QUALITY ASSURANCE PROJECT PLAN (QAPP)

FOR AMBIENT AIR QUALITY MONITORING OF CRITERIA AIR POLLUTANTS

3/7/22

SUBMITTED BY

THE FORSYTH COUNTY OFFICE OF ENVIRONMENTAL ASSISTANCE AND PROTECTION (FCEAP)

Quality Assurance Project Plan Acronym Glossary

A&MD- Analysis and Monitoring Division
A&MPM- Analysis and Monitoring Program Manager
AQI – Air Quality Index
AQS - Air Quality System (EPA's Air database)
CFR – Code of Federal Regulations
DAS - Data Acquisition System
DQA - Data Quality Assessment
DQI - Data Quality Indicator
DQO - Data Quality Objective
EPA - Environmental Protection Agency
FCEAP-Forsyth County Office of Environmental Assistance and Protection
FTS - Flow Transfer Standard
FEM – Federal Equivalent Method
FRM – Federal Reference Method
LAN – Local Area Network
MQO – Measurement Quality Objective
NAAQS - National Ambient Air Quality Standards
NCDAQ - North Carolina Division of Air Quality
NIST - National Institute of Science and Technology
NPAP - National Performance Audit Program
PEP – Performance Evaluation Program
PQAO – Primary Quality Assurance Organization
QA – Quality Assurance
QA/QC - Quality Assurance/Quality Control
QAPP - Quality Assurance Project Plan
QC – Quality Control
SD – Standard Deviation
SLAMS - State and Local Air Monitoring Station
SOP - Standard Operating Procedure
SPM - Special Purpose Monitor
TEOM - Tapered Elemental Oscillating Microbalance
TSA - Technical Systems Audit
TTP – Through the Probe

1.1 Title and Approval Page

Title: *Quality Assurance Project Plan (QAPP) for Ambient Air Quality Monitoring of Criteria Air Pollutants*, Revision 2.1, March 7, 2022.

The attached QAPP is hereby recommended for approval and commits the Forsyth County Office of Environmental Assistance and Protection (FCEAP) to follow the elements described within.

Name: Cary Gentry Signature: Date: 3/7/22

Title: FCEAP QA Specialist

Name: Jason Bodenhamer Signature: Date: 3/7/22

Title: FCEAP Program Manager

Name: Minor Barnette Signature: Date: 3/7/22

Title: FCEAP Director

EPA Region 4

Name: Signature: Date:

Title: Designated Approving Official

REVISION	DATE	CHANGES TO QAPP
2	02/2021	Replaced Agilaire EDAS procedures with Agilaire AirVision procedures. Updated the distribution list. Updated Table 11 to reflect instrumentation changes in the network. Replaced the TEOM MQO tables with the T640(x) MQO tables provided by EPA Region 4. Updated Figure 9 and added Figure 10 to reflect QA process changes for AirVision. Updated file structure from a shared network drive to Microsoft Teams.
2.1	09/2021	The gravimetric lab that FCEAP uses to weigh its PM2.5 FRM filters has changed from NC DAQ to Research Triangle Institute. All language has been updated to reflect this change. PM2.5 sampler colocation information has been updated. Table 17 has been updated to include all available AQS QA flags. Other minor edits as part of the annual review. Updated NO2 QC check acceptance criteria from 10% to 15%.

1.2 TABLE OF CONTENTS

List of Tables and Figures

1.3 QAPP - DISTRIBUTION LIST

Paper or digital copies of this QAPP have been distributed to the people listed in the **Distribution List**. Revised sections or the entire QAPP are sent to these individuals, as appropriate.

A hard copy of this document is maintained in the office of the A&MPM and available at all times to any staff involved in the FCEAP ambient air monitoring program. A PDF version of the document is also available on FCEAP's Local Area Network (i.e., Shared Drive) with the location accessible and known to all air monitoring staff.

W. Minor Barnette, Director
Forsyth County Office of Environmental Assistance and Protection
201 N. Chestnut Street, Winston-Salem, NC 27101
E-mail: barnetwm@forsyth.cc
Phone: 336-703-2441

Jason R. Bodenhamer, A&M Program Manager
Forsyth County Office of Environmental Assistance and Protection
201 N. Chestnut Street, Winston-Salem, NC 27101
Email: bodenhjr@forsyth.cc
Phone: 336-703-2448

Lawrence G. Akoje, Senior Environmental Specialist
Forsyth County Office of Environmental Assistance and Protection
201 N. Chestnut Street, Winston-Salem, NC 27101
E-mail: akojelg@forsyth.cc
Phone: 336-703-2451

Cary D. Gentry, Senior Environmental Specialist
Forsyth County Office of Environmental Assistance and Protection
201 N. Chestnut Street, Winston-Salem, NC 27101
E-mail: gentrycd@forsyth.cc
Phone: 336-703-2453

Jordan Payne, Senior Environmental Specialist
Forsyth County Office of Environmental Assistance and Protection
201 N. Chestnut Street, Winston-Salem, NC 27101
E-mail: paynemj@forsyth.cc
Phone: 336-703-2455

Robert O. Russ, Senior Environmental Specialist
Forsyth County Office of Environmental Assistance and Protection
201 N. Chestnut Street, Winston-Salem, NC 27101
E-mail: russro@forsyth.cc
Phone: 336-703-2450

John M. Stoltz, Environmental Specialist
Forsyth County Office of Environmental Assistance and Protection
201 N. Chestnut Street, Winston-Salem, NC 27101
E-mail: stoltzjm@forsyth.cc
Phone: 336-703-2433

Gregory T. Perrotte, Senior Environmental Specialist
Forsyth County Office of Environmental Assistance and Protection
201 N. Chestnut Street, Winston-Salem, NC 27101
E-mail: perrotgt@forsyth.cc
Phone: 336-703-2452

USEPA Region 4 Contacts

Stephanie McCarthy
US EPA Region 4 (SESD)
980 College Station Rd. Athens, GA 30605
E-mail: mccarthy.stephanie@epa.gov
Phone: 706-355-8745

Ryan Brown
US EPA Region 4 (APTMD)
61 Forsyth St, SW Atlanta, GA 30303
E-mail: brown.ryan@epa.com
Phone: 404-562-9147

Darren Palmer
US EPA Region 4 (APTMD)
61 Forsyth St, SW Atlanta, GA 30303
E-mail: palmer.darren@epa.com
Phone: 404-562-9052

1.4 PROJECT ORGANIZATION

EPA is responsible for developing National Ambient Air Quality Standards (NAAQS), defining the quality of the data necessary to make comparisons to the NAAQS, and identifying a minimum set of quality control samples from which to judge data quality. State and local organizations are responsible for taking this information and developing and implementing a quality assurance program that will meet the data quality requirements. It is the responsibility of the EPA and the monitoring organizations to assess the quality of the data and take corrective action, when appropriate.

The Forsyth County Office of Environmental Assistance and Protection (i.e., FCEAP or Office) is a "certified local air pollution program," acting as the State throughout Forsyth County, North Carolina, including incorporated areas (i.e., the Winston-Salem, Greensboro, and High Point Triad Region, which includes the 10 counties surrounding Forsyth County; see Figure 1 below). FCEAP's mission is to lead and assist Forsyth County towards meeting and maintaining compliance with the NAAQS, as well as to provide air quality forecasting to the Triad Region. FCEAP operates within the jurisdiction of EPA Region 4, and collaborates with the EPA Region 4, as necessary, to ensure FCEAP's ambient air monitoring network meets or exceeds regulatory requirements.

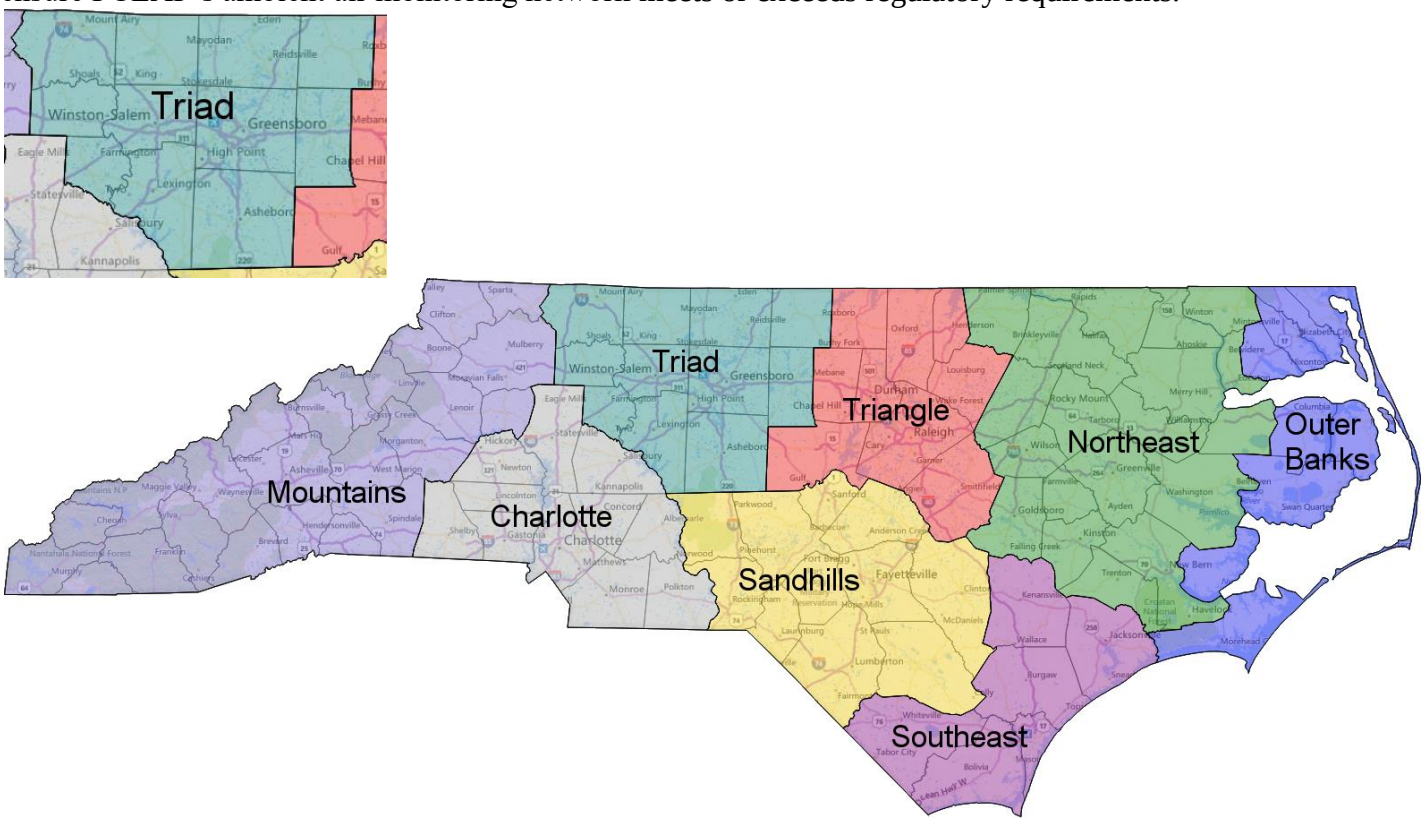


Figure 1: North Carolina Triad Region

FCEAP is organized into 4 divisions, with the Analysis and Monitoring Division (i.e., A&MD or Division) being responsible for all ambient air quality data collection and quality assurance activities (see Figures 2 and 3). FCEAP serves as its own Primary Quality Assurance Organization (PQAO) in accordance with 40 CFR Part 58, Appendix A, Section 1.2; as such, FCEAP is charged with implementing a quality system that provides sufficient information to assess the quality of the monitoring data collected in Forsyth County. As of the date of this QAPP, the A&MD contains approximately 7 positions; however, some of these positions devote a percentage of their time to other FCEAP duties that are not associated with the monitoring network. Given the small size of the A&MD, individuals within this Division are cross-trained to build and ensure staff redundancy, such that FCEAP can continuously maintain monitoring and QA operations, skills and knowledge, in the event of unexpected turnover. As such, there is overlap in the job duties within the A&MD positions.

The following sections describe the roles and responsibilities of staff involved with the FCEAP ambient air monitoring program. As noted above, not all positions within the A&MD are dedicated solely to the ambient air monitoring program; the descriptions that follow highlight the key tasks of these positions as they relate to monitoring, and do not include information regarding other FCEAP job duties. This section also briefly discusses other entities which collaborate and assist FCEAP with ambient air monitoring-related functions.

Director

The Director of FCEAP has the overall responsibility for managing the Office according to Forsyth County policy. The Director maintains overall responsibility for the management and administrative aspects of the QA program; as such, the Director is responsible for establishing QA policy and for resolving QA issues identified through the QA program. The Director has "stop work authority" and will make final decisions regarding monitoring issues. Major responsibilities of the Director include, but are not limited to, the following:

- Directing each Division within the FCEAP;
- Managing and reviewing budgets, contracts, grants and proposals;
- Reviewing, overseeing, and evaluating overall air monitoring activities;
- Assuring that the Office develops and maintains a current and germane quality system;
- Acquiring resources and maintaining budgets pertinent to the collection of environmental data; and,
- Maintaining an active line of communication with the program managers.

The Director delegates the responsibility and authority to develop, organize, implement, and maintain ambient air monitoring programs to the Analysis & Monitoring Program Manager (A&MPM). The Director also delegates the responsibility and authority to implement quality programs and procedures to the A&MPM, in accordance with the FCEAP Quality Management Plan (QMP).

A&M Program Manager

The direct responsibility for assuring ambient air monitoring data quality rests with the A&MPM and the specialists working within the A&MD. The A&MPM reports to the FCEAP Director and serves as the Office's Quality Assurance Officer (QAO), as well as monitoring liaison to EPA Region 4. The A&MPM consults with the Director on monitoring and QA-related issues, and makes recommendations, when appropriate. The manager's duties include, but are not limited to, the following:

- Supervising the activities of A&MD staff;
- Communicating with EPA Region 4 personnel on issues related to routine monitoring and QA activities;
- Maintaining overall responsibility for the monitoring network design, review, and assessment;
- Maintaining oversight of QA/QC activities, which includes ensuring staff correctly implement and complete regulatory and FCEAP QAPP/SOP requirements, along with verifying that data and measurement quality objectives (i.e., DQOs and MQOs, respectively) are met as prescribed in the QAPP;
- Documenting deviations from established procedures and methods;
- Conducting internal audits designed to ensure that A&MD staff are adhering to the FCEAP QAPP and SOP requirements, and documenting the results;
- Directing staff to implement corrective actions based upon the results of internal performance/systems audits;
- Serving as the arbiter on final data quality/validity determinations and corrective action effectiveness;
- Developing and maintaining this QAPP for the Office's Ambient Air Quality Monitoring Program;
- Training staff in the requirements of the QAPP and associated FCEAP SOPs;
- Ensuring timely and appropriate updates to the QAPP and SOPs;
- Managing the retention of the FCEAP quality documents and other QA/QC records;
- Assisting in the acquisition of resources and maintenance of equipment inventories, including ordering supplies and consumables;
- Overseeing that all necessary preventive maintenance and equipment certification activities are completed in accordance with the schedules established within the QAPP;
- Coordinating and reviewing the collection of air quality data, which includes performing data quality assessments and flagging suspect data;
- Providing support for agency databases and data reporting through the EPA's Air Quality System (AQS) database;
- Reviewing QA/QC data files prepared for AQS upload to ensure overall accuracy and completeness, and generating subsequent AQS reports to verify successful and accurate upload;
- Reviewing AQS reports generated by staff, in order to routinely assess and verify the quality of FCEAP data;

- Certifying FCEAP data annually to EPA Region 4 as accurate and complete, in accordance with 40 CFR Part 58 requirements;
- Providing hands-on technical training on instrument operations and maintenance activities, as needed;
- Ensuring staff receive relevant training by other providers (such as EPA), as resources and budgets allow, as well as participating in various training and certification activities in order to stay current on ambient air monitoring and QA requirements;
- Preparing air quality trends reports for FCEAP and other entities within the Triad Region and community, as requested;
- Reviewing budgets, contracts, and proposals related to monitoring; and,
- Responding to public records requests.

Quality Assurance Specialists

The FCEAP has two positions whose primary responsibilities are as QA Specialists for the monitoring program. In addition, a third position functions as a QA Specialist for non-continuous $PM_{2.5}$ data due to the operator of our non-continuous $PM_{2.5}$ network being a QA specialist for all gaseous pollutants. (These QA Specialist positions are also referred to as QA1 and QA2 in FCEAP SOPs.) The QA Specialists report to the A&MPM and are responsible for coordinating, performing, and/or assisting with the QA activities of the FCEAP monitoring program. As described above, personnel in the A&MD are cross-trained and have overlapping responsibilities in order to ensure all network requirements are met, as well as maintain redundancy in skills. Of the two gaseous QA Specialists, one ("QA1") position operates the filter-based $PM_{2.5}$ monitoring network. As a result, a third position that is independent from all non-continuous $PM_{2.5}$ field activities and functions as QA1 for all non-continuous $PM_{2.5}$ data. The second ("QA2") is independent from both gaseous and particulate-based field operation activities which result in the generation of ambient air monitoring concentration data; the Specialist in this position does <u>not</u> operate or maintain any monitoring instruments/stations in the field or collect environmental samples. However, the Specialist in this position is responsible for conducting all performance audits on the monitors/samplers operated within the FCEAP network. The three Specialists are charged with data validation responsibilities; if there is a disagreement on how to flag/code a specific data point, the resolution is made by the A&MPM.

The QA Specialists duties include, but are not limited to, the following (as assigned by position):

- Scheduling and performing quarterly audits on FCEAP air monitors/samplers in accordance with the Office's quality system requirements (QA2 only);
- Scheduling and conducting standards' certifications, in accordance with QAPP requirements (QA2 only);
- Scheduling and conducting site systems audits (QA2 only);
- Conducting Appendix E siting criteria evaluations (QA2 only);
- Documenting the results of performance/systems audits, and siting evaluations, and reporting non-conformances to the A&MPM (QA2 only);
- Preparing AQS files with the results of quarterly performance audits and reviewing them for accuracy (QA2 only);

- Serving as the designated AQS Administrator for the Office and maintaining communication with EPA on AQS-related issues (QA2 position only);
- Maintaining QA records and documentation;
- Organizing, collecting, and processing the data produced by the FCEAP monitoring network;
- Verifying all required QA/QC activities are performed in accordance with the Office's QAPP/SOPs and that MQOs are met;
- Validating data, in accordance with the requirements in this QAPP and as detailed in the FCEAP Data Handling and Reporting SOP;
- Generating monthly reports to attest that all data review activities are completed, prior to generating AQS data files;
- Preparing intermittent-sampler QC data files for AQS entry (Specialist designated by A&MPM only); reviewing these files for accuracy and completeness (QA2);
- Submitting finalized, validated data to the AQS database on the frequency prescribed within this QAPP;
- Reporting nonconforming conditions and corrective actions to the A&MPM;
- Preparing air quality trends reports for FCEAP and the community, as assigned by the A&MPM;
- Writing and/or revising SOPs, as needed, and/or reporting the need to revise SOPs to the A&MPM;
- Performing $PM_{2.5}$ FRM-related QC duties, which includes ensuring data collection and handling meets the requirements of the Office's QAPP and $PM_{2.5}$ SOP (independent QA1 position only); reviewing summary data prepared by the independent QA1 position and data files created by the operator for AQS entry (QA2);
- Performing preventive maintenance and any necessary corrective actions on the Office's independent audit equipment (QA2) and to $PM_{2.5}$ field equipment (QA1), as needed;
- Assisting site operators with sites and grounds maintenance and repairs, when requested;
- Providing support for the Office's databases, including AirVision, and the FCEAP $PM_{2.5}$ Access database, as well as the EPA AQS database;
- Assisting in training Division staff on QA/QC, as well as participating in training and certification activities in order to stay current on monitoring and QA requirements; and,
- Acts as liaison with the RTI gravimetric lab and communicates issues to the A&MPM (QA1 only).

The QA Specialists have the authority to carry out these duties and the responsibility to bring to the attention of the A&MPM any issues related to these responsibilities.

Site operators

Site operators report to the A&MPM and are responsible for conducting routine air quality monitoring QC activities. They are responsible for most of the equipment troubleshooting and repairs, along with monitoring site (building and grounds) maintenance. Their duties generally include, but are not limited to, the following (as assigned by position):

- Performing all required QC activities, including calibrations and precision checks, in accordance with the FCEAP's quality system requirements, and verifying that performance specifications, as defined in the Office's SOPs, are met;
- Performing and documenting all monitoring equipment maintenance activities;
- Informing the A&MPM on supplies and consumables inventory needs;
- Performing troubleshooting on equipment and implementing corrective actions, when necessary;
- Reporting nonconforming conditions and corrective actions to the A&MPM;
- Maintaining QC records and documentation;
- Collecting and reviewing environmental data, as prescribed in FCEAP SOPs;
- Performing data verification activities as described in the FCEAP Data Handling SOP, which includes flagging suspect data;
- Participating in training and certification activities and, in some instances, providing training to fellow site operators;
- Preparing monthly reports, as described in Section 3.1.6 of this QAPP and further detailed in the FCEAP Data Handling SOP;
- Writing and/or revising SOPs, as needed, and/or reporting the need to revise SOPs to the A&MPM;
- Reporting data utilizing the AirVision database; and,
- Providing limited support to the Office's databases, including the FCEAP $PM_{2.5}$ Access database.

The site operators have the authority to carry out these duties and the responsibility to bring to the attention of the A&MPM, or the QA Specialists, any issues related to these responsibilities.

LASS Program Manager

Logistics and Support Services (LASS) Program Manager – *Grant Administrator* – This person maintains the Section 103 and Section 105 grants that provide much of the funding provided by U.S. EPA to the support FCEAP's air quality monitoring network. The LASS Program Manager works with the A&MPM to assure awareness of all reporting requirements and time frames necessary to maintain grant funding. The LASS Manager also oversees supporting staff that facilitate the financial services and budgetary requests needed to maintain the monitoring program.

Management Information Services Department (MIS) – The MIS Department of Forsyth County is a separate entity from the FCEAP, but serves in a supporting role to the FCEAP ambient air monitoring program. Their duties include:

- Assuring site computers are networked to the County servers to assure proper transport and storage of data;
- Assisting and implementing wired and wireless services at the air monitoring sites;
- Assisting FCEAP with the backup and security of all data, including our AirVision SQL database, used by the A&MD;
- Supporting FCEAP workstation configurations to assure appropriate access to AQS and other on-line reporting; and,

- Maintaining servers and data security.

General Services Department of Forsyth County – The General Services Department of Forsyth County is also a separate entity from the FCEAP, but provides assistance to FCEAP in the construction and maintenance of the monitoring sites (buildings and grounds).

North Carolina Division of Air Quality (NCDAQ) – Occasionally, NCDAQ QA staff conduct instrument performance audits of the FCEAP monitoring network. These audits are infrequent, and only occur when budgets and resources allow, and when both agencies agree they would be beneficial. The A&MPM is the point of contact with NCDAQ and makes arrangements for these audits. Similarly, FCEAP QA Specialists may audit NCDAQ air monitoring stations, if requested.

Research Triangle Institute (RTI) – The RTI International laboratory performs gravimetric analysis of $PM_{2.5}$ filters collected in the FCEAP monitoring network. The lab operates under separate QAPP(s) and SOPs. These QA documents are available from RTI upon request by the agency directly in contract with RTI. Since the contract to weigh our filters by RTI is with the NCDAQ, RTI QA documents are only included in and available through the NCDAQ QA documents themselves. Up-to-date copies of the NCDAQ QA documents will be downloaded from the state directly and stored in the FCEAP teams QAPP folder.

Mecklenburg County, Land Use and Environmental Services Agency, Air Quality Section (MCAQ) – Similar to the partnership with NCDAQ, occasionally MCAQ QA staff conduct instrument performance audits of the FCEAP monitoring network. These audits are infrequent, and only occur when budgets and resources allow, and when both agencies agree they would be beneficial. The A&MPM is the point of contact with MCAQ and makes arrangements for these audits. Similarly, FCEAP QA Specialists may audit MCAQ air monitoring stations, if requested.

Figure 2 FCEAP Organizational Chart

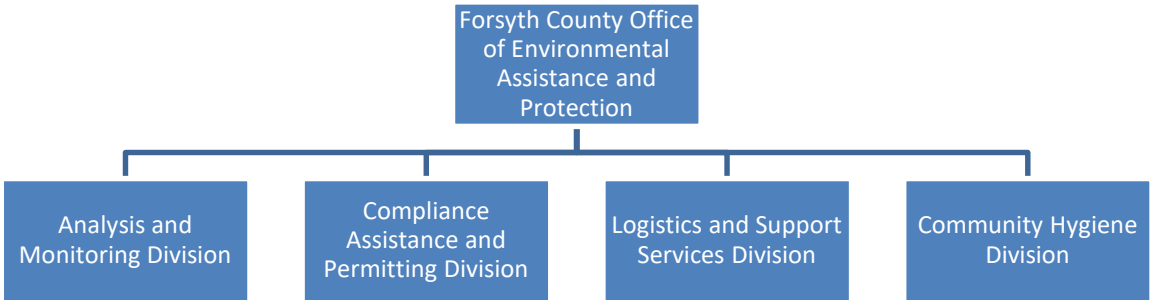
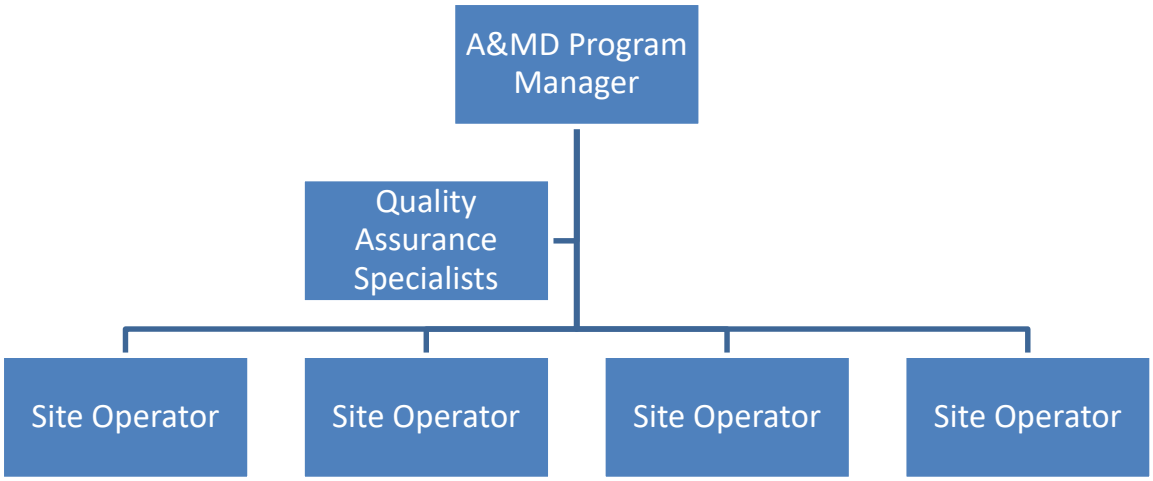


Figure 3 Analysis & Monitoring Division Organizational Chart



1.5 PROBLEM DEFINITION/BACKGROUND

In 1970, the Clean Air Act (CAA) was signed into law. Sections 108 and 109 of the CAA govern the establishment of and revision of the NAAQS for certain air pollutants (i.e., criteria pollutants) that are determined to contribute to air pollution that is harmful to public health and welfare. Table 1 shows the criteria pollutants and their designated NAAQS. Primary standards are set at a level adequate to protect public health within an acceptable margin of safety, while secondary standards are set a level that is requisite to protect public welfare. The CAA and its amendments provide the framework for the monitoring of these criteria pollutants by state, local, and tribal air monitoring organizations. Under the area designations process, data from ambient air monitors are typically used to characterize air concentrations for identification of areas that are either meeting or violating a particular pollutant standard. Monitors used for comparisons against a NAAQS are typically designated as State and Local Air Monitoring Stations (SLAMS) monitors and must meet the requirements stipulated in 40 CFR Parts 50, 53, and 58. For most of the criteria pollutants, three years of valid, quality-assured data are needed for comparison against the NAAQS.

FCEAP initiated air quality monitoring as part of an integrated, County-wide environmental protection effort. The objective of the FCEAP Ambient Air Quality Monitoring Program is to protect the health and sustainability of Forsyth County by identifying any violations of the NAAQS, locating the highest ambient pollution concentrations across the area, and determining the general background concentration. The FCEAP ambient air monitoring network was established in 1969 and has been continuously operated, maintained, and updated since that time, in accordance with county, state, and federal monitoring requirements. The ambient air monitoring data collected are

used to support the local, state, regional, and federal air monitoring programs, County organizations, and the general population. Local goals for environmental protection are to encourage the wise and beneficial use of the natural environment of Forsyth County, to minimize the adverse impact of environmental contaminants on human health and welfare, and to foster public awareness of environmental considerations.

The FCEAP Ambient Air Quality Monitoring Program is established to assure the most applicable and highest quality data are collected to provide a basis for establishing rules, guidelines, and procedures to provide this protective environment to the County and its citizens. The FCEAP Ambient Air Quality Monitoring Program currently includes monitoring and data reporting for the following 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), nitrogen dioxide (NO_2), and ozone (O_3). Of the remaining two criteria pollutants, the County no longer monitors CO levels due to the national trend of CO being much lower than the standard; CO monitoring ended in 2015. Also, due to the small sources of lead-emitting facilities (less than 0.5 tons per year) in Forsyth County, FCEAP does not currently monitor for criteria lead.

US EPA regulations require that all projects involving the generation, acquisition, and use of environmental data are planned, documented, and have an approved QAPP. The QAPP is a compilation of QA/QC requirements, procedures, and guidelines that are designed to achieve a high percentage of valid data samples, while maintaining integrity and accuracy. Adherence to the requirements set forth in this QAPP will ensure consistent, repeatable results, and improve the reliability and comparability of all data collected. This QAPP will be used by all FCEAP monitoring staff as a reference document, providing the framework for the monitoring network's QA program. Additional details and technical specifications are set forth in individual SOPs utilized by FCEAP staff for each aspect of the monitoring program, such as instrument operations and data handling, and will be referenced in later sections of this QAPP. It is the responsibility of all FCEAP monitoring staff to ensure that all procedures and guidelines in this QAPP are properly implemented.

