledge, 1985. Use of the correlation coefficient with normal probability plots. The American Statistician 39:75-79.*

23.2. Data Quality Assessment Report

A summary report, documenting the findings from the five steps associated with the DQA, shall be compiled, reviewed, approved, and distributed. The composition of this report shall parallel the DQA's five steps.

This report shall document any deviations experienced from the sampling plan for each criteria pollutant, on a site-by-site basis. The basic summary statistics, representative of the raw data sets, shall be calculated and presented along with the graphical presentation of the raw data. The report shall provide observations of the data patterns, structures, and relationships. Careful attention must be provided to identify, and document potential anomalous data.

Based upon the evaluation of the raw data, and insight mined from each DQI's condition, the data analyst shall select the most appropriate procedure for summarizing and analyzing the data. The report shall present these selected methods, along with the key underlying assumptions supporting valid statistical conclusions associated with these procedures, i.e. state the null and alternative hypotheses. A check will be performed of the selected analysis methodology, verifying that the underlying assumptions are valid or whether departures are acceptable. The actual data, and resulting raw statistics, along with the QA reported information will provide the foundation for this evaluation.

Apply the selected statistical tests on each data set's basic summary statistics. Evaluate, and draw inferences from the results. Document the projects findings, and provide conclusions and observations that may assist the project correct deficiencies for the next data collection period.

23.3. Action Plan Based on Conclusions from Data Quality Assessments

A thorough DQA process will be conducted whenever the quality of the data appears not to be meeting the DQOs and whenever the data are being used to make important or controversial decisions. For this section, the chief of ambient monitoring assumes that the assumptions for developing the DQOs have been met. If not, the statistician must first revisit the impact of the violation on the bias and precision limits determined by the DQO process.

If the conclusion from the DQA process is that each of the ambient air monitors is operating with less than 10% bias and imprecision, then the chief of ambient monitoring may pursue action to reduce the QA/QC burden associated with the monitor. Possible courses of action may include the following:

- **Modifying the QA Monitoring Network -** 40 CFR Part 58 requires that each QA monitor be the same designation as the primary monitor, with the exception of FEMs and ARMs used for fine particle measurement. In this case, at least one FEM must be collocated with a FRM monitor. Once it is demonstrated that the data collected from the network are within tolerable levels of errors, chief of ambient monitoring may request that DAQ be allowed to modify these requirements.
- **Reducing QC Requirements -** Quality Control is integral to any ambient air-monitoring network and is particularly important to new networks. However, once it is demonstrated that the data collected from the network are within tolerable levels of error, DAQ may request a reduction in QC checks such as those specified in Attachment 1. However, if during any of the annual DQA processes it is determined

that data errors approach or exceed either the bias limits or the precision limits, then the chief of ambient monitoring will return to the prescribed levels of QC checks as indicated in Attachment 1.

If and when the data from at least one of the monitors or sites violates the DQI bias and/or precision limits, then Project and Procedures Branch Chemists will conduct an investigation to uncover the cause of the violation. If all of the monitors/samplers in the network of a similar type or pollutant violate the DQI, the cause may be at the agency level (operator training) or higher (laboratory QC, problems with method designation). If only one monitor/sampler or site violates the DQI, the cause is more likely specific to the site (particular operator, problem with the site). Tools for determining the cause include reviewing:

- Data from a collocated network (Local Program, nearby reporting organizations, national),
- Data from performance audits (DAQ or NPAP), and
- QC trails.

Some particular courses of action include:

- **Determining the level of aggregation at which DQOs are violated -** The DQA process tells which monitors are having problems, since the DQOs were developed at the monitor level. To determine the level at which corrective action is to be taken, it must be determined whether the violations of the DQOs are unique to one site, multiple sites, or a network of similar monitors, or are caused by a broader problem. An example of a broader problem may be a particular sampler demonstrating poor QA on a national level. The AQS generates QA reports summarizing bias and precision statistics at the national and reporting organization levels by method designation. Examination of these reports may assist in determining the level at which the DQOs are being violated.
- **Communicating with EPA Region 4 -** If a violation of the bias and precision DQIs are found, DAQ will remain in close contact with EPA for both assistance and for communication.
- **Extensively reviewing quarterly data until DQOs are achieved –** The chief of ambient monitoring will continue to extensively review the quarterly QA reports and the QC summaries until the bias and precision limits are attained.

ATTACHMENT-1. Pollutants Decision Error Statistics for Computing Tolerable Error Boundaries (determination based on 2014 monitoring data)

1 Point QC

					Tolerance limits (probability of a percent difference being less than the number in the table			
Code	**Parameter**	**N obs.**	**AVG**	**StDev**	**0.50%**	**2.50%**	**97.50%**	**99.50%**
42101	CO	31	0.34	15.41	-39.36	-29.87	30.55	40.05
42401	SO2	4959	-0.32	0.82	-2.44	-1.93	1.28	1.79
42600	NOy	111	0.47	0.99	-2.08	-1.47	2.40	3.01
42601	NO	155	0.76	0.98	-1.76	-1.16	2.68	3.29
42602	NO2	44	0.89	1.03	-1.75	-1.12	2.90	3.53
42603	NOx	44	1.58	1.12	-1.32	-0.63	3.78	4.47
42604	NH3	21	-0.22	0.85	-2.40	-1.88	1.44	1.96
44201	O3	7490	0.30	0.71	-1.54	-1.10	1.70	2.14

Annual PE

					Tolerance limits (probability of a percent difference being less than the number in the table			
Code	**Parameter**	**N obs.**	**AVG**	**StDev**	**0.50%**	**2.50%**	**97.50%**	**99.50%**
42101	CO	13	3.41	16.81	-39.89	-29.53	36.35	46.70
42401	SO2	32	0.04	0.57	-1.42	-1.07	1.16	1.51
42600	NOy	9	0.15	0.59	-1.38	-1.02	1.31	1.68
42601	NO	23	0.47	0.83	-1.68	-1.17	2.10	2.61
42602	NO2	12	0.24	0.36	-0.68	-0.46	0.94	1.16
42603	NOx	14	0.70	1.30	-2.65	-1.85	3.25	4.05
42604	NH3	2	1.30	1.13	-1.61	-0.92	3.52	4.21
44201	O3	73	0.00	0.92	-2.38	-1.81	1.81	2.38

Flow Rate Verification

					Tolerance limits (probability of a percent difference being less than the number in the table			
Code	**Parameter**	**N obs.**	**AVG**	**StDev**	**0.50%**	**2.50%**	**97.50%**	**99.50%**
81102	PM10STD	87	0.10	0.56	-1.36	-1.01	1.20	1.55
85101	PM10 LC	26	-0.07	0.14	-0.44	-0.35	0.22	0.31
85129	LEAD PM10	13	-0.02	0.13	-0.34	-0.26	0.23	0.31
86101	PM10-2.5	42	-0.06	0.15	-0.43	-0.34	0.23	0.32
88101	PM2.5 LC	510	0.02	0.22	-0.55	-0.41	0.46	0.59
88501	PM2.5 LC	306	-0.07	0.29	-0.81	-0.63	0.50	0.68
88502	Accept PM2.5	311	-0.06	0.29	-0.80	-0.63	0.51	0.68

Semi-Annual Flow Rate Audit

					Tolerance limits (probability of a percent difference being less than the number in the table			
Code	**Parameter**	**N obs.**	**AVG**	**StDev**	**0.50%**	**2.50%**	**97.50%**	**99.50%**
81102	PM10STD	63	-0.03	0.47	-1.24	-0.95	0.89	1.18

85101	PM10 LC	20	-0.02	0.14	-0.37	-0.29	0.25	0.34
85129	LEAD PM10	8	0.04	0.19	-0.44	-0.33	0.40	0.51
86101	PM10-2.5	40	0.00	0.15	-0.38	-0.29	0.29	0.38
88101	PM2.5 LC	190	0.00	0.25	-0.64	-0.49	0.50	0.65
88102	Antimony PM25	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88103	Arsenic	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88104	Aluminum	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88107	Barium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88109	Bromine	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88110	Cadmium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88111	Calcium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88112	Chromium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88113	Cobalt	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88114	Cooper	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88115	Chlorine	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88117	Cerium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88118	Cesium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88126	Iron	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88128	LEAD PM25	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88131	Indium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88132	Manganese	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88136	Nickel	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88140	Magnesium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88152	Phosphorus	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88154	Selenium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88160	Tin	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88161	Titanium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88164	Vanadium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88165	Silicon	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88166	Silver	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88167	Zinc	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88168	Strontium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88169	Sulfur	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88176	Rubidium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88180	Potassium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88184	Sodium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88185	Zirconium	28	0.21	1.08	-2.58	-1.92	2.33	3.00
88301	Ammonium	23	0.10	0.51	-1.22	-0.90	1.10	1.41
88302	Sodium ion	23	0.10	0.51	-1.22	-0.90	1.10	1.41
88303	Potassium ion	23	0.10	0.51	-1.22	-0.90	1.10	1.41

88306	Total nitrate	23	0.10	0.51	-1.22	-0.90	1.10	1.41
88313	Black Carbon	8	0.08	0.19	-0.43	-0.31	0.46	0.58
88314	UV Carbon	8	0.08	0.19	-0.43	-0.31	0.46	0.58
88355	OC CSN_REV TOT	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88357	EC CSN_REV	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88370	OC CSN_REV TOR	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88374	OC1 CSN_REV	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88375	OC2 CSN_REV	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88376	OC3 CSN_REV	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88377	OC4 CSN_REV	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88378	OP CSN_REV TOR	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88380	EC CSN_REV TOR	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88383	EC1 CSN_REV	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88384	EC2 CSN_REV	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88385	EC3 CSN_REV	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88388	OP CSN_REV TOT	28	-0.09	0.48	-1.33	-1.03	0.85	1.15
88403	Sulfate	23	0.10	0.51	-1.22	-0.90	1.10	1.41
88501	PM2.5 Raw	91	-0.07	0.27	-0.76	-0.60	0.45	0.62
88502	Acceptable PM2.5	126	-0.01	0.57	-1.46	-1.11	1.10	1.45

The tolerance limits are produced by computing [mean + NORMSINV(prob) * sd] in each row of the table.
The "factors" that were used in the table are as follows: > round(NORMSINV(p=c(.005,.025,.975,.995)),2)

Attachment 2. Normal Probability Plot Correlation Test

Excel Procedure

1. Raw Data and Univariate Statistics
   Start with raw data arranged in a row or column. In these notes, I'll refer to that as $\underline{y}$ or "the data array". It could indeed be a "named range" called that in the Excel worksheet. In these notes, when I underline an algebraic letter, it refers to a vector or list of several numbers; letters that are not underlined are single numerical values. When I refer to an "element" of an array, I am usually describing an operation that is to be applied individually to *every* element of the array.

   You will need the following statistics for the data array:
   ·n - the number of data values = COUNT(data array)
   ·μ - the arithmetic mean = AVERAGE(data array)
   ·s - the standard deviation = STDEV(data array)
2. Ranks
   Parallel to the data array, build a vector of the ranks associated with each element of the data array, computed as $\underline{i}$=RANK([element of data array $\underline{y}$],1).
3. Normal Distribution Plotting Positions
   Also parallel to the data array compute the recommended plotting positions $\underline{p} = (\underline{i} - 0.375)/(n + 0.25)$.
4. Normal Quantiles
   Compute the exact normal distribution values corresponding to $\underline{p}$ with mean μ and std. deviation s.
   This is computed as follows: [element of $\underline{x}$] =NORMDIST([element of $\underline{p}$], μ, s, TRUE)

   Ranks, plotting positions and normal quantiles can be combined into fewer than three steps if it seems otherwise unnecessary to store the ranks or the plotting positions. Only the quantiles are required.
5. Hypothesis Test for Normality
   The test statistic is r, the Pearson product-moment correlation coefficient between y and x. r can be computed using the Excel function =CORREL(quantiles, data array). Alternatively, it can be obtained by applying the linear regression procedure to $\underline{y}$ and $\underline{x}$ and taking the square root of r^2 that is delivered by that procedure. (See next step.)

   It is helpful to create a scatterplot with x on the x-axis and y on the y-axis. One can even compute the ordinary least squares regression line and overlay it on the scatterplot. And the regression procedure itself computes r^2, should the programmer prefer to obtain r that way instead of with the CORREL function.

   A benefit of creating this graph is that the visual appearance of the data will nicely show in what manner the dataset departs from being normal. This may provide clues for ways to transform the data to be normal, or it may make "outliers" visually apparent. (If this procedure is written and filed for others to apply, we should collect and include a few illustrative case examples.)

Critical values for *r* are available in Looney & Gulledge (1985) or in the Helsel and Hirsch (2002) monograph, *Statistical Methods in Water Resources* (see http://water.usgs.gov/pubs/twri/twri4a3, Table B-3.) It would be ideal to compute them in Excel, but I am not aware of a built-in way to do this. Perhaps one of us could devise a look-up table containing enough cases to suit our need.

Attachment 3. List of Monitors Covered by this Quality Assurance Project Plan

Lead monitors: none

PM_{10} monitors, including PM_{10} at local conditions and $PM_{10-2.5}$:

Monitor ID	Site	Monitor Type	Method	SOP
37-003-0005-81102-1 37-003-0005-85101-1	Liledoun, Taylorsville	SPM, Rotating	FRM	Section 2.24
37-033-0001-81102-1	Cherry Grove	SPM, Rotating	Wedding	Section 2.5
37-051-0009-81102-1	William Owen, Fayetteville	SLAMS	Wedding	Section 2.5
37-051-0009-81102-2	William Owen, Fayetteville	SLAMS	Wedding	Section 2.5
37-061-0002-81102-1	Kenansville	SPM, Rotating	Wedding	Section 2.5
37-063-0015-81102-1 37-063-0015-85101-1 37-063-0015-86101-1	Armory, Durham	SLAMS	BAM 1020	Section 2.37
37-081-0013-81102-1	Mendenhall, Greensboro	SLAMS	Wedding	Section 2.5
37-111-0004-81102-1	Marion	SPM, Rotating	Wedding	Section 2.5
37-117-0001-81102-1 37-117-0001-85101-1 37-117-0001-86101-1	Jamesville	SPM, Rotating	FRM	Section 2.24
37-123-0001-81102-1	Candor	SPM, Rotating	Wedding	Section 2.5

Ozone monitors:

Monitor ID	Site	Monitor Type	Method	SOP
37-003-0005-44201-1	Liledoun, Taylorsville	SLAMS	TEI 49i	Section 2.7
37-011-0002-44201-1	Linville Falls	SPM	TEI 49i	Section 2.7
37-021-0030-44201-1	Bent Creek	SLAMS	TEI 49i	Section 2.7
37-027-0003-44201-1	Lenoir	SLAMS	TEI 49i	Section 2.7
37-033-0001-44201-1	Cherry Grove	SPM	TEI 49i	Section 2.7
37-037-0004-44201-1	Pittsboro	SLAMS	TEI 49i	Section 2.7
37-051-0008-44201-1	Wade	SLAMS	TEI 49i	Section 2.7
37-051-0009-44201-1	Honeycutt, Fayetteville	SLAMS	TEI 49i	Section 2.7
37-063-0015-44201-1	Armory, Durham	SLAMS	TEI 49i	Section 2.7
37-065-0099-44201-1	Leggett	SLAMS	TEI 49i	Section 2.7
37-069-0001-44201-1	Franklinton	SLAMS	TEI 49i	Section 2.7

Ozone monitors:

Monitor ID	Site	Monitor Type	Method	SOP
37-075-0001-44201-1	Joanna Bald	SPM	TEI 49i	Section 2.7
37-077-0001-44201-1	Butner	SPM	TEI 49i	Section 2.7
37-081-0013-44201-1	Mendenhall, Greensboro	SLAMS	TEI 49i	Section 2.7
37-087-0008-44201-1	Waynesville	SLAMS	TEI 49i	Section 2.7
37-087-0035-44201-1	Frying Pan	SPM	TEI 49i	Section 2.7
37-087-0036-44201-1	Purchase Knob	SPM	TEI 49i	Section 2.7
37-101-0002-44201-1	West Johnston	SLAMS	TEI 49i	Section 2.7
37-107-0004-44201-1	LCC, Kinston	SPM	TEI 49i	Section 2.7
37-109-0004-44201-1	Crouse, Lincolnton	SLAMS	TEI 49i	Section 2.7
37-117-0001-44201-1	Jamesville	SPM	TEI 49i	Section 2.7
37-129-0002-44201-1	Castle Hayne	SLAMS	TEI 49i	Section 2.7
37-145-0003-44201-1	Bushy Fork	SLAMS	TEI 49i	Section 2.7
37-147-0006-44201-1	Pitt Ag Center, Greenville	SLAMS	TEI 49i	Section 2.7
37-157-0099-44201-1	Bethany	SLAMS	TEI 49i	Section 2.7
37-159-0021-44201-1	Rockwell	SLAMS	TEI 49i	Section 2.7
37-173-0002-44201-1	Bryson City	SPM	TEI 49i	Section 2.7
37-179-0003-44201-1	Monroe	SLAMS	TEI 49i	Section 2.7
37-183-0016-44201-1	Fuquay-Varina	SLAMS	TEI 49i	Section 2.7
37-199-0004-44201-1	Mt. Mitchell	SPM	TEI 49i	Section 2.7

Sulfur dioxide monitors including 5 minute averages:

Monitor ID	Site	Monitor Type	Method	SOP
37-013-0151-42401-1 37-013-0151-42401-2	Bayview Ferry, Bath	SLAMS	TEI 43C	Section 2.8
37-027-0003-42401-1 37-027-0003-42401-2	Lenoir	SPM, Rotating	TEI 43C	Section 2.8
37-037-0004-42401-1 37-027-0003-42401-2	Pittsboro	SPM, Rotating	TEI 43C	Section 2.8
37-051-0009-42401-1 37-051-0009-42401-2	Honeycutt, Fayetteville	SPM, Rotating	TEI 43C	Section 2.8
37-063-0015-42401-1 37-063-0015-42401-2	Armory, Durham	SLAMS	TEI 43C	Section 2.8

Sulfur dioxide monitors including 5 minute averages:

Monitor ID	Site	Monitor Type	Method	SOP
37-117-0001-42401-1 37-117-0001-42401-2	Jamesville	SPM, Rotating	TEI 43C	Section 2.8
37-129-0006-42401-1 37-129-0006-42401-2	New Hanover, Wilmington	SLAMS	TEI 43C	Section 2.8
37-157-0099-42401-1 37-157-0099-42401-2	Bethany	SPM, Rotating	TEI 43C	Section 2.8

Carbon monoxide monitors: none

Nitrogen dioxide monitors including nitric oxide and oxides of nitrogen:

Monitor ID	Site	Monitor Type	Method	SOP
37-183-0014-42601-3 37-183-0014-42602-1 37-183-0014-42603-3	Millbrook, Raleigh	SLAMS	TAPI T200UP	Section 2.17
37-183-0021-42601-1 37-183-0021-42602-1 37-183-0021-42603-1	Triple Oak Road, Cary	SLAMS	TAPI T200UP	Section 2.17

Rain / melt precipitation sensors:

Monitor ID	Site	Monitor Type	Method	SOP
37-173-0002-65102-1	Bryson City	SPM	Bucket	Section 2.12
37-183-0014-65102-1	Millbrook, Raleigh	SPM	Bucket	Section 2.12

Relative humidity sensors:

Monitor ID	Site	Monitor Type	Method	SOP
37-173-0002-62201-1	Bryson City	SPM	Instrumental hygrothermograph	Section 2.12

Solar radiation sensors:

Monitor ID	Site	Monitor Type	Method	SOP
37-003-0005-63302-1	Liledoun, Taylorsville	SPM	UV radiometer	Section 2.12
37-011-0002-63302-1	Linville Falls	SPM	UV radiometer	Section 2.12
37-021-0030-63302-1	Bent Creek	SPM	UV radiometer	Section 2.12
37-027-0003-63302-1	Lenoir	SPM	UV radiometer	Section 2.12
37-033-0001-63302-1	Cherry Grove	SPM	UV radiometer	Section 2.12
37-037-0004-63302-1	Pittsboro	SPM	UV radiometer	Section 2.12
37-051-0008-63302-1	Wade	SPM	UV radiometer	Section 2.12

Solar radiation sensors:

Monitor ID	Site	Monitor Type	Method	SOP
37-051-0009-63302-1	Honeycutt, Fayetteville	SPM	UV radiometer	Section 2.12
37-063-0015-63302-1	Armory, Durham	SPM	UV radiometer	Section 2.12
37-065-0099-63302-1	Leggett	SPM	UV radiometer	Section 2.12
37-069-0001-63302-1	Franklinton	SPM	UV radiometer	Section 2.12
37-075-0001-63302-1	Joanna Bald	SPM	UV radiometer	Section 2.12
37-077-0001-63302-1	Butner	SPM	UV radiometer	Section 2.12
37-081-0013-63302-1	Mendenhall, Greensboro	SPM	UV radiometer	Section 2.12
37-087-0008-63302-1	Waynesville	SPM	UV radiometer	Section 2.12
37-087-0035-63302-1	Frying Pan	SPM	UV radiometer	Section 2.12
37-087-0036-63302-1	Purchase Knob	SPM	UV radiometer	Section 2.12
37-101-0002-63302-1	West Johnston	SPM	UV radiometer	Section 2.12
37-107-0004-63302-1	LCC, Kinston	SPM	UV radiometer	Section 2.12
37-109-0004-63302-1	Crouse, Lincolnton	SPM	UV radiometer	Section 2.12
37-117-0001-63302-1	Jamesville	SPM	UV radiometer	Section 2.12
37-129-0002-63302-1	Castle Hayne	SPM	UV radiometer	Section 2.12
37-145-0003-63302-1	Bushy Fork	SPM	UV radiometer	Section 2.12
37-147-0006-63302-1	Pitt Ag Center, Greenville	SPM	UV radiometer	Section 2.12
37-157-0099-63302-1	Bethany	SPM	UV radiometer	Section 2.12
37-159-0021-63302-1	Rockwell	SPM	UV radiometer	Section 2.12
37-173-0002-63301-1	Bryson City	SPM	Instrumental pyranometer	Section 2.12
37-179-0003-63302-1	Monroe	SPM	UV radiometer	Section 2.12
37-183-0014-63301-1	Millbrook, Raleigh	SPM	Instrumental pyranometer	Section 2.12
37-183-0016-63302-1	Fuquay-Varina	SPM	UV radiometer	Section 2.12
37-199-0004-63302-1	Mt. Mitchell	SPM	UV radiometer	Section 2.12

10-meter ambient temperature sensors and delta temperature:

Monitor ID	Site	Monitor Type	Method	SOP
37-173-0002-62101-1 37-173-0002-62106-1	Bryson City	SPM	Instrumental	Section 2.12
37-183-0014-62101-1 37-183-0014-62106-1	Millbrook, Raleigh	SPM	Instrumental	Section 2.12

2-meter ambient temperature sensors:

Monitor ID	Site	Monitor Type	Method	SOP
37-173-0002-62101-2	Bryson City	SPM	Instrumental	Section 2.12

Resultant wind speed and direction, including standard deviation in horizontal wind direction:

Monitor ID	Site	Monitor Type	Method	SOP
37-013-0151-61103-1 37-013-0151-61104-1 37-013-0151-61106-1	Bayview Ferry, Bath	SPM	Instrumental vector summation	Section 2.8
37-033-0001-61103-1 37-033-0001-61104-1 37-033-0001-61106-1	Cherry Grove	SPM	Instrumental vector summation	Section 2.12
37-159-0021-61103-1 37-159-0021-61104-1 37-159-0021-61106-1	Rockwell	SPM	Instrumental vector summation	Section 2.12
37-173-0002-61103-1 37-173-0002-61104-1 37-173-0002-61106-1	Bryson City	SPM	Instrumental vector summation	Section 2.12

NCore Monitors at the Millbrook NCore Monitoring Site

Monitor ID	Pollutant/Parameter	Monitor Type	Method	SOP
37-183-0014-85129-1	Lead PM_{10} at local conditions FRM/FEM	SLAMS / NCore	Thermo/ R & P 2025 PM_{10} X-ray Fluorescence	Section 2.24
37-183-0014-81102-7 37-183-0014-85101-7 37-183-0014-86101-7	$PM_{10\text{-}2.5}$ monitors, including PM_{10} at local conditions and PM_{10} STP	SLAMS / NCore	FRM (R & P 2025 PM_{10})	Section 2.24
37-183-0014-44201-1	Ozone	SLAMS / NCore	TEI 49i	Section 2.7
37-183-0014-42401-2 37-183-0014-42401-3	Sulfur dioxide, trace level	SLAMS / NCore	TEI 43C TLE	Section 2.34
37-183-0014-42101-2	Carbon monoxide, trace-level	SLAMS / NCore	TEI 48 i	Section 2.36
37-183-0014-42600-2 37-183-0014-42601-2	Reactive oxides of nitrogen, trace level	SLAMS / NCore	TEI 42 i - y	Section 2.38
37-183-0014-62201-1	Relative humidity sensors	SLAMS / NCore	Instrumental hygrothermograph	Section 2.12
37-183-0014-62101-2	2 meter ambient temperature sensors	SLAMS / NCore	Instrumental	Section 2.12

NCore Monitors at the Millbrook NCore Monitoring Site

Monitor ID	Pollutant/Parameter	Monitor Type	Method	SOP
37-183-0014-61103-1 37-183-0014-61104-1 37-183-0014-61106-1	Resultant wind speed and direction, including standard deviation in horizontal wind direction	SLAMS / NCore	Instrumental vector summation	Section 2.12
37-183-0014-88101-1	$PM_{2.5}$ manual method	SLAMS / NCore	FRM (R & P 2025 w/WINS)	Section 2.24
37-183-0014-88101-3	$PM_{2.5}$ continuous method	SLAMS / NCore	Met One BAM 1020	Section 2.37
37-183-0014-88355-5 37-183-0014-88357-5 37-183-0014-88370-5 37-183-0014-88374-5 37-183-0014-88375-5 37-183-0014-88376-5 37-183-0014-88377-5 37-183-0014-88378-5 37-183-0014-88380-5 37-183-0014-88383-5 37-183-0014-88384-5 37-183-0014-88385-5 37-183-0014-88388-5	$PM_{2.5}$ manual speciation method – carbon species	SLAMS / NCore	URG 3000N w/Pall Quartz filter	Section 2.44

NCore Monitors at the Millbrook NCore Monitoring Site

Monitor ID	Pollutant/Parameter	Monitor Type	Method	SOP
37-183-0014-88102-5 37-183-0014-88103-5 37-183-0014-88104-5 37-183-0014-88107-5 37-183-0014-88109-5 37-183-0014-88110-5 37-183-0014-88111-5 37-183-0014-88112-5 37-183-0014-88113-5 37-183-0014-88114-5 37-183-0014-88115-5 37-183-0014-88117-5 37-183-0014-88118-5 37-183-0014-88126-5 37-183-0014-88128-5 37-183-0014-88131-5 37-183-0014-88132-5 37-183-0014-88136-5 37-183-0014-88140-5 37-183-0014-88152-5 37-183-0014-88154-5 37-183-0014-88160-5 37-183-0014-88161-5 37-183-0014-88164-5 37-183-0014-88165-5 37-183-0014-88166-5 37-183-0014-88167-5 37-183-0014-88168-5 37-183-0014-88169-5 37-183-0014-88176-5 37-183-0014-88180-5 37-183-0014-88184-5 37-183-0014-88185-5 37-183-0014-88301-5 37-183-0014-88302-5 37-183-0014-88303-5 37-183-0014-88306-5 37-183-0014-88403-5	$PM_{2.5}$ manual speciation method – metals and ions	SLAMS / NCore	Met One SASS Teflon or Nylon filter	Section 2.45

Appendix A Quality Control Charts

A.1 Description and Theory

Quality control charts are graphical displays of the quality control efficiency. Control limits are set at the mean ±3 standard deviations. Thus, when the procedure is "in control" the data will almost always fall within these limits. Data falling outside is considered defective.

The main purpose of QC charts is not just to find defects but also to discover gradual changes in the data quality. The sensitivity of this method is based primarily on two parameters: the size and the frequency of the samples.

QC charts are discussed in Section 10.5 of EPA-454/B-13-003, dated May 2013.

A.2 Procedures for Development of Quality Control Charts

Control charts are created using Microsoft Excel and other similar types of software. For the scrolling particle electronic logbooks, flow charts are automatically generated to track the percent difference between the flow rate reported by the monitor and the flow rate measured by the NIST traceable flow rate measuring device as well as to track the percent difference between the design flow rate and the flow rate measured by the NIST traceable flow rate measuring device.

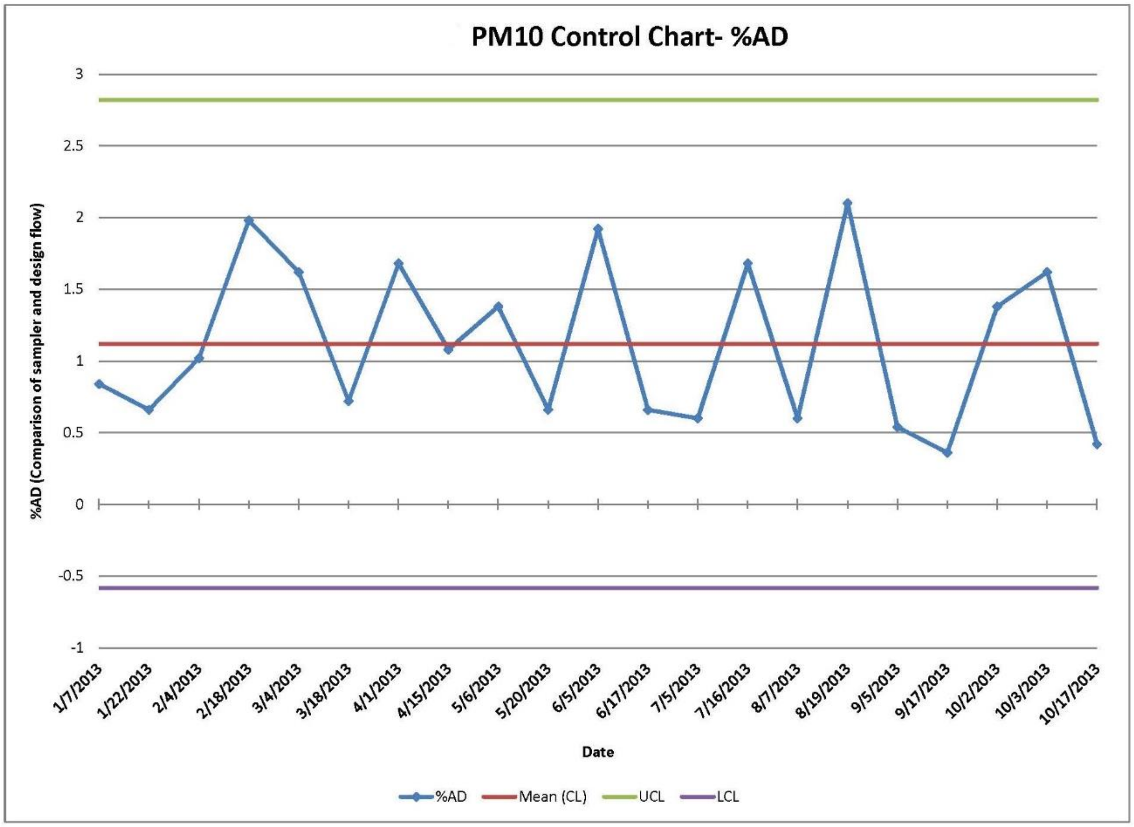
Control charts should be updated and reviewed as soon as new data become available. Control charts will include an action level at which corrective action is initiated as well as an out-of-control level at which data invalidation will most likely occur. Periodically, the action level and out-of-control levels will be evaluated to determine if procedures demonstrate improved control such that tighter control limits are warranted. Relaxation of control limits only occurs when good justification exists for laxer limits.

