REGION 4
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Laboratory Services & Applied Science Division
980 College Station Road
Athens, Georgia 30605-2720

June 21, 2023

Mr. Patrick Butler, Chief
Ambient Monitoring Section
Division of Air Quality (NC DAQ)
North Carolina Department of Environmental Quality
217 West Jones Street
Raleigh, North Carolina 27603

LSASD Project Number: 23-0238

Mr. Butler:

We have reviewed the following document that you submitted for approval:

Quality Assurance Project Plan (QAPP) for the North Carolina Division of Air Quality NCORE Monitoring Program, Revision No. 2.0, June 06, 2023.

The quality assurance and technical elements within this QAPP were compared to EPA regulations and current guidance. The stated procedures appear to be clear, sound, and appropriate as written, to the extent they can be evaluated. EPA approval of this document is granted. Please be aware that approval of this QAPP does not constitute a waiver from any regulatory requirements. Your agency remains accountable for ensuring the background ambient air monitoring project adheres to all the applicable requirements detailed in 40 CFR Part 58, and that the data generated is of sufficient quality to be used for its intended purposes. This QAPP should be reviewed internally by NC DAQ on an annual basis and revised when procedures change; at a minimum, the QAPP must be revised within five years.

If you have any questions, please contact Marshall Varnum II at 706-355-8622 or via email at varnum.marshall@epa.gov.

Sincerely,

Keith Harris, Supervisor
Quality Assurance Section

Roy Cooper
Governer
Elizabeth Biser
Secretary
Michael A. Abraczinskas
Director

NORTH CAROLINA
Environmental Quality

DAQ-01-001

Quality Assurance Project Plan
For The North Carolina Division Of Air Quality
NCore
Monitoring Program

Revision 2

Prepared for:

Caroline Freeman
EPA Region IV Director, Air and Radiation Division
U. S. Environmental Protection Agency
Region IV
Atlanta Federal Building
61 Forsyth Street
Atlanta, Georgia 30303-8960

Submitted by:

Michael Abraczinskas, Director
North Carolina Division of Air Quality
North Carolina Department of Environmental Quality
1641 Mail Service Center
Raleigh, North Carolina 27699-1641

NORTH CAROLINA
Department of Environmental Quality

DISCLAIMER

This quality assurance project plan, or QAPP, covers the national core, or NCore, monitoring network for the North Carolina Department of Environmental Quality, Division of Air Quality or DAQ. The Mecklenburg County Air Quality local program has established an NCore monitoring site, but it is not included in this document. It is the responsibility of this local program to prepare and submit a separate NCore QAPP.

Quality Assurance Project Plan Acronym Glossary

ABS - acrylonitrile-butadiene-styrene
ADQ - Audit of Data Quality
AMS – Ambient Monitoring Section
AMTIC – Ambient Monitoring Technology Information Center
AQI – Air Quality Index
AQS - Air Quality System (EPA's Air database)
ARD – United States Environmental Protection Agency's Air and Radiation Division
ARM – Air Resources Manager
ASC – Aerosol Sample Conditioner
ASTM – American Society for Testing and Materials
AT – Ambient temperature
CAA – Clean Air Act
CAPA – Corrective Action Preventative Action
CAPS – cavity attenuated phase shift spectroscopy
CBSA – Core-based statistical area
CFR – Code of Federal Regulations
Chief – Ambient Monitoring Section chief
CO – Carbon monoxide
COC – chain of custody
Coordinator – Regional Office Monitoring Coordinator
CSN – Chemical Speciation Network
CV – Coefficient of variation
DAQ – North Carolina Division of Air Quality
DAS – Data Acquisition System
DASC – Data Assessment Statistical Calculator
° C – Degrees Celsius
DEQ – North Carolina Department of Environmental Quality
Director – Division of Air Quality Director
DIT – North Carolina Department of Information Technology
DQA – Data quality assessment
DQI – Data quality indicator
DQO – Data quality objective
ECB – Electronics and Calibration Branch
e-log – electronic logbook
EPA – United States Environmental Protection Agency
FEM – Federal equivalent method
FEP – Fluorinated ethylene propylene
FRM – Federal reference method
FTS – Flow Transfer Standard
GPS – global positioning system

HEPA – High-efficiency particulate air
HOBO - HOBO
HTML – Hypertext Markup Language
IBEAM – Internet-Based Enterprise Application Management
IDL – Instrument detection limit
IR – Infrared
JSP – Java Server Pages
km – kilometers
LAB – Laboratory Analysis Branch
LC – Local conditions
LDL – Lower Detectable Limits
LED – Light emitting diode
LMS – North Carolina Learning Management System
LPM –Liters per minute
LSASD – Laboratory Services and Applied Science Division
m – meters
MDL – Method detection limit
mg/m^3 – milligrams per cubic meter
MQO – Measurement quality objective
MSA – Metropolitan statistical area
NAAMS – National Ambient Air Monitoring Strategy
NAAQS - National Ambient Air Quality Standards
NC – North Carolina
NCore- National Ambient Air Monitoring Strategy - National Core Monitoring
NIST – National Institute of Standards and Technology
NO – Nitric oxide
NO_2 – Nitrogen dioxide
NO_y – reactive oxides of nitrogen
NPAP – National Performance Audit Program
O_3 – ozone
OAQPS – Office of Air Quality Planning and Standards
OSHA – Occupational Safety and Health Administration
Pb – lead
PDF – portable document format
PEP – Performance evaluation program
PFA – Perfluoroalkoxy
± - plus or minus
PM – Particulate matter
$PM_{2.5}$ – Particles with an average aerodynamic diameter of 2.5 microns or less, also known as fine particles
PM_{10} – Particles with an average aerodynamic diameter of 10 microns or less
$PM_{10-2.5}$ – Coarse particles with an average aerodynamic diameter between 2.5 and 10 microns
ppb – Parts per billion
PPB – Projects and Procedures Branch
ppm – Parts per million

PQAO – Primary quality assurance organization
psig – pounds per square inch, gauge
PTFE - polytetrafluoroethylene
PZS – precision, zero and span
QA – Quality assurance
QA Handbook – United States Environmental Protection Agency Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II
QA Handbook for Meteorological Measurements – United States Environmental Protection Agency Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2
QA/QC – Quality Assurance/Quality Control
QAM – Quality assurance manager
QAPP – Quality Assurance Project Plan
QC – Quality control
QMP – Quality management plan
RCO – Raleigh central office
RDBMS – Relational Database Management System
RDU – Raleigh Durham International Airport
RH – Relative humidity
RRO – Raleigh Regional Office
SD – standard deviation
sFTP – secure File Transfer Protocol
SLAMS – State and Local Air Monitoring Station
SO_2 – Sulfur dioxide
SOP – Standard Operating Procedure
SPM – Special Purpose Monitor
SQL – Structured Query Language
SR – Solar radiation
SRP – Standard reference photometer
STN – Speciation Trends Network
STP – Standard temperature and pressure, which is 25 degrees Celsius and 760 millimeters mercury
TAD – Technical assistance document
TEI- Thermo Environmental Instruments
TFE - tetrafluoroethylene
TSA - Technical Systems Audit
TSP – total suspended particles
µg – micrograms
$\mu g/m^3$ – micrograms per cubic meter
UV – Ultraviolet
VAC – Alternating current voltage
VIP – Value in performance
VSCC – Very sharp cut cyclone

1.0 Quality Assurance Project Plan Identification and Approval

Title: *Quality Assurance Project Plan for the North Carolina Division of Air Quality NCore Monitoring Program, Revision 2*

The DAQ hereby recommends the attached *Quality Assurance Project Plan for the North Carolina Division of Air Quality NCore Monitoring Program, Revision 1* for approval and commits the State of North Carolina, Department of Environmental Quality, Division of Air Quality to follow the elements described within.

Department of Environmental Quality

1) Signature: DocuSigned by: Michael Abraczinskas 3BB15068A33C492... Date 6/6/2023
Air Quality Division Director

2) Signature: DocuSigned by: Patrick Butler C5EE42DDCFBB4D1... Date 6/6/2023
Quality Assurance Manager
(Ambient Monitoring Section Chief)

3) Signature: DocuSigned by: Jim Bowyer B177070057B8426... Date 6/6/2023
Laboratory Analysis Branch Supervisor

4) Signature: DocuSigned by: Jeremy Pope E04AA1F43924449... Date 6/6/2023
Acting Projects and Procedures Branch Supervisor

5) Signature: DocuSigned by: Kay Roberts 1AEC3DA740184C3... Date 6/6/2023
Primary QAPP Author, Environmental Chemist

6) Signature: _____ Date _____
EPA Region 4 Designated Approving Official

2.0 Table of Contents

LIST OF TABLES AND FIGURES

List of Tables

List of Figures

3.0 Distribution

Table 3.1 lists the primary recipients of this QAPP. In accordance with the organizational chart presented in Figure 4.1, the people on this distribution list ensure and document that the following persons have read and understood this QAPP:

- The Raleigh Regional Office, or RRO, monitoring technicians and coordinator;
- The Electronics and Calibration Branch, or ECB, electronics technicians;
- The Laboratory Analysis Branch, or LAB, data reviewer,
- The Raleigh Central Office, or RCO, chemists and statistician or consultant; and
- Any other personnel involved with this project.

The Ambient Monitoring Section (AMS) chief, or chief, will post the official QAPP after it receives United States Environmental Protection Agency, or EPA, approval on the **Department of Environmental Quality, or DEQ, website** and e-mail a link to it to everyone on this distribution list.

Table 3.1 DAQ Ambient Air Quality Monitoring Program National Ambient Air Monitoring Strategy – National Core Monitoring Quality Assurance Project Plan Distribution List

Name and Position Title	Address	Telephone and e-mail
Michael Abraczinskas, Director	Division of Air Quality (DAQ) 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8447 michael.abraczinskas@ncdenr.gov
Patrick Butler, AMS Chief and Quality Assurance Manager	DAQ, AMS 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8719 patrick.butler@ncdenr.gov
Tim Skelding, Acting Raleigh Regional Office Air Quality Supervisor	DAQ, Raleigh Regional Office 3800 Barrett Drive Raleigh, NC 27609	(919) 791-4200 tim.skelding@ncdenr.gov
Derrick House, Electronics and Calibration Branch Supervisor	DAQ, Electronics and Calibration Branch 1730 Mail Service Center Raleigh, NC 27699-1730	(919) 715-1761 derrick.house@ncdenr.gov
James Bowyer, Laboratory Analysis Branch Supervisor	DAQ, Reedy Creek Laboratory 1622 Mail Service Center Raleigh, NC 27699-1622	(919) 715-7484 jim.bowyer@ncdenr.gov
Joette Steger, Projects and Procedures Branch Supervisor	DAQ, AMS 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8449 joette.steger@ncdenr.gov
Steven Rice, Database Manager	DAQ, Maywood 1641 Mail Service Center Raleigh, NC 27699-1641	(919)715-7220 Steven.rice@ncdenr.gov

Table 3.1 DAQ Ambient Air Quality Monitoring Program National Ambient Air Monitoring Strategy – National Core Monitoring Quality Assurance Project Plan Distribution List

Name and Position Title	**Address**	**Telephone and e-mail**
Caroline Freeman, EPA Region 4 Director, Air and Radiation Division (ARD)	EPA Region 4 Director ARD United States Environmental Protection Agency, Region 4 Atlanta Federal Building 61 Forsyth Street Atlanta, GA 30303-8960	(404) 562-8975 Freeman.Caroline@epa.gov
Keith Harris, Manager, Quality Assurance Section	United States Environmental Protection Agency, Region 4 Laboratory Services and Applied Science Division 980 College Station Road Athens, Georgia 30605-2720	(706) 355-8624 Harris.Keith@epa.gov
Darren Palmer, EPA Region 4 North Carolina State Contact	United States Environmental Protection Agency, Region 4, ARD 61 Forsyth Street SW Atlanta, Georgia 30303-8960	(404) 562-9052 Palmer.Darren@epa.gov

4.0 Project/Task Organization

The EPA is responsible for developing the national ambient air quality standards or NAAQS, defining the quality of data necessary to make comparisons to the NAAQS and identifying a minimum set of quality control, or QC, measurements and samples from which to judge the data quality. The state and local air monitoring organizations are responsible for using this information to develop and implement a quality assurance, or QA, 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 State of North Carolina Division of Air Quality, or DAQ, ambient air monitoring program is an independent primary quality assurance organization, or PQAO, as defined in 40 Code of Federal Regulations, or CFR, Part 58, Appendix A, Section 1.2. The DAQ operates the National Ambient Air Monitoring Strategy – National Core Monitoring, or NCore, program as part of the DAQ PQAO. The DAQ director has organized the AMS into three main branches: The Projects and Procedures Branch, or PPB, the Laboratory Analysis Branch, or LAB, and the Electronics and Calibration Branch, or ECB. The chief has responsibility for managing these branches per stated policy. The chief delegates the responsibility and authority to develop, organize, maintain and implement quality programs to the supervisors of each branch, in accordance with the EPA-approved quality management plan, or QMP. These supervisors have direct responsibility for assuring data quality. The AMS shares the monitoring responsibilities with the RRO monitoring staff.

Figure 4.1 presents the organizational structure for the implementation of this monitoring program. The following information lists the specific responsibilities of each significant position within the DAQ AMS, EPA Region 4, North Carolina Department of Information Technology (DIT) and RRO.

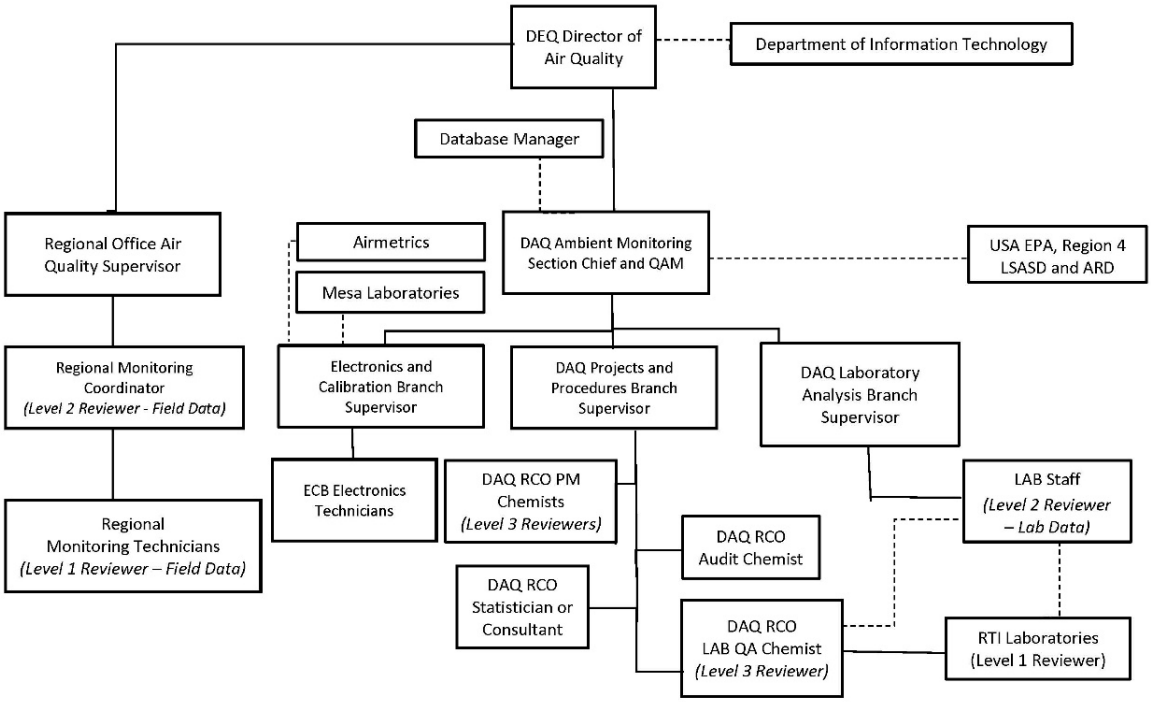


Figure 4.1 Project Organizational Chart

4.1 DAQ Director

The DAQ director, or director, supervises the chief and RRO supervisor. The director is responsible for ensuring adequate human and financial resources are available to support DAQ's NCore monitoring program. The director has ultimate responsibility and final authority on all aspects of the NCore monitoring program. The director has authority to stop or resume work. In the event of an emergency or inclement weather, the director implements the Continuity of Operations Plan, including the hurricane readiness procedures. The director also serves as a liaison with other divisions in DEQ, with the North Carolina General Assembly, DIT and with other regional air-monitoring agencies.

4.2 Ambient Monitoring Section

The AMS contains the PPB, the LAB and ECB and is responsible for coordinating and performing the quality assurance, or QA, data collection, sample collection, sample analysis and data processing aspects of DAQ's ambient air quality NCore Monitoring Program.

Ambient Monitoring Section Chief: The AMS chief, or chief, serves as the QA manager, or QAM, and reports to and has direct access to the director on all matters relating to DAQ's ambient monitoring NCore operation. The chief has ultimate authority for the program's data quality. The chief's duties include, but are not limited to the following:

- Serving as the QAM and maintaining oversight of all QA activities;
- Supervising the ambient monitoring staff and delegating responsibilities as appropriate;
- Serving as the liaison to EPA Region 4 monitoring staff;

- Maintaining overall responsibility for the monitoring network design and review, subject to the director's approval, including oversight and approval of the annual network plan and five-year assessment;
- Authorizing the installation and discontinuation of monitors within the network;
- Approving and distributing division standard operating procedures, or SOPs, and QAPPs to the personnel listed in Table 3.1;
- Serving as the tiebreaker in the event of an impasse on how to handle corrective actions or make a final judgment call on data validity;
- Collaborating with DEQ staff in developing, administering and maintaining the QMP;
- Overseeing training for the ambient monitoring staff;
- Certifying the data every year in accordance with 40 CFR 58.15;
- Reviewing the quarterly QA reports and the QC summaries to ensure the bias and precision limits are attained;
- Overseeing the management of the agency's documents and records;
- Tracking corrective actions and determining their success;
- Participating in systems audits;
- Assuring that QAPPs are established and effectively implemented for each project as applicable; and
- Reviewing budgets, contracts, grants and proposals.

If the section chief (or designee) is unavailable to perform these duties, the chief will assign someone to fulfill these duties, or if the chief is unable to make that assignment, the director will assign someone to fulfill these duties.

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

- Maintaining the RCO data polling station (i.e., Envista Air Resources Manager, or ARM), ensuring it polls hourly, minute and 5-minute data for each hour of every day as well as automated check data for each day;
- Acting as the data-acquisition system manager for the DAQ NCore monitoring program;
- Ensuring correct data are being transferred to the DAQ Internet-Based Enterprise Application Management, or IBEAM, database and DAQ real-time air quality data webpage;
- Participating in systems audits;
- Uploading environmental data to the EPA's Air Quality System, or AQS, and AirNow-Tech databases;
- Serving as the AQS administrator for DAQ;
- Maintaining and updating the RCO data polling software and AQS database when sites and monitors are established or shut down; and
- Completing other duties as assigned.

4.2.1 Projects and Procedures Branch

Projects and Procedures Branch Supervisor: The PPB Supervisor reports to the chief and directs the activities of the PPB staff. This supervisor's duties include the following:

- Directing and supervising the activities of the branch staff;
- Supporting and assisting the QAM in providing oversight of all QA activities;
- Communicating with the QAM to bring to the attention of the QAM QA matters needing attention;
- Verifying implementation of all AMS QAPPs and procedures;
- Assisting the chief with preparing the annual network plan and 5-year network assessment;
- Responding to public records requests and statistical consulting requests;
- Participating in systems audits;
- Ensuring training availability and utilization;
- Approving and implementing procedures; and
- Performing other duties as assigned.

Raleigh Central Office Chemists (level three reviewers): The RCO chemists, who are responsible for the level three review of the data, report to the PPB supervisor and are responsible for coordinating the activities of the DAQ NCore monitoring program. The duties of these RCO chemists include the following:

- Organizing the collection, certification and reporting of air monitoring data using DAQ's electronic logbooks, or e-logs, and correspondence with the RRO monitoring technicians and coordinator;
- Assessing the effectiveness of corrective actions taken in the NCore network to ensure they are appropriate and effective;
- Assisting the RRO and the ECB in prescribing corrective actions;
- Writing and ensuring timely and appropriate SOP and QAPP updates;
- Coordinating with the RRO and ECB staff on the writing, revising and maintaining of SOPs, including documenting annual SOP and QAPP reviews;
- Verifying and validating data by serving as the level 3 reviewer;
- Verifying that all required QA and quality control, or QA/QC, activities are performed and that measurement quality standards are met;
- As the level 3 data reviewer, maintaining QA/QC records, flagging suspect data and assessing and reporting on data quality;
- Participating in systems audits;
- Identifying data quality problems and initiating actions that result in solutions;
- Providing training and certification to appropriate personnel; and
- Performing other duties as assigned.

Raleigh Central Office LAB QA Chemist: The RCO LAB QA chemist reports to the PPB supervisor. This chemist works in conjunction with the particulate matter, or PM, laboratory and has the following responsibilities:

- Acting as the liaison to RTI Laboratories for PM media and analysis;

- Reviewing and recommending for approval all PM weigh lab QAPP and SOPs, ensuring timely and appropriate QAPP and SOP updates and verifying their implementation;
- As the Level 3 PM laboratory data reviewer, maintaining documentation, flagging suspect data and/or samples and validating laboratory data quality;
- As the Level 3 PM laboratory data reviewer, validating the weigh sessions data, ensuring the lab method has been followed appropriately;
- Validating the PM laboratory's Weights Original Excel spreadsheet;
- Maintaining oversight of all RTI PM gravimetric laboratory activities, including corrective actions and their effectiveness;
- Preparing data to be imported into IBEAM for final validation and data storage;
- Participating in systems audits;
- Providing training and certification to appropriate personnel;
- Identifying data quality problems and initiating actions that result in solutions;
- Performing other duties as assigned.

Raleigh Central Office Audit Chemist: The RCO audit chemist reports to the PPB supervisor and is responsible for assessing, auditing and evaluating the data collected for the DAQ NCore monitoring program. The RCO audit chemist's duties include the following:

- Assessing the effectiveness of the network system;
- Tracking SOP and QAPP annual reviews and updates;
- Verifying that all required QA/QC activities are performed, that measurement quality standards are met, and decisions are documented;
- Maintaining QA/QC records and assessing and reporting on data quality;
- Conducting quarterly completeness evaluations and audits of data quality;
- Planning and conducting data quality assessments, or DQAs, based on interpretation of data,
- Participating in systems audits;
- Identifying data quality problems and initiating actions that result in solutions;
- Providing training and certification to appropriate personnel; and
- Performing other duties as assigned.

Raleigh Central Office Internal Systems Auditor or Audit Team: The RCO chemist, or chemists, responsible for conducting the internal systems audit of the NCore monitoring program report(s) to the PPB supervisor. This person or team of people's duties include the following:

- Assessing the effectiveness of the network system;
- Verifying that all required QA/QC activities are performed and that measurement quality standards are met, and decisions are documented;
- Conducting internal systems audits;
- Identifying data quality problems and recommending corrective actions that result in solutions; and
- Determining whether the data meets 40 CFR requirements and can be used for NAAQS determinations.

RCO Statistician or Consultant: The statistician or consultant reports to the PPB supervisor and provides statistical programming support to the branch supervisor and other RCO, ECB and RRO staff, including:

- Assisting the branch supervisor with responding to consulting and data requests;
- Participating in training and certification programs to keep current on technology;
- Interpreting data;
- Developing each business day and maintaining statistical reports that include tabulations of yesterday's hourly raw data;
- Preparing statistical analysis and summaries of the data, including graphs, for QA and reporting;
- Participating in systems audits;
- Preparing and delivering data and statistical interpretation of the data to the regional offices and DAQ;
- Responding to public records requests and statistical consulting requests;
- Serving as a backup to the database manager;
- Uploading data to AQS; and
- Completing other duties as assigned.

4.2.2 Laboratory Analysis Branch

Laboratory Analysis Branch Supervisor: The LAB supervisor reports to the chief. This supervisor supervises the person doing the second level review of the PM laboratory data. This supervisor's duties include the following:

- Supervising the LAB staff and delegating responsibilities as appropriate;
- Preparing budgets, contracts, and proposals;
- Ordering supplies and consumables when needed;
- Participating in systems audits;
- Ensuring training availability and utilization for the DAQ LAB staff; and
- Other duties as assigned.

Laboratory Analysis Branch Staff: The LAB staff, also referred to as level 2 reviewer in Figure 4.1 and in this QAPP, reports to the LAB supervisor. The LAB staff's duties include the following:

- Acting as the PM raw data package liaison to RTI lab;
- Receiving raw data packages from the RTI Lab and performing Level 2 data verification procedures per the instructions and checklist found in Appendix E of this QAPP;
- Verifying that all required QA/QC activities are performed, and measurement quality standards are met;
- Maintaining QA/QC records and reviewing flags for suspect data;
- Assessing data quality and providing data quality reports to the level 3 reviewer;
- Participating in systems audits;
- Identifying data quality problems and initiating actions that result in solutions; and

- Performing other duties as assigned.

RTI International: RTI is the contract gravimetric lab for the intermittent filter based $PM_{2.5}$ sampling. The RTI lab duties include the following:

- Providing PM filter media to the RRO, gravimetric analysis, PM raw data packages, and data and filter archiving for the DAQ PM monitoring program;
- Serving as the Level 1 PM data reviewers for the raw gravimetric data;
- Preparing QAPPs and SOPs for the RTI laboratory, reviewing the QA documents annually, updating them at least every 5-years, and getting them approved by DAQ; and
- Implementing effective corrective action when the need arises and reporting that action and any data impacts to RTI management and DAQ.

4.2.3 Electronics and Calibration Branch

Electronics and Calibration Branch Supervisor: The ECB supervisor reports to and has direct access to the chief. This supervisor directs the activities of the ECB electronics technicians who maintain the infrastructure and equipment for ambient air monitoring. The ECB supervisor has the responsibility and authority to:

- Identify quality problems and initiate corrective action which results in solutions;
- Schedule and document internal performance evaluations and standard certifications;
- Review and approve QAPPs and SOPs;
- Supervise the ECB electronics technicians;
- Participate in systems audits;
- Act as the liaison to Airmetrics and Mesa Laboratories for calibrating and certifying all PM flow transfer standards (FTSs);
- Prepare budgets, contracts, proposals and purchase orders for equipment;
- Provide and document training and certification of field personnel; and
- Complete other tasks as assigned.

Electronics and Calibration Branch Electronics Technicians: The ECB electronics technicians report to the ECB supervisor and are responsible for the following:

- Installing and replacing all field equipment at the NCore monitoring site;
- Purchasing, maintaining and tracking an inventory of spare parts, spare equipment and consumable supplies to prevent unnecessary downtime;
- Calibrating, certifying and tracking all transfer standards or sending them to the vendor to be recertified;
- Returning “local primary standards” to the vendor or EPA for recertification and periodically checking the calibration of backup “local primary standards” to ensure quality calibrations;
- Ordering calibration gases and ensuring DAQ participation in the gas verification program operated by the EPA;
- Maintaining documentation on all transfer standard, “local primary standard” and calibration gas certifications;
- Conducting internal performance evaluations on all gaseous monitors;

- Assisting in prescribing corrective actions;
- Participating in systems audits;
- Recommending changes, when needed, in the QA/QC program;
- Performing and documenting all major maintenance and repair of field equipment as described by SOPs DAQ-08-002.1, DAQ-10-001.1, DAQ-07-003.1, 2.24.1, DAQ-12-001.1, 2.36.1, 2.38.1, 2.44.1 and 2.45.1; and
- Completing other tasks as assigned.

Airmetrics: Airmetrics, or an equivalent vendor, provides the calibration and verification services for all the FTS orifices used in the PM monitoring program. When used, Airmetrics communicates with the ECB Supervisor.

Mesa Laboratories: Mesa Laboratories, or an equivalent vendor, provides the calibration and verification services for all the FTS Tetra-Cals used in the PM monitoring program. When used, Mesa Laboratories communicates with the ECB Supervisor.

4.3. Raleigh Regional Office

Raleigh Regional Office Air Quality Supervisor: The RRO air quality supervisor reports to the director and has direct access to the chief and director on all matters relating to the DAQ ambient air monitoring operation. The RRO supervisor's duties include:

- Assuring division policies are maintained at the regional office level;
- Acquiring needed RRO monitoring resources;
- Verifying implementation of quality programs;
- Recommending changes when needed in the QA/QC program;
- Providing regional input for the design of the monitoring network;
- Reviewing and approving the network plan as far as it affects the region;
- Supervising and delineating duties for the RRO monitoring coordinator and technicians; and
- Completing other duties as assigned.

RRO Ambient Monitoring Coordinator: The RRO ambient monitoring coordinator, also referred to as the monitoring coordinator or coordinator in this QAPP, reports directly to the RRO air quality supervisor. The coordinator has the overall responsibility of ensuring the implementation of the QA/QC program at the regional level. The coordinator coordinates the activities of the RRO monitoring technicians. The coordinator's responsibilities include:

- Coordinating and reviewing the collection of environmental data;
- Implementing the DAQ QA/QC program within the region;
- Acting as a conduit for information to the RRO monitoring technicians;
- Training other regional monitoring coordinators and regional monitoring technicians in the requirements of the QAPP and SOPs;
- Providing a backup to the RRO monitoring technicians;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Providing regional input on the design and documentation of the monitoring network;
- Performing level 2 data verification activities and flagging suspect data;

- Reviewing electronic logbooks, or e-logs, other documentation and the work of the monitoring technicians to ensure they follow the QAPP and associated SOPs;
- Overseeing transfer standard certifications to ensure equipment is returned for recertification before expiration and that all certification documents are appropriately filed and archived;
- Documenting and assessing corrective actions to ensure they are appropriate and effective; and
- Completing other tasks as assigned.

RRO Monitoring Technicians: The RRO monitoring technicians also referred to as site operators or operators in this QAPP report directly to the RRO air quality supervisor and work under the direction of the RRO monitoring coordinator to ensure DAQ meets all monitoring requirements. The RRO monitoring technician's duties include:

- Performing all required QC activities and ensuring that measurement quality objectives, or MQOs are met as prescribed in the QAPP and SOPs;
- Performing corrective actions to address any activities that do not meet the acceptance criteria as prescribed in the QAPP and SOPs;
- Ensuring that monitoring programs implement the QA/QC elements of SOPs and QAPPs;
- Participating in and providing hands-on training as needed of new regional coordinators, monitoring technicians and RCO chemists in the requirements of the SOPs;
- Calibrating and verifying the gaseous monitoring equipment;
- Calibrating, performing verifications and auditing PM monitoring equipment;
- Operating and completing routine maintenance on all monitoring equipment;
- Performing preventative maintenance and small repairs on PM monitoring equipment;
- Sending all PM FTSs to ECB for calibration and certification, and for checking calibration of primary standards to ensure quality calibrations;
- Ensuring all transfer standards used are within their expiration dates;
- Collecting, preserving and transporting samples from intermittent filter-based monitors;
- Maintaining a supply of expendable monitoring items;
- Participating in training and certification activities;
- Documenting deviations from established procedures and methods;
- Reporting nonconforming conditions and corrective actions to the regional coordinator and the regional supervisor;
- Performing level 1 data verification activities and flagging suspect data;
- Conducting 40 CFR Part 58, Appendix E siting criteria evaluations annually as part of the annual network review process;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Preparing corrective action reports, when needed, for the AMS; and
- Completing other tasks as assigned.

4.4 Department of Information Technology

The DIT provides security for the ambient monitoring computers. They manage, in cooperation with the RRO monitoring and ECB electronics technicians and database manager, the computers located at the monitoring site as well as the primary server that houses the Envista ARM database. Their responsibilities include ensuring the security of the computers and network, updating of the operating system and other standard software on the computer and ensuring that the RRO monitoring and ECB electronics technicians maintain adequate access to the computers to perform all necessary monitoring functions.

4.5 United States Environmental Protection Agency, Region 4

The DAQ will operate the NCore monitors as State and Local Air Monitoring Station, or SLAMS, monitors following the procedures in 40 CFR Part 58. As a result, the chief will include information on these monitors in the annual network-monitoring plan and the five-year network assessment and the EPA Region 4 Air and Radiation Division (ARD) director, or his or her designee, will review, comment on and respond to the network plan each year. Likewise, the chief will include the data from these monitors in the annual certification request and the EPA Region 4 ARD director, or his or her designee, will review and apply concurrence codes in AQS in response to DAQ's data certification request. The chief will also submit a QAPP to the EPA Region 4 Laboratory Services and Applied Science Division, or LSASD, for EPA approval. The EPA Region 4 LSASD will include the regulatory (except PM_{10}) NCore monitors in the Performance Evaluation Program (PEP) and National Performance Audit Program (NPAP).

5.0 Problem Definition and Background

The enactment of the Clean Air Act (CAA) of 1970 resulted in a major shift in the federal government's role in air pollution control. This legislation authorized the development of comprehensive federal and state regulations to limit emissions from both stationary or industrial sources and mobile sources. It also established the NAAQS. The CAA and its amendments provide the framework for protecting air quality. To protect air quality, active environmental data collection operations were established and operated in a manner that assures the collection of the most applicable and highest quality data.

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, the EPA and states typically use data from ambient air monitors to characterize air concentrations for identification of areas that either meet or violate a particular pollutant standard. The EPA typically designates monitors used for comparisons against a NAAQS as SLAMS monitors, which must meet the requirements stipulated in 40 CFR Parts 50, 53 and 58. For most of the criteria pollutants, comparison against the NAAQS requires three years of valid, quality-assured data.

Ambient air quality monitoring programs monitor criteria pollutants (PM [particles with an average aerodynamic diameter of 10 micrometers (PM_{10}) or less ($PM_{2.5}$)], sulfur dioxide [SO_2], carbon monoxide [CO], nitrogen dioxide [NO_2], ozone [O_3], and lead [Pb]). Table 5.1 shows the NAAQS limits, defined in 40 CFR Part 50, for the six criteria pollutants.

Table 5.1. National Ambient Air Quality Standards

Pollutant	Averaging Time	Standard Value [a]	Standard Type	Form
Carbon Monoxide (CO)	8-hour average	9 ppm [b] (10 mg/m^3) [c]	Primary	Not to be exceeded more than once per year
	1-hour average	35 ppm (40 mg/m^3)	Primary	
Nitrogen Dioxide (NO_2)	1-hour average	100 ppb [d]	Primary	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	One Year Mean	0.053 ppm (100 $\mu g/m^3$) [e]	Primary and Secondary	Annual Mean
Ozone (O_3)	8-hour average	0.070 ppm (205 $\mu g/m^3$)	Primary and Secondary	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Lead (Pb)	Rolling 3-month average	0.15 $\mu g/m^3$	Primary and Secondary	Not to be exceeded

Table 5.1. National Ambient Air Quality Standards

Pollutant	Averaging Time	Standard Value [a]	Standard Type	Form
Particulate Matter (PM_{10}) Particulates with diameters of 10 micrometers or less	24-hour Average	150 µg/m^3	Primary and Secondary	Not to be exceeded more than once per year on average over 3 years
Particulate Matter ($PM_{2.5}$) Particulates with diameters of 2.5 micrometers or less	One Year Mean	12 µg/m^3	Primary	Annual mean, averaged over 3 years
		15 µg/m^3	Secondary	Annual mean, averaged over 3 years
	24-hour Average	35 µg/m^3	Primary and Secondary	98th percentile, averaged over 3 years
Sulfur Dioxide (SO_2)	1-hour Average	75 ppb (196 µg/m^3)	Primary	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	3-hour Average	0.50 ppm (1300 µg/m^3)	Secondary	Not to be exceeded more than once per year

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

In 2005, the U.S. EPA implemented the National Ambient Air Monitoring Strategy (NAAMS). The goal of the NAAMS was to include improvement of the scientific and technical competency of the nation's air monitoring networks and increase the value in protecting public health and the environment. While the EPA had largely solved the obvious problems of widespread elevated concentrations for some of the criteria pollutants, problems related to PM, O_3, and toxic air pollutants remained. As emissions reductions were realized and concentrations shifted downward, high sensitivity monitors in urban areas would support the detection of trends. It is now clear that even very low air pollution levels can be associated with adverse environmental and human health effects. As a result, the EPA recognized the need for new approaches in air monitoring to measure these low levels and to incorporate these measurements with other data into comprehensive assessments of human and environmental health.

One of the major areas of investment in the NAAMS was the use of highly sensitive commercial air pollutant monitors for the characterization of the precursor gases CO, SO_2 and total reactive oxides of nitrogen (NO_y) in a new national-core monitoring network (NCore). The EPA designed NCore to meet several important data needs:

- Improved flow and timely reporting of data to the public, including supporting air quality forecasting and information systems such as AirNow;
- Continued determination of NAAQS compliance;
- Improved development of emissions control strategies;
- Enhanced accountability for the effectiveness of emission control programs; and
- More complete information for scientific, public health, and ecosystem assessments.

The overarching objective of the high-sensitivity precursor gas monitoring in NCore is to determine pollutant concentrations in well-mixed representative rural and urban atmospheres. The high sensitivity CO and SO_2 analyzers are fundamentally the same as those designated as Federal Reference Methods (FRMs) and Federal Equivalent Methods (FEMs) (https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants) but with modifications to improve sensitivity and accuracy or reduce interferences. The EPA requires the use of NO_y monitors at these sites to collect data on total reactive nitrogen species for understanding O_3 photochemistry. The NO_y measurements will produce conservative estimates for NO_2 that EPA can use to ensure and track continued compliance with the NO_2 NAAQS. The use of such precursor gas analyzers in the NCore network will still allow determination of compliance with the NAAQS but will provide measurements at much lower detection limits than are achievable by traditional monitors. The ability to accurately measure low concentrations will support long-term epidemiological studies, reduce uncertainties in data for modeling of air pollution episodes, and support source apportionment and observational analyses.

On October 17, 2006, as published in the Federal Register, the EPA provided final rule revisions to ambient monitoring regulations as contained in 40 CFR Parts 53 and 58. Included in these revised rules were the requirements for establishing NCore sites. NCore is a multipollutant network that integrates several advanced measurement systems for particles, pollutant gases and meteorology.

In 2009, the DAQ received approval from the U.S. EPA to establish the NCore station at the East Millbrook Middle School (Millbrook) site location. The Millbrook site, operated by DAQ since 1989, is an urban NCore site. Along with the NCore site operated by the Mecklenburg County, North Carolina air monitoring organization, the Millbrook NCore site meets the monitoring requirements in 40 CFR Part 58, Appendix D, Section 3 (a) for the State of North Carolina.

Each state was required to operate at least one NCore site beginning January 1, 2011. The NCore sites must measure, at a minimum:

- Mass of particles with an average aerodynamic diameter of 2.5 micrometers or less, or $PM_{2.5}$ particle mass, using continuous and integrated/filter-based samplers;
- speciated $PM_{2.5}$;
- Mass of coarse particles with an average aerodynamic diameter between 2.5 and 10 microns or $PM_{10\text{-}2.5}$ particle mass;
- sulfur dioxide, or SO_2;
- carbon monoxide, or CO;
- nitric oxide, or NO;
- reactive oxides of nitrogen, or NO_y;
- ozone, or O_3; and

- Surface meteorology including wind speed and wind direction as resultant, relative humidity (RH) and ambient temperature (AT).