FCEAP's QAPP will be reviewed annually and revised if procedures have changed or updates are needed; at a minimum, the QAPP will be revised and updated every 5 years. QAPP changes are subject to the approval of EPA's Region 4 QA staff. Prior to the creation of this QAPP in 2017, Forsyth County operated under the QAPP developed and maintained by NCDAQ. Due to the FCEAP becoming a separate PQAO in 2015, along with differences in organizational structure and staff assignments, as well as differences in local implementation of the monitoring network, FCEAP developed this QAPP for its monitoring program to be more aligned with its current operations. Note that many elements of this QAPP duplicate elements found in the NCDAQ QAPP, where changes were unnecessary and to facilitate EPA's review and approval. FCEAP will adhere to the principles and procedures herein. If any special criteria pollutant-project arises in the future that requires more stringent requirements, the QAPP will be revised or a separate QAPP will be developed to address the requirements of the special project.

Table 1 – National Ambient Air Quality Standards

Pollutant [links to historical tables of NAAQS reviews]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 µg/m^3	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Footnotes and clickable links shown in this table can be found at:
https://www.epa.gov/criteria-air-pollutants/naaqs-table

1.6 PROJECT/TASK DESCRIPTION

This QAPP was developed to ensure that FCEAP's air monitoring network collects ambient data that meet or exceed EPA requirements. Criteria pollutant data collected by FCEAP is used for regulatory decision-making purposes – i.e., determination of compliance with the NAAQS – and will be submitted to EPA via the EPA's national database, AQS. Other purposes of the data include determining trends over time, determining effects on air quality from adjustments to source emissions, developing algorithms based on historical air quality and other conditions which will forecast air quality, verifying air quality modeling programs, and providing real-time monitoring data to the public.

In accordance with 40 CFR Part 58, Appendix D, Section 1.1, SLAMS monitoring networks must be designed to meet three basic monitoring objectives: provide air pollution data to the general public in a timely manner; support compliance with ambient air quality standards and emissions strategy development; and support for air pollution research studies. The FCEAP ambient air monitoring network is designed to support these objectives (see Section 2.1 of this QAPP for more information). Additional specific goals of the FCEAP Ambient Air Quality Monitoring Program include:

- Determining the highest concentrations expected to occur in the area covered by the network.
- Determining representative concentrations in areas with high population density and\or heavily congested areas.
- Determining the impact on ambient pollution levels of significant sources emitting pollutants in the area.
- Determining the general background concentration levels.
- Providing data to the State of North Carolina and US EPA to assist these agencies in determining regional transport of specific pollutants and in support of secondary standards and visibility impairment issues.
- Determining the extent of regional pollutant transport among populated areas and in support of secondary standards.
- Determining the welfare-related impacts in rural and remote areas (such as visibility impairment and effects on vegetation).

Data will be reported to AQS in accordance with the requirements stated in 40 CFR 58.16. The FCEAP monitoring network will operate and collect samples in accordance with the schedules codified in 40 CFR 58.12. The ambient air monitoring concentration data will be collected by monitors and samplers that have been designated as Federal Reference Method (FRM) or Federal Equivalent Method (FEM), in accordance with 40 CFR Part 58, Appendix C, Section 2.1. Collocation of monitors will occur in accordance with 40 CFR Part 58, Appendix A requirements.

The types of data collected by the FCEAP monitoring network, overall, will include:

- Continuous (near real-time) hourly-averaged gaseous pollutant concentration data collected by FRMs or FEMs;
- Continuous (near real-time) five-minute averaged SO_2 concentration data collected by FRMs or FEMs;
- Continuous (near real-time) hourly-averaged $PM_{2.5}$ and PM_{10} concentration data collected by FEMs;
- 24-hour particulate matter samples collected by FRMs or FEMs in the field, and subsequently analyzed at the laboratory using the appropriate analytical method;
- Continuous shelter temperature measurements for ensuring conformity to environmental requirements of the air monitoring equipment;
- Precision measurements;
- Bias measurements; and,
- Geographic measurements (e.g. locational, demographic, topographical).

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

- **Establishing a monitoring network that has:**
  - Appropriate density, location, and sampling frequency;
  - Accurate and reliable monitors, data recording equipment, and software;

- **Developing encompassing documentation for**:
  - Data and report format, content, and schedules;
  - Quality objectives and criteria;

- **Establishing standard operating procedures, which provide activities and schedules for**:
  - Equipment operation and preventative maintenance;
  - Instrument calibrations, precision checks, and accuracy evaluations;

- **Establishing assessment criteria and schedules; and,**

- **Verifying and validating the data produced by network monitors in accordance with the criteria and schedules established herein.**

Towards this end, FCEAP work products also include a series of assessments and reports in order to ensure the network and resulting data continuously meet or exceed regulatory requirements. Similarly, FCEAP maintains this QAPP and its associated SOPs, reviewing and revising them as needed, to ensure they continuously reflect the requirements of the Office and EPA.

1.6.1 Field Activities

FCEAP site operators will perform those activities that support continued successful placement and operation of the ambient air quality monitoring network. Site operators will perform field activities that include, but are not limited to, the following:

- Conducting calibrations and routine QC checks on SLAMS monitors/samplers;
- Conducting periodic maintenance and servicing of SLAMS equipment;
- Performing building/grounds maintenance activities to assure dry and appropriate climate conditions within the monitoring stations;
- Performing routine site operations and servicing activities that include, but are not limited to:
  - Verifying analyzer status and diagnostics to ensure continuous data collection;
  - Recording pertinent field data and measurements in logbooks and on required FCEAP forms;
  - Restocking consumables, such as calibration gases;
- Locating suitable monitoring sites for relocation of existing monitoring equipment or the location of new monitoring stations, when needed; and,

- Collecting $PM_{2.5}$ FRM samples and shipping them to the laboratory for subsequent analysis.

Also, the QA Specialist performs quarterly instrument performance audits, equipment certifications, and internal systems audits, which include visiting and accessing monitoring stations in the field.

1.6.2 Laboratory Activities

FCEAP does not operate a gravimetric laboratory in support of the criteria pollutant program. These activities are completed by RTI, in accordance with their quality system requirements. Activities performed by the RTI lab include $PM_{2.5}$ filter conditioning, weighing, shipping, and archiving, among others. RTI delivers an electronic data package to NCDAQ who then passes it along to FCEAP on a monthly basis (approximate). The data package contains the results of the gravimetric analyses in the form of a detailed spreadsheet. The instrument operator first reviews and processes these data packages for FCEAP. Once the operator processes the data, two independent steps of quality assurance are performed for final validation of $PM_{2.5}$ data in accordance with this QAPP. Any issues observed with the laboratory data packages received will be discussed with the A&MPM, as well as communicated to RTI. Specific details and procedures for the RTI gravimetric laboratory can be found in the RTI $PM_{2.5}$ SOPs.

1.6.3 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, peer review, inspection, or surveillance. Information on the parties implementing assessments and their frequency is provided in **Table 2.**

Table 2 Assessment Schedule

Assessment Type	Assessment Agency	Frequency
Network Review	EPA Region 4 FCEAP	Annually
Network Assessment	FCEAP	Every 5 Years
QAPP Review	FCEAP	Annually
Standard Operating Procedures Review	FCEAP	Annually
Data Quality Review	FCEAP	Monthly
Data Quality Assessment	FCEAP	Quarterly
Instrument Performance Audits	FCEAP	Quarterly

Internal Systems Audits	FCEAP	Every 3 years, minimum
Technical System Audit	EPA Region 4	Every 3 years
$PM_{2.5}$ Performance Evaluation Program	EPA-Designated Contractor	25% of sites per year/4 times per year
National Performance Audit Program	EPA-Designated Contractor	20% sites per/year; 100% every 6 years

1.6.4 Project Records

FCEAP 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 the ambient air quality monitoring program are presented in **Table 3.**

Table 3 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 Logbooks Maintenance/Repair "Lab" Logbooks 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 AQS Reports Data/Summary Reports
Data Management	Data Algorithms Data Management Plans/Flowcharts Data Management Systems PM 2.5 Lab Data Packages
Quality Assurance	Network Reviews & Assessments Data Quality Assessments EPA Technical System Audit Reports FCEAP Performance/Systems Audit Checklists/Logbooks FCEAP Internal Systems Audit Checklists Corrective Action (Logbooks) Significant Event Documentation Packages

1.6.5 Site Locations

Following is the location and information for each ambient monitoring site maintained and operated by FCEAP as shown in **Figure 4:**

1. **Clemmons Middle School Monitoring Site**: This site monitors for continuous $PM_{2.5,}$ FRM $PM_{2.5,}$ and ozone and is located at Clemmons Middle School, 3763 Fraternity Church Road in the SW quadrant of Forsyth County. This is a neighborhood scale site with the objective of monitoring population exposure.
2. **Hattie Avenue "A" Monitoring Site**: This site monitors for SO_2, ozone, and NO_2. It is a neighborhood scale site located at 1302 Hattie Avenue, Winston-Salem, with the objective of collecting background data.
3. **Hattie Avenue "B" Monitoring Site**: This is at the same location as Hattie A and monitors for continuous $PM_{2.5}$ and PM_{10}, FRM $PM_{2.5}$, and $PM_{2.5}$ Speciation (which is part of the CSN, which is covered under a separate QAPP). It is considered a neighborhood scale site with the objective of monitoring population exposure.
4. **Union Cross Monitoring Site**: This site monitors for ozone and collects meteorological data. It is a neighborhood scale site located at 3656 Piedmont Memorial Drive with the objective of monitoring for population exposure.

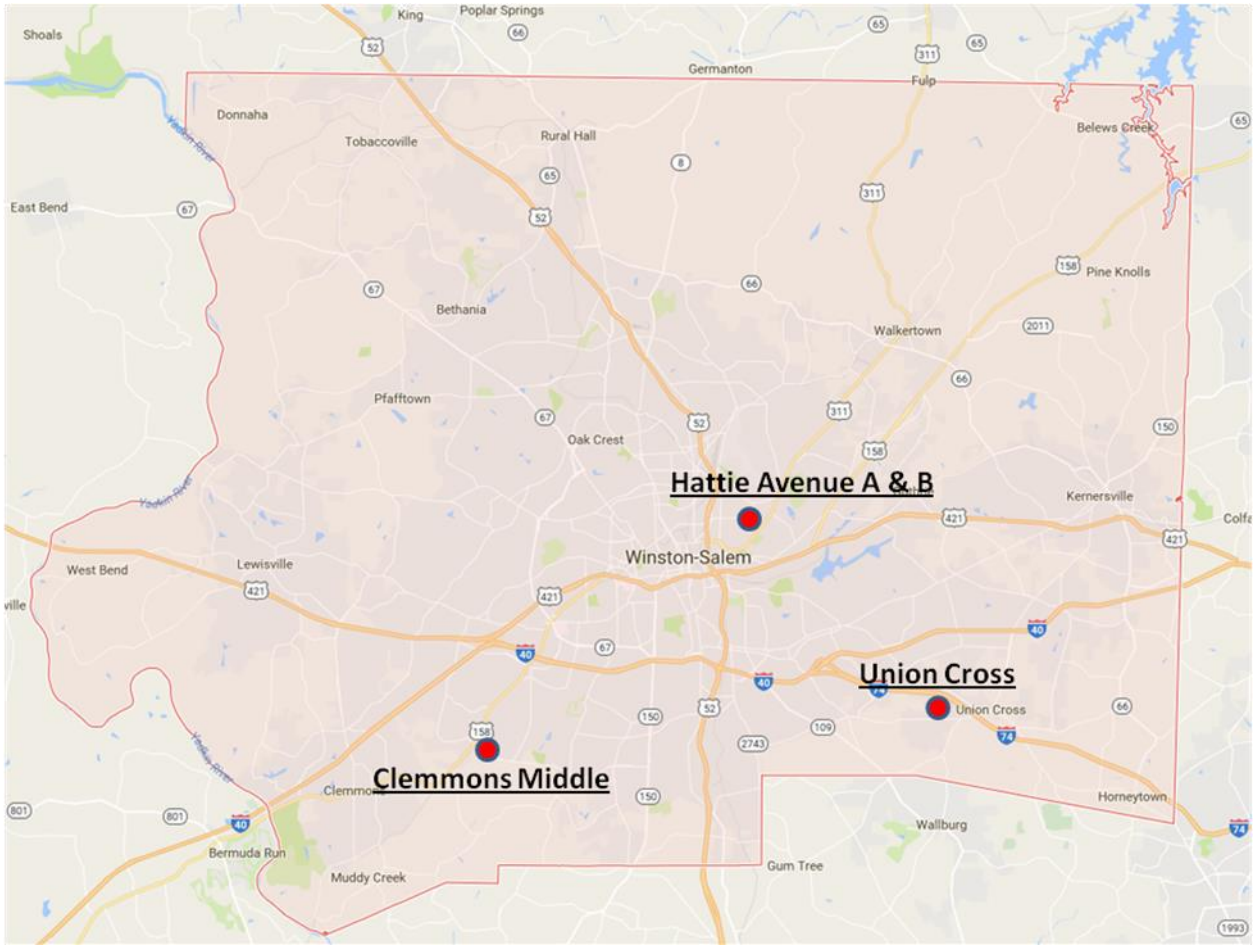


Figure 4 Site Locations in Forsyth County

1.7 QUALITY OBJECTIVES AND CRITERIA FOR MEASURING DATA QUALITY

FCEAP operates under an EPA-approved Quality Management Plan (QMP) that describes the Office's system for communicating and implementing quality within the FCEAP.

A quality system is a structured and documented set of management activities in which an organization applies sufficient quality control practices in order to ensure that the data produced by an operation will be of the type and quality needed and expected by the data user. Quality control defines the procedures implemented to assure that acceptability is 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. The policy of FCEAP is to implement a QA program to assure that data of known and acceptable precision, bias, completeness, comparability, and representativeness are collected within its Ambient Air Quality Monitoring Program.

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 measurement process. Of the five principal DQIs, precision and bias are the quantitative measures, representativeness and comparability are qualitative measures, and completeness is a combination of both qualitative and quantitative measures. The specific requirements of these five DQIs are established before data collection commences. 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 configurations, and the duration of the study.

The written procedures and methodologies in this QAPP for operating air monitoring instrumentation and handling data must be adhered to by all individuals to assure quality data for purposes of Forsyth County's air quality designations with regards to attainment of the NAAQS. EPA approved Federal Reference Methods (FRMs) are the designated methodologies and basis for operating pollutant monitoring equipment, although federal equivalent methods may be used as well.

1.7.1 Data Quality Objectives

This section provides a description of the data quality objectives (DQO) for Forsyth County's Ambient Air Quality Monitoring Program. DQOs are qualitative and quantitative statements that:

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

1.7.2 Intended Use of Data

Data collected in the FCEAP monitoring network will be used to:

- Evaluate compliance with the NAAQS.
- Establish historical baseline concentrations of air pollutants.
- Monitor the current concentrations of NAAQS pollutants.
- Monitor progress made toward meeting ambient air quality standards.
- Provide data upon which long term control strategies can be reliably developed.
- Observe pollution trends in Forsyth County, as well as throughout the region.
- Support daily forecasting efforts, including the activation of burn bans when high ozone levels are observed (i.e., AQI color orange or higher), in accordance with NC state law.

1.7.3 Type of Data Needed

The type of data needed is determined by its intended use. Because the primary use of the FCEAP monitoring data is for comparison to the NAAQS, data must be collected in accordance with 40 CFR Parts 50, 53, and 58 requirements, and be of such quality that decision makers can make comparisons to the NAAQS with confidence and certainty. The monitoring data compiled by FCEAP is a combination of criteria pollutant data including: particulate matter ($PM_{2.5}$ and PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and ozone (O_3). 40 CFR 58.16 specifies the data reporting requirements that FCEAP will follow, and the appendices to 40 CFR Part 50 explain the data handling conventions and computations necessary for determining whether the NAAQS are met for each pollutant.

Criteria pollutant data will be collected for comparison to the NAAQS using hourly concentration data (with each hour considered valid if 45, 1-minute readings have been obtained), 5-minute data (SO_2 only), and 24-hour particulate matter samples. For each of these pollutants, quarterly data capture will need to be ≥75% completeness, as shown in the following subsections. The collection of precision and bias data is also required. In addition to these requirements, the data needed for the FCEAP monitoring program will meet the following principle 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. As noted above, two key quantitative indicators for assessing data quality are precision and bias. Precision and bias requirements are established herein.

- 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. found 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 the standard methodologies contained in the QAPP should ensure that the data generated are representative.

- The QAPP and its associated SOPs must be dynamic to continue to achieve its stated goals as techniques, systems, concepts, and technology change.

The following subsections provides more detail regarding the specifications on the types of data needed in order to compare FCEAP design values to the NAAQS.

1.7.3.1 Ozone -

- Keep each hourly data point (need at least 45 minutes of the hour to be used) with at least three decimal places in units of ppm, with additional digits to the right being truncated.
- Calculate average values for every rolling 8-hour period in the day.
- An 8-hour average shall be considered valid if at least 6 of the hourly concentrations for the 8-hour period are available.

- Determine the highest 8-hour average from each day (there might be some 8-hour averages that overlap through midnight but it is unlikely).
- Daily maximum 8-hour average O_3 concentrations are determined for each day with ambient O_3 monitoring data. The daily maximum 8-hour average O_3 concentration for a given day is the highest of the 17 consecutive 8-hour averages beginning with the 8-hour period from 7:00 a.m. to 3:00 p.m. and ending with the 8-hour period from 11:00 p.m. to 7:00 a.m. the following day (i.e., the 8-hour averages for 7:00 a.m. to 11:00 p.m.).
- A daily maximum 8-hour average O_3 concentration shall be considered valid if valid 8-hour averages are available for at least 13 of the 17 consecutive 8-hour periods starting from 7:00 a.m. to 11:00 p.m.
- The highest 8-hour averages in each year are ranked, and the fourth highest value is used in each year.
- The 4th-highest values in 3 consecutive years are averaged.
- The resulting design value is compared with the standard.

Specific information on the O_3 NAAQS calculation, as well incomplete hours and days, is found in 40 CFR 50 Appendices I, P, and U.

1.7.3.2 Nitrogen Dioxide –

- Keep each hourly data point (need at least 45 minutes of the hour to be used) with at least one decimal place in units of ppb, with additional digits to the right being truncated with no further rounding).
- Calculate 24 hourly average values for a day and determine the maximum. Daily maximum 1-hour values are not rounded.
- The 1-hour design value is the mean of the three 98^{th} percentile values, rounded to the nearest whole number.

Specific information on NO_2 NAAQS calculations is found in 40 CFR 50 Appendix S.

1.7.3.3 Sulfur Dioxide –

- Keep each hourly data point (need at least 45 minutes of the hour to be used) with at least one decimal place in units of ppb, with additional digits to the right being truncated with no further rounding.
- Calculate 24, hourly average values for each day and determine the maximum. Daily maximum 1-hour values (and therefore the 99^{th} percentile of those daily values) are not rounded.
- The 99^{th} percentile of the daily maximum hourly average over 3 years, rounded to the nearest whole number, is used to compare to the standard.

Specific information on SO_2 NAAQS calculations is found in 40 CFR 50 Appendix T.

1.7.3.4 Particulate Matter – PM_{10} –

Specific information on PM_{10} NAAQS calculations is found in 40 CFR 50 Appendix K. The CFR appendix explains the computations necessary for analyzing PM_{10} data to determine attainment of the 24-hour standard specified in 40 CFR 50.6, using the reference method based on 40 CFR Part 50, Appendix J, or a designated equivalent method per 40 CFR Part 53. In accordance with Appendix K, an PM_{10} exceedance means a daily value that is above the level of the 24-hour standard after rounding to the nearest 10 µg/m3 (i.e., values ending in 5 or greater are to be rounded up).

The information in Appendix K is based on high-volume sampling. In the FCEAP network, the PM_{10} samplers are FEMs which collect low-volume, continuous (hourly) PM_{10} data. Therefore, FCEAP will utilize the protocols of the low-volume $PM_{2.5}$ method found in 40 CFR Part 50, Appendix L, for general guidance, which follows.

1.7.3.5 Particulate Matter – $PM_{2.5}$ –

- Keep each hourly data point with at least one decimal place in units of µg/m^3.
- Calculate a 24-hour period in a day from midnight to midnight for the daily average.
- A 24-hour average concentration shall be considered valid if at least 75 percent of the hourly averages (i.e., 18 hourly values) for the 24-hour period are available.
- Twenty-four-hour periods with seven or more missing hours shall also be considered valid if, after substituting zero for all missing hourly concentrations, the resulting 24-hour average daily value is greater than the level of the 24-hour $PM_{2.5}$ NAAQS.
- Twenty-four-hour average $PM_{2.5}$ mass concentrations that are averaged in AQS from hourly values will be truncated to one decimal place, consistent with the data handling procedure for the reported hourly (and also 24-hour filter-based) data.
- For 24-hour filter-based samples, the sampler must have operated for 23-25 hours or the day will not be valid (unless a sample with less than 23 hours run time has a concentration that exceeds the NAAQS).
- The 3-year average of $PM_{2.5}$ annual mean mass concentrations for each eligible monitoring site is referred to as the "*annual $PM_{2.5}$ NAAQS DV*" and compared to the annual standard.
- The 3-year average of annual 98th percentile 24-hour average $PM_{2.5}$ mass concentration values recorded at each eligible monitoring site is referred to as the "*24-hour (or daily) $PM_{2.5}$ NAAQS DV*" and compared to the daily standard.

Specific information on $PM_{2.5}$ NAAQS calculations is found in 40 CFR 50 Appendix N.

1.7.4 Tolerable Error Limits

The Data Quality Objective (DQO) process defines tolerable limits on the probability of making a decision error due to uncertainty in the data. That is, limits on the probability of measuring a false positive or false negative error. With regards to air quality data, a false positive error occurs when

data indicates that an emissions limit has been exceeded when in fact, due to random deviations in the data, it has not been exceeded. Alternatively, a false negative error occurs when data indicate that no emissions limit has been exceeded when in fact, due to random deviations in the data, it has been exceeded.

Utilizing the formal DQO process, EPA established the tolerable error limits for ambient air monitoring precision and bias data in order to reduce the probability of decision errors. 40 CFR Part 58 Appendix A sets the DQOs for the criteria pollutants measured within the FCEAP network, which are as follows:

2.3.1.1 Measurement Uncertainty for Automated and Manual $PM_{2.5}$ Methods. The goal for acceptable measurement uncertainty is defined for precision as an upper 90 percent confidence limit for the coefficient of variation (CV) of 10 percent and ±10 percent for total bias.

2.3.1.2 Measurement Uncertainty for Automated O_3 Methods. The goal for acceptable measurement uncertainty is defined for precision as an upper 90 percent confidence limit for the CV of 7 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 7 percent.

2.3.1.4 Measurement Uncertainty for NO_2. The goal for acceptable measurement uncertainty is defined for precision as an upper 90 percent confidence limit for the CV of 15 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 15 percent.

2.3.1.5 Measurement Uncertainty for SO_2. The goal for acceptable measurement uncertainty for precision is defined as an upper 90 percent confidence limit for the CV of 10 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 10 percent.

1.7.5 Measurement Quality Objectives

The DQO process functions to identify the allowable measurement uncertainty for a given objective. 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. MQOs are derived from the DQOs, and can be established to evaluate overall measurement uncertainty, as well as be established for an individual phase of a measurement process. The MQOs for the FCEAP Ambient Air Quality Monitoring Program are defined in terms of the following data quality indicators (DQI): **precision**, **bias**, **accuracy**, **comparability**, **representativeness**, and **completeness**. Acceptance criteria have been developed for these DQIs using various parts of 40 CFR Parts 50, 53, and 58 and EPA guidance documents. Specifically, the MQOs for the criteria pollutants have been compiled into "validation templates" found in the *EPA Quality Assurance Handbook for Air Pollution Measurements Systems, Volume II* (i.e., QA Handbook). The validation templates have been reproduced here and are included as

Tables 4-9. FCEAP adopts these tables and establishes them as the MQOs for the Office's Ambient Air Monitoring Program. Modifications have been made to some operational criteria in the tables, where permissible, in order to more accurately reflect the procedures FCEAP will follow or to clarify intent. More detailed descriptions of the DQOs and MQOs and how they will be used to control and assess measurement uncertainty are described in the FCEAP SOPs, as well as in Sections 3.1.7 and 3.1.8 of this QAPP.

As described in the QA Handbook and implemented here, for each criteria pollutant listed in the tables that follow, three validation criteria are listed: **critical**, **operational**, and **systematic**. The tables discriminate between criteria that must be met to ensure the quality of the data (i.e., critical criteria), criteria that indicate that there may be issues with the quality of the data and further investigation is warranted before making a determination about the validity of the sample or samples (i.e., operational criteria), and criteria that indicate a potentially systematic problem with the environmental data collection activity, that may impact the ability to make decisions with the data (i.e., systematic criteria). For each criterion, the tables include: (1) the requirement, (2) the frequency with which compliance is to be evaluated, (3) the acceptance criteria, and (4) information where the requirement can be found or additional guidance on the requirement. FCEAP's implementation of these tables – how they will be used to validate data and drive data quality decision-making – will be described in more detail in Section 4.2 of this QAPP, and further illustrated in the FCEAP Data Handling SOP.

Table 4: Ozone Validation Template

1) Requirement (O3)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-OZONE			
Monitor	NA	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Sec. 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
One Point QC Check Single analyzer	***Every 14 days***	< ±7.1% (percent difference)	1 and 2) 40 CFR Part 58 App A Sec. 3.1 3) Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.2. QC Check Conc range 0.005 - 0.08 ppm Check FCEAP Ozone SOP sec. 1.8.2
Zero/span check	Every 14 days	Zero drift < ± 3.1 ppb (24 hr) < ±5.1 ppb (>24hr-14 day) Span drift < ± 7.1 %	1 and 2) QA Handbook Volume 2 Sec. 12.3 3) Recommendation and related to DQO. Check FCEAP Ozone SOP sec. 1.8.2
OPERATIONAL CRITERIA -OZONE			
Shelter Temperature Range	Daily (hourly values)	20.0° to 30.0 °C. (Hourly avg) or 5.0° – 40.0°C (Hourly avg) based on manufacturer requirements	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20°-30° deg C range per 40 CFR Part 53.32
Shelter Temperature Device Check	Every 182 days and 2/calendar year	<± 2.1°C of standard	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2
Annual Performance Evaluation Single analyzer	***Quarterly***	Percent difference of audit levels 3-10 < ±7.1% Audit levels 1&2 <± 1.5 ppb difference or <± 7.1%	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 AMTIC Technical Memo Check FCEAP Ozone SOP sec. 1.8
Federal Audits (NPAP)	***20% of sites audited in calendar year***	Audit levels 1&2 < ± 1.5 ppb difference all other levels percent difference < ± 10.1%	1 and 2) 40 CFR Part 58 App A Sec. 3.1.3 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving and repair and recalibration of standard of higher level. One needs to be done at least once every 90 days.	Calibration: all points <± 2.1 % or < ±1.5 ppb difference of best-fit straight line whichever is greater and Slope 1 ± .05 Verification: all points <±7.1%	1) 40 CFR Part 50 App D 2) Recommendation 3) 40 CFR Part 50 App D Sec 4.5.5.6 Multi-point calibration (0 and 4 upscale points) Slope criteria is a recommendation Check FCEAP Ozone SOP sec. 1.3
Zero Air Check	Every 365 days and 1/calendar year	Concentrations below LDL	1) 40 CFR Part 50 App D Sec. 4.1 2 and 3) Recommendation. Preventative Maintenance includes zero checks. Zero points done during ZSP to verify

1) Requirement (O3)	2) Frequency	3) Acceptance Criteria	Information /Action
Certification/recertification to Standard Reference Photometer (Level 1)	Every 365 days and 1/calendar year	single point difference < ±3.1%	1) 40 CFR Part 50 App D Sec. 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 Check FCEAP Calibrator SOP sec. 12.2
Level 2 and Greater Transfer Standard Precision	Every 365 days and 1/calendar year	***Standard Deviation less than 0.005 ppm or 3.0% 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 Check FCEAP Ozone SOP sec. 1.4
(if recertified via a transfer standard)	Every 365 days and 1/calendar year	Regression slopes = 1.00 ±0.03 and intercepts are 0 ± 3 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10001
Ozone Transfer standard (Level 3 and greater)			
Qualification	Upon receipt of transfer standard	<±4.1% or < ±4 ppb (whichever greater)	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10001
Certification	After qualification and upon receipt/adjustment/repair	RSD of six slopes < 3.7% Std. Dev. of 6 intercepts < 1.5	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10001 1
Recertification to higher level standard	Beginning and end of O3 season or once a year	Slope 0.9800 – 1.02 / intercept < 1.5	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10001
Lower detectable limit	Every 365 days and 1/calendar year	***< 0.005 ppm (standard range) < 0.002 ppm (lower range)***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1 Zero points done during ZSP to verify
			SYSTEMATIC CRITERIA-OZONE
Standard Reporting Units	***All data***	***ppm (final units in AQS)***	1, 2 and 3) 40 CFR Part 50 App U Sec. 3(a)
Rounding convention for design value calculation	***All routine concentration data***	***3 places after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50 App U Sec. 3(a) The rounding convention is for averaging values for comparison to NAAQS not for reporting individual hourly values.
Completeness (seasonal)	***3-Year Comparison***	***> 90% (avg) daily max available in ozone season with min of 75% in any one year.***	1,2,3) 40 CFR Part 50 App U Sec 4(b)
	8- hour average	***> if at least 6 of the hourly concentrations for the 8-hour period are available***	1) 40 CFR Part 50 App U 2 and 3) 40 CFR Part 50 App U Sec. 3(b)
	Valid Daily Max	***> if valid 8-hour averages are available for at least 13 of the 17 consecutive 8-hour periods starting from 7:00 a.m. to 11:00 p.m***	1) 40 CFR Part 50 App U 2,3) 40 CFR Part 50 App U Sec. 3(d)
Sample Residence Time Verification	Every 365 days and 1/calendar year	***< 20 Seconds***	1) 40 CFR Part 58 App E, Sec. 9 (c) 2) Recommendation