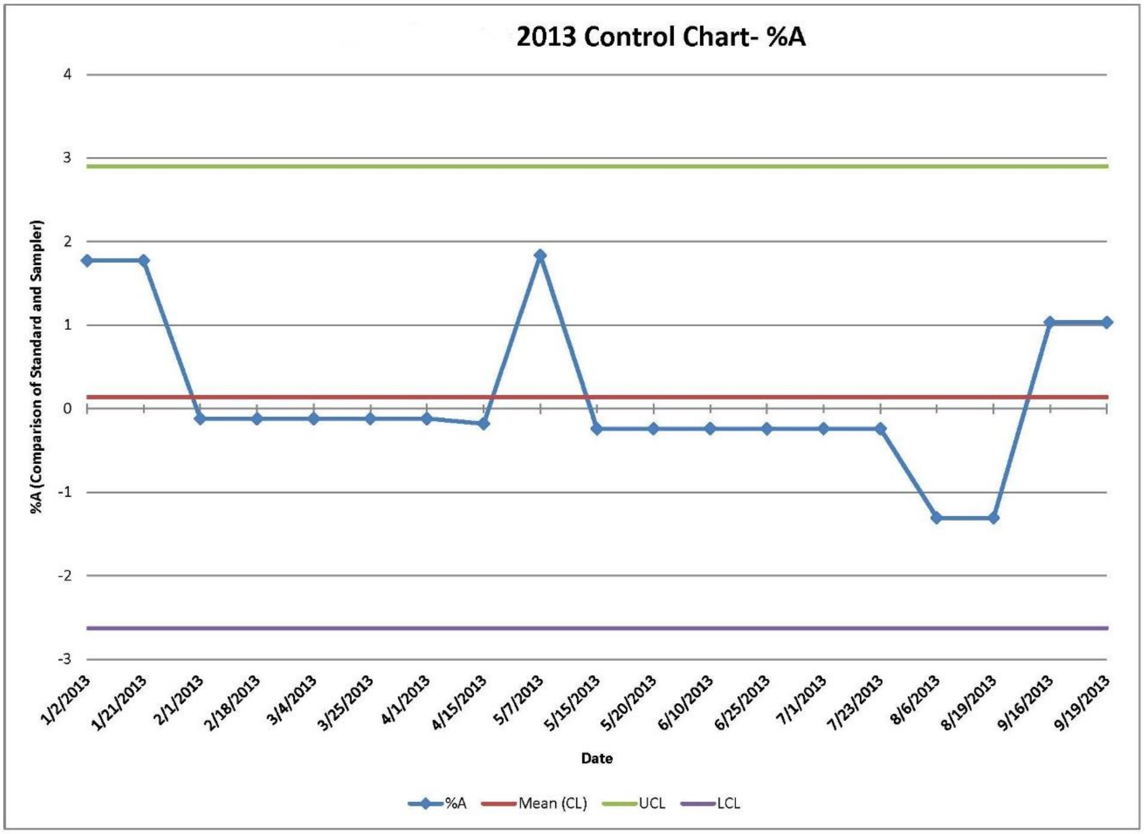
A.3 Control Chart Evaluation

Begin troubleshooting immediately when one or more points are outside the control limits, two consecutive points are outside the warning limits, a run of seven or more points occur, or a cycle or non-random pattern occurs in the data.

A.4 Example Control Charts

On the next page are two control charts. The first control chart shows normal fluctuation around a value and the fluctuation remains within the control limits, which is what one would expect. Sometimes the measured value will be a little high and other times the measured value will be a little low but it remains within the vicinity of what is expected. The second flow chart shows a situation where the measured value is often the same and is often lower than what is expected. This control chart indicates that there may be some type of systemic error because of the unexpected data pattern. Because of the unusual data pattern, an investigation is necessary to identify why the values do not fluctuate up and down as would be expected.


PM10 Control Chart- %AD
%AD (Comparison of sampler and design flow)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
1/7/2013
1/22/2013
2/4/2013
2/18/2013
3/4/2013
3/18/2013
4/1/2013
4/15/2013
5/6/2013
5/20/2013
6/5/2013
6/17/2013
7/5/2013
7/16/2013
8/7/2013
8/19/2013
9/5/2013
9/17/2013
10/2/2013
10/3/2013
10/17/2013
Date
%AD
Mean (CL)
UCL
LCL


2013 Control Chart- %A
%A (Comparison of Standard and Sampler)
4
3
2
1
0
-1
-2
-3
1/2/2013
1/21/2013
2/1/2013
2/18/2013
3/4/2013
3/25/2013
4/1/2013
4/15/2013
5/7/2013
5/15/2013
5/20/2013
6/10/2013
6/25/2013
7/1/2013
7/23/2013
8/6/2013
8/19/2013
9/16/2013
9/19/2013
Date
%A
Mean (CL)
UCL
LCL

Appendix B Miscellaneous Forms

Table of Contents

Many forms are referred to throughout the North Carolina Division of Air Quality Standard Operating Procedures. The purpose of this appendix is present a copy of each form and a brief explanation of its use.

PM 10-2.5 - AQ99 Revision 201302111543

Region		Pollutant ID	Method Code		Report. Org.	Year (YYYY)	QTR
		PM10-2.5	127		0776		

X correct row	
original	X
revision	
deletion	

UNIT	CODES
ug/m3	01
ppm	07
ug/ml	64
CFM	72
l/min STP	73
m3/min	83
l/min LC	118

Prepared By ____________ Comments: ____________

Date Submitted ____________

Blue color filled in by Region

						DATE		Unit	Flow Rates		
AQS Site Code 37CCCSSSS	Cal Device #	Monitor #	Precision (Y/N)			Month (MM, i.e., 2, 5, 8 or 11)	Day	Code	actual/standard	indicated/sampler	% Diff.
Enter PM 10 data below											
Enter PM 2.5 data below											

Save File Using the following name convention: 10RRNQYY

Where:

RR stands for a two digit designation for the region (RR for Raleigh, AR for Asheville, FR for Fayetteville, MR for Mooresville, WA for Washington, WI for Wilmington, and WS for Winston Salem),

N stands for a one digit designation of the quarter (1, 2, 3, or 4), and

YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

Example: 10RR1Q03 would contain the 1st quarter 2003 PM10 accuracy data for the Raleigh Regional Office.

Revised 2/11/13

RCO reviewer initials and date:________________

Figure B-37. AQ-99 Form for Reporting Semi-Annual Flow Audits for PM10-PM2.5 Manual Monitors

PM 2.5 BAM - AQ99 Revision 200909291720

Region		Pollutant ID	Method Code		Report. Org.	Year (YYYY)	QTR
		PM2.5	170		0776		
		88101					

X correct row	
original	X
revision	
deletion	

UNIT	CODES
ug/m3	01
ppm	07
ug/ml	64
CFM	72
l/min STP	73
m3/min	83
l/min LC	118

Prepared By ____________ Comments: ____________

Submitted (MM/DD/YY) ____________

Gray color filled in by Region

						DATE		Unit	L / min Local Conditions		
AQS Site Code 37CCCSSSS	Cal Device #	Monitor #	Precision (Y/N)	Temp	Press	Month (MM, i.e., 2, 5, 8 or 11)	Day	Code	actual/standard	indicated/sampler	% Diff.
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			

Save File Using the following name convention: 25RRNQYY

Where:

RR stands for a two digit designation for the region (RR for Raleigh, AR for Asheville, FR for Fayetteville, MR for Mooresville, WA for Washington, WI for Wilmington, and WS for Winston Salem),
N stands for a one digit designation of the quarter (1, 2, 3, or 4), and
YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

Example: 25RR1Q03 would contain the 1st quarter 2003 PM2.5 FRM accuracy data for the Raleigh Regional Office.

Revised 9/29/09

printed at 12:07 PM on 11/17/2014

RCO Reviewer Initials and date ____________

Figure B-38. AQ-99 for Reporting Semi-Annual Flow Rate Audits for Beta Attenuation Monitors (BAMs)

PM 2.5 - AQ99 Revision 200804021516

Region		Pollutant ID	Method Code		Report. Org.	Year (YYYY)	QTR
		PM2.5	118		0776		
		88101					

X correct row	
original	X
revision	
deletion	

UNIT	CODES
ug/m3	01
ppm	07
ug/ml	64
CFM	72
l/min STP	73
m3/min	83
l/min LC	118

Prepared By

Comments:

Submitted (MM/DD/YY)

Green color filled in by Region

						DATE		Unit	L / min Local Conditions		
AQS Site Code 37CCCSSSS	Cal Device #	Monitor #	Precision (Y/N)	Temp	Press	Month (MM, i.e., 2, 5, 8 or 11)	Day	Code	actual/standard	indicated/sampler	% Diff.
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			
								118			

Save File Using the following name convention: 25RRNQYY

Where:

RR stands for a two digit designation for the region (RR for Raleigh, AR for Asheville, FR for Fayetteville, MR for Mooresville, WA for Washington, WI for Wilmington, and WS for Winston Salem),
N stands for a one digit designation of the quarter (1, 2, 3, or 4), and
YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

Example: 25RR1Q03 would contain the 1st quarter 2003 PM2.5 FRM accuracy data for the Raleigh Regional Office.

Revised 8/16/06

printed at 12:17 PM on 11/17/2014

Figure B-39. AQ-99 For Reporting Semi-Annual Flow Rate Audits for Federal Reference Method Fine Particle Monitors

PM 2.5 - AQ99 Revision 200912101248

Region		Pollutant ID			Report. Org.	Year (YYYY)	QTR
		TEOM			0776		

X correct row	
original	X
revision	
deletion	

UNIT	CODES
ug/m3	01
ppm	07
ug/ml	64
CFM	72
l/min STP	73
m3/min	83
l/min LC	118

Prepared By ____________ Reviewed by ____________

Date Submitted ____________ gray color filled in by Region

AQS Site Code 37CCCSSSS	Cal Device #	Method	Parameter PM10 = 81102 PM2.5 = 88502	Temp	Press	DATE Month (MM, i.e., 2, 5, 8 or 11)	DATE Day	Unit Code	L / min actual/standard (from FTS)	L / min indicated/sampler (should be 3.00 or 16.67)	Difference (should be -0.20 to +0.20 or -1.00 to +1.00)

Save File Using the following name convention: TERRNQYY

Where:

RR stands for a two digit designation for the region (RR for Raleigh, AR for Asheville, FR for Fayetteville, MR for Mooresville, WA for Washington, WI for Wilmington, and WS for Winston Salem),

N stands for a one digit designation of the quarter (1, 2, 3, or 4), and

YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

Example: TERR1Q03 would contain the 1st quarter 2003 TEOM accuracy data for the Raleigh Regional Office.

Revised 12/10/09

printed at 11:31 AM on 11/17/2014

RCO Reviewer Initials and Date ____________

Figure B-40. AQ-99 Form for Reporting TEOM Semi-Annual Flow Rate Audits

Aethalometer - AQ99 Revision 200809101239

Region		Pollutant ID			Report. Org.	Year (YYYY)	QTR
		Aethalometer			0776		

X correct row	
original	X
revision	
deletion	

UNIT	CODES
ug/m3	01
ppm	07
ug/ml	64
CFM	72
l/min STP	73
m3/min	83
l/min LC	118

Prepared By ____________ Reviewed by ____________

Date Submitted ____________

Green color filled in by Region

						DATE		Unit	L / min		
AQS Site Code 37CCCSSSS	Cal Device #	Method	Parameter	Temp	Press	Month (MM, i.e., 2, 5, 8 or 11)	Day	Code	actual/standard (from BIOS Dry Cal)	indicated/sampler (should be 5.0 L/min)	% Diff.
		866	88313					118			

Save File Using the following name convention: TERRNQYY

Where:

RR stands for a two digit designation for the region (RR for Raleigh, AR for Asheville, FR for Fayetteville, MR for Mooresville, WA for Washington, WI for Wilmington, and WS for Winston Salem),

N stands for a one digit designation of the quarter (1, 2, 3, or 4), and

YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

Example: TERR1Q03 would contain the 1st quarter 2003 TEOM accuracy data for the Raleigh Regional Office.

Created 9/10/08

printed at 12:12 PM on 11/17/2014

Figure B-41. AQ-99 for Reporting Semi-Annual Flow Rate Audits for Aethalometers

PM 10 - AQ99 Revision 201103151455

Region		Pollutant ID	Method Code		Report. Org.	Year (YYYY)	QTR
		PM10			0776		

X correct row	
original	X
revision	
deletion	

UNIT	CODES
ug/m3	01
ppm	07
ug/ml	64
CFM	72
l/min STP	73
m3/min	83
l/min LC	118

Prepared By ______ Comments: ______

Date Submitted ______

Gray color filled in by Region

AQS Site Code 37CCCSSSS	Cal Device #	Monitor #	Precision (Y/N)	Temp (degrees C)	Pressure (mm Hg)	DATE Month (MM, i.e., 2, 5, 8 or 11)	Day	Unit Code	Flow Rates actual/standard	indicated/sampler	% Diff.

Save File Using the following name convention: 10RRNQYY

Where:

RR stands for a two digit designation for the region (RR for Raleigh, AR for Asheville, FR for Fayetteville, MR for Mooresville, WA for Washington, WI for Wilmington, and WS for Winston Salem),

N stands for a one digit designation of the quarter (1, 2, 3, or 4), and

YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

Example: 10RR1Q03 would contain the 1st quarter 2003 PM10 accuracy data for the Raleigh Regional Office.

Revised 3/15/11

RCO reviewer initials and date:__________

Figure B-42. AQ-98 Form for Reporting PM10 Wedding Semi-Annual Flow Rate Audits

TSP - AQ99 Revision 200606211051

Region	Pollutant ID	Method Code		Report. Org.	Year (YYYY)	QTR
	TSP	091		0776		
	11101					

X correct row	
original	X
revision	
deletion	

UNIT	CODES
ug/m3	01
ppm	07
ug/ml	64
CFM	72
l/min	73
m3/min	83
ug	77
CFM	

TECHNICIAN

Date Submitted (MM/DD/YY)

Green color filled in by Region

AQS Site Code 37CCCSSSS	Monitor ID	Cal Device #	Precision Monitor (Y or N)	Temp	Press	Month (MM, i.e., 02, 05, 08, 11)	Day	UNIT CODE	actual/standard	indicated/sampler
								072		
								072		
								072		
								072		
								072		
								072		
								072		
								072		
								072		
								072		
								072		
								072		

Save File Using the following name convention: TSRRNQYY

printed at 12:41 PM on 11/17/2014

rev 1/13/06

Figure B-43. AQ-99 for Reporting Semi-Annual Flow Rate Audits for Total Suspended Particle (TSP) Monitors

AQ98 Revision 201402031720

PRECISION

Region	Site	AQS Code (37CCCSSSS)			DATE		Unit	Concentration (ppb or ppm)		
			Cal Device #	Monitor #	Month (nn)	Day	Code	Actual/Standard	Indicated/Monitor	% Diff.
Pollutant ID	**X correct row**	Method Code								
Ozone		600								
Trace SO2										
Trace NOy										
Trace NO										
Trace CO										
NO2										
NO										
NOx										
Report. Org.	Year (20YY)	QTR (1, 2, 3, 4)								
0776										
	X correct row									
	original	X								
	revision									
	deletion									

Submitted by ______ Date ______ Reviewed by ______ Date ______

Comments:

Save File Using the following name convention: CMSSNQYY

Where:

CM stands for the two digit monitor type code (O3 for ozone, NO for nitric oxide, SO for sulfur dioxide, NH for ammonia, CO for carbon monoxide, RO for reactive oxides of nitrogen, 10 for PM 10 TEOM, 25 for PM 2.5 TEOM, and NX for NOx);

SS stands for the two digit site code;

N stands for a one digit designation of the quarter (1, 2, 3, or 4); and

YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

Example: SOMH1Q03 would contain the 1st quarter 2003 SO2 precision data for Mendenhall.

AQ_A_NO2_NO_NOx_02-03-2014_T_98T[1].xlsx, Precision Revised February 3, 2014 11/17/2014, 9:55 AM RCO Reviewer Initials and Date ____________________

Figure B-44. AQ-98 Form for Reporting Manual One-Point Quality Control Checks for Ozone, Trace Level, and Nitrogen Dioxide Monitors

AQ98 Revision 200912301320

PRECISION

Region	Site	AQS Code (37CCCSSSS)			DATE		Unit	Concentration (ppb or ppm)		
			Cal Device #	Monitor #	Month (nn)	Day	Code	Actual/Standard	Indicated/Monitor	% Diff.
Pollutant ID	**X correct row**	Method Code								
Ozone		051								
Sulfur Dioxide										
Trace NOy										
Trace NO										
Carbon Monoxide										
Trace SO2										
Trace CO										
Ammonia										
NOx										
Report. Org.	Year (20YY)	QTR (1, 2, 3, 4)								
0776										
	X correct row									
	original	X								
	revision									
	deletion									

Submitted by ____________ Date ________ Reviewed by ____________ Date ________

Comments:

Save File Using the following name convention: CMSSNQYY

Where:

CM stands for the two digit monitor type code (O3 for ozone, NO for nitric oxide, SO for sulfur dioxide, NH for ammonia, CO for carbon monoxide, RO for reactive oxides of nitrogen, 10 for PM 10 TEOM, 25 for PM 2.5 TEOM, and NX for NOx);

SS stands for the two digit site code;

N stands for a one digit designation of the quarter (1, 2, 3, or 4); and

YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

Example: SOMH1Q03 would contain the 1st quarter 2003 SO2 precision data for Mendenhall.

AQ_A_SO2_CO_NOy_12-30-2009_T_98T[1].xlsx, Precision Revised December 30, 2009 11/17/2014, 10:34 AM RCO Reviewer Initials and Date ____________

Figure B-45. AQ98 Form for Reporting Manual One-Point Quality Control Checks for Sulfur Dioxide, Carbon Monoxide, and Ammonia Monitors

AQ98 Revision 201201041345 **PRECISION**

Region	Site	AQS Code (37CCCSSSS)			DATE		Unit	Flow (liters/minute LC (118) or cubic feet/minute STP (072))		
			Cal Device #	Monitor #	Month (nn)	Day	Code	Actual/Standarc	Indicated/Monitoı	% Difference
Pollutant ID	**Place X in row**	Method Code								
PM 2.5 FRM Primary		091								
PM 2.5 FRM Colocated										
PM 10 Low Volume										
PM 2.5 BAM										
PM 10 Wedding										
PM 10 Colocated										
TSP High Volume										
TSP Colocated										
Report. Org.	Year (20YY)	QTR (1, 2, 3, 4)								
0776										
	Place X in row									
	original	X								
	revision									
	deletion									

Submitted by ______ Date ______ Reviewed by ______ Date ______

Comments:

Save File Using the following name convention: PMMMSS_NQYY

Where:

PM stands for the particulate matter;
MM stands for the two digit monitor type code (TP for TSP, 10 for PM 10, 25 for PM 2.5);
SS_ stands for the two digit site code with A added for the collocated monitors;
N stands for a one digit designation of the quarter (1, 2, 3, or 4); and
YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

AQ_A_PM2.5_BAM_PM10-2.5_PM10_TSP_01-04-2012_T_98T[1].xlsx, Precision Revised January 4, 2012 11/17/2014, 10:07 AM RCO reviewer initials and date ______

Figure B-46. AQ-98 Form for Reporting Monthly Flow Verifications for Particle Monitors except TEOM

AQ98 Revision 200910061729 **PRECISION**

Region	Site	AQS Code (37CCCSSSS)			DATE		Unit	Concentration (ppb or ppm)		
			Cal Device #	Monitor #	Month (nn)	Day	Code	Actual/Standard	Indicated/Monitor	Difference
Pollutant ID	**X correct row**	Method Code								
		717								
PM 2.5 @ BY										
PM 2.5 @ ML										
PM2.5 @ JV										
PM 10 TEOM										
PM 2.5 TEOM										
Report. Org.	Year (20YY)	QTR (1, 2, 3, 4)								
0776										
	X correct row									
	original	X								
	revision									
	deletion									

Submitted by ______ Date ______ Reviewed by ______ Date ______

Comments:

Save File Using the following name convention: CMSSNQYY

Where:

CM stands for the two digit monitor type code (O3 for ozone, NO for nitric oxide, SO for sulfur dioxide, NH for ammonia, CO for carbon monoxide, RO for reactive oxides of nitrogen, 10 for PM 10 TEOM, 25 for PM 2.5 TEOM, and NX for NOx);

SS stands for the two digit site code;

N stands for a one digit designation of the quarter (1, 2, 3, or 4); and

YY stands for a two digit designation of the year (i.e., 03 for 2003, 04 for 2004, etc.)

Example: SOMH1Q03 would contain the 1st quarter 2003 SO2 precision data for Mendenhall.

AQ_A_TEOM_10-06-2009_T_98T[1].xls, Precision   Revised October 6, 2009   11/17/2014, 10:50 AM RCO Reviewer Initials and Date ______

Figure B-47. AQ-98 for Reporting Monthly Flow Verifications for TEOM Monitors

Ambient Air Ozone Monitoring Logbook

Please Note: The Units used in the Ozone Logbook is parts per billion (ppb)

The Ozone Monitoring Logbook is "The Essential Record" that documents the performance of the ozone monitoring system and all site operator activities. The logbook is the Critical Document and the adherence to approved procedures and the evaluation of the quality of the ambient air ozone data reported from each site.

The "Site Operator" must accurately complete this REQUIRED site documentation for All Ozone Site Activities. A NEW LOGBOOK must be completed to document ALL Activities to maintain a continuous site evaluation and instrument performance record that is necessary to ensure that only the highest quality possible ozone data is reported.

The Air Quality Forecast Rule in on-going operation of ozone sites.

AIR QUALITY FORECAST RULE	If the AQI Forecast for Ozone in the Region that most closely represents the ozone monitoring site is ≥ AQI 90, then all site activities that require the ozone monitor to be taken out of the ambient air sampling mode should be postponed until the Air Quality Forecast is AQI is Less Than 90.
RULE EXCEPTION	If the ozone monitor has Failed the Daily Auto-Calibration Check, the performance of the ozone monitor must be immediately evaluated by the operator to ensure instrument performance is within the established data Acceptance Criteria. This includes all actions and evaluations necessary to return the ozone monitoring instrumentation and equipment performance to within performance Acceptance Criteria regardless of the Air Quality Forecast.

Changing of the Silica Gel on the zero air supply does not require the monitor to be taken off-line.

If the Particulate Filter is scheduled to be changed when the Air Quality Forecast is AQI ≥ 90 and the Daily Auto-Calibration Check is has Passed all Acceptance Criteria the particulate filter change and conditioning must be postponed until the Air Quality Forecast is < 90 AQI. If necessary, due to scheduling difficulties and additional regional responsibilities the operator may arrange to have another staff member to change the filter when the forecast improves. The particulate filter conditioning is performance based. As soon as the filter conditioning values satisfy conditioning acceptance criteria the conditioning step is terminated.

9:12 am Rule	It is highly recommended that site activities which require the ozone monitor to be taken out of the ambient air sampling mode be completed before 9:12 am. This specifically applies to Filter Change & Conditioning activities which is othe most frequent reason for the ozone monitoring system to be taken off line. Loss of a reported 1 hour averaghe ozone concentration can result in a falsely high 8-hour average concentration.
9:12 am Rule Exception	The Mountain Top Sites are exempt from the 9:12 am rule. Site operators should whenever possible utilize the last 12 of an hour and the first 12 minutes of the following hour to minimize the loss of acceptable hourly data values
12 Minute Rule	Site activities requiring the ozone monitor to be taken out of the sampling mode can be performed during the last 15 minutes of an hour up to and including the first 15 minutes of the following hour without the invalidation of the ozone hourly averages for either hour. Fifteen (15) minutes is the absolute maximum hourly reduction allowable per the EPA 75% complete rule. A max of 30 minutes is available to take the ozone monitor offline without a reduction in reported hourly ozone concentrations. It is recommended that the operator attempt to accomplish all task from the period of 12 minutes before and after the hour (24 minutes).
	For example -- If a filter is being changed and conditioned and the monitor is taken offline at 7:48 and the filter change and conditioning procedure is completed and the monitor is returned to sampling ambient air at 8:12 both the 7:00 or 8:00 hourly values are valid.

Ozone Site Operation Activities	1. Installation of Equipment and Instrumentation by ECB prior to April 1st. 2. Site Documentation and Inspection Initially and during each site visit. 3. Initial Calibration of the Ozone Monitor Prior to April 1st in 2011. 4. Daily Auto-Calibration Check is the primary ozone site Performance Evaluation Tool 5. Office Actuated Calibration Check (0 and 225 ppb) investigate performance issues remotely. 5. Manual Calibration Check (0 ppb and 225 ppb) performed when Daily Auto Cal-Check Fails 6. Ending Calibration Check is Daily Auto-Calibration Check on November 1 (except year round sites)

Figure B-48. Ozone Logbook Directions Part 1

Site Activities	Calibrations		Ozone monitor calibrations are required prior to the start of the ozone monitoring season, following all Failed Manual Calibration Checks and if either the site Primary Standard, Ozone Monitor, or the Zero Air Supply are replaced or significant maintenance to the either occurs.
	Silica Gel		Silica Gel changes should be performed every 14 days or less. This is site dependent and has some flexibility in scheduling. But keep in mind if the silica gel has failed it may result in a "Failure" of the Daily Auto-Calibration Check which will require an unscheduled site visit.
	Particulate Filter Changes		Particulate filter change and conditioning should occur every 30 days or less. If the particulate filter is scheduled to be changed and the AQI Forecast for ozone is AQI ≥ 90 and if the immediately prior daily auto calibration check passes acceptance criteria then the Particulate Filter Change is postponed until the AQI forecast for ozone is AQI < 90. If re-scheduling the particulate filter change is not possible this activity must occur early in the morning when the ozone concentration is less than 50 ppb to minimize the potential for a false exceedance and or falsely high exceedance.
	Onsite Manual Calibration Check		Onsite Manual Calibration Checks are required when the Daily Auto-Cal Check Fails to meet Acceptance Criteria. The onsite performance evaluation is performed at only the 0 ppb and the 225 ppb ozone concentration levels.
		Passes	Monitor and Calibrator Pass Manual Calibration Check following a Failed Daily Auto-Calibration Check then the Daily Auto Calibration Check Precision Point is not reported and No data is invalidated.
		Fails	Monitor Fails and the Calibrator Passes the Manual Calibration Check following a Failed Daily Auto-Calibration Check then the Precision Point Results from the failed Daily Auto Calibration Check is NOT reported and Data is Invalidated back to most recent satisfactory Calibration, Calibration Check, or Auto-calibration.
	Temperature		The monitoring site is required to be maintained between 20^{0} - 30^{0} C during all site operations including all Calibrations, Daily Auto-Calibration Checks, Manual Calibration Checks, and daily ozone concentration measurements.
		NOTE	All data collected and calibration checks performed at temperatures outside of this temperature range must be Invalidated.

Please review the Flow Chart Of Activities Tab of this Log Book.

If you have any question please contact the Projects and Procedures Branch

Daily Auto Calibration Check	Passes	Monitor and the Calibrator PASS the Daily Auto-Calibration Check. No Additional Action is required and the Precision Point is reported
	Fails	Monitor and/or Calibrator Fails Auto-Calibration Check A Site Visit is Required to perform a Manual Auto calibration Check

Office Actuated Calibration Check		Staff may actuate a Manual Calibration Check at a site from the office to investigate a performance problem that may be due to a power failure or other anomaly when existing additional data indicates that the ozone monitoring system is operating within acceptable criteria. The performance evaluation data from this quality assurance check is recorded in the Office Actuated Calibration Check section of the Logbook. A detailed explanation of observed problem and findings must be provided in the comment section.
		NOTE: If the system Did Not FAIL ANY Data Acceptance Criteria and the AQI Forecast is ≥ 90 and/or the Ambient Air Ozone concentration is ≥ 60 ppb then the Office Actuated Calibration Check should not be performed and the system performance should be closely monitored.
	Passes	If both the Monitor and the Calibrator PASS the Office Actuated Calibration Check
		No further action is required.
	Fails	If either the Monitor or Calibrator FAILS the Office Actuated Calibration Check
		A Site Visit is Required to perform a Manual Calibration Check

1	**Site Documentation** - This Site Documentation serves as the required permanent record of the instrumentation installed at each site and **must be completed during each site visit.** This log serves as a RECORD for all Site Visits, Site Inspections, Shelter Temperatures, Instrumentation Documentation, Compressor Inspections and Data System activities.
	Air Compressor Draining The air compressor must be drained of all condensed water during each visit.
	Inspecting the Sample Probe and Lines This is to insure the sample line is unobstructed and the ozone measured is not artificially reduced due to the presence of water and or particulate matter.
	Computer and Data Logger Time The Primary Data Logger is set to the correct Eastern Standard Time and the computer time is set to 5 minutes earlier. This is to ensure the data logger collects all available data prior to the computer collecting and storing the data for retrieval by the polling and reporting program.
	For Example Only 1 The data Logger Time is set to April 1, 2010 9:00 am.

Figure B- 49. Ozone Logbook Instructions Part 2

2 The computer time is set to April 1, 2010 8:55 am.

Comment Section of the Site Documentation- This section of the site documentation is used to address all problems, failures, changes in site instrumentation and support equipment, site security issues, site power problems, pest and insects, changes in activities adjacent to the site, monitoring building integrity problems (leaks, door misalignment, etc.). This section should document first observation of any and all problems and activities that continue to be not corrected or have the potential impact our ability to accurately measure ambient air ozone in a safe and efficient manner. The section should also serve as documentation of notification to the Ambient Air Monitoring Section of said problems or activities and as documentation of all assistance received.

2 **Calibration.** The Initial Calibration performed prior to April 1st establishes the starting point for all ambient air ozone data collected each year at each site. Throughout the year if the site monitor fails a Manual Calibration Check the system is considered to be "out of control" and a new Calibration of the Ozone Monitor is required to bring the system back within acceptable control limits. **The Silica Gel must be replaced prior to performing a Calibration and a new Particulate Filter must be installed and conditioned in the ambient air sampling line prior to performing a Calibration**In addition, if the monitor is replaced, if the calibrator is replaced, or if major maintenance is performed, a Calibration must be performed to re-establish the data link between each site and the North Carolina Standard Reference Photometer. Maintenance items requiring the performance of a Calibration include cell cleaning, solenoid changes, pump changes, lamp changes, etc. The comments section of the Calibration Log should be used to document all problems or difficulties and in calibrating the on-site ozone monitor. **If unsure about the Calibration Requirement contact Charles Davis at (919) 707-8454 or Joette Steger at (919) 707-8460 of the Projects and Procedure Branch.**

Comments Section of the Calibration Log should be used to document all problems or difficulties encountered in calibrating the on-site ozone monitor and if possible any resolution of those problems. **This record can serve as a valuable record in data validation issues and in the resolution of future problems.**

Figure B-50. Ozone Log book Instructions Part 3

3	**Daily Auto-Calibration Check Analysis** is the ongoing ozone monitoring system performance evaluation tool. Each day the ozone monitor is challenged with three known ozone concentrations (0, 70, and 225 ppb ozone). The daily performance of the ozone monitor and the on-site ozone primary standard must be evaluated versus the data Acceptance Criteria Limits. The failure of the ozone monitoring system to meet the acceptance criteria requires immediate action on the part of the site operator to ensure that the most accurate ozone data possible is produced at his or her assigned ozone monitoring site.
4	**Changing the Silica Gel** - This is to insure the zero air used during all calibrations is moisture free. **It is required to change the Silica Gel in Both Cartridges every 14 days or less. This is a Stand Alone Activity in the Ozone Logbook. When a site visit is occurring to only change the Silica Gel the only other site activity required is the Site Documentation** **The Silica Gel must also be changed prior to performing all Manual Calibration Checks and Calibration Procedures**
5	**Changing and Conditioning of new Particulate Filters**. This protects the monitor and insures that a clean sample is being analyzed. The Changing and conditioning of the particulate filter is a stand alone ongoing activity through out the season. **Filter Change and Conditioning is required immediately prior to every Calibration and is required every 30 days in normal operation. The Filter Conditioning Step is no longer time based but instead as soon as the readings meet the criteria and are stable the operator is to record 5 x 1 minute readings and end the conditioning step.**
	Leak Testing. This is required following all filter changes to insure the ambient air sample is not being diluted with "room air" from inside the monitoring shelter. The system must pass the leak test for the system performance to be considered acceptable.
6	**Manual Calibration Check Analysis** is the **required on-site operator evaluation of the ozone monitoring system when the system fails the Daily Auto-Calibration Check Analysis.** This on-site operator evaluation of the instrument performance is a powerful tool to ensure the highest quality ozone data possible is being produced. The **Silica Gel** for the Zero Air Supply **must be changed** prior to performing the Manual Calibration Check.
	Comments Section of the Manual Calibration Check Analysis should be used to document all problems or difficulties encountered in checking the performance of the site specific ozone monitoring system and if possible any resolution of found problems. **This record can serve as a valuable record in data validation issues and in the resolution of future problems.**
7	**Office Actuated Calibration Check Analysis** is an optional tool to evaluate the ozone monitoring system performance remotely when the operator believes the system is meeting data quality acceptance criteria but because of an operational anomaly the data has become questionable. An example of such is the situation where a power interruption may have occurred during the Daily Auto-Calibration Check Cycle because of an electrical storm. Another example is the system **PASSES** the **Saturday** Morning Auto-Calibration Check, **FAILS** the **Sunday** Morning Calibration Check, and then **PASSES** the **Monday** Morning Calibration Check. During these operational situations it may be more prudent to perform an Office Actuated Calibration Check to confirm the monitoring system is operating properly if no additional evidence indicates the system is producing unacceptable data. It is the regional office operator's option to utilize this evaluation tool based upon their first hand knowledge of the ongoing performance of the site specific ozone monitoring system. **If the monitoring system FAILS the Office Actuated Calibration Check a site visit is required to correct the monitoring system performance failure**
	Comments Section of the Office Actuated Calibration Check Analysis is critical to document the ongoing ozone system performance, the situation leading to the utilization of this evaluation tool, and the findings from this test. The completion of the Site Documentation Section is not possible during this remote performance evaluation test. In all cases the Regional Chemist the Projects and Procedures Branch Chemist, and the staff at ECB will assist as necessary.
8	**Closing Auto-Calibration Check.** The November 1st Daily Auto-Calibration Check serves as the ozone monitoring season yearly final systems performance evaluation. If the November 1st Daily-Auto-Calibration Check is unavailable a Manual Calibration Check should be performed. **This critical Check provides the closing bracket for all data collected during the year.**
9	**Ozone Logbook Review and Submittal** — **The Completed Ozone Logbook shall be submitted 15 days after the end of each month of operation to become part of the Permanent Site Record. The log book for each site shall be Reviewed by the Regional Chemist and Transferred to the Ambient Monitoring Central Data Storage "P Drive" of the central office computer for Review.**
	As an aid in the review of the ozone log book a summary of the performance of the ozone Calibrator, and the Ozone Monitor have been added to the bottom of the Calibration, the on-site Calibration Check, the Filter Conditioning, aqnd the office actuated Cal Check Worksheets.