The carbon and $PM_{2.5}$ speciation monitors are not covered under this QAPP but the EPA Chemical Speciation Network, or CSN, QAPP, modified as necessary to meet the DAQ program requirements. The DAQ is currently reviewing and modifying the EPA CSN QAPP and will submit the revised EPA CSN QAPP at some point in the future. Although non-source Pb monitoring was required at the DAQ NCore site due to the EPA's December 2010 revisions to 40 CFR Part 58, the EPA discontinued Pb monitoring in April 2016 due to the EPA's March 2016 revisions to 40 CFR Part 58.

In 2010, the EPA changed the NO_2 primary NAAQS from an annual to an hourly standard of 100 parts per billion. At this time, the EPA also established a new NO_2 monitoring network to support the new standard. The 2010 NO_2 network required area wide monitors or monitoring stations in each core based statistical area, or CBSA, with a population of 1,000,000 or more persons to monitor a location of expected highest NO_2 concentrations representing the neighborhood or larger spatial scales. The Raleigh CBSA has over 1,000,000 persons and is required to have an area wide site. To meet this requirement, the DAQ began operating a NO_2 monitor at the Millbrook site on Dec. 10, 2013.

On October 1, 2015, the EPA revised the photochemical air monitoring station, or PAMS, program to require all NCore sites in metropolitan statistical areas with one million or more people to measure speciated hydrocarbon compounds, carbonyl compounds, true NO_2 and additional meteorological parameters. As a result, DAQ replaced the photolytic NO_2 monitor at Millbrook with a CAPS monitor and added an auto-gas chromatograph to measure speciated hydrocarbons and a ceilometer to measure mixing layer height. Other than the CAPS monitor, the other PAMS equipment is covered in the PAMS QAPP DAQ-01-007. This QAPP has been updated to include information on the CAPS monitor.

The EPA regulations require that agencies plan, document and have an approved QAPP for all projects involving the generation, acquisition and use of environmental data. The QAPP is the critical planning document for any environmental data collection operation because it documents how the agency will implement QA and QC activities during the project's life cycle. Adherence to the requirements set forth in this QAPP will ensure consistent, repeatable results and improve the reliability and comparability of all data collected.

The State of North Carolina developed the NCore QAPP in 2010 to be a road map for implementing QA and QC policies and procedures in general and the procedures for NCore. The DAQ reviews the QAPP and the associated SOPs annually, revising them as needed, but at least every 5-years, subject to approval by the EPA's Region 4 QA Officer. An RCO chemist will document the annual review of the QAPP in the DAQ document tracker database. Grant commitments also require that annual QAPP reviews be recorded in email correspondence to EPA Region 4. QAPP revisions are subject to the approval of EPA's Region 4 QA staff.

The QAPP incorporates the procedures DAQ follows for NCore, which the DAQ is currently revising to make the same as what DAQ follows for all air monitoring projects. DAQ's NCore program will adhere to the principles and procedures herein, unless a special project has requirements that are more stringent. If any special project has requirements that are more stringent, the chief will revise the QAPP or, depending on the purpose and scope of the project,

will develop a separate QAPP to address the requirements of the special project. Additional details and technical specifications are set forth in separate SOPs used by DAQ for each aspect of the monitoring program (see Table 11.2).

This QAPP should be particularly beneficial to the RRO monitoring technicians and coordinator, ECB electronics technicians, RCO chemists, LAB technician and chemist and supervisors responsible for implementing, designing and coordinating the NCore monitoring project. The QAPP is a compilation of QA requirements, procedures and guidelines applicable to air pollution measurement systems. The EPA and DAQ designed these requirements, procedures and guidelines to ensure DAQ achieves a high percentage of valid data samples (>75 percent) while maintaining the integrity and accuracy of the data. This QAPP clearly and thoroughly establishes QA protocols and QC criteria required to successfully implement and maintain the NCore Monitoring program. The SOPs DAQ uses set forth additional details and technical specifications for each aspect of the program, such as instrument operations (see Table 11.2). The chief is responsible to ensure that the RRO monitoring technicians and coordinator, ECB electronics technicians and RCO chemists implement and adhere to the QA programs for the field and data processing phases of this monitoring program.

Table 5.2 lists the monitors in the NCore Monitoring program. All monitors are located at the Millbrook monitoring station in Raleigh, North Carolina. On June 1, 2021, DAQ replaced the photolytic NO_2 monitor with a CAPS monitor. Consult the most recent DAQ Annual Network Plan for the most current information.

Table 5.2 North Carolina NCore Ambient Air Quality Monitors

NCore Pollutant or Meteorological Data Collected	Air Quality System Monitor Identification Number	Location	Regional Operator
Trace-level carbon monoxide	37-183-0014-42101-2	Millbrook, Raleigh, NC	RRO
Trace-level sulfur dioxide	37-183-0014-42401-2	Millbrook, Raleigh, NC	RRO
Hourly 5-minute maximum trace-level sulfur dioxide data	37-183-0014-42406-2	Millbrook, Raleigh, NC	RRO
Trace-level reactive oxides of nitrogen	37-183-0014-42600-2	Millbrook, Raleigh, NC	RRO
Trace-level nitric oxide	37-183-0014-42601-2	Millbrook, Raleigh, NC	RRO
Nitrogen dioxide	37-183-0014-42602-2	Millbrook, Raleigh, NC	RRO
Ozone	37-183-0014-44201-1	Millbrook, Raleigh, NC	RRO
Resultant wind speed	37-183-0014-61103-1	Millbrook, Raleigh, NC	RRO
Resultant wind direction	37-183-0014-61104-1	Millbrook, Raleigh, NC	RRO
Standard deviation horizontal wind direction	37-183-0014-61106-1	Millbrook, Raleigh, NC	RRO
Outdoor temperature-10 meters	37-183-0014-62101-1	Millbrook, Raleigh, NC	RRO
Outdoor temperature-2 meters	37-183-0014-62101-2	Millbrook, Raleigh, NC	RRO
Temperature difference	37-183-0014-62106-1	Millbrook, Raleigh, NC	RRO
Indoor temperature NCore	37-183-0014-62107-1	Millbrook, Raleigh, NC	RRO

Table 5.2 North Carolina NCore Ambient Air Quality Monitors

NCore Pollutant or Meteorological Data Collected	Air Quality System Monitor Identification Number	Location	Regional Operator
Relative humidity	37-183-0014-62201-1	Millbrook, Raleigh, NC	RRO
Solar radiation	37-183-0014-63301-1	Millbrook, Raleigh, NC	RRO
Rain/melt precipitation	37-183-0014-65102-1	Millbrook, Raleigh, NC	RRO
Ambient average temperature	37-183-0014-68105-1	Millbrook, Raleigh, NC	RRO
Sample average barometric pressure	37-183-0014-68108-1	Millbrook, Raleigh, NC	RRO
PM_{10} Total 0-10um STP	37-183-0014-81102-3 37-183-0014-81102-5	Millbrook, Raleigh, NC	RRO
PM_{10} – Local Conditions	37-183-0014-85101-3 37-183-0014-85101-5	Millbrook, Raleigh, NC	RRO
$PM_{10-2.5}$ - Local Conditions	37-183-0014-86101-3 37-183-0014-86101-5	Millbrook, Raleigh, NC	RRO
$PM_{2.5}$ - Local Conditions	37-183-0014-88101-3 37-183-0014-88101-5	Millbrook, Raleigh, NC	RRO
$PM_{2.5}$ - Local Conditions – Chemical Speciation Network Ions	37-183-0014-88301-5 37-183-0014-88302-5 37-183-0014-88303-5 37-183-0014-88306-5 37-183-0014-88403-5	Millbrook, Raleigh, NC	RRO
$PM_{2.5}$ - Local Conditions – Chemical Speciation Network Organic and Elemental Carbon	37-183-0014-88355-5 37-183-0014-88357-5 37-183-0014-88370-5 37-183-0014-88374-5 37-183-0014-88375-5 37-183-0014-88376-5 37-183-0014-88377-5 37-183-0014-88378-5 37-183-0014-88380-5	Millbrook, Raleigh, NC	RRO

Table 5.2 North Carolina NCore Ambient Air Quality Monitors

NCore Pollutant or Meteorological Data Collected	Air Quality System Monitor Identification Number	Location	Regional Operator
$PM_{2.5}$ - Local Conditions – Chemical Speciation Network Trace Elements	37-183-0014-88102-5 37-183-0014-88104-5 37-183-0014-88107-5 37-183-0014-88109-5 37-183-0014-88110-5 37-183-0014-88111-5 37-183-0014-88112-5 37-183-0014-88113-5 37-183-0014-88114-5 37-183-0014-88115-5 37-183-0014-88117-5 37-183-0014-88118-5 37-183-0014-88126-5 37-183-0014-88128-5 37-183-0014-88131-5 37-183-0014-88132-5 37-183-0014-88140-5 37-183-0014-88152-5 37-183-0014-88154-5 37-183-0014-88160-5 37-183-0014-88161-5 37-183-0014-88165-5 37-183-0014-88166-5 37-183-0014-88167-5 37-183-0014-88168-5 37-183-0014-88169-5 37-183-0014-88176-5 37-183-0014-88180-5 37-183-0014-88184-5 37-183-0014-88185-5	Millbrook, Raleigh, NC	RRO

This version of the QAPP is the second revision to the first revision of the document, conditionally approved by EPA on February 5, 2021. A copy of the conditionally approved first revision as well as the original QAPP are retained in Laserfiche. The original NCore QAPP was submitted to the EPA for approval on October 12, 2010.

6.0 Project/Task Description

The chief developed this QAPP to ensure that DAQ's NCore air monitoring network collects ambient pollutant and meteorological data that meet or exceed EPA QA requirements as listed in 40 CFR 58.12 and 58.16, 40 CFR Part 58, Appendix A (collocation) and Appendix C, Section 2.1 (use of FRMs and FEMs). The EPA and DAQ use the criteria pollutant data collected by DAQ for regulatory decision-making purposes (i.e., determining compliance with the NAAQS). The DAQ enters all these data into the EPA AQS database.

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 public in a timely manner; support compliance with ambient air quality standards and emissions strategy development; and support for air pollution research studies. Section 10.1 of this QAPP provides additional objectives for the NCore network. DAQ designed its NCore air-monitoring network to support these objectives as well as the following specific goals:

- Determining concentrations in well-mixed representative rural and urban atmospheres through high sensitivity precursor gas monitoring.
- Developing a representative report on air quality across the nation, capable of delineating differences among geographic and climatological regions.
- Providing multi-pollutant monitoring data, which researchers can use in health studies, air quality models and source attribution methods to separate confounding effects, particularly in the face of varying ambient concentrations and PM composition.
- Determining representative concentrations in areas with high population density and\or heavily congested areas.
- Determining the general background concentration levels.
- Determining the extent of regional pollutant transport among populated areas and in support of secondary standards.

At a minimum, NCore sites must measure:

- Ozone [O_3];
- Trace-level sulfur dioxide [SO_2], carbon monoxide [CO] and total reactive oxides of nitrogen [NO_y];
- Meteorological parameters: wind speed, wind direction, RH, and AT; and
- Particle Matter: Speciated $PM_{2.5}$, $PM_{2.5}$ particle mass using continuous and integrated/filter-based samplers and $PM_{10-2.5}$ particle mass.

Note: O_3, PM, SO_2 and CO (not related to the NCore network) monitoring are addressed in separate QAPPs. See Table 5.2 for a list of monitors at the NCore site.

The DAQ will report data to AQS in accordance with the requirements stated in 40 CFR 58.16. DAQ's NCore monitoring network will operate and collect data in accordance with the schedules codified in 40 CFR 58.12. When available, the DAQ will collect ambient air monitoring concentration data using monitors designated as FRM or FEM, in accordance with 40 CFR Part

58, Appendix C, Section 2.1. The types of data collected by DAQ's NCore monitoring network will include:

• Continuous (near real-time) hourly-averaged PM, ozone, NO_2, SO_2 and CO concentration data collected by FRMs or FEMs;

• Continuous (near real-time) hourly maximum five-minute averaged SO_2 concentration data collected by FRMs or FEMs;

• Continuous (near real-time) hourly-averaged NO/NO_y concentration data collected by non-FRM/FEM chemiluminescence analyzers;

• 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 these data includes, but is not limited to:

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

Towards this end, DAQ work products also include a series of assessments and reports to ensure the network and resulting data continuously meet or exceed regulatory requirements as specified in 40 CFR Sections 58.12 and 58.16. The DAQ also maintains this QAPP and the associated SOPs reviewing them every year and revising them as needed, but at least once every five years, to ensure they continuously reflect the requirements of DAQ and the EPA.

6.1 Field Activities

DAQ personnel will perform those activities that support continued successful operation of the NCore ambient air-quality monitoring network. Personnel will perform field activities that

include, but are not necessarily limited to, conducting calibrations, routine QC checks and semi-annual flow verifications, performing periodic preventative maintenance and servicing equipment located at the SLAMS (NCore) site located at East Millbrook Middle School, in Raleigh, North Carolina. Operational servicing activities may include, but may not be limited to, collecting samples, recording pertinent field data and restocking consumables, such as particulate filters and calibration gases, at the monitoring sites. Additional field activities include relocating sites and/or locating suitable monitoring sites for possible expansion of the network. Section 4.3 (Regional Offices) provides a more complete description of the field activities that regional monitoring technicians may perform to support the NCore monitoring program. The ECB electronics technicians also conduct performance evaluations on the deployed gaseous monitors.

6.2 ECB Activities

The ECB electronics technicians will perform those activities necessary to support the successful operation of the NCore monitoring network. They will perform electronic laboratory activities consistent with certifying, calibrating and testing all equipment before installing it in the field. In addition, ECB electronics technicians will perform any functions necessary to support the deployed field equipment. The ECB electronics technicians also complete performance evaluations on the deployed gaseous monitors every calendar year. Section 4.2.2 Electronics and Calibration Branch provides a more complete description of the activities the ECB electronics technicians may perform in support of this program.

6.3 Laboratory Activities

The DAQ LAB staff, in conjunction with the RTI Lab, will perform those activities that support a successful operation of the intermittent filter based $PM_{2.5}$ monitoring network. Additionally, where analysis of samples is required, the RTI lab staff shall perform those duties such that the data quality provided meets or exceeds EPA QA requirements. The RTI lab staff shall be responsible for preparing sequential filters for field use. This may include, but not be limited to:

- Scheduling, preparing, weighing, shipping and receiving, and archiving filters for PM sampling;
- Preparing and analyzing control samples (e.g., trip filter blanks and exposure lot blanks);
- Maintaining consumable inventories;
- Maintaining COC records;
- Conducting microbalance daily weight checks, quarterly weight checks and semi-annual weight checks; and
- Maintaining temperature and humidity data records necessary to determine weigh room conditioning compliance per EPA Method 2.12, Section 4.3.8.

The DAQ LAB staff will perform level 2 data review for the RTI gravimetric data package and participate in systems audits. The RCO LAB QA Chemist will work as the liaison to the RTI lab staff, perform level 3 data review for the RTI gravimetric data package and participate in systems audits.

6.4 Project Assessment Techniques

An assessment is an evaluation process used to measure the performance or effectiveness of a system and its elements. As used here “assessment” is an all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection or surveillance. Section

20.0 Assessments and Response Actions discusses the details of assessments. Table 6.1 provides information on the parties implementing assessments and their frequencies.

Table 6.1 Assessment Schedule

Assessment Type	Assessment Agency	Frequency
EPA Technical systems audit	EPA Region 4	Every 3 years
Internal systems audit	State	Every 3 years
Technical systems audit of RTI	State	Annually
Network assessment	EPA Region 4 State	Every 5 years
Network review (40 CFR Part 58, Appendix A, D and E evaluations)	EPA Region 4 State	Annually
Network plan	EPA Region 4 State	Annually
Quarterly data completeness	State	Quarterly
Annual data certification	State	Annually
Quality assurance project plan review and updates	State	Review annually Update as needed and at least every 5 years
Standard operating procedures reviews	State	Annually
Data quality assessment	State	AMP256 and AMP600 review quarterly and annually Control chart review daily and monthly
$PM_{2.5}$ performance evaluation program	EPA-designated contractor	8 valid audits per year for PQAO/each PQAO primary monitor audited every 6 years
$PM_{10-2.5}$ performance evaluation program	EPA-designated contractor	As needed
National performance audit program	EPA-designated contractor	20 percent of PQAO sites per year/each PQAO site once every six years
Annual performance evaluations for gaseous monitors	State	At least once per calendar year
Semi-annual flow rate audit for particle monitors	State	At least once every 6 months, preferably every quarter

6.5 Project Records

DAQ will establish and maintain procedures for the timely preparation, review, approval, issuance, use, control, revision and maintenance of documents and records. Table 6.2 presents the categories and types of records and documents that are applicable to document control for ambient air quality information. Section 9.0 Documentation and Records explains information on key documents in each category in more detail.

Table 6.2 Critical Documents and Records

Categories	Record/Document Type
Site information	Network descriptions Site files Site maps Site pictures
Environmental data operations	Quality assurance project plans Standard operating procedures Field and laboratory notebooks and logbooks Sample handling/custody records Inspection and maintenance records Lab records and data packages
Raw data	Any original data (routine and QC) including data entry forms Sequential PM Field Data Downloads Original Continuous PM Data (Manual Downloads) Polled Continuous PM Data RTI PM Laboratory Raw Weigh and Environmental Data
Data reporting	Air quality index reports Annual data certification Data/summary reports
Data management	Data algorithms Data management plans and flowcharts Data management systems
Quality assurance	Network reviews and assessments Control charts Data quality assessments Quality assurance reports (such as the AMP256 and AMP600) EPA Technical system audit reports Internal systems audit reports Response/corrective action documentation Annual performance evaluation reports NPAP reports Certification documentation Emails related to QA activities and assessments

7.0 Quality Objectives and Criteria for Measurement Data

The DAQ operates under an EPA-approved QMP that describes the agency's system for communicating and implementing quality within the agency.

A quality system is a structured and documented set of management activities in which an organization applies sufficient QC practices to ensure 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 DAQ obtains and maintains acceptability 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 DAQ is to implement a QA program to assure DAQ collects data of known and acceptable precision, bias, sensitivity, completeness, comparability and representativeness within its ambient air quality monitoring program.

The EPA and DAQ use precision, bias, sensitivity, completeness, comparability and representativeness as the primary data quality indicators, or DQIs, that provide qualitative and quantitative descriptions used in interpreting the degree of acceptability of data. Section 7.2 Measurement Quality Objectives defines these DQIs. Establishing acceptance criteria for these DQIs sets quantitative goals for the quality of data generated in the measurement process. Of the six principal DQIs, precision, sensitivity and bias are the quantitative measures, representativeness and comparability are qualitative measures and completeness is a combination of both qualitative and quantitative measures (US EPA QA/G-5, Appendix B[1]). The DAQ establishes the specific requirements of these six DQIs before data collection starts. The goal is to locate and eliminate (or minimize) bias, so the data collected show the true conditions of the area studied. This includes consideration of siting criteria, spatial scales, monitoring objectives, climatic change, source configurations and the duration of the study.

All individuals must adhere to the written procedures and methods in the QAPP and associated SOPs (see Table 11.2) for operating air monitoring instruments and handling data to assure quality data for purposes of DAQ's air quality designations concerning attainment of the NAAQS. EPA-approved FRMs are the designated methodologies and basis for operating pollutant-monitoring equipment, although DAQ may use FEMs as well. However, the NO_y monitor is not a designated FRM or FEM.

7.1 Data Quality Objectives

This section provides a description of the data quality objectives, or DQOs, for the NCore ambient air-quality monitoring program for the DAQ. The DQOs are qualitative and quantitative statements that:

- Clarify the intended use of the data;
- Define the type of data needed; and
- Specify the tolerable limits on the probability of making an erroneous decision due to uncertainty in the data.

[1] https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf

7.1.1 Intended Use of Data

The EPA and DAQ will use these data to:

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

7.1.2 Type of Data Needed

The EPA and DAQ determine the type of data needed by its intended use. Because the EPA and DAQ primarily use the DAQ monitoring data for comparison to the NAAQS, the DAQ must collect data so that it meets 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 DAQ is a combination of criteria pollutant, non-criteria pollutant and meteorological data including:

- Trace-level carbon monoxide (CO),
- Nitrogen dioxide (NO_2),
- Trace-level nitric oxide (NO),
- Trace-level total reactive oxides of nitrogen (NO_y),
- Ozone (O_3),
- Particulate matter ($PM_{2.5}$, low-volume PM_{10}, $PM_{10-2.5}$, chemical speciation),
- Trace-level sulfur dioxide (SO_2) and
- Meteorological data (AT, RH, wind direction, wind speed, solar radiation (SR), and precipitation).

Title 40 CFR 58.16 specifies the data reporting requirements that DAQ will follow, and the appendices to 40 CFR Part 50 explain the data handling conventions and computations necessary for determining whether each criteria pollutant met the NAAQS. The DAQ will measure the following pollutant concentrations and monitor the following meteorological parameters as required by EPA:

- 24-hour averaged concentration data for intermittent filter-based $PM_{2.5}$ collected by FRMs or FEMs in the field and subsequently analyzed at the RTI gravimetric laboratory using the appropriate analytical method;
- 24-hour averaged concentration data for intermittent filter-based speciated $PM_{2.5}$ collected by samplers in the field that are not FRMs or FEMs and subsequently analyzed at the EPA contract laboratory using the appropriate analytical method;
- Continuously hourly-averaged concentration data for O_3, NO_2, CO, SO_2, $PM_{2.5}$, PM_{10} (both local and standard conditions) and $PM_{10-2.5}$ collected by FRMs and FEMs;

- Hourly five-minute averaged maximum concentration data for SO_2 collected by FRMs or FEMs
- Continuous hourly-averaged NO_y (including NO) pollutant concentration data collected by the NOy analyzer which is not a FRM or FEM;
- Continuous shelter temperature measurements for ensuring conformity to environmental requirements for the gaseous and continuous PM monitors;
- Precision measurements;
- Bias measurements;
- Site and monitoring metadata for AQS;
- Locational measurements (geographical, topographical, etc.);
- Continuously averaged hourly data for wind speed and direction (reported as resultant), RH, AT, SR and rain/melt precipitation measured by meteorological equipment; and
- Minute data for the gaseous pollutants and meteorological sensors.

The appendices to 40 CFR Part 50 explain the data reporting and handling conventions for the individual pollutant parameters. 40 CFR Part 50, Appendix T explains the data reporting and handling conventions for SO_2. DAQ will adhere to those reporting conventions.

Section 10.0 Network Description presents specific information on the sampling design, including how to identify the monitoring location.

7.1.3 Tolerable Error Limits

The DQO process defines tolerable limits on the probability of making a wrong decision because of uncertainty in the data (that is, limits on the probability of coming up with a false positive or a false negative error). A decision maker encounters a false positive error when the data indicate a monitor exceeded the NAAQS when in fact, due to random deviations in the data, the monitor did not exceed it. Alternately, a decision maker encounters a false negative error when the data indicate the monitor did not exceed a NAAQS when in fact, due to random deviations in the data, the monitor did exceed the NAAQS. Using the formal DQO process EPA determined the objectives to control precision and bias to reduce the probability of decision errors. The regulations at 40 CFR Part 58, Appendix A, Section 2.3.1 provide the DQOs. The EPA has not completed a formal DQO process for CO or PM_{10}; however, the EPA has provided DQOs for these parameters in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II (QA Handbook). The NCore monitoring program has established the acceptable precision, as measured by coefficient of variation, or CV, and acceptable bias for each pollutant as listed in Table 7.1.

Table 7.1 Acceptable Precision as Measured by Coefficient of Variation (CV) and Bias for the Ambient Air-Quality Monitoring Program

Pollutant	Acceptable Precision	Acceptable Bias
$PM_{2.5}$/ PM_{10}	upper 90 percent confidence limit of ≤10 percent CV	Within ±10 percent
O_3	upper 90 percent confidence limit for the CV of ≤7 percent	upper 95 percent confidence limit for the absolute bias of ≤7 percent
$PM_{10-2.5}$	upper 90 percent confidence limit for the CV of ≤10 percent	upper 95 percent confidence limit for the absolute bias of ≤10 percent

Table 7.1 Acceptable Precision as Measured by Coefficient of Variation (CV) and Bias for the Ambient Air-Quality Monitoring Program

Pollutant	Acceptable Precision	Acceptable Bias
NO_y	upper 90 percent confidence limit for the CV of ≤15 percent	upper 95 percent confidence limit for the absolute bias of ≤15 percent
SO_2	upper 90 percent confidence limit for the CV of ≤10 percent	upper 95 percent confidence limit for the absolute bias of ≤10 percent
NO_2	upper 90 percent confidence limit for the CV of ≤15 percent	Upper 95 percent confidence limit for the absolute bias of ≤15 percent
CO	Upper 90 percent confidence limit for the CV of ≤ 10 percent	Upper 95 percent confidence limit ≤ ±10 percent
All others	≤15 percent CV	Within ±20 percent

The DAQ calculates CV and absolute bias using the procedures in 40 CFR Part 58, Appendix A, Section 4.

7.2 Measurement Quality Objectives

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

Once a DQO is established, the DAQ evaluates and controls the quality of the data to ensure DAQ maintains the data quality within the established acceptance criteria. The EPA designed MQOs to evaluate and control various phases (sampling, preparation, analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. The DAQ defines the MQOs for North Carolina's NCore monitoring program in terms of the following DQIs:

- ***Precision -*** Precision is a measure of agreement between two replicate measurements of the same property, under prescribed similar conditions. The DAQ calculates this agreement as the standard deviation. (US EPA QA/G-5, Appendix B[2]) This is the random component of error.
- ***Bias -*** Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. (US EPA QA/G-5, Appendix B) Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.
- ***Comparability -*** Comparability is the qualitative term that expresses the confidence that two data sets can contribute to a common analysis and interpolation. The DAQ must carefully evaluate comparability to establish whether DAQ can consider two data sets equivalent concerning the measurement of a specific variable or groups of variables. (US EPA QA/G-5, Appendix B)
- ***Representativeness -*** Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling

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

point or for a process condition or environmental condition. Representativeness is a qualitative term that DAQ evaluates to determine whether in situ or other measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the media and phenomenon measured or studied. (US EPA QA/G-5, Appendix B)

- ***Completeness -*** Completeness is a metric quantifying the amount of valid data obtained from a measurement system compared to the amount the agency expected to obtain under correct, normal conditions. The DAQ expresses completeness as a percentage. Data completeness requirements for NAAQS are included in the reference methods (40 CFR Part 50, Appendix K for PM_{10}, and in 40 CFR Part 50, Appendix T for SO_2).
- ***Sensitivity*** – Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest (US EPA QA/G-5, Appendix B). When the NCore program started, DAQ did annual method detection limit (MDL) studies for CO, SO_2 and NO_y. Currently, the DAQ does not perform annual MDL studies but relies on manufacturer's specifications for instrument detection limit (IDL) or something similar.

For each of these attributes, the RCO chemists in consultation with the RRO regional monitoring and ECB electronics technicians developed acceptance criteria using various parts of 40 CFR Parts 50, 53 and 58 and EPA-supplied guidance documents. Tables 7.2 through 7.11 list the MQOs for North Carolina's NCore monitoring program. The RCO chemists based these tables on the validation templates in the QA Handbook. The DAQ derived the MQOs listed in Table 7.2 from the QA Handbook validation template for NO, and NO_2 data and the NCore technical assistance document (TAD). As described in the QA Handbook and implemented here, for each criteria pollutant, Tables 7.2 through 7.11 list three validation criteria: 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 there may be issues with the quality of the data and further investigation is warranted before deciding about the validity of the datum/sample or data/samples, i.e., operational criteria; and
- Criteria that indicate a potentially systematic problem with the environmental data collection activity that may limit 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.

The EPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements, Version 2 (QA Handbook for Meteorological Measurements) provides the MQOs for the meteorological parameters. At the time of this QAPP, DAQ's NCore network does not perform rigid data verification or validation processes (i.e. DAQ performs only rudimentary checks) on the meteorological data and as a result, these MQOs have not been formerly adopted or incorporated into this QAPP. For more details on the meteorology MQOs, please refer to the QA Handbook for Meteorological Measurements.

North Carolina has adopted and implemented EPA Region 4's Laboratory Services and Applied Science Division, or LSASD, recommended warning limits or an even stricter warning limit for gaseous pollutant monitoring. The RCO chemists define warning limits as the level of allowable imprecision before a RRO monitoring technician must calibrate an analyzer or take other corrective action. The RCO chemists set the warning limits lower than the MQOs or control limits to reduce imprecision and bias and enhance data recovery.

The RCO chemists define control limits as the level of allowable imprecision before data invalidation and corrective actions are required. The RCO chemists cannot set control limits higher than the MQOs. The RCO chemists use these limits when validating ambient air measurements against single point precision checks. The use of both warning and control limits strengthens the precision of these measurements and improves the data validation practices meeting regulatory requirements. Tables 7.2 through 7.8 include both the DAQ established warning limits and EPA established control limits.

Other elements, as well as the SOPs associated with this QAPP that are specific to each monitor type, provide more detailed descriptions of these MQOs and how they will be used to control and assess measurement uncertainty.

7.2.1 General Data Quality Objectives

The NCore pollutant data will be collected using hourly concentration data (with each hour considered valid if at least 45 valid 1-minute readings have been obtained), hourly maximum 5-minute SO_2 data and 24-hour $PM_{2.5}$ samples. For each of these pollutants, quarterly data capture will need to be ≥75 percent completeness. The collection of precision and bias data is also required. In addition to these requirements, the data needed for the DAQ NCore monitoring program will meet the following principal quality objectives:

- All data should be traceable to a National Institute of Standards and Technology, or NIST, primary standard;
- All data shall be of a known and documented quality. Two major measurements used to define quality are precision and bias. Refer to Section 7.2 for definitions of the metrics precision and bias;
- All data shall be comparable. This means DAQ shall produce all data in a similar and scientific manner. The use of the standard methodologies for sampling, calibration, auditing, etc. referenced in the QAPP and associated SOPs should achieve this goal;
- All data shall be representative of the measured parameters with respect to time, location and the conditions from which DAQ obtained the data. The use of approved standard methodologies should ensure that the data generated are representative. Support in achieving representativeness is also provided through adhering to the requirements prescribed in 40 CFR Part 58, Appendices D and E;
- All data shall be as complete as possible and will be supplemented, as needed, using either a collocated data logger for shelter temperature or data stored in the monitor for the data collected hourly; and
- The QAPP and its associated SOPs must be dynamic to continue to achieve its stated goals as techniques, systems, concepts and project goals change.

Table 7.2 Nitrogen Oxides Measurement Quality Objectives: Measurement Quality Objective Parameter –Total Reactive Nitrogen (NOy) (Chemiluminescence).

1) Requirement (NO_y)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- NO_y			
One Point QC Check Single analyzer	***1/ 14 days***	Warning limit ≤ ±10.0 percent (percent difference) Control limit ≤ ±15.0 percent (percent difference) or <±1.5 ppb difference, whichever is greater	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.1 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.4 (See DAQ NO_y SOP Section 2.38.2.3.7) QC check concentration range 0.005 - 0.080 ppm Representative of site mean or median concentration
Zero/span check	1/ 14 days	Zero drift ≤ ± 1.0 ppb (24 hour) ≤ ± 5.0 ppb (>24hr-14 day) Span drift ≤ ± 10.0 percent	1) NCore TAD Section 4.3.1.9 2) Recommendation (See DAQ NO_y SOP Section 2.38.2.3.7) 3) NCore TAD Section 4.3.1.9
Converter Efficiency	During multi-point calibrations, span and audit 1/ 14 days	***(≥96.0 percent)*** 96.0 – 104.1 percent	1) Based on 40 CFR Part 50, Appendix F, Section 1.5.10 and 2.4.10 2) Recommendation (See DAQ NO_y SOP Section 2.38.2.3.7) 3) Based on 40 CFR Part 50, Appendix F, Section 1.5.10 and 2.4.10. Regulation states ≥ 96 percent. Since the regulation does not provide a range, the DAQ follows the EPA recommendation of 96 – 104.1 percent.
Molybdenum Converter Temperature	Every site visit, at least once every 14 days (instrument will alarm when outside range)	325 ± 25 ° C	1) NCore TAD Section 4.4.2.1 2) Recommendation (See DAQ NO_y SOP Section 2.38.2.3.1) 3) TEI 42i-y Manual Tables 6-1 and 6-2.
OPERATIONAL CRITERIA- NOy			
Shelter Temperature Range	Daily (hourly values)	20.0 to 30.0° C. (hourly average)	1, 2 and 3) NCore TAD Section 4.3.4.2
Shelter Temperature Control	Daily (hourly values)	<2.1°C Standard Deviation (SD) over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/182 days and 2/calendar year	< ± 2.1° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/365 days and 1/calendar year***	Percent difference of audit levels 3-10 ≤ ±15.0 percent Audit levels 1 and 2 <± 1.5 ppb difference or ≤±15.0 percent, whichever is greater	1) 40 CFR Part 58, Appendix A, section 3.1.2 2) 40 CFR Part 58, Appendix A, section 3.1.2 3) Recommendation - 3 audit concentrations not including zero. (See DAQ NO_y SOP Section 2.38.1.9) AMTIC guidance 5/3/2016

Table 7.2 Nitrogen Oxides Measurement Quality Objectives: Measurement Quality Objective Parameter – Reactive Oxides of Nitrogen (NOy) (Chemiluminescence) – Continued			
1) Requirement (NOy)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving Calibration 1/365 days / *Verification during Calibration and within 182 days of most recent calibration*	> 10 percent excess NO Span within ± 3 percent of expected Precision point within ± 5 percent of expected Zero within ± 1 ppb of expected *(Instrument residence time ≤ 2 min All points <± 2.1 percent or ≤ 1.5 ppb difference of best-fit straight line whichever is greater and Slope 1 ± 0.5)*	1) 40 CFR Part 50 App F 2 and 3) Recommendation (See DAQ NO_y SOP Section 2.38.2.2.4 and 2.38.2.2.5) Multi-point calibration (0 and 3 upscale points) *(Multi-point calibration (0 and 4 upscale points) – Slope is a recommendation. - Verification/Calibration procedures are being revised at the time of this QAPP revision)*
Gaseous Standards	All gas cylinders	**NIST[a] Traceable** (e.g., EPA Protocol Gas) 5-20 ppm[b] of NO in Nitrogen with < 1 ppm NO2	1) 40 CFR Part 50, Appendix F, Section 1.3.1 and 01/30/2018 EPA Technical Note 2) Not applicable Green book 3) NCore TAD Section 4.6.1 Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58, Appendix A, section 2.6.1
Zero Air/ Zero Air Check	Chemicals changed 1/365 days and 1/calendar year; certified 1/365 days and 1/calendar year; verified 1/182 days and 2/calendar year	Concentrations below LDL[c]	1) NCore TAD, Section 4.5.2.2 2) Recommendation 3) NCore TAD, Section 4.5.2.2
Gas Dilution Systems	Certified 1/365 days and 1/calendar year or after failure of 1-point QC check or performance evaluation	Accuracy ***≤*** ± 2.0 percent	1 and 2) Recommendation based on SO2 requirement in 40 CFR Part 50, Appendix A-1, Section 4.1.2 3) NCore TAD, Section 4.5.2.1
Detection			
Noise	Determined by manufacturer at purchase	***≤ 0.05 ppb***	1) 40 CFR Part 53.23 (b) (definition and procedure) 2) Not applicable 3) NCore TAD
Lower detectable level	Determined by manufacturer at purchase	***≤ 0.10 ppb***	1) 40 CFR Part 53.23 (c) (definition and procedure) 2) Recommendation 3) NCore TAD, Section 4.3.1.7
SYSTEMATIC CRITERIA- NO_y			
Sampler/Monitor	Not applicable	***Meets requirements listed in NCore Technical Assistance Document***	1) 40 CFR Part 53 & FRM/FEM method list See EPA's Technical Assistance Document (TAD) for Precursor Gas Measurements in the NCore Multi-Pollutant Monitoring
Standard Reporting Units	***All data***	***ppb[d] (final units in AQS)***	1,2 and 3) Based on 40 CFR Part 50, Appendix S Section 2 (c)
Rounding convention for data reported to AQ S	***All data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) Based on 40 CFR Part 50, Appendix S, Section 4.2 (a)

Table 7.2 Nitrogen Oxides Measurement Quality Objectives:
Measurement Quality Objective Parameter – Reactive Oxides of Nitrogen (NOy) (Chemiluminescence) – Continued

1) Requirement (NO_y)	2) Frequency	3) Acceptance Criteria	Information /Action
Completeness	***All data***	***≥ 75.0 percent of hours in a quarter and 4 complete quarters in a year***	1), 2) and 3) NCore TAD, Section 4.3.1.4
Sample Residence Time Verification	1/365 days and 1/calendar year	***≤ 20.0 seconds***	1) 40 CFR Part 58, Appendix E, section 9 (c) 2) Recommendation 3) NCore TAD, Section 4.2
Sample Probe, Inlet, Sampling train	***All sites***	***Teflon® PFA Tubing***	1, 2 and 3) NCore TAD Section 4.3.4.3. Replace probe line every other year and clean inlet filter holder every year and more frequently if pollutant load or contamination dictate
Siting	1/365 days and 1/calendar year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58, Appendix E, sections 2-6 2) Recommendation 3) 40 CFR Part 58, Appendix E, sections 2-6
Precision (using 1-point QC checks)	***Calculated annually***	***90 percent confidence limits CV ≤ 15.0 percent***	1, 2 and 3) NCore TAD Section 4.3.1.1
Bias (using 1-point QC checks)	***Calculated annually***	***95 percent confidence limits ≤ ± 15.0 percent***	1, 2 and 3) NCore TAD Section 4.3.1.2

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

Table 7.3 Ozone Measurement Quality Objectives:
Measurement Quality Objective Parameter – Ozone (O3) (Ultraviolet Photometric)

1) Requirement (O_3)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-OZONE			
Monitor/Transfer and Calibration Standard	Not applicable	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
One Point QC Check Single analyzer	***1/14 days is required (The DAQ goal is daily checks)***	< ± 7.1 percent difference-(**4.6** ppb) or < ±1.5 ppb, whichever is greater **(The DAQ goal is 65** ppb ± **3** ppb)	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.1 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.2. QC Check Concentration range 0.005 -0.080 ppm, relative to routine concentrations
Zero/span check	***1/14 is required (The DAQ goal is daily checks)***	**Zero** drift <**3.1** ppb (24hr) < ± 5.1 ppb (>24 hr-14 day **(The DAQ goal is 0** ppb ± **≤2** ppb) **Span (225)** drift < ± 7.1 percent---225 x .071 = 15.9 ppb **(The DAQ goal is 225** ppb +/- **5** ppb)	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
Shelter Temperature Range	Daily (hourly values)	5.0 to 40.0° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
OPERATIONAL CRITERIA -OZONE			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2.0° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/182 days and 2/calendar year	≤± 2.0° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single analyzer	***Every site 1/365 days and 1/calendar year within period of monitor operation***	Zero must be 0 ±≤3 ppb 100 ppb must be 100 ±≤7 ppb (7 %) 70 ppb must be 70 ±≤4.9 ppb (7 %) 15 ppb must be 15.0 ±≤1.4 ppb	1 and 2) 40 CFR Part 58, Appendix A, section 3.1.2 3) Recommendation- 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html
Federal Audits (NPAP)	100 percent of PQAO sites every 6 years; 20 percent of PQAO sites audited each year	Audit levels 1 and 2 <± 1.5 ppb difference all other levels percent difference <± 10.1 percent	1 and 2) 40 CFR Part 58, Appendix A, section 3.1.3 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving and repair and recalibration of standard of higher level 1/365 days and 1/calendar year if continuous zero/span performed daily	All points within ± 2 ppb of expected value and all monitor points within ± 2 ppb of calibrator (DAQ goal) All points < ± 2.1 percent or ≤ ±1.5 ppb difference of best-fit straight line whichever is greater and slope 1 ± 0.05	1) 40 CFR Part 50, Appendix D 2) Recommendation 3) Recommendation- Linearity error 40 CFR Part 50, Appendix D Section 4.5.5.6 Multi-point calibration (0 and 4 upscale points) 40 CFR Part 50, Appendix D, section 4.5.2.3 and QA Handbook Volume 2 Section 12.3
Zero Air/Zero Air Check	1/365 days and 1/calendar year	Concentrations below 1 ppb	1) 40 CFR Part 50, Appendix D, Section 4.4.1 2 and 3) Recommendation

Table 7.3 Ozone Measurement Quality Objectives:
Measurement Quality Objective Parameter – Ozone (O3) (Ultraviolet Photometric) – Continued

1) Requirement (O_3)	2) Frequency	3) Acceptance Criteria	Information /Action
Ozone Level 2 Standard			
Certification/recertification to Standard Reference Photometer (Level 1)	1/365 days and 1/calendar year	single point difference ≤ ± 0.002 ppm	1) 40 CFR Part 50, Appendix D, Section 4.5 2 and 3) Transfer Standard Guidance EPA-454/B-13-004 Level 2 standard (formerly called primary standard) usually transported to EPA Region 4 or RTP SRP for comparison
Level 2 and Greater Transfer Standard Precision	1/365 days and 1/calendar year	***Standard Deviation less than 0.005 ppm or 3.0 percent whichever is greater***	1) 40 CFR Part 50, Appendix D, Section 4.3.1 2) Recommendation, part of reverification 3) 40 CFR Part 50, Appendix D, Section 4.3.1
(if recertified via a transfer standard)	1/365 days and 1/calendar year	Regression slopes = 1.00 ± 0.03 and two intercepts are 0 ± 3 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-13-004
Ozone Transfer standard (Level 3 and greater)			
Qualification	Upon receipt of transfer standard	<±3 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-13-004
Certification	After qualification and upon receipt/adjustment/repair	5 levels: 225 ±2 ppb 120 ±2 ppb 65 ±2 ppb 50 ±2 ppb 0 ±2 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-13-004
Recertification to higher level standard	1/365 days and 1/calendar year (EPA guidance is beginning and end of O3 season or every 182 days and 2/calendar year whichever is less)	5 levels: 225 ±2 ppb 120 ±2 ppb 65 ±2 ppb 50 ±2 ppb 0 ±2 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-13-004 recertification test that then gets added to most recent 5 tests. If does not meet acceptability certification fails
Detection (FEM/FRMs)	Noise and Lower Detectable Limits (LDL) are part of the FEM/FRM requirements. The EPA recommends that monitoring organizations perform the LDL test to minimally confirm and establish the LDL of their monitor. Performing the LDL test will provide the noise information.		
Noise	upon receipt (based on manufacturer's specifications and testing)	***≤ 0.0025 ppm (standard range)*** ***≤ 0.001 ppm (lower range)***	1) 40 CFR Part 53.23 (b) (definition and procedure) 2) Recommendation, LDL can provide value 3) 40 CFR Part 53, Table B-1
Lower detectable level	upon receipt (based on manufacturer's specifications and testing)	***≤ 0.005 ppm (standard range)*** ***≤ 0.002 ppm (lower range)***	1) 40 CFR Part 53.23 (c) (definition and procedure) 2) Recommendation 3) 40 CFR Part 53, Table B-1
SYSTEMATIC CRITERIA-OZONE			
Standard Reporting Units	*All data*	*ppm (final units in AQS)*	1, 2 and 3) 40 CFR Part 50, Appendix U, section 3 (a)
Rounding convention for data reported to AQS	*All data*	*3 places after decimal with digits to right truncated*	1, 2 and 3) 40 CFR Part 50, Appendix U, section 3 (a). The rounding convention is for averaging values for comparison to NAAQS not for reporting individual hourly values.