1) Requirement (O3)	2) Frequency	3) Acceptance Criteria	Information /Action
Sample Probe, Inlet, Sampling train	Quarterly but at least every 365 days and 1/calendar year	***Borosilicate glass (e.g., Pyrex®) or Teflon®***	1) 40 CFR Part 58 App E, Sec. Sec. 9 (a) 2) Recommendation 3) 40 CFR Part 58 App E, Sec. Sec. 9 (a) FEP and PFA have been accepted as an equivalent material to Teflon. Replacement is suggested as 1/year and more frequent if pollutant load or contamination dictate. Check FCEAP Ozone SOP sec. 1.8
Siting	Quarterly but at least every 365 days and 1/calendar year	***Meets siting criteria or waiver request documented***	1) 40 CFR Part 58 App E, Sec. 2-6 2) Recommendation 3) 40 CFR Part 58 App E, Sec. 2-6 Check FCEAP Ozone SOP sec. 1.8
EPA Standard Ozone Reference Photometer (SRP) Recertification (Level 1)	Every 365 days and 1/calendar year	Regression slope = 1.00 ±0.01 and intercept < 3 ppb	1, 2 and 3) Transfer Standard Guidance EPA-454/B-10001. 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%**	1) 40 CFR Part 58 App A 2.3.1.2 & 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 < + 7.1%**	1) 40 CFR Part 58 App A 2.3.1.2 & 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 5: NO2 Validation Template

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- NO_2			
Sampler/Monitor	***NA***	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Sec. 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
One Point QC Check Single analyzer	***Every 14 days***	< +15.1% (percent difference) or < + 1.5 ppb difference whichever is greater	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 Conc range 0.005 - 0.08 ppm and 05/05/2016 Technical Note on AMTIC
Zero/span check	Every 14 days	Zero drift < + 3.1 ppb (24 hr) < + 5.1 ppb (>24hr-14 day) Span drift < + 10.1 %	1 and 2) QA Handbook Volume 2 Sec. 12.3 3) Recommendation and related to DQO
Converter Efficiency	During multi-point calibrations, span and audit Every 14 days	***(>96%)*** 96% – 104.1%	1) 40 CFR Part 50 App F Sec. 1.5.10 and 2.4.10 2) Recommendation 3) 40 CFR Part 50 App F Sec. 1.5.10 and 2.4.10 Regulation states > 96%, 96 – 104.1% is a recommendation.
OPERATIONAL CRITERIA- NO_2			
Shelter Temperature Range	Daily (hourly values)	20.0 to 30.0°C. (Hourly avg) or 5.0 – 40.0°C (Hourly avg) based on manufacturer requirements	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 Generally, the 20-30.0°C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20-30°C range per 40 CFR Part 53.32
Shelter Temperature Control	Daily (hourly values)	< 2.1°C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2
Shelter Temperature Device Check	every 182 days and 2/calendar year	< + 2.1°C of standard	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2
Annual Performance Evaluation Single Analyzer	***Quarterly***	Percent difference of audit levels 3-10 < +15.1% Audit levels 1&2 < + 1.5 ppb difference or < +15.1%	1) 40 CFR Part 58 App A Sec. 3.1.2 2) 40 CFR Part 58 App A Sec. 3.1.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC Technical Memo
Federal Audits (NPAP)	20% of sites audited in calendar year	Audit levels 1&2 < + 1.5 ppb difference all other levels percent difference < + 15.1%	1 & 2) 40 CFR Part 58 App A Sec. 3.1.3 3) NPAP QAPP/SOP

1) Requirement (NO2)	2) Frequency	3) Acceptance Criteria	Information /Action
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving and repair and recalibration of standard of higher level. One needs to be done at least once every 90 days.	Instrument residence time < 2 min Dynamic parameter > 2.75 ppm-min All points <+- 2.1 % or < +- 1.5 ppb difference of best-fit straight line whichever is greater and Slope 1 +- 0.05	1) 40 CFR Part 50 App F 2 and 3) Recommendation Multi-point calibration (0 and 4 upscale points) Slope criteria is a recommendation Check FCEAP NO2 SOP sec. 2.4
Gaseous Standards	All gas cylinders	**NIST Traceable** (e.g., EPA Protocol Gas) 50-100 ppm of NO in Nitrogen with < 1 ppm NO2	1) 40 CFR Part 50 App F Sec. 1.3.1 2) NA Green Book 3) 40 CFR Part 50 App F Sec. 1.3.1. A technical memo may change the concentration requirement. Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A Sec. 2.6.1. Check FCEAP NO2 SOP sec. 2.1
Zero Air/ Zero Air Check	Every 365 days and 1/ calendar year	Concentrations below LDL	1) 40 CFR Part 50 App F Sec. 1.3.2 2 and 3) Recommendation
Gas Dilution Systems	Every 365 days and 1/calendar year or after failure of 1-point QC check or performance evaluation	Accuracy < ± 2.1 %	1, 2 and 3) Recommendation based on SO2 requirement in 40 CFR Part 50 App A-1 Sec. 4.1.2
Noise	Every 365 days and 1/ calendar year	***< 0.005 ppm***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) Recommendation- info can be obtained from LDL 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	Every 365 days and 1/calendar year	***< 0.01 ppm***	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1. Zero points done during ZSP to verify
SYSTEMATIC CRITERIA- NO2			
Standard Reporting Units	***All data***	***ppb (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 routine concentration data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50 App S Sec. 4.2 (a) The rounding convention is for averaging values for comparison to NAAQS not for reporting individual hourly values.
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) 3 consecutive 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

1) Requirement (NO2)	2) Frequency	3) Acceptance Criteria	Information /Action
Sample Residence Time Verification	Every 365 days and 1/calendar year	***< 20 Seconds***	1) 40 CFR Part 58 App E, Sec. 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E, Sec. 9 (c). Check FCEAP NO2 SOP sec. 2.9
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 is suggested as 1/year and more frequent if pollutant load or contamination dictate. Check FCEAP NO2 SOP sec. 2.9
Siting	Every 365 days and 1/calendar year	***Meets siting criteria or waiver request documented***	1) 40 CFR Part 58 App E, Secs 2-6 2) Recommendation 3) 40 CFR Part 58 App E, Sec. 2-6. Check FCEAP NO2 SOP sec. 2.9
Precision (using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***90% CL CV < 15.1%***	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 < + 15.1%***	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 6: SO2 Validation Template

1) Requirement (SO2)	2) Frequency	3) Acceptance Criteria	Information /Action
		CRITICAL CRITERIA- SO2	
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Sec. 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
One Point QC Check Single analyzer	***Every 14 days***	< ±10.1% (percent difference) or < ± 1.5 ppb difference whichever is greater	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. 2.3.1.2 QC Check Conc range 0.005 - 0.08 ppm and 05/05/2016 Technical Note on AMTIC Check FCEAP SO2 SOP sec. 3.8.2
Zero/span check	Every 14 days	Zero drift < ± 3.1 ppb (24 hr) < ± 5.1 ppb (>24hr-14 day) Span drift < ± 10.1 %	1 and 2) QA Handbook Volume 2 Sec. 12.3 3) Recommendation and related to DQO. Check FCEAP SO2 SOP sec. 3.8.2
		OPERATIONAL CRITERIA- SO2	
Shelter Temperature Range	Daily (hourly values)	20.0° to 30.0° C. (Hourly avg) or 5.0° – 40.0° C (Hourly avg) based on manufacturer requirements	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2 FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 2030° C range per 40 CFR Part 53.32
Shelter Temperature Device Check	every 180 days and 2/calendar year	< +- 2.1° C of standard	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2
Annual Performance Evaluation Single Analyzer	***Quarterly***	Percent difference of audit levels 3-10 < ±10.1% Audit levels 1&2 < ± 1.5 ppb difference or <± 10.1%	1 and 2) 40 CFR Part 58 App A Sec. 3.1.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC Technical Memo. Check FCEAP SO2 SOP sec. 3.8.1
Federal Audits (NPAP)	20% of sites audited in calendar year	Audit levels 1&2 <± 1.5 ppb difference all other levels percent difference < ± 15.1%	1&2) 40 CFR Part 58 App A Sec. 3.1.3 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving Every 182 day and 2/calendar year if manual zero/span performed biweekly Every 365 day and 1/calendar year if continuous zero/span performed daily	All points <± 2.1 % or < ± 1.5 ppb difference of best-fit straight line whichever is greater and Slope 1 ± 0.05	1) 40 CFR Part 50 App A-1 Sec. 4 2 and 3) Recommendation Multi-point calibration (0 and 4 upscale points) Slope criteria is a recommendation. Check FCEAP SO2 SOP sec. 3.4
Gaseous Standards	***All gas cylinders***	***NIST Traceable (e.g., EPA Protocol Gas)***	1) 40 CFR Part 50 App A-1 Sec. 4.1.6.1 2) NA Green Book 3) 40 CFR Part 50 App F Sec. 1.3.1 Producers must participate in Ambient Air Protocol Gas. Check FCEAP SO2 SOP sec. 3.1

1) Requirement (SO2)	2) Frequency	3) Acceptance Criteria	Information /Action
Gas Dilution Systems	Every 365 days and 1/ calendar year or after failure of 1-point QC check or performance evaluation	***Accuracy < ± 2.1 %***	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
Noise	Every 365 days and 1/ calendar year	***< 0.001 ppm (standard range) < 0.0005 ppm (lower range)***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) Recommendation- info can be obtained from LDL 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	Every 365 days and 1/ calendar year	***< 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 Zero points done during ZSP to verify
SYSTEMATIC CRITERIA- SO2			
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 design value calculation	***All routine concentration data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50 App T Sec. 2 (c) The rounding convention is for averaging values for comparison to NAAQS not for reporting individual hourly values.
Completeness	***1 hour standard***	Hour – 75% of hour ***Day- 75% hourly Conc Quarter- 75% complete days Years-4 complete quarters. 5-min value reported only for valid hours***	1, 2 and 3) 40 CFR Part 50 App T Sec. 3 (b), (c) More details in CFR on acceptable completeness. 5-min values or 5-min max value (40 CFR part 58.16(g)) only reported for the valid portion of the hour reported. If the hour is incomplete, no 5-min or 5-min max reported.
Sample Residence Time Verification	Every 365 days and 1/ calendar year	***< 20 Seconds***	1) 40 CFR Part 58 App E, Sec. 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E, Sec. 9 (c). Check FCEAP SO2 SOP sec. 3.8.1
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 is suggested as 1/year and more frequent if pollutant load or contamination dictate. Check FCEAP SO2 SOP sec. 3.8.1
Siting	Every 365 days and 1/ calendar year	***Meets siting criteria or waiver request documented***	1) 40 CFR Part 58 App E, Sec. 2-6 2) Recommendation 3) 40 CFR Part 58 App E, Sec. 2-6 Check FCEAP SO2 SOP sec. 3.8.1
Precision (using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***90% CL CV < 10.1%***	1) 40 CFR Part 58 App A Sec. 2.3.1.6 & 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%***	1) 40 CFR Part 58 App A Sec. 2.3.1.6 & 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: FRM PM 2.5 Validation Template

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA-PM2.5 Filter Based Local Conditions			
Field Activities			
Sampler/Monitor	NA	*Meets requirements listed in FRM/FEM/ARM designation*	1) 40 CFR Part 58 App C Sec. 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Pre-sampling	*all filters*	*< 30 days before sampling*	1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.3.5 FCEAP PM 2.5 database designed to flag all samples if criteria not met. Check FCEAP FRM PM 2.5 SOP sec. 6.4
Sample Recovery	*all filters*	*< 7 days 9 hours from sample end date*	1, 2 and 3) 40 CFR Part 50, App. L 10.10 FCEAP PM 2.5 database designed to flag all samples if criteria not met. Check FCEAP FRM PM 2.5 SOP sec. 6.4
Sampling Period (including multiple power failures)	*all filters*	*1380-1500 minutes, or if value < 1380 and exceedance of NAAQS / midnight to midnight local standard time*	1, 2 and 3) 40 CFR Part 50 App L Sec. 3.3 and 40 CFR Part 50 App N Sec. 1 for the midnight to midnight local standard time requirement. FCEAP PM 2.5 database designed to flag all samples if criteria not met. Check FCEAP FRM PM 2.5 SOP sec. 6.4
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 Check FCEAP FRM PM 2.5 SOP sec. 6.4
One-point Flow Rate Verification	*every 30 days each seperated by 14 days*	*< ± 4.1% of transfer standard*	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. 3.2.1 Check FCEAP FRM PM 2.5 SOP sec. 6.3
Design Flow Rate Adjustment	*After multi-point calibration or verification*	*<± 2.1% of design flow rate*	1, 2 and 3) 40 CFR Part 50, App. L, Sec. 9.2.6
Individual Flow Rates	*every 24 hours of op*	*no flow rate excursions > ±5% for > 5 min.*	1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.3.1
Filter Temp Sensor	*every 24 hours of op*	*no excursions of > 5° C lasting longer than 30 min*	1, 2 and 3) 40 CFR Part 50, App. L Sec. 7.4.11.4. FCEAP PM 2.5 database designed to flag all samples if criteria not met. Check FCEAP FRM PM 2.5 SOP sec. 6.4
External Leak Check	*Before each flow rate verification/calibration* and before and after PM2.5 separator maintenance	*< 80.1 mL/min* (see comment #1) **< 25 mm Hg**	1) 40 CFR Part 50 App L, Sec. 7.4.6.1 2) 40 CFR Part 50 App L Sec. 9.2.3 and Method 2-12 Sec. 7.4.3 3) 40 CFR Part 50, App. L, Sec. 7.4.6.1. Check FCEAP FRM PM 2.5 SOP sec. 6.3.1.6
Internal Leak Check	If failure of external leak check	Manufacturer's Specifications	1) 40 CFR Part 50, App. L, Sec. 7.4.6.2 2) Method 2-12, Sec. 7.4.4 3) 40 CFR Part 50, App. L, Sec. 7.4.6.2

Laboratory Activities			
1) Criteria (PM2.5 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Post-sampling Weighing	*all filters*	*Protected from exposure to temperatures above 25°C from sample retrieval to conditioning <10 days from sample end date if shipped at ambient temp, or < 30 days if shipped below avg ambient (or 4°C or below for avg sampling temps < 4° C) from sample end date*	1, 2 and 3) 40 CFR Part 50 App L Sec. 8.3.6 and L Sec. 10.13. See technical note on holding time requirements at : https://www3.epa.gov/ttn/amtic/pmpolgud.html
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 Conditioning Environment			
Equilibration	*all filters*	*24 hours minimum*	1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.5
Temp. Range	*all filters*	*24-hr mean 20.0-23.0° C*	1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.1
Temp. Control	*all filters*	*< 2.1° C SD over 24 hr.*	1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.2 SD use is a recommendation
Humidity Range	*all filters*	*24-hr mean 30.0% - 40.0% RH or Within +5.0 % sampling RH but > 20.0%RH*	1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.3
Humidity Control	*all filters*	*< ±5.1 % SD over 24 hr.*	1, 2 and 3) 40 CFR Part 50, App. L Sec. 8.2.4 SD use is a recommendation
Pre/post Sampling RH	*all filters*	*difference in 24-hr means < ± 5.1% 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
Microbalance Auto-Calibration	*Prior to each weighing session*	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. 10.6 3) NA

OPERATIONAL EVALUATIONS TABLE PM2.5 Filter Based Local Conditions			
Field Activities			
One-point Temp Verification	every 30 days	< ± 2.1° C	1) 40 CFR Part 50, App. L, Sec. 9.3 2) Method 2.12 Sec. 7.4.5 and Table 6-1 3) Recommendation Check FCEAP FRM PM 2.5 SOP sec. 6.3.3.2.2
Pressure Verification	every 30 days	<± 10.1 mm Hg	1) 40 CFR Part 50, App. L, Sec. 9.3 2) Method 2.12 Sec. 7.4.6 and Table 6-1 3) Recommendation Check FCEAP FRM PM 2.5 SOP sec. 6.3.3.4.4
Annual Multi-point Verifications/Calibrations			
Temperature multi-point Verification/Calibration	on installation	< ± 2.1° C	1) 40 CFR Part 50, App. L, Sec. 9.3 2 and 3) Method 2.12 Sec. 6.4.4 Table 6-1

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
Pressure Verification/Calibration	on installation, and on one-point verification failure	< ± 10.1 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/year Check FCEAP FRM PM 2.5 SOP sec. 6.3.4.3.2
Flow Rate Multi-point Verification/ Calibration	***Electromechanical maintenance or transport*** or every 365 days and once a calendar year	<± 2.1% 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 Sec. 6.3 & Table 6-1 3) Recommendation Check FCEAP FRM PM 2.5 SOP sec. 6.3.4.4.5
Other Monitor Calibrations	per manufacturers' op manual	per manufacturers' operating manual	1, 2 and 3) Recommendation
Precision			
Collocated Samples	***every 6 days by method designation***	CV < 10.1% of samples > 3.0 µg/m3	1) and 2) Part 58 App A Sec. 3.2.3 3 Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.1
Accuracy			
Temperature Audit	every 90 days and at time of flow rate audit	< ± 2.1° C	1, 2 and 3) Method 2.12 Sec. 11.2.2
Pressure Audit	every 90 days and at time of flow rate audit	<± 10.1 mm Hg	1, 2 and 3) Method 2.12 Sec. 11.2.3
Semi Annual Flow Rate Audit	every 90 days	<± 4.1% of audit standard	1 and 2) Part 58, App A, Sec. 3.2.2 3) Method 2.12 Sec. 11.2.1
Monitor Maintenance			
PM2.5 Separator (VSCC)	every 30 days	cleaned	1, 2 and 3) Method 2.12 Sec. 8.3.3
Inlet Cleaning	every 30 days	cleaned	1, 2 and 3) Method 2.12 Sec. 8.3
Downtube Cleaning	every 90 days	cleaned	1, 2 and 3) Method 2.12 Sec. 8.4
Filter Housing Assembly Cleaning	every 30 days	cleaned	1, 2 and 3) Method 2.12 Sec. 8.3
Circulating Fan Filter Cleaning	every 30 days	cleaned/changed	1, 2 and 3) Method 2.12 Sec. 8.3
Manufacturer-Recommended Maintenance	per FCEAP FRM PM 2.5 SOP sec. 6.3.3.6.1	inspected/cleaned	

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
Field Filter Blank	10% or 1 per weighing session	<= 30.1 µg change between weighings	1) 40 CFR Part 50, App. L Sec. 8.3.7.1 2 and 3) Method 2.12 Table 7-1 & Sec.10.5
Lab Filter Blank	10% or 1 per weighing session	<= 15.1 µg change between weighings	1) 40 CFR Part 50, App. L Sec. 8.3.7.2 2 and 3) Method 2.12 Sec. 10.5
Balance Check (working standards)	beginning, 10th sample, end	< ±3.1 µg from certified value	1, 2 and 3) Method 2.12 Sec. 10.6 Standards used should meet specifications in Method 2.12, Sec. 4.3.7
Routine Filter re-weighing	1 per weighing session	<= 15.1 µg change between weighings	1, 2 and 3) Method 2.12 Sec. 10.8
Microbalance Audit	every 365 days and once a calendar year	<= 0.003 mg or manufacturers specs, whichever is tighter	1, 2 and 3) Method 2.12 Sec. 11.2.7
Lab Temp Check	Every 90 days	< ± 2.1°C	1, 2 and 3) Method 2.12 Sec. 10.10
Lab Humidity Check	Every 90 days	< ± 2.1%	1, 2 and 3) Method 2.12 Sec. 10.10
Verification/Calibration			
Microbalance Calibration	***At installation*** every 365 days and once a calendar year	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. 10.11 3) NA
Lab Temperature Certification	every 365 days and once a year	< ± 2.1°C	1, 2 and 3) Method 2.12 Sec. 4.3.8 and 9.4
Lab Humidity Certification	every 365 days and once a year	< ± 2.1%	1, 2 and 3) Method 2.12 Sec. 4.3.8 and 9.4
Calibration & Check Standards -			
Working Mass Stds. Verification Compared to primary standards	Every 90 days	< ± 2.1 ug	1, 2 and 3) Method 2.12 Sec. 9.7
Primary standards certification	every 365 days and once a calendar year	0.025 mg tolerance (Class 2)	1, 2 and 3) Method 2.12 Sec. 4.3.7
SYSTEMATIC CRITERIA -PM2.5 Filter Based Local Conditions			
Siting	every 365 days and once a calendar year	***Meets siting criteria or waiver request documented***	1) 40 CFR Part 58 App E, Sec. 2-5 2) Recommendation 3) 40 CFR Part 58 App E, Sec. 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***	***µg/m3 at ambient temp/pressure (PM2.5)***	1, 2 and 3) 40 CFR Part 50 App N Sec. 3.0 (b)
Rounding convention for design value calculation	***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) The rounding convention is for averaging values for comparison to NAAQS not for reporting individual values.

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
Annual 3-yr average	***all concentrations***	***nearest 0.1 µg/m3*** (> 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 µg/m3*** (> 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 µg/m3***	1, 2 and 3) 40 CFR Part 50, App. L Sec. 3.1
Upper Conc. Limit	***all filters***	***≥ 200 µg/m3***	1, 2 and 3) 40 CFR Part 50, App. L Sec. 3.2
Precision			
Single analyzer (collocated monitors)	every 90 days	Coefficient of variation (CV) < 10.1% for values > 3.0 µg/m3	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 < 10.1 % for values ≥ 3.0 µg/m3***	1, 2 and 3) 40 CFR Part 58, App A, Sec. 4.2.1 and 2.3.1.1
Bias			
Performance Evaluation Program (PEP)	***5 audits for PQAOs with < 5 sites 8 audits for PQAOs with > 5 sites***	***< ± 10.1% for values ≥3.0 µg/m3***	1, 2 and 3) 40 CFR Part 58, App A, Sec. 3.2.4, 4.2.5 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.	every 365 days and once a calendar year	***< ± 2.1% of NIST Traceable Std.***	1) 40 CFR Part 50, App. L Sec. 9.1 & 9.2 2) Method 2-12 Sec. 4.2.2 & 6.4.3 3) 40 CFR Part 50, App. L Sec. 9.1 & 9.2
Field Thermometer	every 365 days and once a calendar year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Sec. 4.2.2
Field Barometer	every 365 days and once a calendar year	±1 mm Hg resolution, ±5 mm Hg accuracy	1, 2 and 3) Method 2.12 Sec. 4.2.2
Clock/timer Verification	Every 30 days	***1 min/mo***	1 and 2) Method 2.12 Sec. 4.2.1 3) 40 CFR Part 50, App. L Sec. 7.4.12

1) Criteria (PM2.5 LC)	2) Frequency	3) Acceptable Range	Information /Action
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 8: Continuous PM2.5 Local Conditions & PM10 STP Validation Template (T640x)

1) Criteria (T640x)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA- T640x Continuous, Local Conditions ($PM_{2.5}$) and STP (PM_{10})			
Sampler/Monitor Designation	NA	***Meets requirements listed in FEM designation*** Confirm method designation on front panel or just inside instrument.	1) 40 CFR Part 58 App C Sec. 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Firmware of monitor	*At setup and as updated*	***1. Must be the firmware (or later version) as identified in the published method designation summary.*** ***2. Firmware settings must be set for flowrate to operate and report at (1) "local conditions" for $PM_{2.5}$ and (2) STP for PM_{10}.***	1) FEM: EQPM-0516-238/239 2) EPA T640x SOP 3) 1. FEM: EQPM-0516-238/239 2. 40 CFR Part 50 App N. sec. 1 (c)
Data Reporting Period	Report every hour	1. The calculation of an hour of data is dependent on the design of the method. ***2. A 24-hour period is calculated in AQS if 18 or more valid hours are reported for a day*** [1/].	See operator's manual. Hourly data are always reported as the start of the hour on local standard time 40 CFR Part 50 App N. Sec 3 (c)
Sampling Instrument			
PM10 Inlet	At Setup	**Must be a Louvered PM10 size selective inlet as specified in 40 CFR 50 appendix L, Figures L-2 through L-19**	1) FEM: EQPM-0516-238/239 2) EPA T640x SOP 3) FEM: EQPM-0516-238/239
Average Flow Rate	***every 24 hours of operation; alternatively, each hour can be checked***	***average within ±5% of 16.67 liters/minute at local conditions***	1, 2 and 3) 40 CFR 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 (Total Flow)	***every 30 days each separated by 14 days***	***< ± 4.1% of transfer standard*** < ± 5.1% 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. 3.2.1
One-point Flow Rate Verification (Sample Flow)	***every 30 days each separated by 14 days***	***< ± 4.1% of transfer standard***	1, 2 and 3) 40 CFR Part 50, App.L, Sec. 9.2.5, 40 CFR Part 58, Appendix A Sec. 3.2.1
PMT verification	every 90 days	≤ ± 1.5 of SpanDust™ value stated on bottle	1) Teledyne T640 manual 2) EPA T640x SOP 3) To meet DQO set forth in 40 CFR Part 58, Appendix A Sec. 2.3.1.1

1) Criteria (T640x)	2) Frequency	3) Acceptable Range	Information /Action
OPERATIONAL CRITERIA- T640x Continuous, Local Conditions ($PM_{2.5}$) and STP (PM_{10})			
One-point Temp Verification	every 30 days	***< ± 2.1°C***	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual
Pressure Verification	every 30 days	***< ± 10.1 mm Hg***	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual
Leak Check (Zero Test)	every 30 days	***≤ 0.2 µg/m³***	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual
Span Deviation Tracker	Daily	If flagged	1, 2 and 3) Recommended. Teledyne representatives suggest monitoring this metric as a leading indicator of potential instrument malfunction.
Signal Length	Daily	Logged	1, 2 and 3) Recommended. Teledyne representatives suggest monitoring this metric because it is useful when diagnosing instrument malfunction.
Annual Multi-point Verifications/Calibrations			
Pressure Verification/Calibration	on installation, then every 365 days and 1/ calendar year	***< ± 10.1 mm Hg***	1) Teledyne T640 manual 2) Method 2.12 Sec. 6.5 3) Teledyne T640 manual
Flow Rate single-point Verification/ Calibration	***Electromechanical maintenance or transport or*** every 365 days and 1/calendar year	< ± 2.1% 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 Sec. 6.3 & Table 6-1 3) Recommendation
Precision			
Collocated Samples	***every 12 days for 15% of sites by method designation***	CV < 10.1% of samples ≥ 3 µg/m³	1) and 2) 40 CFR Part 58 App A Sec. 3.2.3 3 Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.1
Accuracy			
Temperature Audit	every 180 days and at time of flow rate audit	< ± 2.1°C	1, 2 and 3) Method 2.12 Sec. 11.2.2
Pressure Audit	every 180 days and at time of flow rate audit	< ±10.1 mm Hg	1, 2 and 3) Method 2.12 Sec. 11.2.3
Semi Annual Flow Rate Audit (Total Flow)	***Twice a calendar year and 5-7 months apart***	< ± 4.1% of audit standard < ± 5.1% of design flow rate	1 and 2) 40 CFR Part 58, App A, Sec. 3.2.2 3) Method 2.12 Sec. 11.2.1
Semi Annual Flow Rate Audit (Sample Flow)	***Twice a calendar year and 5-7 months apart***	< ± 4.1% of audit standard	1 and 2) 40 CFR Part 58, App A, Sec. 3.2.2 3) Method 2.12 Sec. 11.2.1

1) Criteria (T640x)	2) Frequency	3) Acceptable Range	Information /Action
Shelter Temperature			
Temperature range	during operation	**0 - 50°C**	1) Teledyne T640 manual 2) Recommendation 3) Teledyne T640 manual
Temperature Control	Daily (hourly values)	< 2.1° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2
Temperature Device Check	every 180 days and twice a calendar year	< ± 2.1° C	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2
Monitor Maintenance			
Inlet Cleaning	***every 30 days***	***cleaned***	1,2 and 3) Teledyne T640 manual
Downtube Cleaning	every 90 days	cleaned	1) Teledyne T640 manual 2 and 3) Method 2.12 Sec. 8.4
Inspect and clean optical chamber and relative humidity/temperature (RH/T) sensors	every 180 days and twice a calendar year. More frequently with high loading	cleaned	1) Teledyne T640 manual 2) EPA T640x SOP 3) EPA T640x SOP
Change Disposable Filter Unit	Annually or when Pump PWM value approaches 80%.	cleaned/changed	1) Teledyne T640 manual 2) EPA T640x SOP 3) EPA T640x SOP
Inspect Downtube and ASC to ensure vertically plumbed	every 90 days	***Plumb (90° from instrument horizontal axis)***	1) Teledyne T640 manual 2) Recommendation 3) Teledyne T640 manual
Check Pump Performance (Pump)	every 30 days	***PWM value 30 < 80%***	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual
Check Pump Performance (Valve)	every 30 days	***PWM value 50 < 85%***	1) Teledyne T640 manual 2) EPA T640x SOP 3) Teledyne T640 manual
Inspect inner and outer sample tubes	***every 30 days***	***Inspected Cleaned as needed***	1,2 and 3) Teledyne T640 manual
Manufacturer-Recommended Maintenance	per manufacturers' manual	per manufacturers' manual	