Figure B-51. Ozone Log Book Instructions Part 4

Additional Instructions

A

NO Monitor checks that interrupt the collection of ambient air ozone data are to be performed during periods of elevated or forecasted elevated ozone concentrations AQI ≥ 90 unless these activities are in response to any Failure of Data Acceptance Criteria

The Ambient Air Ozone Concentration must be recorded on the Site Documentation Page. Activities that require taking the ozone monitor off-line at ambient air ozone concentrations above 60 ppb have the potential for creating a False Exceedance and Falsely High Exceedance.

NOTE - Unless these activities are to address any Failure of Data Acceptance Criteria.

B

Failure of the Calibrator and/or Monitor to meet the Data Acceptance Criteria

1. **All Acceptance Criteria Failures must be reported to Derrick House and/or James Olcott at the ECB and Charles Davis at PPB as they occur if possible or As Soon As Possible.**
2. **All Ozone Logbooks documenting the "Failure of Acceptance Criteria" must be sent to Charles Davis (charles.o.davis@ncdenr.gov) as soon as possible.**

D

Ozone Sites that Operate Year Round - The ozone monitoring sites that operate year round require special considerations and procedural adaptations. Each year NCDAQ recertifies the Site Primary Ozone Standard to establish direct traceability to the NC Standard Ozone Photometer. The site Primary Standard is used to calibrate the site ozone monitor. To accomplish this recertification of the Site Primary Standard and Zero Air Supply the following special procedures must be followed to ensure quality data is collected and minimize the lost of data.

1. **Prior to the removal of site Primary Standard and Zero Air Supply for Recertification a Manual Calibration Check must be performed on the site ozone monitor if the site monitor Failed the immediately Prior Daily Auto-Calibration Check. Then if the Monitor passes the manual Calibration Check Acceptance Criteria the site Primary Standard and Zero Air Supply can be removed for re-certification. If the monitor fails the Manual Calibration Check the Monitor must be recalibrated. If the monitor passes calibration the site Primary Standard and Zero Air Supply can be removed for recertification.**
2. **When the recertified Primary Standard and Zero Air Supply are reinstalled at the site the site operator should first run a Manual Calibration Check on the site monitor. If the site monitor passes the Calibration Check the operator should then calibrate the site monitor with the recertified Primary Site Standard and Zero Air Supply to establish the direct link to the NC Standard Ozone Photometer. If the site monitor does not pass the Manual Calibration Check with the recertified Site Primary Standard and Zero Air Supply contact Charles Davis at (919-707-8454) or Joette Steger at (919-707-*8460) before proceeding with the calibration of the site monitor.**

Projects and Procedures Branch	**Charles Davis 919-707-8454** **Joette Steger 919-707-8460**
Electronics and Calibration Branch	**Derrick House 919-715-1761** **James Olcott 919-715-1761**

Figure B-52. Ozone Log Book Instructions Page 5

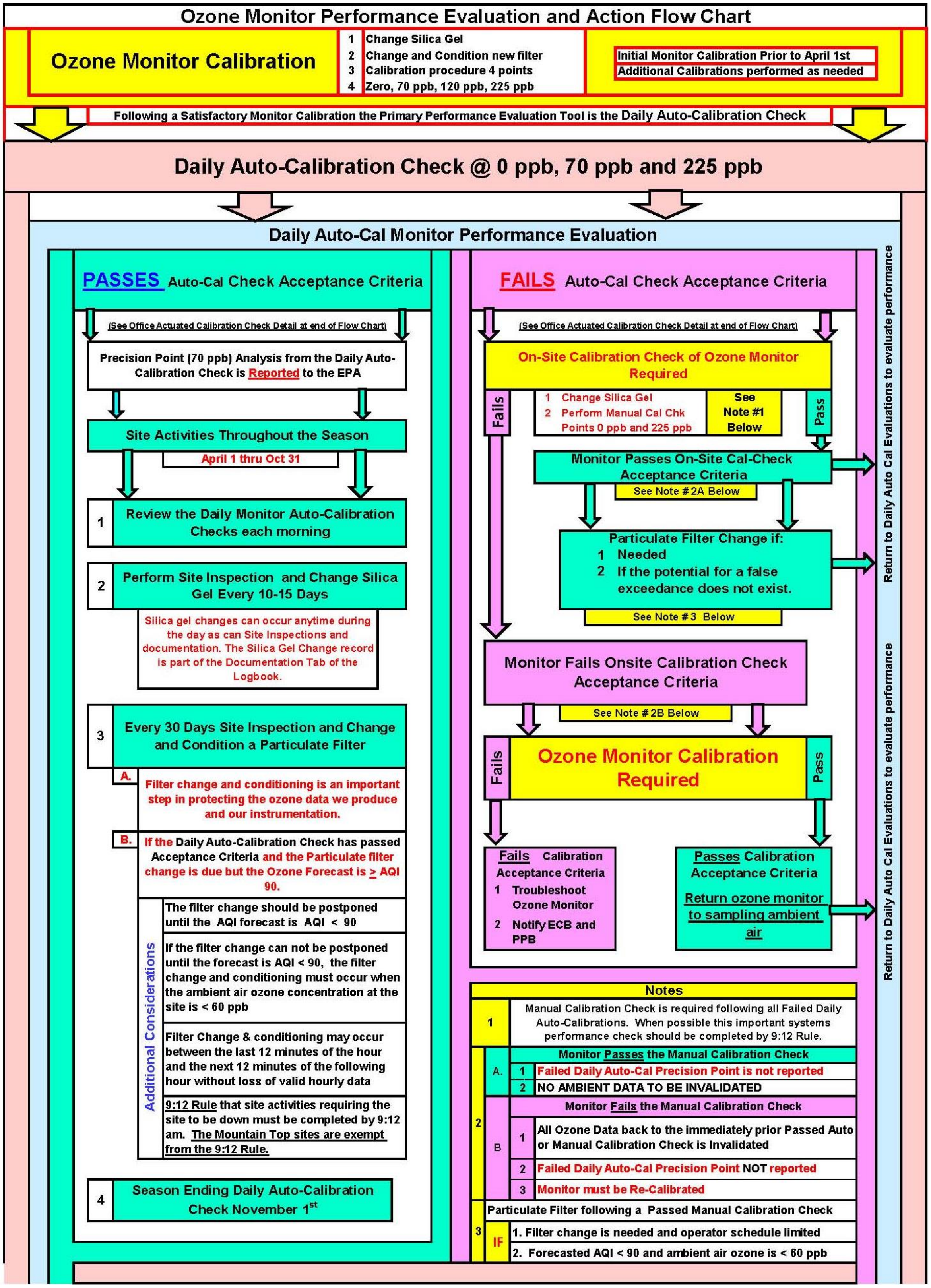


Figure B-53. Ozone Log Book Flow Process

Must Be Completed First to Document Each Site Activity

Date	10/29/2014
Site	UQ
Operator	RND

Site Activity Purpose		
Calibration	N	Y/N
Silica Gel Change	Y	Y/N
Filter Conditioning	N	Y/N
On-Site Cal Check	N	Y/N
Site Temperature	N	Y/N
Office Actuated Cal-Chk	N	Y/N
Other	NA	

Documentation for Office Actuated Calibration Check is limited to Items #1 and # 2 Below.

1	Record Ambient Air Ozone Conc. Prior to Downing Data Collection Channels and the Start of All Site Activities	29	Time	10:00AM	Proceed with Site Activities
2	Site Temperature	Record Site Temperature	25		Proceed with Site Activities
		Site temp. must be 20-30°C for Ozone Data, Calibrations, and Checks to be Valid		Record Adjusted Site Temperature	NA
3	Site Inspection	Sampling Line, Probe and Funnel Intact (Y/N)	Y	Detail Site Inspection Exceptions in Comments Section below	
		Site Secure (Y/N)	Y		
		Change in Activities Around Site (Y/N)	N		
4	TEI 49C Ozone Monitor	ID #	44	Ozone Bkg Factor	1.100
				Ozone Coefficient Cal Factor	0.984
		Alarms Displayed (Y/N)	N	Which Alarm	NA
		If Alarm is Displayed contact ECB and/or PPB Before Proceeding			
		Lamp Intensity	Cell "A" 783341	Cell " B "	80216
				Cooling Fan Filter Clean (Y/N)	Y
5	49C- Primary Standard	ID #	2	Certification Date	1/7/14
		Alarms Displayed (Y/N)	N	The Flow Alarm should be Displayed Upon Arrival	
				All Other Alarms Contact ECB and/or PPB	
				Cooling Fan Filter Clean (Y/N)	Y
6	Zero Air Supply	ID#	38	Certification Date	1/7/14
		Silica Gel Changed (Y/N)	Y	Leak Check Passed (Y/N)	Y
				Pressure Gauge (20-30 psi) (Y/N)	Y
7	Air Compressor	If not Operational Contact ECB at 919-715-1761		Pressure Check (30-40 psi) (Y/N)	Y
				Compressor Drained (Y/N)	Y
				Coalescing Bowl Drained (Y/N)	Y
8	Data Loggers	Set to Correct Eastern Standard Time.		PDL Time	10:00AM
	Computer Time	Set to 5 minutes prior to the Data Logger Time		Computer Time	10:00AM
	Backup Data	Collect Backup Data		Y/N	N
9	Operator Comments, Problems, Discussions, Site Issues, Resolutions	OK			

Figure B-54. Ozone Log Book Site Visit

Date	10/29/2014
Site	UQ
Operator	RND

Ozone Monitor Calibration

EPA Temperature Requirement for Calibration is 20-30° C

Site Temperature	25
Adjusted Site Temp If Applicable	NA

Step One

Site Documentation Must be Completed prior to start of Calibration Procedure

Step Two

Silica Gel	The two (2) Silica Gel Cartridges of the Zero Air Supply must be Changed Prior to the Performance of the Calibration Procedure	Silica Gel Changed
		Y/N

If Silica Gel changed during an immediately prior Calibration Check, it is not necessary to change at this procedural stage.

Step Three

Particulate Filter Change and Conditioning - Immediately Prior to All Calibrations

Performance Based — Filter is Conditioned as soon as Acceptance Criteria are Passed

Conditioning Acceptance Criteria	Conc.	49C-PS	PDL
	225	$\leq \pm$ 2 ppb	$\leq \pm$ 5.0 ppb
	0	$\leq \pm$ 2 ppb	$\leq \pm$ 3.0 ppb

Level 4 Event 225 ppb

Time		
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg.	0.0	0.0

Zero Event 0 ppb

Time		
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg.	0.0	0.0

Evaluation

UNACCEPTABLE

Action

Check for Leaks and Recondition the Filter a Second Time or Replace with a New filter and Rerun Conditioning Procedure

If 2nd Filter conditioning FAILS Notify PPB and ECB.

Step Four

Ozone Monitor Calibration Data

Zero Event 0 ppb

Time		
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg	0.0	0.0

Level 4 Event 225 ppb

Time		
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg	0.0	0.0

Level 3 Event 120 ppb

Time		
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg	0.0	0.0

Level 2 Event 70 ppb

Time		
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg	0.0	0.0

Step Five

Calibration Evaluation

Acceptance Criteria

49C-PS	PDL
0 $\pm$ 2	$\leq \pm$ 2
70 $\pm$ 2	$\leq \pm$ 2
120 $\pm$ 2	$\leq \pm$ 2
225 $\pm$ 2	$\leq \pm$ 2

Primary Standard	Unacceptable Performance
Monitor	Acceptable Performance

Calibration Invalid Primary Standard Exceeds Limits Notify PPB and ECB

Step Six

Calibration Factor Evaluation

Background Factor	> -3 & < +3
Ozone Coefficient	>0.95 & < 1.05

Enter Monitor Background Factor		Unacceptable
Enter Monitor Ozone Coefficient Factor		

Cal Factor Evaluation Actions	Check for Leaks and Perform Calibration Procedure a Second Time, If Second Calibration Fails Calibration Factor Evaluation Notify PPB and ECB

Operator Comments	Regional Chemist Review Comments

Figure B-55. Ozone Calibration Log

Version 3.0 2011	
Date	10/29/14
Site	UQ
Operator	RND
Time	10:00AM

Particulate Filter Change and Conditioning Procedure

Performance Based.	Conditioning is not Time Based. When the Conditioning Values Pass the Acceptance Criteria the Filter is Conditioned and Values should be recorded.

Step One

Site Documentation Must be Completed prior to start of Filter Change and Conditioning Procedure

Step Two

If the AQI forecast ≥ 90 and the Daily Autocal PASSED the Acceptance Criteriait is recommended to not take the ozone monitor off line to change and condition a filter

Ambient Air Concentration Evaluation Prior to Filter Change and Conditioning Procedure		Proceed with Filter Change and Conditioning

Step Three

Change Both Silica Gel Cartridges Before Proceeding	Yes / No	

Step Four

Filter Change and Conditioning ≤ 28 Days

Acceptance Criteria

49C-PS	PDL
225 ≤ ± 2 ppb	≤ ± 5 ppb
0 ≤ + 2 ppb	≤ ± 3 ppb

Level 4 Event 225 ppb		
TIME	9:12 AM	
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg	0.0	0.0

Zero Event 0 ppb		
TIME	9:53 AM	
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg	0.0	0.0

After Readings Stabilize Record 5 x 1 Min Values

Step Six

Primary Standard Evaluation	Unacceptable
Filter Conditioning Evaluation	Proceed to Data Backup

If Filter Values Fail Low a Leak at Holder or Contamination is Probable Cause
If Filters Fail High a Poor Monitor Calibration is the Probable Cause
If Primary Standard Fails Contact ECB & PPB

If the Conditioning of a 2nd Particulate Filter Fails to pass Acceptance Criteria contact ECB and PPB. Considering the Monitor passed the immediately prior Daily Auto-Calibration Check or the Manual Calibration Check the performance of the Monitor and Sampling line is now Suspect.

Operator Comments	Regional Chemist Review Comments

Figure B-56. Ozone Filter Change and Conditioning Log

Date	10/29/14
Site	UQ
Operator	RND

Initial Site Temperature	25
Site Temperature Criteria 20 - 30 c	
Adjusted Site Temperature if Applicable	NA

On-Site Calibration-Check

Version 3.2 2013

Required Following All
Failed Daily Auto-Calibration Checks
Failed Office Actuated Calibration Checks

Site Documentation must be Completed **First** during Each Site Visit

Step One

Ambient Air Concentration Evaluation Prior to Start of the Calibration Check			Unless the Auto-Calibration has Failed Acceptance Criteria DO NOT Proceed with Manual Calibration Check if both the Ozone Air Quality Index Forecast is 90 or greater and the the ambient air ozone concentration is greater than 60 ppb.
	Time	10:00AM	

Step Two

Change Both Silica Gel Cartridges Before Proceeding	Enter Yes/No	

Step Three

Office Actuated Calibration Check

Acceptance Criteria

49C-PS	PDL
0 ± 2 ppb	≤ ± 2 ppb
225 ± 5 ppb	≤ ± 5 ppb

Zero Event 0 ppb		
TIME		
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg	0.0	0.0

Level 4 Event 225 ppb		
TIME		
Reading	49C-PS	PDL
1		
2		
3		
4		
5		
Avg	0.0	0.0

Step Four

Cal-Check Evaluation

Primary Standard	Unacceptable Performance
Ozone Monitor	Acceptable Performance
Action	Primary Standard Exceeds Limits, Make No Monitor Adjustments Contact PPB and ECB

Step Five

If Manual Calibration Check Passes Acceptance Criteria

Ambient Air Ozone Conc.	Performing a Particulate Filter Change is Conditional	
	1	The Monitor just Passed a Manual Calibration
0	2	Changing and conditioning of a new particulate filter will not result in the loss of an additional hour of monitoring data when the ambient air ozone is ≥ 60 ppb.

Operator Comments	Regional Chemist Review Comments

Figure B-57. Ozone Log for On-site calibration checks

INSTRUCTIONS FOR 43C-TLE Trace Level SO_2 E-LOG (Version 2, January 1 2014)

1) This e-log is to be used with the 43C-TLE Trace Level SO2 Monitor (range of 100 ppb).

2) Header Information (Site, Time, Date and Operator Initials) on "LOGBOOK" sheet is linked to "Cal Check" and "Calibration" sheets

3) Enter required information in all white boxes. WHITE

4) All cells except WHITE are locked. All WHITE cells require manual entry of information.

5) Back-up records after every site visit. Download from your laptop to a flash drive, a CD, the network or whatever is most realiable for you or your region. Let your supervisor/Regional Environmental Coordinator know your method of back-up.

6) Prepare a NEW e-log for each visit and save file with site identifier, pollutant identifier and date. (MQ_SO2T_20090828).

7) Gas flow and air flow values are obtained from 146C calibrator during calibration checks or calibration.

8) Under "Calibration" and "Cal Check" sheets, the "Acceptable (YES/NO)" is automatic.

Figure B-58. Instructions for the 43C-TLE Trace Level Sulfur Dioxide Log Book

43C-TLE SO_2 SITE INFORMATION (Version 2, January 1, 2014)

Site:		Time: (hh:mm)		Date: (mm/dd/yy)		Operator:	

Routine Site Inspection

Bldg Secure ? (Y/N):	
Sample Line Inlet in Place? (Y/N):	
Bldg Power On (Y/N):	
Sample Line OK? (Y/N):	

	TC Sensor	NIST	(+/- 2 degrees C)
Bldg Temp (Deg. C):			OK
Thermometer ID			
Thermometer cert Date		(mm/dd/yy)	

SO_2 Analyzer

Model Type: (43C/43C-TLE)		Serial No.		Range: (ppb)	

Cooling Fan/Filter OK? (Y/N)):	
Date Fan Filter Cleaned:	
Date Particulate Filter Changed:	
Internal Temp.(15-35C)	
Chamber Temp.(43-47C)	
Pressure (650-800mmHg)	
Flow (0.35-0.65 Lpm)	

Date of Most Recent Calibration (mm/dd/yy)	
Sample Port Leak Check OK ? (<180mmHg and 0.0 lpm) (Y/N):	
Span Port Leak Check OK ? (<180mmHg and 0.0 lpm) (Y/N):	
Alarms?	

146C Calibrator Information

Serial No.:	
Expiration Date: (mm/dd/yy)	
Days Left:	-41947
Cooling Fan/Filter OK? (Y/N):	
Date Fan Filter Cleaned:	

Cylinder Information

Cylinder No.:		Cylinder Press. (>500 psig):	
Expiration Date:		Delivery Press.(30 psig):	
Days Left:	-41947		
Concentration: (ppm)			
Alarms?:			

Zero Air Pack

Serial No.:	
Expiration Date: (mm/dd/yy)	
Days Left:	-41947
Silica Gel Checked (Y/N):	
Date Silica Gel Changed:	

Delivery Air Pressure (30 +/- 2 psig)	
Compressor Pressure (40 to 45 psig):	
Air Compressor drained ? (Y/N):	

Site computer/Data Logger Date/Time Information

	Date (mm/dd/yy)		Time (hh:mm)	
Site Computer:		Warning		Warning
Data Logger :		Warning		
NIST:		Warning		

(Site Computer Must Agree With Data Logger Retarded By 5 Min)
(Data Logger Must Be Within ± 1 Minute of NIST Time)

Notes

Figure B-59. Sulfur Dioxide Log Book Site Visit Page

43C-TLE SO_2 Calibration Check (Version 2, January 1, 2014)

Site: 0 **Date:** 1/0/1900 **Operator:** 0

Analyzer Range (ppb): 0

Cylinder Conc., ppm: 0.00

From 146C Readings

Span	Flow Rate (Gas, sccm)	Flow Rate (Air, sccm)	146C (SO2, ppb)	Target Value Nominal ppb
0			#DIV/0!	0.00
1			#DIV/0!	85.00
2			#DIV/0!	45.00
4			#DIV/0!	10.00

CALIBRATION CHECK

(record 5 consecutive 1-minute average values from the Datalogger)

SO2	ZERO			SPAN 1 (70-90%)			SPAN 2 (40-60%)			SPAN 4 (10 - 100 pbb)		
	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb
	1			1			1			1		
	2			2			2			2		
	3			3			3			3		
	4			4			4			4		
	5			5			5			5		
		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!
		Diff.,ppb	#DIV/0!		Diff., ppb	#DIV/0!		Diff., ppb	#DIV/0!		Diff., ppb	#DIV/0!
Acceptable (Yes/No):			#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!
Acceptable Range:		Difference ± 2 ppb			Difference ± 3 ppb			Difference ± 3 ppb			Difference ± 2 ppb	
		avg	#DIV/0!		avg	#DIV/0!		avg	#DIV/0!		avg	#DIV/0!

Figure B-60. Sulfur Dioxide Calibration Check Log

43C-TLE SO_2 Calibration (Version 2, January 1, 2014)

Site: 0 **Date:** 01/00/00 **Operator:** 0

Analyzer Range (ppb): 0

Cylinder Conc., ppm: 0.0

From 146C Readings

Span	Flow Rate (Gas, sccm)	Flow Rate (Air, sccm)	146C (SO2, ppb)	Target Value Nominal ppb
0			#DIV/0!	0.00
1			#DIV/0!	85.00
2			#DIV/0!	45.00
3			#DIV/0!	7.00

Calibration Factor Information

	Before Calibration	After Calibration	Expected Range
SO2 Background			0-50 ppb
SO2 Coefficient			0.900-1.100

CALIBRATION

(record 5 consecutive 1-minute average values from the data logger)

SO2

Attempt One						Attempt Two, If Needed					
ZERO			SPAN 1 (70-90%)			ZERO			SPAN 1 (70-90%)		
Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
	Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!
	Diff., ppb	#DIV/0!		Diff., ppb	#DIV/0!		Diff., ppb	#DIV/0!		Diff., ppb	#DIV/0!
Acceptable (Yes/No):		#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!
Acceptable Range:		Difference ± 2 ppb			Difference ± 3 ppb			Difference ± 2 ppb			Difference ± 3 ppb
	avg	#DIV/0!		avg	#DIV/0!		avg	#DIV/0!		avg	#DIV/0!

CALIBRATION VERIFICATION

(record 5 consecutive 1-minute average values from the Datalogger)

SO2

ZERO			SPAN 1 (70-90% FS)			SPAN 2 (40-60% FS)			SPAN 3 (5-10 ppb)		
Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb	Reading Number	Time hh:mm	Logger ppb
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
	Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!		Avg ppb	#DIV/0!
	Diff., ppb	#DIV/0!		Diff., ppb	#DIV/0!		Diff., ppb	#DIV/0!		Diff., ppb	#DIV/0!
Acceptable (Yes/No):		#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!
Acceptable Range:		Difference ± 2 ppb			Difference ± 3 ppb			Difference ± 3 ppb			Difference ± 2 ppb
	avg	#DIV/0!		avg	#DIV/0!		avg	#DIV/0!		avg	#DIV/0!

Figure B-61. Sulfur Dioxide Calibration Log

HSCO-TLE LOGBOOK

Site: | Time: | Date: | Operator:

Routine Site Inspection

Building Secure		Bldg. Power On			Date	Time
Sampling Probe Intact		Bldg. Temperature (°C)		Computer :		
				PDL :		
				BUDL :		

(+/- 1 min. on dataloggers)

TEI Model 48i-TLE HSCO Analyzer

Serial No.

Filters:

Date Particulate Filter changed	
Cooling Fan Filter Cleaned	
Leak Check (Pass / Fail)	

Alarms?

STATS:

Range @ 0-5 ppm? (Y/N)	
Instrument Temp - Internal (°C):	
Instrument Temp - Bench (°C):	
Instrument Pressure (mm Hg):	
Flow Setting (LPM):	
Sample/Ref Ratio:	
AGC Intensity (Hz):	

TEI Model 146C Calibrator

Serial No.

Exp. Date

Days Remaining 0

Cylinder CHECK: **(>500psi)**

Cylinder #		Cylinder Press. (psig)	
Cylinder Exp. Date		Delivery Press. (30 psig)	
Cylinder Conc.			

Days Remaining 0

Filters:

Cooling Fan Filter Cleaned

Alarms?

Zero Air

Serial No. :	
Exp Date:	
Silica Gel Checked (yes/no):	
Date Silica Gel Changed:	

Days Remaining 0

Delivery Air Pressure (30 psig):	
Compressor Pressure (40 psig):	
Air Compressor Drained (yes/no):	

Data Loggers

Primary Data Logger OK?		Data Backed-up? (yes/no):	
Backup Data Logger OK?		Date of last back-up:	

Notes

SILGEL and FILTER change

Mark Y will be cert'ing (maybe change out ?) the zero-air pack in the next few days

EPA Audit scheduled for Nov 5 - 2014

RAT 10/31/14

Figure B-62. Trace Level Carbon Monoxide Log Book

HSCO-TLE CALIBRATION CHECK

Site: 0 | Time: 12:00 AM | Date: 01/00/00 | Operator: 0

Cylinder Conc.	0.0

Calibration Check Span Criteria = 8%
Zero = +/- 35 ppb

Span (ppb)	Flow Rate (Gas)	Flow Rate (Air)	146C (CO)
0			#DIV/0!
4000/5000			#DIV/0!
2000/2500			#DIV/0!
250/500			#DIV/0!

Calibration Factors	
As Found	
Background PPM	
Span Gas	0
CO Coeffecient	

ZERO		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!

[diff +/-35 ppb]
Acceptable: #DIV/0! | #DIV/0!

SPAN 2		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!
% Diff		#DIV/0!	#DIV/0!

[diff +/- 160 ppb]
Acceptable: #DIV/0! | #DIV/0!

SPAN 1		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!
% Diff		#DIV/0!	#DIV/0!

[diff +/-320 ppb]
Acceptable: #DIV/0! | #DIV/0!

SPAN 3		Primary	Backup
Hrs:min	146C	COT	COT
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!
% Diff		#DIV/0!	#DIV/0!

[diff +/- 24 ppb]
Acceptable: #DIV/0! | #DIV/0!

Figure B-63. Trace-Level Carbon Monoxide Calibration Check

HSCO-TLE LOGBOOK

Site: 0 | Time: 12:00 AM | Date: 01/00/00 | Operator: 0

Cylinder Conc.	0.0

Calibration Zero/Span Criteria
Zero = +/- 35 ppb
Span 1 = 4%
Span 2, Span 3 = 5%

Span (ppb)	Flow Rate (Gas)	Flow Rate (Air)	146C (CO)
0			#DIV/0!
4000/5000			#DIV/0!
2000/2500			#DIV/0!
250/500			#DIV/0!

Calibration Factors	
As Found	
Background PPM	
Span Gas	0
CO Coeffecient	
After Calibration	
Background PPM	
Span Gas	0
CO Coeffecient	

ZERO		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!

[diff +/-35 ppb]

Acceptable: #DIV/0! #DIV/0!

SPAN 2		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!
% Diff		#DIV/0!	#DIV/0!

[diff +/- 100 ppb]

Acceptable: #DIV/0! #DIV/0!

SPAN 1		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!
% Diff		#DIV/0!	#DIV/0!

[diff +/-160ppb]

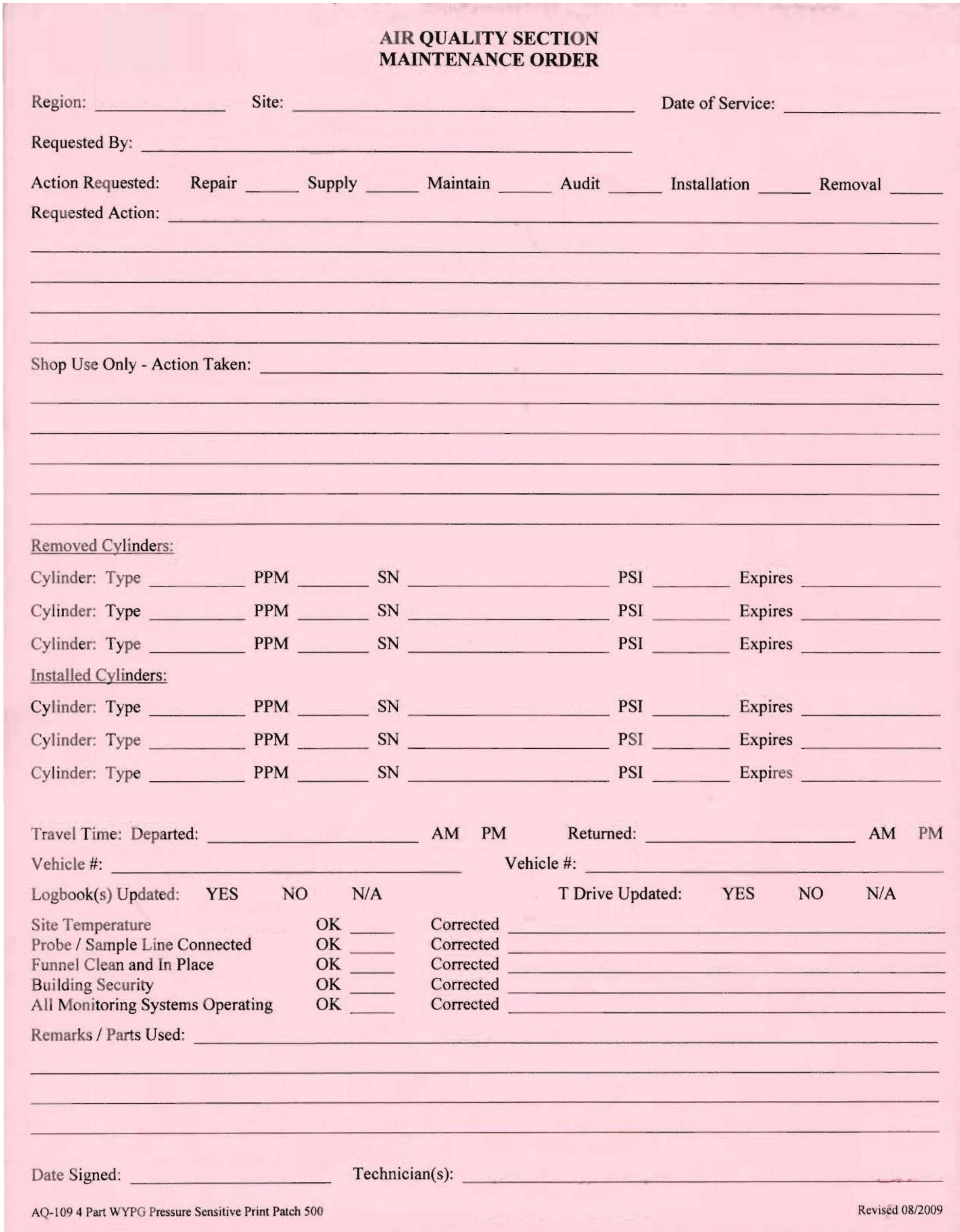
Acceptable: #DIV/0! #DIV/0!

SPAN 3		Primary	Backup
Time Hrs:min	146C	COT	COT
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
	#DIV/0!		NA
Avg ppm	#DIV/0!	#DIV/0!	#DIV/0!
Act. Diff		#DIV/0!	#DIV/0!
% Diff		#DIV/0!	#DIV/0!

[diff +/- 25 ppb]

Acceptable: #DIV/0! #DIV/0!