Table 7.3 Ozone Measurement Quality Objectives: Measurement Quality Objective Parameter – Ozone (O3) (Ultraviolet Photometric) – Continued			
1) Requirement (O_3)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
Completeness (seasonal)	*3-Year Comparison*	*≥ 90 percent (average) daily max available in ozone season with min of 75 percent in any one year.*	1, 2 and 3) 40 CFR Part 50, Appendix U, section 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, Appendix U 2 and 3) 40 CFR Part 50, Appendix U, Section 3 (b)
	Valid Daily Max	***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. local standard time***	1) 40 CFR Part 50, Appendix U 2 and 3) 40 CFR Part 50, Appendix U, Section 3 (d)
Sample Residence Time Verification	1/365 days and 1/calendar year	*< 20 seconds*	1) 40 CFR Part 58, Appendix E, section 9 (c) 2) Recommendation 3) 40 CFR Part 58, Appendix E, section 9 (c)
Sample Probe, Inlet, Sampling train	*All sites*	*Borosilicate glass (e.g., Pyrex®) or Teflon®*	1) 40 CFR Part 58, Appendix E, section 9 (a) 2) Recommendation 3) 40 CFR Part 58, Appendix E, section 9 (a) The EPA accepts FEP and PFA as an equivalent material to Teflon. Although the EPA suggests replacement or cleaning as 1/year and more frequent if pollutant load or contamination dictate, the DAQ replaces the probe line every other year.
Siting	1/365 days and 1/calendar year	*Meets siting criteria or waiver documented*	1) 40 CFR Part 58, Appendix E, sections 2-6 2) Recommendation 3) 40 CFR Part 58, Appendix E, sections 2-6
EPA Standard Ozone Reference Photometer (SRP) Recertification (Level 1)	1/365 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-13-004 This is usually done at RTP or EPA Region 4 and is compared against the traveling SRP
Precision (using 1-point QC checks)	*Calculated annually and as appropriate for design value estimates*	**90 percent confidence limits CV** ≤ 7.0 percent	1) 40 CFR Part 58, Appendix A, sections 2.3.1.2 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.2
Bias (using 1-point QC checks)	*Calculated annually and as appropriate for design value estimates*	**95 percent confidence limits** ≤ ± 7.0 percent	1) 40 CFR Part 58, Appendix A, sections 2.3.1.2 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.3

[a] Relative Standard Deviation

Table 7.4. Sulfur Dioxide Measurement Quality Objectives Parameter – Sulfur Dioxide (SO2) (Ultraviolet Fluorescence).

1) Requirement (SO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- SO_2			
Sampler/Monitor	Not applicable	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
One Point QC Check Single analyzer	***1/14 days is required (The DAQ goal is daily checks)***	Warning Limit: ≤ ±7.0 percent (percent difference) Control Limit: < ±10.1 percent (percent difference) or < ±1.5 ppb whichever is greater	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.1 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.5 (see DAQ SO_2 SOP for details) QC Check Concentration range 0.005 and 0.080 ppm Relative to mean or median monitor concentrations
Zero/span check	***1/14 is required (The DAQ goal is daily checks)***	Zero drift < ± 3.1 ppb (24 hr.) and < ± 5.1 ppb (>24hr-14 day) (The DAQ goal is < ± 1.5 ppb (24 hr.) and < ± 2.5 ppb (>24hr-14 day)) Span drift < ± 10.1 percent (The DAQ Warning limit is < ±5 percent)	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO (see DAQ SO_2 SOP for details)
Shelter Temperature Range	**Daily** (hourly values)	20.0 to 30.0° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2 and FRM/FEM method list
OPERATIONAL CRITERIA- SO_2			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2.0° C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/180 days and 2/calendar year	≤± 2.0° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***1/365 days and 1/calendar year***	Percent difference of audit levels 3-10 ≤ ±15.0 percent Audit levels 1 and 2 < ± 1.5 ppb difference or ≤±15.0 percent, whichever is greater	1 and 2) 40 CFR Part 58, Appendix A, section 3.1.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html
Federal Audits (NPAP)	100 percent of PQAO sites every 6 years; 20 percent of PQAO sites audited each year	Audit levels 1 and 2 <± 1.5 ppb difference; all other levels percent difference <± 15.1 percent	1) 40 CFR Part 58, Appendix A, section 3.1.3 2) 40 CFR Part 58, Appendix A, section 3.1.3.1 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving; When one-point QC check is > ±7.0 percent difference; 1/365 days and 1/calendar year	Span/Span2 within ± 5.0 percent of expected 1-point-QC check ≤ 7.0 percent difference Zero within ± 1.0 ppb of expected Slope of best fit line = 1 ±0.05 and each point within 2 percent of best fit line or ± 1.5 ppb, whichever is greater	1) 40 CFR Part 50, Appendix A-1, Section 4 2 and 3) Recommendation (see DAQ SO_2 Operator SOP) Multi-point calibration (0 and 3 upscale points)
Gaseous Standards	***All gas cylinders***	***NIST-Traceable (e.g., EPA Protocol Gas)***	1) 40 CFR Part 50, Appendix A-1, Section 4.1.6.1 2) Not applicable, Green book 3) 40 CFR Part 50, Appendix A-1, Section 4.1.6.1 Producers must participate in Ambient Air Protocol Gas Verification Program 40 CFR Part 58, Appendix A, section 2.6.1

Table 7.4 Sulfur Dioxide Measurement Quality Objectives Parameter – Sulfur Dioxide (SO2) (Ultraviolet Fluorescence)– Continued			
1) Requirement (SO_2)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
Zero Air/ Zero Air Check	Chemicals changed 1/365 days and 1/calendar year; certified 1/365 days and 1/calendar year; verified 1/182 days and 2/calendar year	Concentrations below LDL < 0.1 ppm aromatic hydrocarbons	1) 40 CFR Part 50, Appendix A-1, Section 4.1.6.2 2) Recommendation (see DAQ SO_2 SOP for details) 3) Recommendation and 40 CFR Part, 50 Appendix A-1 Section 4.1.6.2
Gas Dilution Systems	Certified 1/365 days and 1/calendar year or after failure of 1-point QC check or performance evaluation	***Accuracy ≤± 2.0 percent***	1) 40 CFR Part 50, Appendix A-1, section 4.1.2 2) Recommendation (see DAQ SO_2 SOP for details) 3) 40 CFR Part 50, Appendix A-1, section 4.1.2
Detection (FEM/FRMs)	Noise and Lower Detectable Limits (LDL) are part of the FEM/FRM requirements.		
Noise	Verified by manufacturer at purchase	***≤ 0.001 ppm (standard range)*** ***≤ 0.0005 ppm (lower range)***	1) 40 CFR Part 53.23 (b) (definition and procedure) 2) Not applicable 3) 40 CFR Part 53 Table B-1
Lower detectable limits	Verified by manufacturer at purchase	***≤ 0.002 ppm (standard range)*** ***≤ 0.001 ppm (lower range)***	1) 40 CFR Part 53.23 (c) (definition and procedure) 2) Recommendation 3) 40 CFR Part 53, Table B-1
SYSTEMATIC CRITERIA- SO_2			
Standard Reporting Units	***All data***	***ppb (final units in AQS)***	1, 2 and 3) 40 CFR Part 50, Appendix T, Section 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, Appendix T, Section 2 (c) The rounding convention is for averaging values for comparison to the NAAQS and not for reporting individual hourly values to AQS.
Completeness	***1 hour standard***	Hour – ≥ 75 percent of hour ***Day- ≥ 75 percent of hourly concentrations*** ***Quarter- ≥ 75 percent complete days*** ***Years-4 complete quarters*** 5-minute values – ≥ 75 percent of minutes 5-minute value reported only for valid hours	1, 2 and 3) 40 CFR Part 50, Appendix T, Section 3 (b), (c) More details in CFR on acceptable completeness. 5-minute 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-minute max reported.
Sample Residence Time Verification	At installation, 1/365 days and 1/calendar year	***< 20 seconds***	1) 40 CFR Part 58, Appendix E, section 9 (c) 2) See DAQ SO_2 SOPs 3) 40 CFR Part 58, Appendix E, section 9 (c)
Sample Probe, Inlet, Sampling train	***All sites***	***Borosilicate glass (e.g., Pyrex®) or Teflon®*** (The EPA accepts FEP and PFA as equivalent material to Teflon.)	1, 2 and 3) 40 CFR Part 58, Appendix E, section 9 (a) Replace every 2 years; more frequently if pollutant load or contamination dictate
Siting	1/365 days and 1/calendar year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58, Appendix E, sections 2-6 2) See DAQ Network Review SOP 3) 40 CFR Part 58, Appendix E, sections 2-6
Precision (using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***90 percent confidence limits CV ≤ 10.0 percent***	1) 40 CFR Part 58, Appendix A, section 2.3.1.5 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.2

Table 7.4 Sulfur Dioxide Measurement Quality Objectives Parameter – Sulfur Dioxide (SO2) (Ultraviolet Fluorescence)– Continued			
1) Requirement (SO_2)	**2) Frequency**	**3) Acceptance Criteria**	**Information /Action**
Bias (using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***95 percent confidence limits ≤ ± 10.0 percent***	1) 40 CFR Part 58, Appendix A, section 2.3.1.5 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.3

Table 7.5. Carbon Monoxide Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry)

1) Requirement (CO)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-CO			
Sampler/Monitor	Not applicable	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
One Point QC Check Single analyzer	***1/ 14 days***	Warning limit ≤ ±7.0 percent (percent difference) Control limit ≤ ±10.0 percent (percent difference)	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.1 3)Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1. (See DAQ CO SOP for details) QC Check Concentration range 0.5 - 5 ppm relative to routine concentrations
Zero/span check	1/ 14 days	Zero drift ≤ ± 0.041 ppm (24 hour) ≤ ± 0.060 ppm (>24hr-14 day) Span drift ≤ ± 5.0 percent	1 and 2) QA Handbook Volume 2, Section 12.3 3) Recommendation (See DAQ CO SOP for details)
Shelter Temperature range	Daily (hourly values)	20.0 to 30.0 ° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2, Section 7.2.2
OPERATIONAL CRITERIA-CO			
Shelter Temperature Control	Daily (hourly values)	< 2.1 ° C Standard Deviation over 24 hours	1, 2 and 3) QA Handbook Volume 2, Section 7.2.2
Shelter Temperature Device Check	1/182 days and 2/calendar year	< ± 2.1 ° C of standard	1, 2 and 3) QA Handbook Volume 2, Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/365 days and 1/calendar year***	Audit levels 1 & 2 ≤ ±0.030 ppm or ≤ ±15.0 percent difference, whichever is greater. Audit levels 3-10 ≤ ±15.0 percent difference (DAQ goal is ±10.0 percent difference)	1 and 2) 40 CFR Part 58, Appendix A, section 3.1.2 3) Recommendation- 3 audit concentrations not including zero. (See DAQ ECB CO SOP) AMTIC guidance 5/3/2016
Federal Audits (NPAP)	100 percent of PQAO sites every 6 years; 20 percent of PQAO sites audited each year	Audit levels 1 and 2 ≤ ± 0.030 ppm difference all other levels percent difference ≤ ± 15.0 percent	1) and 2) 40 CFR Part 58, Appendix A, section 3.1.3 3) NPAP QAPP/SOP

Table 7.5. Carbon Monoxide Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry)

1) Requirement (CO)	2) Frequency	3) Acceptance Criteria	Information /Action
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving Calibration 1/365 days and 1/calendar year *Verification during calibration and within 182 days of most recent calibration*	All points <± 2.1 percent or ≤ ± 0.03 ppm difference of best-fit straight line whichever is greater and slope 1 ± 0.05	1) 40 CFR Part 50, Appendix C, Section 4 2 and 3) Recommendation (See DAQ CO SOP for details) Multi-point calibration (0 and 4 upscale points)
Gaseous Standards	All gas cylinders	**NIST-Traceable** (e.g., EPA Protocol Gas)	1) 40 CFR Part 50, Appendix C, Section 4.3.1 2) Not applicable Green Book 3) 40 CFR Part 50, Appendix C, Section 4.3.1 See details about CO_2 sensitive instruments Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program (40 CFR Part 58, Appendix A, section 2.6.1)
Zero Air/Zero Air Check	Chemicals changed 1/365 days and 1/calendar year; certified 1/365 days and 1/calendar year; verified 1/182 days and 2/calendar year	***< 0.1 ppm CO***	1) 40 CFR Part 50, Appendix C, Section 4.3.2 2) Recommendation 3) 40 CFR Part 50, Appendix C, Section 4.3.2
Gas Dilution Systems	Certified 1/365 days and 1/calendar year or after failure of 1-point QC check or performance evaluation	Accuracy ≤± 2.0 percent	1,2 and 3) Recommendation based on SO_2 requirement in 40 CFR Part 50, Appendix A-1, Section 4.1.2
Detection (FEM/FRMs) Noise and lower detectable limits are part of the FEM/FRM requirements.			
Noise	Determined by manufacturer at purchase	***≤ 0.2 ppm (standard range)*** ***≤ 0.1 ppm (lower range)***	1) 40 CFR Part 53.23 (b) (definition and procedure) 2) Recommendation- information obtained from lower detectable limit 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	Determined by manufacturer at purchase	***≤ 0.4 ppm (standard range)*** ***≤ 0.2 ppm (lower range)***	1) 40 CFR Part 53.23 (c) (definition and procedure) 2) Recommendation 3) 40 CFR Part 53 Table B-1
SYSTEMATIC CRITERIA-CO			
Standard Reporting Units	***All data***	***ppm (final units in AQS)***	1, 2 and 3) 40 CFR Part 50.8 (a)
Rounding convention for data reported to AQS	***All routine concentration data***	***1 decimal place***	1, 2 and 3) 40 CFR Part 50.8 (d)
Completeness	***8-hour standard***	***75 percent of hourly averages for the 8-hour period***	1) 40 CFR Part 50.8(c) 2) 40 CFR Part 50.8(a) (1) 3) 40 CFR Part 50.8(c)

Table 7.5. Carbon Monoxide Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry)

1) Requirement (CO)	2) Frequency	3) Acceptance Criteria	Information /Action
Sample Residence Time Verification	1/365 days and 1/calendar year	< 20 seconds	1, 2, and 3) Recommendation. (See DAQ-04-001.2 SOP) CO is not a reactive gas but suggest following same methods as other gaseous criteria pollutants.
Sample Probe, Inlet, Sampling train	All Sites	Borosilicate glass (e.g., Pyrex®) or Teflon™	1, 2, and 3) Recommendation. CO is not a reactive gas but suggest following same methods as other gaseous criteria pollutants. The EPA has accepted FEP and PFA as an equivalent material to Teflon™. The DAQ replaces the probe line every other year and more frequently if pollutant load dictate.
Siting	1/365 days and 1/calendar year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58, Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58, Appendix E, sections 2-6
Precision (using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***90 percent confidence limit CV ≤ 10.0 percent***	1) 40 CFR part 58, Appendix A, section 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.2
Bias (using 1-point QC checks)	***Calculated annually and as appropriate for design value estimates***	***95 percent confidence limit ≤ ± 10.0 percent***	1) 40 CFR Part 58, Appendix A, section 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.3

Table 7.6. $PM_{2.5}$ Measurement Quality Objectives: Parameter – PM2.5 (Gravimetric, Filter-Based, Local Conditions)			
1) Criteria ($PM_{2.5}$ LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
CRITICAL CRITERIA-$PM_{2.5}$ Filter-Based Local Conditions			
Field Activities			
Filter Holding Times			
Presampling	***all filters***	***≤ 30 days before sampling***	1,2 and 3) 40 CFR Part 50, Appendix. L, Section 8.3.5
Sample Recovery	***all filters***	***≤7 days 9 hours from sample end date***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 10.10
Sampling Period (including multiple power failures)	***all filters***	***1380-1500 minutes, or value if < 1380 and exceedance of NAAQS * midnight to midnight local standard time***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 3.3 and 40 CFR Part 50, Appendix N, Section 1.0 *See CFR details if less than 1380 minutes sampled
Sampling Instrument			
Sampler/ Monitor	***Not applicable***	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
Average Flow Rate	***every 24 hours of operation***	***average within ±5 percent of 16.67 liters/minute***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.1
Variability in Flow Rate	***every 24 hours of operation***	***CV ≤ 2 percent***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.2
One-point Flow Rate Verification	Every 30 days each separated by 14 days (DAQ goal is 2/month separated by 14 to 18 days)	<± 4.1 percent of transfer standard <± 5.1 percent of flow rate design value (DAQ warning limit is <±3 percent of transfer standard and <±4 percent of flow design value)	1) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix A Section 3.2.1 2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1, 40 CFR Part 58, Appendix A Section 3.2.1 and *DAQ 2025i SOP* Section 7.0
Design Flow Rate Adjustment	***after multi-point verification or calibration***	***<± 2.1 percent of design flow rate***	1,2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.6
Individual Flow Rates	***every 24 hours of operation***	***no flow rate excursions > ±5 percent for > 5 minutes***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.1
Filter Temp Sensor	***every 24 hours of operation***	***no excursions of > 5°C lasting longer than 30 minutes***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.11.4
External Leak Check	before each flow rate verification or calibration, before and after PM2.5 separator maintenance	<80.1 mL/minute (The DAQ goal is ≤ 25 mm Hg/minute)	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, *DAQ QAPP, PM 2.5,* SOP DAQ-11-001.2 *for DAQ limits*
Internal Leak Check	If failure of external leak check	<80.1 mL/min (The DAQ goal is ≤ 140 mm Hg/minute)	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, *DAQ QAPP, PM 2.5,* SOP DAQ-11-001.2, *for DAQ limits*

Table 7.6. $PM_{2.5}$ Measurement Quality Objectives: Parameter – PM2.5 (Gravimetric, Filter-Based, Local Conditions)

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Laboratory Activities			
Filter Visual Defect Check (unexposed)	***all filters***	***Correct type and size and for pinholes, particles or imperfections***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 10.2
Determine Deadline for Post-sampling Weighing	***all filters***	Protected from temperatures above 25°C from sample retrieval to conditioning. ≤10 days from sample end date if shipped at AT, or ≤30 days if shipped < average ambient (or 4°C or below for average sampling temperature < 4° C) from sample end date. >25°C receiving temperature = void	1, 2 and 3) 40 CFR Part 50, Appendix L, Sec. 8.3.6 and 10.13. See technical note on holding time requirements at: https://www3.epa.gov/ttn/amtic/pmpolgud.html Check the *DAQ QAPP, PM 2.5, 2.24 Fine Particles, Section 3, Laboratory Responsibilities* for laboratory activities
Filter Integrity (exposed)	each filter	no visual defects	1,2 and 3) Method 2.12, Section 10.7, Region 4 guidance
Filter Conditioning Environment			
Equilibration	***all filters***	***24 hours minimum***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.2.5
Temperature Range	***all filters***	***24-hr mean 20.0-23.0° C (DAQ goal is 21.0 to 23.0 ° C)***	1 and 2) 40 CFR Part 50, Appendix L, Section 8.2.1 3) 40 CFR Part 50, Appendix L, Section 8.2.1 and DAQ SOP 2.24.3 *Fine Particles, Laboratory Responsibilities*
Temperature Control	***all filters***	***< 2.1° C SD** over 24 hours***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.2.2
Humidity Range	***all filters***	***24-hr mean 30.0 – 40.0 percent RH or ≤ 5.0 percent sampling RH but ≥ 20.0 percent RH*** (DAQ's RH range goal is 35-40 percent)	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.2.3 3) 40 CFR Part 50, Appendix L, Section 8.2.3 and DAQ SOP 2.24.3 *Fine Particles Laboratory Responsibilities*
Humidity Control	***all filters***	***<± 5.1 percent SD** over 24 hr.***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.2.4
Pre/post Sampling RH	***all filters***	***difference in 24-hr means < ± 5.1 percent RH***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.3.3
Balance	***all filters***	***located in filter conditioning environment***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.3.2
OPERATIONAL EVALUATIONS TABLE $PM_{2.5}$ Filter- Based Local Conditions			
Field Activities			
Routine Verifications			
One-point Temp Verification	1/30 days	<± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Method 2.12, 7.4.5 3) Recommendation
Pressure Verification	1/30 days	<± 10.1 mm Hg	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Method 2.12, 7.4.6 3) Recommendation

Table 7.6. $PM_{2.5}$ Measurement Quality Objectives: Parameter – PM2.5 (Gravimetric, Filter-Based, Local Conditions)

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Annual Calibrations			
Temperature multipoint Verification and Calibration	***On installation, then every 365 days and 1/calendar year***	<± 2.1°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) Method 2.12, section 6.4
Pressure Verification and Calibration	***On installation and on one point verification failure***	<± 10.1 mm Hg	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) Method 2.12, section 6.5 Sampler barometric pressure verified against an independent standard verified against a laboratory primary standard that is certified as NIST-traceable 1/365 days
Flow Rate Multi-point Verification and Calibration	***Electromechanical maintenance or transport or*** 1/365 days and 1/calendar year	***<± 2.1 percent of transfer standard***	1) 40 CFR Part 50, Appendix L, Section 9.2. 2) 40 CFR Part 50, Appendix L, Section 9.1.3, Method 2.12, section 6.3 3) 40 CFR Part 50, Appendix L, Section 9.2.5
Other Monitor Calibrations	per manufacturers' operation manual	per manufacturers' operating manual	1, 2 and 3) Recommendation
Precision			
Collocated Samples	***every 12 days for 15 percent of sites by method designation***	CV < 10.1 percent of samples > 3.0 µg/m^3	1) and 2) 40 CFR Part 58, Appendix A, Section 3.2.3 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.1
Accuracy			
Temperature Audit	1/180 days and at time of flow rate audit (DAQ goal is 1/90 days)	± 2°C	1, 2 and 3) Method 2.12, Section 11.2.2 and Table 11-1
Pressure Audit	1/180 days and at time of flow rate audit (DAQ goal is 1/90 days)	±10 mm Hg	1, 2 and 3) Method 2.12, Section 11.2.2 and Table 11-1
Semi Annual Flow Rate Audit	Twice a calendar year and between 5-7 months apart (DAQ's goal is 1/90 days)	± 4.1 percent of audit standard (DAQ's warning limit is ≤±3 percent) ± 5.1 percent of design flow rate (DAQ's warning limit is ≤±4 percent)	1 and 2) Part 58, Appendix A, Section 3.3.3 3) Method 2.12 Section 11.2.1 and Table 11-1
Monitor Maintenance			
Very Sharp Cut Cyclone	every 30 days	cleaned/changed	1,2 and 3) Method 2.12, Section 8.3.3
Inlet Cleaning	1/30 days	cleaned	1,2 and 3) Method 2.12, Section 8.3
Downtube Cleaning	1/90 days	cleaned	1,2 and 3) Method 2.12, Section 8.4
Filter Chamber Cleaning	1/30 days	cleaned	1,2 and 3) Method 2.12, Section 8.3

Table 7.6. $PM_{2.5}$ Measurement Quality Objectives: Parameter – PM2.5 (Gravimetric, Filter-Based, Local Conditions)

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Circulating Fan Filter Cleaning	1/90 days	cleaned/changed	1,2 and 3) Method 2.12, Section 8.3
Manufacturer-Recommended Maintenance per manufacturers' Shopper manufacturers' SOP	per manufacturers' SOP	per manufacturers' SOP	1,2 and 3) EPA Recommendation
Laboratory Activities			
Filter Checks			
Lot Blanks	9 filters per lot	< ± 15.1-microgram change between initial and final weighing	1, 2, 3) Recommendation and used to determine filter stability of the lot of filters received from EPA or vendor. Method 2.12. Section 10.5
Exposure Lot Blanks	3filters per lot	less than ±15.1 µg change between weighings	1,2 and 3) Method 2.12, Section 10.5 Used for preparing a subset of filters for equilibration
Filter Integrity (exposed)	each filter	no visual defects	1, 2 and 3) Method 2.12, Section10.7 and 10.3
Lab QC Checks			
Field Filter Blank	10 percent or 1 per weighing session	<± 30.1 µg change between weighings	1) 40 CFR Part 50, Appendix L, Section 8.3.7.1 2 and 3) Method 2.12 Section 10.5
Lab Filter Blank	10 percent or 1 per weighing session	<± 15.1 µg change between weighings	1) 40 CFR Part 50, Appendix L, Section 8.3.7.2 2 and 3) Method 2.12, Section 10.5
Balance Check (working standards)	beginning, 10th sample, end	< ± 3.1 µg from certified value	1,2 and 3) Method 2.12, Section 10.6 Standards used should meet specifications in Method 2.12, Section 4.3.7
Routine Filter Re-weighing	1 per weighing session	<± 15.1 µg change between weighings	1,2 and 3) Method 2.12, Section 10.8
Microbalance Audit	1/365 days and 1/calendar year	<± 0.003 mg or manufacturers specs, whichever is tighter	1,2 and 3) Method 2.12, Section 11.2.7
Laboratory Temperature Check	Every 90 days	< ±2.1°C	1, 2 and 3) Method 2.12 Section 10.10
Laboratory RH Check	Every 90 days	<±2.1 percent RH	1, 2 and 3) Method 2.12 Section 10.10
Verification/Calibration			
Laboratory Temperature Certification	1/365 days and 1/calendar year	<± 2.1°C	1, 2 and 3) Method 2.12 Sec. 4.3.8 and 9.4
Laboratory Humidity Certification	1/365 days and 1/calendar year	<± 2.1 percent	1, 2 and 3) Method 2.12 Sec. 4.3.8 and 9.4

Table 7.6. $PM_{2.5}$ Measurement Quality Objectives: Parameter – PM2.5 (Gravimetric, Filter-Based, Local Conditions)

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Microbalance Calibration	At installation and 1/365 days and 1/calendar year	Manufacturer's specification	1) 40 CFR Part 50, Appendix L, Section 8.1 2) 40 CFR Part 50, Appendix L, Section 8.1 and Method 2.12, Section 9.3 3) Not applicable
Calibration and Check Standards			
Working Mass Standards Verification Compared to Primary Standards	1/90 days	< ±2.1 µg	1, 2 and 3) Method 2.12, Section 9.7
Primary Standards Certification	Every 365 days and once per year	0.025 mg tolerance (Class 2)	1, 2 and 3) Method 2.12, Section 4.3.7
SYSTEMATIC CRITERIA -$PM_{2.5}$ Filter-Based Local Conditions			
Siting	1/365 days and 1/calendar year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58, Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58, Appendix E, sections 2-6
Data Completeness	***Annual Standard***	***≥ 75 percent scheduled sampling days in each quarter***	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b)
	24- Hour Standard	***≥ 75 percent scheduled sampling days in each quarter***	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 4.2 (b)
Reporting Units	***all filters***	***µg/m³ at AT and pressure***	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b)
Rounding convention for data reported to AQS	***all filters***	***to one decimal place, with additional digits to the right being truncated***	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b) Rounding rule for AQS data is a recommendation
Rounding Convention for Comparisons to the NAAQS			
Annual 3-yr average	***all concentrations***	***nearest 0.1 µg/m³*** (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4
24-hour, 3-year average	***all concentrations***	***nearest 1 µg/m³*** (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4
Detection Limit			
Lower DL	***all filters***	***≤ 2 µg/m³***	1,2 and 3) 40 CFR Part 50, Appendix L, Section 3.1
Upper Concentration Limit	***all filters***	***≥ 200 µg/m³***	1,2 and 3) 40 CFR Part 50, Appendix L, Section 3.2
Precision			
Single analyzer (collocated monitors)	1/90 days.	Coefficient of variation (CV) < 10.1 percent 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 percent confidence limit of CV < 10.1 percent for values ≥ 3.0 µg/m³***	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 and 2.3.1.1.

Table 7.6. $PM_{2.5}$ Measurement Quality Objectives: Parameter – PM2.5 (Gravimetric, Filter-Based, Local Conditions)

1) Criteria ($PM_{2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Bias			
Performance Evaluation Program (PEP)	***8 valid audits per year for PQAO/each PQAO primary monitor audited every 6 years***	***< ±10.1 percent for values ≥ 3.0 µg/m³***	1,2 and 3) 40 CFR Part 58, Appendix A, Section 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 Standard.	Every 365 days and once a calendar year	***< ± 2.1 percent of NIST-Traceable Standard.***	1) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2 2) Method 2-12 Sections 4.2.2 and 6.3.3 3) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2
Field Manometer	Every 365 days and once a calendar year	± 0.1 inches water resolution, ± 1.0 inch water accuracy	1, 2 and 3) Method 2.12, Table 4-1
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, Section 4.2.2 and Table 4-1
Field Barometer	Every 365 days and once a calendar year	± 1 millimeters mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.12, Section 4.2.2 and Table 4-1
Clock/timer Verification	1/30 days	***± 1 minute/month***	1 and 2) Method 2.12, Section 4.2.2 and Table 4-1 3) 40 CFR Part 50, Appendix L, Section 7.4.12
Laboratory Activities			
Microbalance Readability	***at purchase***	***± 1 µg***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 8.1
Microbalance Repeatability	At purchase	1 µg	1) Method 2.12, Section 4.3.6 2) Recommendation 3) Method 2.12, Section 4.3.6
Primary Mass/Working Mass Verification and Calibration Standards	At purchase	0.025 mg tolerance (Class 2)	1, 2 and 3) Method 2.12, Section 4.3.7 and Table 4-2
Comment #1 The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.			

*** value must be flagged ** SD = standard deviation CV= coefficient of variation AT = ambient temperature RH = relative humidity**

Table 7.7. True Nitrogen Dioxide Measurement Quality Objectives:
Measurement Quality Objective Parameter –Nitrogen Dioxide (NO_2) (Cavity attenuated phase shift spectroscopy).

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- NO_2			
Sampler/Monitor	***Not applicable***	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
1-Point-QC Check Single analyzer	***1/ 14 days***	Warning limit ≤ ± 10.0 percent (percent difference) Control limit ≤ ±15.0 percent (percent difference) or <±1.5 ppb difference, whichever is greater	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.1 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.4 (see DAQ NO2 CAPS SOP for details.) QC check concentration range 0.005 - 0.080 ppm and 05/05/2016 Technical Note on AMTIC. Relative to routine concentrations
Zero/span check	1/ 14 days	Zero drift ≤ ± 1.0 ppb (24 hour) ≤ ± 5.0 ppb (>24hr-14 day) Span drift < ± 10.1 percent	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO (see DAQ NO2 CAPS SOP for details.)
Shelter Temperature Range	Daily (hourly values)	20 to 30 °C. (hourly average)	1, 2 and 3) QA Handbook Volume 2, Section 7.2.2
OPERATIONAL CRITERIA- NO_2			
Shelter Temperature Control	Daily (hourly values)	< 2.1 °C Standard Deviation over 24 hours	1, 2 and 3) QA Handbook Volume 2, Section 7.2.2
Shelter Temperature Device Check	1/182 days and 2/calendar year	< ± 2.1 °C of standard	1, 2 and 3) QA Handbook Volume 2, Section 7.2.2
Internal Performance Evaluation Single Analyzer	***Every site 1/365 days and 1/ calendar year***	Percent difference of audit levels 3-10 ≤ ±15.0 percent Audit levels 1 and 2 ± 1.5 ppb difference or < ±15.1 percent	1) 40 CFR Part 58, Appendix A, section 3.1.2 2) 40 CFR Part 58, Appendix A, section 3.1.2 3) Recommendation - 3 audit concentrations not including zero. (See DAQ NO2 CAPS SOP for details.) AMTIC guidance 5/3/2016
Federal Audits (NPAP)	100 percent of PQAO sites every 6 years; 20 percent of PQAO sites audited each year	Audit levels 1 and 2 ≤ ± 1.5 ppb difference all other levels percent difference < ± 15.1 percent	1) 40 CFR Part 58, Appendix A, section 3.1.3 2) NPAP adequacy requirements on AMTIC 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving/failure of zero/span or 1-point-QC check Calibration 1/365 days / *Verification during Calibration and within 182 days of most recent calibration*	*All points <± 2.1% or ≤ 1.5 ppb difference of best-fit straight line whichever is greater and Slope 1 ± 0.5)*	1) 40 CFR Part 50, Appendix F 2 and 3) Recommendation based on instrument manual and experience (see DAQ NO_2 CAPS SOP for details.) Multi-point calibration (0 and 4 upscale points) *Slope criteria is a recommendation~~)~~*

Table 7.7. True Nitrogen Dioxide Measurement Quality Objectives: Measurement Quality Objective Parameter –Nitrogen Dioxide (NO_2) (Cavity attenuated phase shift spectroscopy).

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
Zero Air/ Zero Air Check	1/365 days and 1/ calendar year	Concentrations below lower detectable level [c]	1) 40 CFR Part 50, Appendix F, Section 1.3.2 2 and 3) Recommendation
Gaseous Standards	All gas cylinders	**NIST Traceable** (e.g., EPA Protocol Gas) 10-25 ppm [b] of NO in Nitrogen with < 1 ppm NO2	1) 40 CFR Part 50, Appendix F, Section 1.3.1 and 01/30/2018 EPA Technical Note 2) Not applicable Green book 3) 40 CFR Part 50, Appendix F, Section 1.3.1 requires 50 -100 ppm but to successfully calibrate the CAPS monitor DAQ found using 10 to 25 ppm works better (see Guidance Document). Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58, Appendix A, section 2.6.1
Gas Dilution Systems	1/365 days or after failure of 1-point-QC check or performance evaluation; 1/calendar year	Accuracy < ± 2.1 percent	1,2 and 3) Recommendation based on SO_2 requirement in 40 CFR Part 50, Appendix A-1, Section 4.1.2
Detection (FEM/FRMs) Noise and lower detectable limits are part of the FEM/FRM requirements.			
Noise	Determined by manufacturer at purchase	***≤ 0.005 ppm***	1) 40 CFR Part 53.23 (b) (definition and procedure) 2) Not applicable 3) 40 CFR Part 53.20, Table B-1
Lower detectable level	Determined by manufacturer at purchase	***≤ 0.01 ppm***	1) 40 CFR Part 53.23 (c) (definition and procedure) 2) Recommendation 3) 40 CFR Part 53.20, Table B-1

SYSTEMATIC CRITERIA- NO_2			
Standard Reporting Units	***All data***	***ppb [d] (final units in AQS)***	1,2 and 3) 40 CFR Part 50, Appendix S, Section 2 (c)
Rounding convention for data reported to AQ S	***All data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50, Appendix S, Section 4.2 (a)

Table 7.7. True Nitrogen Dioxide Measurement Quality Objectives:
Measurement Quality Objective Parameter –Nitrogen Dioxide (NO_2) (Cavity attenuated phase shift spectroscopy).