1) Criteria (T640x)	2) Frequency	3) Acceptable Range	Information /Action
SYSTEMATIC CRITERIA- T640x Continuous, Local Conditions ($PM_{2.5}$) and STP (PM_{10})			
Siting	every 365 days and once a calendar year	*Meets siting criteria or waiver documented*	1) 40 CFR Part 58 App E, Sec. 2-6 2) Recommendation 3) 40 CFR Part 58 App E, Sec. 2-6
Data Completeness	*Annual Standard*	*≥ 75% scheduled sampling days in each quarter*	1, 2 and 3) 40 CFR Part 50, App. N, Sec. 4.1 (a)(b)
	24- Hour Standard	*≥ 75% scheduled sampling days in each quarter*	1, 2 and 3) 40 CFR Part 50, App. N, Sec. 4.2 (a)(b)
Reporting Units	*all data*	*µg/m³ at ambient temp/pressure ($PM_{2.5}$)* *µg/m3 at STP (PM_{10})*	1. 2 and 3) 40 CFR Part 50 App N Sec. 3.0 (b), 40 CFR Part 50 App K
Rounding convention for data reported to AQS	*all concentrations*	*to one decimal place or as reported by instrument*	1. 2 and 3) 40 CFR Part 50 App N Sec. 3.0 (b)
Annual 3-yr average	*all concentrations*	*nearest 0.1 µg/m³* (≥ 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 ($PM_{2.5}$)* *quarterly (PM_{10})*	*nearest 1 µg/m³* (≥ 0.5 round up) *($PM_{2.5}$)* *nearest 10 µg/m3 (> 5 round up) (PM_{10})*	1,2 and 3) 40 CFR Part 50, App. N Sec. 3 and 4 Rounding convention for data reported to AQS is a recommendation, 40 CFR Part 50 App K Sec. 1 The rounding convention for comparison to NAAQS not for reporting individual values.
Verification/Calibration Standards Recertifications - All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	every 365 days and once a calendar year	*< ± 2.1% of NIST Traceable Std.*	1) 40 CFR Part 50, App.L Sec. 9.1 & 9.2 2) Method 2.12 Sec. 4.2.3 & 6.3.3 3) 40 CFR Part 50, App.L Sec. 9.1 & 9.2
Field Thermometer	every 365 days and once a calendar year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Sec. 4.2.2
Field Barometer	every 365 days and once a calendar year	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1, 2 and 3) Method 2.12 Sec. 4.2.2
Clock/timer Verification	Every 30 days	±5 min/mo**	1 and 2) Method 2.12 Sec. 4.2.1 3) Recommendation
Precision ($PM_{2.5}$)			
Single analyzer (collocated monitors)	every 90 days	Coefficient of variation (CV) < 10.1% for values ≥ 3.0 µg/m³	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 < 10.1 % for values ≥ 3.0 µg/m³*	1,2 and 3) 40 CFR Part 58, App A, Sec. 4.2.1 and 2.3.1.1
Bias			
Performance Evaluation Program (PEP)	*5 audits for PQAOs with ≤ 5 sites* *8 audits for PQAOs with > 5 sites*	*< ±10.1% for values ≥ 3 µg/m³*	1,2 and 3) 40 CFR Part 58, App A, Sec. 3.2.4, 4.2.5 and 2.3.1.1

SD= standard deviation , CV= coefficient of variation

**** = need to ensure data system stamps appropriate time period with reported sample value**

Table 9: Continuous PM2.5 Local Conditions Validation Template (T640)

1) Criteria (T640)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA- T640 $PM_{2.5}$ Continuous, Local Conditions			
Sampler/Monitor Designation	NA	***Meets requirements listed in FEM designation*** Confirm method designation on front panel or just inside instrument.	1) 40 CFR Part 58 App C Sec. 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Firmware of monitor	***At setup and as updated***	***1. Must be the firmware (or later version) as identified in the published method designation summary.*** ***2. Firmware settings must be set for flowrate to operate and report at "local conditions" (i.e., not STP).***	1) FEM: EQPM-0516-236 2) EPA T640 SOP 3) 1. FEM: EQPM-0516-236 2. 40 CFR Part 50 App N. sec. 1 (c)
Data Reporting Period	Report every hour	1. The calculation of an hour of data is dependent on the design of the method. ***2. A 24-hour period is calculated in AQS if 18 or more valid hours are reported for a day 1/.***	See operator's manual. Hourly data are always reported as the start of the hour on local standard time 40 CFR Part 50 App N. Sec 3 (c)
Sampling Instrument			
TSP Sampling Inlet	***At Setup***	***TAPI 5-Lpm sample inlet (P/N: 081050000)***	1) FEM: EQPM-0516-236 2) EPA T640 SOP 3) 1. FEM: EQPM-0516-236
One-point Flow Rate Verification	***every 30 days each separated by 14 days***	$< \pm$ 4.1% of ±5.0 LPM design flowrate	1, 2 and 3) 40 CFR Part 50, App.L, Sec. 9.2.5, 40 CFR Part 58, Appendix A Sec. 3.2.1
PMT verification	every 90 days	$\leq \pm$ 1.5 of SpanDust™ value stated on bottle	1) Teledyne T640 manual 2) EPA T640 SOP 3) To meet DQO set forth in 40 CFR Part 58, Appendix A Sec. 2.3.1.1

1) Criteria (T640)	2) Frequency	3) Acceptable Range	Information /Action
OPERATIONAL CRITERIA- T640 $PM_{2.5}$ Continuous, Local Conditions			
One-point Temp Verification	every 30 days	***< ± 2.1°C***	1) Teledyne T640 manual 2) EPA T640 SOP 3) Teledyne T640 manual
Pressure Verification	every 30 days	***< ± 10.1 mm Hg***	1) Teledyne T640 manual 2) EPA T640 SOP 3) Teledyne T640 manual
Leak Check (Zero Test)	every 30 days	***≤ 0.2 µg/m³***	1) Teledyne T640 manual 2) EPA T640 SOP 3) Teledyne T640 manual
Span Deviation Tracker	Daily	If flagged	1, 2 and 3) Recommended. Teledyne representatives suggest monitoring this metric as a leading indicator of potential instrument malfunction.
Signal Length	Daily	Logged	1, 2 and 3) Recommended. Teledyne representatives suggest monitoring this metric because it is useful when diagnosing instrument malfunction (e.g., deviation from design flow rate).
Annual Multi-point Verifications/Calibrations			
Pressure Verification/Calibration	on installation, then every 365 days and 1/calendar year	***< ± 10.1 mm Hg***	1) Teledyne T640 manual 2) Method 2.12 Sec. 6.5 3) Teledyne T640 manual
Flow Rate single-point Verification/ Calibration	***Electromechanical maintenance or transport or*** Every 365 days and 1/ calendar year	< ± 2.1% 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 Sec. 6.3 & Table 6-1 3) Recommendation
Precision			
Collocated Samples	***every 12 days for 15% of sites by method designation***	CV < 10.1% of samples ≥ 3 µg/m³	1) and 2) 40 CFR Part 58 App A Sec. 3.2.3 3 Recommendation based on DQO in 40 CFR Part 58 App A Sec. 2.3.1.1
Accuracy			
Temperature Audit	every 180 days and at time of flow rate audit	< ± 2.1°C	1, 2 and 3) Method 2.12 Sec. 11.2.2
Pressure Audit	every 180 days and at time of flow rate audit	< ±10.1 mm Hg	1, 2 and 3) Method 2.12 Sec. 11.2.3
Semi Annual Flow Rate Audit	***Twice a calendar year and 5-7 months apart***	< ± 4.1% of 5.0 LPM design flowrate	1 and 2) 40 CFR Part 58, App A, Sec. 3.2.2 3) Method 2.12 Sec. 11.2.1

1) Criteria (T640)	2) Frequency	3) Acceptable Range	Information /Action
Shelter Temperature			
Temperature range	during operation	**0 - 50°C**	1) Teledyne T640 manual 2) Recommendation 3) Teledyne T640 manual
Temperature Control	Daily (hourly values)	< 2.1° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2
Temperature Device Check	every 180 days and twice a calendar year	< ± 2.1° C	1, 2 and 3) QA Handbook Volume 2 Sec. 7.2.2
Monitor Maintenance			
Inlet Cleaning	***every 30 days***	***cleaned***	1,2 and 3) Teledyne T640 manual
Downtube Cleaning	every 90 days	cleaned	1) Teledyne T640 manual 2 and 3) Method 2.12 Sec. 8.4
Inspect and clean optical chamber and relative humidity/temperature (RH/T) sensors	every 180 days and twice a calendar year. More frequently with high loading	cleaned	1) Teledyne T640 manual 2) EPA T640 SOP 3) EPA T640 SOP
Change Disposable Filter Unit	Annually or when Pump PWM value approaches 80%.	cleaned/changed	1) Teledyne T640 manual 2) EPA T640 SOP 3) EPA T640 SOP
Inspect Downtube and ASC to ensure vertically plumbed	every 90 days	***Plumb (90° from instrument horizontal axis)***	1) Teledyne T640 manual 2) Recommendation 3) Teledyne T640 manual
Check Pump Performance	every 30 days	***PWM value 30 < 80%***	1) Teledyne T640 manual 2) EPA T640 SOP 3) Teledyne T640 manual
Inspect inner and outer sample tubes	***every 30 days***	***Inspected Cleaned as needed***	1,2 and 3) Teledyne T640 manual
Manufacturer-Recommended Maintenance	per manufacturers' manual	per manufacturers' manual	

SYSTEMATIC CRITERIA- T640 $PM_{2.5}$ Continuous, Local Conditions			
1) Criteria (T640)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Siting	every 365 days and once a calendar year	*Meets siting criteria or waiver documented*	1) 40 CFR Part 58 App E, Sec. 2-6 2) Recommendation 3) 40 CFR Part 58 App E, Sec. 2-6
Data Completeness	*Annual Standard*	*≥ 75% scheduled sampling days in each quarter*	1, 2 and 3) 40 CFR Part 50, App. N, Sec. 4.1 (a)(b)
	24- Hour Standard	*≥ 75% scheduled sampling days in each quarter*	1, 2 and 3) 40 CFR Part 50, App. N, Sec. 4.2 (a)(b)
Reporting Units	*all data*	*µg/m³ 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 concentrations*	*to one decimal place or as reported by instrument*	1. 2 and 3) 40 CFR Part 50 App N Sec. 3.0 (b)
Annual 3-yr average	*all concentrations*	*nearest 0.1 µg/m³* (≥ 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 µg/m³* (≥ 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
Verification/Calibration Standards Recertifications - All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Std.	every 365 days and once a calendar year	*< ± 2.1% of NIST Traceable Std.*	1) 40 CFR Part 50, App.L Sec. 9.1 & 9.2 2) Method 2.12 Sec. 4.2.3 & 6.3.3 3) 40 CFR Part 50, App.L Sec. 9.1 & 9.2
Field Thermometer	every 365 days and once a calendar year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Sec. 4.2.2
Field Barometer	every 365 days and once a calendar year	± 1 mm Hg resolution, ± 5 mm Hg accuracy	1, 2 and 3) Method 2.12 Sec. 4.2.2
Clock/timer Verification	Every 30 days	±5 min/mo**	1 and 2) Method 2.12 Sec. 4.2.1 3) Recommendation
Precision			
Single analyzer (collocated monitors)	every 90 days	Coefficient of variation (CV) < 10.1% for values ≥ 3.0 µg/m³	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 < 10.1 % for values ≥ 3.0 µg/m³*	1,2 and 3) 40 CFR Part 58, App A, Sec. 4.2.1 and 2.3.1.1
Bias			
Performance Evaluation Program (PEP)	*5 audits for PQAOs with ≤ 5 sites* *8 audits for PQAOs with > 5 sites*	*< ±10.1% for values ≥ 3 µg/m³*	1,2 and 3) 40 CFR Part 58, App A, Sec. 3.2.4, 4.2.5 and 2.3.1.1

SD= standard deviation , CV= coefficient of variation

**** = need to ensure data system stamps appropriate time period with reported sample value**

1.7.6 Network Scale

Representativeness is defined as a measure of the degree to which data accurately and precisely represent a selected characteristic of a monitoring system. Support in achieving representativeness (i.e., a DQI) 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 definitions in 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 4000 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 definitions.
- **Regional Scale** – Describes air volumes associated with rural areas of reasonably homogenous geography that extends for tens to hundreds of kilometers.

As described in Section 1.6.5, the FCEAP sites are ***Neighborhood Scale*** sites.

1.8 TRAINING / CERTIFICATION

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. Personnel assigned to the FCEAP Analysis & Monitoring Division will meet the educational requirements, accountability standards, and training requirements for their positions. All FCEAP staff are required to take specific, mandatory governmental training courses, such as safety training, operation of government vehicles, and EEO courses, among others. Records on personnel qualifications and training may be maintained in a number of locations, dependent upon the applicability of the information. For examples, staff may maintain copies of certificates received from particular classes or workshops, whereas the A&MPM will keep records of personnel qualifications and in-house training. Other personnel training and qualification records are maintained by Forsyth County HR.

Ambient air monitoring training is aimed at increasing the effectiveness of each employee individually, as well as the effectiveness of the A&MD as a whole, and is documented by the A&MPM. In general, training for the ambient air monitoring program consists of a combination of required reading, weekly informational meetings, active cross-training amongst A&MD staff, completion of EPA-lead training classes (when available), and attendance at NCDAQ and/or EPA workshops and conferences. Observations made during internal systems audits may result in the need for specific refresher training to be provided to A&MD staff. Completion of additional training – such as self-instructional air monitoring courses (e.g., online APTI) and EPA-provided webinars (e.g., AQS) – is encouraged by all staff. A&MD staff are also encouraged to communicate with the A&MPM to discuss options and availability for additional career development training.

A large component of the FCEAP air monitoring training program is centered around equipment cross-training. As described in Section 1.4 of this QAPP, given the small size of the A&MD, individuals are cross-trained to build and ensure staff redundancy. Training occurs when backup roles are needed to maintain coverage for all equipment. With that in mind, individuals within the Division are assigned as "back-ups" for various roles, as they relate to the operation and maintenance of particular analyzers or samplers. For example, a site operator is assigned as a back-up to the QA2 position, as it relates to $PM_{2.5}$ responsibilities; this includes operation and maintenance of the $PM_{2.5}$ FRM samplers and subsequent sample handling in the field, as well as use/maintenance of the in-house $PM_{2.5}$ Access database. Every July, staff rotate responsibilities, such that the back-up operators become the primary operators. This annual rotation of duties serves as refresher training, ensuring staff maintain their skills.

The following describes the base-training that is required for A&MD air monitoring staff.

1. **Quality Assurance**

The foundation of the ambient air monitoring program is an understanding of basic quality assurance and the overall ambient air monitoring program goals. In order to achieve this understanding the following activities are required:

- Reading and understanding the FCEAP *QAPP for Ambient Air Quality Monitoring of Criteria Air Pollutants*.
    - All staff are required to read this QAPP. Afterwards, the A&MPM commits ~2 hours per A&MD staff member to review and discuss the QAPP together personally, in order to ensure the concepts and requirements are understood by each staff member.
- Reading and understanding the EPA *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II* (QA Handbook).
    - All staff are required to read the sections of the QA Handbook that clearly address duties they perform for the A&MD. These sections will be identified by the A&MPM. Topics are routinely covered during the A&MD weekly meetings in order to ensure the concepts and requirements are understood by each staff member.
- Participation in weekly monitoring staff meetings to stay current with program policy, procedure, and guidance.

- The weekly A&MD meetings are held on Mondays to help prepare staff for the week's activities and to communicate the potential need for help from other staff members. This weekly meeting also serves as an educational tool to expose staff to a variety of topics the Division has to handle on a daily basis. Agendas vary weekly; educational topics include subjects such as quality assurance, instrument maintenance, and troubleshooting, among others. Meetings are held virtually or in-person and the A&MPM uses Microsoft Teams to review a variety of air monitoring files and documentation as a way of enhancing quality assurance understanding. The files reviewed may include, but not be limited to, up-to-date logbook records, data completeness reports, nightly auto-calibration results, audit reviews, and overall documentation completeness. The A&MPM may also conduct mini-quizzes during these meetings by asking questions for the group using hypothetical scenarios, which serves as a way of ensuring A&MD staff understand FCEAP procedures, EPA requirements, and perpetuates staff learning from each other.

2. **Equipment / Monitor-Specific Procedural Training**

The vast majority of work in the ambient air quality monitoring program involves operation, maintenance, and troubleshooting of equipment. Staff need to be trained on the procedures involved for proper installation of equipment, daily operation, required quality assurance check procedures, preventative maintenance, and troubleshooting.

Proper understanding and implementation of this QAPP requires the following specific training regimen for all monitoring staff:

- Reading and understanding the monitoring-specific SOPs associated with the equipment the site operator is responsible for operating.
- General and background knowledge of installation, operation, and maintenance of specific equipment.
  - This is provided by reading and understanding the manufacturer's operating manuals and guides, and is supplemented by vendor-offered formal training sessions, when available.
  - This is also a major focus of the weekly staff meetings (described above).
- Completion of "on-the-job training," which includes learning an instrument hands-on through collaboration with a senior A&MD staff member.
  - The trainee will operate the instrument until deemed proficient by the training staff member and the A&MPM. Close attention is paid to the typical operation of the equipment and the understanding of data flow from the analyzer to AQS. If any abnormalities occur, the trainees are always to notify the A&MPM.
- Applicable health and safety training conducted as part of the FCEAP safety program.

3. **Data Review and Validation**

Data can be considered the true work product of the ambient air quality monitoring program. Accordingly, thorough attention must be given to review, verification, and validation to ensure data

is accurate and reliable. Staff must completely understand the importance of following defensible procedures by reading and understanding this QAPP and the FCEAP Data Handling SOP. Like with equipment training, on-the-job training is the primary means by which staff members learn to review and validate data in accordance with FCEAP procedures. The QA training and required reading described above also assists in ensuring staff understand the fundamentals of data review. Supplemental training is offered during weekly staff meetings, as necessary.

1.9 DOCUMENTATION AND RECORDS

This element includes information concerning the management of documentation and records, including this QAPP. The majority of documentation and records produced by the FCEAP ambient air monitoring program consist of data and information gathered to support the data collection activities. Documentation and records include:

1) Standard Operating Procedures (SOPs)
2) Sample collection records in electronic and written format
3) Logbooks and data sheets in electronic format
4) Instrument and equipment calibration information
5) Quality assurance documentation in electronic and written format
6) Documentation that supports data review, validation, and certification activities.

Section 2.10 of this QAPP contains more detailed information regarding how data will be managed from FCEAP's monitoring network, including information on data recording, transmittal, storage, and retrieval. In addition to storage within the AQS database, the criteria pollutant concentration data and its associated QC data will be archived in FCEAP's in-house databases for future reference by the Office, the EPA, and other interested parties.

1.9.1 Program Policy and Procedure Documentation

FCEAP maintains records of program policy and procedure documentation. Documents in this category are published with the date and revision information clearly noted, generally in a document header. Documents in this category include:

1) Quality Assurance Project Plans (QAPPs – i.e., this document)
2) Standard Operating Procedures (SOPs)
3) Inter-office memos/emails or other official FCEAP correspondence, which provide air monitoring policy interpretation.

Some of these records/documents contain a "Distribution List" that itemizes the individuals who are to receive hard-copy versions of the document. Others are distributed electronically via email to all affected staff. Current versions of program policy and procedure documentation are distributed by the A&MPM, and additional copies may be obtained from the A&MPM when requested. When a document is superseded by a newer version, the replacement document clearly states that it is a

replacement. All individuals on the document's Distribution List receive notification of the new version and are provided a copy (in either paper or electronic form) by the A&MPM.

Copies of current program policy and procedure documents are retained in electronic file format (i.e., pdf) in a secured folder in Microsoft Teams, where access is limited to a read-only status to personnel other than the A&MPM. When replaced by a newer version, the A&MPM moves the previous (older) version to a subfolder in Microsoft Teams that is marked for archived documents. In this manner, older versions of the Office's policy/procedure documents are always available, in case procedures from a specific time period in the past ever need to be revisited.

1.9.2 Sample Collection Records

Each site operator or QA Specialist is responsible for completing the appropriate field logbook or maintenance/repair shop (i.e., "lab") logbook for the tasks he or she conducts. Logbooks consist of electronic record sheets, which cover in-lab checks and/or repairs that are needed, and electronic Excel site logbooks, which contain all QC checks. Other sample collection records required to be documented by the operators include preventive maintenance logs, which are paper records that detail equipment activity and are attached directly to each analyzer and calibrator in use in the network. These maintenance logs contain a list of the required, routine maintenance activities for which the operator checks off, and space to detail additional activities that were completed on the instrument. Other documentation/records include digital strip charts with memos attached.

Logbooks are assigned for specific activities related to the task being performed. Logbooks are available for sampling sites (e.g,. – AirVision electronic logs), specific parameters (e.g., – O_3), or additional categories, such as audits. Electronic logs must be filled out clearly and completely. The logbooks contain locked cells so that formulas cannot be overwritten.

Hand written data entry forms (such as the equipment maintenance logs) must be dated and signed prior to attaching to the instrument. All forms must be completed in ink (ball point). If mistakes are made on hardcopy forms, the site operator is to cross out the mistake with a single line through the incorrect entry, and initial and date the correction. The correct information should then be written beside the incorrect entry, if there is space to legibly do so, or should be written in a space nearby. These hardcopy records stay with the equipment until such time as the equipment is decommissioned; at that point, the log is archived in a file cabinet maintained by the A&MPM.

The FCEAP $PM_{2.5}$ Database (maintained in Microsoft Teams) was created in Microsoft Access and is used as a tool to streamline the numerous aspects of the $PM_{2.5}$ program. Similar to a digital logbook, the database is used to store information from when a filter arrives from the RTI lab, is taken to the site for sampling, and is shipped back to the lab post-sampling. All filter information (pre and post) from the beginning of the $PM_{2.5}$ network (January 1, 1999) to the current date is stored in the database. Additionally, all comments and leak checks performed on the FRMs are input into the database. The database is also used to aid the process of creating AQS files for each filter post sampling. Hence, the database serves as a major repository for $PM_{2.5}$ documentation and records within the Office.

Significant Documentation packages are used to document unique occurrences, which could affect true ambient conditions during sample collection. Examples include: firework activity near the site, road construction or paving taking place near a site, etc. These electronic file packages can include pictures of the evidence supporting the activity did take place, as well as a brief description. In general, these efforts are just to document that ambient conditions may not have been a true representation due to the abnormal activities near a particular monitoring site. These packages are accessed during data validation activities, when necessary, or in the event that the Office determines an exceptional event demonstration is needed for a particular pollutant data set. All significant documentation packages are stored in Microsoft Teams.

Electronic logbooks and handwritten data entry forms serve as the official records of sample collection activities. Electronic format is the preferred method of storing and archiving documentation and records in the FCEAP network. Some of the electronic logs and records described above are stored electronically in Excel or portable document format (i.e., PDF) at the individual monitoring sites on the site computer. For these, the operator must transfer the records from the field sites to the FCEAP long-term storage location (Microsoft Teams) on a routine basis. Other electronic records are stored on the central AirVision server. Hardcopy records are stored in the main office of the A&MD.

1.9.3 Chain-of-Custody Forms

Most ambient air monitoring data is collected via real-time or near real-time monitoring equipment. However, some monitoring – specifically, FRM $PM_{2.5}$ – involves the collection of a physical sample for analysis by a laboratory. Any samples collected for analysis that are packaged and transported to another location are required to be accompanied with a Chain-of-Custody (COC) Form that includes specific information regarding the sample. This form assists in tracking the integrity of the sample through the various stages of transportation and receipt. While COC forms themselves may vary by laboratory and analyses required, the general content of forms includes:

1) Submitter – Individual submitting samples to the laboratory.
2) Submission Date(s) – Date(s) the sample transferred into the possession of the new entity.
3) Delivery Method – The method that was used to transfer possession of the sample.
4) Tracking information on relevant sample conditions, such as minimum or maximum temperatures in the shipping container, or condition of any integrity seals.
5) Sample specific information, such as the date the sample was collected and other sample/site identifiers.

Section 2.3 of this QAPP will provide more information about COC forms. In the FCEAP network, COCs are used for $PM_{2.5}$ FRM sampling and $PM_{2.5}$ speciation sampling (which is covered under a separate QAPP and involves a different laboratory than RTI). Refer to the specific FCEAP Standard Operating Procedures for further details on COC application and usage. Completed Chain of Custody forms are retained by the laboratory as part of the official analytical record and are accessible through laboratory procedures.

1.9.4 QA/QC Records

Quality assurance and quality control are achieved through the performance of periodic activities such as:

- Technical systems audits (TSAs)
- Internal systems audits
- One-point QC Checks
- Zero/span/precision checks
- Verification/calibration procedures
- Maintenance activities
- One-point flow rate verifications
- Semi-annual flow rate audits
- Other performance audits (i.e., - internal, NCDAQ, PEP, NPAP)
- Acceptance testing procedures
- Collocated sampling
- Traceability certifications/calibrations
- Corrective actions

FCEAP uses a variety of methods to collect and document QA/QC data, some of which were previously described in Section 1.9.2 above. Documentation methods include: Excel spreadsheets, PDF records, worksheets, and data management systems (AirVision – e.g., the strip chart annotations and electronic logbooks which are included with the software). Use of these records is described in the associated FCEAP SOPs. These records are retained and archived according to the procedures identified in Section 1.9.6 below.

However, for some of the QA/QC activities described above – such as the traceability certifications – many of those records are retained in the FCEAP main office in hardcopy format. For example, the Certificates of Analyses that accompany gas cylinders are typically in paper format. Similarly, certificates of calibrations from many of the vendors where the FCEAP standards are sent annually for testing are provided to FCEAP in paper form. Where possible, these hardcopy records are scanned so that electronic versions can also be maintained in Microsoft Teams, along with the other electronic air monitoring records.

1.9.5 Reference Materials

Because of the technical nature of ambient air monitoring, numerous reference materials are required to effectively administer the program. Publications such as instrument operation manuals, troubleshooting guides, EPA guidance documentation, EPA technical memoranda, and various other reports are included in this category. FCEAP maintains access to applicable reference materials as long as they are administratively valuable. These documents are maintained in the A&MD office and/or in Microsoft Teams.

1.9.6 Archiving and Retrieval

Documentation is classified according to its intended use, future applicability, and regulatory requirement for retention. Information listed in Table 10 will be retained for three years from the date of collection in accordance with 2 CFR §200.334 "Retention requirements for records". However, in most instances, records will be retained for a period of four years to allow a buffer period that will provide overlap for end-of-cycle reporting and TSAs. Additionally, if any litigation, claim, designation, audit, or other action involving the records has been started before the expiration of the three-year period, the records will be retained until completion of the action and resolution of all issues which arise from it, or until the end of the regular (three-year) period, whichever is later. Records are retained longer due to the ease of data storage and organizational naming structure adopted by the FCEAP.

Electronic records are stored in Microsoft Teams, within the channel "EAP" or within the FCEAP data acquisition system (e.g., – Agilaire AirVision). Data stored in Microsoft Teams is backed up automatically by Microsoft and stored off-site. The FCEAP central AirVision server is backed up automatically by MIS.

Table 10 Documentation and Records

Categories	Record/Document Type	File Locations
Management and Organization	Reporting Agency Information	Annual Network Plan-EAP\Analysis-Monitoring\Network Assessments and Plans
	Organizational Structure	EAP\LASS\Forms\Organizational Chart
	Personnel Qualification and Training	A&MPM file cabinet and EAP\A-M Admin\Staff Primary and Secondary Responsibilities\Continuing Education Docs
	County (Governmental) Training Certifications	Forsyth County HR
	Quality Management Plan	EAP\Analysis-Monitoring\QA Documents (QMP QAPP SOP)\QMP
	Grant Information/Work Plans	FCEAP LASS Division
	Support Contracts (for equipment certification services)	FCEAP LASS Division (MS Teams)
Site Information	Network Descriptions	EAP\Analysis-Monitoring\Network Assessments and Plans
	Site Files, maps, pictures	EAP\Analysis-Monitoring\Network Assessments and Plans
Environmental Data Operations, Raw Data, Data Management	QAPPs	EAP\Analysis-Monitoring\QA Documents (QMP QAPP SOP)\QAPP
	SOPs	EAP\Analysis-Monitoring\QA Documents (QMP QAPP SOP)

	Field and Lab Notebooks, Inspection/Maintenance Records, Sample Handling/Custody Records	EAP\Pollutant Excel Logbooks EAP\PM2.5\Database EAP\Analysis-Monitoring\Equipment\Repair Supplies and Logs EAP\Analysis-Monitoring\Audits RTI (COC records)
	Original Data, Data Algorithms, Data Management System, Pollutant Data, Meteorological Data	Agilaire AirVision Database (SQL)
Quality Assurance/Reports	Network Reviews	EAP\Analysis-Monitoring\Network Assessments and Plans EAP\Analysis-Monitoring\Network Assessments and Plans\YYYY Assessment and Plan
	Data Quality Assessment Summary, Site Audits	AQS Database EAP\AQS Files Email EAP\PM2.5\Database EAP\Analysis-Monitoring\Audits
Data Reports	AQI Reports, Annual Network Plan, Data Summary Report	AQS Database, AMP 450, AMP 450NC, AMP 256 EAP\AQS Files\YYYY AQS files and Data Cert Reports

2.0 Measurement / Data Acquisition

2.1 Sampling Process Design

The primary function of the FCEAP Air Monitoring Program is to verify compliance with the NAAQS. Towards that end, sampling network design and monitoring site selection comply with the following appendices of 40 CFR Part 58:

1) 40 CFR Part 58, Appendix A - Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)
2) 40 CFR Part 58, Appendix D - Network Design for Ambient Air Quality Monitoring
3) 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

2.1.1 Network Objectives

The FCEAP monitoring program provides air quality monitoring services for Forsyth County, North Carolina. Our air quality monitoring services are conducted to measure concentrations of the criteria air pollutants (particulate matter, ozone, sulfur dioxide, and nitrogen dioxide) and other parameters of interest (PM Speciation, meteorological, etc.) The ambient air monitoring network is designed to meet three basic monitoring objectives. These basic objectives, per 40 CFR 58 Appendix D, are:

1) Provide air pollution data to the general public in a timely manner.
2) Support compliance with national ambient air quality standards (NAAQS) and emissions strategy development.
3) Support air pollution research studies.

Other goals and objectives are described in Section 1.6 of this QAPP.

2.1.2 Site Types

In order to support the air quality management work indicated in the three basic air monitoring objectives, a network may be designed with a variety of types of monitoring sites. Monitoring sites must be capable of informing managers about many things including the peak air pollution levels, typical levels in populated areas, air pollution transported into and outside of a city or region, and air pollution levels near specific sources. There are six general site types:

1) Sites located to determine the highest concentrations expected to occur in the area covered by the network.
2) Sites located to measure typical concentrations in areas of high population density.
3) Sites located to determine the impact of significant sources or source categories on air quality.
4) Sites located to determine general background concentration levels.
5) Sites located to determine the extent of regional pollutant transport among populated areas; and in support of secondary standards.
6) Sites located to measure air pollution impacts on visibility, vegetation damage, or other welfare-based impacts.

The network may be comprised of one or more of the basic site types. Site type requirements for the network are determined by a variety of factors, such as pollutant of interest, monitoring objective, geographic location, and meteorology. The Annual Network Plan covers this specifically, and in greater detail. The ANP can be found at this link:

http://www.forsyth.cc/EAP/quality_assurance_documents.aspx

2.1.3 Monitoring Station Types

The national ambient air monitoring system includes several types of monitoring stations, each targeting a key data collection need and each varying in technical sophistication.