Figure B-64. Trace Level Carbon Monoxide Calibration Log



AIR QUALITY SECTION
MAINTENANCE ORDER

Region: ____________ Site: ______________________________ Date of Service: ______________

Requested By: ____

Action Requested: Repair _____ Supply _____ Maintain _____ Audit _____ Installation _____ Removal _____

Requested Action: ____

____

____

____

____

Shop Use Only - Action Taken: ____

____

____

____

____

____

Removed Cylinders:

Cylinder: Type _________ PPM _______ SN __________________ PSI _______ Expires ____________

Cylinder: Type _________ PPM _______ SN __________________ PSI _______ Expires ____________

Cylinder: Type _________ PPM _______ SN __________________ PSI _______ Expires ____________

Installed Cylinders:

Cylinder: Type _________ PPM _______ SN __________________ PSI _______ Expires ____________

Cylinder: Type _________ PPM _______ SN __________________ PSI _______ Expires ____________

Cylinder: Type _________ PPM _______ SN __________________ PSI _______ Expires ____________

Travel Time: Departed: __________________ AM PM Returned: __________________ AM PM

Vehicle #: ______________________________ Vehicle #: ______________________________

Logbook(s) Updated: YES NO N/A T Drive Updated: YES NO N/A

Site Temperature OK ____ Corrected ______________________________

Probe / Sample Line Connected OK ____ Corrected ______________________________

Funnel Clean and In Place OK ____ Corrected ______________________________

Building Security OK ____ Corrected ______________________________

All Monitoring Systems Operating OK ____ Corrected ______________________________

Remarks / Parts Used: ____

____

____

____

Date Signed: __________________ Technician(s): ______________________________

AQ-109 4 Part WYPG Pressure Sensitive Print Patch 500 Revised 08/2009

Figure B-65. AQ-109 Form

146C MASS FLOW CONTROLLER CERTIFICATION
20 lpm Air

Date: Tech.:

Calibrator Serial #:
L.B. #:
F.A.S. #:
M.F.C. Serial #:
146C Expiration Date :

Alicat Model #:
Alicat Serial #:
Alicat Cert. Date:
Alicat Cert.Due Date:

Barometric Pressure: 760.0 mm. Hg
Ambient Temperature: 25.0 Deg. C.
Rel. Volume: 1.000
Cert. Gas: Air
Delivery Pressure (P.S.I.): 30
Location: ECB

5%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

20%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

35%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

50%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

65%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

80%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

95%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

Figure B-66. Certification sheet for 146C Calibrator 20 Liter Mass Flow Controller

146C MASS FLOW CONTROLLER CERTIFICATION
50 sccm Gas

Date: Tech.:

Calibrator Serial #:
L.B. #:
F.A.S. #:
M.F.C. Serial #:
146C Expiration Date :

Alicat Model #:
Alicat Serial #:
Alicatl Cert. Date:
Alicatl Cert.Due Date:

Barometric Pressure: 760.0 mm. Hg
Ambient Temperature: 25.0 Deg. C.
Rel. Volume: 1.000
Cert. Gas: N2
Delivery Pressure (P.S.I.): 30
Location: ECB

5%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

20%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

35%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

50%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

65%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

80%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

95%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

Figure B-67. Certification Form for 146C Calibrator 50 cc Mass Flow Controller

146C MASS FLOW CONTROLLER CERTIFICATION
10 lpm Air

Date: Tech.:

Calibrator Serial #:
L.B. #:
F.A.S. #:
M.F.C. Serial #:
146C Expiration Date :

Alicat Model #:
Alicatl Serial #:
Alicat Cert. Date:
Alicat Cert.Due Date:

Barometric Pressure:
Ambient Temperature:
Rel. Volume:
Cert. Gas:
Delivery Pressure (P.S.I.):
Location:

5%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

20%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

35%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

50%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

65%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

80%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

95%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	sccm	
Avg. Flow:	**#DIV/0!**	slm	

Figure B-68. Certification Form for 146C Calibrator 10 Liter Mass Flow Controller

146C MASS FLOW CONTROLLER CERTIFICATION
100 sccm Gas

Date: Tech.:

Calibrator Serial #:
L.B. #:
F.A.S. #:
M.F.C. Serial #:
146C Expiration Date :

Alicat Model #:
Alicatl Serial #:
Alicatl Cert. Date:
Alicatl Cert.Due Date:

Barometric Pressure:
Ambient Temperature:
Rel. Volume:
Cert. Gas:
Delivery Pressure (P.S.I.):
Location:

5%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

20%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

35%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

50%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

65%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

80%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

95%

TEST POINT	FLOW READING	PERCENT DIFF.	USABLE POINT?
K1		#DIV/0!	#DIV/0!
K2		#DIV/0!	#DIV/0!
K3		#DIV/0!	#DIV/0!
K4		#DIV/0!	#DIV/0!
K5		#DIV/0!	#DIV/0!
Avg. Flow:	#DIV/0!	ccm	

Figure B-69. Certification Form for 146C Calibrator 100 cc Mass Flow Meter

AIR VERIFICATIONS

#1	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#2	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#3	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#4	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#5	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#6	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#7	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#8	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#9	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#10	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#11	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#12	146c Avg Reading	Ali-Cat Reading	% DIFF.	Date :	
				Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

Figure B-70. Certification Form for 146C Calibrator Air Verifications

GAS VERIFICATIONS

#1				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#2				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#3				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%				M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#4				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#5				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#6				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#7				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#8				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#9				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#10				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#11				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

#12				Date :	
	146c Avg Reading	Ali-Cat Reading	% DIFF.	Calibrator Serial #:	
				L.B. #:	
5%			#DIV/0!	M.F.C. Serial #:	
25%			#DIV/0!	Last M.F.C. Cert.Date:	
50%			#DIV/0!	ALICAT Model #:	
75%			#DIV/0!	ALICAT Serial #:	
95%			#DIV/0!	Cert. Date:	
				Cert. Exp.:	
SLOPE (m)			#DIV/0!	Verification Gas:	
INTERCEPT (b)			#DIV/0!	Delivery Pressure (psi):	
CORRELATION COEF (r^2)			#DIV/0!	Location:	

Figure B-71. Certification Forms for 146C Gas Verifications

Cal Point	Date / Time	Flow sccm
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

POST FLOW CALIBRATION TEST

Cal Point	T700U Flow sccm	Ali-Cat Reading	% ERROR
0			#DIV/0!
2			#DIV/0!
5			#DIV/0!
8			#DIV/0!
11			#DIV/0!
14			#DIV/0!
17			#DIV/0!
20			#DIV/0!
	SLOPE (m)		#DIV/0!
	INTERCEPT (b)		#DIV/0!
	CORRELATION COEF (r^2)		#DIV/0!

Date :	
Calibrator Serial #:	
L.B. #:	
M.F.C. Serial #:	
Last M.F.C. Cert.Date:	
ALICAT Model #.	
ALICAT Serial #.	
Cert. Date:	
Cert. Exp.:	
Verification Gas:	
Delivery Pressure (psi):	
Location:	

MFC/Photo Field Exp.
MFC/Photo Audit Exp.

Figure B-72. Certification Form for the T700U Calibrator

ALLOWANCE — AS FOUND — % ERROR — PPB ERROR

ALLOWANCE		Point	Date	Time	T700U	Cert CPS	% ERROR	PPB ERROR	
+ - 1 ppb	ALLOWANCE	0.0						0.0	ppb
+ - 1% + - 4.5 ppb	ALLOWANCE	425.0					#DIV/0!	0.0	ppb
+ - 1% + - 1.5 ppb	ALLOWANCE	150.0					#DIV/0!	0.0	ppb
+ - 2% + - 1.0 ppb	ALLOWANCE	50.0					#DIV/0!	0.0	ppb
+ - 4% + - 1.0 ppb	ALLOWANCE	25.0					#DIV/0!	0.0	ppb

AS FOUND :
PH SLOPE =
PH OFFSET = ppb

ALLOWANCE — AS LEFT — % ERROR — PPB ERROR

ALLOWANCE		Point	Date	Time	T700U	Cert CPS	% ERROR	PPB ERROR	
+ - 1 ppb	ALLOWANCE	0.0						0.0	ppb
+ - 1% + - 4.5 ppb	ALLOWANCE	425.0					#DIV/0!	0.0	ppb
+ - 1% + - 1.5 ppb	ALLOWANCE	150.0					#DIV/0!	0.0	ppb
+ - 2% + - 1.0 ppb	ALLOWANCE	50.0					#DIV/0!	0.0	ppb
+ - 4% + - 1.0 ppb	ALLOWANCE	25.0					#DIV/0!	0.0	ppb

AS LEFT :
PH SLOPE =
PH OFFSET = ppb

Figure B-73. Certification Form for the T200U Ozone Photometer

ECB CYLINDER INVENTORY

Rev. Date 01/23/15

STATUS CODES : E/L = Empty, Expired or Low Pressure
NR = Needs Recert.
RR = Returned for Recert.
BU = Bench Use
RC = Recertified

VENDOR	MFR	CYLINDER #	BAR CODE	STATUS	TYPE	CONC.	IMP.	P.S.I.	CERT.DATE	EXP.DATE	UPDATE	LOCATION	LIFE (Days)

Figure B- 74. Cylinder Inventory Form

SITE	Init Cal date	1st Qtr.2015	2nd Qtr.2015	3rd Qtr.2015	4th Qtr.2015
Bayview	Continuous				
Durham Armory	Continuous				
Pittsboro	01/22/14				
Bethany	01/27/14				
New Hanover	Continuous				
Bryson City	07/30/14				
Bushy Fork	05/21/14				
Blackstone	12/08/14				

25% of sites must be audited each quarter.
Each site must be audited once a calendar year of its operation.

Figure B-75. Annual Performance Evaluation Tracking Sheet for Sulfur Dioxide Monitors

APPENDIX C DUKE ENERGY – ROXBORO STATION
Semora Monitoring Station
Semora North Carolina

QUALITY ASSURANCE PROJECT PLAN (QAPP)
Sulfur Dioxide (SO_2) and Meteorological Monitoring
Revision 3

Prepared by

Duke Energy EHS
Environmental Instrumentation
and Data Management
Huntersville, North Carolina

August, 2016

1 PROJECT MANAGEMENT ELEMENTS

1.1 QA PROJECT PLAN IDENTIFICATION AND APPROVAL

Title: Duke Energy

Duke Energy	
1. Signature:	Date: 9/1/16
Mr. Kris Knudsen, Project Manager	
2. Signature:	Date: 9/1/16
Mr. Zachary S. Hall, Director – Environmental Science	

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TABLES

FIGURES

APPENDICES

Appendix A Standard Operating Procedures (SOPs)

Appendix B Training

Appendix C List of References

REVISION LIST OF CHANGES

Page	Description
Revision 3 - August 2016	
1	Changed Donnie Redmond who has retired to Joette Steger.
2	Corrected typos
12-13	Updated Table 5.1 SO2
27	Under a calibration required, changed from 7 days to 2 days
Revision 2 – August 2016	
ii	Changed signature line from Mark Knapp to Zach Hall, pending filling of the vacant Supervising Scientist – EIDM position
1	Revised the distribution list to update for organization changes.
5	Deleted Mark Knapp and indicated the position is currently vacant. (Zach Hall has management oversight until this vacancy is filled.)
8	Updated the schedule of activities to align with calendar quarter operations. Internal quarterly reporting will be completed within 45 days after end of each quarter. Performance audits will be conducted annually.
14	Changed regulatory reference to 40 CFR Appendix A 3.1.1.
26	Changed "TBD" to "X" in the Annual column to confirm that the Field Activity "Audit pollutant analyzers (independent)" will be conducted annually per updated EPA guidance. More frequent audits may be conducted but are not required.
33	In Table 15-3, changed the frequency of the audit to "Annually." More frequent audits may be conducted but are not required. Updated the reference to 40 CFR 58.
33-34	Updated Table 15-4 to incorporate revisions to 40 CFR 58 Appendix A, including expanded Audit Levels.
34	Changed regulatory reference to 40 CFR 58 Appendix A 5.1.1
41	Reference changed from Duke Energy SOP 7834 to 7834.1 for the Thermo Environmental 43i-TLE.
Various	Changed several references to the Roxboro Monitoring Station to the Semora Monitoring Station to be consistent throughout the document and consistent with the NCDEQ naming of the monitoring site.
Revision 1 – June 2016	
vii	Added Revision List of Changes
1	Changed Donnie Redmond affiliation from "NCDENR" to "NCDEQ"
5	Figure 3.1 – Added Derek Grady as Data Technician
6	Removed 15 minute reporting intervals from meteorological parameters
7	Table 4-2, Removed serial numbers
12 -13	Table 5-1 updated to reflect NCDEQ AMTIC table
13	Table 5-1minimum sample frequency and raw data collection frequency updated to reflect NCDEQ QAPP Revision 1 guidance
15	Statement "All health and safety training records are maintained in the EIDM files (Learner Hall.)" changed to All training requirements and records are maintained

	in the EIDM files (Learner Hall.) Information about the Learner Hall System is found in Appendix A (Training).
17	Section 7.1 Data Reporting – Added "Electronic site logs (PDF copies of the site paper logbooks) along with equipment certifications and maintenance records will be sent to NCDEQ quarterly."
17	Section 7.1 Data Reporting – Added "Air Vision hourly polls will be posted automatically to the secure FTP site maintained by EIDM (https://sftp2.duke-energy.com/human.aspx). Password validation is required to access the site, and the password can be obtained by contacting the Air Vision data administrator. The password is changed every ninety days."
17	Section 7.2 Documentation Control "NCDENR" changed to "NCDEQ"
26	Table 10-1, Changed step to "Inspect/clean sample manifold" to "Inspect/Clean or Replace sample tubing/filter"
26	Table 10-1, Added "Replace sample tubing" as an annual task
28	Table 11-1, 43i changed to 43i-TLE
38	Removed statement "The degree to which data comply with the quality requirements addressed in Section B of this QAPP is determined by these criteria."
39	Changed Appendix A to Appendix A Standard Operating Procedures (SOPs)
41	Appendix B List of References changed to Appendix C and moved to page 42
40 – 41	Added new Appendix B Training

1. DISTRIBUTION LIST

A hard copy of this QAPP has been distributed to the individuals in the table below. The document is also available upon request.

Distribution List		
Name	**Position**	**Affiliation**
North Carolina Department of Environment and Natural Resources		
Joette Steger	Projects and Procedures Branch Manager	NCDEQ Ambient Monitoring
Duke Energy		
Kris Knudsen	Project Manager	EHS- Env. Programs
Zach Hall	Director	EHS- Env. Science
[Position Vacant]	Supervising Scientist/ EIDM	EHS - Env. Inst. & Data Mgt.
Dawn Lowe	Data Coordinator	EHS - Env. Inst. & Data Mgt.
Vince Houston	Field Technician	EHS - Env. Inst. & Data Mgt.
Andrew Morris	Field Technician	EHS - Env. Inst. & Data Mgt.
Derek Grady	Field Technician	EHS - Env. Inst. & Data Mgt.

2. PROBLEM DEFINITION AND BACKGROUND

2.1 Problem Statement and Background

2.1.1 Background

Duke Energy (Duke) is conducting an ambient air quality monitoring program in response to concerns from the local community to determine whether SO2 emissions from the Roxboro Station may impact attainment of the 75 ppb one-hour National Ambient Air Quality Standard (NAAQS) for SO2, as requested by NCDEQ. Data collected under this program will be provided to NCDEQ for their use for classifying the area for NAAQS attainment based on source-oriented monitoring. Attainment of the NAAQS is defined by regulation as achieving a value of 75 ppb or less of the average of the 4th highest values in each year over a three year period. The monitoring will be conducted in the vicinity of the Roxboro Station in Semora, North Carolina to document concentrations sulfur dioxide (SO_2) and meteorological measurements including horizontal wind speed (u), direction (θ) and standard deviation of wind direction ($\sigma\theta$).

2.1.2 Ambient Monitoring- Purpose and Objectives

The purpose of this program is to conduct air quality and meteorological monitoring in the vicinity of the Roxboro Station for a period of five years (January 2016 through December 2020.) Monitoring will be performed at one location. The station will be operated following source-oriented State and Local Air Monitoring Stations (SLAMS) guidelines. This air quality and meteorological monitoring program has been designed to provide valid, reliable and regulatory compliant ambient measurement data. The monitoring program will be operated to provide data to NCDEQ so that it can make a determination of the attainment status for the area surrounding the Roxboro Station as required by the USEPA.

The Ambient Air Quality Monitoring program will be conducted in accordance with the applicable requirements of 40 CFR Parts 50, 53, 58 and other requirements specified by NCDEQ. The air monitoring data will be used by NCDEQ and/or Duke Energy to:

- Evaluate attainment of National Ambient Air Quality Standards (NAAQS) for Sulfur Dioxide,
- Monitor the current dynamic concentrations of Sulfur Dioxide,
- Activate emergency control procedures that prevent or alleviate air pollution episodes,
- Provide data upon which short term strategies can be reliably developed, if needed, to address actual observed air quality impacts, and
- Provide a database for researching and evaluating air quality model performance.

3 PROJECT ORGANIZATION

3.1 Roles and Responsibilities

An ambient air quality monitoring program will be conducted in the vicinity of the Roxboro Station in Semora, North Carolina to document concentrations sulfur dioxide (SO_2) and meteorological measurements including horizontal wind speed (u), direction (θ) and standard deviation of wind direction (σθ). The North Carolina Department of Environmental Quality (NCDEQ) and Duke Energy (Duke) will work together during this project. The role of each participant is summarized below and described in Table 3-1. A project flow chart is provided as Figure 3-1**.**

Table 3-1: Program Responsibilities

Position	**Role**
North Carolina Department of Environmental Quality (NCDEQ)	Assist in performance and system audits, if requested
Duke Energy Environmental Programs – Project Manager	Overall program management and coordination. Reviews data prepared by EHS EIDM and submits the information to NCDEQ. Responsible for site acquisition and response to SO_2, action levels.
EHS Environmental Instrumentation and Data Management (EIDM)	Responsible for field operation of monitoring equipment, data management and reporting of data to Duke Energy Environmental Manager.
EIDM Supervising Scientist	The Supervising Scientist has the overall responsibility of field operations, field activities, and the operation of the monitoring sites. Responsible for management of data acquisition and reporting activities. All field and data management personnel report to the Supervising Scientist.
EIDM Data Coordinator	Responsible for database management, data validation and the preparation of periodic reports.
EIDM Field Technicians	Responsible for site operation, deploying monitoring equipment, quality control checks and retrieving data from the monitoring sites.

3.1.1 North Carolina Department of Environmental Quality

NCDEQ may conduct independent performance audits or provide an independent contracted auditor. EIDM will accommodate Technical Systems Audits of the network, if requested by the agency.

3.1.2 TRC Environmental Corporation

TRC has been contracted by Duke and will be responsible for network installation and initial operation, data collection, data validation and reporting. TRC will assist in the site selection, provide the equipment, instrumentation and personnel necessary to ensure that the data are of sufficient quantity and quality to meet the objectives of the program. TRC will ensure that quality control (QC) and standard operating procedures (SOPs) are followed in accordance with EPA and NCDEQ requirements such that the quality assurance (QA) objectives of this plan are met until operational control of the monitoring site is turned over to Duke Energy EHS-EIDM. Following a successful review of operation and review of operation by NCDEQ, a turnover to Duke Energy EHS – EIDM will be accomplished. Successful turnover will be dependent upon a full system calibration by TRC with EIDM in observance to demonstrate proper system operation. Following turnover, TRC will continue in a technical support role as requested by EIDM.

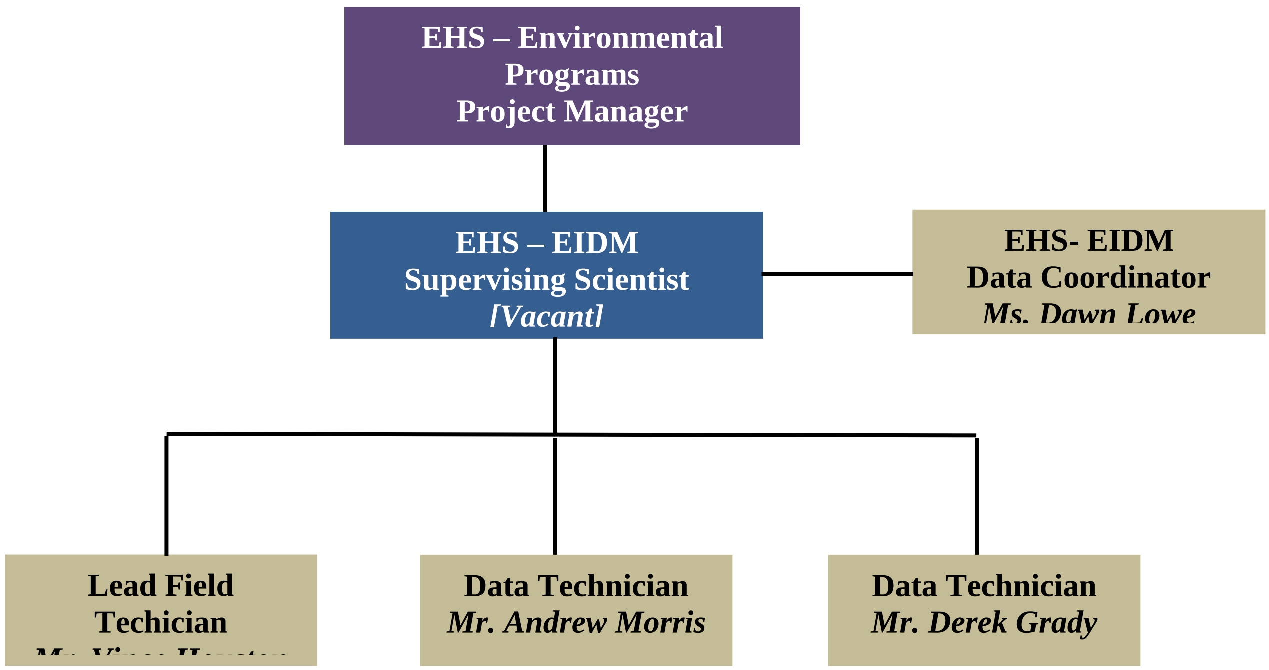
3.1.3 EHS – Environmental Programs

EHS – Environmental Programs will be responsible for assisting in the selection of sites, securing use of the site locations, site security, installation of utilities and overall leadership of the project. Duke will review all data reports prepared by EIDM and submit reports to NCDEQ.

3.1.4 EHS – Environmental Instrumentation and Data Management (EIDM)

EIDM will be responsible for system operation, and data collection, data validation and reporting. EIDM will assume operation of the system following a turnover from the vendor (TRC Environmental Corporation) contracted to install and initially maintain the site. Turnover will be accomplished following a successful operation by TRC that includes a review (independent audit) by NCDEQ to assure all monitoring requirements are being met and a final system calibration observed by EIDM personnel. Following the turnover, EIDM will assume operation and maintenance of the equipment and instrumentation provided by TRC and will provide personnel necessary to ensure that the data are of sufficient quantity and quality to meet the objectives of the program. EDIM will ensure that quality control (QC) and standard operating procedures (SOPs) are followed in accordance with EPA and NCDEQ requirements such that the quality assurance (QA) objectives of this plan are met.

Figure 3-1: Project Organizational Chart



4 PROJECT DESCRIPTION

4.1 Project Overview

As previously stated, the purpose of this monitoring program is to install and operate sulfur dioxide and meteorological monitoring at one site in the vicinity of the Roxboro Station. This air quality and meteorological monitoring program has been designed to provide valid, reliable and regulatory compliant ambient measurement data from the monitoring station located in Semora, North Carolina. The air monitoring station is situated in a one acre clearing northeast of the plant in a fenced parcel of property owned by the CertainTeed wallboard manufacturing facility on Shore Rd. in Semora, NC. The coordinates of the monitoring station are 36º 29' 23.55" N, 79º 3' 30.60" W.

The parameters measured at the air quality monitoring program are as follows:

- Sulfur Dioxide (SO_2)
  - SO_2 will be monitored on a continuous basis. One minute, five minute and hourly averages will be recorded. Hourly concentrations as well as the highest hourly 5-minute average will be reported in compliance with SO_2 reporting requirements.

In addition, the following meteorological parameters will be measured:

- Horizontal wind speed (WS or u), wind direction (WD) and standard deviation of wind direction (σθ) at a height of 10 meters (m).

Monitoring program parameters are summarized in Table 4-1.

Table 4-1: Summary of Monitoring Program Parameters

Parameter	Measurement Units	Reporting Interval
SO_2	Parts per billion (ppb)	Hourly (average and highest 5-min)
Wind Speed (μ)	Meters per second (m/s)	Hourly
Wind Direction (θ)	Directional degrees (°)	Hourly
Standard Deviation of Wind Direction (σθ)	Directional degrees (°)	Hourly

Table 4-2 is a summary of equipment in use at the Semora Monitoring Station

Table 4-2: Summary of Monitoring Equipment at Skyland		
Parameter	**Manufacturer/Model**	**Comments**
Environmentally Controlled Shelter	EKTO 866	Heated, Air Conditioned Re-locatable Shelter
Sulfur Dioxide Analyzer	Thermo Environmental Instruments Model 43i-TLE	US EPA Equivalent Method EQSA-0486-060
Wind Speed and Direction Sensor	RM Young Model 05305 Wind Monitor AQ	Mechanical Wind Speed and Direction Sensor
Gas Dilution Calibrator	Thermo Environmental Instruments Model 146i	Dynamic Gas Dilution Calibrator
Zero Air Supply	Thermo Environmental Instruments Model 111	Clean Air Supply for Gas Calibrator
Certified Gas Standard	AirGas	Lab Certified Calibration Standard
Data Logger	Primary: Environmental Systems Corporation 8832 data logger (or equivalent Secondary: Lenovo/ThinkPad Laptop with TRC Data Processing Software	Data Acquisition System and Electronic User Interface
Communications	Verizon Cell Modem	Cellular Data Modem
Support Equipment	Various Suppliers	Manifolds, Tubing, Instrument Racks and Required Accessories

The major equipment supplier contact information is supplied in Table 4-3.

Table 4-3: Equipment Suppliers

Manufacturer/Supplier	**Equipment**
R.M. Young Company 2801 Aero Park Drive Traverse City, MI 49686 (231)946-3980 Youngusa.com	Wind Sensors and Translator
Thermo Fisher Scientific Inc. 81 Wyman Street Waltham, MA 02454 (781)622-1000 and (800)678-5599 thermoscientific.com	43i-TLE SO_2 Analyzer
EKTO Manufacturing Corp. Eagle Drive Sanford, ME 04073 (207)324-4427 Ekto.com	Shelters

4.2 Project Schedule

The project schedule for annual operation of the monitoring programs is outlined in Table 4-4. Preliminary operation of the Semora monitor began December 31, 2015, and data collection began effective January 1, 2016 after system operations were verified and QA schedules were implemented. Operation of the monitor for the period from January 1, 2016 through March 31, 2016 was performed by TRC under contract to Duke Energy. Duke Energy-EIDM group assumed all operation, including maintenance and QA, effective April 1, 2016. NCDEQ provided an initial performance audit of the monitoring system on March 21, 2016.

Table 4-4:Project Schedule for Calendar Year Monitor Operation

Date	**Milestone**
January 1	Monitoring Program Calendar Year Begins
March	Semi-Annual Maintenance and Calibration of Air Quality and Meteorological Instrumentation
March 31	End of 1st Quarter Monitoring
May 15	1st Quarter Monitoring Report Complete
June	Quarterly Maintenance and Air Quality Calibration
June 30	End of 2nd Quarter Monitoring
August 15	2nd Quarter Monitoring Report Complete

September	Semi-Annual Maintenance and Calibration of Air Quality and Meteorological Instrumentation by EIDM
September 30	End of 3rd Quarter Monitoring
November 15	3rd Quarter Monitoring Report Completed
December	Quarterly Maintenance and Air Quality Calibration
December 31	End of 4th Quarter Monitoring
February 15	4th Quarter Monitoring Report Completed
Annually	Performance Audit conducted, to be scheduled by NCDEQ during the calendar year.

4.3 Scheduled Field Activities

Federal regulation provides for the implementation of a number of qualitative and quantitative checks to ensure that data will meet the Data Quality Objectives (DQOs) for the project. Each of the checks attempts to evaluate phases of measurement uncertainty.

TRC will have initial responsibility for implementation of all monitoring program QC measures through the turnover of operation to EIDM (scheduled to be completed by April 1, 2016). EIDM will continue with established monitoring program QC measures The following is a summary of QC activities that will be implemented to ensure that measurement uncertainty is maintained within established acceptance criteria for the attainment of the program DQOs. QC activities will include, but not be limited to, the following:

Sulfur Dioxide

- Daily automated calibration checks (zero/span and precision),
- Daily review of instrument measurements and diagnostics,
- Monthly operational checks by local site operator, and
- Quarterly maintenance and calibration (if deemed necessary) as specified in TRC's Standard Operating Procedure (SOP).

Meteorological Measurements

- Semiannual maintenance and calibrations, and
- Monthly reasonableness checks by site operator
  - o Verification that wind sensors are operational and show no sign of damage, and
  - o Wind speed, wind direction and shelter temperature measurements represent actual conditions.

4.4 Project Records

EIDM will provide quarterly summary reports to the EHS – Environmental Programs Manager that contain information to evaluate the attainment of the Data Quality Objectives. Quarterly reports will be submitted within 45 days after the end of each monitoring quarter. Each report will be comprised of the following:

- Executive Summary,
- Hourly values for SO_2, in tabular and Excel format. Data is also provided using Air Vision data ,acquisition system supplying data in prescribed AQS format as specified by NCDEQ,
- 5-minute data (special format to go into AQS as specified by NCDEQ,
- Highest 5-minute SO_2 concentration in each hour, in tabular and Excel format,
- 1 min SO2 data, accessible by NCDEQ via Air Vision data acquisition system,
- Annual performance evaluation data (special format to go into AQS-example attached), also known as “audit” in prescribed AQS format as specified by NCDEQ,
- Hourly values for WS, WD in Excel format,
- Hourly values for shelter temperature,
- Frequency distribution plot (wind rose) of wind speed and wind direction,
- Frequency distribution plot (pollutant rose) of SO_2 concentrations and wind direction,
- Results of instrument QC checks, (daily and/or biweekly zero/ precision/ span checks - precision needs to be in a special format to go into AQS- format as specified by NCDEQ,)
- Explanation of corrective actions addressed during period,
- QA/QC and equipment maintenance documentation, and
- Monthly and cumulative data capture statistics by parameter.
- .

Other information required by NCDEQ includes the following:

- Certification for SO2 cylinders (every two years – it may have been extended or whenever replaced).
- Certification for calibrator (at least annually or whenever replaced).
- Any paper logs or electronic logs documenting activities.
- Documentation of zero air certification and/or maintenance.
- Monitor and calibrator instrumentation specifications (one-time per instrument).
- Annual documentation that the sample/probe line meets < 20 seconds residence time.
- Annual documentation that the site meets Appendix E siting requirements.
- Semi-annual documentation of shelter temperature probe audit.
- Documentation of probe material, length, height (when installed and replaced).
- Quality assurance project plan (at start of project) including standard operating procedures.

In addition, EIDM will prepare and provide EHS- Environmental Programs a final summary report following completion of the monitoring program. The contents of the reports are discussed in greater detail in Section 17 of this QAPP.

5 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

5.1 Data Quality Objectives (DQOs)

This section provides a description of the data quality objectives (DQOs) for the Semora Station Monitoring Program. Data quality objectives are qualitative and quantitative statements that:

- Clarify the intended use of the data,
- Define the type of data needed, and
- Specify the tolerable limits on the probability of making a decision error due to uncertainty in the data.

5.1.1 DQO Process

The Data Quality Objectives (DQOs) of this project are designed to provide valid data that satisfy the regulating authority's requirements for ambient air quality. Monitoring is performed in accordance with EIDM Standard Operating Procedures (SOPs) and EPA regulations and guidance documents.

The Semora Monitoring Program is designed to achieve program DQOs and meet or exceed the minimum standard requirements for field monitoring and analytical methods. The overall QA objective is to develop and implement procedures for continuous air quality and meteorological monitoring, data validation and reporting which will provide results that are scientifically valid, and the levels of which are sufficient to meet program DQOs.

5.1.2 Measurement Quality Objectives (MQOs)

Measurement Quality Objectives (MQOs) are designed to evaluate and control various phases (monitoring, maintenance, and calibration) 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 agreement is calculated as either the range or as the standard deviation. This is the random component of error.
- *Bias* – the systematic or persistent distortion of a measurement process which causes error in one direction. Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.
- *Representativeness* – a qualitative term that expresses "the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition."
- *Completeness* – a measure of the amount of valid data needed to be obtained from a measurement system.
- *Comparability* – a qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made.

Table 5-1: Summary of Measurement Quality Objectives - Pollutant Parameters

Tables 5-1 and 5-2 summarize the MQOs for the pollutant monitors and the meteorological station, respectively.

1) Requirement (SO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- SO_2			
One Point QC Check Single analyzer	*1/ 2 weeks*	Warning limit: ≤ ±7% (percent difference) Control limit: ≤ ±10% (percent difference)	1 and 2) 40 CFR Part 58 App A Sec 3.1.1 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.5 QC Check Concentration range 0.005 and 0.08 ppm Relative to mean or median monitor concentrations
Zero/span check	1/ 2 weeks	Zero drift ≤ ± 1.5 ppb (24-hour) ≤ ± 2.5 ppb (>24hr-14 day) Span drift ≤ ± 10 %	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
Shelter Temperature Range	**Daily** (hourly values)	20 to 30° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
OPERATIONAL CRITERIA- SO_2			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/6 month	± 2° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	*Every site 1/year with an equal proportion of sites in each of the 4 quarters*	Percent difference of audit levels 3-10 ≤ ±15% Audit levels 1&2 ± 1.5 ppb difference or ±15%	1 and 2) 40 CFR Part 58 App A sec 3.1.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html
Federal Audits (NPAP)	100 percent of sites every 6 years; 20% of sites audited each year	Audit levels 1&2 ± 1.5 ppb difference; all other levels percent difference ± 15%	1) 40 CFR Part 58 App A sec 3.1.3 2) 40 CFR Part 58 App A sec 3.1.3.1 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving; When one-point QC check is > 7 % difference; 1/year if continuous zero/span performed daily	Criteria: Span 1&2 within ± 5 % of expected Span 3 within ± 3 ppb of expected NCore: Span 1&2 within ± 3 ppb of expected Span 3 within ± 2 ppb of expected Both: Zero within ± 1 ppb of expected	1) 40 CFR Part 50 App A-1 Section 4 2 and 3) Recommendation Multi-point calibration (0 and 3 upscale points)
Gaseous Standards	*All gas cylinders*	*NIST Traceable* *(e.g., EPA Protocol Gas)*	1) 40 CFR Part 50 App A-1 Section 4.1.6.1 2) NA Green book 3) 40 CFR Part 50 App A-1 Section 4.1.6.1 Producers must participate in Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A sec 2.6.1
Zero Air/ Zero Air Check	Chemicals changed 1/year NCore – certified 1/year & verified 1/6 months	Concentrations below LDL < 0.1 ppm aromatic hydrocarbons	1) 40 CFR Part 50 App A-1 Section 4.1.6.2 2) Recommendation 3) Recommendation and 40 CFR Part 50 App A-1 Section 4.1.6.2

Table 5-2: Summary of Measurement Quality Objectives - Pollutant Parameters (cont.)