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
Completeness	***Annual Standard***	***≥ 75 percent hours in year***	1) 40 CFR Part 50, Appendix S, section 3.1(b) 2) 40 CFR Part 50, Appendix S, section 3.1(a) 3) 40 CFR Part 50, Appendix S, section 3.1(b)
	1-hour standard	***1) 3consecutive calendar years of complete data 2) 4 quarters complete in each year 3) ≥75 percent sampling days in quarter 4) ≥ 75 percent of hours in a day***	1) 40 CFR Part 50, Appendix S, section 3.2(b) 2) 40 CFR Part 50, Appendix S, section 3.2(a) 3) 40 CFR Part 50, Appendix S, section 3.2(b) More details in 40 CFR Part 50, Appendix S
Sample Residence Time Verification	1/365 days and 1/calendar year *(The DAQ goal is every 30 days)*	*< 20 seconds* *(≥ 810 cm^3/min and ≤ 990 cm^3/min)*	1) 40 CFR Part 58, Appendix E, section 9 (c) 2) Recommendation (See DAQ ECB NO_2 SOP *(in progress)* for details.) 3) 40 CFR Part 58, Appendix E, section 9 (c)
Sample Probe, Inlet, Sampling train	***All sites***	***Borosilicate glass (e.g., Pyrex®) or Teflon™***	1, 2 and 3) 40 CFR Part 58, Appendix E, section 9 (a) The EPA accepts FEP and PFA as equivalent material to Teflon™. Replacement every two years and more frequent if pollutant load or contamination dictate
[a]-National Institute of Standards and Technology [b]-parts per million [c]-Lower Detection Limit [d]-parts per billion			
Siting	1/365 days and 1/calendar year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58, Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58, Appendix E, sections 2-6
Precision (using 1-point-QC checks)	***Calculated annually and as appropriate for design value estimates***	***90 percent confidence limit CV <15.1 percent***	1) 40 CFR Part 58, Appendix A, Section 2.3.1.4 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.2
Bias (using 1-point-QC checks)	***Calculated annually and as appropriate for design value estimates***	***95 percent confidence limit < ± 15.1 percent***	1) 40 CFR Part 58, Appendix A, section 2.3.1.4 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.3

AMTIC – Ambient Monitoring Technology Information Center
FEP – Fluorinated ethylene propylene
PFA - perfluoroalkoxy

Table 7.8. Measurement Quality Objectives: Teledyne T640X Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (PM T640X)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA - Measurement Quality Objectives: Teledyne T640X Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)			
Sampler/Monitor	Not applicable	meets requirements listed in FRM/FEM designation; confirm method designation on front panel or just inside instrument	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and 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 PM2.5 and (2) STP for PM10.	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, 2 and 3) 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 Period			
PM_{10} Inlet	At setup	Must be a Louvered PM_{10} size selective inlet as specified in 40 CFR Part 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 percent of 16.67 LPM for total flow	1, 2 and 3) 40 CFR Part 50 App L Sec. 7.4.3.1
Variability in Flow Rate	every 24 hours of operation	CV* ≤ 2 percent	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.2
One-point Flow Rate Verification (Total Flow)	Every 30 days, each separated by 14 days (DAQ goal is 2/month separated by 14 to 18 days)	< ± 4.1 percent of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard); < ± 5.1 percent of flow rate design value (DAQ's warning limit is ≤± 4 percent of flow rate design value)	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix B Section 3.2.1 and 3.3.1 3) *DAQ T640X SOP*, Section 7.0
One-point Flow Rate Verification (Sample Flow)	1/30 days, separated by 14 days (DAQ goal is 2/month separated by 14 to 18 days)	< ± 4.1% of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard)	1, 2 and 3) 40 CFR Part 50, App.L, Sec. 9.2.5, 40 CFR Part 58, Appendix B, Sec. 3.2.1, 3) DAQ T640X SOP, Section 7.0
PMT verification	every 90 days	≤ ± 1.5 of SpanDust™ value stated on bottle	1) Teledyne T640 manual

Table 7.8. Measurement Quality Objectives: Teledyne T640X Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)			
1) Criteria (PM T640X)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
			2) EPA T640x SOP 3) To meet DQO set forth in 40 CFR Part 58, Appendix B, Sec. 2.3.1.1 and DAQ T640X SOP, Section 7.0
OPERATIONAL CRITERIA - Measurement Quality Objectives: Teledyne T640X Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)			
Routine Verifications			
Mid-Month Flow Rate Verification	1/30 days	Total Flow < ± 4.1% of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard); < ± 5.1% of flow rate design value (DAQ's warning limit is ≤± 4 percent of flowrate design value) Sample Flow < ± 4.1% of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard)	1) 40 CFR Part 50, Appendix L, Section 9.2.5 and 40 CFR Part 58, Appendix B, Section 3.2.1 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0
One-point Temperature Verification	1/30 days	< ± 2.1 °C	1) Teledyne T640 manual and 40 CFR Part 50, Appendix L, Section 9.3 2) EPA T640x SOP 3) Teledyne T640 manual and *DAQ T640X SOP*, Section 7.0
Pressure Verification	1/30 days	< ± 10.1 millimeters mercury	1) Teledyne T640 manual and 40 CFR Part 50, Appendix L, Section 9.3 2) EPA T640x SOP 3) Teledyne T640 manual and *DAQ T640X SOP*, Section 7.0
Leak Check (Zero Test)	every 30 days	≤ 0.2 µg/m^3	1) Teledyne T640 manual and 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) EPA T640x SOP 3) Teledyne T640 manual and *DAQ T640X SOP*, Section 7.0. DAQ designates this as an operational criterion.
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.

Table 7.8. Measurement Quality Objectives: Teledyne T640X Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (PM T640X)	2) Frequency	3) Acceptable Range	Information /Action
Annual Multi-Point Calibrations			
Pressure Verification or Calibration	On installation, electromechanical maintenance or transport or 1/365 days and once per calendar year	<± 10.1 millimeters mercury	1) Teledyne T640 manual and 40 CFR Part 50, Appendix L, Section 9.3 2) Method 2.12, section 6.5 3) Teledyne T640 manual and Method 2.12, section 6.5 Barometric pressure verified against an independent standard verified against a laboratory primary standard that is certified NIST-traceable 1/365 days
Flow Rate Multi-Point Calibration	Electromechanical maintenance or transport or 1/365 days and once per calendar year	<± 2.1 percent of transfer standard for all flows	1) 40 CFR Part 50, Appendix L, Section 9.2. 2) 40 CFR Part 50, Appendix L, Section 9.1.3, Method 2.12 Section 6.3 and Table 6-1 3) 40 CFR Part 50, Appendix L, Section 9.2.5
Accuracy			
Temperature Audit	1/90 days and at time of flow rate audit	± 2°C	1, 2 and 3) Method 2.12, Section 11.2.2
Pressure Audit	1/90 days and at time of flow rate audit	<±10 millimeters mercury	1, 2 and 3) Method 2.12, Section 11.2.3
Semi-Annual Flow Rate Audit (Total Flow)	1/90 days	< ± 4.1 percent of audit standard; < ± 5.1 percent of design flow rate (DAQ's warning limit for percent of transfer standard and flow design value is ≤±3.0 and ≤±4.0 percent, respectively)	1 and 2) 40 CFR Part 58, Appendix B, Sections 3.2.2 and 3.3.2 3) Method 2.12 Section 11.2.1
Semi-Annual Flow Rate Audit (Sample Flow)	1/90 days	< ± 4.1 percent of audit standard; (DAQ's warning limit for percent of transfer standard a is ≤±3.0 percent)	1 and 2) 40 CFR Part 58, Appendix B, Sections 3.2.2 and 3.3.2 3) Method 2.12 Section 11.2.1
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 Section 7.2.2

Table 7.8. Measurement Quality Objectives: Teledyne T640X Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (PM T640X)	2) Frequency	3) Acceptable Range	Information /Action
Monitor Maintenance			
Clean inlet (PM_{10} Head)	Every 30 days	cleaned	1) DAQ T640X SOP Section 8.0 and Teledyne T640 manual 2) Teledyne T640 manual 3) DAQ T640X SOP Section 8.0 and 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 or changed	1) DAQ T640X SOP Section 8.0 and Teledyne T640 manual 2) EPA T640X SOP 3) DAQ T640X SOP Section 8.0 and EPA T640X SOP
Replace Disposable Filter Unit	Annually or when Pump PWM value approaches 80%.	cleaned or changed	1) DAQ T640X SOP Section 8.0 and Teledyne T640 manual 2) EPA T640X SOP 3) DAQ T640X SOP Section 8.0 and 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) DAQ T640X SOP Section 8.0 and Teledyne T640 manual 2) EPA T640X SOP 3) DAQ T640X SOP Section 8.0 and Teledyne T640 manual
Check Pump Performance (Valve)	Every 30 days	PWM value 50 < 85%	1) DAQ T640X SOP Section 8.0 and Teledyne T640 manual 2) EPA T640X SOP 3) DAQ T640X SOP Section 8.0 and Teledyne T640 manual
Inspect inner and outer sample tubes	Every 30 days	Inspected and cleaned as needed	1,2 and 3) Teledyne T640 manual
Empty Water Collection Bottle	Every 30 days	cleaned	1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0
Inspect O-rings	Every 30 days	Visual inspection	1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0
Clean Temperature Probe Solar Shield	1/90 days	cleaned	1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0
Internal/External Data Logger Data	Every month highest value on three randomly selected days	agree exactly (digital) and ± 1 µg/m3 (analog)	1) DAQ T640X SOP Section 9.0 2) DAQ practice 3) DAQ T640X SOP Section 9.0

Table 7.8. Measurement Quality Objectives: Teledyne T640X Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)			
1) Criteria (PM T640X)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
ASC Test	1/30 days	heater turns on when forced off	1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0
Manufacturer Recommended Maintenance	per manufacturers' manual	per manufacturers' manual	1, 2 and 3) Manufacturer-Recommended Maintenance
SYSTEMATIC CRITERIA - Measurement Quality Objectives: Teledyne T640X Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)			
Siting	1/365 days and 1/calendar year	meets siting criteria or waiver documented	1) 40 CFR Part 58 Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58 Appendix E, sections 2-6
Data Completeness	Annual Standard ($PM_{2.5}$)	≥ 75 percent of scheduled sampling days in each quarter	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
	24-hour averages and quarterly	≥ 75 percent of hours per day and scheduled sampling days in each quarter	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
	PSD determinations	12-month period - ≥ 80 percent of hours	1, 2 and 3) Ambient Monitoring Guidelines for Prevention of Significant Deterioration, Section 2.4.2.
Reporting Units	all hourly and 24-hour values	µg/m3 at ambient temperature and pressure (PM2.5, PM10, PM10-2.5) µg/m3 at STP (PM10)	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b), 40 CFR Part 50, Appendix K, Section 2.3 (a)
Rounding convention for data reported to AQS	all 1-hour averages	to one decimal place, with additional digits to the right being truncated or as reported by instrument	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b) Rounding rule for AQS data is a recommendation
Rounding convention for PM10 design value calculation	All 24-hour averages from midnight to midnight	nearest 10 µg/m3 at STP (≥ 5 round up)	1, 2 and 3) 40 CFR Part 50, Appendix K, Section 1 The rounding convention is for averaging values for comparison to the NAAQS and not for reporting individual values to AQS.
Rounding convention for annual 3-yr average for PM2.5	all concentrations	all concentrations nearest 0.1 µg/m3 (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4, the rounding convention for comparison to NAAQS not for reporting individual values
Rounding convention for 24-hour, 3-yr average for PM2.5	all concentrations	all concentrations nearest 1 µg/m3 (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4, the rounding convention for comparison to NAAQS not for reporting individual values

Table 7.8. Measurement Quality Objectives: Teledyne T640X Continuous $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Local Conditions and PM_{10} Standard Temperature and Pressure (STP)

1) Criteria (PM T640X)	2) Frequency	3) Acceptable Range	Information /Action
Verification/Calibration Standards and Recertifications - All standards should have multi-point certifications against NIST Traceable standards			
Flow Rate Transfer Standard	1/365 days and once each calendar year	< ± 2 percent of NIST-Traceable Standard	1) 40 CFR Part 50, Appendix L, Section 9.1 and 9.3 and Appendix J, Section 7.3 2) Method 2-12, Section 4.2.3 and 6.3.3 and Method 2.11 Section 1.1.3 3) 40 CFR Part 50, Appendix L, Section 9.1 and 9.3 and Appendix J, Section 7.3
Field Thermometer	1/365 days and once each calendar year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Barometer	1/365 days and once each calendar year	± 1 millimeter mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Manometer	1/365 days and once each calendar year	± 0.1 in water resolution, ± 1.0 in water accuracy	1, 2 and 3) Method 2.12, Table 4-1
Clock/timer Verification	1/30 days	± 1 minute/month	1 and 2) Method 2.12 Table 3-1 3) 40 CFR Part 50, Appendix L Section 7.4.12
Precision (using flow rate verifications – no collocation is required for continuous PM10)			
Primary Quality Assurance Organization	Annual and 3-year estimates (if monitor operated that long)	90 percent confidence limit of CV* < 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix B, Section 3.2.1, 3.3.1, 4.2.2 and 2.3.1.1.
Bias (using flow rate verifications – no NPAP or PEP is available for PM_{10})			
Primary quality assurance organization	Annual and 3-year estimates (if monitor operated that long)	≤ ±10.0 percent for total bias	1, 2 and 3) 40 CFR Part 58, Appendix B, Section 2.3.1.1, 4.2.2 and 3.3.1
ASC = Aerosol Sample Conditioner			

Table 7.9. Ambient Temperature Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Ambient Temperature (AT) (Thermistor)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-AT			
Accuracy	At purchase Every 182 days	± 0.5°C	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C

Table 7.9. Ambient Temperature Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Ambient Temperature (AT) (Thermistor)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
Time Constant	At purchase	≤ 1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C
Operating Range	At purchase	-30 – 50	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Resolution	At purchase	0.1	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving and every 182 days	CTS Method.Ran For 7 days with a minimum of 48 valid hours.	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final) Table 0-4 NCore Calibration & Accuracy Criteria
OPERATIONAL CRITERIA-AT			
Calibration and audit standards	Purchase, recertify 1/365 days or per NIST/ASTM certification frequency	CTS Method. Ran For 7 days with a minimum of 48 valid hours.	1, 2 & 3) Quality Assurance Handbook for Air Pollution Meas-urement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final) Table 0-4 NCore Calibration & Accuracy Criteria
Annual Accuracy Evaluation	Every site 1/365 days	CTS Method. Ran For 7 days with a minimum of 48 valid hours.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Minimum Sample Frequency	Every site Every workday	Hourly	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Raw Data Collection Frequency	Every site Every workday	1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Hourly Recorded AT	1/30 days	Local record low ≤ Temp ≤ local record high; Temp ≤ 5°C from previous hourly record; Temp varies ≥ 0.5°C/12 consecutive hours, or per site specific climatology criteria	1, 2 and 3) EPA -454/R-99-005 Feb 2000, Chapter 8,Table 8-4

Table 7.9. Ambient Temperature Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Ambient Temperature (AT) (Thermistor)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
Appropriate radiation shield	1/182 days	Free from dirt, no surface damage	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final)
DAS Clock/timer Verification	1/7 days (or every site visit if site visited less than weekly)	< ± 1 minute NIST EST.	1, 2 and 3) Recommendation
Data Acquisition System (internal battery back-up)	1/182 days	Check Battery Back-up, replace as needed	1, 2 and 3) Recommendation
SYSTEMATIC CRITERIA-AT			
Sensor/Monitor	At purchase/installation	Meets requirements listed in QA Handbook	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Standard Reporting Units	All data	ºC (final units in AQS)	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Rounding convention for data reported to AQS	All data	1 decimal place	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Completeness	Quarterly Hourly	75 % of hourly averages for the quarter 75 % of minute averages for the hour	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Siting	1/365 days	Meets siting criteria or waiver documented	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
Distance from Obstruction	At installation/moving 1/365 days	1.5x the tower diameter from tower support & at least 4x height from ground (i.e., 8 m for a sensor located at 2 m above ground) from trees & buildings	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Distance Above Ground	At installation/moving 1/365 days	10 meters	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors

Table 7.9. Ambient Temperature Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Ambient Temperature (AT) (Thermistor)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
Recommended Ground Cover	At installation/moving 1/365 days	Non-irrigated or un-watered short grass, or natural earth at least 9 m in diameter. The surface should not be concrete, asphalt or oil soaked. Reflection from these surfaces may affect sensor performance.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Technical Systems Audit	1/3 years	Data meets acceptance criteria in validation table	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 10 & Appendix A

Table 7.10. NCore Wind Speed Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Speed (WS) (Cup, prop or sonic anemometer)

1) Requirement (WS)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-WS			
Accuracy	At purchase 1/182 days	± 1.0 m/s	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C
Starting Threshold	At purchase 1/182 days	≤ 0.5 meters per second	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final)
Operating Range	At purchase	0.5 – 50.0 meters per second	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Resolution	At purchase	0.1 meters per second	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/182 days	CTS method. Ran for 7 days with a minimum of valid 48hrs, excluding rain events, and using hours with WS in range of 1 m/s to 10 m/s	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
OPERATIONAL CRITERIA-WS			
Calibration and audit standards	Purchase, recalibrate 1/365 days or at frequency dependent upon use	CTS method. Ran for 7 days with a minimum of valid 48hrs, excluding rain events, and using hours with WS in range of 1 m/s to 10 m/s	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria

Table 7.10. NCore Wind Speed Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Speed (WS) (Cup, prop or sonic anemometer)

1) Requirement (WS)	2) Frequency	3) Acceptance Criteria	Information /Action
Annual Accuracy / Performance Evaluation	Every site 1/182 days	CTS method. Ran for 7 days with a minimum of valid 48hrs, excluding rain events, and using hours with WS in range of 1 m/s to 10 m/s	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Minimum Sample Frequency	Every site Every day	Hourly	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Raw Data Collection Frequency	Every site Every day	1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Hourly Recorded WS	Every workday 1/30 days	0 m/s ≥ WS ≤ 25 m/s0, WS varies ≥ 0.1 m/s/3 consecutive hours, WS varies ≥ 0.5 m/s/12 consecutive hours, or per site specific climatology criteria	1, 2 and 3) EPA -454/R-99-005 Feb 2000, Chapter 8, Table 8-4
Preventative maintenance	1/182 days	Follow manufacturer's instructions	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Routine maintenance	1/182 days	Application of cleaning and protective lubricants to mounting hardware	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Visual Inspection	1/7 days (or every site visit if site visited less than weekly)	No visual damage	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.1
DAS Clock/timer Verification	1/7 days (or every site visit if site visited less than weekly)	< ± 1 minute NIST EST	1, 2 and 3) Recommendation
Data Acquisition System (internal battery back-up)	1/182 days	Check Battery Back-up, Replace as needed	1, 2 and 3) Recommendation
SYSTEMATIC CRITERIA-WS			
Sensor/Monitor	At purchase/installation	Meets requirements listed in QA Handbook	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Standard Reporting Units	All data	Meters per second (final units in AQS)	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore

Table 7.10. NCore Wind Speed Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Speed (WS) (Cup, prop or sonic anemometer)

1) Requirement (WS)	2) Frequency	3) Acceptance Criteria	Information /Action
			Meteorological Measurement Quality Objectives
Rounding convention for data reported to AQS	All data	1 decimal place	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Completeness	Quarterly Hourly	75 % of hourly averages for the quarter 75 % of minute averages for the hour	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Siting	1/365 days	Meets siting criteria or waiver documented	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
Distance from Obstruction	At installation/moving 1/365 days	10x the height of the obstruction	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Distance Above Ground	At installation/moving 1/365 days	10 meters	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Recommended Ground Cover	At installation/moving 1/365 days	Grass or gravel	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Technical Systems Audit	1/3 years	Data meets acceptance criteria in validation table	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 10 & Appendix A

Table 7.11. NCore Wind Direction Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Direction (WD) (Vane or sonic anemometer)

1) Requirement (WD)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-WD			
Data Validity	Every 182 days	Compass stability. Standard deviation ≤ 2.0 for 24hr period before and 24 hr period after site visit.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.5.2.5
Orientation	1/182 days	AIO2 sensor self-orients and corrects for WD	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.5.2.1
Starting Threshold	1/182 days	≤ 0.5 meters per second at 10 degrees	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final)
Operating Range	At purchase	0 – 360 (or 540) degrees	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Resolution	At purchase	1.0 degrees	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/182 days	CTS method. Ran for 7 days with a minimum of valid 48hrs, excluding rain events, and using hours with WS in range of 1 m/s to 10 m/s	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
OPERATIONAL CRITERIA-WD			
Calibration and audit standards	Purchase, recalibrate 1/365 days or at frequency dependent upon use	CTS method. Ran for 7 days with a minimum of valid 48hrs, excluding rain events, and using hours with WS in range of 1 m/s to 10 m/s	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Annual Accuracy Evaluation	Every site 1/365 days	CTS method. Ran for 7 days with a minimum of valid 48hrs, excluding rain events, and using hours with WS in range of 1 m/s to 10 m/s	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria

Table 7.11. NCore Wind Direction Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Direction (WD) (Vane or sonic anemometer)

1) Requirement (WD)	2) Frequency	3) Acceptance Criteria	Information /Action
Minimum Sample Frequency	Every site Every work day	Hourly	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Raw Data Collection Frequency	Every site Every workday	1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Hourly Recorded WD	Every workday 1/30 days	0°≥ WD ≤ 360°, WD varies ≥ 1°/3 consecutive hours, or per site specific climatology criteria	1, 2 and 3) EPA -454/R-99-005 Feb 2000, Chapter 8,Table 8-4
Preventative maintenance	1/182 days	Follow manufacturer's instructions	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Routine maintenance	1/182 days	Application of cleaning and protective lubricants to mounting hardware	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Visual Inspection	1/7 days (or every site visit if site visited less than weekly)	No visual damage	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.1
DAS Clock/timer Verification	1/7 days (or every site visit if site visited less than weekly)	< ± 1 minute NIST EST	1, 2 and 3) Recommendation
Data Acquisition System (internal battery back-up)	1/182 days	Check Battery Back-up, Replace as needed	1, 2 and 3) Recommendation
SYSTEMATIC CRITERIA-WD			
Sensor/Monitor	At purchase/installation	Meets requirements listed in QA Handbook	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Standard Reporting Units	All data	Degrees (final units in AQS)	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final)

Table 7.11. NCore Wind Direction Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Direction (WD) (Vane or sonic anemometer)

1) Requirement (WD)	2) Frequency	3) Acceptance Criteria	Information /Action
			Table 0-3 NCore Meteorological Measurement Quality Objectives
Rounding convention for data reported to AQS	All data	1 decimal place	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Completeness	Quarterly Hourly	75 % of hourly averages for the quarter 75 % of minute averages for the hour	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Siting	1/365 days	Meets siting criteria or waiver documented	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
Distance from Obstruction	At installation/moving 1/365 days	10x the height of the obstruction	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Distance Above Ground	At installation/moving 1/365 days	10 meters	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Recommended Ground Cover	At installation/moving 1/365 days	Grass or gravel	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Technical Systems Audit	1/3 years	Data meets acceptance criteria in validation table	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 10 & Appendix A
GPS = global positioning system			

Table 7.12. Relative Humidity Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Relative Humidity (RH) (Capacitive)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-RH			
Accuracy	At purchase Every 182 days	±5.0%	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C
Time Constant	At purchase	≤ 1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C
Operating Range	At purchase	0 – 100	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Resolution	At purchase	1.0%	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving and every 182 days	CTS Method.Ran For 7 days with a minimum of 48 valid hours.	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final) Table 0-4 NCore Calibration & Accuracy Criteria
OPERATIONAL CRITERIA-RH			
Calibration and audit standards	Purchase, recertify 1/365 days or per NIST/ASTM certification frequency	CTS Method. Ran For 7 days with a minimum of 48 valid hours.	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final) Table 0-4 NCore Calibration & Accuracy Criteria
Annual Accuracy Evaluation	Every site 1/365 days	CTS Method. Ran For 7 days with a minimum of 48 valid hours.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Minimum Sample Frequency	Every site Every workday	Hourly	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Raw Data Collection Frequency	Every site Every workday	1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives

Table 7.12. Relative Humidity Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Relative Humidity (RH) (Capacitive)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
Appropriate radiation shield	1/182 days	Free from dirt, no surface damage	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final)
DAS Clock/timer Verification	1/7 days (or every site visit if site visited less than weekly)	< ± 1 minute NIST EST.	1, 2 and 3) Recommendation
Data Acquisition System (internal battery back-up)	1/182 days	Check Battery Back-up, replace as needed	1, 2 and 3) Recommendation
SYSTEMATIC CRITERIA-RH			
Sensor/Monitor	At purchase/installation	Meets requirements listed in QA Handbook	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Standard Reporting Units	All data	% RH (final units in AQS)	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Rounding convention for data reported to AQS	All data	1 decimal place	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Completeness	Quarterly Hourly	75 % of hourly averages for the quarter 75 % of minute averages for the hour	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Siting	1/365 days	Meets siting criteria or waiver documented	1) 40 CFR Part 58 App E, sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, sections 2-6
Distance from Obstruction	At installation/moving 1/365 days	1.5x the tower diameter from tower support & at least 4x height from ground (i.e., 8 m for a sensor located at 2 m above ground) from trees & buildings	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Distance Above Ground	At installation/moving 1/365 days	10 meters	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors

Table 7.12. Relative Humidity Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Relative Humidity (RH) (Capacitive)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
Recommended Ground Cover	At installation/moving 1/365 days	Non-irrigated or un-watered short grass, or natural earth at least 9 m in diameter. The surface should not be concrete, asphalt or oil soaked. Reflection from these surfaces may affect sensor performance.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Technical Systems Audit	1/3 years	Data meets acceptance criteria in validation table	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 10 & Appendix A

7.3 Network Scale

The EPA defines representativeness as a measure of the degree to which data accurately and precisely represent a selected characteristic of a monitored system. The DAQ achieves representativeness 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).

The chief with assistance from the RRO monitoring technicians and coordinator and PPB supervisor assign each monitor a scale of representativeness based on the 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 4,000 m (0.5 to 4.0 km) range.
- ***Urban Scale -*** describes air volumes within cities with dimensions about 4,000 m to 50,000 m (4.0 km to 50 km). This scale would usually require more than one site for definition.
- ***Regional Scale -*** describes air volumes associated with rural areas of reasonably homogeneous geography that extends for tens to hundreds of kilometers.

NCore multi-pollutant sites are sites that measure multi-pollutant concentrations primarily used to characterize air quality trends, to assist in understanding transport across representative areas, for model evaluation and for comparison to the NAAQS. NCore sites include both neighborhood and middle scale measurements and therefore shall be located away from direct emission sources.

8.0 Training Requirements

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. DAQ personnel will meet the educational requirements, accountability standards and training requirements for their positions. Section 4 of the QMP describes the DEQ training program. DAQ requires all staff to take specific, mandatory governmental training courses, such as safety training, defensive driving and harassment awareness courses, among others. The DAQ maintains records on personnel qualifications and training in several locations, dependent upon the applicability of the information. For example, staff may maintain copies of certificates received from classes or workshops, whereas human resources will keep records of personnel qualifications. The DAQ uses the North Carolina Learning Management System, or LMS, to track training by DIT and the Office of State Human Resources.

The DAQ aims ambient air monitoring training at increasing the effectiveness of employees as well as the effectiveness of DAQ. In general, training for the ambient air monitoring program consists of a combination of required reading, ambient monitoring monthly meetings, active cross-training amongst staff, completion of EPA-led training classes and attendance at DAQ and EPA workshops and conferences. Currently, no recurring annual training is required for the NCore monitoring staff other than attendance at the annual ambient monitoring workshop. Observations made during internal systems audits or EPA technical systems audits (TSAs) may result in the need for specific refresher training provided by DAQ staff. Completion of additional training – such as self-instructional air monitoring courses and EPA-provided webinars – is encouraged by all staff.

Specific air monitoring personnel training consists of required reading before implementing the requirements of this QAPP. Documents monitoring personnel must read shall include this QAPP and the SOPs (see Table 11.2) and instrument manuals specific to the equipment personnel will be working with or servicing. Employee supervisors or trainers typically document required reading on a form indicating the employee has read and understood the QAPP and SOP. These forms are archived in Laserfiche. Specific training requirements are provided in SOP DAQ-15-003 (*in draft and under review at this time*). DAQ continually revises the training program and updates the training forms used to document training as needed.

All positions have a training guide that provides suggested training for each employee to complete for competency in that position. Staff are encouraged to also read applicable parts of the CFR (e.g., 40 CFR, Part 50 and 58), the QA Handbook, Vol. II, and EPA's data validation guidance documents and policy memoranda. See Table 11.2 for relevant SOPs to review.

The DAQ makes efforts to ensure all employees receive timely training and periodic refreshers in accordance with the established training guide. Experienced staff members provide on-the-job training. As the RRO has the largest ambient monitoring staff with the most diversified monitoring equipment, the chief often calls upon the RRO to provide hands-on training when needed. The chief or PPB supervisor or equivalent typically arranges for this training. In some cases, the chief calls upon other regional offices, the ECB electronic technicians and PPB chemists to provide hands-on training. Employees document their training on the provided training forms (obtained from Laserfiche), which are archived in Laserfiche as well as in the employee's valuing individual performance (VIP). Before 2021, the employee may also have archived training records in the North Carolina Learning Management System, or LMS.

The DAQ supervisors actively encourage all employees to pursue training opportunities whenever possible and as needed, because the chief continually evaluates DAQ's monitoring network to ensure it continues to meet its objectives. Because of these evaluations, the chief could add new equipment, procedures or new personnel to the project. DAQ provides vendor-based training for its personnel when DAQ obtains new equipment. The employees document this training on the provided training forms (obtained from Laserfiche), which are archived in Laserfiche. The employee may also archive the training records in the LMS. Additionally, personnel are encouraged to periodically identify, request, and attend pertinent courses and seminars. The chief may provide these courses and seminars as videotapes, closed circuit transmission, web-based real-time interactive formats and/or live instruction or a combination of one or more. Organizations that provide these training opportunities include local and regional universities, the Air and Waste Management Association, the Mid Atlantic Regional Air Management Association and EPA. The DAQ supervisors track this training for their employees on the appropriate training form and archive it in Laserfiche. Air monitoring personnel have sufficient training to perform necessary functions at an acceptable level. The DAQ supervisors also track and document this training in both the LMS and VIP. They also evaluate employee proficiency, based on performance and feedback from peers and other coworkers. During the VIP review, the supervisors recommend any refresher training the employee may need and develop a plan for the employee to receive the needed training. The LMS provides and archives certificates of completion for any course work taken through the LMS.

Prior to the start of on-site work, DAQ provides all field personnel instruction specific to the project covering the following areas:

- Organization and lines of communication and authority,
- Overview of the QAPP, including monitoring maintenance, calibration, and QC activities,
- Quality assurance / quality control, or QA/QC, requirements,
- Document requirements, and
- Health and safety requirements.

Monitoring staff provide new monitoring personnel and the NCore monitoring station technicians, who operate this site, necessary on-the-job training for their individual monitoring tasks, including data review, verification and validation. Upon completion of training, the trainee will be performance tested on knowledge, skills, and abilities in the field and at the office. Upon successful demonstration of initial competency, the trainer will complete Form DAQ-16-022 DAQ Initial Demonstration of Competency. Continuing demonstration of competency is noted during VIP reviews and internal TSAs and documented using Form DAQ-16-019 DAQ Continuing Demonstration of Competency. The employee documents all on-the-job training on the appropriate form and archives it in Laserfiche. Ongoing proficiency is reviewed on an as needed basis. No certificates are provided to the trainee and trainee proficiency is documented as part of the on-the-job training process and documentation.

The chief invites the coordinators and regional monitoring technicians to the North Carolina DAQ ambient monitoring workshop held each year. This workshop provides an opportunity to discuss and train on monitoring and the QC and QA processes, including data review and verification, to ensure the collection of valid data. A senior staff member provides hands-on instruction with the analyzers as on the job training when new employees are hired. The vendor

provides training when DAQ purchases new monitors and other equipment. The DAQ and EPA staff provides training annually during the monitoring workshop. All available presentations and materials generated at the workshop are maintained on the RCO group drive or in SharePoint for archival purposes. No formal evaluation forms are collected during or after the workshop.

DEQ - DAQ Training Links:

Air Monitoring: https://www.epa.gov/amtic/conferences-and-training

Professional Skills: http://oshr.nc.gov/state-employee-resources/training

9.0 Documentation and Records

The following information describes DAQ's management of documents and records, including this QAPP, for the NCore Ambient Air Quality Monitoring Program. Currently, DAQ does not have a single designated position responsible for policing documents and/or records for the entire AMS. A dedicated document and records custodian would be a tremendous asset; however, such a position is unlikely to be created anytime in the foreseeable future due to a lack of funding. Also, this huge responsibility cannot be assigned to a single position within the already overburdened monitoring staff. Therefore, the AMS has established that the individual staff members who generate the original document and/or record are responsible for the placement, maintenance and archival of their respective documents and records. DAQ-14-003 provides additional details on document retention procedures.

DIT maintains a shared group drive for use by ambient monitoring personnel in the RCO and RRO. Access to this drive is restricted to DAQ personnel and assigned DIT personnel. Although it is commonly referred to as the "P" drive, the group drive may have different letter designations in the regional offices. To reduce confusion, the group drive will be referred to as the "RCO group drive" in this QAPP.

Microsoft SharePoint is used as an access-restricted document and records storage repository by the RRO. The RRO ambient monitoring coordinator is responsible for all ambient monitoring documents and/or records stored on the RRO SharePoint site. Access to the RRO SharePoint page is restricted to RRO personnel. RRO records and/or documents are stored on the RRO SharePoint site and the RRO retains its records and/or documents according to the retention schedule. RCO chemists do not have access to the RRO SharePoint site. Therefore, any document and/or record requiring RCO review is placed on the RCO group drive by the RRO staff for the RCO chemist to review and approve. The RCO chemists are assigned specific program areas for which they are responsible. For instance, each chemist is responsible for a specific criteria pollutant, such as ozone, particulate matter, SO_2, nitrogen oxides, and carbon monoxide (CO). Also, a specific RCO chemist is assigned to meteorology data and a specific RCO Chemist is assigned to air toxics data. These chemists are responsible for the final approved records that are stored on the RCO group drive.

Documents and records are archived in the internal access restricted Laserfiche. The RCO staff also use SharePoint to share information such as reference materials, meeting notes, draft copies of documents, news articles, workshop materials, presentations, and other miscellaneous information.

The RCO SharePoint page is for internal division usage by the AMS and access is restricted to specific North Carolina air quality and DAQ staff, but it is not the official location of the approved QMP, QAPPs and SOPs. The approved QMP, QAPPs and SOPs are posted to the DEQ/DAQ website for the ease of access for all State, Local and Tribal staff at any location where internet access is available, such as the monitoring sites. All approved documents are posted to the website under strict approval processes and protocols.

DIT routinely creates backups of all data stored on the RCO group drive and Laserfiche. Files stored in the "Ambient Monitoring" module of Laserfiche are protected from deletion; any file a user attempts to delete remains in the database but is hidden from view. A supervisor can restore that file to its previous location via a request to the Laserfiche administration staff. As a cloud-

based file storage location, SharePoint file backups are facilitated by Microsoft, Inc.; all files are backed up twice daily and Microsoft provides a 90-day window for recovery of documents from inadvertent editing or deletion.

The DAQ secures all electronic documents using encrypted laptops or password protected computers and by storing paper documents in limited access areas. The ambient monitoring chief must approve QAPP and SOP revisions, including changes to forms, before monitoring personnel use them. The DAQ also ensures sufficient document control of all these records. Additionally, SOPs must not conflict with any part of this QAPP or with any other relevant local, state or federal regulation.

Table 9.1 lists the documents and records pertaining to all data the EPA requires DAQ to collect and all other data deemed important by DAQ's policies and records management procedures, including documents and records required to support the concentration data reported to EPA.

Table 9.1. Documentation and Records Information

Categories	Record/Document Type	File Locations
Management and Organization	State implementation plan Reporting agency information EPA directives Grant allocations Support contracts	Raleigh, NC – Raleigh Central Office (RCO)
	Quality management plan	DEQ Website
	Organizational structure	Ambient Monitoring Administration Page on SharePoint
	Personnel qualifications and training	DEQ HR and DAQ Training page on SharePoint
	Training records and certification	Learning Management System, Laserfiche Ambient Monitoring Module and Valuing Individual Performance
Site Information	Network descriptions Site files Site maps Site pictures	RCO group drive, Raleigh Regional Office group drive, Laserfiche Ambient Monitoring Module
Environmental Data Operations	Quality assurance project plans	DEQ Website for official repository. Other file locations include Laserfiche Ambient Monitoring Module for archived versions, NC AMS QAPP page on SharePoint or RCO group drive (see below)
		RTI: RTI; SharePoint for official repository; Raleigh Central Office Group Drive; Laserfiche Ambient Monitoring Module for archived versions
	Standard operating procedures	DEQ Website for official repository. Other file locations include Laserfiche Ambient

Table 9.1. Documentation and Records Information

Categories	Record/Document Type	File Locations
		Monitoring Module for archived versions, (see Section 9.1)
		RTI: RTI; SharePoint for official repository; Raleigh Central Office Group Drive; Laserfiche Ambient Monitoring Module for archived versions
	QA bulletins and technical notes	DEQ Website, Laserfiche Ambient Monitoring Module (see below)
	Field and site notebooks	RCO group drive, Raleigh Regional Office group drive, Millbrook site
	Laboratory notebooks Sample handling and custody records	RCO
	Inspection and maintenance records	RCO group drive, Raleigh Regional Office group drive, ECB
Raw Data	Any original data including routine, QC, RTI data packages (see section 9.2.1), etc. Including data entry forms	Raleigh, NC – RCO, Raleigh Regional Office, ECB and RTI Lab
Data Reporting	Air quality index reports	DAQ Website, Laserfiche Ambient Monitoring Module
	Annual data certification report	Laserfiche Ambient Monitoring Module
	Data/summary reports	DAQ Website, Laserfiche Ambient Monitoring Module
	Journals/articles/papers/presentations	RCO group drive, Laserfiche Ambient Monitoring Module
Data Management	Data algorithms Data management plans and flowcharts Data management systems	Raleigh, NC – RCO
	Pollutant data Minute data Meteorological data	Envista ARM database

Table 9.1. Documentation and Records Information

Categories	Record/Document Type	File Locations
Quality Assurance	Network reviews and assessments Control charts Certification documentation Data quality assessments EPA technical systems audit reports Internal systems audit reports RTI Technical Systems Audits Response/corrective action reports Site audits e-mails related to QA activities and assessments	Raleigh, NC – RCO, ECB and Raleigh Regional Office Laserfiche Ambient Monitoring Module
	RTI Corrective Action reports	RTI: RTI; SharePoint for official repository; Raleigh Central Office Group Drive; Laserfiche Ambient Monitoring Module for archived versions

The state of North Carolina considers all e-mails official records, and the state of North Carolina retains all e-mail correspondence for a minimum of 10 years. In addition, DAQ archives critical e-mails for documenting official decisions regarding network decisions and data quality decisions in Laserfiche.

Most documentation and records produced by DAQ's NCore monitoring program consist of data and information gathered to support the data collection activities. Documentation and records include:

- QAPPs;
- SOPs;
- Logbooks and data collection records in electronic and written format;
- Instrument and equipment calibration information;
- QA documentation in electronic and written format; and
- Documentation that supports data review, validation, and certification activities.

Upon assuming a new role working with DAQ documents and/or records, personnel are trained on the appropriate specific locations for each of the document and record types listed in Table 9.1, how to access the various locations, and proper procedures for maintaining those documents and/or records for which they are responsible. If DAQ personnel require access to documents or records outside of their sphere of responsibility, they may contact the appropriate RCO branch supervisor or regional monitoring coordinator for more information.

Section 19.0 Data Management contains detailed information regarding how DAQ will manage data from the NCore network, including information on data recording, transmittal, storage, and retrieval.

9.1 Statewide Policy and Procedure Documentation

DAQ maintains records of program policy and procedure documentation. The DAQ publishes documents in this category with the date and revision information clearly noted, generally in a document header. Documents in this category include:

- QAPPs;
- SOPs;
- Electronic QA/QC data forms that technicians must use to document their work; and
- QA and technical notes, which provide air monitoring policy interpretations or best practices.