1) Research Grade Stations – platforms for scientific studies, either involved with health or welfare impacts, measurement methods development, or other atmospheric studies.
2) NCore Multi-pollutant Stations – sites that measure multiple pollutants in order to provide support to integrated air quality management data needs.
3) State and Local Air Monitoring Stations (SLAMS) – sites intended to address specific air quality management interest.

4) Special Purpose Monitoring (SPM) Stations – short-term monitoring stations for criteria pollutants or longer-term monitoring stations for non-criteria pollutants or non-FRM/non- FEM methodologies.

The FCEAP ambient air monitoring sites are **SLAMS** station-types.

2.1.4 Site Selection

FCEAP adheres to the site selection criteria specified in 40 CFR Part 58, Appendix D. The selection of a specific monitoring site includes the following activities:

1) Developing and understanding the monitoring objective and appropriate data quality objectives.
2) Identifying the spatial scale most appropriate for the monitoring objective of the site.
3) Identifying potential locations where the monitoring site could be placed.
4) Identifying the specific monitoring site.

Four criteria are considered when evaluating potential sites. Monitoring sites are generally oriented to measure the following (individually 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.
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:

1) ***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.

2) ***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.

3) ***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.

4) ***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).

5) ***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 consist of 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.

6) ***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.

Interdependence exists between all of the factors listed above. Consequently, an iterative procedure must be employed in order to successfully select appropriate sites that can provide the data necessary to accomplish the network's stated objectives. In situations where the sites do not specifically meet the requirements necessary to obtain the network objectives, re-evaluation of the project priorities may be necessary prior to the final monitoring site selection.

Experience in the 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. These responsibilities currently reside with the FCEAP A&MPM; although in some rare circumstances, in-house modelers within the Office may collaborate with or assist the A&MPM, if requested.

FCEAP performs an annual network review and submits it to EPA and the State of NC to address changes identified to meet the monitoring objectives. EPA will review the ANP and grant approval of the network design (and recommended changes, if applicable), if the design is found to meet the minimum regulatory requirements. Additionally, FCEAP performs a very rigorous Network Assessment and submits it to EPA on a rolling 5-year schedule.

The current FCEAP ambient air monitoring network – its site types, station types, monitoring methods, and operating schedules – are described in Section 1.6 of this QAPP and illustrated in Figure 4. More detailed information about the network and monitors can be found in the Annual Network Plan.

2.2 Sampling Methods

Sampling methodology for ambient air monitoring is continually evolving. Methods continue to be refined in attempts to improve accuracy and reliability, with a goal of improving efficiency in identifying and quantifying various air pollutants. This section will discuss the field equipment/stations and their design, which is critical for the collection of NAAQS-comparable monitoring data.

Analyzers/Samplers

Sampling methods may be categorized into two general categories:

1) Intermittent sample collection (non-continuous or static) – A physical sample is collected using a monitoring device that passes ambient air through a filter, collects a sample in a container, or exposes a sample collection media to a sample stream. The sample containing media (i.e., filter) is then removed and analyzed via laboratory methods to identify and/or quantify the pollutant of interest.

2) Real-time or near real-time sample analysis (continuous) – Physical samples are not collected. "In situ" analysis of the composition of the sample is performed within the analyzer itself using a specific methodology.

FCEAP uses only EPA-approved FRM (federal reference method) or FEM (federal equivalent method) instrumentation for determining pollutant concentrations for NAAQS compliance determinations. An instrument that has received FRM or FEM status has been rigorously tested, in accordance with 40 CFR Part 53 requirements, and been found to meet (or be comparable to) the reference methods codified in 40 CFR Part 50 (which are discussed in Section 2.4 of this QAPP). Table 11 specifies the FRM/FEM measurement methods for the criteria air pollutants utilized within the FCEAP monitoring network. Additionally, the specific EPA-designated method code associated with the monitoring instrumentation is shown in Table 11; the Annual Monitoring Network Plan can be referenced to see which instrument method is located at each monitoring station within the FCEAP network.

The scientific measurement principles of the differing sampling methods utilized by the air monitoring instrumentation are not described here. However, detailed descriptions of these principles for the specific pollutants analyzers, including theories of operation, can be found in the instrument manuals. Copies of these manuals can be found online and are also maintained by FCEAP in Microsoft Teams, as well as on the site computers housed within the monitoring stations and on the computer located in the maintenance/repair shop ("lab"). Similarly, for the detailed specifications upon which the instrument has received its FRM/FEM status, see the *List of Designated Reference and Equivalent Methods*, issued by the EPA Office of Research and Development, which can be found at the following webpage: https://www3.epa.gov/ttn/amtic/criteria.html.

Table 11 FCEAP Monitoring Network Monitoring Methods

Pollutant	Analyzer/Sampler	Method	EPA Reference/Equivalence Method Code
Ozone	Teledyne API T400	Continuous. UV Photometry	EQOA-0992-087
Reactive Oxides of Nitrogen	Teledyne API T200U	Continuous. Chemiluminescence	RFNA-1194-099
Sulfur Dioxide	Teledyne API T100U	Continuous. Fluorescence Spectrometry	EQSA-0495-100
PM_{10}	Teledyne API T640x	Continuous. Scattered Light Spectrometry	EQPM-0516-239
$PM_{2.5}$	Thermo Model 2025i Sequential Air Sampler	Intermittent. Filter-based, Gravimetric	EQPM-0202-145
	Teledyne API T640	Microbalance. Scattered Light	EQPM-0516-236
	Teledyne API T640x	Spectrometry	EQPM-0516-238

The instruments listed in Table 11 above must be operated in accordance with the its FRM/FEM specifications in order for the data produced to be NAAQS-comparable. The FCEAP Standard Operating Procedures (SOPs) detail these requirements. Table 12 below lists the SOPs currently used by FCEAP that are covered by this QAPP. FCEAP SOPs are submitted to EPA Region 4 for review and approval.

Table 12 Forsyth County Ambient Air Monitoring SOPs

Pollutant/Task	Title	Revision #	Date
Ozone	Section 1 Ozone SOP	2.1	1/21
NO_2	Section 2 NO-NO_2-NOx SOP	2.1	1/21
SO_2	Section 3 SO_2 SOP	3.1	1/21
$PM_{10}/PM_{2.5}$	Section 4 T640X/T640 SOP	0	9/18
PM 2.5	Section 6 FRM $PM_{2.5}$ SOP	1.1	1/17

Data Handling	Section 10 Data Handling and Processing SOP	2.1	1/21
Data Logger	Section 11 Datalogger SOP	1	1/02
Calibrators	Section 12 Calibrators SOP	1	6/16
Zero Air Supplies	Section 13 Zero-Air Supplies SOP	1	6/16
Hastings Bubble Tower	Section 14 Hastings Bubble Tower	1	10/21

Please note, for special purpose monitoring (such as community-specific AQI determination), FCEAP may use alternative non-FEM or non-FRM methods for measurement. In these instances, other industry-accepted and tested methodology is used.

Monitoring Stations

The FCEAP monitoring stations are EKTO-type design. This design supports the operational needs of the equipment, provides an environment that supports sample integrity, and allows the operator to safely and easily service and maintain the equipment. Site operator safety and site security considerations are paramount to station design.

In addition to the overall shelter design, for continuous monitoring, the climate-control capabilities of the station interior are critical considerations. Analyzers must be housed in a shelter capable of fulfilling the following requirements:

- The shelter temperature must be maintained at a temperature that meets the equivalency requirements for all instrumentation that it contains. For the API models, shelters must be operated at temperatures between 5º and 40º C. For other models, shelters temperatures must be operated within the acceptable range for that model. For sites that contain more than one model type, the most restrictive temperature range will apply.
- The power supply should not vary more than ±10% from an Alternating Current Voltage (VAC) of 115.
- 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.

Sample Probes

FCEAP uses Teflon (FEP or an approved equivalent) sample probes in its network. The probes will be cited in accordance with 40 CFR Part 58, Appendix E criteria. As a goal, these siting requirements will be verified on a quarterly basis by the QA Specialist during routine performance audits; however, all sites will be inspected at least once per year.

FCEAP uses a through-the-probe (TTP) configuration at all gaseous monitoring stations. This includes connecting a calibration Teflon line to a certified calibrator output, and then to a solenoid valve, that feeds a known concentration up to the sample probe box outside the shelter via a Teflon line with outer diameter of 1/4" and a minimum inner diameter of 1/8". The transfer standard (calibrator) will send known concentrations up the calibration gas line into the probe box to a "tee". The tee is also connected to the short inlet line that goes to the inlet funnel and the sample feed going to the analyzer. In ambient operation, the analyzer pulls ambient air from the inlet line and the calibration gas line is sealed by the solenoid. In calibration operation, the transfer standard supplies the calibration gas concentrations through the solenoid and calibration gas line up to the probe box. The analyzer pulls what it needs through the sample line and the inlet line becomes the vent for the excess calibration feed. The entire sample path, except the short inlet line (less than 12"), is used during all reportable QC/QA checks. See Figure 5 for an example.

Dirt buildup on the inside of the sample lines has the potential to absorb pollutants from the air stream during high concentration periods and release pollutants during low concentration periods, skewing the data collected. To prevent this, particulate filters are installed in the probe box downstream from the "tee". In addition, because of these particulate filters, the sample lines themselves are not cleaned on a set schedule; rather, the particulate filters are replaced monthly. Sample lines will be replaced when/if visible debris is sighted inside the lines. Since the FCEAP started this probe box design in ~2009, no sample line has been replaced except the short piece from the "tee" to the inlet funnel, due to that short piece being the only section not protected by the particulate filter.

Note: Sample train materials and design cannot be altered by site operators without consent of the A&MPM.

Figure 5: TTP Sample Probe Box

2.3 Sample Handling and Custody

The FCEAP network collects $PM_{2.5}$ samples and ships them to the RTI gravimetric laboratory, where the analysis is conducted following EPA regulation, and in accordance with RTI's QAPP and SOPs. Due to the use of this data for comparison to the NAAQS and the requirement for extreme care in sample collection, sample custody procedures must be followed. Custody procedures are detailed in the FCEAP $PM_{2.5}$ SOP.

Pre-Sample Custody

Filters used for $PM_{2.5}$ sampling are initially equilibrated and weighed in the gravimetric laboratory maintained by RTI. Due to the small size of mass to be measured, extreme care is taken to prevent contamination of the samples. Filters used in the $PM_{2.5}$ program are provided by EPA. Upon receipt of the new filter lot each year, the RTI analyst will inspect and test the filters, and then store them until they are needed for sampling. At that time, the filters will be conditioned and subsequently weighed. The lab is responsible for documenting the laboratory conditions during the weigh sessions. Filter conditioning data (e.g. weigh date, initial temperature mean, temperature control (i.e., standard deviation (SD)), initial RH mean, RH control (SD), etc) are documented.

After the initial (tare) weighing, the analyst will prepare the $PM_{2.5}$ filters for field use, including any blanks. Filters will be placed into filter support cassettes, and then the filters/cassettes will be placed into a sample magazine(s). The magazine(s) is then placed into a cooler and prepared for shipment to FCEAP. A COC (Figure 6) is provided with the shipment that contains the identification numbers for all filters in the magazine(s). The COC is signed and dated by the site operator upon receipt.

FCEAP monitoring staff inspect the FRM $PM_{2.5}$ filters received from RTI for possible shipping and handling damage or other atypical characteristics. Compromised or damaged filters are not sampled in the field. Compromised or damaged filters may be evidenced by visible damage noted on the filter substrate (e.g. – pinholes, rips, etc.), damage to the filter screen, or damage to the filter cassette. Compromised or damaged filters are returned to the RTI weighing laboratory.

Post-Sample Custody

Site operators collect $PM_{2.5}$ samples using procedures outlined in the FCEAP $PM_{2.5}$ SOP. In general, site operators collect exposed $PM_{2.5}$ samples from the FRM samplers in the field within 177 hours of sample collection. The samples are removed from the samplers in the protective magazines and then transferred into a cooler containing frozen blue ice packs (or equivalent). From there, the samples are taken to the FCEAP office. Site operators observe the exposed filters for possible instrument processing or sample handling damage. Compromised or damaged filters are noted on the associated filter data sheet. If it is determined that damage to the filter is significant, such as a breach in the filter substrate, the sample is considered to be invalid.

Using the $PM_{2.5}$ Access database, shipment reports are prepared for the filters to be returned to the laboratory, along with the completed/signed COC. (A separate shipment report can be printed for each

individual filter if needed. See Figure 7 below for an example.) However, if the filters are not going to be shipped back immediately, then the filters are stored in a designated refrigerator in the FCEAP office, along with the paperwork, until it is time to ship them. Filter holding requirements for the samples can be found in Table 7 of this QAPP.

When preparing the exposed samples for shipment, the site operator places a digital thermometer into the shipment cooler, along with the sample magazines (in their metal transport boxes), surrounded by frozen ice packs. The shipment report(s), signed by the operator, is included in the cooler. The cooler is then sealed with duct tape and addressed to the RTI lab. The coolers are shipped via United Parcel Service (or equivalent) and are delivered with overnight service to the lab.

Upon receipt, the RTI lab analyst documents the date the samples are received and records the cooler shipment temperature. Analytical holding time is dependent upon the shipment temperature and will be determined by the lab analyst. Filters are subsequently conditioned and prepared for weighing. Filter conditioning data (e.g. weigh date, final temperature mean, temperature control (SD), final RH mean, RH control (SD), etc) are documented during the final weigh session. During this process, samples are also inspected for damage. The lab analyst notes compromised or damaged filters and discloses this information in the filter data package that we get from NCDAQ. This includes filters deemed to be significantly affected by damage or other atypical characteristics. FCEAP is notified by NCDAQ if out-of-specification conditions are recorded in the laboratory. Filter conditioning information, and other weigh session data, is provided to FCEAP in the form of a $PM_{2.5}$ weigh lab summary spreadsheet. FCEAP uses this information to determine sample data validity.

Filter Archive

$PM_{2.5}$ filters are archived in a refrigerator in the RTI laboratory for up to 1 year past the termination of the contract with NCDAQ, per the following excerpt from RTI's QAPP, supplied to us from the NCDAQ:

Filter Archive Procedures

Filters will be archived until one year after termination of the contract performance period, or until the client (NCDAQ) requests return of such materials, whichever comes earlier. One year after termination of the contract the client (NCDAQ) will be contacted by FCEAP to instruct RTI to return the filters to them, NCDAQ, and then route the filters to FCEAP. The filters will be stored in capped petri-slide containers, in trays, which will be placed inside zipper seal bags. Each bagged tray will be placed within a larger bin and labeled. Filters will be stored in a cold-room facility or refrigerator whose temperature is maintained at 4 ˚C or less.

Make-Up Samples

Scheduled $PM_{2.5}$ samples may be missed due to a variety of situations including: sampler malfunction; power outage; and filter problems, among others. Adequate numbers of $PM_{2.5}$ measurements are important to maintain high data capture, in accordance with 40 CFR Part 50,

Appendix N. Specifically, 75% of scheduled samples per quarter are required to show that a site meets the standard. The use of replacement samples (i.e., make-ups) are allowed by EPA to help monitoring organizations achieve desirable data capture goals.

FCEAP collects $PM_{2.5}$ samples in accordance with the scheduled specified in 40 CFR 58.12. The national sampling schedule is set each year by EPA. A "make-up" sample becomes a replacement for a scheduled day. The number of make-up samples permitted by EPA in any calendar quarter is limited to 5 samples.

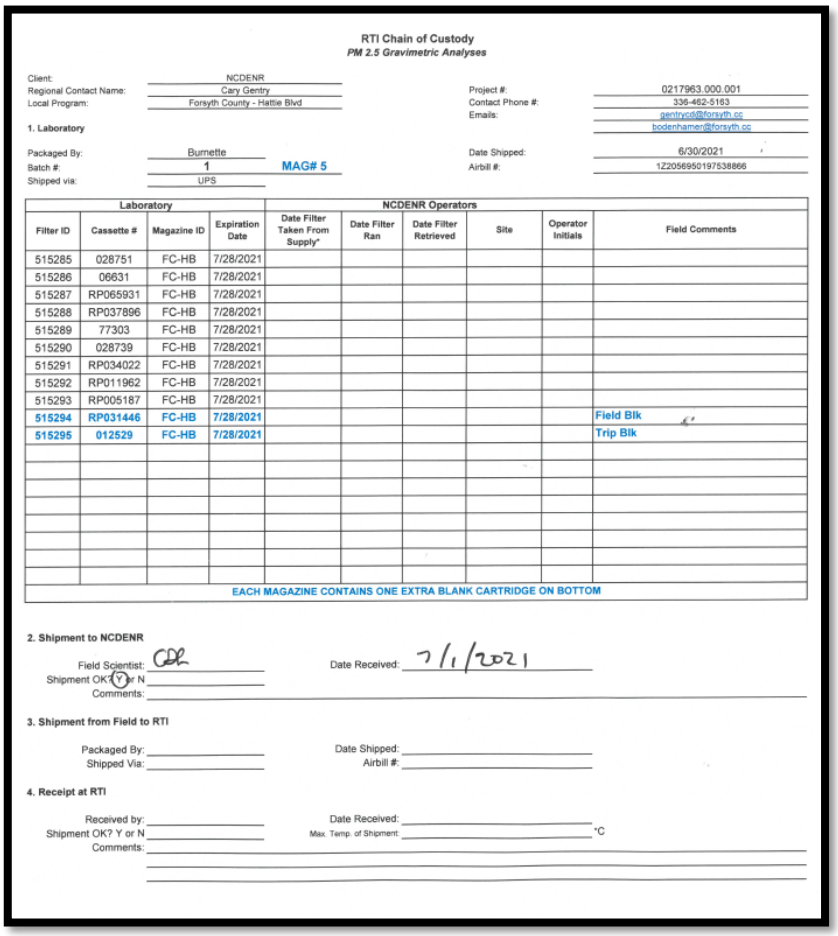
When make-up samples are necessary, FCEAP site operators will document the reason why the original sample was invalidated.

The following is the approach FCEAP site operators will take when selecting the make-up sampling day. In all cases, the make-up sampling day must be no later than 1 week from the missed sampling day.

Preferred choice for make-up sampling day: before the next scheduled sampling day.

- For monitoring sites sampling every sixth day, the preferred replacement day is the next scheduled every third-day sample. This provides the benefit of additional spatial resolution of network measurements and is likely to be most convenient for site operators. Otherwise, a day closest to the missed sampling day is suggested.
- For monitoring sites sampling every third day, the earliest possible day before the next scheduled sample at the monitoring site is suggested. Although there are only two possible make-up days with 1-in-3 day sampling, selection of a replacement day as close as possible to the missing day increases the chances of a replacement day with similar meteorological conditions.

Alternative approach: Sample one week later, on the same calendar day. This provides a replacement day on the same day of the week, thereby helping with temporal balance for the quarterly data set to reduce any potential day of the week effect of emissions.



RTI Chain of Custody
PM 2.5 Gravimetric Analyses

Client: NCDENR
Regional Contact Name: Cary Gentry
Local Program: Forsyth County - Hattie Blvd

Project #: 0217963.000.001
Contact Phone #: 336-462-5183
Emails: gentrycd@forsyth.cc
bodenhamer@forsyth.cc

1. Laboratory

Packaged By: Burnette
Batch #: 1 MAG# 5
Shipped via: UPS

Date Shipped: 6/30/2021
Airbill #: 1Z2056950197538866

Laboratory				NCDENR Operators					
Filter ID	Cassette #	Magazine ID	Expiration Date	Date Filter Taken From Supply*	Date Filter Ran	Date Filter Retrieved	Site	Operator Initials	Field Comments
515285	028751	FC-HB	7/28/2021						
515286	06631	FC-HB	7/28/2021						
515287	RP065931	FC-HB	7/28/2021						
515288	RP037896	FC-HB	7/28/2021						
515289	77303	FC-HB	7/28/2021						
515290	028739	FC-HB	7/28/2021						
515291	RP034022	FC-HB	7/28/2021						
515292	RP011962	FC-HB	7/28/2021						
515293	RP005187	FC-HB	7/28/2021						
515294	RP031446	FC-HB	7/28/2021						Field Blk
515295	012529	FC-HB	7/28/2021						Trip Blk
EACH MAGAZINE CONTAINS ONE EXTRA BLANK CARTRIDGE ON BOTTOM									

2. Shipment to NCDENR

Field Scientist: CDL
Shipment OK? (Y) or N
Comments:

Date Received: 7/1/2021

3. Shipment from Field to RTI

Packaged By:
Shipped Via:

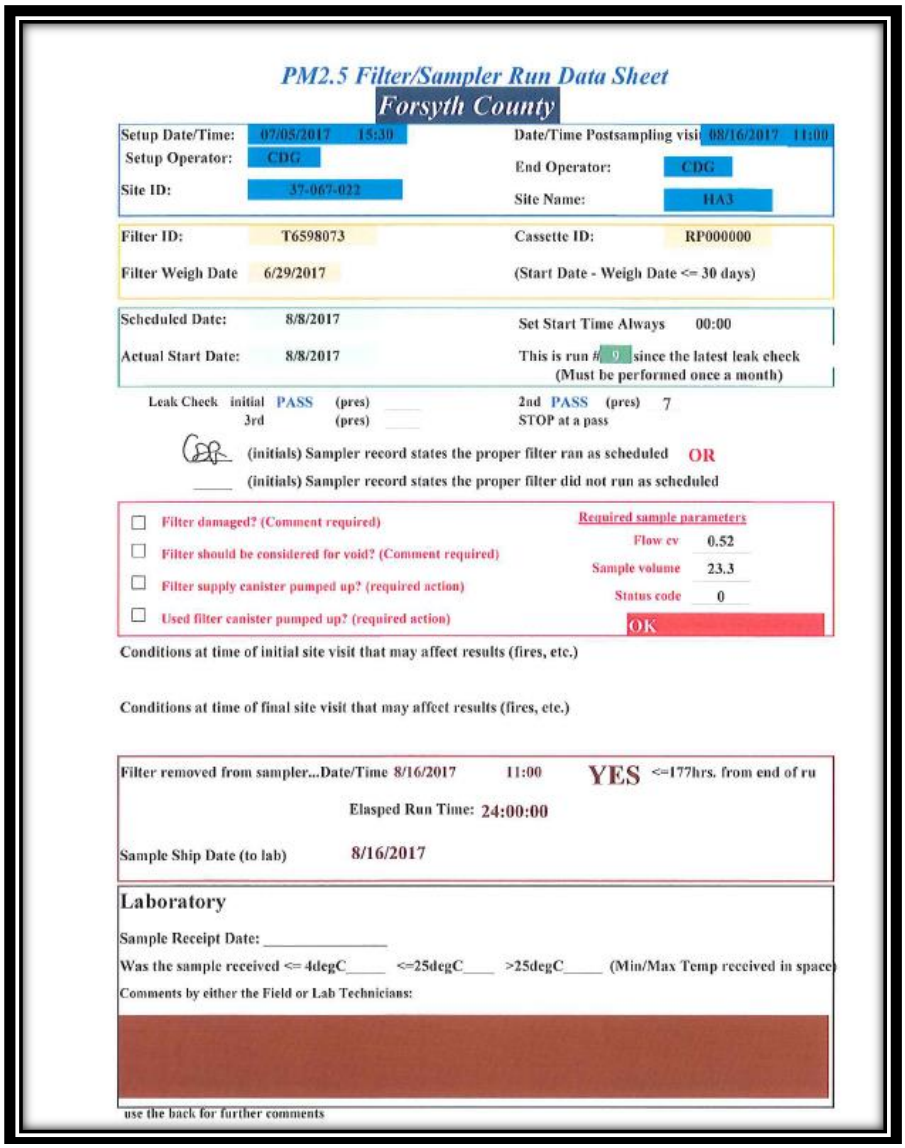
Date Shipped:
Airbill #:

4. Receipt at RTI

Received by:
Shipment OK? Y or N
Comments:

Date Received:
Max. Temp. of Shipment: °C

Figure 6: Chain-of-Custody Form



PM2.5 Filter/Sampler Run Data Sheet

Forsyth County

Setup Date/Time: 07/05/2017 15:30 Date/Time Postsampling visi 08/16/2017 11:00
Setup Operator: CDG End Operator: CDG
Site ID: 37-067-022 Site Name: HA3

Filter ID: T6598073 Cassette ID: RP000000
Filter Weigh Date 6/29/2017 (Start Date - Weigh Date <= 30 days)

Scheduled Date: 8/8/2017 Set Start Time Always 00:00
Actual Start Date: 8/8/2017 This is run # 9 since the latest leak check
(Must be performed once a month)

Leak Check initial PASS (pres) 2nd PASS (pres) 7
3rd (pres) STOP at a pass

(initials) Sampler record states the proper filter ran as scheduled OR
(initials) Sampler record states the proper filter did not run as scheduled

☐ Filter damaged? (Comment required)
☐ Filter should be considered for void? (Comment required)
☐ Filter supply canister pumped up? (required action)
☐ Used filter canister pumped up? (required action)

Required sample parameters
Flow cv 0.52
Sample volume 23.3
Status code 0
OK

Conditions at time of initial site visit that may affect results (fires, etc.)

Conditions at time of final site visit that may affect results (fires, etc.)

Filter removed from sampler...Date/Time 8/16/2017 11:00 YES <=177hrs. from end of ru
Elasped Run Time: 24:00:00
Sample Ship Date (to lab) 8/16/2017

Laboratory
Sample Receipt Date: _____
Was the sample received <= 4degC____ <=25degC____ >25degC____ (Min/Max Temp received in space)
Comments by either the Field or Lab Technicians:

use the back for further comments

Figure 7: $PM_{2.5}$ Sample Run Data Sheet (Shipment Report)

2.4 Analytical Methods

The equipment required for the criteria pollutant network is listed in Table 11 of this QAPP. With regards to the gaseous criteria pollutants equipment, the analyzers are designed as completely contained monitoring units that do not require additional analytical methods to establish the pollutants' environmental concentrations. Similarly, PM_{10} monitoring is also accomplished by means of continuous monitors in the FCEAP network; like with the gaseous analyzers, PM_{10} analysis occurs *in situ* using the Teledyne API T640x method and, therefore, does not require any separate analyses within a laboratory. As stated previously, all monitors used in the FCEAP network for regulatory purposes must be an FRM or FEM. Reference the following appendices of

40 CFR Part 50 to find the detailed regulatory method requirements for each of continuous monitors in the FCEAP network:

- Appendix A-1 – Sulfur Dioxide
- Appendix D – Ozone
- Appendix F – Nitrogen Dioxide
- Appendix J – PM_{10}

For intermittent $PM_{2.5}$ sampling, sample collection occurs in the field using a sampler that has been designated as an FRM, but the final sample analysis of the collected filter occurs in the laboratory. The gravimetric analysis of the $PM_{2.5}$ filter must also be completed in accordance with the federal reference method. These method requirements for $PM_{2.5}$ sampling, which includes both the field and laboratory (analytical) components, are detailed in 40 CFR Part 50, Appendix L. The analytical instrument that will be used for the gravimetric analysis of the FRM $PM_{2.5}$ sample is the microbalance. The required filter media is a 46.2 millimeter polytetrafluoroethylene (PTFE Teflon) filter. As stated in Section 2.3 above, EPA supplies the filter media to monitoring organizations, including FCEAP.

The RTI gravimetric laboratory will conduct the gravimetric analysis of $PM_{2.5}$ samples in accordance with the RTI QAPP/SOPs, and in accordance with the filter weighing requirements specified in 40 CFR Part 50, Appendix L, Section 8.

2.5 Quality Control

Quality control is the overall system of technical activities that measure the attributes and performance of a process against established standards to verify that performance meets the stated requirements. This section contains QA/QC information regarding the specifications and performance criteria for the criteria pollutant monitors/samplers utilized in the FCEAP network. Information on QA data validation and verification can be found in Section 4.

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 second function is to control measurement error by implementing specific QC checks at established frequencies to ensure the monitoring instrumentation operates within specified criteria.

QC procedures for each pollutant type are addressed (and discussed in more detail) in the FCEAP pollutant-specific SOP (see Table 12). Calculations and formulas related to the QC checks are defined in the individual SOPs. Associated Excel forms utilized by FCEAP staff contain these formulas embedded in cells, and generate values for the site operators immediately. Similarly, EPA's AQS provides statistical software that evaluates the DQIs of precision, bias, and completeness, once the FCEAP data is uploaded into the database.

The following summarizes the QC procedures performed by FCEAP A&MD staff. Traceability of calibration standards is discussed in Section 2.7 of this QAPP.

1) **Calibration** – The process employed to verify and rectify an instrument's measurements in order to minimize deviation from a known standard. This multi-phase process begins with certifying a calibration/transfer standard against an authoritative, NIST-traceable standard. The sampling or analytical instrument's measurements are then compared to that of the calibration/transfer standard. If deviations exist between the instrument's measurements and the calibration/transfer standard's measurements that are beyond the acceptance specification, corrective action is implemented to rectify the instrument's measurements. This corrective action is in the form of an instrument adjustment. Henceforth, the term calibration will be used to mean **adjustment**.

In general, analyzers are to be calibrated upon receipt, when installed, when physically moved from current location, and when certain repairs are made. A calibration may also be necessary if power is lost for more than 24 continuous hours at a site. The calibration consists of adjustments made to the analyzer at a zero concentration and at an upscale "span" concentration, followed by 3 additional verification points spaced along the **calibration scale**. The span point is typically performed at 80-90% of the calibration scale of the analyzer. In the FCEAP monitoring network, O_3 and NO_2 gaseous analyzers are calibrated on a 0-250 parts per billion (ppb) calibration scale; SO_2 analyzers are calibrated on a 0 – 100 ppb calibration scale. Although the Teledyne API analyzers utilized in the monitoring network can operate on a larger range, ambient concentrations in Forsyth County – as well as in the state of North Carolina – have been steadily decreasing in recent years. Because of this decrease in concentrations, FCEAP decided to reduce the calibration scales such that calibrations can occur across a range that is more representative of the pollutant concentrations seen in ambient air.

Calibration acceptance criteria includes limits on slope and intercept, in addition to percent differences for each concentration point generated during the calibration. These requirements are specified in Tables 4 – 6 of the QAPP, as well as in the individual pollutant SOPs. Calibrations put the equipment in good standing for future data collection.