1) Requirement (SO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
Gas Dilution Systems	1/year or after failure of 1 point QC check or performance evaluation	*Accuracy ± 2 %*	1) 40 CFR Part 50 App A-1sec 4.1.2 2) Recommendation 3) 40 CFR Part 50 App A-1 sec 4.1.2
Detection (FEM/FRMs)			
Noise	NA	*0.001 ppm (standard range)* *0.0005 ppm (lower range)*	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) NA 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	Verified by manufacturer at purchase	*0.002 ppm (standard range)* *0.001 ppm (lower range)*	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1
SYSTEMATIC CRITERIA- SO_2			
Sampler/Monitor	NA	*Meets requirements listed in FRM/FEM designation*	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	*All data*	*ppb (final units in AQS)*	1, 2 and 3) 40 CFR Part 50 App T Sec 2 (c)
Rounding convention for data reported to AQS	*All data*	*1 place after decimal with digits to right truncated*	1, 2 and 3) 40 CFR Part 50 App T Sec 2 (c)
Completeness	*1 hour standard*	*Hour – 75% of hour* *Day- 75% hourly concentrations* *Quarter- 75% complete days* *Years-4 complete quarters* *5-min value reported only for valid 5-min blocks*	1, 2 and 3) 40 CFR Part 50 App T Section 3 (b), (c) More details in CFR on acceptable completeness.
Sample Residence Time Verification	At installation	*< 20 seconds*	1) 40 CFR Part 58 App E, section 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E, section 9 (c)
Sample Probe, Inlet, Sampling train	*All sites*	*Borosilicate glass (e.g., Pyrex®) or Teflon®* (FEP and PFA have been accepted as equivalent material to Teflon.)	1, 2 and 3) 40 CFR Part 58 App E sec 9 (a) Replace 1 / 2 years; more frequently if pollutant load or contamination dictate
Siting	1/year	*Meets siting criteria or waiver documented*	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Precision(using 1-point QC checks)	*Calculated annually and as appropriate for design value estimates*	*90% CL CV ≤ 10%*	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.1.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.2
Bias (using 1-point QC checks)	*Calculated annually and as appropriate for design value estimates*	*95% CL ≤ ± 10%*	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.1.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.3

CL – Confidence Level
CV – Coefficient of Variation

Table 5-3: Meteorological Data Measurement Quality Objectives

Parameter	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Accuracy	Raw Collection Frequency	Data Completeness
Horizontal Wind Speed	Propeller Anemometer	m/sec	0.5 – 50.0	0.1	Hourly	±0.2 m/s ≤ 5 ±5 % > 5 m/s	1 minute	90%

Wind Direction	Vane anemometer	Degrees	0 – 360	1	Hourly	± 5 Degrees	1 minute	90%

5.2 Data Quality Assessment

Methods for calculating precision and bias are conducted following the procedures specified in Appendix A of 40 CFR Part 58 and guidance provided in the Quality Assurance Handbook for Air Pollutions Measurement Systems, Volume II (EPA-454/B-13-003 May, 2013). These procedures are summarized below.

5.2.1 Precision

Precision is the agreement among a set of replicate measurements without consideration of the "true" or accurate value: i.e., variability between measurements of the same material for the same analyte. Simply stated, precision is a measure of the variability of a measurement.

The precision of automated analyzers is evaluated by making multiple comparisons of the sample's known concentration against the instrument's response and calculating the upper bound of the coefficient of variation (CV).

5.2.2 Bias Estimate

For continuous gaseous pollutant measurements (SO_2), the bias estimate is calculated using the one-point QC checks as described in Section 3.1.1 of 40 CFR Part 58 Appendix A. The bias estimator is an upper bound on the mean absolute value of the percent differences calculated on a quarterly basis.

5.2.3 Completeness

The monitoring network will be operated to meet the valid data capture goal of 90% for pollutant and 90% for meteorological parameters.

6 SPECIAL TRAINING REQUIREMENT/CERTIFICATION

Appropriate training will be provided to employees supporting the Semora Station SO_2 and Meteorological Monitoring Program, commensurate with their duties. No special training or certifications are required for this monitoring project. Field technicians and scientists, data analysts and the QA manager are all either environmental scientists or science technicians with expertise in operation of monitoring instrumentation, data management and data QC procedures as they apply to meteorological and ambient air quality monitoring programs.

On-site personnel will receive training on station and instrumentation operation, maintenance and QC procedures. Additional training will be provided, as appropriate, throughout the entire term of the project as deemed necessary by the EIDM supervising scientist.

Documents relevant to adhering to this QAPP will be made available to all site personnel and located in the EHS Environmental Laboratory for accessibility. Such documents include, but are not limited to:

- Roxboro Station– Semora Monitoring Station Air Monitoring Plan,
- EIDM SOP's,
- Roxboro Station – Semora Monitoring Station Quality Assurance Project Plan,
- Instrument manuals, and
- Site specific safety assessments.

Most of the on-site activities described in this QAPP constitute routine sampling and analyses for which no special training requirements or certifications are needed. However, all EIDM staff working on-site will comply with the Duke Energy Health and Safety Handbook in effect at the time. All training requirements and records are maintained in the EIDM files (Learner Hall.) Information about the Learner Hall System is found in Appendix A (Training). Prior to the start of the on-site work, all field personnel will be given instruction specific to the project, covering the following areas:

- Organization and lines of communication and authority,
- Overview of the QAPP, including sample collection, handling, and labeling procedures,
- QA/QC requirements,
- Documentation requirements, and
- Health and safety requirements.

Instructions will be provided by the EIDM Supervising Scientist.

7 DOCUMENTATION AND RECORDS

Table 7-1 indicates the categories and types of records and documents which are kept relating to this project. Current copies of all documents are maintained at the specified locations. At the conclusion of the project, copies of documents will be archived at EIDM's laboratory in Huntersville, North Carolina for a period of not less than five years. Additional records produced during the period of operation conducted by TRC will be maintained at the TRC regional office in Gainesville, Florida. A summary of project documents are presented in Table 7-1.

Table 7-1: Project Documentation and Records

Record/Document Type		Location
Management & Organization	Correspondence	Project Files – HUNT/GNV
	Staff Training/Certifications	Project Files - HUNT/GNV
	Siting Criteria Checklists	Project Files - HUNT/GNV
Site Information	Site Maps and Photos	Project Files – HUNT, GNV & DSMS
	QAPP	Project Files – HUNT, GNV & DSMS
Field Operations	Standard Operating Procedures	Project Files – HUNT, GNV & DSMS
	Site Logbooks	Project Files - DSMS
	Quality control documents	Project Files - DSMS
	Data Entry Forms	Project Files - DSMS
	Standard/Calibration Certs.	Project Files – HUNT, GNV & DSMS
	Electronic Data	EIDM Central Server
Data Reporting	Annual data/summary reports	Project Files - HUNT/GNV
	Electronic format reports	EIDM Central Server
	QA Assessments and Reports	Project Files - HUNT/GNV
	Hardware and software manuals	Project Files - HUNT/GNV
Data Management	Data Validation Procedures	Project Files - HUNT/GNV
	Audit results	Project Files - HUNT/GNV
Quality Assurance	QA Assessments and Reports	Project Files - HUNT/GNV

HUNT – EIDM Huntersville, N.C. laboratory
GNV – TRC's Gainesville, FL office location
DSMS – Duke's Semora Monitoring Station
Note: Some electronic files from initial period of study maintained on TRC Central Server

Examples of quality assurance documents and forms are attached in B.

7.1 Data Reporting

The documents and records that will be produced during this air monitoring program include, but are not limited to, the following types:

- Interim progress reports,
- Quarterly data reports,
- Hourly and averages met data in Excel format and wind roses,
- Annual data reports,
- Revisions to this QAPP,
- Data entry forms, and
- Logbooks

Electronic site logs (PDF copies of the site paper logbooks) along with equipment certifications and maintenance records will be sent to NCDEQ quarterly.

Air Vision hourly polls will be posted automatically to the secure FTP site maintained by EIDM (https://sftp2.duke-energy.com/human.aspx). Password validation is required to access the site, and the password can be obtained by contacting the Air Vision data administrator. The password is changed every ninety days.

QA reports will be submitted to the EIDM Supervising Scientist to ensure that any problems identified during the sampling and analysis program are investigated and the proper corrective measures taken in response. The QA reports may include:

- Problems noted during data validation and assessment, and
- Significant QA/QC problems, recommended corrective actions, and the outcome of corrective actions.

QA reports will be prepared and submitted on an as-needed basis.

7.2 Documentation Control

All raw data required for calculations, the submissions to the NCDEQ, and QA/QC data shall be collected electronically or on data forms that are included in the field methods, see Section 10. All hardcopy information shall be filled out in indelible ink. Corrections shall be made by inserting one line through the incorrect entry, initialing and dating this correction, and placing the correct entry alongside the incorrect entry, if this can be accomplished legibly, or by providing the information on a new line if the above is not possible.

7.2.1 Logbooks

The field technician will be responsible for maintaining appropriate field logbooks, including paper bound notebooks as well as electronic notepad files. These logbooks will be uniquely numbered and associated solely with the Semora monitoring station. The logbooks will be used to record information about the site and routine operations.

7.2.2 Electronic Data Collection

Certain instruments can provide an automated means for collecting information that would otherwise be recorded on data entry forms. In order to reduce the potential for data entry errors, automated systems will be utilized where appropriate and will record the same information that would be recorded on data entry forms. In order to provide a backup, electronic copies of the automated data collected information will be stored on the local PC as well the server location initially at TRC's Gainesville, Florida office until turnover of the system to EIDM. Electronic copies will then be maintained on the central server located at the EIDM laboratory in Huntersville, North Carolina for the remainder of the study.

7.2.3 Data Entry Forms

Completion of data entry forms, associated with all routine environmental data operations are required, even with the field logbooks, to contain all appropriate and associated information required for the routine operation being performed. For example, when a multipoint calibration is performed, the data from the calibration must be entered in a calibration form as well as documented in the field logbook.

8 NETWORK DESCRIPTION

8.1 SAMPLING PROCESS DESIGN

Refer to Section 4 for the monitoring design of this project. This section discusses the areas being sampled, what is being tested, and frequency. The Air Monitoring Plan that will be prepared for this program goes into greater detail regarding the design of the monitoring system.

8.2 MONITORING METHODS AND REQUIREMENTS

8.2.1 Meteorological Data Collection

Horizontal wind speed and direction will be determined with an RM Young Wind Monitor AQ Model 05305. Met data will be recorded, calculated ($\sigma\theta$, σw and σE) and displayed using an RM Young Model 26800 translator. Horizontal wind sensors will be mounted on a tower at a height of 10 meters. All met data collected from this station will be polled by the central computer location on an hourly basis. Fifteen minute and hourly averaged data will be stored in separate data tables. Standard deviation of wind direction will be calculated following equation 9-9 of EPA QA Handbook Volume IV (EPA-454/B-08-002, March 2008).

8.2.2 Sulfur Dioxide Monitoring

Continuous monitoring of SO_2 concentrations will be conducted using a Thermo Environmental 43i-TLE UV Fluorescence SO_2 Analyzer. The 43i-TLE is designated as a Federal Equivalent Method (FEM), designation EQSA-0486-060. Federal Register: Vol. 51, page 12390, 04/10/1986.

The Thermo 43i-TLE SO_2 Analyzer has a lower detectable limit of 0.05 parts per billion (ppb) and will be operated on the 500 ppb range. The instrument’s internal data acquisition system will be configured to store 1-minute averages for SO_2 and hourly averaged diagnostic parameters (e.g. lamp intensity, sample flow, etc.).

Multipoint calibrations and daily calibration verifications will be performed using a Thermo Environmental 146i dilution calibrator and a 10 part per million (ppm) NIST traceable EPA Protocol 1 gas cylinder. This system combination will allow calibration gases to be accurately generated in the range of 10 to 500 ppb.

8.3 SITE OPERATION AND CONFIGURATION

EIDM personnel will visit this station as necessary to conduct routine operations as described above. This station will be powered by line voltage obtained from an adjacent source. All instrumentation will be housed within a new EKTO shelter equipped with an industrial heating and air conditioning system. The shelter will be a fixed, semi-permanent system. Normal spare parts and consumable items will be stored on-site for instrument maintenance.

8.4 SITE SELECTION AND SITING CRITERIA

The Semora monitoring location was selected in accordance with the criteria specified in 40 CFR Part 58, Appendix E. The monitoring shelter must be placed away from obstructions such as trees and tall fences in order to avoid their effects on airflow. To prevent sampling bias, airflow around the monitoring sampling probes must be representative of the general airflow in the area.

8.4.1 Probe Siting Criteria for Sulfur Dioxide Analyzer

Probe and monitoring path siting criteria for SO_2 shall adhere to the requirements listed in 40 CFR Part 58, Appendix E, as outlined below.

The SO_2 intake probe must be 2 to 15 meters (m) above the ground. The probe must be at least one meter away, both vertically and horizontally, from any supporting structure. The probe must have unrestricted airflow and be located away from obstacles. The distance from the obstacle to the probe must be at least twice the height that the obstacle protrudes above the probe. An exception to this requirement can be made for measurements taken in street canyons or at source-oriented sites where buildings and other structures are unavoidable. Trees can also act as obstructions in cases where they are located between the air pollutant sources or source areas and the monitoring site, and where the trees are of a sufficient height and leaf canopy density to interfere with the normal airflow around the probe. To reduce this possible interference/obstruction, the probe must be at least 10 meters or further from the drip line of trees. The distance shall be measured from the drip-line or outside edge of the crown, not the trunk. There should be no minor sources of SO_2 (coal or oil fired stoves or furnaces) within 100 m of the probe intake that could have a significant impact.

The sampler must have an unrestricted airflow in at least a 180^o arc around the sampler. The arc must include the predominant wind directions and any major sources in the area.

Approval of monitoring system installation is determined by NCDEQ in accordance with EPA criteria, and some discretion is allowed based on specific monitoring objectives (for example, in determining the best location for a source-oriented monitoring site). However, the Semora monitoring site was selected to meet the above criteria. The site offers an unobstructed airflow from the Roxboro Station. There are no nearby structures and the nearest trees are more than 20 meters away and downwind from the direction of the Roxboro Station to the monitoring site. Probe height is 12 feet above ground.

8.4.2 Meteorological Sensors

Instruments shall be mounted on booms at the top of, or projecting horizontally from, the tower. The booms shall be securely fastened to the tower and shall be strong enough so that they will not sway or vibrate in strong winds. Wind instruments shall be mounted on a boom so that the sensors are twice the maximum diameter or diagonal of the tower away from the tower. The boom shall project into the prevailing winds. Wind sensors shall be mounted on booms or cross arms so that a sensor's wake does not impact adjacent sensors. Usually, this means mounting the sensors a minimum of 2 meters apart. If the wind sensors are to be mounted on top of a tower, they shall be mounted at a height and distance from the tower so that the diagonal distance between the sensor and the tower is equal to twice the maximum diameter or diagonal of the tower.

8.4.2.1 *Towers*

The sensor should be securely mounted on a mast (tower or pole) that will not twist, rotate, or sway. The towers shall be of an open grid-type construction and designed so that they either tilt or can be cranked into place so that the sensors can be installed, serviced and audited from the ground so that the operator will not need to climb the tower. A tower must be rigid enough to maintain all mounted instruments in proper alignment and orientation in high winds.

When instruments are located on a cross arm projecting out from the tower, the cross arms shall be securely fastened to the tower and shall be strong enough so that the sensors do not sway or vibrate in high winds. The sensors shall be securely fastened to the cross arm at a distance of two tower diameters or widths, measured from the edge of the tower to the sensor, to avoid any influence of tower-induced turbulence on the sensors. The cross arm shall be installed so that it is horizontally level and the sensors shall be installed so that they are vertical. The cross arm shall be mounted and aligned so that the wind direction sensor is correctly aligned. (The correct alignment varies on a sensor-by-sensor basis. Consult the appropriate section of manufacturer's operator's manual for the correct alignment.)

8.4.2.2 *Wind Velocity Sensors*

Wind sensors are used to measure surface level winds, therefor sensors should be located on a 10-m tower in open terrain. Open terrain is defined as an area where the distance between the tower base and any obstruction is at least ten times the height of that obstruction above the instrument. This applies to manmade (buildings) and natural (trees, rocks, or hills) obstructions. All distances are to be measured from the edge of the obstruction nearest the tower. Trees and shrubs shall be measured from the outside edge of the crown or drip-line, and not the trunk.

9 SAMPLING METHODS REQUIREMENTS

The purpose of this section is to:

- Identify the sampling methods,
- Identify the procedures for collecting the required environmental samples,
- Describe the:
  - Equipment used in the data collection network,
  - Necessary support facilities,
  - Sample preservation requirements,
  - Implementation requirements,
  - Required materials, and
  - Processes for preparing and decontaminating sampling equipment.
- Identify the:
  - Corrective actions necessary to reestablish network data integrity,
  - Responsible parties to implement the corrective actions, and
  - Methods required to verify corrective action effectiveness.

9.1 Sulfur Dioxide Monitoring Technology/Methodology

The physical principle used in SO_2 molecule measurement relies on exciting an electron shell, which occurs in the presence of a specific wavelength (214 nanometers [nm]) of ultraviolet (UV) radiation, and the subsequent relaxation, which produces a photon of light. A photo multiplier tube measures light emissions as the SO_2 molecule returns to the ground state. The intensity of this light is proportional to the quantity of SO_2 present in the sample. A reference detector continuously monitors the intensity of the UV lamp used to excite the SO_2, and allows use of a ratiometric measurement technique that compensates for lamp degradation. A hydrocarbon scrubbing system containing no consumable material removes interfering hydrocarbons prior to the ambient sample entering the measurement chamber.

9.2 Meteorological Monitoring Technology/Methodology

Wind speed and wind direction will be measured by a mechanical “prop vane” style sensor mounted at 10 meters on a hinged-base tower. The wind speed is determined by the spinning of a four blade helicoid propeller shaft generating a pulse signal detected by a transducer and measured by a translator/data logger. The wind direction sensor is a durable molded vane. Vane angle is sensed by a precision potentiometer housed in a sealed chamber and its signals transmitted to the same translator/data logger.

9.3 Methodology for the Collection of Electronic Data

Electronic data collection is possible through the network's data loggers and modems. This equipment is located in the shelter where the data loggers record the data history and the modems provide a path to download and transmit the data for analysis.

Data acquisition will be accomplished using an Environmental Systems Corporation 8832 data logger (or equivalent.) A Lenovo ThinkPad PC (X-140e or equivalent) configured with a solid-state hard drive running TRC’s data acquisition software (TRC_Logger) will provide data acquisition during the initial phase of operation until turnover is complete to EIDM. At that point, the Lenovo system will continue as a backup data acquisition system. All data are acquired digitally from the instruments. Meteorological sensors are interfaced using a R. M. Young Company (Young) 26800 Programmable Translator. The 26800 performs analog to digital conversion and meteorological calculations. TRC_Logger polls the 26800 over a serial interface on a 15-minute basis. The Environmental Systems data logger will be polled hourly by the EIDM central computer using Agilaire Air Vision software. The data acquisition system will store data in a local database and transmit measurements to TRC's SQL database or the Air Vision central computer via a 4G cellular modem.

9.4 Support Facilities

9.4.1 Monitoring Station Design

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.

9.4.2 Shelter Criteria

An 8' x 6' x 6' walk-in style shelter (EKTO model 866 Special) equipped with an instrument rack, work bench, roof rails and tower mount, will house the air monitoring instrumentation, with the exception of meteorological sensors. This shelter is capable of fulfilling the following requirements:

- The shelter temperature must be maintained between 20º and 30ºC,
- The power supply should not vary more than ± 10% from 117 Alternating Current Voltage (VAC),
- The shelter must protect the instrumentation from precipitation and excessive dust and dirt, provide third wire grounding, meet federal Occupational Safety and Health Administration (OSHA) regulations and be cleaned regularly to prevent a buildup of dust, and
- The shelter must protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light, or radiation.

The SO_2 analyzer will draw outside air, through a single sample line, from the probe inlet. The inlet system will be made of Teflon®, which is nonreactive. Additionally, the probe must prevent rainwater from entering the analyzers.

9.5 Sample Collection

Continuous monitoring of SO_2 concentrations will be conducted using a Thermo Environmental 43i-TLE UV Fluorescence SO_2 Analyzer. The Thermo 43i-TLE SO2 Analyzer has a lower detectable limit of 0.05 parts per billion (ppb) and will be operated on the 500 ppb range. The instrument's internal data acquisition system (DAS) will be configured to store 1-minute averages for SO_2 and hourly averaged diagnostic parameters (e.g. lamp intensity, sample flow, etc.).

Wind speed and wind direction will be measured with an R.M. Young Model 05305 meteorological sensor at a height of 10 m. All instrumentation specifications will meet the measurement quality objectives (MQO) and accuracy requirements for prevention of significant deterioration (PSD) meteorological monitoring instrumentation presented in Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final), EPA-454/B-08-002, March 2008 (QA Handbook Volume IV).

9.6 Sampling/Measurement System Corrective Action

Corrective action measures in the Ambient Air Quality Monitoring Network will be taken to ensure 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.

9.7 Analyzer Audits

Audits 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-454/B-13-003, May 2013). For each parameter and sampler type, audit procedures are performed following the procedures defined by the approved standard operating procedure.

10 QUALITY CONTROL REQUIREMENTS AND PROCEDURES

To assure the quality of data from air monitoring measurements, two distinct and important interrelated functions must be performed. One function is the control of the measurement process through broad QA activities, such as establishing policies and procedures, developing DQOs, assigning roles and responsibilities, conducting oversight and reviews, and implementing corrective actions. The other function is the control of the measurement process through the implementation of specific quality control procedures, such as audits, calibrations, checks, replicates, routine self-assessments, etc.

QC, as it applies to an air quality monitoring program, is the overall system of technical activities and procedures developed to measure the attributes and performance of the sampling program against defined standards to verify that they meet the stated requirements established by the program. Quality control includes:

- Establishing specifications or acceptance criteria for each quality characteristic of the monitoring/analytical process,
- Assessing procedures used in the monitoring/analytical process to determine conformance to these specifications, and
- Taking any necessary corrective actions to bring them into conformance.

The overall goal of QC is to minimize loss of data through invalidation by establishing a reasonable level of checking at various stages of the data collection process. QC procedures determine if field and lab procedures are producing acceptable data and are used to initiate appropriate corrective actions; therefore QC is both proactive and corrective.

Initially, TRC will have primary responsibility for implementation of all monitoring program QC measures. After turnover of the system, EIDM will continue implementation of all QC measures following protocol established during the initial monitoring period by TRC. The following is a summary of QC activities that will be implemented to ensure that measurement uncertainty is maintained within established acceptance criteria for the attainment of the program DQOs. QC activities will include, but not be limited to, the following:

Sulfur Dioxide

- Daily automated calibration checks (zero/span and precision),
- Daily review of instrument measurements and diagnostics,
- Semiannual multipoint calibrations or as needed,
- Monthly operational checks by site operator,
- Routine maintenance as specified in TRC's Standard Operating Procedure (SOP), and
- Performance audits by NCDEQ, as determined by their schedule.

Meteorological Measurements

- Semiannual calibrations,
- Monthly on-site reasonableness checks by site operator,
- Verification that wind sensors are operational and show no sign of damage,

- Wind speed, direction and shelter temperature measurements represent actual conditions, and
- The initial audit will be performed within 60 days of the start-up date of the monitoring program, and
- Performance audits by NCDEQ, as determined by their schedule.

Detailed Measurement Quality Objectives (MQO's) have been developed for each criteria pollutant and are incorporated into Validation Templates.

Routine field activities for each measurement system are conducted according to the schedule in Table 10-1. Refer to the identified TRC SOPs for detailed procedures.

Table 10-1: Scheduled Field Activities

Field Activity	Every Visit	Daily	Monthly	Quarterly	Semi-Annually	Annually
Communication with Supervising Scientist	X		X			
Change inlet filter	X		X			
Verify Instrument/Sensor	X		X			
Inspect/Clean or Replace sample tubing/filter	X		X			
Replace sample tubing						X
Visually Inspect Meteorological sensors/cables	X		X			
Site operator checks/inspections, logbook	X		X			
Calibration verification checks (automated)		X				
Perform & record analyzer calibrations.					X	
Perform & record meteorological calibrations.					X	
Audit pollutant analyzers (independent)						X
Met systems Audit					X	
Certify SO_2 tank					X	
Certify SO_2 dilution calibrator					X	
Ship documentation to Env. Programs				X		

10.1 Calibrations

Calibration is the process employed to verify and rectify an instrument's measurements in order to minimize deviation from a standard. This multiphase process begins with certifying a calibration or transfer standard against an authoritative standard. The analytical instrument's measurements are then compared to this calibration/transfer standard. If significant deviations exist between the instrument's measurements and the calibration/transfer standard's measurements, corrective action is implemented to rectify the analytical instrument's measurements.

Calibration requirements for the critical field and laboratory equipment are found in the SOPs and in the specific instruments' operations manuals.

A calibration is required:

- At the initial station start-up,
- If the monitor is replaced,
- If repairs to any of the measurement components of the monitor are performed,
- When two consecutive daily auto-calibration check results fail to meet acceptance criteria,
- When the operation is interrupted for more than 2 days without power (such as in the case with Extended weather related power outage or shelter repairs), and
- At a minimum of once per year per EPA guidance.

10.2 Precision Checks

Precision is the measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. In order to meet the DQOs for precision, TRC will ensure the entire measurement process is within statistical control. Various tools will be employed in evaluating and monitoring precision measurements. Daily one point calibration verification checks and monitoring data integrity with control charts will provide evidence of deviations from the required precision measurement. Precision requirements for the applicable instrumentation are found in the SOPs and in the specific instruments' operations manuals.

10.3 Accuracy or Bias Checks

Accuracy is defined as the degree of agreement between an observed value and an accepted reference value. Accuracy is a combination of random error (precision), and systematic error (bias). Weekly zero and span checks can also provide data capable of identifying bias. Accuracy or bias requirements for various types of instrumentation are found in the SOPs and in the specific instruments' operations manuals.

11 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

All monitoring equipment will be tested during the pre-operational phase of the program. All instruments and sensors will receive a cursory calibration check to verify operation prior to deployment. All calibration standards will be inspected for current calibrations and traceability to NIST or the appropriate authority.

The following is a summary of activities and procedures TRC will follow to ensure all instrumentation and equipment will operate at acceptable performance levels throughout the duration of the program.

- SO_2
    - Daily review of instrument measurements and diagnostics,
    - Monthly operational checks by site operator, and
    - Routine maintenance as specified in EIDM Standard Operating Procedures (SOPs), and
    - Periodic performance audits by NCDEQ.

- Meteorological Measurements
    - Daily review of incoming data, and comparison to local NWS/NOAA data,
    - Monthly reasonableness checks by site operator
        - Verification that wind sensors are operational and show no sign of damage,
        - Wind speed, wind direction and temperature measurements represent actual conditions,
    - The initial audit will be performed within 60 days of the start-up date of the monitoring program,
    - Semi-annual performance audits, and
    - Routine maintenance as specified in EIDM SOPs.

Documentation of all site activities will be provided through the use of multiple forms including the site log books, site visit check sheets, maintenance and repair activities as well as calibration records. Inventory of spare parts and a schedule of routine activities will be maintained at the station. Copies of these forms are included in the appropriate EIDM SOP.

Table 11-1 presents an inventory of spare parts and expendable items that will be maintained on site for the duration of this monitoring program.

Table 11-1: Inventory of Spare Parts and Expendables	
Item	**Inventory at Site**
R.M. Young Wind Monitor - Complete	1
Prop for Vertical Wind Speed	1
43i-TLE Expendables Kits, 1 Year Supply	1
111 Zero Air Expendables, 1 Year Supply	1

12 INSTRUMENT CALIBRATION AND FREQUENCY

- SO_2
    - Daily automated calibration checks (zero/span and precision point in the range of 10-500 ppb), and
    - Semiannual multipoint calibrations, or as needed.

- Meteorological Measurements
    - Initial calibrations upon mobilization and installation, and
    - Semiannual calibrations.

Calibrations will be performed initially according to TRC SOPs. Following turnover, calibrations will be performed according to EIDM SOPs. All calibration equipment, including calibration gases, will be in current certification and traceable to the National Institute of Standards and Technology (NIST) or the appropriate authoritative standard. Hardcopy certification records will be maintained at the site location and in TRC's Gainesville office for the initial operating period until turnover and in the EIDM Huntersville laboratory for the remainder of the study. Electronic copies will be stored and backed-up on a central TRC server for the initial operating period until turnover and in the EIDM Huntersville central server for the remainder of the study. Calibrations and certifications will be performed by trained and experienced field scientists and technicians. Calibration equipment, as required, will be sent to the manufacturer or a facility equipped and qualified to perform traceable calibrations.

Calibrations and calibration checks will be performed according to the schedule in Table 4-4.

13 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES

TRC has installed new equipment purchased by Duke Energy for this project to minimize the potential for instrument failure and data loss. In addition, consumables and spare parts for a minimum of 13 months have been purchased for this monitoring location. These parts and consumables were obtained from the original equipment manufacturer and will be located at the site. The EIDM site operator will be responsible for maintaining an inventory of these items. In the event additional parts or supplies are needed, they will be procured from the instrument manufacturer through EIDM’s Huntersville, North Carolina laboratory where they will be inspected prior to deployment. On a monthly basis, the local site operator will communicate to the project manager the status of all spare parts and consumable items. The site operator, or an individual designated by the EIDM Supervising Scientist will be responsible for ordering all parts, supplies and materials, as required, to meet the requirements of this program. The site operator will also be responsible for ensuring that these parts and supplies meet the specifications of the instrument manufacturer allowing all instrumentation to be operated in compliance with this QAPP.

14 DATA MANAGEMENT

Data management involves the collection, storage, transmittal, validation, reporting and archiving of measurements taken from continuous and time integrated samplers, sensors and instruments. The primary data collection system will initially be comprised of an on-site PC running software developed to acquire data digitally from the instrumentation operating at the monitoring station. Following turnover of the system from TRC to EIDM, the primary system will be an Environmental Systems Corporation 8832 data logger (or the equivalent) polled by a central server running Agilaire Air Vision data acquisition software. All continuous measurement instrumentation has built in data averaging and storage capabilities, as well as the ability to transmit those data digitally (e.g. USB, RS-485 or LAN interface). The data acquisition software (DAS) requests data from the instruments and populates a locally stored database containing multiple averaging intervals of each parameter. This database is the primary source of data.

During the initial operation by TRC, at 5-minute intervals, data are transferred via TCP/IP to a central server hosted by TRCAir.com. This server maintains TRC's central air monitoring database and hosts a limited access/secure website to allow for data display, review and editing. Software running on the central server performs a diagnostic check on incoming data and generates error reports based on screening criteria. These reports are emailed to project personnel. For QC purposes, data will also be stored on a local USB memory device and transferred to TRC's central server.
During the subsequent operating period by EIDM, the Air Vision central server will poll the Environmental Systems Corporation data logger on an hourly basis to retrieve 1-minute, 5-minute and hourly averages. The 5-minute average data will be posted to a secure FTP site by the Air Vision software for access by NCDEQ. All data will be maintained on the central server, and hourly data will be transferred to a historical SQL archive for backup and long-term storage.

The data technician and the site operator will review measurement data on a daily basis as a first level of validation. If any data are determined to be missing, the DAS software will attempt to retrieve these data from the instruments and place them in the local database. These values will be transferred to and populated in the central server. In the event data are not retrieved automatically, the data technician can connect to the instrument directly, retrieve data manually and load those data in to the central database.

The central database is structured with duplicate tables. The original data tables are protected, so they cannot be altered. A duplicate set of tables are identified as 'edited.' All data validation activities are stored in the edited tables.

Review and validation activities will be documented to ensure integrity and traceability of the measurement data. Edits will be independently verified by the data manager, the Supervising Scientist or other project staff. Status codes will be entered into the database indicating the action taken and validity of the datum.

Hard copy data (station logs, QC checks sheets, etc.) will be sent to the Gainesville office on a monthly basis during the initial operation period. Following turnover to EIDM, the hard copy records will be transferred to the EIDM Huntersville laboratory. Site documentation will be reviewed as part of the data validation process.

All data management activities will be performed in a manner consistent with TRC and EIDM SOPs, as applicable.

15 ASSESSMENTS AND OVERSIGHT

15.1 ASSESSMENTS AND RESPONSE ACTIONS

Assessment activities take place throughout the project to ensure that the QAPP is being implemented as approved.

15.1.1 Performance Audits

Performance audits, while intended to determine data accuracy, are also used to ensure that other aspects of the QAPP are being implemented. These audits will be conducted by an independent audit team, in the actual field location. The test equipment and standards used for the audit will be independent of those used for field operations. The audit equipment will also be documented and traceable to applicable standards. Performance audits will be performed by NCDEQ as determined by the agency's schedule. . EPA Appendix D, page 5 specifies annual performance audits.

15.1.1.1 *Meteorological Sensors*

Audits of the meteorological data collection systems will be conducted in accordance with the 2008 version of the US EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV - Meteorological Measurements* and *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/B-08-002). The initial audit will be performed within 60 days of the start-up date of the monitoring program. Follow-up audits will be conducted at six-month intervals.

Acceptable limits of accuracy for the meteorological sensors are identified in Table 15-1. In the event that any of the limits are exceeded calibration checks will be performed immediately after the audit.