The DAQ ensures that document numbers and revision numbers and dates are clearly discernible, generally in the header and on the cover page. The DAQ generates document numbers for these documents using the DAQ Document ID Builder, which can be found on the RCO SharePoint page. Detailed instructions for drafting SOPs can be found in DAQ-14-001 - Standard Operating Procedure (SOP) for Preparing SOPs for the North Carolina Division of Air Quality (NCDAQ).

As of this QAPP revision, DAQ has purchased and is in the process of implementing a new document and record storage database, which may result in changes to these procedures and locations. When these changes are made, this QAPP and relevant SOPs will be revised to reflect new procedures and document and record locations.

The DAQ currently uses Laserfiche for a controlled internal locale for archiving all QA/QC forms, new and past revisions of SOPs and QAPPs. PPB chemists are responsible for the blank QA/QC forms and final records concerning their assigned pollutant(s). Intermediate records are the responsibility of the regional ambient monitoring coordinator(s). In Laserfiche archived documents are marked as *OBSOLETE* in the title so that staff know not to use them for current procedures. The QAM or his designee is responsible for changing the title to *OBSOLETE* when a new version is approved. QA/Tech Notes are also stored in Laserfiche. The DEQ website is the official DAQ repository for controlled QMPs, QAPPs and SOPs, i.e., current approved versions. All other QMPs, QAPPs and SOPs not on the website or in Laserfiche are uncontrolled and therefore not considered official. Personnel are responsible for obtaining and utilizing current versions of documents.

Also, at the time of this QAPP revision, RCO uses the RCO group drive and SharePoint as repositories for working documents. The RRO uses SharePoint as a repository for working documents, and transfer completed documents to the RCO group drive. Draft documents will be watermarked as *DRAFT* so that no confusion arises as to the finality of a document. The QAM or designee receives final versions for review and approval. Once all approvers sign the QAPPs and SOPs, the QAM or designee will upload or assign someone to upload the document to the website and the Laserfiche Ambient Monitoring Module. The QAM will notify staff of the issuance of the new document via e-mail and on the next ambient monitoring work group call. The chief and RCO chemists may change these procedures as the new document and record storage database is implemented and will revise the QAPP as changes are made.

9.2 Data Collection Records and Logbooks

Table 9.1 lists the documents and records that DAQ must retain. The appropriate sections of this QAPP will discuss the details of these various documents and records. The DAQ will collect all raw data required for calculations, the submissions to the AQS database and QA/QC data electronically, in e-logs, spreadsheets or on data forms recorded in the field; see Section 11.0 Sampling Methods Requirements for additional information.

All of the RRO monitoring technicians and coordinator, RCO chemists and other DAQ personnel shall fill out information in the site visit logbook in indelible ink. In addition, the ECB electronics technicians will fill out instrument maintenance logs and Air Quality Section Maintenance Order or AQ-109 forms and Continuous Monitor Performance Audit Report or AQ-121 forms in indelible ink. They shall make corrections by inserting one line through the incorrect entry, initialing, and dating this correction and placing the correct entry alongside the incorrect entry, if they can accomplish this legibly or by providing the information on a new line if the above is not possible.

9.2.1 Logbooks and Forms

Each field and laboratory technician will be responsible for obtaining, maintaining, and documenting the appropriate logbooks or associated QA/QC data forms. Each NCore monitor type (SO_2, CO, PM, etc.) has an e-log that has been created for that specific monitor type. The e-log contains all data entry forms required by the RRO monitoring technicians to document all routine operations. After each use, the RRO monitoring technician uniquely numbers these e-logs by giving them a specific file name before saving them to a storage device such as a laptop computer. From the laptop computer, the RRO monitoring technician will transfer the e-log to the RRO SharePoint page for the RRO monitoring coordinator to review. The RRO monitoring technician will use these e-logs to record information about the site and laboratory operations, as well as document routine operations. The e-logs are editable, but the original e-logs remain on the access-restricted RRO SharePoint page, which tracks changes and edits and are recoverable in the event of inadvertent deletion. Once the RRO monitoring coordinator has reviewed and approved an e-log, he or she uploads it to the RCO group drive, which is the official repository of these records.

The ECB electronics technicians will fill out instrument maintenance logbooks and Air Quality Section Maintenance Order or AQ-109 forms, and Continuous Monitor Performance Audit Report or AQ-121 forms. The original AQ-109 forms are retained at the ECB facility. The AQ-121 forms are scanned and stored in Laserfiche; hard-copies are stored in a filing cabinet at RCO.

The regional monitoring staff and ECB electronics technicians must complete e-logs, instrument maintenance logbooks and Air Quality Section Maintenance Order or AQ-109 forms associated with all routine environmental data operations, even when the site logbooks contain all appropriate and associated information required for the routine operations performed.

- ***Field Logbooks*** – The DAQ uses a combination of bound paper logbooks and/or e-logs for recordkeeping for each sampling site, sampling instrument, specific program or individual. Each paper logbook should be hardbound and paginated. The

regional monitoring and ECB electronics technicians use the paper site logbooks to document site visits and other activities, including who is at a site, when and why. Every visitor must sign the site logbook. In addition, the NCore monitoring site contains a bound paper logbook, generated and maintained by the regional office. The logbooks generated and maintained by RRO staff are filed and archived at the RRO once completed. Logbooks generated and maintained by ECB staff are filed and archived at the ECB once completed. The e-logs are required documentation by site technicians for each and every site visit regardless of the activity involved.

- **RTI Lab Logbooks** – A combination of bound paper logbooks and electronic databases exist in which the RTI laboratory retains all records pertaining to PM gravimetric analysis. Copies of all pertinent records are sent electronically to DAQ in the form of a "data package" on a routine basis. All other records kept at RTI labs that may be needed for audit purposes that are not included in the data package are available upon request and are reviewed during DAQ TSAs on the RTI lab.

At the time of this QAPP revision, DAQ is in the process of developing logbooks that meet EPA's guidance for electronic records. The chief and RCO chemists will revise this QAPP as needed when DAQ implements these new e-logs.

9.2.2 Chain of Custody

As part of the pre-weighing process, the RTI lab prepares a chain of custody, or COC, form with the batch of filters that are sent to the RRO for use at the NCore site. After the sample run, the operators of the NCore FRM monitor collect exposed filters from the sequential sampler and return them to the RTI lab accompanied by COC forms, packing material and synthetic ice packs. RTI retains COC records on site, while the DAQ retains copies of COC records at the RRO and the RCO. For more about COC see Section 12.0 Sample Handling and Custody.

9.2.3 Electronic Data Collection

Certain instruments can provide an automated means for collecting information that RRO monitoring technicians would otherwise record on data entry forms. Section 19.0 Data Management details the information on these systems. To reduce the potential for data entry errors, DAQ uses automated systems where appropriate to record the same information the regional monitoring technician would record on data entry forms. To provide a backup, the PPB staff will store electronic copies of the automated data collection information (daily poll) for an appropriate period on the RCO group drive. Electronic backup copies of automated data collection information will also be stored on the site computers, in the RRO and in the RCO.

9.3 QA/QC Records

The DAQ achieves QA/QC through the performance of periodic activities such as:

- EPA TSAs;
- Internal systems audits;
- One-point QC checks;
- Zero and span checks;
- Verification and calibration procedures;
- Maintenance and repair activities;

- Annual performance evaluations;
- EPA performance audits such as the NPAP, Ambient Air Protocol Gas Verification Program, and Performance Evaluation Program, or PEP for regulatory monitors (with the exception of PM_{10});
- Traceability certifications and calibrations; and
- Corrective actions.

The EPA and DAQ document TSAs and internal systems audits in the form of a written report. The DAQ typically documents and maintains most of the other QA/QC activities using a variety of methods, including e-mails, Excel spreadsheets, fillable portable document format (PDF) data forms, worksheets, and data management systems such as Envidas Ultimate and Envista ARM, both developed by the software developer, Envitech. The associated SOPs (see Table 11.2) describe the use of these methods to create air monitoring QA/QC records. The DAQ retains and archives these records according to the procedures identified in Section 9.5 Data Archiving and Retrieval. The DAQ corrects records either by crossing out the incorrect information with a single line and entering the correct information followed by the person's initials and date or by creating a revised form from the original with the correct information, retaining both forms on the RCO group drive. The RRO monitoring technician or coordinator names the revised document following naming conventions in SOPs 2.7.2, DAQ-08-001.2, DAQ-12-002.2, DAQ-04-001.2, 2.38.2, 2.44.2, 2.45.2, DAQ-11-001.2, and 2.47.2.

However, for some of the QA/QC activities described above – such as the traceability certifications – the ECB retains many of those records at the ECB. Currently, the vendors typically provide the certificates of analyses that accompany gas cylinders in paper format, which the ECB stores in a secured file in the office. If DAQ personnel require information related to these documents, they may contact the ECB for assistance. The RRO monitoring coordinator stores certifications for PM equipment provided by the vendors in file cabinets at the RRO and in Laserfiche. EPA photometer certification records are both paper and electronic. The paper records are stored at the ECB in a file cabinet. The electronic records are stored on the computers in the certification room. Records for internal certifications of the photometers and calibrators used in the field and for audits are stored electronically on the group drive. The division has purchased a database for generating and archiving these types of records and is in the process of implementing it. When the database is fully implemented, the chief and RCO chemists will review the new record generating and retention process and will revise the QAPP when the new process is implemented.

9.4 Reference Materials

Because of the technical nature of ambient air monitoring, DAQ requires numerous reference materials to administer the NCore monitoring program effectively. This category includes publications such as instrument operation manuals, troubleshooting guides, EPA guidance documentation, such as the NCore TAD, EPA technical memoranda and various other reports. DAQ maintains access to applicable reference materials until DAQ no longer has an administrative need for them. DAQ retains these documents at the RCO, in the Laserfiche Ambient Monitoring module or on the RCO group drive.

9.5 Data Archiving and Retrieval

The DAQ classifies documentation according to its intended use, future applicability, and regulatory requirement for retention. DAQ follows the state of North Carolina's functional schedules for files. Files used and created by DAQ will be kept for a minimum amount of time set by these functional schedules. To meet DAQ's contractual obligation to the EPA, DAQ will retain all the information listed in Table 9.1 for a minimum of four complete calendar years from the date of collection in accordance with 2 CFR 200.334. However, if any litigation, claim, negotiation, audit, or other action involving the records has been started before the expiration of the four-year period, DAQ will retain the records until completion of the action and resolution of all issues that arise from it or until the end of the regular four-year period, or until the minimum time required by the state of North Carolina functional schedules, whichever is later. The records custodians are responsible for ensuring these retention times are met and disposing of records after their retention period has elapsed.

DAQ stores electronic records within the data management systems located at the NCore site, or Envidas Ultimate, the RCO, or Envista ARM, and on network servers in the RRO and RCO. The database manager regularly backs up the Envista ARM database following the procedures in Section 5.7 of DAQ-05-001.5 AMS Database Manager Standard Operating Procedure. Section 19.7 Data Storage and Retrieval provides more details on the Envista ARM archival process.

10.0 Network Description

The primary function of the NCore air-monitoring network is to provide accurate measurements at low concentration levels. Other purposes include verifying compliance with the NAAQS, determining trends over time, developing algorithms based on historical air quality and other conditions, which will allow verifying air quality modeling programs, providing real-time pollutant data to the public, and correlating health effects to air quality levels.

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

- 40 CFR Part 58, Appendix A —Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards
- 40 CFR Part 58, Appendix D - Network Design Criteria for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

10.1 Network Objectives

The EPA designed the NCore multi-pollutant ambient air-quality monitoring network to meet the monitoring objectives provided in Section 6.0. Other objectives of the NCore network include the following:

- Timely reporting of data to the public by supporting AirNow, air quality forecasting and other public reporting mechanisms;
- Support for development of emission strategies through air quality model evaluation and other observational methods;
- Accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors;
- Support for long-term health assessments that contribute to ongoing reviews of the NAAQS;
- Compliance through establishing nonattainment/attainment areas through comparison with the NAAQS;
- Support to scientific studies ranging across technological, health and atmospheric process disciplines; and
- Support to ecosystem assessments recognizing that national air quality networks benefit ecosystem assessments and, in turn, benefit from data specifically designed to address ecosystem analyses.

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

The RRO monitoring technicians and coordinator, with assistance from the PPB supervisor, assign each monitor within DAQ's NCore ambient air quality monitoring network one or more of the following monitoring objective designations:

- ***Population exposure -*** the monitor is in an area associated with high population density;
- ***General / Background -*** the monitor is located where manmade pollutant emissions are minimal; and
- ***Maximum ozone concentration -*** the monitor measures or is representative of areas with the highest O_3 concentrations in the represented urban area.

Data collected within the network must be representative of the spatial area under study. The goal in siting a monitoring station is to match the spatial scale represented by the samples obtained with the spatial scale most appropriate for the monitoring objective of the station. All monitors at the NCore site are neighborhood scale except for the CO monitor, which is middle scale. For a description of representative measurement scales, see Section 7.3.

10.2 Site Selection

The current NCore site is East Millbrook Middle School, AQS ID 37-183-0014, located at latitude 35.856111 and longitude -78.574167. Figure 10.1 shows an aerial view of the location. The DAQ has been operating monitors at this site since April 17, 1989, and has no plans to relocate this site. The site is located at a school and the school has been very cooperative in allowing DAQ to make necessary changes at the site so that the site will meet 40 CFR Part 58, Appendix E requirements. The school property is fully developed and the DAQ does not anticipate the Wake County School System will need to develop the area where the monitoring site is located or will evict DAQ from their property anytime soon. This SLAMS and NCore site is designed to measure multiple pollutants to provide support to integrated air quality management data needs. It is also intended as a long-term site useful for a variety of applications including air quality trends analyses, model evaluation and tracking metropolitan area statistics.

Figure 10.1. Aerial View of the Millbrook NCore Monitoring Station Location, Blue Balloon

When selecting a site, the DAQ 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:

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

The RRO monitoring technician will evaluate the monitoring site each year to assure it adheres to the site selection criteria specified in 40 CFR Part 58, Appendix E.

10.2.1. Site Location

The RRO monitoring technicians and coordinator, ECB electronics technicians and RCO chemists consider four criteria when evaluating potential sites. Monitoring sites should be oriented to measure the following (singly or in combination as appropriate for the sampling objective):

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

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

The chief uses EPA provided guidance to assist in selecting the geographic locations of NCore monitoring locations. In addition, the sampling site selection process also involves consideration of the following factors:

- ***Economics -*** The quantity of resources required to accomplish all data collection activities, including instrumentation, installation, maintenance, data retrieval, data analysis, QA and data interpretation, must be established.
- ***Security -*** In some cases, a preferred location may have associated problems that compromise the security of monitoring equipment (i.e., high risk of theft, vandalism, etc.). When the DAQ cannot remedy such problems using standard measures such as additional lighting, fencing, etc., then DAQ shall attempt to locate the site as near to the preferred location as possible.
- ***Logistics -*** This process includes procurement, maintenance and transportation of material and personnel for the monitoring operation. The logistics process requires full knowledge of all aspects of the data collection operation: planning, reconnaissance, training, scheduling, safety, staffing, procuring goods and services, communications and inventory management.
- ***Atmospheric Considerations -*** These considerations may include spatial and temporal variability of pollutants and their transport. Effects of buildings, terrain and heat sources or sinks on air trajectories can produce localized anomalies of pollutant concentrations. The DAQ considers meteorology 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 locate properly many monitoring sites (e.g., siting to either detect or avoid emissions from specific sources).

- ***Topography*** **–** The DAQ completed an evaluation of the local topography based upon land use maps, U.S. Geological Survey topographic maps and other available resources. The DAQ identified and evaluated both minor and major topological features that affect both the transport and diffusion of air pollutants. Minor features may include an adjacent tree-lined stream or tall structures 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 affect the prevailing wind patterns or create their own local weather such as katabatic or anabatic winds.
- ***Pollutant Considerations -*** The monitoring site location for a specific pollutant may or may not be appropriate for another pollutant. The DAQ evaluated the changes that pollutants undergo temporally and spatially to determine the applicability of each particular site for a specific pollutant.

An interdependence exists between all the factors listed above. Consequently, the DAQ successfully employed an iterative procedure to select appropriate sites that can provide the data necessary to accomplish the stated objectives of the project. In situations where the sites do not specifically meet the requirements necessary to obtain the project objectives, reevaluation of the project priorities may be necessary before 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. The AMS shares these responsibilities amongst its members as well as with other DAQ staff.

10.2.2 Monitor Placement

General inlet siting criteria for monitors at the DAQ NCore site shall adhere to the requirements in 40 CFR Part 58, Appendix E. The placement of each monitor is generally determined by the defined monitoring objective or objectives. Therefore, monitors are usually placed in accordance with the potential exposure to pollution. Due to various factors discussed previously, tradeoffs are often necessary to locate a site for collection of optimally representative data. Final placement of a particular monitor at a selected site is dependent on physical obstructions and activities in the immediate area. The ECB electronics technicians must place monitors away from obstructions such as trees and fences to avoid their effects on airflow. To prevent sampling bias, airflow around monitor sampling probes must be representative of the general airflow in the area. In addition, the availability of utilities (i.e., electricity and cellular telephone services) is critical.

10.3 Probe Siting Criteria for Pollutant Sampler/Analyzer

General probe siting criteria for criteria pollutants shall adhere to the requirements listed in 40 CFR Part 58, Appendix E. Siting criteria for the noncriteria pollutants are discussed below.

10.3.1 Reactive Oxides of Nitrogen (NO_y)

The siting criteria for NO_y analyzers are the same as for O_3 analyzers, except the inlet for the NO_y monitor must be 10 meters above grade. The NO_y converter box is mounted on a tower at 10 meters in height to avoid the physical removal of nitric acid (HNO_3) from the atmosphere.

10.3.2 Meteorological Sensors

The siting criteria for meteorological sensors vary greatly from parameter to parameter. DAQ will follow NCore siting criteria guidance in the QA Handbook for Meteorological Measurements. If siting deviations occur, DAQ will obtain a waiver from the EPA. This section discusses the siting criteria on a parameter-by-parameter basis.

The ECB electronics technicians must mount meteorological sensors on mounting arms at the top of, or projecting horizontally from, the tower. The ECB electronics technicians shall securely fasten the mounting arms to the tower. The mounting arms shall be strong enough to limit sway and vibration during periods of strong winds. Some vibration and sway will happen, but every effort will be made to limit this potential interference.

DAQ uses a MetOne All-In-One (AIO2) sensor which monitors windspeed, wind direction, ambient temperature, barometric pressure, and relative humidity. The ECB electronics technicians shall mount the AIO2 sensor 10 meters above the ground and in the dominate wind. Every effort is made to mount the wind sensors at a distance away from the tower that is at a minimum twice the diameter of the tower. Meaning if the tower is 0.1 meters in diameter, the wind sensors will be mounted at a minimum of 0.2 meters away from the nearest point on the tower to limit wind current interference from the tower. Should additional AIO2 sensors be used at the site, they will be mounted at least 1 horizontal meter away from the site sensor and within 1 vertical meter of the site sensor.

The SR sensors must be mounted on the south side of a tower and every effort must be made to limit shadows from interfering with the SR sensor measurements.

Precipitation sensors must be sited to limit interference from rain splash and wind. Typically, precipitation sensors are protected by a wind screen to limit interference from blowing and splashing precipitation. DAQ utilizes wind screens surrounding the precipitation sampler to limit these interferences.

10.3.5.1 Towers

The ECB electronics technicians will securely mount the meteorological sensors on a tower or pole that will not twist, rotate or sway.

The towers shall be of an open grid-type construction and designed so that they either tilt or can be cranked into place so that the meteorological sensors can be installed, serviced and audited from the ground. A tower must be rigid enough to maintain all mounted instruments in proper alignment and orientation in high winds.

When meteorological sensors are located on a cross-arm projecting out from the tower, the cross-arms shall be installed so that it is horizontally level and the sensors shall be installed so that they are vertical.

10.3.5.2 Wind Speed and Direction Sensors

The wind speed and direction sensors are mounted at a height of approximately 10 meters to accurately measure surface level winds speeds and directions. Every effort is made to mount the meteorological sensors on a tower in open terrain. Open terrain is defined as an area where the distance between the tower base and any obstruction is at least ten times the height of that

obstruction. This applies to manmade (buildings) and natural (trees, rocks or hills) obstructions. All distances are to be measured from the edge of the obstruction nearest the tower. Trees and shrubs shall be measured from the outside edge of the crown or dripline and not the trunk.

If the ECB electronics technician places the sensors (and tower) in areas of uneven terrain or terrain containing obstacles, the technician follows the limits for terrain variation and obstacle height near the tower in Table 10.1, when possible.

Table 10.1 Limits on Terrain and Obstacles near Towers

Distance from Tower (m)	Slope, no greater than (percent)	Maximum Obstruction or Vegetation Height (m)
0 – 15	± 2	0.3
15 – 30	± 3	0.5 – 1.0 (most vegetation <0.3)
30 – 100	± 7	3.0
100 – 300	± 11	10 x obstruction height (must be less than the distance to the obstruction

10.3.5.3 Temperature, Barometric Pressure and Humidity Sensors

DAQ is using new sensor technology that allows temperature, humidity, barometric pressure, wind speed, wind direction, and wind gust measurements to be collected at 10 meters using an all-in-one, sonic meteorological sensor (Met One AIO2). The Met One AIO2 sensors shall be attached to the tower with a mounting arm so that the sensors are located over an open plot of short grass or natural earth (not concrete or asphalt) at a height of approximately 10-meters above ground-level.

The Met One AIO2 sensors shall be mounted at a distance from the tower that is equal to or greater than the diameter of the tower. Meaning, that if the tower is 0.1 meters in diameter, the sensors must be mounted at least 0.1 meters away from the tower's closest point to the sensors.

10.3.5.4 Solar Radiation Sensors

The SR sensors must be mounted on the southern side of the tower to provide unobstructed views of the sun's path and to prevent shadows from interfering with the SR sensor. Every effort is made to prevent shadows from being cast on the SR sensor. The SR sensor is typically mounted near the tower at a height of approximately 2 to 3-meters above ground-level. The SR sensor mounting height is not as important as limiting shadow interference.

10.3.5.5 Precipitation Sensor

Precipitation sensors used at the NCore site will be sighted on a level surface at ground-level over natural grass or gravel as ground cover. DAQ uses the tipping bucket precipitation sampler at the NCore site. The tipping bucket shall be placed in a location so that any height obstruction (omitting the meteorological tower) is at least two times the distance away as the height of the obstruction. For example, if a nearby building is 3-meters in height, the tipping bucket should be at least 6-meters from the nearby building. A wind screen surrounds the tipping bucket to limit the interference from wind-blown precipitation and splashing.

10.3.6 PM Monitoring

When monitoring PM, it is important to select a site or sites where the collected PM mass is representative of the monitored area. Optimum placement of the sampling inlet for PM is at breathing height level. However, the chief must also consider practical factors such as prevention of vandalism, security, and safety precautions. For neighborhood scale NCore sites, the inlet must be 2 to 15 m above the ground.

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

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

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

There must be unrestricted airflow in an arc of at least 270° around the sampler inlet. The predominant wind direction for the season with the greatest pollutant concentration potential must be included in the 270° unrestricted arc. If the sampler is to measure concentrations from a road or point source, there must be no obstructions between the sampler inlet and the road or point source, even when other spacing from obstruction criteria are met. 40 CFR Part 58, Appendix E gives the required separation distance of the sampler inlet from the nearest traffic lane.

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

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

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

For the DAQ NCore monitoring site, all PM monitors are located at ground level on a dedicated 16'x 16' wooden deck that is secured by a chain-linked fence.

10.4 Sampling Frequency

As prescribed in 40 CFR 58.12, the EPA establishes minimum sampling frequencies. The DAQ follows the EPA's requirements for the sampling frequencies of monitors. In instances requiring every third and sixth-day sampling, the EPA specifies which days DAQ must collect samples so

that the entire nation is sampling on the same day. This intermittent sampling is accomplished in accordance with a national sampling schedule published annually by EPA. The DAQ ensures the monitors collect the minimum amount of data required to calculate the appropriate summary statistics. At least 75 percent of the total possible observations must be present before summary statistics are calculated. The exact requirements appear in 40 CFR Part 50 and Table 10.2. For filter based $PM_{2.5}$ monitoring, DAQ follows EPA guidance for collecting makeup samples. Makeup samples can be collected either before the next scheduled sample or one week later. The number of make-up $PM_{2.5}$ samples in a calendar quarter is limited to no more than five samples. Table 10.3 provides the NCore sampling schedule and frequency.

Table 10.2 Requirements for Calculating Summary Statistics

Parameter	Completeness Requirement	Time Frame
Carbon Monoxide	75 percent	Per hour, 8-hour, day, quarter, and annual
Nitrogen Dioxide	75 percent	Per hour, day, days per quarter and hours per year
	4	Complete quarters per year
Reactive Oxides of Nitrogen	75 percent	Per quarter
Ozone	75 percent	Per quarter and season
	90 percent	Per three years
PM_{10}	75 percent	Per hour and quarter
$PM_{2.5}$	75 percent	Hours per day for continuous monitors; days per quarter
	4	Complete quarters per year
Sulfur Dioxide	75 percent	Per 5-minutes, hour, hours per day and days per quarter
	4	Complete quarters per year
Wind Speed	75 percent	Per hour and quarter
Wind Direction	75 percent	Per hour and quarter
Ambient Temperature	75 percent	Per hour and quarter
Relative Humidity	75 percent	Per hour and quarter
Solar Radiation	75 percent	Per hour and quarter
Rain/melt Precipitation	75 percent	Per hour and quarter

Table 10.3 NCore Sampling Schedule and Frequency

Pollutant	Time Frame (local standard time)	Frequency	Monitor Type
Carbon Monoxide	Midnight to midnight	24/7	continuous
Nitrogen Dioxide	Midnight to midnight	24/7	continuous
Reactive oxides of Nitrogen	Midnight to midnight	24/7	continuous
Ozone	Midnight to midnight	24/7	continuous
PM_{10}	Midnight to midnight	24/7	continuous
$PM_{2.5}$	Midnight to midnight	1 in 3	filter-based
$PM_{2.5}$	Midnight to midnight	24/7	continuous
$PM_{10\text{-}2.5}$	Midnight to midnight	24/7	continuous
Sulfur dioxide	Midnight to midnight	24/7	continuous
Speciated $PM_{2.5}$	Midnight to midnight	1 in 3	filter-based
Wind Speed	Midnight to midnight	24/7	continuous
Wind Direction	Midnight to midnight	24/7	continuous
Ambient Temperature	Midnight to midnight	24/7	continuous
Relative Humidity	Midnight to midnight	24/7	continuous
Solar Radiation	Midnight to midnight	24/7	continuous
Rain/melt Precipitation	Midnight to midnight	24/7	continuous

10.5 Rationale for DAQ's NCore Ambient Air Quality Monitoring Network

The primary rationale for the operation of the DAQ NCore Ambient Air Quality Monitoring Network is to determine compliance with the NAAQS and provide the public with information on current air quality. In addition, DAQ collects monitoring data to evaluate EPA models and assess air pollution trends.

11.0 Sampling Methods Requirements

11.1 General Overview of Sample Methodology

In accordance with 40 CFR Part 58, Appendix C, Section 2.1, a criteria pollutant monitoring method used for making NAAQS decisions at a SLAMS site must be a reference or equivalent method. Towards that end, the DAQ uses only EPA-approved FRM or FEM instrumentation to measure criteria pollutants at the NCore site. Criteria pollutant analyzer methods that have received FRM or FEM status have been rigorously tested, in accordance with 40 CFR Part 53 requirements and found to meet or be comparable to the EPA reference methods codified in 40 CFR Part 50. The Ambient Monitoring Technology Information Center (AMTIC) website (https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants) provides the List of Designated Reference and Equivalent Methods, issued by the EPA Office of Research and Development, which provides the detailed specifications upon which a specific monitoring method has received its FRM or FEM status. The DAQ will operate each FRM and FEM analyzer in accordance with these designation specifications. To ensure the monitors meet these specifications, DAQ uses the criteria in the validation templates in Section 7.0 as well as the procedures specified in the SOPs listed in Table 11.2. This subsection describes the sampling methods used in the DAQ NCore monitoring network. Table 11.1 lists the specific methods used. The methods for O_3, SO_2, NO_2 and continuous $PM_{2.5}$, PM_{10}, and $PM_{10-2.5}$ data collection are FEMs. The method for CO data collection is a FRM method. The method for filter based $PM_{2.5}$ data collection is dual designated as a FRM and FEM method. The DAQ uses alternative non-FEM or non-FRM methods for NO_y and speciated $PM_{2.5}$ measurements. The DAQ operates the NO_y sample collection method analyzer in accordance with the NCore TAD. The DAQ may also use alternative non-FEM or non-FRM methods for Air Quality Index (AQI) reporting. When the current analyzers used in the network become obsolete, the ECB supervisor and electronics technicians in consultation with the chief, RCO chemists and regional monitoring staff will select a new monitor type to replace the existing monitor type used throughout the network. Rollout of the new monitor type will be coordinated by the chief with input from the ECB, RCO and regional monitoring staff.

Table 11.1 DAQ NCore Ambient Air Monitoring Network Analyzers

Parameter	Analyzer	AQS Method Codes	EPA Reference/Equivalence Method
Ozone	Thermo Electron/ Thermo Environmental Instruments Model 49i	047	EQOA-0880-047
Carbon Monoxide (Trace-Level)	Thermo Electron/ Thermo Environmental Instruments Model 48i TLE	554	RFCA-0981-054
Reactive Oxides of Nitrogen (Trace-Level)	Thermo Electron/ Thermo Environmental Instruments Model 42i-Y	674	Not Applicable
Sulfur Dioxide	Thermo Electron Model 43i TLE	560	EQSA-0486-060

Table 11.1 DAQ NCore Ambient Air Monitoring Network Analyzers

Parameter	Analyzer	AQS Method Codes	EPA Reference/Equivalence Method
(Trace-Level)			
PM_{10} continuous (STP)	Teledyne T640x (with PM10 head)	239	EQPM-0516-239
PM_{10} local conditions, continuous	Teledyne T640x (with PM_{10} head)	238	EQPM-0516-238
$PM_{2.5}$ filter-based	Thermo Model 2025 i Sequential Air Sampler (with PM_{10} head and VSCC)	145	RFPS-1006-145
$PM_{2.5}$ local conditions, continuous	Teledyne T640x (with PM10 head)	240	EQPM-0516-240
$PM_{10-2.5}$, local conditions continuous	Teledyne T640x (with PM10 head)	238	EQPM-0516-238
$PM_{2.5}$ speciated	Met One Super SASS URG	811, 812 846	Not Applicable
Nitrogen Dioxide	Teledyne Model T500U	212	EQNA-0514-212
Indoor Shelter Temperature	Comet Temperature Sensor Model T0310 primary, HOBO as backup	013	No FRM or FEM
Wind Speed, resultant Wind Direction, resultant Temperature Relative Humidity Barometric Pressure	Met One AIO2 All-in-one weather sensor	069	No FRM or FEM
Solar Radiation Rain/Melt Precipitation	Pyranometer Tipping bucket precipitation sampler	011 011	No FRM or FEM

11.2 Description of Monitoring Technology/Methodology

11.2.1 Carbon Monoxide (Trace-Level Nondispersive Infrared Analyzer)

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

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

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

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

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

11.2.2 Sulfur Dioxide (Trace-level Fluorescence Analyzer)

The measurement of SO_2 is based on the principle that SO_2 molecules absorb ultraviolet (UV) light and become excited at one wavelength and subsequently decay to a lower energy state by emitting light at a different wavelength (fluoresces) that is proportional to the concentration. This emitted light is detected by a photomultiplier tube which in turn produces a voltage signal. A hydrocarbon “kicker” removes interfering hydrocarbons prior to the ambient sample entering the measurement chamber.

11.2.3 Reactive Oxides of Nitrogen: NO and NO_y (Trace-Level Chemiluminescence Analyzer)

NO_y includes all nitrogen oxide compounds emitted to the atmosphere or formed in the lower atmosphere. NO_y compounds include NO, NO_2 and other organic and inorganic nitrogen containing species.

The principle of measurement is based upon the reaction of a NO molecule with an internal source of O_3 in an evacuated reaction cell that results in the emission of light or chemiluminescence. The monitor operates by dividing the air sample alternately into two streams. The first stream passes the sample directly to the evacuated reaction cell. A reaction

between the NO present in the sample and the analyzer supplied O_3 occurs. The detector monitors the resulting light emitted by the reaction and correlates it to the concentration of NO in the sample.

The second stream of sample gas passes through a catalytic converter, which reduces the NO_y to NO. This second stream, now containing NO from both the reduction of NO_y and the original NO, is cycled through the evacuated reaction cell where the new augmented concentration of NO is measured. The catalytic converter is positioned at the extreme sample inlet 10 meters above grade and has an enhanced sample flow rate of approximately 10 liters per minute, or LPM, to minimize any reactions in the sample line.

The measurement of the untreated sample provides an NO concentration, while the measurement of the converted sample provides a measurement of the NO_y concentration.

11.2.4 Ozone (Ultraviolet Photometry)

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

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

11.2.5 Particulate Matter (Intermittent filter-based operation)

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

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

Monitors can separate trapped PM into finer grades of matter than was originally mandated under federal total suspended particulates, or TSP, regulations using an inertial separator on the inlet stream. These inertial separators selectively pass PM classified as either PM_{10} or $PM_{2.5.}$

11.2.6 Particulate Matter (Continuous Operation, T640X)

The Model T640X PM Mass Monitor is an optical aerosol spectrometer that converts optical measurements to mass measurements by determining sampled particle size via scattered light at the single particle level according to Lorenz-Mie Theory. Briefly, the sampling head draws in ambient air, which is dried (i.e., brought below 35 percent RH) with the Aerosol Sample Conditioner (ASC) and moved into the optical particle sensor where scattered light intensity is measured to determine particle size diameter. The particles move separately into the T-aperture through an optically differentiated measurement volume that is homogeneously illuminated with polychromatic light. The polychromatic light source, a light emitting diode (LED), combined with a 90° scattered light detection, achieves a precise and unambiguous calibration curve in the Mie range, resulting in a large size resolution.

Each particle generates a scattered light impulse that is detected at an 85° to 95° angle where amplitude (height) and signal length are measured; the amplitude of the scattered light impulse is directly related to the particle size diameter. The T-aperture and simultaneous signal length measurements eliminate border zone error, which is characterized by the partial illumination of particles at the border of the measurement range.

The T640x operates at 16.7 LPM and uses an EPA-approved PM_{10} inlet. The EPA approved this configuration as an FEM for PM_{10}, $PM_{2.5}$ and $PM_{10\text{-}2.5}$. The monitor reports sample volume in actual conditions by using the instrument's AT and barometric pressure sensor data.

11.2.7. Nitrogen Dioxide

The PAMS monitoring network, which is collocated with the NCore network, uses the Teledyne Model T500U NO_2 analyzers utilizing cavity attenuated phase shift spectroscopy (CAPS) technology. This technology results in a direct measurement of NO_2 using an optical absorption spectrometer. The basic components of the analytical system include an optical cell, a pair of highly reflective mirrors centered at 450 nm (a strong NO_2 absorbance band), a light emitting diode (LED), and a vacuum photodiode detector. The LED is located behind one of the mirrors and the detector is positioned at the end of the cell behind the other mirror. The LED introduces ultraviolet (UV) light into the cell which is reflected between the mirrors. While the sample flows through the cell, precisely timed data acquisition in combination with an algorithm translate the absorbance into a phase shift. The phase shift in turn is used to calculate the NO_2 concentration. There is an inverse relationship between the phase shift and the NO_2 concentration – as the phase shift decreases the NO_2 signal increases.

11.2.8 Indoor Shelter Temperature

The shelter temperature is measured using a Comet temperature transmitter. The sensor measures temperature in the range of -30 to +80 degrees Celsius (° C) with an accuracy of ± 0.4 ° C and resolution of 0.1 ° C. Measurements are collected every minute. Backup temperature measurements are collected using a HOBO data logger and temperature sensor. The site operator downloads data from the HOBO at least once a month and archives the data. The data verifiers and validators only use the HOBO data when the Comet data are unavailable.

11.2.9 Meteorological Sensors

The AIO2 All-in-one weather sensor collects wind speed and wind direction using high frequency sound pulses. The rate to which these pulses slow down or speed up are the basis for determining wind speed and wind direction without any moving parts. The AIO2 sensor also contains an internal compass that automatically corrects the wind direction results to magnetic north. If a declination angle is entered into the sensor's wind direction settings, wind direction can further be adjusted relative to true north. The AIO2 also contains a resistance-type sensor for determining AT. The AIO2 contains a capacitive/solid state sensor for determining RH. The AIO2 also contains a piezo resistive silicone sensor for determining barometric pressure. All parameters are calibrated by the manufacturer before being deployed and every 2 calendar years and 730 days even if the AIO2 appears to be functioning normally.

11.3 Sample Collection Methodology

Table 11.2 lists the specific SOP titles used at the NCore site.