For particulate matter samples, the calibration process is considerably different from that described for the gaseous analyzers. For these samplers, flow rate is adjusted when performing a calibration. The design (targeted) flowrate of low-volume $PM_{2.5}$ and PM_{10} samplers, including the T640x, is 16.67 liters per minute (LPM). After flow rate has been adjusted – using the procedures specified in the appropriate FCEAP SOP – the flow rate is verified to ensure the calibration is successful. Using a certified flow transfer standard (FTS), flow rate is measured and a comparison between the known (transfer standard) and the measured (sampler) is calculated using percent difference. This calibration verification must be within 2% for the calibration to be successful (see Tables 7 – 9).

2) **90-Day Verification** – A multi-point verification conducted once per quarter, and includes 4 upscale points and a zero concentration, similar to calibrations. 90-Day verifications do not make any adjustments to the analyzer or data, but rather verify (confirm) the analyzer remains in good working order, which supports the defensibility of the data collected. For each concentration point, a percent difference is calculated between the known (standard) and the indicated (analyzer), and the results are then compared to the acceptance criteria in Tables 4-6. The slope/intercept is also

assessed in comparison to the MQO table requirements to ensure the analyzer's calibration curve has not drifted.

An adjustment (calibration) must be performed if the 90-day verification fails (i.e., exceeds acceptance criteria) and the analyzer itself is determined to be in good working order. Before the recalibration is performed, all typical troubleshooting techniques should be applied to verify the complete system is in good working order (which, in turns, verifies the failed verification is valid).

Generally speaking, invalid QC checks could occur due to several reasons that need attention; therefore, confirming the equipment/calibration system status before proceeding to recalibration can help site operators avoid conducting unnecessary calibrations or any wrongly flagging data. The situations that could result in an invalid QC check can include, but are not limited to, the following:

- Faulty zero-air being supplied to the calibrator
- Sample/calibration line connections developing leaks
- Calibrator problems (malfunction) causing poor concentrations to be produced
- Internal electronic problems for the calibration equipment
- External weather conditions causing problems, such as excessive humidity
- Operator error, including incorrect documentation in logbooks

2) **Precision Checks** – Precision is defined as 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, FCEAP will ensure the entire measurement process is within statistical control. Various tools will be employed in evaluating and monitoring precision measurements. To evaluate precision, the following checks will be performed.

Gaseous Analyzers

One-point QC checks – Pursuant to 40 CFR Part 58, Appendix A, Section 3.1.1, a one-point QC check must be performed at least once every 2 weeks on each continuous analyzer used to measure the gaseous criteria pollutants. The QC check is made by challenging the analyzer with a QC check gas of known concentration between the prescribed range of 0.005 and 0.08 parts per million (ppm) for SO_2, NO_2, and O_3. In the FCEAP network, the 1-point QC checks are automated, performed daily, and include a zero concentration along with the upscale concentration of 0.070 ppm (70 ppb) for O_3 and NO_2, and 0.040 ppm (40 ppb) for SO_2. Site operators refer to these checks as "auto-cals" (and this term is used in FCEAP SOPs). For each check, a percent difference is calculated, the results of which are compared to the acceptance criteria established in Tables 4 - 6, and as specified in the SOPs.

Zero/Span/Precision (ZSP) Checks – These precision checks are performed **manually** by the site operators every two weeks (approximately ~14 days), and include 2 upscale concentration points and a zero. For these ZSP checks, the percent difference is calculated for at each point; each point must be within the specifications in Tables 4 - 6 for the check to pass. The calculation for the precision measurement (i.e., percent difference) is found in 40 CFR Part 58, Appendix A, Section 4.1.1, and is embedded in FCEAP Excel logbooks used by site operators.

Precision checks (1-pt QC and ZSPs) verify (confirm) the analyzer remains is in good working order, and, therefore, support the defensibility of the data.

A calibration must be performed if the 1-point QC check or ZSP fails and the instrument is found to be in good working order. Normally if either of these checks fail there is a problem within the monitoring system that needs addressing (i.e, results in equipment maintenance and/or repair). If the zero check is outside >± 0.005 ppm of the known zero or the span check >± 10% for SO2, 7% for Ozone, and 15% for NO_2. of the expected value, then a calibration will be done **after** equipment failure is diagnosed, repaired, and the instrument is cleared for normal operation. However, if a typical slow drift causes the check to fail, no routine maintenance may be necessary – it simply indicates it is time to recalibrate the analyzer. However, the site operator should consult the A&MPM about the zero drift issue before proceeding to recalibration. FCEAP does not adjust ambient concentration data to correct for zero drift. If the investigation deems the analyzer is at fault, then data will be invalidated based on the failed check, including failed zeros.

Note: FCEAP does not post-process monitoring data to "correct" for a failing QC check. Based upon calibration data and validation criteria, monitoring data is either reported as collected, and appropriately qualified, or the data are invalidated.

Particulate Samplers

Flow Rate Verifications – In accordance with 40 CFR Part 58, Appendix A, Sections 3.2 and 3.3, a one-point flow rate verification check must be performed at least once every month on each sampler used to measure $PM_{2.5}$ and low-volume PM_{10}. In the FCEAP network, the goal is to complete these every 2 weeks. The verification is made by checking the operational flow rate of the sampler. If the verification is made in conjunction with a flow rate adjustment (calibration), it must be made **prior** to the adjustment. The flow rate of the transfer standard is compared to the flow rate measured by the sampler. Percent difference is calculated and the results compared to the acceptance criteria in Tables 7 - 9 of the QAPP, as well as in FCEAP $PM_{2.5}$ and T640 SOPs. The percent difference is also calculated between the design flow rate of the sampler (i.e., 16.67 LPM) and the flow rate measured during the check for $PM_{2.5}$. These QC checks verify (confirm) the particulate sampler remains is in good working order and, therefore, support the defensibility of the data.

In addition to the QC checks performed by the site operators, precision is also determined in the FCEAP network by employing collocated $PM_{2.5}$ samplers. FCEAP collocates $PM_{2.5}$ monitors, as discussed in Section 1.6 of this QAPP. The primary samplers are FEMs that measure continuous $PM_{2.5}$. The co-located samplers are intermittent filter-based samplers that are operated in accordance with the schedules codified in 40 CFR 58.12; currently, the Hattie Avenue co-located sampler is set to a 1-in-3 day sampling schedule, and the Clemmons co-located sampler is set to a 1-in-6 day sampling schedule. For this type of precision estimate, $PM_{2.5}$ sample concentrations from both the primary and collocated samplers are compared. For the precision estimate, data pairs are considered valid if both concentrations are greater than or equal to 3 $\mu g/m^3$. The precision data is aggregated quarterly, annually, and at the 3-year level, and compared to the requirements in Tables 7 - 9 of this QAPP.

Note: Regulations do not require gaseous analyzers to be collocated.

Quality Control Samples – Collecting field blanks is required under 40 CFR Part 50, Appendix L, §8.3.7.1. As such, FCEAP will collect field blanks samples as a QC check. A field blank is a filter that is pre-weighed with routine samples, installed in the field sampler without any flow passing over the filter, re-weighed with routine samples, and then initial/final weights compared. The purpose of field blanks is to provide an estimate of total measurement system contamination, including laboratory and field activities. Through a comparison of laboratory blanks against field blanks, contamination from field activities can be assessed. The acceptance criterion for field blanks is ±30 µg between weighings. Field blanks are to be collected in the FCEAP network at a frequency of ~10% of the sampling runs scheduled per site. For example, for a sampler operating on a 1-in-6 day operating schedule, 6 field blanks would be collected over the course of a year. Field blanks are taken throughout the duration of the sampling schedule (spaced evenly across the year) and not concentrated in a short period of time.

As an additional QC check, FCEAP will also collect trip blank filters. Collecting trip blanks is not a requirement under 40 CFR Part 50, Appendix L; however, collecting trips blanks is a best practice. A trip blank is a filter that is treated exactly as a field blank, but it is never placed into the sampler or exposed to the ambient environment. The purpose of the trip blank is to assess possible contamination to filters during packing and transport to and from the laboratory to the sampling location. The acceptance criterion for trip blanks is ±15 µg between weighings. If the weight change exceeds 15 µg, contamination in the laboratory or during shipping may be occurring. As with field blanks, trip blanks are collected in the FCEAP network at a frequency of ~10% of the sampling runs.

Field blanks and trip blanks are issued to FCEAP by the RTI gravimetric laboratory. The lab analyst prepares batches of filters in accordance with the RTI SOPs and tracks the issuance and number of blanks.

3) **Accuracy or Bias Checks** – 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. With that in mind, by employing percent difference calculations and monitoring patterns of collocated $PM_{2.5}$ samplers, trends can be observed that indicate bias occurring within the measurements. These measurements (using flow rates in lieu of concentrations, obtained during flow rate verifications) are used to assess the bias as described in 40 CFR Part 58, Appendix A, Section 4.2.2. For the reactive gaseous analyzers, ZSP checks can also provide data capable of identifying bias. Performance audits are also an indicator of accuracy/bias and are discussed below.

4) **Performance Audits** – Audits are performed by comparing analyzer or sampler measurements to independent standards (or references). The standard used for auditing must not be the same standard used to calibrate the analyzer/sampler. However, both the calibration standard and the audit standard can be referenced to the same primary standard. Personnel conducting audit procedures should be designated staff that are not normally involved in routine operational activities of equipment that is under evaluation. In the FCEAP network, the QA Specialist (QA2) is independent from routine

field operations and conducts performance audits on network equipment using dedicated QA equipment. These audits are conducted using the methodology specified in the FCEAP SOP specific to the pollutant being measured.

The requirements and frequency for performance audits are specified in 40 CFR Part 58, Appendix A. In general, for the gaseous analyzer audits, the audits are required annually per Section 3.1.2 of Appendix A. The FCEAP's goal is to conduct these audits quarterly, as a way of ensuring continued compliance with EPA QA requirements and ensuring the quality of the data produced. For low-volume particulate samples, performance audits are discussed in Section 3.2 and 3.3 of Appendix A for $PM_{2.5}$ and PM_{10}, respectively. In general, these flow rate audits are to be performed twice per year, with the audits spaced, ideally, between 5-7 months apart. Like with the gaseous analyzers, FCEAP's goal is to conduct these flow rate audits every quarter.

5) **External Agency Audits** - FCEAP participates in performance audits from multiple organizations:

- FCEAP participates in the EPA Performance Evaluation Program (PEP), EPA Protocol Gas Program, and EPA National Performance Audit Program (NPAP). Information on EPA's Performance Evaluation Program, including PEP and NPAP, can be found at: http://www.epa.gov/ttn/amtic/npepqa.html
- FCEAP may request an independent instrumentation audit from NCDAQ or MCAQ and may offer to perform such audits for each agency.

6) **Corrective Actions** – Corrective action measures in the A&MD are taken as necessary to ensure the MQOs are attained. Given the number of monitors, the diversity of monitoring activities, and the complexity of the instruments, there is a potential that issues may arise with sampling and measurement systems. In a properly functioning monitoring network, issues may be anticipated in advance and staff should be prepared and equipped to address issues as they arise.

Corrective actions may also be implemented on an "as-necessary" basis when unexpected or unforeseen circumstances are encountered, such as a failed QA/QC check. The FCEAP SOPs contains examples of corrective actions that may need to be completed under certain circumstances. Site operators should consult the appropriate pollutant-specific SOP for technique-specific checks, required frequency of checks, acceptance criteria, and additional corrective action guidance. The following is an abridged list for typical problems that require corrective action. It is the FCEAP policy that the need for corrective actions be reported to the A&MPM within two business days and addressed as soon as possible. Generally speaking, most problems can be fixed within a one or two business days, but occasionally parts have to be ordered to repair the equipment. Most of the time the parts can be purchased and arrive to the Office within one business week. When equipment is down, staff must work to repair the problem as fast as possible to limit the amount of data loss.

Table 13 Corrective Actions

Activity	Problem	Likely Actions
QA/QC Check	Out of specification; QC check or failed performance audit exceeds acceptance criteria	1) Verify / reproduce performance check findings. Use an alternate transfer standard to confirm failures. 2) Perform alternate performance checks to determine cause (for example - leak tests to aid in flow rate issues). 3) Recalibrate monitor using standard operating procedures. 4) Identify any required procedural changes to prevent reoccurrence. 5) Document actions on audit worksheet, data sheet, or logbook as appropriate. 6) Notify air monitoring program manager of performance audit failures as soon as practical.
Filter Inspection (Pre- or Post-sample)	Pinhole(s) or torn	1) Void filter with pinhole or tear. 2) Obtain a new filter from lab. 3) Inspect sample stream and exchange mechanism to determine cause. 4) Document action taken on field chain of custody form, data sheets, or logbook, as appropriate.
Run-time parameter check	Shortened sample run times	1) Verify proper monitor run-time programming. 2) Diagnose likely causes - low flow rates, low pressure, power disruption, others. 3) Document cause and any actions on field chain of custody form, data sheets, or logbook as appropriate.
Power	Loss or interruptions	1) Verify power supply integrity. 2) Verify circuit breaker and fuse integrity. 3) Document cause and actions taken on field chain of custody form, data sheets, or logbook as appropriate.
Data Review	Data missing from data acquisition system (DAS)	1) Verify DAS operation. 2) Ensure monitor polling is current. 3) Isolate telecommunications problem by connecting to the monitor using alternate processes. 4) Verify monitor operations remotely. 5) Notify the QA Specialist(s) or A&MPM, as appropriate. 6) Perform site visit to resolve monitor or telecommunication issues.

2.6 Instrument /Equipment Acceptance Testing, Inspection, and Maintenance

Preventative maintenance is a foundational element to an effective QA program. The maintenance/repair shop (referred to in-house as the "lab") is maintained at the FCEAP main office building for off-site repair, maintenance, and field readiness certification of equipment. This work is performed by site operators and/or QA specialists, depending on the instrument. However, as discussed in Sections 1.4 and 1.8, staff are strongly encouraged to share knowledge and equipment experience, such that FCEAP continuously maintains these imperative technical skills. With that in mind, these equipment maintenance responsibilities are shared, to some degree, amongst all A&MD staff, including the A&MPM.

FCEAP uses established procedures to verify that all instruments and equipment are maintained in sound operating condition and are capable of operating at acceptable performance levels. Refer to the instrument specific SOPs (listed in Table 12 of this QAPP) for more details on the specific preventative maintenance activities.

In general, the following acceptance/testing activities are performed upon receipt of new analyzers and samplers, and/or after an analyzer/sampler has undergone significant repair. If the equipment is new and fails to meet the field readiness certification described below, the vendor will be contacted.

- Verify that instrument contains its EPA equivalent or reference method decal and meets the specifications of the purchase request.
- Verify that all expected parts arrived with the instrument and that nothing is physically broken. Contact the vendor if there are issues.
- Perform field readiness "certification" testing, summarized as follows. Although the designation of the FRM/FEM status ensures the make/model of the instrument meets EPA requirements for use in a SLAMS network, FCEAP staff must still ensure individual instruments perform as expected before deployed in the field.
    - For the gaseous analyzers:
        - Check and document the diagnostics of the analyzer, looking for any fault lights or warnings. Ensure that parameters such as sample flow rate, pressure, temperatures, and so forth are within specifications (see user manuals). Perform a leak check(s) on the analyzer.
        - Perform verification check(s). Generate zero concentration, followed by 4 upscale concentrations across the calibration scale of the analyzer, as would be completed for a typical multi-point verification. For example, for O_3, this test would include 0, 40, 70, 150, and 225 ppb concentrations. If all points fall within the acceptance criteria (see SOPs), the analyzer is deemed "field ready". If any point fails, the verification fails, and troubleshooting has to be done. The performance/maintenance log is documented with the results of this testing. **Note: A performance/maintenance log is maintained for each individual analyzer used in the FCEAP network, which serves as the record of the analyzer's performance testing and maintenance/repair history throughout its entire life cycle.**

        - Allow the analyzer to run in its normal sampling mode in the shop for several days before deployment.
    - For particulate samplers:
        - Check the diagnostics of the sampler, looking for any fault lights or warnings, and document the status.
        - Check, and if need be, calibrate, the temperature and pressure sensors.
        - Perform flow rate checks and make sure they fall within the acceptance criteria.
        - Run the intermittent sampler in FCEAP maintenance shop ("lab") for a short period of time (e.g., ~1 week) and track the sampler's operational performance. For example, these tests confirm the functionality of the filter exchange mechanism in the sampler and verify that the software is working appropriately. For continuous particulate samplers, the sampler is run in the lab (~ 1 week) and the ambient concentration values are observed; they should be low (as this is indoor air) and track steadily.

After this testing in the shop, the sampler is deployed to field where final testing is performed; the sampler is "run" in the field, collocated against the existing particulate sampler on site for multiple days. (It is important to note here that although the ambient data produced by the test sampler is not reported to AQS.) The results between these two samplers are compared; if acceptable, data collection can then officially begin. In general, the following inspection activities are used:

- Monitoring shelters, sample inlets, and other enclosures are inspected quarterly to ensure conditions do not adversely affect monitor operation or data integrity.
- Data collection and data quality is reviewed each business day and trends are inspected for signs of problems. Data trends that signal inspection would include such as issues as frozen numbers for multiple hours in a row, or erratic spikes or valleys in the concentrations obtained.
- Inspections on equipment also occur during site visits to verify the entire system is in good working order. Site visit checklists are available to the site operators and found on the ZSP forms (within electronic logbooks), as well as on performance audit forms.

With regard to routine maintenance, the following are general protocols:

- A limited supply of critical spare parts is maintained in the FCEAP maintenance/repair shop to aid in rapid response to issues. For example, pump rebuild kits, spare pumps, photometer lamps, filters, ozone scrubbers, and Teledyne-API expendable kits are routinely on hand.
- Preventive maintenance is scheduled ahead of time so all parts/tools can be easily available to complete the tasks so data loss is kept at a minimum.
- Preventive maintenance activities are typically performed in the field, although some activities are completed in the shop.

The routine preventive activities and schedules are detailed in the specific equipment FCEAP SOPs and supplemented by the equipment user manuals. General speaking, particulate filters for the TTP sample trains are changed monthly, followed by a leak check to ensure sample train integrity. All particulate matter inlet heads and downtubes are serviced at least quarterly. All gaseous equipment,

including analyzers, calibrators, and zero air supplies, undergoes a comprehensive annual preventive maintenance regime (also detailed in the SOPs).

2.7 Instrument /Equipment Calibration and Frequency

Calibration is defined as the comparison of a measurement standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by **adjustment**. Use of the term "calibration" indicates that an adjustment either in the instrument or the software occurred. EPA recommends that adjustments be minimized to prevent introducing measurement uncertainty and that verifications, "i.e., checks without correction (adjustment)," be used to confirm whether or not an instrument is operating within its acceptance range. Thus, the purpose of calibration is to minimize bias. Calibrations are discussed in more detail in Section 2.5 of this QAPP. Calibration procedures for each specific pollutant analyzer/sampler are described in the applicable FCEAP SOP.

40 CFR Part 58, Appendix A, §2.6 requires that gaseous standards (i.e., gas cylinders), photometers, and flow rate standards used in the ambient air monitoring network be traceable to National Institute of Standards and Technology (NIST). As such, instrument calibrations performed in the FCEAP network are conducted using traceable standards to ensure that the ambient air quality data meets FCEAP and EPA quality objectives.

Traceable is defined in 40 CFR Parts 50 and 58 as meaning that a local standard (i.e., one maintained by a monitoring organization) has been compared and certified, either directly or via not more than one intermediate standard, to a primary standard such as a NIST Standard Reference Material (NIST SRM) or an EPA/NIST-approved Certified Reference Material (CRM). Similarly, traceability is the property of a measurement result whereby the result can be related to a stated reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty. Standard traceability, therefore, is the process of transferring the accuracy or authority of a primary standard to a field-usable standard, resulting in a documented unbroken chain of calibrations/certifications. Recommended timeframes for certifications of the various calibration standards used in the FCEAP network are defined in Tables 4 - 9 of this QAPP and within the FCEAP SOPs.

To achieve and ensure traceability, FCEAP adheres to the following principles:

- Most standards used for calibration are purchased and re-certified by vendors with accredited NIST-traceable calibration processes. Devices are re-certified at least annually. Records of these certifications are kept in Microsoft Teams for easy access by A&MD staff.
- Primary and transfer standard calibration certificates are retained as part of the QC documentation process (see Section 1.9 of this QAPP). All devices utilized have an identification number for ease of tracking.
- Where applicable, in-house certification procedures (i.e., certifying a transfer standard against a certified primary standard – i.e., one of higher authority) are performed using FCEAP SOPs. Documentation of these procedures is maintained in the appropriate FCEAP electronic logbook, and records of these certifications are also kept in Microsoft Teams.

- Records of all instrument calibrations, using the traceable standards (with instrument identification numbers clearly documented), are maintained in Microsoft Teams.

In this manner, documentation exists that provides a documentation trail that links all FCEAP calibrations back to NIST.

The following summarizes the standards used in the FCEAP network and their recertification process. All certification periods are monitored to ensure that equipment or certified materials are not used beyond the documented certification expiration dates. Tracking these certifications – those performed in-house, as well as those performed by vendors – is the responsibility of the QA Specialist (QA2). However, the certifications themselves are performed by both the QA Specialists and the site operators (as assigned). This is yet another example of one of the ways A&MD staff share responsibilities in order to ensure redundancy in skill sets and knowledge, and ensure continuity of operations in case of unexpected turnover.

Photometers

A standard reference photometer (SRP) is maintained in Region 4 at the LSASD Lab in Athens. The SRP is the highest-authority ozone standard, equivalent to NIST, and is considered a Level 1 standard. Two FCEAP Level 2 calibrators (containing photometers) are taken to EPA Region 4 and compared to the SRP on an annual basis. One calibrator (photometer) is defined as the FCEAP "bench standard," which means it is stationary in the maintenance/repair lab. The other calibrator (photometer) is used as a transfer standard, which is carried (transported) to the FCEAP monitoring sites for certification of site calibrators. These two Level 2 ozone standards are identified as the "L2TS primary standard" within the Office.

All site calibrators (photometers) – identified as "L3TS site primary standards" – are certified versus the ozone L2TS standards (either in the lab against the bench standard, or in the field against the transfer standard). These certifications are performed annually by the FCEAP QA Specialist.

An additional calibrator is designated as an audit back-up unit, and is certified versus the ozone bench standard annually. This back-up audit calibrator is identified as "L3TS - audit primary standard" within the Office.

Gas Cylinders

Compressed Gas Standards are purchased as certified, EPA-Protocol cylinders with concentrations traceable to NIST standards. Only EPA Protocol gases are used in the FCEAP network. Gas cylinders are typically not recertified. Instead, FCEAP purchases new cylinders to replace existing cylinders with eminent expirations.

Flow Standards

FCEAP uses multiple types of flow standards within the air monitoring program (e.g., Alicat, BIOS, TetraCal, or Streamline FTS). These devices are certified annually by an accredited organization that provides a certificate of traceability to NIST standards. It is FCEAP's policy to stagger (i.e.,

rotate) the certifications of the flow standards when sent to vendors, such that a certified device remains available in-house at all times.

Currently, the Alicat Model #MBD-10LPMD/5m is considered to the be a "local primary standard" for flow rate used in-house. This is the device against which in-house mass flow controller (MFC) certifications are performed. Each gas dilution calibrator used in the network (for SO_2 and NO_2) must generate gases using certified MFCs. The QA Specialist performs these certifications of the MFCs on a semi-annual (i.e., ~6 months) basis.

Other Devices

Handheld temperature standards, such as Fisher Scientific Traceable units, are certified annually by an accredited organization that provides a certificate of traceability to NIST standards.

Handheld barometric pressure standards, such as the Druck DPI 705, are certified annually by an accredited organization that provides a certificate of traceability to NIST standards.

A voltage calibrator, such as the Fluke 726, is used for datalogger certifications, and is certified annually by the vendor as well, with FCEAP receiving a certificate of traceability.

Note: **Calibration/certification of laboratory standards for the $PM_{2.5}$ program are the responsibility of RTI. The microbalance, mass reference standards, and other laboratory standards will be certified in accordance with the RTI QAPP and $PM_{2.5}$ SOPs. These devices are typically certified on an annual basis.**

2.8 Inspection/Acceptance of Supplies and Consumables

FCEAP SOPs itemize the apparatus, equipment, materials, and supplies required for various monitoring equipment. In general, supplies and consumables are procured directly from the vendor manufacturing the analyzers/samplers used by FCEAP. Parts lists, including recommended replacement schedules, are itemized in most manufacturers' operating manuals as well. FCEAP uses this information to determine the appropriate procurement schedule and volume of consumables required to support continuing operations.

Supplies and consumables are tracked by the site operators; when replacements are needed, the A&MPM is notified, who is then responsible for purchasing. Supplies are inventoried in the maintenance/repair "lab" for later distribution. Received materials are inspected to ensure the proper part number was received as ordered. General inspection to identify any damaged products is also performed. Parts received are dated so that storage duration can easily be determined. A revolving inventory system (first in, first out) is used to ensure that storage times do not affect the material's integrity. If a manufacturer or EPA requirement indicates a specific expiration period for supplies, those supplies exceeding expiration dates are discarded if not used within the acceptable period.

Sample lines and fittings are important supplies. If used in the sampling train of a reactive gaseous analyzer, they must be FEP Teflon or equivalent. Air sampling filters used to collect $PM_{2.5}$ samples are also considered supplies. Filter handling, conditioning, and integrity is of primary concern. EPA provides vendor lot certification of filters used to support the ambient air quality monitoring programs prior to distribution to monitoring organizations. RTI operates the $PM_{2.5}$ low-volume filter weighing laboratory that serves agencies operating in North Carolina, including FCEAP. RTI receives documents, and inspects and conditions air sampling filters for use in FRM $PM_{2.5}$ sampling program. Filters that do not meet initial quality control specifications are removed from service.

A consumable that is critical to the successful operation of the gaseous monitoring network is that of gas cylinders used for calibrations and QC checks of SO_2 and NO_2 analyzers, as well as gas cylinders used for conducting internal performance audits. Gas cylinders ordered by FCEAP are EPA Protocol Cylinders. Certificates of Analyses are reviewed upon receipt of new gas cylinders to ensure the cylinder meets purchase specifications. The certificates indicate the expiration date of the gases contained within the cylinders. FCEAP abides by these expiration dates; dates and usage are tracked, with cylinders being replaced before they expire. Additionally, FCEAP participates in the EPA Protocol Gas Certification program, such that gas cylinders can be independently assessed to ensure their integrity (and that of the supplier).

Note: In general, calibrations, QC checks, or performance audits conducted with expired gases would not be considered valid calibrations or QA/QC checks, unless compelling, empirical evidence was available to justify using the expired cylinders. Otherwise, the data from such checks would not be used for data validation purposes.

2.9 Non-Direct Measurements

Some data not obtained by direct measurement from the FCEAP Ambient Air Quality Monitoring Program are used to support the monitoring program. This includes data from outside sources and historical monitoring data. Possible databases and types of data and information that might be used include:

- Sampler manufacturers' operational literature
- Geographic location data
- Historical monitoring data measured by other sources
- Traffic Count Data
- Census Data
- Dispersion modeling
- National Weather Service data

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

2.10 Data Management

The primary work product of the FCEAP Ambient Air Quality Monitoring Program is data. Accordingly, formalized procedures are required to ensure successful data management. Data management describes an inter-related set of standardized processes used to acquire, transmit, transform, reduce, analyze, store, and retrieve data. When documented and followed, a data management system helps maintain the integrity and validity of the data throughout its entire life cycle. FCEAP's air monitoring data follows a documented flow path. The data life-cycle starts before sample collection actually begins and ends with use of the data. The major components of FCEAP's data management process are summarized here, and further detailed in the FCEAP Data Handling SOP.

The following diagram (Figure 8) show the generalized flow path of the FCEAP ambient air monitoring data, as well as the QA/QC data collected within the network. All staff in the A&MD are involved in the acquisition and processing of ambient air monitoring data. Staff responsibilities are described in more detail in Section 4.2.

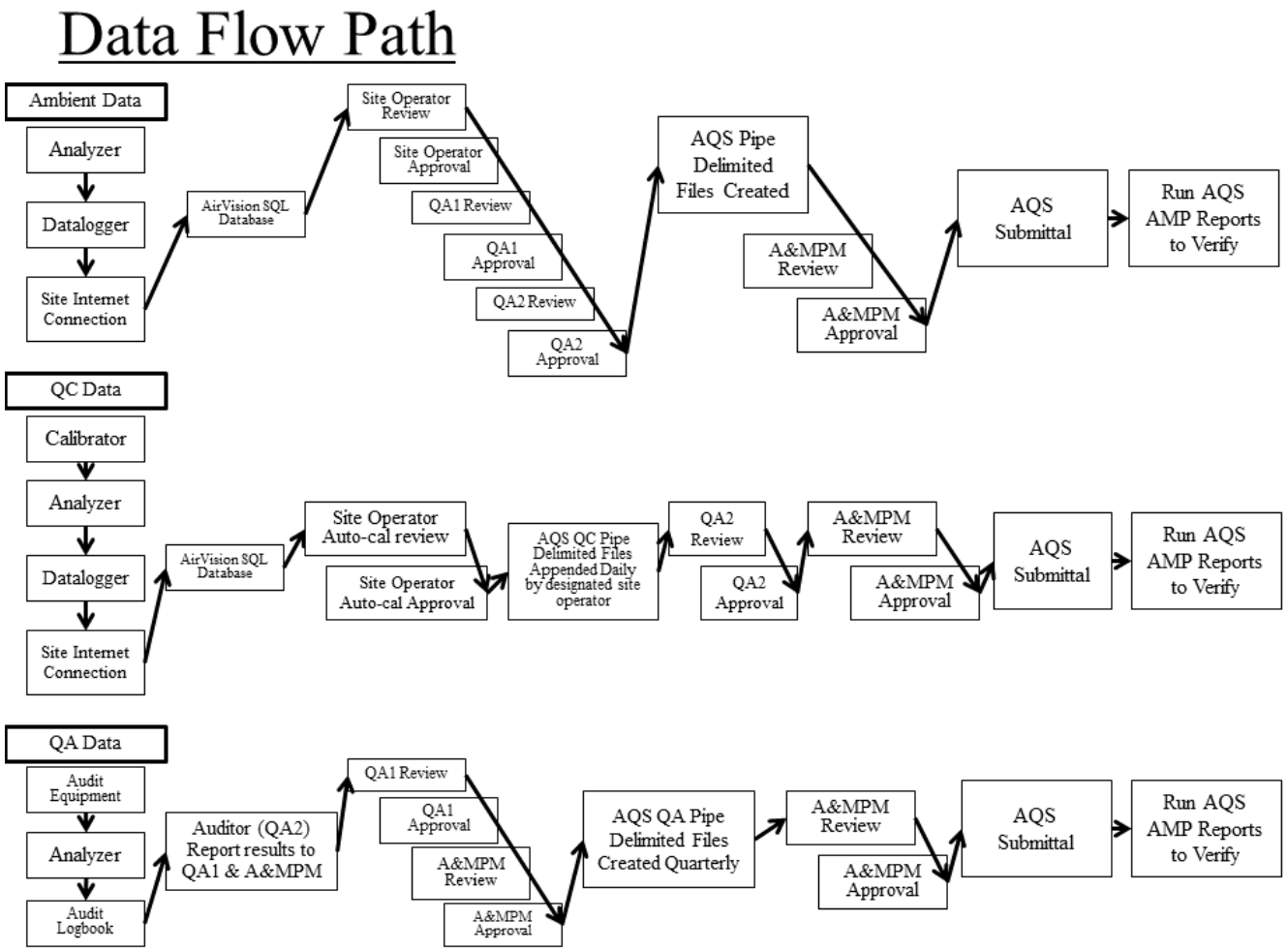


Figure 8: FCEAP Data Flow Path

2.10.1 Data Collection and Recording

Ambient air monitoring analyzers and samplers which have been designated by EPA as reference or equivalent methods (FRMs or FEMs, respectively) will be used to collect the criteria pollutant data in the FCEAP network used for NAAQS compliance. Upon installation and at regular intervals as specified, ambient air monitoring instrumentation is calibrated in accordance with the Office's SOPs. Calibration of the analyzer or instrument establishes the quantitative relationship between the actual value of a standard, be it a pollutant concentration, a temperature, or a mass value, and the analyzer's response. The relationship is used to convert subsequent analyzer response values to corresponding concentrations.