Table 15-1: Calibration and Accuracy Criteria – Meteorological Measurements

Measurement	Calibration			Accuracy		
	Type	**Acceptance Criteria**	**Frequency**	**Type**	**Acceptance Criteria**	**Frequency**
Horizontal Wind Speed	NIST-traceable Synchronous Motor	±0.25 m/s < 5 m/s, ±5%. 5 m/s not to exceed 2.5m/s	Semi-Annual	NIST-traceable Synchronous Motor	±0.25 m/s < 5 m/s, ±5%. 5 m/s not to exceed 2.5m/s	Within 60 days of startup and semi-annually
Wind Direction	Magnetic Compass or GPS	±5 degrees Including orientation	Semi-Annual	Magnetic Compass or GPS	±5 degrees including orientation	Within 60 days of startup and

		error			error	semi-annually

Note: Threshold sensitivity for wind speed is 0.5 m/s (1.0 mph). Threshold sensitivity for wind direction is 0.5 m/s (1.0 mph) at 10°displacement, 0.7 m/s (1.6 mph) at 5° displacement.

15.1.1.2 *Air Quality Analyzers*

Audits of the continuous SO_2 data collection system will be conducted in accordance with the schedule presented in Table 15-2. Audits will be conducted in accordance with the 2013 version of USEPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II – Ambient Air Quality Monitoring Program* (EPA-454/B-13-003).

Table 15-2: Audit Schedule

Table 15-3: Accuracy Limits and Validation Criteria for Pollutant Measurements

Parameter	Criteria	Samples Evaluated	Acceptable Range	Frequency of	Reference
SO_2	3 consecutive audit levels	Test atmosphere generated from Certified Standard	≤15% difference for each audit level	Annually	40 CFR 58 App. A Section 3.1.2

Performance Audit Schedule	**Parameters to be Audited**
60 days after startup	SO_2 Analyzer, DAS
Performed by NCDEQ, as needed - EPA specifies annual	SO_2 Analyzer, DAS

Acceptable limits of accuracy for air quality instruments are identified in Table 15-3. In the event that any of the limits are exceeded calibration checks will be performed immediately after the audit.

SO_2 analyzers will be audited by introducing three known concentrations through as much of the inlet system as practicable. Audit procedures will be conducted in accordance with 40 CFR 58, Appendix A requirements at concentration levels specified in this part and Table 15-4. Audit concentration levels will be selected based on the ambient concentrations expected at this location. The instrument responses compared to the known input concentrations of the audit gases, as a percent difference, will be used to assess accuracy of the measurement data. The percent difference (d_i) is calculated as:

$$d_i = (\text{measured-audit})/\text{audit} \times 100$$

Table 15-4: SO_2 Audit Levels – 40 CFR 58 App. A 3.1.2.1	
Audit Level	**Concentration Range (ppb)**
1	0.3 – 2.9
2	3.0 – 4.9
3	5.0 – 7.9
4	8.0 – 19.9
5	20.0 – 49.9
6	50.0 – 99.9
7	100.0 – 149.9
8	150.0 – 259.9
9	260.0 – 799.9
10	800.0 – 1000.0

For the Semora monitor, the audit levels for SO2 will be 0, 2.9, 18, and 70 ppb as specified by NCDEQ, which meets the above criteria.

All data used for the assessment of measurement accuracy will be submitted quarterly as specified in 40 CFR 58, Appendix A section 5.1.1.

15.1.2 Technical System Audits

A system audit of field activities including sampling and field measurements may be conducted and documented by the TRC Project QA Officer (or NCDEQ) at the start of sampling. The purpose of this audit is to verify that all established procedures are being followed as planned and documented and to allow for timely corrective action, reducing the impact of any nonconformance. The audit will ensure that all personnel have read the QAPP. The audit will cover field sampling records, field measurement results, field instrument operation and calibration records, sample collection, preservation, handling, and packaging procedures, adherence to QA procedures, personnel training, sampling procedures, review of sampling design versus the sampling plan, and corrective action procedures, etc. Follow-up surveillance will be conducted by the TRC Field Operations Manager to verify that QA procedures are maintained throughout the investigation.

Prior to performing the audit, the auditor will review the QAPP and assure that the audit equipment is certified and is up to date with calibrations.

Upon completion of the audit, the TRC Project QA Officer will prepare a written audit report, which summarizes the audit findings, identifies deficiencies and recommends corrective actions. In addition, a verbal debriefing will also be given to the TRC Field Operations Manager and TRC Project Manager at the time of the audit. The written report will be submitted to the TRC Project Manager, who will be responsible for ensuring that corrective measures are implemented.

A field system audit will be conducted by TRC personnel at the time of turnover to EIDM. EIDM will participate in the field system audit as observers. For the turnover, a system calibration check of all instrumentation will be performed to ensure proper operation at the time of transfer.

15.1.3 Field Systems Audit

The following tasks will be performed during the audit:

Station Location:

- Instrument shelter and surrounding area inspections,
- Inventory of air monitoring equipment,
- Review of calibration records – NIST traceable,
- Review SOPs – ensure they are being followed,
- Review site logs and documentation – ensure procedures are followed, and
- Ensure site personnel are knowledgeable about the project and procedures by interviews.

Meteorological Instruments (semi-annual):

- Ensure heights and exposures are in accordance with USEPA regulations, and
- Check for accuracy of sensors as required by manufacturer as well as USEPA regulations.

Air Quality Instruments and Inlet (quarterly):

- Ensure inlet heights and exposures are in accordance with USEPA regulations
- Visually inspect sampling lines
- Manually calculate flow rates, if possible. Ensure flow rates meets guidelines, and
- Review documentation to ensure instruments meet Federal Reference Methods equivalent specifications.

15.1.4 Data Quality Systems Audits

The data quality audit will consist of an evaluation of the project management organization, field operations, personnel qualifications and training, data management and processing procedures, QA program, and data reporting methods. The intent of the data quality audit is to ensure traceability of data from point of collection to reporting.

15.1.5 Regulatory Audits

The state regulatory agency may choose to perform a systems audit, which would provide an assessment of adherence to the QAPP. The Duke Energy Environmental Supervisor will coordinate access to the sites for any audits needed.

15.1.6 QAPP Revisions

It may be necessary for sections of this QAPP to be updated in the event that: additional information is received; changes in any system or procedure; changes in conditions at the site. Any revisions to this QAPP will be made by a written and approved amendment, which will become a permanent part of this plan.

15.1.7 Field Non-Conformances

Corrective action in the field may be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the QAPP), or when sampling procedures and/or field procedures require modification, etc. due to unexpected conditions. The field team may identify the need for corrective action. The TRC Operations and Data Manager will approve the corrective action and notify the TRC Project Manager and TRC QA Officer. The TRC Project Manager, in consultation with the NCDEQ, if necessary, will approve the corrective action. The TRC Operations and Data Manager will ensure that the corrective action is implemented by the field team. Following turnover of the system to EIDM, the field team will identify the need for corrective actions to the EIDM Supervising Scientist. Corrective actions will be documented within the EHS Etrac documentation system. Corrective actions will be communicated to the EHS Environmental Programs Project Manager and to NCDEQ. The EIDM Supervising Scientist will ensure that the corrective action is implemented and results are documented within Etrac.
Corrective actions will be implemented and documented in the field logbook. Documentation will include:

- A description of the circumstances that initiated the corrective action,
- The action taken in response,
- The final resolution, and
- Any necessary approvals.

No staff member will initiate corrective action without prior communication of findings through the proper channels as described above. All corrective actions will take into account the possible effect on the data. If necessary, a problem resolution audit will be conducted. Corrective actions will be described in the quarterly reports.

16 REPORTS TO MANAGEMENT

16.1 Performance and Technical Systems Audit Reports

Performance audits will be conducted of the ambient air monitors and the meteorological sensors by NCDEQ, as needed. The initial audit of the station will be performed within 60 days of the start-up date of the monitoring program.

16.2 Quarterly Data Reports

The Duke Energy Environmental Programs Project Manager is routinely kept informed of project oversight and assessment activities and findings via meetings with the TRC project manager or the EIDM Supervising Scientist. Additionally, the Project Manager receives the quarterly report, which contains the following elements: quarterly data summary including any violation of standards, completeness achieved, explanation of any missing or invalidated data, hourly pollutant and calibration and audit forms. The TRC Data Manager is initially responsible for compiling the quarterly report. Following turnover, the EIDM Supervising Scientist will compile the quarterly report. Quarterly electronic data submittals will include pollutant concentrations along with measurement quality checks (as specified in section 1.4 of 40 CFR 58, App. A).

Each quarterly report will be comprised of the following:

- Executive Summary,
- 5-minute and hourly values for SO_2,
- Highest 5-minute SO_2 concentration in each hour,
- Hourly values for WS, WD in Excel format,
- Frequency distribution plot (wind rose) of wind speed and wind direction,
- Frequency distribution plot (pollutant rose) of SO_2 concentrations and wind direction,
- Results of instrument QC checks,
- Explanation of corrective actions addressed during period,
- QA/QC and equipment maintenance documentation, and
- Quarterly and cumulative data capture statistics by parameter.

After internal approval, the report is forwarded to the Duke Energy Environmental Programs Project Manager, who is responsible for submitting the information to NCDEQ with the appropriate certification form. The reports are to be submitted to NCDEQ within 45 days of the end of each monitoring quarter.

16.3 Corrective Action Reports

The need for corrective action may be identified during audits, data validation, or data assessment. Potential types of corrective action may include data qualification. These actions are dependent upon whether the data to be collected is necessary to meet the required QA objectives. If the data validator or data assessor identifies a corrective action situation, the TRC Project Manager or EIDM Supervising Scientist will be responsible for informing the appropriate personnel. All corrective actions of this type will be documented by the TRC Project Manager or EIDM Supervising Scientist and maintained in the project files.

17 DATA VALIDATION AND USABILITY

17.1 DATA REVIEW, VERIFICATION AND VALIDATION

Data review, validation and verification procedures are used to accept, reject or qualify air quality and meteorological measurement data in an objective and consistent manner. Criteria used to review and validate measurement data are defined in this section. Ambient air quality data will be validated, invalidated or qualified by comparing measurements with criteria established in the Data Validation Tables as presented in EPA QA Handbook Volume II, Appendix D. These tables and be found here: http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/appd_validation_template_amtic.pdf and presented in Appendix B. These tables establish three levels of criteria where each table has a different degree of implication about the quality of the data. Criteria that are deemed **Critical** to maintaining the data integrity are shown in the first section of the tables. Observations that do not meet all criterion on the Critical Criteria Table should be invalidated unless there are compelling reason and justification otherwise. Criteria that are important for maintaining and evaluating data quality are included in the second section of the table. Violation of an **Operational** criterion or a number of operational criteria may be cause for invalidation. Detailed review of quality control results and operational information may or may not indicate data are acceptable for the parameter being evaluated. If one or more of these criteria are not met data are considered suspect unless other quality control information demonstrates otherwise. **Systematic** criteria which are important for the correct interpretation of the data but may not impact the validity are shown in the third section of the Tables.

Meteorological data will be evaluated based on the results of calibration criteria previously presented in Table 15-1.

Overall, in order for data to be considered valid, each data point must be identifiable in terms of parameter, date, time and units. Instruments and sensors must be calibrated and operated according to applicable EIDM and TRC SOP's and must be bracketed by acceptable calibrations, QC checks and audits to support determination of validity. All documentation, including site logs, check lists and maintenance records must be sufficient to support validity of the data.

17.2 VALIDATION AND VERIFICATION METHODS

Verification can be defined as confirmation that specified operational requirements have been fulfilled by providing objective evidence. Data verification involves the inspection, analysis, and acceptance of measurement data or samples. Data validation is a routine process designed to ensure that reported values meet the DQOs of the measurement program. The data validation process should examination the collected evidence, in the form QC data and operation documentation, to determine if measurement data meets the requirements for the specific intended use. The purpose of data validation is to detect and then verify any data values that may not represent actual air quality conditions at the sampling station.

17.2.1 Data Validation Process

TRC and EIDM will employ a 3 tiered approach to data validation; Level 0, Preliminary (sometimes referred to as Level 1) and Final (Level 2). This process will assure that data collected for this air quality monitoring program are of sufficient quality to meet the project objectives. Records of QC activities, to be described in the QAPP, will be reviewed on an on-going basis and used for determination of data validity. Calibrations, flow audits, automated QC checks, sample data sheets and operator log entries will also be used in the validation process. Daily review will be conducted by staff in Gainesville, FL. or by EIDM staff in Huntersville, N.C. during the respective periods of operation. Visual data inspection as well as results of screening software will be used for validation on a daily basis. The following is an overview of TRC's and EIDM's data validation process:

Level 0 Validation (Daily)

- Review for completeness and acquire missing data if available,
- Review for anomalies and reasonableness,
- Visually review graphed data, and
- Evaluate automated QC checks (zero/span/precision, etc.).

Preliminary Validation (Level 1)

- Review site records (i.e. operator logbook and sample data sheets),
- Review operator QC checks (i.e. sampler flow rate checks),
- Evaluate any noted anomalies to other data sources (i.e. meteorological conditions compared to nearest National Weather Station (NWS) or other verifiable measurements),
- Review instrument calibration records,
- Review performance audit results, and
- Edit/enter validation codes.

Final (Level 2) Validation

Data are considered final when it can be demonstrated that they meet the data quality objectives of the program and are a true representation of the air quality and meteorological conditions in the region. Data must pass Final Validation criteria before submittal to NCDEQ. Activities for Final Validation include:

- Generation of monthly data summaries,
- Review of monthly data by TRC Program Manager, Operation and Data Manager and TRC QA Manager during initial operation, and EIDM Supervising Scientist following system turnover,
- Resolution of any inconsistencies, and
- Update validation codes to final.

17.3 RECONCILIATION WITH USER REQUIREMENTS

The objectives of this monitoring program are described in Section 2.1. TRC and Duke have established this air monitoring program to measure the levels of gaseous pollution. Sulfur dioxide and meteorological monitoring systems are installed to provide scientifically defensible air quality data to characterize the extent, frequency of occurrence, and magnitude of pollutant concentrations in the region. Data are expected to provide a true representation of air quality in the vicinity.

EIDM will conduct quarterly and annual review of the monitoring program to ensure all data considered valid meet the defined network acceptance criteria and monitoring objectives by verifying that quality assurance procedures and documentation are reviewed and evaluated in the data validation process. Performance audits, calibrations, automated and manual precision and accuracy tests, technical systems audits, as well as all other methods used to ensure data quality are considered as part of this review. If, at any time, the review process indicates objectives of the monitoring program are not being met, the project and QA managers will reassess this QAPP.

APPENDIX A

Standard Operating Procedures (SOPs)

TRC Standard Operating Procedures (SOPs)

AM 050 Routine Station Check of Ambient Air Quality Station

AM 100-03 Thermo Scientific Model 43C, 43i Operations and Maintenance

Duke Energy EIDM Standard Operating Procedures (SOPs)

7404 Data Validation Procedure for Ambient Air Quality, Ambient Water Quality and Meteorological Data

7830 Environmental Systems Corp. (ESC) 8832 Data Logger Calibration Procedure for SO2 Sites

7831 Air Vision Setup; Retrieval, Review, Correction and Storage of Data; Report Submission

7832 Manual Calibration Check Procedure

7833 Ambient Air Quality Site Check

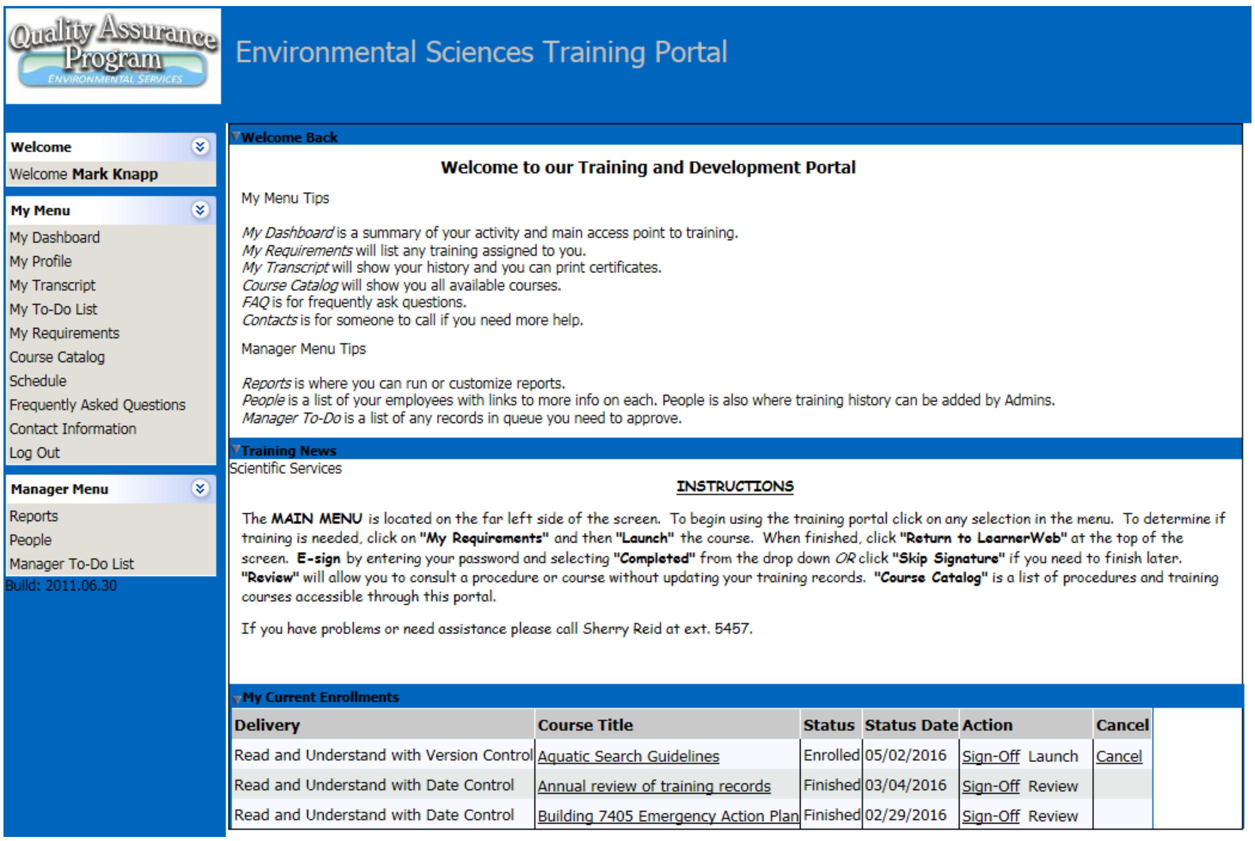
7834.1 Thermo Environmental Model 43i-TLE Analyzer Calibration Procedure7835 R.M. Young 05305v Wind Speed/Direction Transmitter Bench Calibration Procedure

7836 R.M. Young 05305v Wind Speed/Direction Transmitter Field Calibration Procedure

APPENDIX B

<u>Training</u>

Training requirements and records are maintained within Environmental Sciences' training database system, Learner Hall. This system is accessed through the Environmental Sciences Training Portal at: http://scientificservices.learnerhall.com/DukeEnergy/Programs/Standard/Control/elmLearner.wml?RemoteST=ac10017807e00517090c12870



The Leaner Hall **MAIN MENU** is located on the far left side of the screen. To begin using the training portal, click on any selection in the menu. To determine if training is needed, click on **"My Requirements"** and then **"Launch"** the course. When finished, click **"Return to LearnerWeb"** at the top of the screen. The user may **E-sign to indicate completion of a course** by entering their password and selecting **"Completed"** from the drop down *OR* click **"Skip Signature"** if they need to finish later. **"Review"** will allow a user to consult a procedure or course without updating their training records. **"Course Catalog"** is a list of procedures and training courses accessible through this portal.

Employee training requirements and records may be reviewed by the section supervising scientist by selecting Reports under the Manager Menu. Available reports include the following:

Report Name
Training Tracking by Course
Expiring Training By Person
Training Tracking by Person
Learning Track Progress By Track then By Person
Learning Track Progress By Person then By Track
Annual Training Report

APPENDIX C

<u>List of References</u>

EPA QA Handbook for Air Pollutions Measurement Systems, Volume II (EPA-454/B-13-003, May 2013)

EPA QA Handbook for Air Pollutions Measurement Systems, Volume IV (EPA-454/B-08-002, March 2008)

Duke Energy Health and Safety Handbook

40 CFR 58 Appendix A

APPENDIX D DUKE ENERGY – ASHEVILLE STATION
Skyland Monitoring Station
Arden, North Carolina

QUALITY ASSURANCE PROJECT PLAN (QAPP)
Sulfur Dioxide (SO_2) and Meteorological Monitoring
Revision 3

Prepared by

Duke Energy EHS
Environmental Instrumentation
and Data Management
Huntersville, North Carolina

August, 2016

18 PROJECT MANAGEMENT ELEMENTS

18.1 QA PROJECT PLAN IDENTIFICATION AND APPROVAL

Title: Duke Energy

Duke Energy	
1. Signature:	Date: 9/1/16
Mr. Kris Knudsen, Project Manager	
2. Signature:	Date: 9/1/16
Mr. Zachary S. Hall, Director – Environmental Science	

19 TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

REVISION LIST OF CHANGES

Page	Description
Revision 3 - August 2016	
1	Changed Donnie Redmond who has retired to Joette Steger.
2	Corrected typos
12-13	Updated Table 5.1 SO2
27	Under a calibration required, changed from 7 days to 2 days
Revision 2 – August 2016	
ii	Changed signature line from Mark Knapp to Zach Hall, pending filling of the vacant Supervising Scientist – EIDM position
1	Revised the distribution list to update for organization changes.
5	Deleted Mark Knapp and indicated the position is currently vacant. (Zach Hall has management oversight until this vacancy is filled.)
8	Updated the schedule of activities to align with calendar quarter operations. Internal quarterly reporting will be completed within 45 days after end of each quarter. Performance audits will be conducted annually.
14	Changed regulatory reference to 40 CFR Appendix A 3.1.1.
26	Changed “TBD” to “X” in the Annual column to confirm that the Field Activity “Audit pollutant analyzers (independent)” will be conducted annually per updated EPA guidance. More frequent audits may be conducted but are not required.
33	In Table 15-3, changed the frequency of the audit to “Annually.” More frequent audits may be conducted but are not required. Updated the reference to 40 CFR 58.
33-34	Updated Table 15-4 to incorporate revisions to 40 CFR 58 Appendix A, including expanded Audit Levels.
34	Changed regulatory reference to 40 CFR 58 Appendix A 5.1.1
41	Reference changed from Duke Energy SOP 7834 to 7834.1 for the Thermo Environmental 43i-TLE.
Various	Changed several references to the Asheville Monitoring Station to the Skyland Monitoring Station to be consistent throughout the document and consistent with the NCDEQ naming of the monitoring site.
Revision 1 – June 2016	
vii	Added Revision List of Changes
1	Changed Donnie Redmond affiliation from “NCDENR” to “NCDEQ”
5	Figure 3.1 – Added Derek Grady as Data Technician
6	Removed 15 minute reporting intervals from meteorological parameters
7	Table 4-2, Removed serial numbers
12 -13	Table 5-1 updated to reflect NCDEQ AMTIC table
13	Table 5-1minimum sample frequency and raw data collection frequency updated to reflect NCDEQ QAPP Revision 1 guidance

15	Statement "All health and safety training records are maintained in the EIDM files (Learner Hall.)" changed to "All training requirements and records are maintained in the EIDM files (Learner Hall.) Information about the Learner Hall System is found in Appendix A (Training)."
17	Section 7.1 Data Reporting – Added "Electronic site logs (PDF copies of the site paper logbooks) along with equipment certifications and maintenance records will be sent to NCDEQ quarterly."
17	Section 7.1 Data Reporting – Added "Air Vision hourly polls will be posted automatically to the secure FTP site maintained by EIDM (https://sftp2.duke-energy.com/human.aspx). Password validation is required to access the site, and the password can be obtained by contacting the Air Vision data administrator. The password is changed every ninety days."
17	Section 7.2 Documentation Control "NCDENR" changed to "NCDEQ"
26	Table 10-1, Changed step to "Inspect/clean sample manifold" to "Inspect/Clean or Replace sample tubing/Filter"
26	Table 10-1, Added "Replace sample tubing" as an annual task
28	Table 11-1, 43i changed to 43i-TLE
38	Removed statement "The degree to which data comply with the quality requirements addressed in Section B of this QAPP is determined by these criteria."
39	Changed Appendix A to Appendix A Standard Operating Procedures (SOPs)
41	Appendix B List of References changed to Appendix C and moved to page 42
40 – 41	Added new Appendix B Training

3. DISTRIBUTION LIST

A hard copy of this QAPP has been distributed to the individuals in the table below. The document is also available upon request.

Distribution List		
Name	**Position**	**Affiliation**
North Carolina Department of Environmental Quality		
Joette Steger	Projects and Procedures Branch Manager	NCDEQ Ambient Monitoring
Duke Energy		
Kris Knudsen	Project Manager	EHS- Env. Programs
Zach Hall	Director	EHS- Env. Science
[Position Vacant]	Supervising Scientist/ EIDM	EHS - Env. Inst. & Data Mgt.
Dawn Lowe	Data Coordinator	EHS - Env. Inst. & Data Mgt.
Vince Houston	Field Technician	EHS - Env. Inst. & Data Mgt.
Andrew Morris	Field Technician	EHS - Env. Inst. & Data Mgt.
Derek Grady	Field Technician	EHS - Env. Inst. & Data Mgt.

2 PROBLEM DEFINITION AND BACKGROUND

2.1 Problem Statement and Background

2.1.1 Background

Duke Energy (Duke) is proposing an ambient air quality monitoring program to determine whether SO2 emissions from the Asheville Station may impact attainment of the 75 ppb one-hour National Ambient Air Quality Standard (NAAQS) for SO2, as requested by NCDEQ. Data collected under this program will be provided to NCDEQ for their use for classifying the area for NAAQS attainment based on source-oriented monitoring. Attainment of the NAAQS is defined by regulation as achieving a value of 75 ppb or less of the average of the 4^{th} highest values in each year over a three year period. The monitoring will be conducted in the vicinity of the Asheville Station in Arden, North Carolina to document concentrations sulfur dioxide (SO_2) and meteorological measurements including horizontal wind speed (u), direction (θ) and standard deviation of wind direction (σθ).

2.1.2 Ambient Monitoring- Purpose and Objectives

The purpose of this program is to conduct air quality and meteorological monitoring in the vicinity of the Asheville Station for a period of approximately four years. (The Asheville Station coal-fired units will retire by the end of 2019, and thus there will be no need for conducting further source-oriented monitoring at this site after that time.) Monitoring will be performed at one location. The station will be operated following source-oriented SLAMS guidelines. This air quality and meteorological monitoring program has been designed to provide valid, reliable and regulatory compliant ambient measurement data. The monitoring program will be operated to provide data to NCDEQ so that it can make a determination of the attainment status for the area surrounding the Asheville Station as required by the USEPA.

The Ambient Air Quality Monitoring program will be conducted in accordance with the applicable requirements of 40 CFR Parts 50, 53, 58 and other requirements specified by NCDEQ. The air monitoring data will be used to:

- Evaluate attainment of the National Ambient Air Quality Standards (NAAQS) for Sulfur Dioxide,
- Monitor the current dynamic concentrations of Sulfur Dioxide,
- Activate emergency control procedures that prevent or alleviate air pollution episodes,
- Provide data upon which short term strategies can be reliably developed, if needed, to address actual observed air quality impacts prior to retirement of the coal-fired units, and
- Provide a database for researching and evaluating air quality model performance.

3 PROJECT ORGANIZATION

3.1 Roles and Responsibilities

An ambient air quality monitoring program will be conducted in the vicinity of the Asheville Station at Skyland, North Carolina to document concentrations sulfur dioxide (SO_2) and meteorological measurements including horizontal wind speed (u), direction (θ) and standard deviation of wind direction ($\sigma\theta$). The North Carolina Department of Environmental Quality (NCDEQ) and Duke Energy (Duke) will work together during this project. The role of each participant is summarized below and described in Table 3-1. A project flow chart is provided as Figure 3-1**.**

Table 3-1: Program Responsibilities

Position	Role
North Carolina Department of Environmental Quality (NCDEQ)	Performance of system audits.
Duke Energy Environmental Programs – Project Manager	Overall program management and coordination. Reviews data prepared by EHS EIDM and submits the information to NCDEQ. Responsible for site acquisition and response to SO_2, action levels.
EHS Environmental Instrumentation and Data Management (EIDM)	Responsible for field operation of monitoring equipment, data management and reporting of data to Duke Energy Environmental Manager.
EIDM Supervising Scientist	The Supervising Scientist has the overall responsibility of field operations, field activities, and the operation of the monitoring sites. Responsible for management of data acquisition and reporting activities. All field and data management personnel report to the Supervising Scientist.
EIDM Data Coordinator	Responsible for database management, data validation and the preparation of periodic reports.
EIDM Field Technicians	Responsible for site operation, deploying monitoring equipment, quality control checks and retrieving data from the monitoring sites.

3.1.1 North Carolina Department of Environmental Quality

NCDEQ may conduct independent performance audits or provide an independent contracted auditor. EIDM will accommodate Technical Systems Audits of the network, if requested by the agency.

3.1.2 TRC Environmental Corporation

TRC has been contracted by Duke and will be responsible for network installation and initial operation, data collection, data validation and reporting. TRC will assist in the site selection, provide the equipment, instrumentation and personnel necessary to ensure that the data are of sufficient quantity and quality to meet the objectives of the program. TRC will ensure that quality control (QC) and standard operating procedures (SOPs) are followed in accordance with EPA and NCDEQ requirements such that the quality assurance (QA) objectives of this plan are met until operational control of the monitoring site is turned over to Duke Energy EHS-EIDM. Following a successful review of operation by NCDEQ, a turnover to Duke Energy EHS – EIDM will be accomplished. Successful turnover will be dependent upon a full system calibration by TRC with EIDM in observance to demonstrate proper system operation. Following turnover, TRC will continue in a technical support role as requested by EIDM.

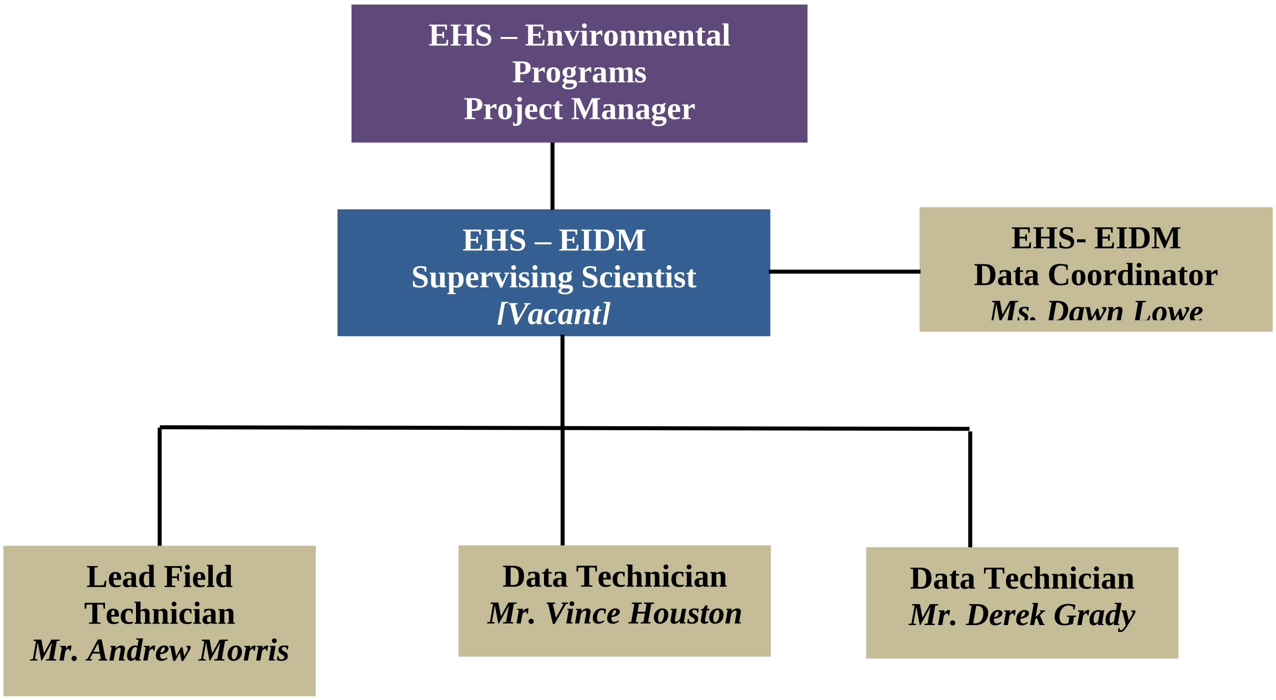
3.1.3 EHS – Environmental Programs

EHS – Environmental Programs will be responsible for assisting in the selection of sites, securing use of the site locations, site security, installation of utilities and overall leadership of the project. Duke will review all data reports prepared by EIDM and submit reports to NCDEQ.