Table 11.2 List of SOPs Associated with This Quality Assurance Project Plan

General Standard Operating Procedures
DAQ-05-001.5 AMS Database Manager Standard Operating Procedure Version 0.0, March 5, 2021
DAQ-14-001 SOP for Preparing SOPs for the DAQ, Revision 2.0, May 21, 2021
DAQ-14-002.5 Quality Assurance Project Plan and Standard Operating Procedure Tracking Database Procedure, Revision 0, Dec. 1, 2020
DAQ-14-003 Document Retention Procedure, Revision 1, Nov. 1, 2022
DAQ-15-002 North Carolina Division of Air Quality Corrective Action Process Operator Responsibilities, Revision 0, Dec. 1, 2021
DAQ-15-007.1 Method Detection Limit Determination Electronics and Calibration Branch (ECB) Responsibilities, Revision 0.0, May 7, 2021
Section 2.39 SOP for Quarterly Completeness Data Review, Revision 1, June 12, 2020
Section 2.43 SOP for Completing the Annual Network Review for the DAQ, Revision 2, Sep. 29, 2017
Calibration and Maintenance Procedures for NCore Monitoring Support Equipment
DAQ-13-006.1 Field Barometer Certification, Revision 0, Sept. 20, 2022
DAQ-15-001.1 Verification of Ambient Monitoring Thermometers Version 0.0, November 13, 2020
SOP R2020 Calibration of the Dwyer and SPER Manometers, Revision 2020, February 18, 2020
DAQ-13-002.1 Standard Operating Procedure (SOP) for the DryWell 3101 Temperature Generator ECB Responsibilities, Revision 0, May 5, 2021
DAQ-13-007.1 Teledyne-API Model T700U Calibrator Certification / Verification, Revision 2.0, June 3, 2022
Section 2.3.4 Thermo Environmental Model 146C Calibrator Certification, Revision 12.2, Sept. 17, 2014

Table 11.2 List of SOPs Associated with This Quality Assurance Project Plan

Standard Operating Procedures for Collecting and Validating Gaseous NCore Monitoring Data
DAQ-10-001.1 Thermo Scientific Model 49i Ozone Monitoring System Electronics and Calibration Branch Responsibilities, Revision 7.3, March 15, 2022
Section 2.7.2 Thermo Scientific Model 49i Ozone Monitoring System Operators' Responsibilities, Revision 9.0, March 17, 2022
DAQ-08-002.1 Teledyne Model T500U Nitrogen Dioxide Monitoring System SOP for the Electronics and Calibration Branch, Revision 1.0, June 17, 2022
DAQ-08-001.2 Teledyne Model T500U Nitrogen Dioxide Monitoring System SOP for Operators, Revision 2.0, June 17, 2022
DAQ-08-007.2 Reactive Oxides of Nitrogen (NO_y) Monitoring System SOP for Operator Revision 0, May 15, 2023
DAQ-12-001.1 ECB Responsibilities Sulfur Dioxide Standard Operating Procedure, Revision 11, Aug. 10, 2022
DAQ-12-002.2 Operator Responsibilities Trace Sulfur Dioxide Standard Operating Procedure, Revision 14, Oct. 1, 2020
Section 2.36.1 Trace-Level Carbon Monoxide SOPs for the Electronics and Calibration Branch, Revision 10.7, April 21, 2016
DAQ-04-001.2 Trace-Level Carbon Monoxide SOPs for Operator Responsibilities, Revision 7.0, April 1, 2022
Section 2.38.1 Model 42i-Y Trace Level Reactive Oxides of Nitrogen (NO_y) Monitoring System Electronic Calibration Branch Responsibilities, Revision 1.6, April 21, 2016
Section 2.38.2 Model 42i-Y Trace Level Reactive Oxides of Nitrogen (NO_y) Monitoring System Operator Responsibilities, Revision 5.5, Feb. 10, 2016 *
DAQ-15-005.5 Data Validation for Continuous Gaseous Monitors and Meteorological Data Raleigh Central Office Responsibilities, Revision 2.0, May 1, 2022
**SOP is in the process of being revised – the SOP will become DAQ-08-007.2, Revision 0.0, April 1, 2023*
Standard Operating Procedures for Collecting and Validating PM NCore Monitoring Data
Section 2.24.1 Particulate Matter 2.5 Standard Operating Procedures for the Electronics and Calibration Branch, Revision 2011, Jan. 1, 2011
DAQ-11-001.2 Thermo Scientific 2025i Standard Procedures for Operators, Revision 1.0, June 1, 2022
Section 2.44.1 Particulate Matter 2.5 Speciation QA Plan for URG 3000N Electronics and Calibration Branch Responsibilities, Revision 0, Oct. 1, 2013
Section 2.44.2 Particulate Matter 2.5 Speciation QA Plan for URG 3000N Operator Responsibilities, Revision 2020, Dec. 16, 2019
Section 2.45.1 Particulate Matter 2.5 SASS Speciation Electronic Calibration Branch Responsibilities, Revision 2, Sept. 1, 2015

Table 11.2 List of SOPs Associated with This Quality Assurance Project Plan

Section 2.45.2 Particulate Matter 2.5 SASS Speciation Operator Responsibilities, Revision 2020, Dec. 16, 2019 Section 2.47.2 Teledyne Model 640X Standard Procedures for Operators, Revision 2020, Dec. 16, 2019 DAQ-13-001.1 Standard Operating Procedure (SOP) for the BGI TetraCal Flow Transfer Standards ECB Responsibilities, Revision 0.0, May 7, 2021 Section 2.49.2 BGI TetraCal Standard Procedures for Operators, Revision 2020, Dec. 16, 2019 Section 2.63.4 Standard Operating Procedures for Validation of Particulate Matter, Revision 0, August 15, 2020	
Standard Operating Procedures for Collecting Meteorological NCore Monitoring Data	
DAQ-07-003.1 MetOne AIO2 All-in-One Weather Sensor for the North Carolina Division of Air Quality (DAQ) ECB Responsibilities, Revision 1, Nov. 1, 2021 DAQ-07-003.2 MetOne AIO2 All-in-One Weather Sensor for the North Carolina Division of Air Quality (DAQ) Operator Responsibilities, Revision 0.1, Nov. 1, 2021 DAQ-07-003.3 MetOne AIO2 All-in-One Weather Sensor for the North Carolina Division of Air Quality (DAQ) Coordinator Responsibilities, Revision 0.1, Nov. 1, 2021	
RTI Laboratory QAPP and SOPs and DAQ Laboratory Review Checklist	
Appendix A	RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 16)
Appendix B	RTI SOP for PM Sample Receipt & Log-in Revision 9 Date: March 29, 2022
Appendix C	RTI SOP for PM Gravimetric Analysis Revision 15 Date: March 29, 2022
Appendix D	RTI SOP for PM Chain of Custody Revision 8 Date: March 29, 2022
Appendix E	NCDAQ Checklists (DAQ-16-018.4 R0) for review of RTI PM Data Packages
Appendix F	Sample RTI Data Package

11.3.1 Physical Collection

The physical collection of intermittent (i.e., filter based) samples, sample transport, and preservation techniques adhere to the requirements of 40 CFR Part 50, Appendix L. Particulate matter data that are collected via continuous monitoring do not produce a physical sample, therefore no handling requirements are necessary.

11.3.2 Electronic Data Collection

Electronic data collection is possible for the continuous monitors through the network's data acquisition system, or DAS, which is currently Envidas Ultimate, and wireless modems. This equipment is in a shelter where the DAS records the data history and the modem provides a path to download the data for analysis. The database manager configures the computers in the state's RCO, managed by DIT, to connect automatically to the station at least hourly to retrieve these data for analysis. Monitoring personnel can log into the station remotely to retrieve data through the Envista Ultimate DAS or determine the status of the systems.

For the sequential particle sampler operated at the NCore site, the RRO monitoring technician downloads data on a weekly basis and uploads it to IBEAM. With both monitors and samplers, DAQ monitoring staff personnel can contact the stations manually to retrieve data or determine the status of the systems, if needed. Section 19.0 Data Management will discuss these procedures in more detail.

The Envista ARM data software automatically sends all data to AirNow-Tech and the IBEAM database for real time reporting of ambient concentrations and the AQI to the public via EPA's AirNow website and the DEQ Air Quality Portal and real-time web page.

IBEAM is a Java-based web application system used by DAQ as a repository and tracking system for many of the division's business processes including tracking of facilities, permit applications, mobile source compliance activities, emission source inventories, ambient monitoring data, compliance and enforcement actions, and source testing.

The DAQ modeled the design architecture of IBEAM after the standard n-tier architecture supported by Tomcat Application Server running on a Windows Server. The system uses a thin client interface for presenting information, via HTML and Java Server Pages, or JSP's, in Internet Explorer. The DAQ designed the system in a modular format with each module containing subcategories as appropriate. The DAQ defined security at the module level with a range of security options appropriate to staff requirements. Although IBEAM displays systems in a modular format, it stores the data in the background in an integrated data structure managed by the Oracle Relational Database Management System, or RDBMS. This means no duplication of data or data entry and a single point source for reporting and information dissemination.

11.4 Support Facilities

This subsection describes the monitoring shelters used in the DAQ background monitoring network.

11.4.1 Monitoring Station Design

The monitoring station design must encompass the operational needs of the equipment, provide an environment that supports data collection and sample integrity and allows the operator to service and maintain the equipment easily and safely. The chief considers winter and hurricane weather conditions during site selection to meet the station safety and serviceability requirements.

11.4.2 Shelter Criteria

The ECB electronics technicians house air pollution analyzers and support equipment, except intermittent, filter-based PM monitors and meteorological sensors, in a shelter capable of fulfilling the following requirements:

- The DAQ maintains the shelter temperature at a temperature that meets the reference or equivalency method requirements for all instrumentation that it contains;
- The power supply should not vary more than ±10 percent from 117V Alternating Current Voltage (VAC). It is best to provide some type of voltage regulation to accomplish this;
- The shelter must protect the instrumentation from precipitation and excessive dust and dirt, provide third-wire grounding as in modern electrical codes, meet federal Occupational

Safety and Health Administration regulations and be cleaned regularly to prevent a buildup of dust; and

- The shelter must protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light or radiation.

At the NCore site, the DAQ uses one shelter for all the gaseous pollutants. The shelter has roof access. The continuous PM monitor is housed inside a small shelter on a wooden deck at ground level.

For the gaseous monitors, the ECB electronics technicians use insulated heat-tape wrapped single sample lines, as shown in Figure 11.1, to provide ambient air to the monitor. The heat tape helps eliminate the presence of moisture and potential scrubbing of ambient air pollutants from being recorded by the respective analyzer. The analyzer draws ambient air from the probe inlet. The probe material and sample lines must be either borosilicate glass or an acceptable inert plastic, such as polytetrafluoroethylene, perfluoroalkoxy (PFA), or other Teflon™-type materials. The ECB electronics technicians use Teflon™ probe lines to ensure the probe material is non-reactive with O_3, SO_2, CO, NO_y and NO_2. The probe, intake vent and interconnecting tubing design must provide a minimum number of bends to avoid particles impacting on the surfaces. Impacted particles may provide surfaces to which these pollutants may adsorb or, if the impacted particle is metallic, catalyze to a non-criteria species. In addition, the ECB electronics technicians attach the probe lines to a PM filter to prevent contaminants from entering the analyzer. The ECB electronics technicians typically locate the filter within the protected shelter, between the probe inlet and the analyzer The gaseous analyzers are calibrated through the PM filter and the 1-point QC checks also enter the analyzer via the PM filter. The internal performance evaluations for the gaseous analyzers are also conducted through the probe inlet. The ECB electronics technicians protect the NOy sample-transfer line from light using a plastic-coated flex provided by the vendor.

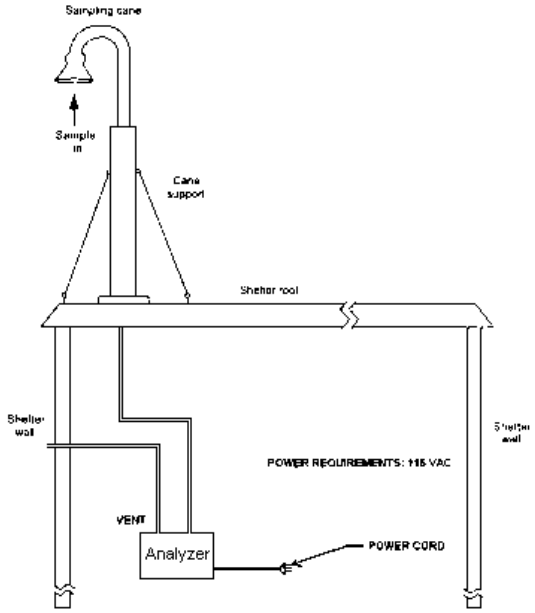


Figure 11.1 Teflon® Sampling Configuration

Additionally, the DAQ uses part of a Teflon™ filter holder on the end of the probe to prevent rainwater from entering the analyzers. Any liquid water will absorb pollutants, reducing the concentration by removing the pollutant from the sampled ambient air and consequently, yielding inaccurate environmental data.

Residence time is the amount of time it takes for a sample of air to travel from the opening of the probe inlet to the inlet of the instrument. The residence time in the probe must be 20 seconds or less for all pollutants. The RRO monitoring technician evaluates the residence time in the probe at every site visit and documents it in the e-log. If the physical configuration of the probe restricts the flow such that the probe configuration cannot meet the residence time, then the ECB electronics technicians will modify the physical configuration to fix this deficiency. They may accomplish this by reducing the length of interconnecting tubing, using tubing with a smaller inner diameter, decreasing the number of bends in the tubing between the probe and analyzer or other alterations that allow the system to meet the residence time requirements.

Dirt buildup on the inside of the inlet system will absorb pollutants from the air stream during high concentration periods and release pollutants during low concentration periods, skewing the data collected when the inlet system is dirty. The ECB electronics technicians replace all probe sample lines at least once every two years or as needed when the line is damaged or contaminated. Based on years of monitoring experience and evaluation of the data, DAQ has not observed any problems with probe lines between one and two years except in situations where other problems occurred. Situations that may cause probe problems include, but are not limited to, the monitor pulling rain or other precipitation into the probe, insects entering the probe or a cold spot developing along the probe causing condensate to form in the probe.

The ECB electronics technicians should house the T640X in a cabinet shelter capable of fulfilling these requirements:

- The shelter temperature should be maintained between 0-50 °C, with a SD of < 2.1°C, over 24 hours;
- The power supply should not vary more than ±10 percent from 117 alternating current voltage. It is best to provide some type of voltage regulation to accomplish this;
- The shelter should protect the instrumentation from precipitation and excessive dust and dirt, provide third wire grounding as in modern electrical codes, meet federal OSHA regulations, and be cleaned regularly to prevent a buildup of dust; and
- The shelter should protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light, or radiation.

Filter-based samplers, which operate unprotected from ambient conditions, have no need for a shelter capable of fulfilling these requirements.

12.0 Sample Handling and Custody

The goal of the sample handling and custody process is to preserve and maintain the integrity of the PM sample from initial equilibration of the new filter through the archiving and storing of the exposed filter. Sample handling and custody processes practiced by the RTI Lab are described fully in Appendix A through D of this document. Procedures followed by DAQ for the collection of particulate filter data are described fully in the documents listed in Table 16 of this document. Throughout the process a COC form (see RTI Chain of Custody.pdf) is used to track each sample through the various stages of its life. The sample custody process is designed to do the following:

- Ensure the PM samples are not altered either intentionally or inadvertently at any time prior, during or after use at the location where the sample was taken;
- Identify a person or agency responsible for that filter for specific stages of the filter; and
- Assign specific responsibility to help ensure that problems do not arise from improper handling or storage and helps to trace the cause of a problem when it does occur.

12.1 Pre-Sample Custody

The sample custody is initiated when the bulk shipment of EPA approved filter media is received at RTI for gravimetric analyses. The filters are visually inspected, identified, prepared for field use, labeled and recorded at the RTI lab during the pre-weighing (tare) procedure. The pertinent information regarding the filter batch inspection and conditioning are recorded at the lab. The RTI lab staff ships the filters with COC to the designated field locations on a specified schedule. An example of the COC form is included in the RTI Raw Data Package (Appendix F) The RRO monitoring technicians receive filters from RTI and document on the COC that they received the filters. They inspect the filters upon receipt and document compromised or damaged filters on a photocopy of the COC and return them unused to RTI.

12.2 Post-Sample Custody

Site operators collect $PM_{2.5}$ samples using procedures outlined in the DAQ 2025i $PM_{2.5}$ SOPs. In general, site operators collect exposed $PM_{2.5}$ samples from the FRM samplers in the field within 177 hours of sample collection. The site operators remove samples from the samplers in the protective magazines and then transfer the protective magazines into a cooler containing frozen blue ice packs (or equivalent). From there, the site operators take the samples to the RRO. Site operators observe the exposed filters for possible instrument processing or sample handling damage. They note compromised or damaged filters on the COC and in the e-logs (sample log). If it is determined that damage to the filter is significant, such as a breach in the filter substrate, the sample is invalid.

The site operators complete and sign the COC for the filters going back to the laboratory. If the site operators do not ship the filters back immediately, then they store the filters in a designated refrigerator in RRO, along with the COCs, until they do ship them. Table 7 of this QAPP provides filter-holding requirements for the samples.

When preparing the exposed samples for shipment, the site operator places the sample magazines (in their metal transport boxes), surrounded by frozen ice packs. The signed COC is included in the cooler. The site operator then seals the cooler with tape and addresses it to the RTI

gravimetric lab. The site operators or coordinator ship (overnight delivery service) or hand deliver the coolers to the RTI gravimetric lab.

Upon receipt, the lab staff documents the shipment details, date he or she received the samples and records the cooler shipment temperature using an infrared thermometer to measure it. The lab staff will determine the analytical holding time based upon the shipment temperature. 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, the lab staff also inspects samples for damage. He or she notes compromised or damaged filters and documents the findings in the data package and on the COC. Based on RTI's schedule, the exposed filters will be weighed immediately or stored in a controlled environment until a weighing session is scheduled. The original COC form is filed in a binder at RTI and retained in accordance with Section 12.3. Copies of all COCs are included in the RTI Raw Data Package. The RTI lab staff also notifies DAQ when the PM laboratory relative humidity and temperature data loggers record out-of-specification conditions in the gravimetric laboratory. The RTI lab provides filter conditioning information, and other weigh session data, to the DAQ in the form of a data package.

Site operators may miss scheduled samples 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, the EPA requires a minimum of 75 percent of scheduled samples per quarter to show that a site meets the standard. The EPA allows agencies to use replacement samples (i.e., makeups) to help monitoring organizations achieve desirable data capture goals.

DAQ collects PM2.5 samples in accordance with the scheduled specified in 40 CFR Section 58.12. The national sampling scheduled 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 should be limited to no more than 5 samples.

When make-up samples are necessary, site operators will document the reason why the original sample was invalidated. The following is the approach DAQ 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: Sample before the next scheduled sampling day.

- For monitoring sites sampling every sixth day (not applicable to NCore), 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, the EPA suggests a day closest to the missed sampling day.
- For monitoring sites sampling every third day, the EPA suggests the earliest possible day before the next scheduled sample at the monitoring site. 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.

12.3 Sample Custody: Archive

After the exposed filters are weighed, they will be archived at RTI for the period of the contract with DAQ and for one additional year thereafter. At that time, RTI will return the filters to DAQ for storage or disposal. DAQ may also, at its discretion, take possession of the filters at an earlier date. Regardless of the term of the contract with RTI, DAQ will continue to store any exposed filters or other records, in compliance with its own record retention rules, discussed in other sections of this QAPP, in the DAQ QMP, and in SOP DAQ-14-003. All exposed filters will be properly stored in a cold-room facility or refrigerator whose temperature is maintained at 4 ˚C or less for at least one year. After the first year, the filters may be stored at room temperature in a secured indoor location. All filters will be archived for a minimum of five years before disposal.

13.0 Analytical Methods

The DAQ has chosen to utilize RTI as the contract lab for analysis of the $PM_{2.5}$ FRM samplers. All analysis performed by RTI will satisfy the requirements set forth in 40 CFR Part 50, Appendix L, and the recommendations in the QA Guidance Document 2.12 and in the QA Handbook Volume II. The analytical methods and descriptions in the following section are included to provide an understanding of the methods used. Copies of the most current versions of the RTI QAPP and laboratory SOPs are included in Appendix A through D of this document. Note: Continuous PM and gaseous monitors are not included in this section because there is no external analytical method used in producing data from those monitors.

13.1 Purpose/Background

This section identifies the method requirements to complete analyses of the samples collected by sequential PM samplers. The DAQ uses one analytical method for analyzing filters collected by sequential samplers: Appendix L to 40 CFR Part 50—Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere. The RTI laboratory will conduct these gravimetric analyses, where the net mass of the sample is identified. The net mass is calculated by subtracting the initial filter weight from the final filter weight of the exposed filter. Once the data package from RTI is received and reviewed by DAQ, the field data providing the total filter exposure air volume, recorded during the exposure of the filter, will be used to determine the PM concentration for each filter. The net mass of the exposed filter is divided by the total filter exposure volume to calculate the PM concentration for that filter. The concentration data will be used for comparison to the daily and annual NAAQS. Since the method is non-destructive, and due to possible interest in sample composition (e.g., subsequent chemical analyses), the DAQ has contracted RTI to archive the filters as described in Section 12.3.

13.2 Preparation of Samples

Detailed procedures for receiving, inspecting and conditioning the filters and preparing the samples are described in the RTI SOP for PM Gravimetric Analysis Sections 1.13.1 through 1.13.3 and 1.13.4 (see Appendix C RTI SOP for PM Gravimetric Analysis Revision 15 Date: March 29, 2022). These procedures are summarized here. The bulk shipment of EPA approved Teflon™ filters designated for DAQ are received at the RTI lab. Filters are put into the conditioning room by laboratory staff and laid out sequentially to detect any missing or duplicate filter numbers. Laboratory staff concurrently inspect the filters to ensure they are suitable for use. Once the filters have been conditioned, they are weighed and their id numbers and weights are recorded into the laboratory database. The laboratory staff records the number for each filter, loads the filter into a cassette and prints the COC form. The cassettes are put into magazines around which is wrapped the COC form. The wrapped magazine is then sealed individually in a plastic bag for shipment. Lab staff ship the magazines by next day air carrier on previously specified dates to the RRO. Site operators keep the unexposed filters at their field locations until they are installed in the samplers.

13.3 Analysis Methods: Gravimetric $PM_{2.5}$

The gravimetric analysis for the Teflon filters used in the $PM_{2.5}$ monitoring program includes conditioning and pre-sample weighing, and conditioning and post-sample weighing. The components of the methods are described below:

Filter Conditioning: Detailed procedures for conditioning the filters are described in the RTI SOP for PM Gravimetric Analysis Section 1.13.3 (see Appendix C RTI SOP for PM Gravimetric Analysis Revision 15 Date: March 29, 2022). The lab staff expose new for pre-sample and used for post-sample filters on open petri slides for a minimum of 24 hours in the weighing room. The conditions in the weighing room during the 24-hour conditioning period must be stable, monitored and available for use in data verification. The temperature and humidity for the 24-hour period must be reported in 5-minute averages or less. Mean 5-minute average temperature for the entire equilibration and weigh session must be no less than 20 °C and no more than 23 °C, with a variation of no more than ± 2 °C. Humidity measured during this period must be no less than 30 percent and no more than 40 percent with a variation of no more than ± 5 percent. For QA/QC purposes, various filters are weighed and used as blanks to ensure that filter conditioning is adequate. A brief explanation of the designated purpose of each type of blank follows. A more complete description of these processes and the intended purpose and name for each different type of blank used is contained in Section A8 and Table 5 of the RTI QAPP attached as Appendix A RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 16). In short, exposure lot blanks (also known as lab blanks) and lot blanks are checked periodically to ensure that the filter conditioning is adequate. The lab filter and field filter blanks must meet the pre and post weight change stability requirements of 15 and 30 micrograms (µg), respectively. Exposure lot blanks should be initially weighed and then re-weighed weekly as soon as batches of filters are received to determine that the conditioning period is adequate for each batch of filters.

Pre-weigh Procedure: Laboratory staff weigh each conditioned $PM_{2.5}$ filter without the cassette installed within the 30 days prior to the filter being used in the field. The lab staff record the following information in a database table when each filter is weighed: Filter Number, Cassette Number, Batch, Weight, Weigh Date, Use by Date, and Lab Blank weight, as well as other pertinent data listed in the attached Appendix D RTI SOP for PM Chain of Custody Revision 8 Date: March 29, 2022. (See Appendix F Sample RTI Data Package for an example of information that is recorded.) The filter is loaded into a cassette and put into the sequential sampler magazine. Magazines are loaded with filters and field and trip filter blanks as required. A filter information sticker is attached to each magazine with the batch number, use by dates, and magazine ID. The COC documentation (filter ID numbers, cassette numbers, filter expiration date) are included in the shipment from RTI. (See Appendix F)

Post-weigh Procedure: The RTI lab receives filters from the field in plastic insulated coolers. The cooler contains: the metal shipping container with the sequential sampler magazines, the COC, and ice substitutes (above and below the magazines in the shipping container). The ice substitute is designed to freeze at minus 1˚C and maintains the temperature of the filters during transport below 4˚C. The lab staff inspect the shipping container upon arrival, open the shipping box and record the temperature of the sampling magazines. The temperature recorded by the infrared thermometer is considered to be the highest temperature experienced by the filters throughout the entire trip from the shipping locations to the laboratory. The lab staff log in the filters and take them to the conditioning room where they are taken out of the cassettes. After equilibration for at least 24 hours or the minimum amount of time as determined by the lot blank procedure, the lab staff then weigh the filters and update the database tables with the following information: shipment temperature, filter and cassette number, conditioning room temperature and humidity during weighing, analyst's name, filter weight and the five-minute mean temperature and humidity in the conditioning room for the 24 hours prior to weighing.

13.4 Internal QC and Corrective Action for Measurement System

The internal QC at the RTI lab is designed to meet or exceed the requirements in 40 CFR Part 50, Appendix L, and recommendations in the QA Guidance Document 2.12. The RTI quality assurance officer (QAO) is responsible for ensuring that the quality system is implemented and followed. The RTI QAO will notify management of deficiencies in the quality system and monitor corrective action. The RTI Lab internal QC standards and processes, including data review responsibilities, is discussed in detail in Appendix A of this document and includes but is not limited to: the use of lot and lot exposure (i.e., lab) blanks, instrument calibration/verifications (balance, thermometer, RH), accuracy audits (balance audits, balance checks), use of certified calibration standards (working mass standards and primary standards) and precision checks (duplicate filter weighing). The failure of any internal QC check to meet the criteria previously established for that measurement triggers a corrective action on the part of RTI which will include the following as necessary:

1. Immediate retest of the result found to be at variance with established criteria.
2. Examination of the instrumentation involved, including visual inspection, cleaning, system internal and external diagnostic checks (performed by RTI staff).
3. Equipment service/ repair (performed by external vendor).
4. Determination of impact of the nonconformance on data quality.
5. Preparation and dissemination of the Corrective Action report to RTI management and DAQ outlining the nonconformance, the reason it occurred, the steps taken to correct the problem and prevent it from reoccurring and an assessment of the impact of the nonconformance on DAQ data.

14.0 Quality Control Requirements and Procedures

Quality control is the overall system of technical activities that measure the attributes and performance of a process, item or service against defined standards to verify they meet the stated requirements established by the end user. The DAQ must perform two distinct and important interrelated functions to assure the quality of data from air monitoring measurements. One function is the control of the measurement process through broad QA activities, such as establishing policies and procedures, developing DQOs, assigning roles and responsibilities, conducting oversight and reviews and implementing corrective actions. The other function is the control of the measurement process through the implementation of specific QC procedures, such as audits, calibrations, checks, replicates, routine self-assessments, etc.

In the case of the NCore Ambient Air Quality Monitoring Network, the DAQ uses QC activities to ensure DAQ maintains measurement uncertainty, as discussed in Section 7.0 Quality Objectives and Criteria for Measurement Data, within acceptance criteria for the attainment of the DQOs. The SOPs in Table 11.2, the specific instruments' operation manuals and Table 14.2 provide lists of pertinent QC checks.

The DAQ achieves QC through:

- Daily automated calibration checks, consisting of a zero, span and 1-point QC check;
- Daily review of instrument measurements;
- Annual, or as needed, multipoint calibrations;
- Verifications following calibrations;
- Verification within 182 days of the most recent calibration for CO, NO_2 and NO_y monitors;
- Monthly operational checks by the RRO site operators;
- Performance evaluations;
- Periodic maintenance;
- Flow rate verifications and audits;
- Acceptance test procedures;
- Accuracy, bias, and precision checks;
- Collocated instruments;
- Control charts; and
- Other verification techniques.

Zero, span and 1-point QC-checks are required once every fourteen days for gaseous analyzers. The DAQ chooses to use a goal of daily checks for the SO_2 and O_3 analyzers. Data analyzed from monitors in the DAQ NCore network do not undergo routine post-processing to correct for zero and span drift. In the sections that follow, the RCO chemists embedded the calculations for the following QC procedures in e-log books. The RRO monitoring and ECB electronics technicians do not compute any calculations by hand to reduce human error to the extent possible. The RCO chemists derived the formulas from relevant sections of 40 CFR Part 58 and the appendices to 40 CFR Part 50. Based upon the QC data and the validation criteria, the monitoring data are either reported as collected, and appropriately qualified, or the data are invalidated. Tables 7.2 thru 7.8 provide the acceptance criteria for specific QC procedures.

14.1 Calibrations

Adjusted calibration, which DAQ calls calibration, is the process used to verify and rectify an instrument's measurements to minimize deviation from a standard. This multiphase process begins with certifying a calibration or transfer standard against an authoritative standard, such as a NIST-traceable standard. The RRO monitoring technician compares the instrument's measurements to this calibration/transfer standard. If significant deviations exist between the instrument's measurements and the calibration/transfer standard's measurements, the RRO monitoring technician adjusts the instrument's response to rectify the analytical instrument's measurements.

SOPs 2.7.2 Section 3, DAQ-08-001.2 Section 5.5, DAQ-12-002.2 Section 5.5, DAQ-04-001.2 Section 5.5, 38.2 Section 3, 2.45.2, DAQ-11-001.2, and 2.47.2 and the specific instruments' operations manuals provide calibration requirements for the critical field and laboratory equipment. For the particle monitors, the RRO operator adjusts the flow rate when performing a calibration, upon installation, following electromechanical maintenance and monitor transport, after a failed verification, after major maintenance and annually.

The design or desired flowrate of low-volume particle samplers is 16.67 LPM, which is equivalent to 1 cubic meter per hour. The measurement principle involves separating particles by size using a PM_{10} inlet head (and very sharp cut cyclone for $PM_{2.5}$) and then either collecting them on a filter tape or measuring them by the way they diffract light. Therefore, the flow rate is set higher than human air intake (normally 0.5 LPM) to collect a quantity of PM that is sufficient for a reliable and repeatable measurement. One benefit of such a comparatively high flow rate is that it minimizes diffusion losses of the smallest particles and allows for a sharp cut-off curve at the upper limit for coarse particles.

Calibration of the sampler's flow rate measurement device must consist of at least three separate flow rate measurements (a multi-point calibration), evenly spaced within the range of -10 to +10 percent of the sampler's operational flow rate (40 CFR Part 50, Appendix L, Section 9.2.4). The sampler's flow control system shall allow for operator adjustment of the operational flow rate of the sampler over a range of at least ±15 percent of the targeted flow rate (40 CFR Part 50, Appendix L, Section 7.4.2).

After the RRO operator has adjusted the flow rate, the operator performs a post-calibration validation of the flow rate to ensure the calibration is successful. Using a certified 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 percent for the calibration to be successful.

DAQ requests RTI to provide specific documentation demonstrating calibration of the analytical microbalance used to weigh all filters when the devices are recalibrated. RTI must provide to DAQ, upon request, documentation demonstrating that all calibrations meet listed requirements for frequency and accuracy and that all standards used to establish instrument performance are in certification and meet listed requirements for NIST traceability.

To calibrate the gaseous analyzers at the NCore site, the DAQ uses a gas dilution system to generate specific upscale calibration points. The ECB electronics technicians established the calibration scale for the NO_y, SO_2 and CO monitors based on the recommendations in the NCore technical assistance document, or TAD. The ECB electronics technicians established the calibration scales for the O_3 and NO_2 monitors based on the highest average minute concentrations expected to occur at the site. See Table 14.1 below; the zero and span represent the calibration scale of the monitor. The regional monitoring technicians generally follow the calibration frequencies in the QA Handbook to calibrate

the gaseous monitors. The selected schedule requires calibration of the gaseous monitors upon receipt, at installation or following relocation, when the 1-point QC check fails, when the monitor is without power for 72-hours, after major maintenance and annually. For the CO, SO_2 and NO_y, the DAQ is following calibration frequencies in the QA Handbook rather than the NCore TAD. For the O_3, NO_2, SO_2 and NO_y monitors, the zero and the span, which is set at 80 to 90 percent of the calibration range, are adjusted during a calibration. These adjusted points have tight acceptance ranges, between which the analyzers' measured values must fall.

According to the Principles of Operation on pages 1 and 2 of the Thermo 48i manual, the Model 48i Trace Level-Enhanced (TLE) monitor operates on the principle that CO absorbs infrared radiation at a wavelength of 4.6 microns. Because infrared absorption is a non-linear measurement technique, it is necessary to transform the basic analyzer signal into a linear output. To accomplish this, the RRO monitoring technician adjusts the zero and three upscale points during a calibration. The Model 48i TLE monitor uses an internally stored calibration curve based on the zero and three upscale points to accurately linearize the instrument output up to a concentration of 4000 ppb at the NCore site.

After the monitors are calibrated, the RRO monitoring technician verifies the calibration by repeating the points and doing additional points. SOPs 2.7.2 Section 3, DAQ-08-001.2 Section 5.5, DAQ-12-002.2 Section 5.5, DAQ-04-001.2 Section 5.5, and 2.38.2 Section 3 and the instruments' operation manuals provide specific calibration requirements for the O_3, NO_2, SO_2, CO and NO_y analyzers. Table 14.1 shows a summary of calibration requirements as well as QC requirements which will be discussed in the next section.

Table 14.1 Acceptance Criteria for Calibrations and 1-Point-QC Checks

Nitric Oxide (NO) and Oxides of Nitrogen (NOy) Channels (Chemiluminescence)						
Operation	Concentration / Acceptance Criteria	Zero	Span	Precision		
One Point QC Check (1/14 days)	Concentration (ppb)	0	180	36		
	Acceptance (±)	1 ppb	10 %	10 %		
Calibration	Concentration (ppb)	Zero	Span	Mid-Range	Low Mid-Range	Lowest Point
		0	180	100	50	25
		1 ppb	< ± 2.1 % *or* 1.5 ppb	< ± 2.1 % *or* 1.5 ppb	< ± 2.1 % *or* 1.5 ppb	< ± 2.1 % *or* 1.5 ppb
	Acceptance (±)	Linearity test – slope must be 1 ± 0.05; each point must be < ± 2.1 % *or 1.5* ppb of the best fit line, whichever is greater				
Nitrogen Dioxide (NO_2) Channel (Cavity Attenuated Phase Shift Spectroscopy)						
Operation	Concentration / Acceptance Criteria	Zero	Span	Precision		
One Point QC Check (1/14 days)	Concentration (ppb)	0	180	20		
	Acceptance (±)	<1.5 ppb	<10.0 %	<10.0 %		
		Zero	Span	Mid-Range	Low Mid-Range	Lowest Point

Table 14.1 Acceptance Criteria for Calibrations and 1-Point-QC Checks

Calibration and Multi-Point Verification	Concentration (ppb)	0	180	135	95	45
	Acceptance (±)	1.5 ppb	< ± 2.1 % *or* 1.5 ppb	< ± 2.1 % *or* 1.5 ppb	< ± 2.1 % *or* 1.5 ppb	< ± 2.1 % *or* 1.5 ppb
	Linearity test – slope must be 1 ± 0.05; each point must be < ± 2.1 % ***or*** *1.5* ppb of the best fit line, whichever is greater					
Carbon Monoxide (CO)						
Operation	Concentration / Acceptance Criteria	Zero	Span	Mid-Range	Precision	
One Point QC Check (1/14 days)	Concentration (ppb)	0	4000	2000	500	
	Acceptance (±)	35 ppb	< 5 %	< 50%	< 7 %	
Calibration (see comment) Verification	Concentration (ppb)	Zero	Span	Mid-Range	Low Mid-Range	Lowest Point
		0	4000	3000	2000	1000
	Acceptance (±)	≤ ±30 ppb	< ± 2.1 % *or* 30 ppb	< ± 2.1 % *or* 30 ppb	< ± 2.1 % *or* 30 ppb	< ± 2.1 % *or* 30 ppb
	Linearity test – slope must be 1 ± 0.05; each point must be < ± 2.1 % ***or*** 30 ppb of the best fit line, whichever is greater					
Sulfur Dioxide (SO_2)						
Operation	Concentration / Acceptance Criteria	Zero	Span	Precision	NA	Mid-Range
One Point QC Check (1/14 days)	Concentration (ppb)	0	85	7	N/A	N/A
	Acceptance (±)	<1 ppb	< 5%	< 7%	N/A	N/A
Calibration Verification	Concentration (ppb)	0	85	7	N/A	45
	Acceptance (±)	<1 ppb	< 5%	< 7%	N/A	< 5%
	Linearity test – slope must be 1 ± 0.05; each point must be within 2.0 percent of the best fit line or ± 1.5 ppb whichever is greater					
Ozone (O_3)						
Operation	Concentration / Acceptance Criteria	Zero	Span	Precision		Mid-Range
One Point QC Check (1/14 days)	Concentration (ppb)	0	225	65	N/A	N/A
	Acceptance (±)	3 ppb	5 ppb	3 ppb	N/A	N/A
Calibration Verification	Concentration (ppb)	0	225	65	180	120
	Acceptance (±)	2 ppb	2 ppb	2 ppb	2 ppb	2 ppb
	Linearity test – slope 1 ± 0.05; All points < ± 2.1 percent or ≤ ±1.5 ppb difference of best-fit straight line whichever is greater					

All DAQ calibration criteria includes the EPA criteria requiring the linearity assessment with slope being 1 ± 0.05 and each point being within ± 2 percent of the best-fit line. All pollutants, with the exception of SO2, adhere to calibrations that use four upscale points as recommended by the EPA or required by some of the appendices in 40 CFR Part 50. Ozone, NO_2, and CO use a linear regression analysis during the calibration / verification procedure, which includes a zero and 4 upscale points. SO_2, uses a linear regression analysis during the calibration / verification procedure, which includes a zero and 3 upscale points. For the CO calibration, the points ran and entered into the monitor to establish the curve are 4000 ppb and 300 ppb. There is no way to set the zero value; however, the regional monitoring technician runs it and records it as one of the points. For SO_2, the DAQ uses zero and three upscale points with a linear regression analysis. For NO_y, the DAQ uses zero and four upscale points for the NO and NO_y calibration and does one gas-phase titration.

14.2 Precision Checks

The EPA defines precision as the measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. To meet the DQOs for precision, the DAQ will ensure the entire measurement process is within statistical control. To do this, DAQ will employ various tools to evaluate and monitor precision measurements. For the gaseous monitors, to measure precision the monitoring technicians challenge the instruments with a 1-point-QC check at least every 14 days, preferably every night, to provide evidence of deviations from the required precision measurement as described in 40 CFR, Part 58, Appendix A, Section 3. The SOPs listed in Table 11.2, the instrument operations manuals and Table 14.1 provide the 1-point-QC check and precision requirements for the gaseous analyzers. Precision calculations follow the procedures described in 40 CFR, Part 58, Appendix A, Section 4. For PM monitoring, viewing data integrity with control charts will provide evidence of deviations from the required precision measurement. A check may be invalid due to a problem with the calibrator or zero air system, a bad solenoid, or a problem with the monitor. The SOP and instrument operations manual provides 1-point QC checks and precision requirements for the gaseous monitors. The DAQ will use various tools in evaluating and monitoring precision measurements. To evaluate precision, the DAQ will perform the following checks.

14.2.1 One-Point QC Checks

Pursuant to 40 CFR Part 58, Appendix A, Section 3.1.1, a one-point QC check or auto-precision, zero and span (PZS) must be performed at least once every 2 weeks on each continuous analyzer used to measure the gaseous criteria pollutants. The 1-point QC check will provide evidence of deviations from the required precision measurement as described in 40 CFR Part 58, Appendix A, Section 3. The ECB electronics technicians set up equipment at the site to challenge the trace-level analyzer with a NIST-traceable QC check gas of a known concentration that is representative of the mean or median concentrations at the site. At DAQ's NCore site the QC check gas concentration must be between the prescribed range of 5 and 80 parts per billion (ppb) for O_3, SO_2 NO_2 and NO_y and between 0.5 and 5 parts per million (ppm) for CO, per 40 CFR Part 58, Appendix A. The NCore air monitoring network performs both automated and manual checks. The auto-PZS checks are typically performed daily for O_3 and SO_2. While manual PZS checks are performed every 14 days for CO, NO_2 and NO_y, RRO field technicians typically refer to the automated check as either an "auto-PZS" or "PZS", which are terms used in the statewide instrument SOPs. Automated checks must include a precision measurement but also include the span and zero. For each check, a percent difference is

calculated, the results of which are compared to the acceptance criteria established in Tables 7.2 to 7.8, and as specified in the SOPs. Table 14.1 summarizes this information.

For the CO, NO_2 and NO_y monitors DAQ performs a nightly "diagnostic auto –PZS" and manual on-site 14-day checks, that are the official values reported to AQS. For the nightly "diagnostic" PZS checks, the percent difference is calculated for each point; each point must be within the specifications in Table 14.2 for the check to pass. These checks are considered diagnostic and not reported to AQS because they do not run for a long enough period to be accurate enough for an official, reportable check.