Each criteria pollutant monitoring instrument has internal adjustments. During the calibration process, the settings are adjusted to accurately reflect the concentration at which the instrument is tested. Instrument output is transformed from measurement engineering units to pollutant concentrations either by the instrument itself, the data logger, the data management system, or a combination of these elements. The end result is the reporting of pollutant concentration data in the unit specified in the appropriate SOP.

Continuous monitoring sites and non-continuous instruments (i.e., particulate samplers) are equipped with data recording capabilities. The data logging function may be internal to the monitoring instrument (e.g., $PM_{2.5}$ 2025i samplers) or an external device (i.e. – Agilaire 8864 data logger) connected to the instrument (e.g., continuous analyzer). The data logger records the monitoring instrument outputs. It may also perform specific data reduction and/or format data in preparation for downloading to a database or spreadsheet.

Manual data collection is limited in the FCEAP network. It mainly consists of transferring $PM_{2.5}$ sampler data to the office (described below in Section 2.10.2) and recording results of the internal QA performance evaluations. For the performance audits, the response of the continuous analyzers themselves are captured as described by the site dataloggers, and can be seen or retrieved using AirVision software. However, the audit concentrations produced by the known standards (e.g., audit calibrators) are recorded manually by the QA Specialist during the audit. These data must then be transferred from the audit logbooks (Excel forms). For the intermittent particulate matter samplers, all data capture from the performance audit is recorded manually. Care must be taken in order to ensure all data that is recorded manually into logbooks (Excel forms) is accurate and complete.

2.10.2 Data Transmittal

Data transmittal from the field monitor to the FCEAP central data acquisition system (DAS) is accomplished 1) via wired or wireless TCP/IP process to connect to the site's data logger or 2) by manually downloading data from instruments through a TCP/IP connection or 3) by manually downloading data from instruments through external devices transported between the central computer system and the monitoring station.

For the continuous monitors, specifically, data transmittal from the field to the FCEAP central office is accomplished through FCEAP's network of dataloggers and wired or wireless internet connections. This equipment is located in the air monitoring shelters, where the dataloggers record the data history of the instrumentation to which it is connected, and the IP address provides a path to download the data for analysis. The Office's DAS, utilizing AirVision software, is configured to automatically poll the stations hourly to retrieve these data for analysis. Alternate data retrieval processes are defined that consist of direct on-site access to the data logger or retrieving data remotely using alternate communications processes. These are described in the FCEAP Data Handling SOP, along with instructions on how A&MD staff set-up and maintain the AirVision software utilized on the central server.

The transmittal of intermittent sampler (particulate) data from the field to the FCEAP central office is accomplished through the use of TCP/IP connection. Data is downloaded directly from the sampler unto the external storage device, where it is transported to the office; from there, data is uploaded into the $PM_{2.5}$ Access Database (located in Microsoft Teams). Alternatively, data can be downloaded through vendor provided software via a TCP/IP connection. This data represents the results of the field sampling run. However, the physical sample that is collected by the $PM_{2.5}$ sampler must be analyzed at the laboratory. Therefore, analytical data is produced at a separate facility (RTI) and maintained using the data management system at that location. However, the results of the gravimetric analysis, along with pertinent laboratory and conditioning data, are later provided by NCDAQ to FCEAP in the form of an Excel spreadsheet that they received from the lab. Data from the spreadsheet are then transferred into the $PM_{2.5}$ Access database, where the field and analytical data are then combined for subsequent data reduction, verification, and validation processes.

It is important to note that the downloading of collected monitoring data does not delete the data from the data logger. Data is removed from the data logger continuously by overwriting data on a first-in, first-out basis. This configuration requires that the data be extracted from the data logger on a regular basis, thus preventing any loss of data.

All transmitted raw data sets are stored electronically. The DAS is designed to prevent alteration of the raw data file. As such, raw data sets are retained in unalterable form before any reduction or validation is performed. Data validation operations (e.g.,- AirVision database) use replicate versions of the raw data to avoid violating the integrity of the original raw dataset. Data stored in the "edit" database can be added, changed, flagged, or voided following the procedures described within the FCEAP Data Handling SOP. An edit history is recorded and available to track changes made to the editable database.

2.10.3 Data Verification and Validation

Each analyzer or sampler used to measure ambient concentrations undergoes precision and bias checks on a prescribed frequency, in order to verify the instrument's calibration. Together with performance evaluations and other QC checks as described in Section 2.5 of this QAPP, the precision, bias, accuracy, and repeatability of each instrument can be ascertained.

Site operators verify the data collected when reviewing and documenting their electronic strip charts throughout the sample collection process. Data verification also occurs when site operators document their monthly reports, which are subsequently reviewed by the QA Specialists during data validation. (See Section 4 of this QAPP for more details.)

During telemetry, the data are downloaded to the central DAS server on an ongoing basis. Following download, A&MD staff perform an electronic verification by searching the data for data logger status flags and comparing reported values to a set of pre-programmed criteria to identify questionable, missing, or invalid data.

Once data have been flagged, QA Specialists evaluate the associated data to identify underlying causes and make a decision 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 and properly documented. Data are validated in accordance with the MQOs shown in Section 1.7 of this QAPP.

2.10.4 Data Reduction and Analysis

Data reduction occurs throughout the data management process. Generally speaking, an analyzer is scanned by a data logger once per 6-10 seconds. Each block of one minute readings are then averaged (or reduced) to produce one-minute averages, which is the base-unit stored by the data logger. The data logger further processes the minute data to produce one-hour averages, as well as 5-minute averages. The air monitoring site's data logger stores the hourly and five-minute averages from each monitor and transmits them (in response to a poll) via the wireless TCP/IP process, described above. Filter samples are physically measured by a laboratory and mathematically reduced into weights (i.e., mass measurements), and then into weights per unit volume, once the analytical data is combined with the field sampling data. Ultimately, data reduction activities aggregate the raw criteria pollutant data collected at the ambient air monitoring station into the hourly-averages that are required for comparison against the NAAQS.

Criteria for the quantity of valid data points required within a data set are defined in 40 CFR Part 50; for most pollutants, a minimum data completeness of 75% of the required interval (e.g., quarterly) must be captured for the interval to be considered valid and used in NAAQS comparisons. Section 1.7 of this QAPP contains more information regarding data reduction to produce pollutant design values for NAAQS-comparison.

Data is analyzed periodically throughout the data collection and validation process. Ultimately, it is the responsibility of the A&MPM, in coordination with the QA Specialists, to certify data collected within a calendar year as usable for NAAQS comparisons. The A&MPM primarily relies upon AQS calculated metrics of precision, bias, and completeness, via a number of AQS-generated reports (discussed in more detail in Section 3 of this QAPP) to complete assessments of the data. AQS will also estimate the design values for each of the criteria pollutants, based upon the concentrations entered for each monitor in the network.

2.10.5 Data Storage and Retrieval

Once collected, data is stored in a variety of ways and for varying periods of time. Initially, data is stored in the instrument and/or the station-specific data logger. Data loggers keep an un-alterable record of instrument measurements for a period of five (5) to sixty (60) days, depending on the complexity of the data logger and the amount of information stored. Data stored in the data loggers is accessed automatically by the central DAS.

Supporting electronic and written information such as logbooks (Excel workbooks), maintenance logs, and diagnostic information worksheets are retained by FCEAP for a period of at least four (4) years.

Data is stored in electronic form in the DAS (Agilaire AirVision) for a minimum period of three years to provide the ability to analyze trends and use system reporting features.

Backup and recovery procedures exist to ensure that data can be recovered in the event of a catastrophic failure. When storage space limits the amount of data that can be kept in the database, procedures exist for moving the data into an archive database.

The primary database is stored on the hard drive of the server housing the AirVision server software installation. The AirVision SQL database is backed up each day by the MIS Department.

All data is stored according to Section 1.9.6. After the storage period has passed, the storage media may be disposed of or recycled. However, the validated dataset is uploaded to the EPA Air Quality System (AQS) for long term storage.

3.0 Assessment / Oversight

Assessments or evaluations are designed to determine whether the ambient air quality monitoring program is being implemented in conformance with its approved QA Project Plan. These activities are conducted to increase confidence in the information obtained, and ultimately to determine whether the information may be used for their intended purpose. Table 14 provides a summary of the relevant assessments performed in the FCEAP ambient air quality monitoring network.

3.1 Assessments and Response Actions

In order to ensure the adequate performance of the quality system, FCEAP performs and/or participates in the following assessments. These assessments are used to measure the performance and effectiveness of the quality system, the ambient air quality monitoring network design and operation, and various measurement phases of the data operation.

- Network Plans and Assessments
- Technical Systems Audits

- Internal Systems Audits
- External Agency Audits
- Internal Performance Audits
- Data Quality Audits
- Data Quality Assessments
- Data Certification

3.1.1 Network Plans/Assessments

40 CFR §58.10 provides the requirements for annual network plans and the more intensive 5-year assessment. At FCEAP, these assessments are completed primarily by the A&MPM, collaborating with other Office staff when necessary.

In summary, the annual monitoring network plan provides documentation of the establishment and maintenance of the FCEAP air monitoring network, which consists of SLAMS monitoring stations that include FRM and FEM monitors. The goal of the network plan is to determine conformance with network requirements as set forth in 40 CFR Part 58, Appendices A, C, D, and E. Any proposed changes to the monitoring network are detailed in the annual plan; proposed additions and discontinuations of SLAMS monitors are subject to EPA approval in accordance with 40 CFR §58.14. The annual monitoring network plan is made available for public inspection and comment for at least 30 days prior to submission to the EPA Region 4 and the submitted plan addresses, as appropriate, any received comments. Annual network plans, in accordance with 40 CFR §58.10, began July 1, 2007. Annual network plans are due to EPA Region 4 on July 1 of each year.

The 5-year network assessment is a more extensive evaluation of the air monitoring network. The assessment determines, at a minimum, if the network meets the monitoring objectives defined in 40 CFR Part 58, Appendix D, 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. During the network assessment, the FCEAP A&MPM (and other staff, when necessary) consider 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), as well as the potential impact any sites proposed for discontinuance may have on other data users. FCEAP submits a copy of the 5-year assessment, along with a revised annual network plan, to the EPA Region 4. These assessments began in 2010, and are due to EPA every five years on July 1.

See Section 1.6.5 of this QAPP for more information about the monitoring locations in the FCEAP network. The Annual Network Plan can be found at this link:
http://www.forsyth.cc/EAP/quality_assurance_documents.aspx

3.1.2 Technical Systems Audits

A Technical Systems Audit (TSA) is a thorough, independent, and systematic on-site qualitative assessment, where facilities, equipment, personnel, training procedures, protocols, and recordkeeping are examined for conformance with regulatory requirements and this QAPP. EPA

Region 4 QA staff conducts a TSA of the FCEAP program every 3 years, in accordance with 40 CFR Part 58, Appendix A, §2.5. The EPA reports its findings to FCEAP senior management (e.g., the Director and A&MPM). The A&MPM (or delegate) regularly monitors progress on corrective action(s) required as a result of TSA findings, and communicates progress to the Director and EPA Region 4.

EPA TSA auditors may segregate the TSA activities into multiple categories. The categories may be audited independently or they may be combined. Key personnel with responsibilities for planning, field operations, laboratory operations, QA/QC, data management, and reporting are included in TSA audit activities and are often interviewed during the process.

The TSA categories may include:

1) Field activities – Instrument operations, preventive maintenance, acceptance testing, and documentation; probe assessments, to ensure the inlet and probe placement within the FCEAP network adheres to the requirements of 40 CFR Part 58, Appendix E; and $PM_{2.5}$ sample handling and filter shipping/receiving.

2) Laboratory activities - Pre-sampling weighing, shipping, receiving, post-sampling weighing, archiving, and associated QA/QC activities. As stated previously, low-volume filter weighing laboratory services are provided by RTI. RTI is evaluated directly by EPA during TSAs of RTI. FCEAP should request a copy of the EPA TSA report, containing the results of RTI's gravimetric laboratory audit, after the final audit report has been received by NCDAQ.

3) Data management activities – Data collecting, reporting, and archive/back-up (security) are reviewed. EPA TSA staff will also perform an audit of data quality during the TSA, which includes reviewing supporting documentation and records for a limited number of data points, in order to ensure the monitoring data reported to by FCEAP to AQS is accurate, traceable, and defensible. The documentation and records reviewed during the audit of data quality are maintained by the FCEAP and not available in AQS. The audit of data quality also ensures that null value codes and qualifier flags reported to AQS are appropriate, and that the data has been flagged in accordance with EPA requirements and the FCEAP Data Handling SOP.

Upon completion of the audit, EPA verbally alerts FCEAP management of any deficiencies/findings during an on-site TSA exit briefing. This briefing allows FCEAP A&MD staff to begin formulating or implementing corrective actions. A draft TSA Report is typically distributed within 30 days of the completion of the audit. EPA Region 4 allows a brief comment period of the draft report for factual accuracy; after comments from FCEAP are received (if necessary), the TSA report will be finalized and resubmitted to FCEAP. At that time, FCEAP has 30 days to prepare its formal response to address the TSA findings. This response is in the form of a Corrective Action Plan, which will be submitted to EPA Region 4. The A&MPM will communicate with EPA routinely after the Corrective Action Plan has been submitted and provide progress updates on a periodic basis until the corrective actions have been completed.

3.1.3. Internal Systems Audits

Internal systems audits will also be performed by the A&MPM to assess proper implementation, by the A&MD staff, of the requirements and procedures presented within the agency's approved QA documents, including this QAPP and all SOPs. The A&MPD will document the findings and observations in a systems audit logbook. Deviations from the Office's QA documents will be cited during the audit, and an email will be sent to the operator communicating the findings. The results of the systems audit may result in additional, refresher training for A&MD staff. Training may be provided in the form of additional communications regarding the Office's approved practices, along with discussions of the elements necessary to satisfy these requirements. It may also be in the form on hands-on technical training.

Points of interest investigated during the systems audits include:

- All QC check results are reviewed;
- Documentation in logbooks (both Excel & AirVision) is reviewed, to ensure it is up-to-date and accurate;
- Verification that verification/calibration procedures are followed;
- Verification that maintenance activities are thoroughly documented and data flagged appropriately;
- Verification that equipment traceability certifications/calibrations are up-to-date;
- Verification that all QC checks are performed on time;
- Verification that all performance audits (i.e. - internal, PEP, NPAP) are performed on time; and,
- Observation of the site operator performing specific QC procedures, in order to verify all steps within the appropriate SOP have been followed.

During quarterly equipment performance evaluations, the QA2 staff member also conducts a surface-level systems audit by reviewing site conditions, housekeeping/cleanliness, documentation completeness, certification compliance, and adherence to 40 CFR Part 58, Appendix E siting criteria. Any issues discovered by the QA2 member are relayed to the A&MPM so they can be addressed.

3.1.4 External Agency Performance Audits

FCEAP participates in the EPA Performance Evaluation Program (PEP) and the EPA National Performance Audit Program (NPAP) for performance audits of monitoring equipment. Information about these audits, which are part of the EPA National Performance Evaluation Program, are detailed in 40 CFR Part 58, Appendix A, Section 2.4.

In general, the NPAP is a performance evaluation where quantitative data are collected independently in order to evaluate the accuracy of the monitoring equipment. In Region 4, a mobile laboratory arrives at an FCEAP site and generates known concentrations of pollutant-specific audit gases, used to challenge the specific FCEAP analyzer on site. Results of the comparison are immediately available to FCEAP site operators and the A&MPM. More information about NPAP can be found in 40 CFR Part 58, Appendix A, §3.1.3.

Similarly, the PEP is an independent assessment used to estimate total measurement system bias. During PEP audits, an EPA contractor sets up a $PM_{2.5}$ sampler such that it is collocated with the FCEAP sampler. Both samplers are programmed to collect 24-hour samples during the same time period. Afterwards, the samples are analyzed – the independent sample will be analyzed by the EPA Region 4 laboratory, whereas the FCEAP sample will be analyzed by the RTI laboratory. The results of these two samples are later compared, after the gravimetric analyses have been completed. Because of the nature of the $PM_{2.5}$ program, and need for sample analysis in a laboratory, the results of PEP audits are not immediate. More information about PEP audits can be found in 40 CFR Part 58, Appendix A, §3.2.4.

Periodically, FCEAP participates in other independent assessments of the FCEAP network. For example, the State of North Carolina Division of Air Quality (NCDAQ) or the Mecklenburg County Land Use and Environmental Services Agency Air Quality Section (MCAQ) may audit FCEAP's ambient air monitoring program. These external audits may be qualitative or quantitative assessments. For example, NCDAQ or MCAQ may review criteria pollutant monitoring data for completeness, compliance with DQO and MQO requirements, and may provide a general review of overall maintenance and operation procedures. Performance assessments (audits) of field instrumentation may be conducted. When completed, a written report of the audit findings may submitted to FCEAP – the report may be in the form of a memo or email. Any findings may be verbally communicated to the A&MPM as well.

3.1.5 Internal Performance Audits

As stated in Sections 1.4 and 2.5 of this QAPP, the FCEAP QA Specialist (QA2) conducts quarterly performance audits of the FCEAP monitoring equipment. The QA Specialist is independent from the Office's site operators and does not operate (calibrate/maintain) any monitors/samplers in the field, and therefore is not responsible for the generation of any routine, ambient air monitoring concentration data. To complete these audits, the QA Specialist uses dedicated, independent, NIST-traceable audit equipment to challenge the instrumentation on site. The results of the performance audits are communicated to the A&MPM, who then directs site operators to complete corrective actions (when necessary). The results of the FCEAP performance audits are documented on audit forms, which are then maintained in Microsoft Teams. The results of these audits are compiled and uploaded to the AQS database on a quarterly basis.

3.1.6 Data Quality Audits

The FCEAP, in an effort to effectively assess data validity on a more regular basis, conducts data reviews by site operators and QA specialists every month. Each site operator inspects data continuity and accuracy, while documenting all edits and coding for that month. QA specialists review and verify the data and documentation to further validate data before going into AQS. Details for this process can be found in Section 4.2 of this QAPP, as well as in the FCEAP Data Handling SOP.

3.1.7 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 of measurement uncertainty are carried out by the EPA according to the procedures and equations identified in 40 CFR Part 58, Appendix A, §4. The DQIs are used to assess how well the monitoring data compare to the established DQOs and MQOs. AQS provides statistical software that evaluates the DQIs of precision, bias, and completeness for the monitoring organizations. With that in mind, the PQAOs (including FCEAP) must report the data for QA/QC checks (per Section 2.5 of this QAPP) to AQS. Measurement uncertainty will be estimated for both automated and manual data recording methods.

The statistical estimates of the data quality will be calculated in AQS on the basis of single monitors, as well as aggregated for monitors within the PQAO for a specific pollutant. The precision estimate (calculation) used to assess the precision checks for the gaseous analyzers is found in 40 CFR Part 58, Appendix A, §4.1.2; the bias estimate is found in the §4.1.3. The precision estimate (calculation) for particulates is found in 40 CFR Part 58, Appendix A, §4.2.1; the bias estimate is found in the §4.2.2. Other DQA calculations are also detailed in this section of the CFR.

To complete the DQAs, the A&MPM (or delegate, usually a QA Specialist) will generate a series of standard AMP reports from AQS to review and assess FCEAP data quality quarterly. For this quarterly assessment, the AQS AMP 600 (Certification Evaluation and Concurrence) and/or AMP 256 (Data Quality Indicator) reports are generated, evaluated, and then kept as a record to document the review. These reports provide the results of the statistical analyses, which the A&MPM then compares to the DQOs in Section 1.7 of this QAPP. If the monitoring data are found to meet the DQOs, the data is considered to be "in control" and no further action is needed. However, if issues are observed in the data during these assessments such that DQOs are not met, the issues will be investigated to determine root cause and then corrective actions implemented.

Also, during these quarterly data assessments, the A&MPM will generate AMP 430 (Data Completeness) and AMP 251 (QA Raw Assessment) reports. The results of these reports are compared to the MQOs in Section 1.7 of this QAPP, documented in Tables 4 - 9. If issues are observed in the data, the A&MPM will discuss these issues with the QA Specialists and determine the necessary course of action. If data completeness requirements have not been met, the A&MPM will communicate this issue to EPA Region 4, in accordance with grant commitments.

3.1.8 Data Certification

In accordance with 40 CFR §58.15, an annual air monitoring data certification letter is required to certify that the data collected by the FRM and FEM monitors at SLAMS (and SPMs, if applicable) sites within the FCEAP network meet criteria in 40 CFR Part 58, Appendix A from January 1 to December 31 of the previous year. Along with the certification letter, FCEAP must submit to EPA an annual summary report of all the ambient air quality data collected by the monitors, as well as a summary of the precision and accuracy data, for the previous year.

Data Certification is the final process of assessing the Office's data for the previous calendar year. Data is verified and validated on a monthly basis, as stated in Section 3.1.6 above, and explained in greater detail in Section 4.2 of this QAPP. Additionally, data is assessed on a quarterly basis by the A&MPM when specific AQS reports are generated to assess the DQIs (as described in Section 3.1.7 above). With these assessments ongoing throughout the year, annual certification, then, serves as the last assessment of the data – looking at it from an all-inclusive, annual perspective – to see if any unidentified anomalies or trends exist in the data that were not previously identified. The annual data certification process starts with running and reviewing AMP reports contained in AQS. Typical reports queried include the following:

a. AMP 350 Raw Data
b. AMP251 QA Data
c. AMP430 Data Completeness
d. AMP600 Certification Evaluation
e. AMP256 Data Quality Indicator
f. AMP504 Extract QA Data

The A&MPM, QA1, and QA2 staff members review these reports and confirm everything is complete and accurate. The reports are also reviewed to ensure the statistical results indicate that the monitoring data were "in control" over the course of the entire year and met the DQOs. If problems are identified, they are investigated in accordance with Section 4.3 of this QAPP.

Ultimately, this process verifies that the FCEAP monitoring data submitted to AQS is correct and complete. Once any necessary corrections/additions/deletions have been completed in AQS and the data set is finalized, the A&MPM officially recommends the data for certification to EPA Region 4, as the A&MPM is the individual delegated this responsibility by the Office Director. The data certification package provided to EPA includes a signed copy of the AMP 600 report, along with a signed letter that attests that the previous year of ambient concentration and quality assurance data are completely submitted to AQS and that the ambient concentration data are accurate, taking into consideration the quality assurance findings.

The annual data certification package is due to EPA Region 4 by May 1 of each year.

3.1.9 Reporting and Resolution of Issues

An important function of a quality system is a communication structure that ensures corrective actions, when needed, are implemented in a timely manner and their effectiveness is confirmed. In order to address the findings from the assessments described above, the following structure and associated protocols shall be employed to identify and implement corrective actions.

All A&MD staff members are responsible for identifying the need for corrective actions. Identifying the need for corrective actions can occur during site visits, audits, data review activities, or other monitoring activities. This shared responsibility, coupled with diligent attention to detail and accuracy, will assure that the FCEAP ambient air monitoring network consistently collects quality data, and that the data is reduced, analyzed, and presented in an accurate and representative manner.

Any A&MD staff member who perceives a need for corrective action(s) shall present the situation/concern to the A&MPM and/or the QA Specialists.

In most cases, the A&MPM will assess the need for corrective action, although occasions may arise where a QA Specialist or other A&MD staff member is delegated this responsibility. If one is deemed necessary, a suitable corrective action will be selected and disseminated to the site operator(s) or QA Specialist. If the issue is of major significance, the situation will be communicated by the A&MPM to the Director, who may determine that the issue is of such import that work must stop until corrective action(s) can be implemented and the situation completely resolved. For example, although it is not a reactive corrective action measure, a proactive corrective measure that may involve the Director stopping work would be the circumstance of emergency weather conditions. The State of North Carolina is sometimes impacted by hurricanes and other significant weather events, the effects of which can be felt in the Triad Region. During times such as these when a hurricane is approaching, the A&MPM may communicate concern to the Director about the security and safety of the monitoring stations and equipment, as well as the Office staff themselves. The Director may initiate emergency shutdown procedures at this time, as a safety measure.

Site operators are primarily responsible for implementing corrective actions, although, due to the nature of cross-training within the Office, QA Specialists and even the A&MPM may participate in corrective action implementation, when necessary and appropriate. The corrective action must be implemented (begun) within 2 business days, notwithstanding extenuating circumstances. The A&MPM judges the efficacy and success of corrective actions.

Corrective actions are tracked and monitored for completion using a variety of mechanisms based on the severity of the identified action:

- Simple operational corrections are made in the case of isolated performance issues. Examples include performance of routine maintenance, calibration, or troubleshooting in the case of a specific performance evaluation failure. Documentation of the corrective action is recorded in monitor specific log books.
- Procedural corrections and subsequent training are made when findings identify larger systemic issues. Examples include findings that indicate a failure of current procedures to adequately address QA /QC objectives, or recent changes that result in the need for development of new guidance/SOPs. Documentation of this type of corrective action and its effectiveness is provided in SOP revision histories (because SOPs will be revised as part of the corrective action) and in emails.
- Formal corrective action plans are used when administrative over-sight is required to implement corrective actions. Examples include formal audit findings, identification of major deviations from the QAPP, or broad systemic problems. Formal corrective action plans indicate responsibilities, actions to be taken, and a schedule for resolution. Corrective action plans such as these are typically formulated by the FCEAP A&MPM as a result of an EPA Region TSA.

Table 14 Assessment Summary and Schedule

Assessment Type	Frequency	Performing Agency	Assessment Implementation
Technical Systems Audit	Every 3 years	EPA	A&MPM
External Agency Audit	Periodically, when needed	NCDAQ/MCAQ	A&MPM
Performance Evaluation Program Audit	Per EPA schedule	EPA/PEP Contractor	A&MPM
National Performance Audit Program	Per EPA schedule	EPA/NPAP Contractor	A&MPM
Laboratory Audit	Every 3 years	EPA	RTI
Data Quality Assessment	Quarterly	FCEAP	A&MPM
Data Certification	Annually	FCEAP	A&MPM, QA1, QA2
Annual Monitoring Network Plan	Annually	FCEAP	Subject to EPA approval
5-year Monitoring Network Assessment	Every 5 years	FCEAP	Subject to EPA approval
Data Quality Audits	Monthly	Site Operators	QA1, QA2

3.2 Reports to Management

As discussed in earlier sections of this QAPP, the A&MD is a small division within the FCEAP, and communication is paramount to the success of the Office. Weekly staff meetings are an integral part of the Office's process, and any issues or concerns within the monitoring program or data are discussed at that time. As described in Section 1.8, the weekly meetings frequently involve a review of data forms and various monitoring documentation. With that in mind, the A&MD does not generate and issue many formal reports to management – because management is intricately involved in the daily operations and, as such, awareness is ongoing.

However, there are several quality-related reports and communications that are completed by A&MD operators, or the A&MPM directly, in order to formally document the review/assessment of the Office's monitoring program. Some of these reports are shared with the Office Director. Similarly, there are several official reports that are routed through the Office Director and submitted to EPA, per regulatory requirements. These reports to are summarized in Table 15. More information about the content of these reports can be found in Section 3.1 of this QAPP, as well as in the appropriate sections of 40 CFR Part 58. Guidance for report format and content is generally provided by EPA's Office of Air Quality Planning and Standards.

Table 15 FCEAP Ambient Monitoring Program Reports

Report Type	Frequency	Projected Delivery Date	Report Preparation	Recipients
Technical Systems Audit	Every 3 years	Per EPA Schedule	EPA	FCEAP Director & A&MPM
Monthly Reports	Continual	10th of every month	Site Operators	QA staff
NPAP	Per EPA schedule	EPA/NPAP Contractor	EPA	Site Operator & A&MPM
Data Certification Package	Annually	May 1	A&MPM	EPA
Annual Monitoring Network Plan	Annually	July 1	A&MPM	EPA
5-year Monitoring Network Assessment	Every 5 years	July 1, starting in 2010	A&MPM	EPA

4.0 Data Validation and Usability

4.1 Data Review, Verification, and Validation

Each of the network's analytical instruments are employed to measure ambient concentrations of specific pollutants. In order to be useful the data must undergo evaluation to determine the degree to which each data point has met its quality specifications. A&MD staff, particularly the QA Specialists, evaluate the data to establish that data collection is consistent with QAPP and SOP requirements. Then, the A&MPM, in collaboration with the QA Specialists, estimates the potential effect any deviation from the QAPP or SOP requirements 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.