3.1.4 EHS – Environmental Instrumentation and Data Management (EIDM)

EIDM will be responsible for system operation, and data collection, data validation and reporting. EIDM will assume operation of the system following a turnover from the vendor (TRC Environmental Corporation) contracted to install and initially maintain the site. Turnover will be accomplished following a successful operation by TRC that includes a review (independent audit) by NCDEQ to assure all monitoring requirements are being met and a final system calibration observed by EIDM personnel. Following the turnover, EIDM will assume operation and maintenance of the equipment and instrumentation provided by TRC and will provide personnel necessary to ensure that the data are of sufficient quantity and quality to meet the objectives of the program. EDIM will ensure that quality control (QC) and standard operating procedures (SOPs) are followed in accordance with EPA and NCDEQ requirements such that the quality assurance (QA) objectives of this plan are met.

Figure 3-1: Project Organizational Chart



4 PROJECT DESCRIPTION

4.1 Project Overview

As previously stated, the purpose of this monitoring program is to install and operate sulfur dioxide and meteorological monitoring at one site in the vicinity of the Asheville Station. This air quality and meteorological monitoring program has been designed to provide valid, reliable and regulatory compliant ambient measurement data from the monitoring station located at the Skyland community in Arden, North Carolina. The air monitoring station is situated in a one acre clearing directly north of the plant across Lake Julian, in Arden, NC. The coordinates of the monitoring station are 28º 38’ 38.08” N, 82º 32’ 32.25” W.
The parameters measured at the air quality monitoring program are as follows:

- Sulfur Dioxide (SO_2)
    - SO_2 will be monitored on a continuous basis. One minute, five minute and hourly averages will be recorded. Hourly concentrations as well as the highest hourly 5-minute average will be reported in compliance with SO_2 reporting requirements.

In addition, the following meteorological parameters will be measured:

- Horizontal wind speed (WS or u), wind direction (WD) and standard deviation of wind direction (σθ) at a height of 10 meters (m).

Monitoring program parameters are summarized in Table 4-1.

Table 4-1: Summary of Monitoring Program Parameters

Parameter	Measurement Units	Reporting Interval
SO_2	Parts per billion (ppb)	Hourly (average and highest 5-min)
Wind Speed (μ)	Meters per second (m/s)	Hourly
Wind Direction (θ)	Directional degrees (°)	Hourly
Standard Deviation of Wind Direction (σθ)	Directional degrees (°)	Hourly

Table 4-2 is a summary of equipment in use at the Skyland Monitoring Station

Table 4-2: Summary of Monitoring Equipment at Skyland

Parameter	**Manufacturer/Model**	**Comments**
Environmentally Controlled Shelter	EKTO 866	Heated, Air Conditioned Re-locatable Shelter
Sulfur Dioxide Analyzer	Thermo Environmental Instruments Model 43i-TLE	US EPA Equivalent Method EQSA-0486-060
Wind Speed and Direction Sensor	RM Young Model 05305 Wind Monitor AQ	Mechanical Wind Speed and Direction Sensor
Gas Dilution Calibrator	Thermo Environmental Instruments Model 146i	Dynamic Gas Dilution Calibrator
Zero Air Supply	Thermo Environmental Instruments Model 111	Clean Air Supply for Gas Calibrator
Certified Gas Standard	AirGas	Lab Certified Calibration Standard
Data Logger	Primary: Environmental Systems Corporation 8832 data logger (or equivalent Secondary: Lenovo/ThinkPad Laptop with TRC Data Processing Software	Data Acquisition System and Electronic User Interface
Communications	Verizon Cell Modem	Cellular Data Modem
Support Equipment	Various Suppliers	Manifolds, Tubing, Instrument Racks and Required Accessories

The major equipment supplier contact information is supplied in Table 4-3.

Table 4-3: Equipment Suppliers	
Manufacturer/Supplier	**Equipment**
R.M. Young Company 2801 Aero Park Drive Traverse City, MI 49686 (231)946-3980 Youngusa.com	Wind Sensors and Translator
Thermo Fisher Scientific Inc. 81 Wyman Street Waltham, MA 02454 (781)622-1000 and (800)678-5599 thermoscientific.com	43i-TLE SO_2 Analyzer
EKTO Manufacturing Corp. Eagle Drive Sanford, ME 04073 (207)324-4427 Ekto.com	Shelters

4.2 Project Schedule

The project schedule for annual operation of the monitoring programs is outlined in Table 4-4. Preliminary operation of the Skyland monitor began August 15, 2015, and data collection began effective September 1, 2015 after system operations were verified and QA schedules were implemented. Operation of the monitor for the period from September 1, 2015 through March 31, 2016 was performed by TRC under contract to Duke Energy. Duke Energy-EIDM group assumed all operation, including maintenance and QA, effective April 1, 2016. NCDEQ provided an initial performance audit of the monitoring system on March 22, 2016.

Table 4-4:Project Schedule for Calendar Year Monitor Operation	
Date	**Milestone**
January 1	Monitoring Program Calendar Year Begins
March	Semi-Annual Maintenance and Calibration of Air Quality and Meteorological Instrumentation
March 31	End of 1st Quarter Monitoring
May 15	1st Quarter Monitoring Report Complete
June	Quarterly Maintenance and Air Quality Calibration
June 30	End of 2nd Quarter Monitoring
August 15	2nd Quarter Monitoring Report Complete
September	Semi-Annual Maintenance and Calibration of Air Quality and Meteorological Instrumentation by EIDM
September 30	End of 3rd Quarter Monitoring

November 15	3rd Quarter Monitoring Report Completed
December	Quarterly Maintenance and Air Quality Calibration
December 31	End of 4th Quarter Monitoring
February 15	4th Quarter Monitoring Report Completed
Annually	Performance Audit conducted, to be scheduled by NCDEQ during the calendar year.

4.3 Scheduled Field Activities

Federal regulation provides for the implementation of a number of qualitative and quantitative checks to ensure that data will meet the Data Quality Objectives (DQOs) for the project. Each of the checks attempts to evaluate phases of measurement uncertainty.

TRC will have initial responsibility for implementation of all monitoring program QC measures through the turnover of operation to EIDM (scheduled to be completed by April 1, 2016). EIDM will continue with established monitoring program QC measures. The following is a summary of QC activities that will be implemented to ensure that measurement uncertainty is maintained within established acceptance criteria for the attainment of the program DQOs. QC activities will include, but not be limited to, the following:

Sulfur Dioxide

- Daily automated calibration checks (zero/span and precision),
- Daily review of instrument measurements and diagnostics,
- Monthly operational checks by local site operator, and
- Quarterly maintenance and calibration (if deemed necessary) as specified in TRC's Standard Operating Procedure (SOP).

Meteorological Measurements

- Semiannual maintenance and calibrations, and
- Monthly reasonableness checks by site operator
    - Verification that wind sensors are operational and show no sign of damage, and
    - Wind speed, wind direction and shelter temperature measurements represent actual conditions.

4.4 Project Records

EIDM will provide quarterly summary reports to the EHS – Environmental Programs Manager that contain information to evaluate the attainment of the Data Quality Objectives. Quarterly reports will be submitted within 45 days after the end of each monitoring quarter. Each report will be comprised of the following:

- Executive Summary,
- Hourly values for SO_2, in tabular and Excel format. Data is also provided using Air Vision data acquisition system supplying data in prescribed AQS format as specified by NCDEQ,
- 5-minute data (special format to go into AQS as specified by NCDEQ,
- Highest 5-minute SO_2 concentration in each hour, in tabular and Excel format,
- 1 min SO2 data, accessible by NCDEQ via Air Vision data acquisition system
- Annual performance evaluation data (special format to go into AQS), also known as "audit" in prescribed AQS format as specified by NCDEQ,
- Hourly values for WS, WD in Excel format,
- Hourly values for shelter temperature,
- Frequency distribution plot (wind rose) of wind speed and wind direction,
- Frequency distribution plot (pollutant rose) of SO_2 concentrations and wind direction,
- Results of instrument QC checks, (daily and/or biweekly zero/ precision/ span checks - precision needs to be in a special format to go into AQS- format as specified by NCDEQ,)
- Explanation of corrective actions addressed during period,
- QA/QC and equipment maintenance documentation, and
- Monthly and cumulative data capture statistics by parameter.

Other information required by NCDEQ includes the following:

- Certification for SO2 cylinders (every two years – it may have been extended or whenever replaced).
- Certification for calibrator (at least annually or whenever replaced).
- Any paper logs or electronic logs documenting activities.
- Documentation of zero air certification and/or maintenance.
- Monitor and calibrator instrumentation specifications (one-time per instrument).
- Annual documentation that the sample/probe line meets < 20 seconds residence time.
- Annual documentation that the site meets Appendix E siting requirements.
- Semi-annual documentation of shelter temperature probe audit.
- Documentation of probe material, length, height (when installed and replaced).
- Quality assurance project plan (at start of project) including standard operating procedures.

In addition, EIDM will prepare and provide EHS- Environmental Programs a final summary report following completion of the monitoring program. The contents of the reports are discussed in greater detail in Section 17 of this QAPP.

5 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

5.1 Data Quality Objectives (DQOs)

This section provides a description of the data quality objectives (DQOs) for the Skyland Monitoring Program. Data quality objectives are qualitative and quantitative statements that:

- Clarify the intended use of the data,
- Define the type of data needed, and
- Specify the tolerable limits on the probability of making a decision error due to uncertainty in the data.

5.1.1 DQO Process

The Data Quality Objectives (DQOs) of this project are designed to provide valid data that satisfy the regulating authority's requirements for ambient air quality monitoring. Monitoring is performed in accordance with EIDM Standard Operating Procedures (SOPs) and EPA regulations and guidance documents.

The Skyland Monitoring Program is designed to achieve program DQOs and meet or exceed the minimum standard requirements for field monitoring and analytical methods. The overall QA objective is to develop and implement procedures for continuous air quality and meteorological monitoring, data validation and reporting which will provide results that are scientifically valid, and the levels of which are sufficient to meet program DQOs.

5.1.2 Measurement Quality Objectives (MQOs)

Measurement Quality Objectives (MQOs) are designed to evaluate and control various phases (monitoring, maintenance, and calibration) 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 agreement is calculated as either the range or as the standard deviation. This is the random component of error.
- *Bias* – the systematic or persistent distortion of a measurement process which causes error in one direction. Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.
- *Representativeness* – a qualitative term that expresses "the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition."
- *Completeness* – a measure of the amount of valid data needed to be obtained from a measurement system.
- *Comparability* – a qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made.

Tables 5-1 and 5-2 summarize the MQOs for the pollutant monitors and the meteorological station, respectively.

Table 5 1: Summary of Measurement Quality Objectives - Pollutant Parameters

1) Requirement (SO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- SO_2			
One Point QC Check Single analyzer	*1/ 2 weeks*	Warning limit: ≤ ±7% (percent difference) Control limit: ≤ ±10% (percent difference)	1 and 2) 40 CFR Part 58 App A Sec 3.1.1 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1.5 QC Check Concentration range 0.005 and 0.08 ppm Relative to mean or median monitor concentrations
Zero/span check	1/ 2 weeks	Zero drift ≤ ± 1.5 ppb (24-hour) ≤ ± 2.5 ppb (>24hr-14 day) Span drift ≤ ± 10 %	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
Shelter Temperature Range	**Daily** (hourly values)	20 to 30° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
OPERATIONAL CRITERIA- SO_2			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/6 month	± 2° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	*Every site 1/year with an equal proportion of sites in each of the 4 quarters*	Percent difference of audit levels 3-10 ≤ ±15% Audit levels 1&2 ± 1.5 ppb difference or ±15%	1 and 2) 40 CFR Part 58 App A sec 3.1.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html
Federal Audits (NPAP)	100 percent of sites every 6 years; 20% of sites audited each year	Audit levels 1&2 ± 1.5 ppb difference; all other levels percent difference ± 15%	1) 40 CFR Part 58 App A sec 3.1.3 2) 40 CFR Part 58 App A sec 3.1.3.1 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving; When one-point QC check is > 7 % difference; 1/year if continuous zero/span performed daily	Criteria: Span 1&2 within ± 5 % of expected Span 3 within ± 3 ppb of expected NCore: Span 1&2 within ± 3 ppb of expected Span 3 within ± 2 ppb of expected Both: Zero within ± 1 ppb of expected	1) 40 CFR Part 50 App A-1 Section 4 2 and 3) Recommendation Multi-point calibration (0 and 3 upscale points)
Gaseous Standards	*All gas cylinders*	*NIST Traceable (e.g., EPA Protocol Gas)*	1) 40 CFR Part 50 App A-1 Section 4.1.6.1 2) NA Green book 3) 40 CFR Part 50 App A-1 Section 4.1.6.1 Producers must participate in Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A sec 2.6.1
Zero Air/ Zero Air Check	Chemicals changed 1/year NCore – certified 1/year & verified 1/6 months	Concentrations below LDL < 0.1 ppm aromatic hydrocarbons	1) 40 CFR Part 50 App A-1 Section 4.1.6.2 2) Recommendation 3) Recommendation and 40 CFR Part 50 App A-1 Section 4.1.6.2

Table 5 1: Summary of Measurement Quality Objectives - Pollutant Parameters (cont.)

1) Requirement (SO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
Gas Dilution Systems	1/year or after failure of 1 point QC check or performance evaluation	*Accuracy ± 2 %*	1) 40 CFR Part 50 App A-1sec 4.1.2 2) Recommendation 3) 40 CFR Part 50 App A-1 sec 4.1.2
Detection (FEM/FRMs)			
Noise	NA	*0.001 ppm (standard range)* *0.0005 ppm (lower range)*	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) NA 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	Verified by manufacturer at purchase	*0.002 ppm (standard range)* *0.001 ppm (lower range)*	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1
SYSTEMATIC CRITERIA- SO_2			
Sampler/Monitor	NA	*Meets requirements listed in FRM/FEM designation*	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	*All data*	*ppb (final units in AQS)*	1, 2 and 3) 40 CFR Part 50 App T Sec 2 (c)
Rounding convention for data reported to AQS	*All data*	*1 place after decimal with digits to right truncated*	1, 2 and 3) 40 CFR Part 50 App T Sec 2 (c)
Completeness	*1 hour standard*	*Hour – 75% of hour* *Day- 75% hourly concentrations* *Quarter- 75% complete days* *Years-4 complete quarters* *5-min value reported only for valid 5-min blocks*	1, 2 and 3) 40 CFR Part 50 App T Section 3 (b), (c) More details in CFR on acceptable completeness.
Sample Residence Time Verification	At installation	*< 20 seconds*	1) 40 CFR Part 58 App E, section 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E, section 9 (c)
Sample Probe, Inlet, Sampling train	*All sites*	*Borosilicate glass (e.g., Pyrex®) or Teflon®* (FEP and PFA have been accepted as equivalent material to Teflon.)	1, 2 and 3) 40 CFR Part 58 App E sec 9 (a) Replace 1 / 2 years; more frequently if pollutant load or contamination dictate
Siting	1/year	*Meets siting criteria or waiver documented*	1) 40 CFR Part 58 App E, sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-5
Precision(using 1-point QC checks)	*Calculated annually and as appropriate for design value estimates*	*90% CL CV ≤ 10%*	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.1.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.2
Bias (using 1-point QC checks)	*Calculated annually and as appropriate for design value estimates*	*95% CL ≤ ± 10%*	1) 40 CFR Part 58 App A sec 2.3.1.5 & 3.1.1 2) 40 CFR Part 58 App A sec 4 (b) 3) 40 CFR Part 58 App A sec 4.1.3

CL – Confidence Level
CV – Coefficient of Variation

Table 5-1: Meteorological Data Measurement Quality Objectives

Parameter	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Accuracy	Raw Collection Frequency	Data Completeness

Horizontal Wind Speed	Propeller Anemometer	m/sec	0.5 – 50.0	0.1	Hourly	±0.2 m/s ≤ 5 ±5 % > 5 m/s	1 minute	90%
Wind Direction	Vane anemometer	Degrees	0 – 360	1	Hourly	± 5 Degrees	1 minute	90%

5.2 <u>Data Quality Assessment</u>

Methods for calculating precision and bias are conducted following the procedures specified in Appendix A of 40 CFR Part 58 and guidance provided in the Quality Assurance Handbook for Air Pollutions Measurement Systems, Volume II (EPA-454/B-13-003 May, 2013). These procedures are summarized below.

5.2.1 <u>Precision</u>

Precision is the agreement among a set of replicate measurements without consideration of the "true" or accurate value: i.e., variability between measurements of the same material for the same analyte. Simply stated, precision is a measure of the variability of a measurement.

The precision of automated analyzers is evaluated by making multiple comparisons of the sample's known concentration against the instrument's response and calculating the upper bound of the coefficient of variation (CV).

5.2.2 <u>Bias Estimate</u>

For continuous gaseous pollutant measurements (SO_2), the bias estimate is calculated using the one-point QC checks as described in Section 3.1.1 of 40 CFR Part 58 Appendix A. The bias estimator is an upper bound on the mean absolute value of the percent differences calculated on a quarterly basis.

5.2.3 <u>Completeness</u>

The monitoring network will be operated to meet the valid data capture goal of 90% for pollutant and 90% for meteorological parameters.

6 SPECIAL TRAINING REQUIREMENT/CERTIFICATION

Appropriate training will be provided to employees supporting the Skyland SO_2 and Meteorological Monitoring Program, commensurate with their duties. No special training or certifications are required for this monitoring project. Field technicians and scientists, data analysts and the QA manager are all either environmental scientists or science technicians with expertise in operation of monitoring instrumentation, data management and data QC procedures as they apply to meteorological and ambient air quality monitoring programs.

On-site personnel will receive training on station and instrumentation operation, maintenance and QC procedures. Additional training will be provided, as appropriate, throughout the entire term of the project as deemed necessary by the EIDM supervising scientist.

Documents relevant to adhering to this QAPP will be made available to all site personnel and located in the EHS Environmental Laboratory for accessibility. Such documents include, but are not limited to:

- Asheville Station – Skyland Air Monitoring Plan,
- EIDM SOP's,
- Asheville Station – Skyland Quality Assurance Project Plan,
- Instrument manuals, and
- Site specific safety assessments.

Most of the on-site activities described in this QAPP constitute routine sampling and analyses for which no special training requirements or certifications are needed. However, all EIDM staff working on-site will comply with the Duke Energy Health and Safety Handbook in effect at the time. All training requirements and records are maintained in the EIDM files (Learner Hall.) Information about the Learner Hall System is found in Appendix A (Training). Prior to the start of the on-site work, all field personnel will be given instruction specific to the project, covering the following areas:

- Organization and lines of communication and authority,
- Overview of the QAPP, including sample collection, handling, and labeling procedures,
- QA/QC requirements,
- Documentation requirements, and
- Health and safety requirements.

Instructions will be provided by the EIDM Supervising Scientist.

7 DOCUMENTATION AND RECORDS

Table 7-1 indicates the categories and types of records and documents which are kept relating to this project. Current copies of all documents are maintained at the specified locations. At the conclusion of the project, copies of documents will be archived at EIDM's laboratory in Huntersville, North Carolina for a period of not less than five years. Additional records produced during the period of operation conducted by TRC will be maintained at the TRC regional office in Gainesville, Florida. A summary of project documents are presented in Table 7-1.

Table 7-1: Project Documentation and Records

Record/Document Type		Location
Management & Organization	Correspondence	Project Files – HUNT/GNV
	Staff Training/Certifications	Project Files - HUNT/GNV
	Siting Criteria Checklists	Project Files - HUNT/GNV
Site Information	Site Maps and Photos	Project Files – HUNT, GNV & DSMS
	QAPP	Project Files – HUNT, GNV & DSMS
Field Operations	Standard Operating Procedures	Project Files – HUNT, GNV & DSMS
	Site Logbooks	Project Files - DSMS
	Quality control documents	Project Files - DSMS
	Data Entry Forms	Project Files - DSMS
	Standard/Calibration Certs.	Project Files – HUNT, GNV & DSMS
	Electronic Data	EIDM Central Server
Data Reporting	Annual data/summary reports	Project Files - HUNT/GNV
	Electronic format reports	EIDM Central Server
	QA Assessments and Reports	Project Files - HUNT/GNV
	Hardware and software manuals	Project Files - HUNT/GNV
Data Management	Data Validation Procedures	Project Files - HUNT/GNV
	QA Assessments and Reports Audit results	Project Files - HUNT/GNV
Quality Assurance	QA Assessments and Reports	Project Files - HUNT/GNV

HUNT – EIDM Huntersville, N.C. laboratory
GNV – TRC's Gainesville, FL office location
DSMS – Duke's Skyland Monitoring Station
Note: Some electronic files from initial period of study maintained on TRC Central Server

7.1 Data Reporting

The documents and records that will be produced during this air monitoring program include, but are not limited to, the following types:

- Interim progress reports,
- Quarterly data reports,
- Hourly and averages met data in Excel format and wind roses,
- Annual data reports,
- Revisions to this QAPP,
- Data entry forms, and
- Logbooks

Electronic site logs (PDF copies of the site paper logbooks) along with equipment certifications and maintenance records will be sent to NCDEQ quarterly.

Air Vision hourly polls will be posted automatically to the secure FTP site maintained by EIDM (https://sftp2.duke-energy.com/human.aspx). Password validation is required to access the site, and the password can be obtained by contacting the Air Vision data administrator. The password is changed every ninety days.

QA reports will be submitted to the EIDM Supervising Scientist to ensure that any problems identified during the sampling and analysis program are investigated and the proper corrective measures taken in response. The QA reports may include:

- Problems noted during data validation and assessment, and
- Significant QA/QC problems, recommended corrective actions, and the outcome of corrective actions.

QA reports will be prepared and submitted on an as-needed basis.

7.2 Documentation Control

All raw data required for calculations, the submissions to the NCDEQ, and QA/QC data shall be collected electronically or on data forms that are included in the field methods, see Section 10. All hardcopy information shall be filled out in indelible ink. Corrections shall be made by inserting one line through the incorrect entry, initialing and dating this correction, and placing the correct entry alongside the incorrect entry, if this can be accomplished legibly, or by providing the information on a new line if the above is not possible.

7.2.1 Logbooks

The field technician will be responsible for maintaining appropriate field logbooks, including paper bound notebooks as well as electronic notepad files. These logbooks will be uniquely numbered and associated solely with the Skyland monitoring station. The logbooks will be used to record information about the site and routine operations.

7.2.2 Electronic Data Collection

Certain instruments can provide an automated means for collecting information that would otherwise be recorded on data entry forms. In order to reduce the potential for data entry errors, automated systems will be utilized where appropriate and will record the same information that would be recorded on data entry forms. In order to provide a backup, electronic copies of the automated data collected information will be stored on the local PC as well the server location initially at TRC's Gainesville, Florida office until turnover of the system to EIDM. Electronic copies will then be maintained on the central server located at the EIDM laboratory in Huntersville, North Carolina for the remainder of the study.

7.2.3 Data Entry Forms

Completion of data entry forms, associated with all routine environmental data operations are required, even with the field logbooks, to contain all appropriate and associated information required for the routine operation being performed. For example, when a multipoint calibration is performed, the data from the calibration must be entered in a calibration form as well as documented in the field logbook.

8 NETWORK DESCRIPTION

8.1 SAMPLING PROCESS DESIGN

Refer to Section 4 for the monitoring design of this project. This section discusses the areas being sampled, what is being tested, and frequency. The Air Monitoring Plan that will be prepared for this program goes into greater detail regarding the design of the monitoring system.

8.2 MONITORING METHODS AND REQUIREMENTS

8.2.1 Meteorological Data Collection

Horizontal wind speed and direction will be determined with an RM Young Wind Monitor AQ Model 05305. Met data will be recorded, calculated ($\sigma\theta$, σw and σE) and displayed using an RM Young Model 26800 translator. Horizontal wind sensors will be mounted on a tower at a height of 10 meters. All met data collected from this station will be polled by the central computer location on an hourly basis. Fifteen minute and hourly averaged data will be stored in separate data tables. Standard deviation of wind direction will be calculated following equation 9-9 of EPA QA Handbook Volume IV (EPA-454/B-08-002, March 2008).

8.2.2 Sulfur Dioxide Monitoring

Continuous monitoring of SO_2 concentrations will be conducted using a Thermo Environmental 43i-TLE UV Fluorescence SO_2 Analyzer. The 43i-TLE is designated as a Federal Equivalent Method (FEM), designation EQSA-0486-060. Federal Register: Vol. 51, page 12390, 04/10/1986.

The Thermo 43i-TLE SO_2 Analyzer has a lower detectable limit of 0.05 parts per billion (ppb) and will be operated on the 500 ppb range. The instrument's internal data acquisition system will be configured to store 1-minute averages for SO_2 and hourly averaged diagnostic parameters (e.g. lamp intensity, sample flow, etc.).

Multipoint calibrations and daily calibration verifications will be performed using a Thermo Environmental 146i dilution calibrator and a 10 part per million (ppm) NIST traceable EPA Protocol 1 gas cylinder. This system combination will allow calibration gases to be accurately generated in the range of 10 to 500 ppb.

8.3 SITE OPERATION AND CONFIGURATION

EIDM personnel will visit this station as necessary to conduct routine operations as described above. This station will be powered by line voltage obtained from an adjacent source. All instrumentation will be housed within a new EKTO shelter equipped with an industrial heating and air conditioning system. The shelter will be a fixed, semi-permanent system. Normal spare parts and consumable items will be stored on-site for instrument maintenance.

8.4 SITE SELECTION AND SITING CRITERIA

The Skyland monitoring location was selected in accordance with the criteria specified in 40 CFR Part 58, Appendix E. The monitoring shelter must be placed away from obstructions such as trees and tall fences in order to avoid their effects on airflow. To prevent sampling bias, airflow around the monitoring sampling probes must be representative of the general airflow in the area.

8.4.1 Probe Siting Criteria for Sulfur Dioxide Analyzer

Probe and monitoring path siting criteria for SO_2 shall adhere to the requirements listed in 40 CFR Part 58, Appendix E, as outlined below.

The SO_2 intake probe must be 2 to 15 meters (m) above the ground. The probe must be at least one meter away, both vertically and horizontally, from any supporting structure. The probe must have unrestricted airflow and be located away from obstacles. The distance from the obstacle to the probe must be at least twice the height that the obstacle protrudes above the probe. An exception to this requirement can be made for measurements taken in street canyons or at source-oriented sites where buildings and other structures are unavoidable. Trees can also act as obstructions in cases where they are located between the air pollutant sources or source areas and the monitoring site, and where the trees are of a sufficient height and leaf canopy density to interfere with the normal airflow around the probe. To reduce this possible interference/obstruction, the probe must be at least 10 meters or further from the drip line of trees. The distance shall be measured from the drip-line or outside edge of the crown, not the trunk. There should be no minor sources of SO_2 (coal or oil fired stoves or furnaces) within 100 m of the probe intake that could have a significant impact.

The sampler must have an unrestricted airflow in at least a 180° arc around the sampler. The arc must include the predominant wind directions and any major sources in the area.

Approval of monitoring system installation is determined by NCDEQ in accordance with EPA criteria, and some discretion is allowed based on specific monitoring objectives (for example, in determining the best location for a source-oriented monitoring site). However, the Skyland monitoring site was selected to reasonably meet the above criteria. The site is located in an open field adjacent to Lake Julian directly across from the Asheville Station. There are no large obstructions in the vicinity of the monitoring site. Distance to tree drip-line is maintained 10 meters or greater in all directions and significantly greater in the direction from the monitoring site to the Asheville Station.

8.4.2 Meteorological Sensors

Instruments shall be mounted on booms at the top of, or projecting horizontally from, the tower. The booms shall be securely fastened to the tower and shall be strong enough so that they will not sway or vibrate in strong winds. Wind instruments shall be mounted on a boom so that the sensors are twice the maximum diameter or diagonal of the tower away from the tower. The boom shall project into the prevailing winds. Wind sensors shall be mounted on booms or cross arms so that a sensor's wake does not impact adjacent sensors. Usually, this means mounting the sensors a minimum of 2 meters apart. If the wind sensors are to be mounted on top of a tower, they shall be mounted at a height and distance from the tower so that the diagonal distance between the sensor and the tower is equal to twice the maximum diameter or diagonal of the tower.

8.4.2.1 *Towers*

The sensor should be securely mounted on a mast (tower or pole) that will not twist, rotate, or sway. The towers shall be of an open grid-type construction and designed so that they either tilt or can be cranked into place so that the sensors can be installed, serviced and audited from the ground so that the operator will not need to climb the tower. A tower must be rigid enough to maintain all mounted instruments in proper alignment and orientation in high winds.

When instruments are located on a cross arm projecting out from the tower, the cross arms shall be securely fastened to the tower and shall be strong enough so that the sensors do not sway or vibrate in high winds. The sensors shall be securely fastened to the cross arm at a distance of two tower diameters or widths, measured from the edge of the tower to the sensor, to avoid any influence of tower-induced turbulence on the sensors. The cross arm shall be installed so that it is horizontally level and the sensors shall be installed so that they are vertical. The cross arm shall be mounted and aligned so that the wind direction sensor is correctly aligned. (The correct alignment varies on a sensor-by-sensor basis. Consult the appropriate section of manufacturer's operator's manual for the correct alignment.)

8.4.2.2 *Wind Velocity Sensors*

Wind sensors are used to measure surface level winds, therefor sensors should be located on a 10-m tower in open terrain. Open terrain is defined as an area where the distance between the tower base and any obstruction is at least ten times the height of that obstruction above the instrument. This applies to manmade (buildings) and natural (trees, rocks, or hills) obstructions. All distances are to be measured from the edge of the obstruction nearest the tower. Trees and shrubs shall be measured from the outside edge of the crown or drip-line, and not the trunk.

9 SAMPLING METHODS REQUIREMENTS

The purpose of this section is to:

- Identify the sampling methods,
- Identify the procedures for collecting the required environmental samples,
- Describe the:
  - Equipment used in the data collection network,
  - Necessary support facilities,
  - Sample preservation requirements,
  - Implementation requirements,
  - Required materials, and
  - Processes for preparing and decontaminating sampling equipment.
- Identify the:
  - Corrective actions necessary to reestablish network data integrity,
  - Responsible parties to implement the corrective actions, and
  - Methods required to verify corrective action effectiveness.

9.1 Sulfur Dioxide Monitoring Technology/Methodology

The physical principle used in SO_2 molecule measurement relies on exciting an electron shell, which occurs in the presence of a specific wavelength (214 nanometers [nm]) of ultraviolet (UV) radiation, and the subsequent relaxation, which produces a photon of light. A photo multiplier tube measures light emissions as the SO_2 molecule returns to the ground state. The intensity of this light is proportional to the quantity of SO_2 present in the sample. A reference detector continuously monitors the intensity of the UV lamp used to excite the SO_2, and allows use of a ratiometric measurement technique that compensates for lamp degradation. A hydrocarbon scrubbing system containing no consumable material removes interfering hydrocarbons prior to the ambient sample entering the measurement chamber.

9.2 Meteorological Monitoring Technology/Methodology

Wind speed and wind direction will be measured by a mechanical “prop vane” style sensor mounted at 10 meters on a hinged-base tower. The wind speed is determined by the spinning of a four blade helicoid propeller shaft generating a pulse signal detected by a transducer and measured by a translator/data logger. The wind direction sensor is a durable molded vane. Vane angle is sensed by a precision potentiometer housed in a sealed chamber and its signals transmitted to the same translator/data logger.

9.3 Methodology for the Collection of Electronic Data

Electronic data collection is possible through the network's data loggers and modems. This equipment is located in the shelter where the data loggers record the data history and the modems provide a path to download and transmit the data for analysis.

Data acquisition will be accomplished using an Environmental Systems Corporation 8832 data logger (or equivalent.) A Lenovo ThinkPad PC (X-140e or equivalent) configured with a solid-state hard drive running TRC’s data acquisition software (TRC_Logger) will provide data acquisition during the initial phase of operation until turnover is complete to EIDM. At that point, the Lenovo system will continue as a backup data acquisition system. All data are acquired digitally from the instruments. Meteorological sensors are interfaced using a R. M. Young Company (Young) 26800 Programmable Translator. The 26800 performs analog to digital conversion and meteorological calculations. TRC_Logger polls the 26800 over a serial interface on a 15-minute basis. The Environmental Systems data logger will be polled hourly by the EIDM central computer using Agilaire Air Vision software. The data acquisition system will store data in a local database and transmit measurements to TRC's SQL database or the Air Vision central computer via a 4G cellular modem.

9.4 Support Facilities

9.4.1 Monitoring Station Design

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.

9.4.2 Shelter Criteria

An 8' x 6' x 6' walk-in style shelter (EKTO model 866 Special) equipped with an instrument rack, work bench, roof rails and tower mount, will house the air monitoring instrumentation, with the exception of meteorological sensors. This shelter is capable of fulfilling the following requirements:

- The shelter temperature must be maintained between 20^o and 30^oC,
- The power supply should not vary more than ± 10% from 117 Alternating Current Voltage (VAC),
- The shelter must protect the instrumentation from precipitation and excessive dust and dirt, provide third wire grounding, meet federal Occupational Safety and Health Administration (OSHA) regulations and be cleaned regularly to prevent a buildup of dust, and
- The shelter must protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light, or radiation.

The SO_2 analyzer will draw outside air, through a single sample line, from the probe inlet. The inlet system will be made of Teflon®, which is nonreactive. Additionally, the probe must prevent rainwater from entering the analyzers.

9.5 Sample Collection

Continuous monitoring of SO_2 concentrations will be conducted using a Thermo Environmental 43i-TLE UV Fluorescence SO_2 Analyzer. The Thermo 43i-TLE SO2 Analyzer has a lower detectable limit of 0.05 parts per billion (ppb) and will be operated on the 500 ppb range. The instrument's internal data acquisition system (DAS) will be configured to store 1-minute averages for SO_2 and hourly averaged diagnostic parameters (e.g. lamp intensity, sample flow, etc.).