Table 14.2 Acceptance Criteria for Nightly Precision-Zero Span Checks

Carbon Monoxide (CO) Channel			
Concentration/Acceptance Criteria	Span		
	Precision	Zero	Span
Concentration (ppb)	500	0	4000
Acceptance (±) [1]	7 percent	45 ppb	7 percent
Nitric Oxide (NO) and Oxides of Nitrogen (NO_y)			
Concentration/Acceptance Criteria	Span		
	Precision	Zero	Span
Concentration (ppb)	36	0	180
Acceptance (±) [1]	15 percent	0.5 ppb	6 percent
Nitrogen Dioxide (NO_2) Channel (Cavity attenuated phase shift spectroscopy)			
Concentration/Acceptance Criteria	Span		
	Precision	Zero	Span
Concentration (ppb)	20	0	180
Acceptance (±) [1]	7 percent	<1.0 ppb	7 percent

[1] Warning Limit

The calculation for the precision measurement (i.e., percent difference) is found in 40 CFR Part 58, Appendix A, Section 4.1.1, and the RCO chemists also embed this calculation in the e-logs used by the RRO monitoring technicians.

Precision checks (1-point QC and PZSs) verify or confirm the analyzer is in good working order; and, therefore, support the defensibility of the data.

The RRO monitoring technician must perform a calibration if the 1-point QC check or PZS fails and calibration and analytical equipment are working properly. Normally if either of these checks fail, a problem exists within the monitoring system that needs addressing (i.e., results in equipment maintenance and/or repair). If the zero check or span check exceed the specifications in Table 14.2, then a calibration will be done after the 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 – the drift may simply indicate it is time to recalibrate the analyzer. The DAQ staff do not adjust ambient concentration data to correct for zero drift. However, the CO monitor automatically corrects for zero drift in the monitor at a set period. For the CO, NO_2 and NO_y monitors, failure at the zero or

span points will require investigation and if deemed appropriate (based on a weight-of-evidence approach), the data will be invalidated based on the failed check.

14.2.2 Flow Rate Verifications

In accordance with 40 CFR Part 58, Appendix A, Sections 3.2 and 3.3, the RRO monitoring technician must perform a one-point flow rate verification check at least once every month on each sampler used to measure $PM_{2.5}$ and low volume PM_{10}. DAQ has set a goal to complete these verifications every 14-18 days, except during audit months, when the audit takes the place of the second monthly verification. The RRO monitoring technician makes the verification by checking the operational flow rate of the sampler. If the RRO monitoring technician makes the verification in conjunction with a flow rate adjustment, also known as a calibration, the monitoring technician must complete the verification before making the adjustment. The RRO monitoring technician compares the flow rate reported by the transfer standard to the flow rate measured by the sampler. The RRO monitoring technician calculates percent difference between the two readings and compares the results to the acceptance criteria in Tables 7.6 and Tables 7.8. The RRO monitoring technician also calculates percent difference between the design flow rate of the sampler (i.e., 16.67 LPM) and the flow rate measured by the transfer standard during the check using the calculations embedded in the e-log. These QC checks verify or confirm the PM sampler is in good working order and, therefore, support the defensibility of the data.

14.2.3 Duplicate Filter Weights

For the gravimetric monitor, DAQ requires RTI to complete duplicate filter weighing for at least one filter per batch, or 10% of the total filters per batch, whichever is more. Successive filter weights may vary no more than 15 µg to meet acceptance requirements. RTI randomly selects one or more filters to reweigh from each batch. The frequency of filter duplicate weighing is in accordance with Quality Assurance Guidance Document 2.12.

14.3 Accuracy or Bias Checks

The EPA defines accuracy as the degree of agreement between an observed value and an accepted reference value. Accuracy is a combination of random error (precision) and systematic error (bias). Currently at the NCore station the 1-in-three-day FRM is collocated with a continuous monitor. When collocated data are available, collocated data may be used for evaluating and controlling precision and bias.

The PZS checks can also provide data capable of identifying bias for gaseous monitors. For the PM monitors, percent difference measurements, obtained during flow rate verifications, in lieu of concentrations, are used to assess the bias. These calculations are described in 40 CFR Part 58, Appendix A, Section 4. Performance audits are also an indicator of accuracy/bias and are discussed below.

For the PM monitors, the DAQ will monitor data integrity with control charts to provide evidence of deviations from the required precision measurement. Accuracy and bias requirements for the applicable instrumentation are found in the SOPs DAQ-11-001.2, and 2.47.2 (see Table 11.2 for SOP titles) and in the specific instruments' operations manuals.

14.3.1 Annual Performance Evaluations

For the gaseous instruments, ECB electronics technicians will perform an annual performance evaluation at least every 365 days and once per calendar year and whenever requested by the chief. The ECB electronics technicians perform these evaluations by comparing the analyzer measurements to independent standards or references. The ECB electronics technicians determine audit concentrations following requirements in 40 CFR Part 58, Appendix A, Section 3. The audit concentrations selected for evaluation include a value at or near the detection limit of the monitor, a value near the level of the primary NAAQS, and a value that is less than the 99th percentile of the data within the network. The ECB electronics technician uses a different gas cylinder and calibrator to complete the audit than the gas cylinder and calibrator used to calibrate the monitor and complete the nightly or biweekly QC checks. However, the ECB may reference both the calibration standard and the audit standard to the same primary standard. The DAQ designates the ECB electronics technicians, who are not normally involved in the routine operational activities of the O_3, NO_2, SO_2, CO and NO_y monitors, to do the annual performance evaluations using dedicated QA equipment. The applicable instruments' operations manuals and SOPs DAQ-08-002.1, DAQ-10-001.1, DAQ-12-001.1, 2.36.1 and 2.38.1 (see Table 11.2 for SOP titles) provide details for implementing annual performance evaluations. The EPA has designed these checks to assess the accuracy and measure the bias.

14.3.2 Field Flow Rate Audits

For the PM instruments that measure flow, a RRO monitoring technician other than the regular operator must perform a flow rate audit at least every 6 months and preferably every quarter. The auditor completes the audit by measuring the analyzer's normal operating flow rate using a certified flow rate transfer standard. The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the analyzer. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate or volume standard. Tables 7.6 and 7.8, the applicable instruments' operations manuals and SOPs 2.45.2, DAQ-11-001.2 and 2.47.2 (see Table 11.2) provide details for implementing flow audits. The auditor uses the calculations embedded in the e-log to determine the percent differences. See Table 14.3 for example corrective actions for failed flow rate audits.

14.3.3 Meteorological Sensor Checks

The DAQ audits the meteorological equipment twice per calendar year and every 182 days using the collocated transfer station audit method by comparing the site sensor to a dedicated "audit sensor" installed at the same site. During which, the DAQ audits for wind speed, wind direction, ambient temperature, barometric pressure, and relative humidity. Additionally, the DAQ sends the meteorological site sensors to the manufacturer for wind tunnel calibration once per calendar year and every 365 days or whenever the collocated transfer station audit check fails to meet control limits in Table 1 of SOP DAQ-07-003.1. The dedicated "audit sensor" is also sent to the manufacturer for wind tunnel calibration once per calendar year and every 365 days. When a sensor is sent to the manufacturer, the DAQ asks that all other parameters of the AIO2 are calibrated as well. The DAQ takes corrective action when the audits or calibrations fail. The DAQ may flag any affected data back to the last passing collocated transfer station audit method check. For further details on the meteorology requirements at NCore sites, please refer to the QA Handbook for Meteorological Measurements.

14.3.4 External Agency Audits

The DAQ participates in the EPA Ambient Air Protocol Gas Verification Program and the NPAP. Information regarding the frequencies and acceptance criteria for the NPAP audits is available in Tables 6.1 and 7.2. Information on the NPAP is available at https://www.epa.gov/amtic/national-performance-audit-program-npap-gaseous-monitoring. Information on the EPA's Ambient Air Protocol Gas Verification Program is available at https://www.epa.gov/amtic/ambient-air-protocol-gas-verification-program.

The EPA defines a performance evaluation as a type of audit in which an independent party obtains the quantitative data generated in a measurement system and compares it with routinely obtained data to evaluate the proficiency of the site operator. The DAQ participates in the EPA PEP and NPAP which includes only the regulatory monitors at the NCore site. Information on the PEP and NPAP is available at https://www3.epa.gov/ttn/amtic/npepqa.html.

For $PM_{2.5}$, the PEP is a QA activity, which the DAQ uses to evaluate measurement system bias of the PM monitoring network. In the case of the PM PEP, the goal is to evaluate total measurement system bias, which includes measurement uncertainties from the field and the laboratory activities. The strategy is to collocate a portable $PM_{2.5}$ air-sampling instrument within 2 to 4 m of an air-monitoring instrument, operate both monitors in the same manner, and then compare the results. Further information on the PEP is available at this link.

14.4 Filter Inspections

Initial filter inspections are performed by RTI technical staff prior to weighing. The RTI technician will inspect all filters before weighing to ensure that the filters are the correct type and size and do not have pinholes, particle contamination, or other imperfections. The technician will discard any filter that fails the initial visual defect check.

When the DAQ field operators receive the filters from RTI, they inspect the filters for damage and pin holes before installing the filters into the sampler. They document compromised or damaged filters on a photocopy of the COC and return them unused to RTI. The DAQ field operators also inspect the filters after sampling is complete before shipping the filters back to RTI. Any damage to the filter is recorded on the COC that accompanies the filter back to RTI.

When the DAQ field operators return the exposed filters to the lab, the technician will again inspect each filter and note any imperfections that are apparent. The RTI technician will carefully note any filters which are damaged and record his observations on the filter data page in the data package reported to DAQ. The DAQ PM chemist will void sampled filters which are found to be damaged or to have defects which might have affected sampling data.

14.5 Laboratory QC

14.5.1 Balance Checks

Balance checks are frequent checks of the balance working standards against the laboratory balance to ensure precision throughout weighing sessions to test the micro-balance repeatability. RTI will use American Society for Testing and Materials Class 1 weights for its primary and secondary (working) standards. The RTI technician will measure working standards at the beginning of each weighing session. Additionally, the analyst will weigh standards after every 10 filters and at the end of each weighing session. All balance verifications performed by RTI during the weighing of DAQ filters

will be supplied to DAQ as part of the QC documentation for the weigh session. DAQ will conduct yearly audits of the RTI facility utilizing EPA supplied audit forms and procedures. DAQ audits will rely on RTI supplied third party validations to determine balance function and accuracy. These function and accuracy tests are discussed more fully in Appendix A of this document.

14.5.2 Quarterly Weight Verifications

RTI has the working standards re-certified annually against a NIST-traceable standard at an accredited metrology laboratory. RTI verifies the working standards' masses against the laboratory's in-house primary standards every 90 days to check for mass shifts associated with handling or contamination. RTI staff must record the verified values of the working standards as measured relative to the laboratory primary standards in a laboratory QC log and use them to check the integrity of the working standards.

The double substitution method is the method for conducting quarterly verifications of the working mass reference standards. This procedure is a version of SOP Number 4 in NIST Handbook Number 14521. Using this method, the RTI technician weighs a set of primary standards against a set of working standards to generate a reference point. The working and primary standards are each weighed twice.

Whenever the RTI technician computes the double substitution, he or she compares the new calculation to the previous calculation to determine if there has been a significant shift in mass. The technician does not use the double substitution method to generate a "new mass" for any weight standard; the double substitution method serves only as a verification (check) of the standards. The acceptance criterion is ±2 µg from the certified weights.

14.5.3 Blank Checks

Collecting blanks is required under 40 CFR Part 50, Appendix L Section 8.3.7.1. DAQ currently requires field personnel and RTI to collect field filter, trip filter, exposure lot (i.e., lab), and lot blank samples for use as QC checks. RTI pre-weighs field blank filters with routine sample filters; the RRO monitoring technician then installs this pre-weighed filter in the field sampler without any flow passing over the filter; RTI re-weighs the field blank filters with routine exposed samples filters and then calculates the change in weight. Results are included in the data package. Final weights for field blanks must differ from initial recorded weights by less than 30 micrograms to meet acceptance criteria. All other blanks may vary by no more than 15 micrograms between the final and initial weights.

The purpose of blanks is to provide an estimate of total measurement system contamination, such as for transport or field activities. Through a comparison of exposure lot blanks against field filter blanks, DAQ can assess contamination from field activities.

The DAQ network collects field blanks within its network at a frequency of approximately 10 percent of the sampling runs scheduled per site. For example, for a sampler operating on a 1-in-3-day operating schedule, DAQ would collect 12 field filter blanks over the course of a year. The DAQ takes field filter blanks throughout the duration of the sampling schedule (spaced evenly across the year) and not concentrated in a short period.

As an additional QC check, DAQ will also collect trip filter blank samples. Collecting trip filter blanks is not a requirement under 40 CFR Part 50, Appendix L; however, collecting trip filter blanks is a best practice. The site operator treats a trip filter blank exactly as a field filter blank, but the

operator never places the filter into the sampler or exposes it to the ambient environment. The purpose of the trip filter blank is to assess possible contamination to filters during packing and transport to and from the laboratory to the sampling location. The trip filter blanks may vary by no more than 15 micrograms between the initial and final weighing. If the weight change exceeds 15 micrograms, contamination in the laboratory or during shipping may be occurring and further assessment of the exposure lot (i.e., lab) blank data will be necessary to identify the contaminant source. As with field filter blanks, the DAQ collects trip filter blanks within its PM network at a frequency of approximately 10 percent of the sampling runs.

RTI includes field filter blanks and trip filter blanks in the shipments of filters to the RRO. All filter blanks are accounted for using the seam processes as regular filters and use the same COC.

Lot blanks are conditioned, unsampled filters used to determine filter weight stability for each new supply of filters. RTI will randomly select nine filters from the manufacturer's lot received through the EPA. These filters will be used to determine the minimum conditioning time required for all the filters in the new lot. The procedure followed includes weighing the nine filters several times over the course of several days until the change in mass is no more than 15 micrograms. The number of hours needed to achieve this stability becomes the conditioning time of the whole lot. At a minimum, filters must be conditioned for at least 24 hours.

RTI will select and weigh exposure lot (i.e., laboratory) blanks with each batch of filters. Laboratory blanks may vary by no more than 15 micrograms compared to the original mass measurement made when the blank filter was first pre-conditioned. If the exposure lot blanks are not within the specifications after weighing, RTI will implement corrective action to locate and correct the problem.

14.5.4 Filter Holding Times

The RTI technicians must document, using COC documents, receiving logs, and temperature data to determine that all filters do not exceed acceptable holding times. DAQ field operators must only use filters to collect samples that are within 30 days of their initial weighing. If an operator collects a sample on a filter 31 days after its initial weighing, the PM chemist will void the sample. The operator must recover all sampled filters within 7 days and 9 hours from the sample end date. The PM chemist will void any samples recovered later than that. RTI must weigh all received filters within a specified time. The holding time on received filters vary depending on the temperature of the sample during collection and when received at the lab. To meet the requirements of EPA Method 2.12, filters received at ambient temperature must be weighed within 10 days of the sample date. Filters received at less than the average ambient temperature or at less than 4 °C, must be weighed within 30 days of the collection date to remain valid. RTI must note holding times for all filters and include this information on the filter data page of the data package supplied to DAQ. The PM chemist will void any data from filters which are received above 25 °C or which exceed their holding times.

14.5.5 Filter Conditioning Environment

RTI will equilibrate all filters in a temperature and humidity-controlled environment for a minimum of 24 hours. The controlled environment must meet the following conditions:

- The 24-hour mean temperature must fall between 20 and 23 ° C;
- The SD in the temperature over a 24-hour period must be less than ± 2.1 ° C;
- The 24-hour mean RH must fall between 30 and 40 percent or less than or equal to 5 percent sample RH but greater than 20 percent RH;

- The SD in the RH over a 24-hour period must be less than ± 5.0 percent; and
- The difference in the 24-hour mean RH must be less than or equal to 5.1 percent between when the analyst takes the initial and final weights.

14.5.6 Quality Control Samples

Weighing blanks is required under 40 CFR Part 50, Appendix L Section 8.3.7. As such, DAQ will weigh lab and lot blank samples as a QC check. Lot blanks are conditioned, un-sampled filters used to determine filter weight stability for a new supply of filters. Typically, the analyst randomly selects nine filters, from the manufacturer's lot sent by EPA at the beginning of the year, to use to determine conditioning time of all filters in the entire lot. Lab blanks are weighed with each batch of filters and must meet the criterion of ± 15 µg, compared to the original mass measurement made when the blank filter was first pre-conditioned. If the blanks are not within the specifications after weighing, check the balance and filter to see if there are any unusual debris. It is suggested to brush off the balance, perform an internal adjustment, and re-zero the balance.

14.6 Corrective Actions

All DAQ personnel take corrective action measures as necessary to ensure DAQ attains the MQOs. Given the number of monitors, the diversity of monitoring activities and the complexity of the instruments, a potential exists that issues may arise with sampling and measurement systems. In the NCore monitoring network, the DAQ has anticipated certain issues in advance and prepared and equipped the staff to address the issues as they arise.

However, the staff will encounter unexpected or unforeseen circumstances, such as a failed QA/QC check, so they will also need to implement corrective actions on an "as-necessary" basis. The DAQ SOPs listed in Table 11.2 contain examples of corrective actions that the staff may need to complete under certain circumstances. RRO monitoring technicians should consult the operator SOPs listed in Table 11.2 for technique-specific checks, required frequency of checks, acceptance criteria and additional corrective action guidance. Table 14.3 is an abridged list for typical problems that require corrective action. It is the DAQ policy that monitoring and ECB electronics technicians and RCO chemists report the need for corrective actions to the appropriate monitoring coordinator or supervisor within two business days and address the issue as soon as possible, ideally within five business days. The RRO monitoring technicians, ECB electronics technicians and RCO chemists can resolve most problems within one or two business days, but occasionally it takes longer to identify what caused the problem and find a solution. When equipment is down, staff must work to repair the problem as quickly as possible to limit the amount of data loss.

Table 14.3 Corrective Actions

Activity	Problem	Likely Actions
QA/QC Check	Out of specification; flow rate check or failed flow rate audit exceeds acceptance criteria	1) Verify / reproduce performance check findings (e.g. flow rate verification or audit). Use an alternate transfer standard or operator 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 SOPs. 4) Identify any required procedural changes to prevent reoccurrence. 5) Document actions on audit worksheet, data sheet or logbook as appropriate. 6) Notify the RRO monitoring coordinator and RCO chemist of performance audit failures as soon as practical.
	Zero/Span/1-point-QC check exceeds acceptance criteria; Monitor/Program fails to meet operational or critical criteria	1) Verify / reproduce performance check findings (e.g., Zero, Span and Precision). Use an alternate transfer standard to confirm failures. 2) Perform alternate performance checks to determine cause (for example – filter change and leak tests). 3) Replace solenoid and send old solenoid to ECB for testing. 4) Recalibrate the monitor using the appropriate SOP (see Table 11.2). 5) Identify any required procedural changes to prevent reoccurrence. 6) Document actions on audit worksheet or logbook as appropriate. 7) Notify the coordinator of check 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 COC form, data sheets, and 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 and logbook as appropriate.
Probe Line Integrity Check	Probe wet or contaminated	1) Verify probe inlet is intact and protectors from rain, insects and dirt are in place. 2) Check line for cold spots and bends or low points where water could accumulate. 3) Blow line out with zero air and dry for several hours if needed. 4) Document cause and any actions in the e-log or site logbook as appropriate.

Table 14.3 Corrective Actions

Activity	Problem	Likely Actions
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 and logbook as appropriate.
Internal Performance Evaluation	Out of specification	1) Verify integrity of the audit equipment. 2) If a problem exists with the audit equipment, repair the equipment and repeat the audit. 3) If the audit equipment is good, verify the monitor is operating correctly and if problems exist, fix them. 4) If no problems exist with the audit equipment or monitor, notify the regional monitoring technician so he or she can recalibrate the monitor. 5) Document cause and actions taken on the audit data sheets or site 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 database manager, ECB electronics technicians and RCO chemists, as appropriate. 6) Perform site visit to resolve monitor or telecommunication issues.

14.7 Documentation

The RRO monitoring technicians will document all events including routine site visits, calibrations, analyzer maintenance and calibration equipment maintenance in e-logs and site logbooks. The ECB electronics technicians will document all their activities, including site visits, internal performance evaluations, and equipment installs, in the site logbooks and removals and monitoring and calibration equipment maintenance on Air Quality Section Maintenance Order or AQ-109 forms and Continuous Monitor Performance Audit Report or AQ-121 forms. The ECB electronics technicians will also record in indelible ink field maintenance activities associated with equipment used by the RRO monitoring technicians in dedicated instrument logbooks as well, which are stored at the ECB. The RRO monitoring technicians document data from PM2.5 FRM sample runs and speciation monitors on COC forms and in e-logs. The records generated by the RRO monitoring technicians or at the monitoring site will normally be controlled by the regional ambient monitoring coordinator and located in the field site when in use or at the regional office when being reviewed or used for data verification. The regional coordinator transfers these records to the RCO group drive for the RCO chemists to use to validate the data.

Documentation of the lab QC is maintained by RTI and submitted with each data package.

15.0 Equipment Testing, Inspection and Maintenance Requirements

15.1 Purpose/Background

Preventative maintenance is a foundational element to an effective QA program. The ECB in the Maywood facility operates the maintenance and repair shop, referred to as the "shop," for off-site repair, maintenance and field or lab readiness certification of equipment. This section discusses the procedures RRO monitoring and ECB electronics technicians use to maintain all instruments and equipment, including spare analyzers, in sound operating condition so they can operate at acceptable performance levels. Refer to the instrument specific SOPs (listed in Table 11.2) for more details on the specific preventative maintenance and repair activities. The RRO monitoring and ECB electronics technicians must document and file all instrument inspection and maintenance activities. See Section 9.0 Documentation and Records for document and record details.

15.2 Testing

For all criteria pollutant monitors used in the monitoring network, the DAQ shall purchase equipment listed on the EPA's List of Reference or Equivalent Methods. Therefore, the DAQ assumes the monitors and procedures used to be of sufficient quality for the data collection operation. Table 11.1 identifies the model designations for the monitors used in the NCore monitoring program. For indoor shelter temperature, meteorological sensors and NO_y measurements, where EPA equivalent or reference methods do not exist, DAQ will follow EPA guidance. Currently when the DAQ purchases new monitors, the DAQ makes every effort to evaluate the monitor as soon as possible after receipt to ensure the monitor is working so that DAQ can address any problems while the monitor is still under warranty. The ECB electronics technicians will create a new maintenance logbook for each new piece of equipment received.

Before the ECB electronics technicians install the monitors at the NCore site, they assemble and operate newly purchased or repaired monitors at the ECB. For the gaseous analyzers and spares, the analyzers shall successfully undergo at least one zero, span and multi-point verification and must meet the criteria in the SOPs listed in Table 11.2. If the monitor meets the acceptance criteria, the ECB electronics technician allows it to operate in the shop until he can confirm functionality. Functionality is determined by the analyzers undergoing at least one zero, span and multi-point calibration using the criteria found in Table 14.1. If any of these checks are out of specification, the ECB electronics technician will contact the vendor for initial corrective action. Often these contacts are documented via email. The ECB electronics technician will not deploy an analyzer to the field until it has successfully passed all required checks. The SOPs listed in Table 11.2 provide further information on the instrument specific testing that new and recently repaired gaseous analyzers must undergo. After site installation, the RRO monitoring technicians will initiate, observe, and document the successful completion of a zero and span cycle by the ECB electronics technicians installing the equipment. If the analyzers meet the zero and span acceptance criteria, the ECB electronics technicians will assume the monitors are operating properly and ready for calibration by the RRO monitoring technician. The ECB electronics technician will properly document and file these tests in the instrument maintenance logbooks stored at the ECB.

The DAQ PM monitoring program uses established procedures to verify that the regional monitoring and ECB electronics technicians maintain all instruments and equipment in sound operating condition and capable of operating at acceptable performance levels. Refer to the instrument specific SOPs (listed in Table 11.2 of this QAPP) for more details on the specific preventative maintenance

activities. In general, the ECB electronics technicians perform the following acceptance and testing activities upon receipt of new monitors and samplers and after a monitor or sampler has undergone significant repair. If the equipment is new and fails to meet the field readiness certification described below, the ECB electronics technicians will contact the vendor.

- 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 the network, DAQ must still ensure individual instruments perform as expected before the ECB electronics technician deploy them in the field.
    - 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 at the ECB for a short period of time (e.g., a 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 PM samplers, the ECB electronics technician runs the sampler in the lab and observes the ambient concentration values; these values should be low (as this is indoor air) and track steadily.

If the equipment is new and fails to meet the field readiness certification described above, the ECB electronics technician will contact the vendor. If an instrument has undergone significant repair and fails to meet the field readiness certification (testing), the ECB electronics technician will contact the vendor. If after working with the vendor, the instrument cannot be repaired such that it passes performance testing, then the instrument will be shelved (i.e., discontinued from service). At that point, the ECB electronics technician tags the instrument as inoperable, sets it on the shelf and uses it for spare parts. If the shelved and tagged instrument served as a back-up instrument, then the ECB will begin the process to purchase a new instrument to replace that backup, such that a spare is once again available for use.

Once installed at the site, the regional monitoring technicians will again run the tests mentioned above. If the sampling instrument meets the acceptance criteria, the ECB electronics technician will assume the monitor is operating properly. The SOPs listed in Table 11.2 provide detailed information on the instrument specific testing that PM monitors must undergo before field deployment. The ECB electronics technician will properly document and file these tests in the instrument maintenance logbooks stored at the ECB.

15.3 Inspection

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

15.3.1 Inspections in Conditioning/Weighing Room

Several items need routine inspection in the gravimetric laboratory, including the RH and temperature sensors, sticky mats and functioning of the antistatic devices. (See Section 1.13.3 of RTI SOP for PM Gravimetric Analysis.) The RTI lab provides laboratory RH and temperature data in the data package submitted to DAQ. Day-to-day laboratory inspections are documented at RTI and made available to DAQ upon request and during the DAQ RTI TSA. Any testing, inspection, and maintenance of lab equipment that is outside the scope of RTI's laboratory is performed by a contract vendor.

15.3.2 Inspections of Field Items

Several items periodically require field inspection. The applicable equipment SOPs in Table 11.2 and operations manuals present details on these items and procedures. In general, the following inspection activities are used:

- The RRO monitoring technicians inspect monitoring shelters, sample inlets and other enclosures during each site visit and at least once a month to ensure conditions do not adversely affect monitor operation or data integrity. The ECB electronics technicians inspect monitoring shelters, sample inlets and other enclosures during each site visit and at least once a year to ensure conditions do not adversely affect monitor operation or data integrity.
- A zero-air system is a vital piece of support equipment maintained at any NCore monitoring station. The calibrator blends zero air with calibration gases to dilute them to the necessary concentrations for conducting routine calibrations, precision checks, including 1-point QC checks and zero-span-precision checks and performance evaluations or audits. Zero air systems used by DAQ for conducting these QA/QC checks and audits should be able to deliver 10 LPM of air that is free of O_3, NO, NO_2, SO_2, CO and non-methane hydrocarbons to below the instruments' method detection limits. Zero air supplies do not have to be NIST-traceable but will be inspected and tested semi-annually by the ECB electronics technicians to ensure they remain free of contaminants.
- The RRO monitoring technicians, regional coordinators and RCO chemists and statistician review data collection and data quality each business day. They inspect the data for trends and signs of problems. Data trends that signal a need for further inspection would include issues such 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 monitoring and ECB electronics technicians, who document equipment operating parameters on the zero-span-precision, calibration and maintenance tracking forms within the e-logs, as well as on performance evaluation audit forms. During each site visit the monitoring technician also does a probe-line integrity check to ensure the probe line remains attached to the monitor, is intact, dry and clear of debris and insects. The RRO monitoring technician also inspects the meteorological equipment during each site visit to ensure that the equipment is not broken and still functioning.
- The ECB electronics technicians test and inspect spare equipment at the time of purchase or after major repairs and before deployment to the field. When the equipment passes the tests and inspections, the ECB electronics technicians certify equipment as field ready and store it on a shelf or bench (typically at the ECB) until deployment.

- The RRO monitoring technician reviews the site and monitors annually to ensure continuing compliance with 40 CFR Part 58, Appendices A, D and E. The RRO monitoring technician documents the review on the DAQ site review form.

15.4 Routine Maintenance

In general, all monitors undergo routine maintenance as part of the monthly site visit. If necessary, the RRO monitoring technicians may contact the ECB electronics technicians for specific non-routine maintenance. The following are general routine maintenance protocols:

- The ECB electronics technicians maintain a limited supply of critical spare parts in the ECB maintenance and repair shop to aid in rapid response to issues. For example, pump rebuild kits, spare pumps, filters and other expendable supplies and kits are routinely on hand.
- Preventative maintenance is scheduled ahead of time so all parts and tools can be easily available to complete the tasks, so data loss is kept at a minimum.
- The RRO monitoring and ECB electronics technicians typically perform preventative maintenance activities in the field, although the ECB electronics technicians complete some activities at the ECB.
- The regional monitoring technicians maintain the grounds within the secured area for the NCore site as needed.

The routine preventive activities and schedules are detailed in the specific equipment SOPs (see Table 11.2) and supplemented by the equipment user manuals. The regional monitoring technicians perform diagnostic checks and document them before and after preventive maintenance. They document these diagnostic checks in the e-log. The RRO monitoring technicians service all PM inlet heads monthly, VSCCs monthly and down-tubes at least quarterly. They also replace all gaseous instrument PM filters at least monthly.

The RTI lab will perform, or contract routine preventive maintenance of all laboratory systems as listed in Appendix A through D of this document. Maintenance outside the scope of RTI's laboratory is performed by a contract vendor. These records are made available to DAQ upon request and during the DAQ RTI TSA.

16.0 Instrument Calibration and Frequency

The EPA defines “calibration” 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. The EPA recommends that agencies minimize adjustments to prevent introducing measurement uncertainty and that verifications, “i.e., checks without correction (adjustment),” be used to confirm whether an instrument is operating within its acceptance range. Thus, the purpose of calibration is to minimize bias. Section 14.0 Quality Control Requirements and Procedures discusses calibrations in more detail. The operator SOPs listed in Table 11.2 describe calibration procedures for each specific pollutant analyzer or sampler.

Title 40 CFR Part 58, Appendix A, Section 2.6 requires that gaseous standards (i.e., gas cylinders) and flow rate standards used in the ambient-air monitoring network be traceable to NIST. The ECB electronics technicians are responsible for procuring and maintaining dedicated NIST-traceable standards for the certification of the ambient air quality monitoring systems. These standards provide a direct link to established national standards, i.e., NIST, and are the foundation for the collection of the highest quality ambient air pollution data possible in accordance with current procedures and existing federal regulations and guidelines.

Traceability 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. Similarly, traceability is the property of a measurement result whereby the agency can relate the result 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 and certifications. Specific calibration procedures for and timeframes for certifications of field equipment can be found in the applicable SOPs DAQ-13-006.1 R0, 2.3.4, DAQ-15-001.1, DAQ-13-007.1 and DAQ-10-001.1 (see Table 11.2 for SOP titles) or operation manuals.

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

- DAQ and RTI recertify devices at least annually. These records are kept at RTI and the ECB and in the RRO office. All records, including RTI lab records, are available to the RCO chemists and auditors upon request.
- 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 following the applicable SOPs in Table 11.2. The ECB electronics technicians maintain documentation of these procedures in the ECB shop on appropriate forms.
- The DAQ and RTI maintain records of all instrument and equipment calibrations, using the traceable standards (with instrument identification numbers clearly documented). DAQ stores all records including QC, COC, and raw data files, received from RTI on the RCO group drive or DAQ Ambient Monitoring Team SharePoint page. DAQ stores all other records on the regional SharePoint page or RCO group drive.

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

The following subsections summarize the standards used by the DAQ in the NCore network and their recertification process. The RTI QAPP provides details on the standards used by RTI and their recertification process. The RRO monitoring and ECB electronics technicians monitor all certification periods to ensure the RRO monitoring technicians and auditors do not use equipment beyond the documented certification expiration dates. The RRO monitoring technicians are responsible for verifying the equipment they are using is within certification and contacting the ECB electronics technicians at least 30 days before the certification expires. Likewise, the RTI Lab maintains records of service and calibration records ensuring all equipment used in the laboratory are within its certification period. Records at the RTI Lab which are not included in the RTI data packages, are available to DAQ upon request and during the DAQ RTI audits.

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

16.1 Certification of "Local Primary Standards"

A primary standard is a standard that is sufficiently accurate such that it is not calibrated by or subordinate to other standards. The vendors and ECB electronics technicians use primary standards to calibrate other standards referred to as transfer standards. The DAQ uses "local primary standards" or standards certified against NIST-traceable standards and kept in the ECB shop for the sole purpose of certifying transfer standards used in the field to calibrate equipment and verify equipment calibrations. The DAQ owns two "local primary standards" for each type of device. The ECB sends each "local primary standard" to the vendor for recertification in alternate years ensuring that one local primary standard is always available for use and has been certified within 365 days. The vendor provides the DAQ with a certificate of authentication. DAQ staggers the rotation of standards such that one device always remains in certification. An ECB electronics technician compares the "local primary standard" that did not return to the vendor to the one that did return to the vendor to certify it and uses it to certify equipment for the next year. The vendors provide certificates of calibration that accompany the primary standards in paper format. The ECB electronics technicians store these certifications at the ECB. The DAQ is currently reviewing this record retention process and will revise the QAPP when a new process is implemented.

16.1.1 Local Primary Temperature Standard

The ECB electronics technicians use an Omega Digital Thermometer DP41 with a bridge sensor as a "local primary temperature standard" to verify the accuracy of the field-temperature transfer standards. An ECB electronics technician sends the "local primary standard" to the vendor for recertification against a NIST primary standard every 365 days. SOP DAQ-15-001.1 provides information on and procedures for the certification and verification of the local primary temperature standards.

16.1.2 Local Primary Pressure Standard

The ECB electronics technicians use a Mensor Model # 2500 as a "local primary pressure standard" used to verify the accuracy of the field-barometer transfer standards. An ECB electronics technician sends it to the vendor for recertification every 365 days. DAQ-13-006.1 R0 provides information on and procedures for the certification and verification of the local primary barometer standards.

16.1.3 Ozone Primary Standard

Every 365 days, the ECB electronics technicians compare the DAQ standard O_3 photometers to an EPA O_3 Standard Reference Photometer (SRP). The SRP is the highest-authority O_3 standard, equivalent to NIST, and is considered a Level 1 standard. The EPA maintains SRPs to set the standard for all ambient air O_3 measurements made nationwide. The DAQ standard O_3 photometer (Level 2) serves as the NIST-traceable reference instrument for all ambient air O_3 measurements made by the DAQ.

16.1.4 Local Primary Flow Rate Standard

The ECB uses Alicat mass flow meters as a "local primary flow standard" to certify the accuracy of the mass flow controllers in the monitors, field calibrators and audit calibrators. The DAQ uses the same local primary flow standard to certify the field and audit calibrators. An ECB electronics technician sends the mass flow meters to the vendor for recertification against a NIST-traceable standard every 365 days.

16.1.5 "Local Primary Time Standard"

The ECB electronics and RRO monitoring technicians use the WWV NIST atomic clock in Boulder, Colorado (telephone number: 1-303-499-7111) as a primary time standard. They can also obtain the correct time via the website http://nist.time.gov. The RRO monitoring technicians can also call the ECB electronics technicians to request the NIST Time. The DIT configures all state network resources and devices, including the site computer at the NCore site, to receive time settings from the web clock at Nist.gov (primary) and the Internet Time Service at bldroc.gov (backup). The DIT also configures the site computer at the NCore site to remain on Eastern Standard Time throughout the year, which is the local standard time for Wake County.

16.2 Calibration of Transfer Standards

The DAQ certifies transfer standards against either a primary standard or the "local primary standard." This establishes the traceability of the calibration.

16.2.1 Flow Transfer Standards for PM Monitors

The field FTSs used for flow rate calibrations, verifications and independent audits of PM monitors will have their own certifications and will be NIST-traceable to the factory primary flow rate standard. The ECB will supply either a TetraCal or streamline FTS for field calibrations, verifications, and independent audits of the flow rates of the NCore PM monitors. Both devices have the advantage of providing volumetric flow rate values directly, without requiring conversion for mass flow measurements, temperature, pressure, or water vapor content. The manufacturer establishes (and verifies as needed) a calibration relationship for the flow rate standard, such as an equation, curve, or family of curves, as accurate to within ±2 percent over the expected range of ATs

and pressures at which the flow rate standard is used. The vendor shall recalibrate and recertify flow rate standards at least annually and provide a certificate of traceability to DAQ.

16.2.2 Temperature Transfer Standards

The RRO monitoring technicians use either mineral thermometers or Tetra-Cals as field-temperature transfer standards. The Tetra-Cals have their own certification by the vendor every 365 days. The ECB electronics technicians will reverify or recertify the mineral thermometers at least annually against the "local primary temperature standard," or auditor's transfer standard, to within ± 1 ° C, over the expected range of ATs at which the temperature standard is to be used. SOP DAQ-15-001.1 provides information on and procedures for the certification and verification of the field temperature transfer-standards. ECB will provide a certificate of traceability to DAQ field staff for those devices certified by the ECB.

16.2.3 Pressure Transfer Standards

The field-pressure transfer standards will be handheld digital barometers or Tetra-Cals that will have their own certification by the vendor every 365 days. An ECB electronics technician reverifies or recertifies the handheld digital barometers at least annually against the "local primary pressure standard." DAQ-13-006.1 R0 provides information on and procedures for the certification and verification of the field pressure transfer-standards. ECB will provide a certificate of traceability to DAQ field staff for those devices certified by the ECB.

16.2.4 Pressure Differential Transfer Standards

The field manometers will have their own certification. The ECB reverifies or recertifies them at least annually against the local primary pressure standard or auditor's transfer standard, to within 1 millimeter of mercury, over the expected range of pressures at which the standard is to be used. SOP Calibration of the Dwyer and SPER Manometers provides information on and procedures for the certification and verification of the manometer transfer-standards. ECB will provide a certificate of traceability to DAQ field staff.

16.2.5 Calibrators for Gaseous Monitors

The field calibrators are transfer standards that have their own certification against "local primary flow rate standards." At the NCore site, the DAQ uses the Teledyne T700U calibrators as the field calibration device and as the audit device for NO_2 monitoring. The DAQ uses the Thermo Environmental Instruments (TEI) 146i calibrators as field calibration devices and audit devices for CO, NO_y and SO_2 continuous monitoring. An ECB electronics technician certifies the mass flow controllers within field calibrators every 12 months and audit calibrators every 12 months using Alicat flow measurement units. SOP DAQ-13-004.1, currently under development, contains further details on the certification procedures.

16.2.6 Model 49C-PS for Ozone Monitors

The ECB electronics technicians perform all necessary response adjustments to each site primary O_3 standard (Level 3) to duplicate the concentration readings of the primary DAQ standard O_3 photometers (Level 2).

The site primary standard TEI 49i-PS is the source of known concentrations of O_3 used for the calibration of the ambient air O_3 monitor. The RRO monitoring technicians adjust the ambient air O_3 monitor to duplicate the concentration of O_3 produced by the site primary O_3 standard.

The calibration of each 49i-PS will have its own certification. The ECB electronics technicians will reverify or recertify the calibration of each 49i-PS against the DAQ standard O_3 photometers at least annually. The ECB electronics technicians also certify independent standards designated for independent O_3 annual performance evaluations every 365 days.