Data review is the in-house examination to ensure that the data has been recorded, transmitted, and processed correctly. It includes completeness checks to determine if there are any deficiencies such as missing data or lost integrity. The data under evaluation should be compared to actual events, as per guidance (*Guidance on Environmental Verification and Validation* (EPA QA/G-8)). 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 with AQS codes prior to upload to AQS. The review of the routine and the associated QC data will be verified and validated on a monthly basis. Continuous data is downloaded to the central DAS daily and examined daily to ensure the data is acquired according to requirements. Continuous data is

later reviewed in batches during the data validation process. Non-continuous data is reviewed and verified by the site operators during collection and retrieval and is reviewed and verified in batches as part of the data reduction and validation process. Corrective action is taken if errors or anomalies are found. In cases when data does not meet quality goals it may be flagged or invalidated.

Data verification is the process for evaluating the completeness, correctness, and conformance / compliance of the data set against method, procedural and contractual specifications. Verification can be further defined as confirmation, through provision of objective evidence, that specified requirements have been fulfilled. The verification process also involves the inspection and acceptance of the field samples. Site operators verify the gaseous data collected when reviewing and documenting their electronic strip charts throughout the sample collection process, as well as by verifying the status flags applied to data by the site data loggers. Site operators verify intermittent data when downloading/transferring files from $PM_{2.5}$ samplers and checking/documenting the sampler's "as found"/ "as left" status; also, site operators inspect the intermittent samples – pre and post-sampling – to ensure they are intact and undamaged. Data verification also occurs when site operators complete their monthly reports. Any missing data (gaps) are reviewed and accounted for, and unacceptable or questionable data will be flagged by the site operators during this monthly process. The reports are then submitted to the QA Specialists. At that time, all flagged data will be re-verified by the QA Specialists. The procedures for verifying data are detailed in FCEAP's Data Handling SOP. Once the reports are complete, the data are reviewed for routine data outliers and conformance to acceptance criteria.

Data validation is a routine process designed to ensure that reported values meet the quality goals of the environmental data operations. Data validation is further defined as examination and provision of objective evidence that the particular requirements for a specific *intended use* are fulfilled. The primary intended use for the FCEAP data set is NAAQS compliance. A progressive, systematic approach to data validation must be used to ensure and assess the quality of data. Data validation includes the review of the FCEAP data sets against the individual pollutant MQOs (see Section 1.7 of this QAPP), which is completed by the QA Specialists. It also includes the review of data against the Office's QC reports, QA reports, and electronic strip charts, as well as the comparison of the data against basic statistics (such as completeness). Reviewing data long-term (over a monthly or quarterly time-frame) provides information about the structure of the data and may identify patterns, relationships, or potential anomalies. QA Specialists also spot-check comparisons between the electronic strip charts and data summary reports from the AirVision data system to ensure data consistency. If a problem/discrepancy is found, further investigations must be done to find the source of the error and then corrected. FCEAP applies a "Weight of Evidence" approach when determining data validity. Invalidated data are replaced with AQS Null Data codes prior to upload to AQS. Deviations from operational procedures or quality assurance requirements that do not result in data invalidation may require that data be qualified with QA qualifier flags prior to upload to AQS. The A&MPM spot-checks these data after validation by the QA Specialists is completed, prior to AQS upload.

4.1.1 Data Usability

The location of all FCEAP sites have received EPA approval; thus, data from each monitor will be considered spatially representative as long as the sites continue to meet the requirements set forth by 40 CFR 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring. Measured deviation from the siting criteria will require data to be flagged in the AQS database (i.e., "SX" qualifier) until such time as corrective actions can be implemented (e.g., tree trimming to correct dripline issues), or an approved waiver from EPA Region 4 must be obtained. The impact of any deviations shall be evaluated by the A&MPM, in consultation with EPA Region 4, prior to the use of the data for calculation of summary statistics.

Sample collection documentation procedures are outlined in Section 1.9.2 of this QAPP; sampling methodologies and acceptable technologies are outlined in Sections 2.3 and 2.4. Monitors and samplers used by FCEAP for the collection of criteria pollutant data are designated as FRM/FEM; thus, the methodologies/technologies are considered acceptable for regulatory decision making purposes. Furthermore, all aspects of sample collection are detailed in FCEAP's pollutant/task specific SOPs, which are reviewed and approved by EPA Region 4. Any deviation from the established sample collection procedures must be documented in the appropriate site pollutant logbook (Excel form). The impact of any deviations shall be evaluated during data validation by the QA Specialists prior to upload of the data to AQS.

Quality control activities are outlined in Section 2.5 of this QAPP. Prior to upload of sample data to AQS, the impact of any deviations shall be evaluated by QA Specialist during the data validation process. While not exhaustive, the list contains some examples of data loss/invalidation and the associated methods of data handling.

- All periods of missing concentration data (e.g. during QC activities, maintenance, and power failures) will be replaced with the appropriate AQS Null Data codes.
- Each hour of pollutant concentration data is composed of at least 45 minutes of valid minute data. Hours of data with less than 45 minutes of valid data collection will require invalidation of the hourly data. The affected data will be replaced with AQS Null Data codes.
- The shelter temperature must be maintained within 5-40 °C for the Teledyne-API gaseous monitors. The shelter temperature must be maintained within the acceptable range for any other given model type used. If a shelter contains each make of analyzer, the more restrictive shelter criterion will be applied. All data collected when outside of this temperature range will be invalidated and replaced with AQS Null Data codes.
- The precision point during automated, overnight "auto-cal" checks must meet MQO for the 1-point QC checks for each pollutant. These MQOs serve as "**control limits**" in the FCEAP – meaning, the maximum threshold for which data is considered acceptable, and above which data is considered "out of control" and must be invalidated. For example, the calculated difference for the precision point of each nightly auto-cal check for ozone must be ≤ ±7 %d. If the point exceeds the allowable criteria, all ozone data will be invalidated back to the point of the last acceptable QC check or a known point of analyzer malfunction and

invalidated forward from the failed check until corrective action was taking producing a good QC check result. The affected data will be replaced with AQS Null Data codes.

- Precision and Bias Check data uploaded to AQS as QC data must actually quality-assure the applicable concentration data within AQS. Examples include:
    - If concentration data is invalidated due to failed QC check results (i.e., control limit exceeded), the results of the failed QC check will be uploaded to AQS with the "1F" code.
    - If a QC check occurs during a period of equipment malfunction, the QC data will be uploaded to AQS regardless of the QC check's percent difference results with a "1C" code.
- The calculated percent difference during a QA Performance Evaluation must meet the MQO guidance for each pollutant. If the Performance Evaluation exceeds the MQO difference, concentration data will be invalidated back to the last known acceptable QA/QC check or known point of analyzer malfunction. The affected data will be replaced with AQS Null Data codes.
- Performance Evaluation data uploaded to AQS as QA data must actually quality-assure the applicable concentration data within AQS. Examples include:
    - If concentration data are invalidated due to unacceptable results during a Performance Evaluation (i.e. quarterly QA audit) the results of the failed Performance Evaluation will be uploaded to AQS.
    - If the QA auditor's equipment is malfunctioning during a Performance Evaluation, resulting in unacceptable audit results, no ambient concentration data will be invalidated and the results of the Performance Evaluation will not be uploaded to AQS.

It is the responsibility of the QA Specialists to ensure that all invalidated concentration data is coded appropriately, and then correctly uploaded to AQS. With the exception of "data completeness" statistics, invalidated concentration data, and its related QA/QC data, are not used in the calculation of annual and three-year summary statistics. Therefore, the data uploaded to AQS must be properly validated and coded to ensure that summary statistics are calculated accurately.

Exceptional Events

40 CFR 50.14 allows the EPA Administrator to exclude certain data from being used for determinations of exceedances and violations of a NAAQS, so long as a State/Local demonstrates to the Administrator's satisfaction that the exceedance or violation was caused by an "exceptional event." 40 CFR 50.1 defines an "Exceptional Event" as an event or events, in which:

- The resulting emissions affect air quality in such a way that there exists a clear causal relationship between the specific event(s) and the monitored exceedance(s) or violation(s);
- The event(s) is not reasonably controllable or preventable; and,
- The event(s) is caused by a human activity that is unlikely to recur at a particular location or is a natural event(s).

An Exceptional Event does not include:

- Air pollution relating to source noncompliance;

- Stagnation of air masses or meteorological inversions; and,
- Meteorological events involving high temperatures or lack of precipitation.

Note: Conditions involving high temperatures or a lack of precipitation may promote occurrences of particular types of exceptional events, such as wildfires or high wind events, which do directly cause emissions.

Data impacted by an Exceptional Event is not considered "representative" of air quality for NAAQS comparison purposes, or calculation of certain summary statistics. All concentration data impacted by an Exceptional Event should be flagged with an AQS Information code and linked within AQS to an event description. Exceptional Event codes and descriptions are typically due by July 1 of the following year, but alternative schedules may be established during Federal rulemaking.

It is the responsibility of the A&MPM to analyze data for potential Exceptional Events and to add the necessary flags and descriptions into AQS by July 1 of the following year (or by applicable regulatory deadlines).

A State seeking concurrence must notify and cooperate with the appropriate EPA Regional Office (i.e. EPA Region 4) to prepare a demonstration package for the Administrator.

Exceptional Event data in AQS must receive concurrence from the EPA Administrator. Data that does not receive a concurrence is still eligible for NAAQS comparisons, regardless of the application of Request Exclusion flags.

4.2 Verification and Validation Methods

40 CFR Part 58, Appendix A, states the following in Section 1.2.3:

*Each PQAO is required to implement a quality system that provides sufficient information to assess the quality of the monitoring data…Failure to conduct or pass a required check or procedure, or a series of required checks or procedures, does not by itself invalidate data for regulatory decision making. Rather, PQAOs and the EPA shall use the checks and procedures required in [Part 58, Appendix A] in combination with other data quality information, reports, and similar documentation that demonstrate overall compliance with Part 58. Accordingly, the EPA and PQAOs shall use a "**weight of evidence**" approach when determining the suitability of data for regulatory decisions…Consensus built validation templates or validation criteria already approved in QAPPs should be used as the basis for the weight of evidence approach.*

As stated in Section 1.7 of this QAPP, FCEAP has adopted the consensus-built data validation templates in the EPA QA Handbook and modified them, where appropriate, to reflect the FCEAP monitoring network. The templates are included in this QAPP as the Office's MQO Tables and will be used for the weight of evidence approach afforded to PQAOs within the regulation. The QA Handbook provides the following guidance regarding the use of the templates, which FCEAP will follow when validating data.

- ***Critical Criteria****- Deemed critical to maintaining the integrity of a sample (or ambient air concentration value) or group of samples. Observations that do not meet each and every criterion on the critical table should be invalidated unless there are compelling reason and justification for not doing so. Basically, the sample or group of samples for which one or more of these criteria are not met is invalid until proven otherwise. In most cases the requirement, the implementation frequency of the criteria, and the acceptance criteria are found in CFR and are therefore regulatory in nature.*

- ***Operational Criteria*** *- Violation of a criterion or a number of criteria may be cause for invalidation. The data validator should consider other quality control information that may or may not indicate the data are acceptable for the parameter being controlled. Therefore, the sample or group of samples for which one or more of these criteria are not met is suspect unless other quality control information demonstrates otherwise and is documented. The reason for not meeting the criteria should be investigated, mitigated or justified.*

- ***Systematic Criteria*** *- include those criteria which are important for the correct interpretation of the data, but do not usually impact the validity of a sample or group of samples. An example criterion is that at least 75% of the scheduled samples for each quarter should be successfully collected and validated.* ***The DQOs are also included in this table.*** *If the data quality objectives are not met, this does not invalidate any of the samples but it may impact the confidence in the attainment/non-attainment decision.*

- *The designation of QC checks or QC samples as Operational or Systematic do not imply that these quality control checks need not be performed. Not performing an operational or systematic QC check that is required by regulation can be a basis for invalidation of all associated data.* ***The validation templates are meant to be applied to small data sets (single values or a few weeks of information) and should not be construed to allow a criterion to be in non-conformance simply because it is operational or systematic.***

The following levels of data review describe the overall FCEAP data verification and validation process, including the individuals responsible for the stated activities.

RAW – Level 0 (All Staff): These data are obtained directly from the data loggers that acquire the data in the field. Averaging times represent the minimum intervals recorded by the data logger. Raw data may have been reduced, but are unedited, not reviewed, and are not adjusted. Raw data has not been edited for instrument downtime, but may be flagged with pre-programmed, user-defined status flags that the logger will apply to data points when excursions occurs. Raw data are consulted on a regular basis to ascertain instrument functionality and to identify potential episodes prior to the monthly report step (described in Section 4.2.4 below).

REVISED – Level 1 (Site Operators): This is the next step in the verification process, that occurs after the Level 0 data review. Data are revised (in the **edited** database only; original data remains intact in the unedited database). Verification and associated data edits include the following:
1) Removal of values when monitoring instruments fail specified validation criteria.
2) Verifying computer file entries against data sheets / logbooks, where appropriate.

3) Replacement of data from a backup data acquisition system in the event of failure of the primary system.
4) Identification and flagging of data that are beyond reasonable bounds, significantly deviate from measurement assumptions, or that may be deemed unrepresentative.
5) Identification of data collected during periods of maintenance or malfunction.

QA REVIEW – Level 2 (QA Specialists): QA validation is the next step in data analysis. In addition to a review of the revised data, the QA Specialists verify the measurement assumptions and review comparisons of collocated measurements (e.g., primary and precision monitoring pair do not vary significantly for a specific data point). These tests are in addition to ensuring the data results meet the MQOs found in Tables 4 - 9. Data that do not meet the requirements of the critical criteria elements will be invalidated, unless compelling evidence and justification exists for not doing so. (Some examples of compelling evidence were discussed in Section 2.5.) In case of the latter, the reason(s) for not invalidating the data will be documented. Qualifier flags may be applied to data that are found to not meet operational or systematic criteria. If multiple operational criteria flags are applied to the data, the QA Specialists, in collaboration with the A&MPM, may deem that the data should be invalidated instead of qualified.

AQS READY – Level 3 (A&MPM): Data is prepared for AQS submission and text files are created (see Data Handling SOP). AQS Ready files will be reviewed by the A&MPM before submittal approval is granted. Once submitted successfully, AQS AMP reports will be reviewed to verify data upload (transfer) was successful. The data will also be spot-checked for accuracy.

The following subsections list the AQS null value codes, QA qualifier flags, and informational flags that may be applied to FCEAP data during verification/validation processes.

4.2.1 AQS Null Value Codes & Descriptions

Table 16 illustrates common AQS Null Value Codes, as well as the equivalent AirVision null codes, and provides a brief description of what the codes mean. **Null value codes invalidate data**. Their use by FCEAP staff indicates the data they replace do not meet quality specifications. It is FCEAP policy to select the null value code that most closely describes the reason for the data invalidation. For example, if data were lost due to a multi-point calibration verification, the code "BC" would be applied to the impacted hour(s). Only one null value code can be used to replace a single hour of data loss; if there are multiple reasons why an hour of data is lost (such as a site operator conducting routine maintenance during a portion of the hour, and then begin a recalibration procedure in that same hour), the code that best reflects the majority of that hour's data loss will be selected. In some instances, the A&MPM may be consulted to help select a code when multiple null value codes could be used to describe the event (such as data loss due to both a power outage and a subsequent instrument malfunction).

For the majority of these codes, the code description alone is sufficient to explain its intended use – and, subsequently, FCEAP's interpretation of the code. However, the last column in Table 16 contains some examples of circumstances when certain codes may be used that are not as straightforward. Therefore, the examples in the last column are more to illustrate FCEAP's

interpretation and application of codes that may be ambiguous or where duplicate codes exist (such as AT versus BC), so that it is clear as to how FCEAP will apply these specific codes. Because of that, the last column is not documented for every code.

Table 16: AQS Null Value Codes

AQS Code	Code Description	Common FCEAP Use of Code
AA	Sample Pressure out of Limits	
AB	Technician Unavailable	
AC	Construction/Repairs in Area	
AD	Shelter Storm Damage	
AE	Shelter Temperature Outside Limits	
AF	Scheduled but not Collected	
AG	Sample Time out of Limits	
AH	Sample Flow Rate out of Limits	
AI	Insufficient Data (cannot calculate)	
AJ	Filter Damage	
AK	Filter Leak	
AL	Voided by Operator	
AM	Miscellaneous Void	
AN	Machine Malfunction	
AO	Bad Weather	
AP	Vandalism	
AQ	Collection Error	
AR	Lab Error	
AS	Poor Quality Assurance Results*	This code is used when the analyzer is confirmed to have drifted and does not pass its QC check criterion
AT	Calibration	
AU	Monitoring Waived	
AV	Power Failure	
AW	Wildlife Damage	
AX	Precision Check	
AY	Q C Control Points (zero/span)	
AZ	Q C Audit*	This code is for in-house audits
BA	Maintenance/Routine Repairs*	This code covers checks to test/troubleshoot gaseous equipment, in addition to maintenance and repair activities
BB	Unable to Reach Site	
BC	Multi-point Calibration*	This code is for gaseous calibrations
BD	Auto Calibration*	This code covers all automatic gaseous QC checks

BE	Building/Site Repair	
BF	Precision/Zero/Span*	This code covers all manual gaseous ZSP QC checks
BG	Missing ozone data not likely to exceed level of standard	
BH	Interference/co-elution/misidentification	
BI	Lost or damaged in transit	
BJ	Operator Error	
BK	Site computer/datalogger down	
BL	QA Audit*	This code is used for NPAP audits or other external audits not performed by FCEAP
BM	Accuracy check	
BN	Sample Value Exceeds Media Limit	
CS	Laboratory Calibration Standard	
DA	Aberrant Data (Corrupt Files, Aberrant Chromatography, Spikes, Shifts)*	This code is used for any negative concentration data that is outside the AQS MDL for the analyzer
DL	Detection Limit Analyses	
FI	Filter Inspection Flag	
MB	Method Blank (Analytical)	
MC	Module End Cap Missing	
SA	Storm Approaching	
SC	Sampler Contamination	
ST	Calibration Verification Standard	
TC	Component Check & Retention Time Standard	
TS	Holding Time Or Transport Temperature Is Out Of Specs.	
QV	Quality Control Multi-point Verification*	This code is for gaseous 90-day verifications
XX	Experimental Data	

4.2.2 AQS Qualifier Flags

Table 17 illustrates common AQS QA Qualifier Flags. This list is not all-inclusive. **QA qualifier flags do <u>not</u> invalidate data.** Rather, the flags are a way of adding additional narrative to a data point(s) to better explain things/events that may have impacted them. The data are still considered valid and acceptable for their intended use, but need to be qualified in order to have a more complete record in AQS as to "what happened". These flags are used sparingly, but when needed allow FCEAP staff to document a more complete story about the data.

Table 17: AQS QA Qualifier Flags

Qualifier Flag	Description	Qualifier Flag	Description
1	Deviation from a CFR/Critical Criteria Requirement.	FX	Filter Integrity Issue.
1V	Data reviewed and validated.	HT	Sample pick-up hold time exceeded.
2	Operational Deviation.	LB	Lab blank value above acceptable limit.
3	Field Issue.	LJ	Identification Of Analyte Is Acceptable; Reported Value Is An Estimate.
4	Lab Issue.	LK	Analyte Identified; Reported Value May Be Biased High.
5	Outlier.	LL	Analyte Identified; Reported Value May Be Biased Low.
6	QAPP Issue.	MD	Value less than MDL.
7	Below Lowest Calibration Level.	MS	Value reported is 1/2 MDL substituted.
9	Negative value detected - zero reported.	MX	Matrix Effect.
CB	Values have been Blank Corrected.	ND	No Value Detected, Zero Reported.
CC	Clean Canister Residue.	NS	Influenced by nearby source.
CF	Canister Bias: NATTS/UATMP Data for compounds that have failed certification for the canister.	QP	Pressure Sensor Questionable.
CL	Surrogate Recoveries Outside Control Limits.	QT	Temperature Sensor Questionable.
DI	Sample was diluted for analysis.	QX	Does not meet QC criteria.
DN	DNPH peak less than NATTS TAD requirement, reported value should be considered an estimate.	SB	Sampler Bias: NATTS/UATMP Data for compounds that have failed certification for the sampler.
EH	Estimated; Exceeds Upper Range.	SP	NATTS/UATMP data with Spike Recovery outside acceptance limits.
FB	Field Blank Value Above Acceptable Limit.	SQ	Values Between SQL and MDL.
SS	Value substituted from secondary monitor.	VB	Value below normal; no reason to invalidate.
SX	Does Not Meet Siting Criteria.	W	Flow Rate Average out of Spec.

TB	Trip Blank Value Above Acceptable Limit.	X	Filter Temperature Difference or Average out of Spec.
TT	Transport Temperaure is Out of Specs.	Y	Elapsed Sample Time out of Spec.
V	Validated Value.	1C	QC check exceeds acceptance criteria but there is compelling evidence that the analyzer data is valid.
1F	No 1 Point QC but need to count for completeness		

4.2.3 Informational Flags

Table 18 contains AQS informational flags. These are types of qualifier flags that FCEAP will add to data believed to be impacted by an exceptional event. Like the QA qualifier flags in Section 4.2.2 above, these flags do not invalidate data, but rather allow FCEAP to tell a more complete story about the events which may have impacted the data. Exceptional events are discussed further in Section 4.1.2 of this QAPP.

Table 18: AQS Informational Flags

< Qualifier Code >	< Qualifier Desc >	< Qualifier Type Desc >
IA	African Dust	Informational Only
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

4.2.4 Guideline for Monthly Reports

Figure 9 is a flow chart taken from the FCEAP Data Handling SOP. The flow chart illustrates and summarizes the data review steps completed each month by A&MD staff, which results in the monthly data reports that are documented by site operators and then reviewed and verified by the QA Specialists. Please refer to the SOP for additional information and more details about this process. Details on the acceptance criteria for various QC procedures specific to each pollutant or measurement technique can be found in parameter-specific SOPs.

Data Handling Steps

Site Operator → QA1 → QA2

Site Data Review & Validation

Revision Date: 6/10/19

Operator Duties

1. Review minute/hourly data and auto cal results daily. Report any site/pollutant problems or abnormalities to the Program Manager.
2. Ensure Excel logbooks and instrument records are uploaded to the correct folder on the shared drive after every check.
3. Print an **Original Monthly Report**. In AirVision navigate to *Reports → Summary Reports → Monthly Report*. Select the month and pollutant and ensure all four checkboxes under the *Options* section are unchecked. Generate and print the report.
4. Verify that all missing or flagged data are shaded YELLOW and highlight any bad data with BLUE. Add notes detailing why hours were missing or need to be edited. Highlight the daily maximum value for each day with ORANGE. Circle all dates using BLACK pen that have missing, flagged, or bad data; or data to which qualifier codes will be applied.
5. Print an **Original Flag Report**. Navigate back to the Monthly Report selection menu and check only the *Show Flags Box*. Generate then print the report.
6. Add appropriate null codes to corresponding hours by navigating to *Data Editors → Average Data Editor* in AirVision. Select the pollutant and *Hourly average of 60 minutes* for the averaging interval. Adjust the date range then click *Retrieve Data*. Using any of the editor views (linear, cross-tab, matrix) or the batch editor highlight hours that need to have null codes applied, right click, then select *Set AQS Null Code*. When prompted to mark the data invalid, click "Yes". Qualifier codes and AirVision flags can be set in the same manner. Codes should "tell a story" about the data.
7. Print a **Revised Monthly Report**. In AirVision navigate back to the Monthly Report selection screen and check only the *Show Null Codes* box. Generate then print the report. Verify null codes are shaded GREEN and highlight any edited good numbers with BLUE. Circle hours with qualifier codes using RED pen and give a brief explanation. Highlight the date of all days to which any edits were made using GREEN.
8. Complete the Data Coding/Editing Summary for your pollutant and sign off on it.
9. No chart memo related tasks need to be performed until AirVision sync is running.
10. **Submit a hardcopy of the Original Monthly Report, Original Flag Report, and Revised Monthly Report to QA1 by the 15th of the following month.**

Figure 9: Monthly Data Verification/Validation Steps – Site Operator

Systems QA for the Data

QA1

1. Review minute data and verify good traces during checks. Look for good "stair steps" during checks. Verify annotations were added to explain what activities were performed.
2. Review auto cal results and verify percent errors are within tolerances. In AirVision, navigate to *Reports → Calibration Reports → Calibration Trend Graph*. Review the *Historical Graph* and/or the *Response Graph*, looking for trends in precision results.
3. Make sure Excel logbooks are up to date and no more than 14 days old in the correct folder on the shared drive.
4. Review Original Monthly Report, Original Flag Report, Revised Monthly Report, and Data Coding/Editing Summary and approve or make suggestions to null codes used by the operators. Codes should "tell a story" about the data.
5. Make sure good data is bracketed by QC checks. Look for QC checks before and/or after maintenance/repairs are performed.
6. Suggested modifications (if any) should be discussed with the operator and a consensus reached. QA1 makes the changes and reprints the Revised Monthly Report.
7. Review Data Coding/Editing Summary and sign off on it.
8. **Complete QA1 steps by the last day of the following month.**

QA2

1. Review minute data during checks and look for good traces and quality "stair steps".
2. ********MINUTE DATA FILES*****do we still need this step or an equivalent?***
3. Make sure annotations, Excel logbooks, and Missing Data Reports are consistent and have "meaty" documentation to cover data activities.
4. Review Original Monthly Report, Original Flag Report, Revised Monthly Report, and Data Coding/Editing Summary and sign off on Data Coding/Editing Summary. Print Data Coding/Editing Summary and finalize Monthly Report.
5. Using AirVision, navigate to *Reports → AQS Reports → AQS 2.2 Text Report*. Select the date/time range, pollutant, and averaging interval then click *Generate Report*. Make any necessary edits in the *Report Output* section and click *Save to File*. Save them to the proper folder on the shared drive with the following naming convention: "MMYY-site ID-Pollutant.dat".
6. **Complete QA2 steps by the 10th day of the 2nd following month.**
7. Review SOPs annually for changes and revise as needed. Procedural changes need EPA approval.

Figure 10: Monthly Data Verification/Validation Steps – QA Personnel

4.3 Reconciliation with Data Quality Objectives (DQOs)

The FCEAP follows procedures that verify data collected by the A&MD comply with the criteria pollutant DQOs. Actions will be taken based upon assessment of the DQOs to maintain compliance.

To reiterate, the data collected by the FCEAP will be used to:

- monitor the ambient concentrations of criteria pollutants within Forsyth County, NC;
- evaluate compliance with the NAAQS;
- observe pollution trends; and,
- alert the public when unhealthy pollution levels are detected or predicted.

The quantitative DQOs are established in 40 CFR Part 58, Appendix A, and stated in Section 1.7 of this QAPP. To review the results of required statistical analyses (codified in Section 4 of 40 CFR Part 58, Appendix A), various AQS reports will be generated (see Section 3.1.7 of the QAPP). It is noted here, however, that because the FCEAP utilizes control limits for its criteria pollutant data – and implements EPA's critical criteria for precision checks – FCEAP should not have to directly calculate confidence intervals annually because all data should, statistically, meet the DQOs.

While DQOs will be assessed quarterly throughout the year, FCEAP will evaluate whether these objectives are achieved on an annual basis as well. Evaluation of measurement uncertainty will occur in conjunction with Annual Data Certification, which is to be completed by May 1 of each year. The evaluation will be conducted by the A&MPM under the supervision of the Director. The data used to calculate measurement uncertainty will be obtained from AQS, which will have been previously quality assured, coded, qualified, and evaluated based upon applicable MQOs.

If and when the data from at least one of the monitors violates the DQI bias and/or precision limits, then the A&MPM will conduct an investigation to uncover the cause of the violation. If all of the monitors in the network of a similar type or pollutant violate the DQI, the cause may be at the agency level (operator training) or higher (problems with method designation). If only one monitor 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 (e.g., state, other local program, national)
- Data from performance audits (e.g., other agency or NPAP), and,
- QC trails.

Once the cause(s) of non-conformance has been determined, FCEAP will institute and document corrective actions to correct quality system deficiencies. Corrective actions may include revising the following:

- pollutant MQOs (e.g., to make them more stringent);
- this QAPP; and
- specific SOPs.

While multiple A&M staff will be involved in any such investigation, the A&MPM and QA Specialists will be responsible for oversight of the investigation. Modification of the Office's

MQOs, QAPP, and related SOPs will be the responsibility of the A&MPM, with revisions subsequently approved by EPA Region 4. The A&MPM will contact EPA Region 4 for guidance during this process, when/if necessary.

Ultimately specifying tolerable error limits reduces the probability of making a decision error due to uncertainty in the data. Decision-makers, such as EPA, need to determine if the data collected within the FCEAP monitoring network will be less than, equal to, or greater than the level of the NAAQS for each specific criteria pollutant. The annual data certification process, and reports generated as part of the certification, provide a quantitative assessment of the measurement uncertainty within the FCEAP criteria pollutant data set. By controlling uncertainty in the data to the extent prescribed by the DQOs, decision makers can use FCEAP's ambient air monitoring data with confidence.

5.0 References

1) Environmental Protection Agency. 2002. *Guidance for Quality Assurance Project Plans (QA/G-5)* (EPA/240/R-02/009). Washington, D.C.

2) Environmental Protection Agency. 2001a. *EPA Requirements for QA Project Plans (QA/R-5)* (EPA/600/R-98/018). Washington, D.C.

3) Environmental Protection Agency. 2017. *QA Handbook for Air Pollution Measurement Systems Volume II Ambient Air Quality Monitoring Program* (EPA/454/B-17/003). RTP, North Carolina. March 2017.

4) U.S. Environmental Protection Agency. 2008. *QA Handbook for Air Pollution Measurement Systems Volume IV Meteorological Measurements Version 2.0* (EPA/454/B-08/002). RTP, North Carolina. March 2008.

5) Environmental Protection Agency. 2006. *Data Quality Assessment: A Reviewer's Guide (QA/G-9R)* (EPA/240/B-06/002). Washington, D.C.

6) Environmental Protection Agency. 2015. *List of Designated Reference and Equivalent Methods*. RTP, North Carolina. Updated routinely; at the time of this QAPP, it was last published on June 17, 2017.

7) Humphrey, Richard K., Mecklenburg County BSSA - Information Technology, *RE: LAN Backup - General Description*, E-Mail Correspondence to Jeff Francis, December 8, 2015.

8) Mecklenburg County Air Quality Section Quality Assurance Project Plan Revision 18.2.1 2016