Wind speed and wind direction will be measured with an R.M. Young Model 05305 meteorological sensor at a height of 10 m. All instrumentation specifications will meet the measurement quality objectives (MQO) and accuracy requirements for prevention of significant deterioration (PSD) meteorological monitoring instrumentation presented in Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final), EPA-454/B-08-002, March 2008 (QA Handbook Volume IV).

9.6 Sampling/Measurement System Corrective Action

Corrective action measures in the Ambient Air Quality Monitoring Network will be taken to ensure 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.

9.7 Analyzer Audits

Audits 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-454/B-13-003, May 2013). For each parameter and sampler type, audit procedures are performed following the procedures defined by the approved standard operating procedure. Audits are conducted by NCDEQ, or by an independent contract auditor provided by NCDEQ. EIDM will accommodate the audit if requested by the agency.

10 QUALITY CONTROL REQUIREMENTS AND PROCEDURES

To assure the quality of data from air monitoring measurements, two distinct and important interrelated functions must be performed. One function is the control of the measurement process through broad QA activities, such as establishing policies and procedures, developing DQOs, assigning roles and responsibilities, conducting oversight and reviews, and implementing corrective actions. The other function is the control of the measurement process through the implementation of specific quality control procedures, such as audits, calibrations, checks, replicates, routine self-assessments, etc.

QC, as it applies to an air quality monitoring program, is the overall system of technical activities and procedures developed to measure the attributes and performance of the sampling program against defined standards to verify that they meet the stated requirements established by the program. Quality control includes:

- Establishing specifications or acceptance criteria for each quality characteristic of the monitoring/analytical process,
- Assessing procedures used in the monitoring/analytical process to determine conformance to these specifications, and
- Taking any necessary corrective actions to bring them into conformance.

The overall goal of QC is to minimize loss of data through invalidation by establishing a reasonable level of checking at various stages of the data collection process. QC procedures determine if field and lab procedures are producing acceptable data and are used to initiate appropriate corrective actions; therefore QC is both proactive and corrective.

Initially, TRC will have primary responsibility for implementation of all monitoring program QC measures. After turnover of the system, EIDM will continue implementation of all QC measures following protocol established during the initial monitoring period by TRC. The following is a summary of QC activities that will be implemented to ensure that measurement uncertainty is maintained within established acceptance criteria for the attainment of the program DQOs. QC activities will include, but not be limited to, the following:

Sulfur Dioxide

- Daily automated calibration checks (zero/span and precision),
- Daily review of instrument measurements and diagnostics,
- Semiannual multipoint calibrations or as needed,
- Monthly operational checks by site operator,
- Routine maintenance as specified in TRC's Standard Operating Procedure (SOP), and
- Performance audits by NCDEQ, as determined by their schedule.

Meteorological Measurements

- Semiannual calibrations,
- Monthly on-site reasonableness checks by site operator,
- Verification that wind sensors are operational and show no sign of damage,

- Wind speed, direction and shelter temperature measurements represent actual conditions, and
- The initial audit will be performed within 60 days of the start-up date of the monitoring program, and
- Performance audits by NCDEQ, as determined by their schedule.

Detailed Measurement Quality Objectives (MQO's) have been developed for each criteria pollutant and are incorporated into Validation Templates.

Routine field activities for each measurement system are conducted according to the schedule in Table 10-1. Refer to the identified TRC SOPs for detailed procedures.

Table 10-1: Scheduled Field Activities

Field Activity	**Every Visit**	**Daily**	**Monthly**	**Quarterly**	**Semi-Annually**	**Annually**
Communication with Project Manager	X		X			
Change inlet filter	X		X			
Verify Instrument/Sensor	X		X			
Inspect/Clean or Replace sample tubing/filter	X		X			
Replace sample tubing						X
Visually Inspect Meteorological sensors/cables	X		X			
Site operator checks/inspections, logbook	X		X			
Calibration verification checks (automated)		X				
Perform & record analyzer calibrations.					X	
Perform & record meteorological calibrations.					X	
Audit pollutant analyzers (independent)						X
Met systems Audit					X	
Certify SO_2 tank					X	
Certify SO_2 dilution calibrator					X	
Ship documentation to Env. Programs				X		

10.1 Calibrations

Calibration is the process employed to verify and rectify an instrument's measurements in order to minimize deviation from a standard. This multiphase process begins with certifying a calibration or transfer standard against an authoritative standard. The analytical instrument's measurements are then compared to this calibration/transfer standard. If significant deviations exist between the instrument's measurements and the calibration/transfer standard's measurements, corrective action is implemented to rectify the analytical instrument's measurements.

Calibration requirements for the critical field and laboratory equipment are found in the SOPs and in the specific instruments' operations manuals.

A calibration is required:

- At the initial station start-up,
- If the monitor is replaced,
- If repairs to any of the measurement components of the monitor are performed,
- When two consecutive daily auto-calibration check results fail to meet acceptance criteria,
- When the operation is interrupted for more than 2 days without power (such as in the case with Extended weather related power outage or shelter repairs), and
- At a minimum of once per year per EPA guidance.

10.2 Precision Checks

Precision is the measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. In order to meet the DQOs for precision, TRC will ensure the entire measurement process is within statistical control. Various tools will be employed in evaluating and monitoring precision measurements. Daily one point calibration verification checks, and monitoring data integrity with control charts will provide evidence of deviations from the required precision measurement. Precision requirements for the applicable instrumentation are found in the SOPs and in the specific instruments' operations manuals.

10.3 Accuracy or Bias Checks

Accuracy is defined as the degree of agreement between an observed value and an accepted reference value. Accuracy is a combination of random error (precision), and systematic error (bias). Weekly zero and span checks can also provide data capable of identifying bias. Accuracy or bias requirements for various types of instrumentation are found in the SOPs and in the specific instruments' operations manuals.

11 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

All monitoring equipment will be tested during the pre-operational phase of the program. All instruments and sensors will receive a cursory calibration check to verify operation prior to deployment. All calibration standards will be inspected for current calibrations and traceability to NIST or the appropriate authority.

The following is a summary of activities and procedures TRC will follow to ensure all instrumentation and equipment will operate at acceptable performance levels throughout the duration of the program.

- SO_2
    - Daily review of instrument measurements and diagnostics,
    - Monthly operational checks by site operator, and
    - Routine maintenance as specified in EIDM Standard Operating Procedures (SOPs), and
    - Periodic performance audits by NCDEQ.

- Meteorological Measurements
    - Daily review of incoming data, and comparison to local NWS/NOAA data,
    - Monthly reasonableness checks by site operator
        - Verification that wind sensors are operational and show no sign of damage,
        - Wind speed, wind direction and temperature measurements represent actual conditions,
    - The initial audit will be performed within 60 days of the start-up date of the monitoring program,
    - Semi-annual performance audits, and
    - Routine maintenance as specified in EIDM SOPs.

Documentation of all site activities will be provided through the use of multiple forms including the site log books, site visit check sheets, maintenance and repair activities as well as calibration records. Inventory of spare parts and a schedule of routine activities will be maintained at the station. Copies of these forms are included in the appropriate EIDM SOP.

Table 11-1 presents an inventory of spare parts and expendable items that will be maintained on site for the duration of this monitoring program.

Table 11-1: Inventory of Spare Parts and Expendables	
Item	**Inventory at Site**
R.M. Young Wind Monitor - Complete	1
Prop for Vertical Wind Speed	1
43i-TLE Expendables Kits, 1 Year Supply	1
111 Zero Air Expendables, 1 Year Supply	1

12 INSTRUMENT CALIBRATION AND FREQUENCY

- SO_2
  - Daily automated calibration checks (zero/span and precision point in the range of 10-500 ppb), and
  - Semiannual multipoint calibrations, or as needed.

- Meteorological Measurements
  - Initial calibrations upon mobilization and installation, and
  - Semiannual calibrations.

Calibrations will be performed initially according to TRC SOPs. Following turnover, calibrations will be performed according to EIDM SOPs. All calibration equipment, including calibration gases, will be in current certification and traceable to the National Institute of Standards and Technology (NIST) or the appropriate authoritative standard. Hardcopy certification records will be maintained at the site location and in TRC's Gainesville office for the initial operating period until turnover and in the EIDM Huntersville laboratory for the remainder of the study. Electronic copies will be stored and backed-up on a central TRC server for the initial operating period until turnover and in the EIDM Huntersville central server for the remainder of the study. Calibrations and certifications will be performed by trained and experienced field scientists and technicians. Calibration equipment, as required, will be sent to the manufacturer or a facility equipped and qualified to perform traceable calibrations.

Calibrations and calibration checks will be performed according to the schedule in Table 4-4.

13 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES

TRC has installed new equipment purchased by Duke Energy for this project to minimize the potential for instrument failure and data loss. In addition, consumables and spare parts for a minimum of 13 months have been purchased for this monitoring location. These parts and consumables were obtained from the original equipment manufacturer and will be located at the site. The EIDM site operator will be responsible for maintaining an inventory of these items. In the event additional parts or supplies are needed, they will be procured from the instrument manufacturer through EIDM's Huntersville, North Carolina laboratory where they will be inspected prior to deployment. On a monthly basis, the local site operator will communicate to the project manager the status of all spare parts and consumable items. The site operator, or an individual designated by the EIDM Supervising Scientist will be responsible for ordering all parts, supplies and materials, as required, to meet the requirements of this program. The site operator will also be responsible for ensuring that these parts and supplies meet the specifications of the instrument manufacturer allowing all instrumentation to be operated in compliance with this QAPP.

14 DATA MANAGEMENT

Data management involves the collection, storage, transmittal, validation, reporting and archiving of measurements taken from continuous and time integrated samplers, sensors and instruments. The primary data collection system will initially be comprised of an on-site PC running software developed to acquire data digitally from the instrumentation operating at the monitoring station. Following turnover of the system from TRC to EIDM, the primary system will be an Environmental Systems Corporation 8832 data logger (or the equivalent) polled by a central server running Agilaire Air Vision data acquisition software. All continuous measurement instrumentation has built in data averaging and storage capabilities, as well as the ability to transmit those data digitally (e.g. USB, RS-485 or LAN interface). The data acquisition software (DAS) requests data from the instruments and populates a locally stored database containing multiple averaging intervals of each parameter. This database is the primary source of data.

During the initial operation by TRC, at 5-minute intervals, data are transferred via TCP/IP to a central server hosted by TRCAir.com. This server maintains TRC's central air monitoring database and hosts a limited access/secure website to allow for data display, review and editing. Software running on the central server performs a diagnostic check on incoming data and generates error reports based on screening criteria. These reports are emailed to project personnel. For QC purposes, data will also be stored on a local USB memory device and transferred to TRC's central server.

During the subsequent operating period by EIDM, the Air Vision central server will poll the Environmental Systems Corporation data logger on an hourly basis to retrieve 1-minute, 5-minute and hourly averages. The 5-minute average data will be posted to a secure FTP site by the Air Vision software for access by NCDEQ. All data will be maintained on the central server, and hourly data will be transferred to a historical SQL archive for backup and long-term storage.

The data technician and the site operator will review measurement data on a daily basis as a first level of validation. If any data are determined to be missing, the DAS software will attempt to retrieve these data from the instruments and place them in the local database. These values will be transferred to and populated in the central server. In the event data are not retrieved automatically, the data technician can connect to the instrument directly, retrieve data manually and load those data in to the central database.

The central database is structured with duplicate tables. The original data tables are protected, so they cannot be altered. A duplicate set of tables are identified as 'edited.' All data validation activities are stored in the edited tables.

Review and validation activities will be documented to ensure integrity and traceability of the measurement data. Edits will be independently verified by the data manager, the Supervising Scientist or other project staff. Status codes will be entered into the database indicating the action taken and validity of the datum.

Hard copy data (station logs, QC checks sheets, etc.) will be sent to the Gainesville office on a monthly basis during the initial operation period. Following turnover to EIDM, the hard copy records will be transferred to the EIDM Huntersville laboratory. Site documentation will be reviewed as part of the data validation process.

All data management activities will be performed in a manner consistent with TRC and EIDM SOPs, as applicable.

15 ASSESSMENTS AND OVERSIGHT

15.1 ASSESSMENTS AND RESPONSE ACTIONS

Assessment activities take place throughout the project to ensure that the QAPP is being implemented as approved.

15.1.1 Performance Audits

Performance audits, while intended to determine data accuracy, are also used to ensure that other aspects of the QAPP are being implemented. These audits will be conducted by an independent audit team, in the actual field location. The test equipment and standards used for the audit will be independent of those used for field operations. The audit equipment will also be documented and traceable to applicable standards. Performance audits will be performed by NCDEQ as determined by the agency's schedule. . EPA Appendix D, page 5 specifies annual performance audits.

15.1.1.1 *Meteorological Sensors*

Audits of the meteorological data collection systems will be conducted in accordance with the 2008 version of the US EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV - Meteorological Measurements* and *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/B-08-002). The initial audit will be performed within 60 days of the start-up date of the monitoring program. Follow-up audits will be conducted at six-month intervals.

Acceptable limits of accuracy for the meteorological sensors are identified in Table 15-1. In the event that any of the limits are exceeded calibration checks will be performed immediately after the audit.

Table 15-1: Calibration and Accuracy Criteria – Meteorological Measurements

Measurement	**Calibration**			**Accuracy**		
	Type	**Acceptance Criteria**	**Frequency**	**Type**	**Acceptance Criteria**	**Frequency**
Horizontal Wind Speed	NIST-traceable Synchronous Motor	±0.25 m/s < 5 mph, ±5%> 2 mph not to exceed 2.5m/s	Semi-Annual	NIST-traceable Synchronous Motor	±0.25 m/s < 5 m/s, ±5%> 2 m/s not to exceed 2.5m/s	Within 60 days of startup and semi-annually
Wind Direction	Magnetic Compass or GPS	±5 degrees Including orientation	Semi-Annual	Magnetic Compass or GPS	±5 degrees including orientation	Within 60 days of startup and

		error			error	semi-annually

Note: Threshold sensitivity for wind speed is 0.5 m/s (1.0 mph). Threshold sensitivity for wind direction is 0.5 m/s (1.0 mph) at 10°displacement, 0.7 m/s (1.6 mph) at 5° displacement.

15.1.1.2 *Air Quality Analyzers*

Audits of the continuous SO_2 data collection system will be conducted in accordance with the schedule presented in Table 15-2. Audits will be conducted in accordance with the 2013 version of USEPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II – Ambient Air Quality Monitoring Program* (EPA-454/B-13-003).

Table 15-2: Audit Schedule

Performance Audit Schedule	**Parameters to be Audited**
60 days after startup	SO_2 Analyzer, DAS
Performed by NCDEQ, as needed - EPA specifies annual	SO_2 Analyzer, DAS

Table 15-3: Accuracy Limits and Validation Criteria for Pollutant Measurements

Parameter	**Criteria**	**Samples Evaluated**	**Acceptable Range**	**Frequency of**	**Reference**
SO_2	3 consecutive audit levels	Test atmosphere generated from Certified Standard	≤15% difference for each audit level	Annually	40 CFR 58 App. A Section 3.1.2

Acceptable limits of accuracy for air quality instruments are identified in Table 15-3. In the event that any of the limits are exceeded calibration checks will be performed immediately after the audit.

SO_2 analyzers will be audited by introducing three known concentrations through as much of the inlet system as practicable. Audit procedures will be conducted in accordance with 40 CFR 58, Appendix A requirements at concentration levels specified in this part and Table 15-4. Audit concentration levels will be selected based on the ambient concentrations expected at this location. The instrument responses compared to the known input concentrations of the audit gases, as a percent difference, will be used to assess accuracy of the measurement data. The percent difference (d_i) is calculated as:

$$d_i = (\text{measured-audit})/\text{audit} \times 100$$

Table 15-4: SO_2 Audit Levels – 40 CFR 58 App. A 3.1.2.1	
Audit Level	**Concentration Range (ppb)**
1	0.3 – 2.9
2	3.0 – 4.9
3	5.0 – 7.9
4	8.0 – 19.9
5	20.0 – 49.9
6	50.0 – 99.9
7	100.0 – 149.9
8	150.0 – 259.9
9	260.0 – 799.9
10	800.0 – 1000.0

For the Skyland monitor, the audit levels for SO2 will be 0, 2.9, 18, and 70 ppb as specified by NCDEQ, which meets the above criteria.

All data used for the assessment of measurement accuracy will be submitted quarterly as specified in 40 CFR 58, Appendix A section 5.1.1.

15.1.2 Technical System Audits

A system audit of field activities including sampling and field measurements may be conducted and documented by the TRC Project QA Officer (or NCDEQ) at the start of sampling. The purpose of this audit is to verify that all established procedures are being followed as planned and documented and to allow for timely corrective action, reducing the impact of any nonconformance. The audit will ensure that all personnel have read the QAPP. The audit will cover field sampling records, field measurement results, field instrument operation and calibration records, sample collection, preservation, handling, and packaging procedures, adherence to QA procedures, personnel training, sampling procedures, review of sampling design versus the sampling plan, and corrective action procedures, etc. Follow-up surveillance will be conducted by the TRC Field Operations Manager to verify that QA procedures are maintained throughout the investigation.

Prior to performing the audit, the auditor will review the QAPP and assure that the audit equipment is certified and is up to date with calibrations.

Upon completion of the audit, the TRC Project QA Officer will prepare a written audit report, which summarizes the audit findings, identifies deficiencies and recommends corrective actions. In addition, a verbal debriefing will also be given to the TRC Field Operations Manager and

TRC Project Manager at the time of the audit. The written report will be submitted to the TRC Project Manager, who will be responsible for ensuring that corrective measures are implemented.

A field system audit will be conducted by TRC personnel at the time of turnover to EIDM. EIDM will participate in the field system audit as observers. For the turnover, a system calibration check of all instrumentation will be performed to ensure proper operation at the time of transfer.

15.1.3 Field Systems Audit

The following tasks will be performed during the audit:

Station Location:

- Instrument shelter and surrounding area inspections,
- Inventory of air monitoring equipment,
- Review of calibration records – NIST traceable,
- Review SOPs – ensure they are being followed,
- Review site logs and documentation – ensure procedures are followed, and
- Ensure site personnel are knowledgeable about the project and procedures by interviews.

Meteorological Instruments (semi-annual):

- Ensure heights and exposures are in accordance with USEPA regulations, and
- Check for accuracy of sensors as required by manufacturer as well as USEPA regulations.

Air Quality Instruments and Inlet (quarterly):

- Ensure inlet heights and exposures are in accordance with USEPA regulations
- Visually inspect sampling lines
- Manually calculate flow rates, if possible. Ensure flow rates meets guidelines, and
- Review documentation to ensure instruments meet Federal Reference Methods equivalent specifications.

15.1.4 Data Quality Systems Audits

The data quality audit will consist of an evaluation of the project management organization, field operations, personnel qualifications and training, data management and processing procedures, QA program, and data reporting methods. The intent of the data quality audit is to ensure traceability of data from point of collection to reporting.

15.1.5 Regulatory Audits

The state regulatory agency may choose to perform a systems audit, which would provide an assessment of adherence to the QAPP. The Duke Energy Environmental Supervisor will coordinate access to the sites for any audits needed.

15.1.6 QAPP Revisions

It may be necessary for sections of this QAPP to be updated in the event that: additional information is received; changes in any system or procedure; changes in conditions at the site. Any revisions to this QAPP will be made by a written and approved amendment, which will become a permanent part of this plan.

15.1.7 Field Non-Conformances

Corrective action in the field may be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the QAPP), or when sampling procedures and/or field procedures require modification, etc. due to unexpected conditions. The field team may identify the need for corrective action. The TRC Operations and Data Manager will approve the corrective action and notify the TRC Project Manager and TRC QA Officer. The TRC Project Manager, in consultation with the NCDEQ, if necessary, will approve the corrective action. The TRC Operations and Data Manager will ensure that the corrective action is implemented by the field team. Following turnover of the system to EIDM, the field team will identify the need for corrective actions to the EIDM Supervising Scientist. Corrective actions will be documented within the EHS Etrac documentation system. Corrective actions will be communicated to the EHS Environmental Programs Project Manager and to NCDEQ. The EIDM Supervising Scientist will ensure that the corrective action is implemented and results are documented within Etrac.
Corrective actions will be implemented and documented in the field logbook. Documentation will include:

- A description of the circumstances that initiated the corrective action,
- The action taken in response,
- The final resolution, and
- Any necessary approvals.

No staff member will initiate corrective action without prior communication of findings through the proper channels as described above. All corrective actions will take into account the possible effect on the data. If necessary, a problem resolution audit will be conducted. Corrective actions will be described in the quarterly reports.

16 REPORTS TO MANAGEMENT

16.1 Performance and Technical Systems Audit Reports

Performance audits will be conducted of the ambient air monitors and the meteorological sensors by NCDEQ, as needed. The initial audit of the station will be performed within 60 days of the start-up date of the monitoring program.

16.2 Quarterly Data Reports

The Duke Energy Environmental Programs Project Manager is routinely kept informed of project oversight and assessment activities and findings via meetings with the TRC project manager or the EIDM Supervising Scientist. Additionally, the Project Manager receives the quarterly report, which contains the following elements: quarterly data summary including any violation of standards, completeness achieved, explanation of any missing or invalidated data, hourly pollutant and calibration and audit forms. The TRC Data Manager is initially responsible for compiling the quarterly report. Following turnover, the EIDM Supervising Scientist will compile the quarterly report. Quarterly electronic data submittals will include pollutant concentrations along with measurement quality checks (as specified in section 1.4 of 40 CFR 58, App. A).

Each quarterly report will be comprised of the following:

- Executive Summary,
- 5-minute and hourly values for SO_2,
- Highest 5-minute SO_2 concentration in each hour,
- Hourly values for WS, WD in Excel format,
- Frequency distribution plot (wind rose) of wind speed and wind direction,
- Frequency distribution plot (pollutant rose) of SO_2 concentrations and wind direction,
- Results of instrument QC checks,
- Explanation of corrective actions addressed during period,
- QA/QC and equipment maintenance documentation, and
- Quarterly and cumulative data capture statistics by parameter.

After internal approval, the report is forwarded to the Duke Energy Environmental Programs Project Manager, who is responsible for submitting the information to NCDEQ with the appropriate certification form. The reports are to be submitted to NCDEQ within 45 days of the end of each monitoring quarter.

16.3 Corrective Action Reports

The need for corrective action may be identified during audits, data validation, or data assessment. Potential types of corrective action may include data qualification. These actions are dependent upon whether the data to be collected is necessary to meet the required QA objectives. If the data validator or data assessor identifies a corrective action situation, the TRC Project Manager or EIDM Supervising Scientist will be responsible for informing the appropriate personnel. All corrective actions of this type will be documented by the TRC Project Manager or EIDM Supervising Scientist and maintained in the project files.

17 DATA VALIDATION AND USABILITY

17.1 DATA REVIEW, VERIFICATION AND VALIDATION

Data review, validation and verification procedures are used to accept, reject or qualify air quality and meteorological measurement data in an objective and consistent manner. Criteria used to review and validate measurement data are defined in this section. Ambient air quality data will be validated, invalidated or qualified by comparing measurements with criteria established in the Data Validation Tables as presented in EPA QA Handbook Volume II, Appendix D. These tables and be found here:
http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/appd_validation_template_amtic.pdf and presented in Appendix B. These tables establish three levels of criteria where each table has a different degree of implication about the quality of the data. Criteria that are deemed **Critical** to maintaining the data integrity are shown in the first section of the tables. Observations that do not meet all criterion on the Critical Criteria Table should be invalidated unless there are compelling reason and justification otherwise. Criteria that are important for maintaining and evaluating data quality are included in the second section of the table. Violation of an **Operational** criterion or a number of operational criteria may be cause for invalidation. Detailed review of quality control results and operational information may or may not indicate data are acceptable for the parameter being evaluated. If one or more of these criteria are not met data are considered suspect unless other quality control information demonstrates otherwise. **Systematic** criteria which are important for the correct interpretation of the data but may not impact the validity are shown in the third section of the Tables.

Meteorological data will be evaluated based on the results of calibration criteria previously presented in Table 15-1.

Overall, in order for data to be considered valid, each data point must be identifiable in terms of parameter, date, time and units. Instruments and sensors must be calibrated and operated according to applicable EIDM and TRC SOPs and must be bracketed by acceptable calibrations, QC checks and audits to support determination of validity. All documentation, including site logs, check lists and maintenance records must be sufficient to support validity of the data.

17.2 VALIDATION AND VERIFICATION METHODS

Verification can be defined as confirmation that specified operational requirements have been fulfilled by providing objective evidence. Data verification involves the inspection, analysis, and acceptance of measurement data or samples. Data validation is a routine process designed to ensure that reported values meet the DQOs of the measurement program. The data validation process should examination the collected evidence, in the form QC data and operation documentation, to determine if measurement data meets the requirements for the specific intended use. The purpose of data validation is to detect and then verify any data values that may not represent actual air quality conditions at the sampling station.

17.2.1 Data Validation Process

TRC and EIDM will employ a 3 tiered approach to data validation; Level 0, Preliminary (sometimes referred to as Level 1) and Final (Level 2). This process will assure that data collected for this air quality monitoring program are of sufficient quality to meet the project objectives. Records of QC activities, to be described in the QAPP, will be reviewed on an on-going basis and used for determination of data validity. Calibrations, flow audits, automated QC checks, sample data sheets and operator log entries will also be used in the validation process. Daily review will be conducted by staff in Gainesville, FL. or by EIDM staff in Huntersville, N.C. during the respective periods of operation. Visual data inspection as well as results of screening software will be used for validation on a daily basis. The following is an overview of TRC's and EIDM's data validation process:

Level 0 Validation (Daily)

- Review for completeness and acquire missing data if available,
- Review for anomalies and reasonableness,
- Visually review graphed data, and
- Evaluate automated QC checks (zero/span/precision, etc.).

Preliminary Validation (Level 1)

- Review site records (i.e. operator logbook and sample data sheets),
- Review operator QC checks (i.e. sampler flow rate checks),
- Evaluate any noted anomalies to other data sources (i.e. meteorological conditions compared to nearest National Weather Station (NWS) or other verifiable measurements),
- Review instrument calibration records,
- Review performance audit results, and
- Edit/enter validation codes.

Final (Level 2) Validation

Data are considered final when it can be demonstrated that they meet the data quality objectives of the program and are a true representation of the air quality and meteorological conditions in the region. Data must pass Final Validation criteria before submittal to NCDEQ. Activities for Final Validation include:

- Generation of monthly data summaries,
- Review of monthly data by TRC Program Manager, Operation and Data Manager and TRC QA Manager during initial operation, and EIDM Supervising Scientist following system turnover,
- Resolution of any inconsistencies, and
- Update validation codes to final.

17.3 RECONCILIATION WITH USER REQUIREMENTS

The objectives of this monitoring program are described in Section 2.1. TRC and Duke have established this air monitoring program to measure the levels of gaseous pollution. Sulfur dioxide and meteorological monitoring systems are installed to provide scientifically defensible air quality data to characterize the extent, frequency of occurrence, and magnitude of pollutant concentrations in the region. Data are expected to provide a true representation of air quality in the vicinity.

EIDM will conduct quarterly and annual review of the monitoring program to ensure all data considered valid meet the defined network acceptance criteria and monitoring objectives by verifying that quality assurance procedures and documentation are reviewed and evaluated in the data validation process. Performance audits, calibrations, automated and manual precision and accuracy tests, technical systems audits, as well as all other methods used to ensure data quality are considered as part of this review. If, at any time, the review process indicates objectives of the monitoring program are not being met, the project and QA managers will reassess this QAPP.

APPENDIX A

Standard Operating Procedures (SOPs)

TRC Standard Operating Procedures (SOPs)

AM 050 Routine Station Check of Ambient Air Quality Station

AM 100-03 Thermo Scientific Model 43C, 43i Operations and Maintenance

Duke Energy EIDM Standard Operating Procedures (SOPs)

7404 Data Validation Procedure for Ambient Air Quality, Ambient Water Quality and Meteorological Data

7830 Environmental Systems Corp. (ESC) 8832 Data Logger Calibration Procedure for SO2 Sites

7831 Air Vision Setup; Retrieval, Review, Correction and Storage of Data; Report Submission

7832 Manual Calibration Check Procedure

7833 Ambient Air Quality Site Check

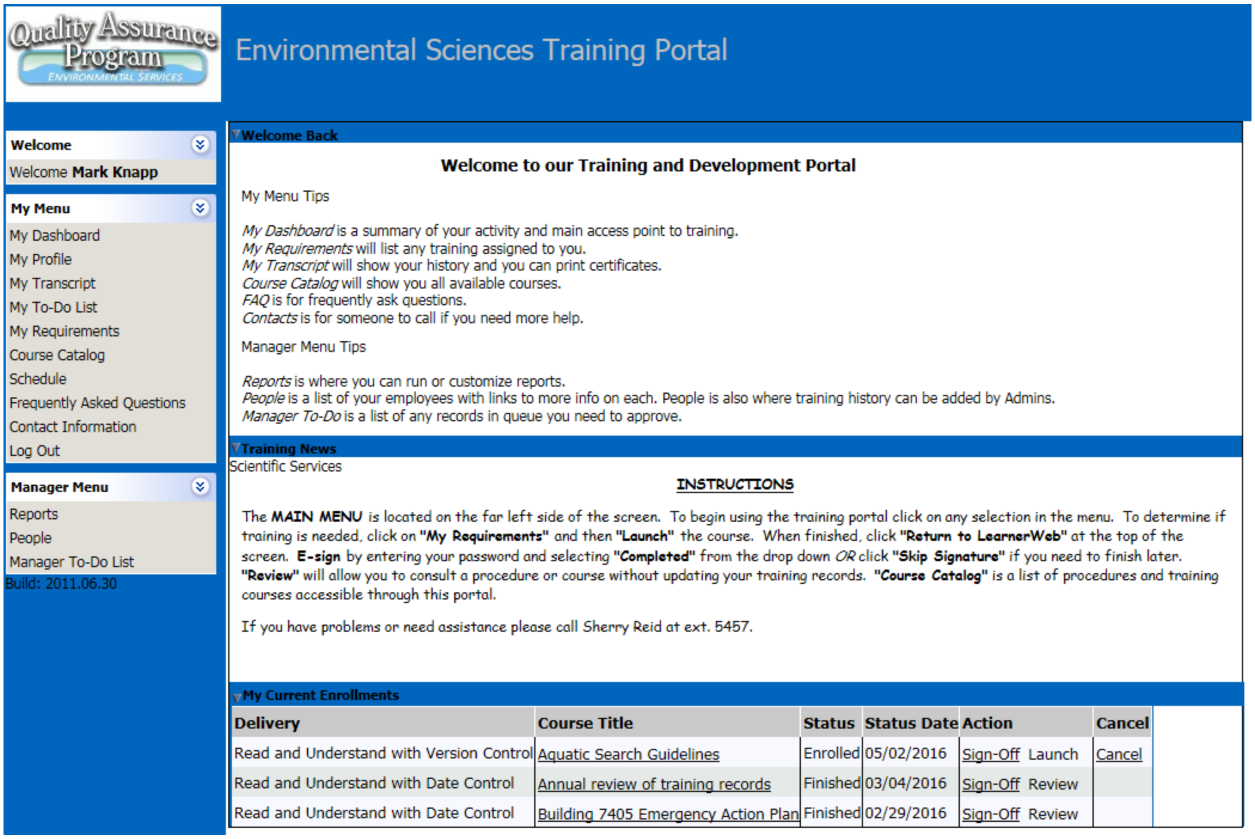
7834.1 Thermo Environmental Model 43i-TLE Analyzer Calibration Procedure7835 R.M. Young 05305v Wind Speed/Direction Transmitter Bench Calibration Procedure

7836 R.M. Young 05305v Wind Speed/Direction Transmitter Field Calibration Procedure

APPENDIX B

<u>Training</u>

Training requirements and records are maintained within Environmental Sciences' training database system, Learner Hall. This system is accessed through the Environmental Sciences Training Portal at: http://scientificservices.learnerhall.com/DukeEnergy/Programs/Standard/Control/elmLearner.wml?RemoteST=ac10017807e00517090c12870



The Leaner Hall **MAIN MENU** is located on the far left side of the screen. To begin using the training portal, click on any selection in the menu. To determine if training is needed, click on **"My Requirements"** and then **"Launch"** the course. When finished, click **"Return to LearnerWeb"** at the top of the screen. The user may **E-sign to indicate completion of a course** by entering their password and selecting **"Completed"** from the drop down *OR* click **"Skip Signature"** if they need to finish later. **"Review"** will allow a user to consult a procedure or course without updating their training records. **"Course Catalog"** is a list of procedures and training courses accessible through this portal.

Employee training requirements and records may be reviewed by the section supervising scientist by selecting Reports under the Manager Menu. Available reports include the following:

Report Name
Training Tracking by Course
Expiring Training By Person
Training Tracking by Person
Learning Track Progress By Track then By Person
Learning Track Progress By Person then By Track
Annual Training Report

APPENDIX C

List of References

EPA QA Handbook for Air Pollutions Measurement Systems, Volume II (EPA-454/B-13-003, May 2013)

EPA QA Handbook for Air Pollutions Measurement Systems, Volume IV (EPA-454/B-08-002, March 2008)

Duke Energy Health and Safety Handbook

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