16.2.7 Weighing Lab Calibration and Check Standards

An external certified metrology lab recertifies the working and primary weights used at the RTI lab annually or on an as-needed basis. These calibration certifications are made available to DAQ upon request.

16.3 Calibration Gases

All SO_2, NO and CO calibration gases must be EPA Protocol (NIST-traceable) and include the following information:

- Cylinder serial number;
- SO_2, NO or CO concentration;
- Recertification status;
- Gas type;
- Cylinder pressure (double checked upon receipt);
- Impurity concentration; and
- Expiration date.

The ECB services zero air generators used at the NCore monitoring site annually or more frequently if needed. The calibration gas standards have their own certifications. The vendor will reverify or recertify SO_2 standards after four years, NO standards after three years and CO standards after eight years.

16.4 Analytical Balance

The RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 16), explains that an external certified metrology lab calibrates the analytical microbalance at the RTI lab annually and on an as-needed basis (see Section A8). The RTI lab staff verifies the calibration before each weighing session. These verifications are provided to DAQ in the monthly data package. RTI calibration certificates are available to DAQ upon request.

16.5 Lab Temperature and Relative Humidity

The RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 16) provides the accuracy and resolution of the temperature and RH sensors (see Section A7). The temperature and RH sensors are calibrated annually against NIST traceable standards. The sensor that monitors lab temperature must be within ± 2 °C of the NIST transfer standard. The sensor that monitors lab RH must be within ± 2 percent of the NIST transfer standard. RTI lab staff maintains records of service and certifications of calibration. These documents are made available to DAQ upon request.

16.6 Documentation

See the appropriate operator SOPs in Table 11.2 for field QC checks that include frequency and acceptance criteria and references for calibration and verification tests of analyzer concentration responses, sampler flow rates, temperature, pressure, and time synchronization. The field PM sampler

flow rate, temperature and pressure-sensor verification checks include one-point checks at least monthly. The analyzer verification checks include 1-point-QC checks for SO_2, O_3, NO_y, NO_2, NO, and CO at least every 14 days (DAQ does daily checks for SO_2 and O_3 and daily diagnostic auto-checks for NO_2 (for the CAPS only), NO_y, NO, and CO) and multipoint calibrations at least annually, as documented by tracking on control charts.

The $PM_{2.5}$-field analyzer flowrate, temperature- and pressure-sensor verification checks include one-point checks at least monthly. All these events, as well as sampler and calibration equipment maintenance, will be documented in field data records and logbooks. The RRO monitoring technician will keep field activities associated with equipment used by the technical staff in record logbooks as well. The records will normally be controlled by the RRO coordinator and located in the field site when in use or at the regional office when being reviewed or used for data validation.

The ECB electronics technicians will retain calibrator and gas cylinder certification documentation at the ECB facility in Raleigh, North Carolina. Please reference Table 9.1 for the storage location of all documentation.

17.0 Inspection/Acceptance of Supplies and Consumables

DAQ SOPs (see Table 11.2) itemize the apparatus, equipment, materials, and supplies required for various monitoring equipment. In general, the ECB electronics technicians procure supplies and consumables directly from the vendor manufacturing the monitors used by DAQ. Most manufacturers' operating manuals itemize parts lists, including recommended replacement schedules, as well. The DAQ uses this information to determine the appropriate procurement schedule and volume of consumables required to support continuing operations.

The RRO monitoring technicians track supplies and consumables (e.g., gas analyzer in-line particulate filters). When the RRO monitoring technician needs replacements, he or she notifies the ECB. The ECB then supplies the needed items out of its inventory or purchases what the RRO monitoring technician needs. The ECB maintains an inventory of supplies in the ECB shop for later distribution. The ECB technicians inspect materials received to ensure they received the proper part number as ordered. They also perform a general inspection to identify any damaged products. They date parts received so they can easily determine storage duration. The ECB uses a revolving inventory system (first in, first out) to ensure storage times do not affect the material's integrity. If a manufacturer or EPA requirement indicates a specific expiration period for supplies, the ECB discards those supplies exceeding expiration dates 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 fluorinated ethylene propylene, or FEP, Teflon™ or equivalent. A consumable that is critical to the successful operation of the gaseous monitors are the gas cylinders used for calibration and QC checks of SO_2, NO_y, NO_2 and CO analyzers, as well as internal performance audits. Gas cylinders ordered by DAQ are EPA Protocol Cylinders. The ECB technicians review Certificates of Analyses 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. DAQ abides by these expiration dates; the ECB tracks dates and usage, replacing cylinders before they expire. Additionally, DAQ participates in the EPA Ambient Air Protocol Gas Verification program. The following link provides information about this program on AMTIC: Ambient Air Protocol Gas Verification Program | US EPA This program allows the independent assessment of gas cylinders 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.

The RTI lab technician must properly handle and condition the air sampling filters used to collect PM2.5 samples and the integrity of the filter is of primary concern. The EPA provides vendor lot certification of filters used to support the ambient air quality monitoring programs before distributing the filters to monitoring organizations. The lab technician receives, documents, and inspects and conditions air sampling filters for use in the PM2.5 sampling program. The lab technician removes filters that do not meet initial QC specifications from service.

18.0 Non-Direct Measurements

This section addresses data not obtained by direct measurement from the NCore Ambient Air Quality Monitoring Program that are used to support the program. This includes data provided by outside sources and historical monitoring data. Possible databases and types of data and information DAQ might use include:

- Core-based statistical area boundaries;
- Census data;
- Roadway traffic volumes, that is annual average daily traffic;
- Chemical and Physical Properties Data;
- Sampler Manufacturers' Operational Literature;
- Geographic Location Data (e.g., site metadata for AQS);
- Historical Monitoring Information;
- Emissions inventory data;
- Modeling data;
- External Monitoring Databases; and
- National Weather Service Data.

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

19.0 Data Management

19.1 Purpose/Background

The primary work product of the DAQ NCore monitoring program is data. Accordingly, formalized procedures are required to ensure successful data management. Data management describes an interrelated 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 data integrity and validity of the data throughout its entire life cycle. DAQ's air monitoring data follows a documented flow path. The data life cycle starts before data and sample collection begins and ends with use of the data. The following subsections identify the processes and procedures to follow to acquire, transmit, transform, reduce, analyze, store, and retrieve data. These processes and procedures maintain the data integrity and validity through application of the identified data custody protocols.

Figures 19.1 and 19.2 display the generalized flow path of the DAQ ambient air monitoring data, including the QA/QC data collected within the network. The DAQ follows the procedures in SOP DAQ-15-005.5. The RRO monitoring technicians and monitoring coordinator, RCO chemists and statistician and database manager acquire and process the NCore ambient air monitoring data. Section 4.0 Project/Task Organization describes staff responsibilities.

19.2 Data Collection and Recording

Ambient air monitoring analyzers which have been designated by EPA as reference or equivalent methods (FRMs or FEMs) will be used to collect data used for NAAQS compliance, while high sensitivity NO_y analyzers (no FRM/FEM designation) will be used for research purposes, within the NCore network. Upon installation and at regular intervals as specified, the RRO monitoring technicians calibrate the ambient air monitoring instrumentation following the specific pollutant SOPs identified in Table 11.2 of this QAPP. Note: When DAQ establishes a new site, the coordinator and ECB electronics technicians manually collect metadata for the site (global positioning system, or GPS, coordinates, etc.). The database manager maintains the metadata and uploads it into AQS, as appropriate. The RRO monitoring technician and coordinator review the metadata annually during the network review and update it as needed.

DAQ records most data electronically. The site computer is equipped with a DAS, called Envidas Ultimate, and a wireless modem used to transmit data to the master polling system, i.e., the Envista ARM data storage database, which is a separate software package located on a state server. The DAS and site computer have the capability to record the output of the monitors at the site, perform any required data transformation, and format the resulting data in preparation for downloading to the Envista ARM database or a Microsoft Excel spreadsheet. The Envidas Ultimate and Envista ARM databases do not allow the deletion of raw (i.e., original) data. The DAQ uses the Envista ARM database for data verification, validation, and reporting and it can produce plots of the minute data. The database uses replicate versions of the raw data to avoid violating the integrity of the original dataset. The Envidas Ultimate and Envista ARM databases do not allow the deletion of data. The database manager and level 1, 2 and 3 reviewers can modify, flag or void data stored in the Envista ARM “edit” database, as needed; an edit history is recorded and available to track changes made to the data. The procedures to test and audit the acceptability of the hardware and software used for data management at the NCore site are delineated in SOP DAQ-05-001.5.

The DAQ also collects data manually. Monitoring and ECB technicians keep e-logs for most parameters, documenting QA/QC activities and preventive maintenance. For example, the operators

Figure 19.1 NCore Data Flow Path for Gaseous Monitors and Meteorological Sensors

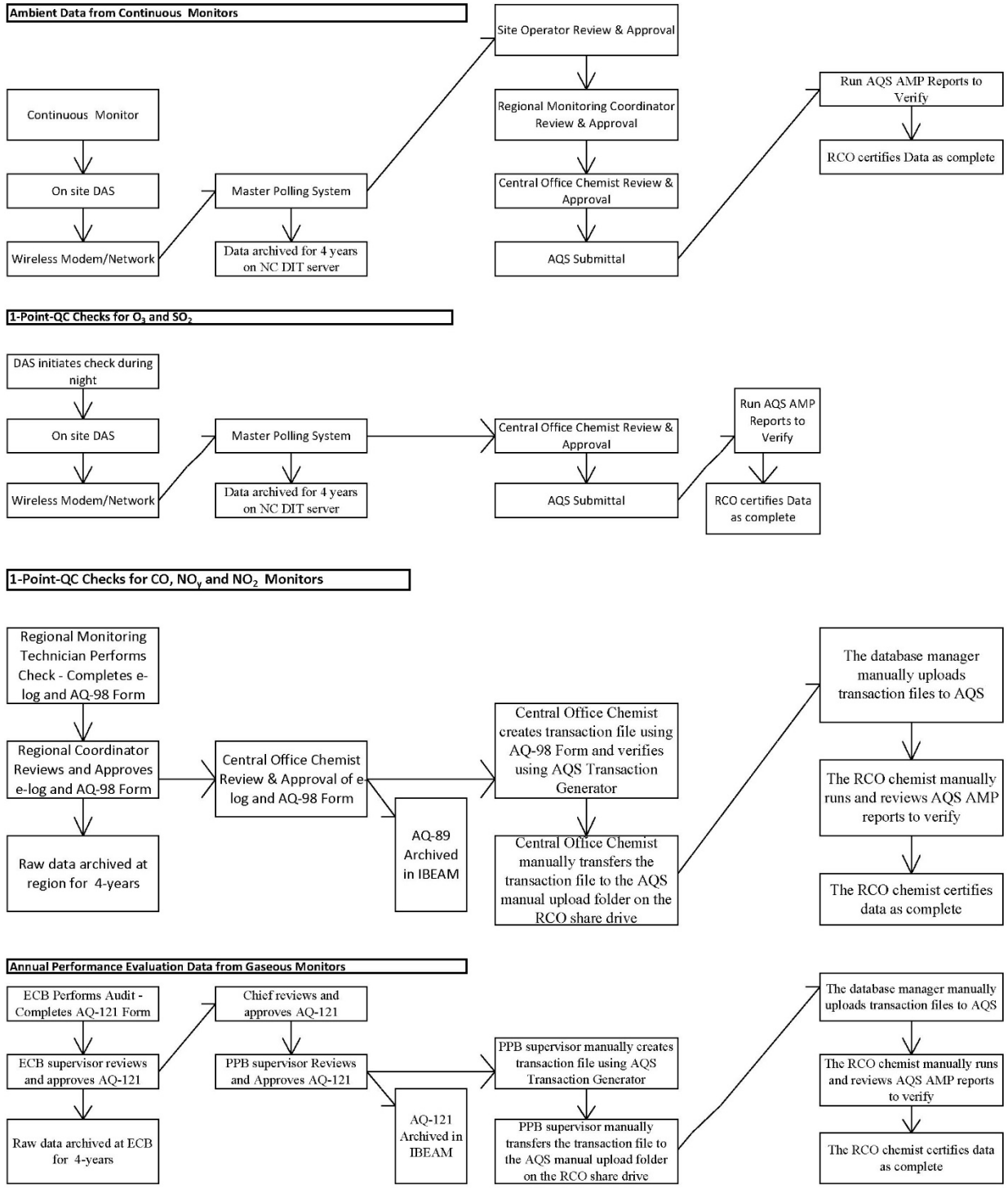
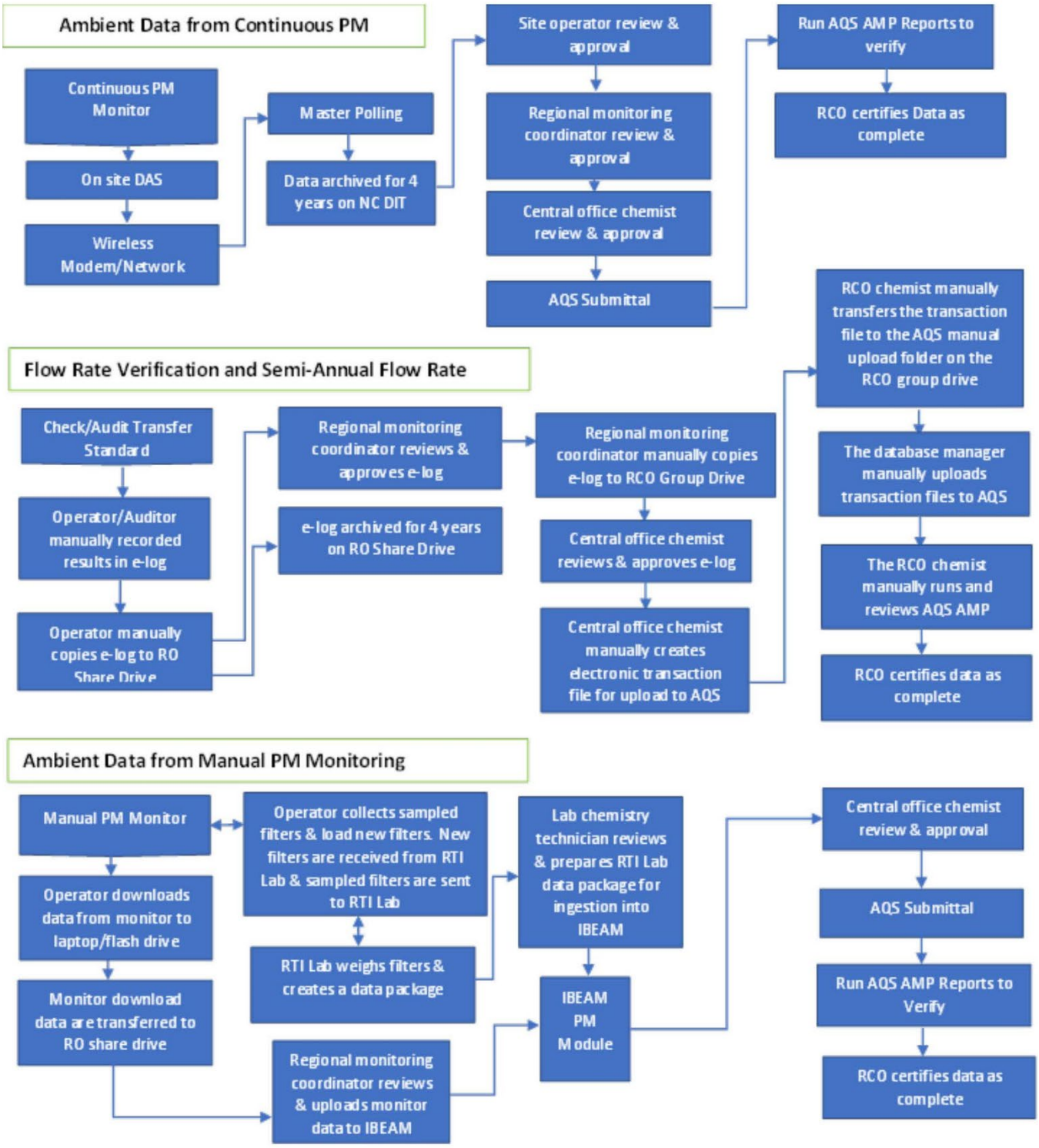


Figure 19.2 NCore Data Flow Path for PM Data



document activities such as operational checks, leak check results, flow check results, audit results, filter changes and calibrations in these spreadsheets. The RRO monitoring technician uploads the resulting e-logs to the RRO group drive. Then the coordinator transfers the e-logs to the RCO group drive for subsequent incorporation into the data validation process, discussed in Section 23 of this QAPP. Additionally, the RRO monitoring technicians and RCO chemists manually compile the results of the QA/QC checks from these e-logs for submission into the AQS database.

For the reports from the performance evaluations, which are currently paper documents, the PPB supervisor or a designee manually creates records to upload to AQS as described in DAQ-15-005.5, archives a scanned copy of the paper document in Laserfiche and files the paper copy in a secured file cabinet in the RCO. The database manager electronically transfers the data using the transaction file to AQS.

For 1-Point-QC checks for O_3 and SO_2, every night, a Precision, Zero, Span runs to determine if the O_3 and SO_2 analyzers are running within specifications. Each month, the RCO statistician generates excel files that contain the PZS checks for each monitor for the previous month. The RCO chemist then uses this file to validate the PZS checks, uses Envista ARM to add any missing PZS checks, adds null codes where appropriate, and adds comments where appropriate. Once the RCO chemist finishes validating the PZS checks, the RCO statistician creates transaction files from the excel spreadsheet using macros and transfers the transaction files to the database manager to electronically upload to AQS. See DAQ-15-005.5 for additional details.

For 1-Point-QC checks for CO, NO_y and NO_2, every 14-days or less, the regional monitoring technician manually runs a zero, span and precision point. The regional monitoring technician records the results in the e-log and on an AQ-98 form. At the end of the quarter, the regional monitoring coordinator reviews the e-log and AQ-98 forms and transfers the documents to the RCO. The RCO chemist reviews the documents and submits the transactions created by the AQ-98 forms to the database manager to upload to AQS. The RCO chemist archives the AQ-98 forms in Laserfiche.

For the intermittent filter-based method, DAQ uses IBEAM to determine the 24-hour concentration values. This process combines the electronically provided data from the gravimetric laboratory with the electronically collected data from the field instrument during a 24-hour sampling event. The DAQ environmental specialist electronically receives the data package from the RTI lab and performs the Level 2 data verification as detailed in Appendix E DAQ Instructions and Checklists for review of RTI PM Data Packages. Upon completion of the Level 2 verification, the DAQ environmental specialist stores the entire data package on the RCO group drive. Then either the DAQ environmental specialist or the RCO PM FRM chemist directly copies and pastes the pertinent information from the electronic RTI data package into the filter tracking, final weights, initial weights, and lab blanks excel files, uploads the files to the secure File Transfer Protocol (sFTP) folder and runs a macro that uploads the files into IBEAM. IBEAM is designed to recognize upload errors and rejects any data that does not meet its internal criteria, providing a report on which data were not accepted and why so the specialist or chemist can make appropriate corrections. DAQ has developed a program which will automate the transfer process of the data from the RTI spreadsheets into the spreadsheets IBEAM uploads. The filter weigh data, once in IBEAM, is transferred into the PM module, which stores and archives it. The regional operator downloads the field data generated directly from the site sampler; these data represent the conditions of the 24-hour sampling event. The regional monitoring coordinators transfer these data electronically to IBEAM using sFTP. The operator transfers sampler runtime data into the e-logs and completes the COC form. The exposed filters and COC form are

returned to the RTI lab, as discussed in Section 12 of this QAPP. Once the DAQ LAB environmental specialist verifies the data package, IBEAM combines the verified lab data with the sFTP-transferred field data to determine final concentration values for the filter-based $PM_{2.5}$ samples.

If DAQ establishes a new NCore site, the coordinator and ECB electronics technicians will collect metadata for the site. The database manager will enter the metadata into AQS. The regional monitoring technician and coordinator will review the metadata annually during the network review and the database manager will update it in AQS as needed.

19.3 Data Transmittal and Transformation

Data transmittal is accomplished using wireless communication to access the site's modems. The site has more than one modem because of the number of monitors and buildings at the site and the distance between the shelters and outdoor monitors. Downloading collected data does not delete data from the DAS. The Envidas Ultimate software removes data from the site computer by overwriting data on a first-in, first-out basis. This configuration requires the Envista ARM software to extract data from the site computer on a regular basis to prevent any data loss (hourly for minute data and hourly data, and the following hour after the data are collected for nightly checks). If communications problems arise, the Envista ARM software retrieves the data from the Envidas Ultimate system when it can once again communicate with the site. A monitoring technician must make a site visit if the database manager or ECB electronics technician informs him or her that he or she cannot correct the communications problems in a timely fashion.

The DAS reads instantaneous values from the gaseous monitors and averages each 60-second interval to create a one-minute average. The DAS stores each minute average, and this average acts as the base unit for all measurements taken by the gaseous monitors within the DAQ NCore monitoring network. The data are reviewed daily by RCO chemists as well as regional monitoring technicians. There exists dynamic ongoing open communication with the monitoring staff to discuss anomalies, missed data, or observed errant issues with respect to the daily data. In addition, at least once a month, the statistician downloads the instantaneous data for at least one hour for three different days from at least one of the network monitors and compares the values to the data captured in Envista ARM to verify the data for accuracy. The monitors, as well as the Envidas Ultimate system, average the stored 1-minute averages to form averaged hourly values, which are the blocks of ambient gaseous measured concentrations that the database manager submits to the EPA. Note that for SO_2, the 1-minute averages are also used to calculate 5-minute averages for determination of the 5-minute maximum average for the hour, which the DAQ reports to AQS. Envidas Ultimate transmits all these values to Envista ARM for retention.

The DAS reads hourly PM values from the continuous PM monitors. The DAS stores each hour, and this acts as the base unit for all measurements taken by the continuous PM monitors at the NCore site. The PM monitor measures and stores hourly averages. The monitors, as well as the Envidas Ultimate system, average the stored hourly averages to form averaged 24-hour values. Envidas Ultimate transmits all these values to the Envista ARM database for retention. The monitors and the Envista ARM system then average the stored hourly averages to form averaged 24-hour values. However, the database manager only submits hourly PM values to the EPA AQS database for the continuous PM monitors. The AQS database then averages the submitted hourly averages to form averaged 24-hour values and weighted annual averages. The RRO monitoring technician downloads data directly from the continuous monitor to a universal serial bus (USB) flash drive, personal computer (PC) or laptop or via Comet software in the field twice a month. These data downloads serve as a backup.

For the filter-based sampling, the data review process contains a similar structure and procedure as the continuous data review. However, this process is done manually and via IBEAM and includes the RTI lab. Section 23 of this QAPP discusses the data review process in more detail.

19.4 Data Verification and Validation

Data verification and validation is an important routine process that involves several steps to ensure the RRO monitoring technicians, coordinator and RCO chemists have carried out the field and data processing operations correctly. The verification and validation process will identify data with errors, biases, and physically unrealistic values before DAQ or the EPA uses them for the identification of NAAQS exceedances, for further analysis, or for modeling. Once the RRO or RCO have identified these problems, the monitoring technicians, coordinator and RCO chemists can correct, flag, or invalidate the data. If necessary, the RRO monitoring and ECB electronics technicians can take corrective actions to address monitor-related issues identified during the data review process. Section 23.0 Verification and Validation Methods contains additional information on data verification and validation.

Each of the network's analytical instruments employed to measure the ambient concentrations of the criteria pollutants undergoes periodic audits, one-point QC checks, or monthly flow rate verifications and calibrations. SOPs DAQ-10-001.1, 2.7.2, DAQ-07-003.1, DAQ-08-002.1, DAQ-08-001.2, DAQ-12-001.1, DAQ-12-002.2, 2.36.1, DAQ-04-001.2, 2.38.1, 2.38.2, 2.44.2, 2.45.2, DAQ-11-001.2, and 2.47.2 (see Table 11.2 for SOP titles) outline these procedures. Audits and verification checks ascertain the accuracy, precision, and repeatability of each instrument in performing its required function.

The instrument-generated data are stored on site in the DAS. When Envista ARM accesses the data through the wireless modems, it downloads the data into its database where the data undergo verification, reduction, and analysis (Level 0). The monitoring technician using Envista ARM performs data verification electronically by searching the data for status flags and comparing reported values to acceptable range criteria (Level 1). After the monitoring technician flags data as questionable, level 2 (preliminary) and 3 (final) reviewers evaluate the flagged data to identify underlying causes and decide whether the data are valid. If the data are invalid, DAQ and the EPA do not use them in calculations. If the data are valid, but flagged due to some extenuating circumstance, then DAQ and the EPA may use the data in calculations, accompanied by a comment documenting the situation. Section 23 of this QAPP discusses the data review process in more detail. DAQ 15-005.5 and 2.63.4 contain further details on the verification and validation procedures.

19.5 Data Reduction and Analysis

As described in the subsections above, data reduction activities take place throughout the entire data management process. The on-site DAS gathers data from the monitors at each site each hour and transmits them to the Envista ARM database. The data are gathered and transmitted in response to a poll via the wireless modem. The gaseous data do not require special aggregation. The Envista ARM system aggregates data into 5-minute, hourly, and 24-hour averages, as appropriate. Once validated, the database manager uploads the data into the AQS database. The EPA compares submitted results to the NAAQS for the criteria pollutants.

The regulations at 40 CFR Part 50 define the quantity of valid data points required within a data set. For most pollutants, the EPA requires a minimum data capture of 75 percent of the interval – hour, day, quarter – for the EPA to consider the interval valid for use in NAAQS comparisons. Tables 7.2

through 7.8 summarize these completeness requirements as well as provide specific references to the CFR.

The DAQ analyzes data periodically throughout the data collection and validation process. For example, the RRO monitoring and ECB electronics technicians, coordinator, RCO chemists, audit chemist and statistician can download data from Envidas Ultimate directly into Microsoft Excel spreadsheets. The monitoring technicians, coordinator, RCO chemists and statistician use Microsoft Excel spreadsheets solely for data analysis and in-depth study of the data. For example, each business day the statistician prepares a tabulation of the raw hourly data from the previous day, evaluating it for missing data, data higher or lower than for that day and trends and to ensure it is within specifications.

The RCO chemist and statistician also review all validated data looking for trends, data outside of three times the interquartile range, etc. to establish the reasonableness of the data sets. The RCO chemist and statistician accomplish these tasks by retrieving several reports from the AQS database, such as the AMP256, AMP430, AMP450 and AMP600, and analyzing the results.

19.6 Data Submission

After the monitoring technicians, coordinator and RCO chemists complete all three levels of verification and validation for a month of data, as described in Section 23.0 Verification and Validation Methods, the database manager or statistician uploads the data to the AQS database. In addition to hourly data, the database manager also uploads to AQS hourly 5-minute maximum SO_2 data, internal performance evaluations, and one-point-QC checks. This submittal must occur no later than 90 days following the close of each calendar quarter, as specified in 40 CFR 58.16. The RCO chemist assigned to this task shall certify to the chief that the data are complete to the best of his or her knowledge. The quarterly data submittal shall contain the following summary data:

- The AQS site code, monitoring method code and parameter occurrence code;
- The results of all valid precision, bias and accuracy tests performed during the quarter for O_3, SO_2, CO, PM_{10} (including both local and standard conditions), $PM_{10-2.5}$, $PM_{2.5}$, NO_y (including NO) and NO_2;
- The ambient air quality data obtained for O_3, SO_2 (including maximum hourly 5-minute block averages for each valid hour), CO, PM_{10} (including both local and standard conditions), $PM_{10-2.5}$, $PM_{2.5}$, NO_y (including NO), NO_2 and meteorological parameters.

At the end of each quarter, a RCO chemist runs the AMP251, AMP256, AMP350, AMP430 and AMP600 (for regulatory monitors) reports in AQS and verifies that all hourly data, annual performance evaluation, one-point QC check, monthly flow rate verification and semi-annual flow rate audit data have been successfully entered. The DAQ will also notify the EPA if a monitor does not meet the completeness requirements summarized in Tables 7.2 through 7.8.

Every year before the annual data certification due date, the chief reviews the data from the EPA AQS summary reports, along with internal performance evaluation and audit reports, to confirm the data meets the required criteria. The RCO chemists address any concerns with the data.

DAQ shall submit to the EPA an annual AMP600 summary report of all the NCore monitoring data from any NCore monitoring station designated as a SLAMS and from all FRM, FEM and special purpose monitors that meet criteria in appendix A, in accordance with 40 CFR 58.15. DAQ will also

submit a signed certification letter on DAQ agency letterhead signed by the chief. The chief will submit the report by May 1 of each year for the data collected from Jan. 1 through Dec. 31 of the previous year. The chief, or designee, must certify the report as accurate to the best of his or her knowledge. The chief will base this certification on the various assessments and reports performed by DAQ, including the AMP600 report discussed in Section 21.0 Reports to Management, which documents the quality of the ambient air quality data and the effectiveness of the quality system.

19.7 Data Storage and Retrieval

Once collected, data are stored in a variety of ways and for varying periods. Initially, data are stored in the monitor and/or the station-specific DAS. The monitors keep an unalterable record of instrument measurements for a period of days to weeks, depending on the amount of information stored. The on-site DAS also keeps an unalterable record of instrument measurements for a period of months to years depending on the number of monitors operated at the site. The RCO Envista ARM database system automatically accesses data stored in the on-site Envidas Ultimate system.

Because of the DAQ archiving system, the DAQ can store and retrieve air quality monitoring data. Backup and recovery procedures exist to ensure the regional monitoring and ECB electronics technicians and database manager can recover data in the event of a catastrophic failure. The database manager manually executes a backup of the full database every Friday. Due to the lack of a second structured query language (SQL) database in which to import the backup files, the database manager has not routinely tested procedures for using the backup files; however, he has used backup files to import data into the virtual server's database. The use of backup files worked as expected. The DAQ has recently established a backup computer with SQL software installed to continue the data polling operation in the event of a catastrophic failure of the server. The DAQ is in the process of scheduling a process for uploading the backup files to the backup SQL database. When DAQ has finished developing that process, DAQ will update and revise this QAPP. When storage space limits the amount of data that DAQ can keep in the database, procedures exist for moving the data into an archive database. Presently, the database manager backs up data weekly using Zip File. The database manager keeps the most recent copy available on SharePoint. Envidas Ultimate polls data older than one week old directly from the site computer. DAQ keeps all data in real time.

Note that the monitoring technicians also download data directly from instruments to USB flash drives, PCs, or laptops in the field for the continuous $PM_{2.5}$ and $PM_{2.5}$ FRM samplers twice a month; these data downloads serve as a backup, as they are uploaded to the RRO SharePoint page for archival. The monitoring technicians also download backup site temperature data and store it on the RRO SharePoint page for archival purposes.

All supporting electronic and written information, such as logbooks, maintenance logs, certifications and diagnostic information worksheets are retained by DAQ for a minimum period of four years, unless any litigation, claim, negotiation, audit, or other action involving the records has been started before the expiration of the four-year period. When this type of situation occurs, DAQ will retain the records until completion of the action and resolution of all issues that arise from it or until the end of the regular four-year period, whichever is later. The data shall be stored on electronic media or in hard copy, whichever format proves most advantageous. Envitech software updates have no impact on data accessibility. After the storage period has passed, the storage media may be disposed of or recycled. However, the database manager uploads the validated dataset to the EPA AQS for long-term storage.

20.0 Assessments and Response Actions

An assessment is the process used to measure the performance or effectiveness of the quality system, the NCore Ambient Air Quality Monitoring Network and various measurement phases of the data operation. The DAQ also uses assessments to determine whether the monitoring staff has implemented the ambient-air quality monitoring program in accordance with the approved QAPP. To ensure the adequate performance of the quality system, DAQ will perform the following assessments:

- Network reviews and assessments
- External performance evaluations
- Internal performance evaluations
- Semi-annual flow rate audits
- Quarterly completeness assessments
- Annual data certification
- Data quality audits
- Data quality assessments
- EPA TSAs
- Internal systems audits

Table 6.1 provides information on the parties implementing assessments and their frequency.

20.1 Network Reviews and Assessments

Conformance with network requirements of the NCore Monitoring Network as set forth in 40 CFR Part 58, Appendices A, C, D and E are determined through annual network reviews of the ambient air quality monitoring system, as required by 40 CFR 58.10(a). The DAQ uses the network review to determine if the NCore site collects adequate, representative, and useful data in pursuit of its air monitoring objectives. Additionally, the annual network review may identify possible network modifications to enhance the system or correct deficiencies in attaining network objectives.

Before implementing an annual network review, the RRO monitoring technician compiles and evaluates significant data and information pertaining to the network and NCore monitoring site. Such information might include:

- Network files (including metadata, updated site information and site photographs);
- AQS reports, especially the AMP380 and AMP390 reports;
- Network monitors' five-year air quality summaries;
- Raleigh MSA area emissions trends reports;
- Emissions information, such as a monitor's emission density maps and maps delineating an area's major emissions sources; and
- National Weather Service summaries from the Raleigh Durham International Airport (RDU).

Upon receiving the information, the RRO monitoring technician will check it to ensure it is current. The RRO monitoring technician will note any discrepancies and resolve them during the review. The RRO monitoring technician will also identify and update files and photographs that need updating during the review. The network review will emphasize several categories of data and information, such as the monitor location, the annual average daily traffic on Spring Forest Road, potential changes to the

East Millbrook school campus, population density, changes in nearby land use and other pertinent information.

During the annual network review, the RRO monitoring technician and coordinator will reconfirm the stated objective for the monitoring site and reverify the location's spatial scale. If the site location does not support the stated objectives or the designated spatial scale, the coordinator will propose changes to rectify the discrepancy. The RRO and RCO monitoring staff will then act to correct the information in AQS, relocate the monitors or site, or move the site to a more suitable location, if needed. Proposed additions and discontinuations of SLAMS monitors are subject to EPA approval in accordance with 40 CFR Section 58.14.

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

- Installation of new monitors,
- Relocation of existing monitors,
- Siting criteria problems and suggested solutions,
- Problems with data submittals and data completeness,
- Maintenance and replacement of existing monitors and related equipment,
- QA problems,
- Air quality studies and special monitoring programs and
- Other issues such as proposed regulations and funding.

The RRO monitoring technician completes a network review of the NCore site and submits a network review form to the RCO every year. EPA regions are also required to perform these reviews. The RRO monitoring technician considers the following criteria during the review:

- Date of last review;
- Areas where attainment/nonattainment redesignations are likely to take place or did take place;
- Results of special studies, saturation sampling, point source oriented ambient monitoring, etc.; and
- Proposed network modifications since the last network review.

The regulations at 40 CFR Part 58, Appendix D discuss the number of NCore monitors required, depending upon the measurement objectives.

Once the annual network plan is updated based on the annual network review, any changes to the regulations and other pertinent information, the network plan is posted on the DAQ website for a 30-day public comment period. The plan is prepared by DAQ and submitted to EPA Region 4 by July 1 each year.

20.1.1 Five-Year Network Assessment

The five-year network assessment is a more extensive evaluation of the air-monitoring network. This assessment is prepared by the chief with assistance by the PPB supervisor or his/her designee(s). The assessment determines at a minimum:

- If the NCore network meets the monitoring objectives defined in 40 CFR Part 58, Appendix D,

- Whether DAQ needs to make any monitoring changes at the NCore site,
- Whether the existing NCore site needs to be relocated or moved, and
- Whether new technologies are appropriate for incorporation at the NCore site.

During the 5-year network assessment, the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals, for example, children with asthma, as well as the potential impact any sites proposed for discontinuance may have on other data users is considered. As part of the 5-year network assessment, DAQ requests renewals and provides additional information related to applicable waivers for the NCore monitoring network site in the network plan submitted with the 5-year network assessment. The DAQ submits a copy of the five-year assessment, along with a revised annual network plan, to the EPA Region 4. These assessments began in 2015 for the NCore network and are due to EPA every five years on July 1.

For more information about the five-year network assessment requirements, please see 40 CFR 58.10(d). For more information about the NCore monitoring location, please see the annual network plan at https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan.

20.2 External Performance Evaluations

DAQ addresses performance evaluation activities for regulatory monitors (except PM_{10}) by participating in the EPA's NPAP and PEP. Only qualified and authorized personnel execute performance audits. In general, the NPAP program audits 20 percent of an agency's sites per year and each site every six years. Since DAQ has 32 sites, including the NCore site, the EPA may only audit the NCore site once every six years. In Region 4, a mobile laboratory arrives at the DAQ NCore site and generates known concentrations of audit gases, used to challenge the on-site gaseous analyzers. EPA contractors typically provide the results of NPAP audits immediately following the results of the NPAP audit. The NPAP audit results are also reported to AQS by EPA or its support contractor(s). Acceptance criteria applicable to NPAP audits may be found in Tables 7.2 through 7.5 and 7.7. If a monitor does not pass the NPAP evaluation, the RRO and RCO monitoring staff will take appropriate action to identify why the monitor failed the evaluation and to correct the situation.

For PEP, the EPA contractor must collect, and report eight valid performance evaluation audits each year for $PM_{2.5}$ and must evaluate each $PM_{2.5}$ method designation each year. EPA must evaluate all $PM_{2.5}$ monitors at least once every six years. Since DAQ has 16 $PM_{2.5}$ sites, including the NCore site, and operates three method designations, the EPA may audit the NCore $PM_{2.5}$ site more frequently than once every six years. Because the EPA reports the PEP results directly to AQS after the national laboratory completes the analysis, the RRO and RCO monitoring staff will initiate corrective actions, when needed, after the results become available in AQS.

DAQ also participates in EPA's Ambient Air Protocol Gas Verification Program when it is available. See Section 17.0 of this QAPP and 40 CFR Part 58, Appendix A, Section 2.6.1 for more information.

20.3 Annual Performance Evaluations

The ECB electronics technicians, who do not operate the monitors, conduct annual performance evaluations at least once each calendar year and every 365 days on the gaseous monitors by challenging the monitor with known concentrations of gas using an independent, NIST traceable, calibrator and gas standard. The ECB electronics technicians certify the audit system and the monitor's calibration system using the same primary standard for both. Likewise, the ECB purchases the gas standards for the audit system and monitor's calibration system from the same vendor at the

same time, so both come from the same lot of gas. The ECB electronics technicians follow the audit procedures in the gaseous pollutant SOPs for ECB responsibilities listed in Table 11.2. The ECB electronics technicians document the results of these audits on the Continuous Monitor Performance Audit Report AQ-121 form. Acceptance criteria applicable to gaseous monitor performance evaluations may be found in Tables 7.2 through 7.5 and 7.7. If a monitor does not pass the evaluation, the RRO monitoring and ECB electronics technicians will take appropriate action to identify why the monitor failed the evaluation and to correct the situation. See 40 CFR Part 58, Appendix A, Sec 3.1.2 for more information regarding performance audits.

20.4 Semi-Annual Flow Rate Audits

A RRO monitoring technician other than the RRO monitoring technician who routinely operates the PM monitors completes a flow rate audit on the monitors at least once every 182 days, preferably once every quarter or 91 days, and two must be between 5 and 7 months apart. This RRO monitoring technician uses different, NIST traceable, equipment to conduct the audit than the equipment used to calibrate the monitors and do the monthly or semimonthly flow verification checks. The RRO monitoring technician follows the audit procedures in SOPs DAQ-11-001.2, 2.47.2, 2.44.2 and 2.45.2. Acceptance criteria applicable to PM flow rate audits may be found in Tables 7.6 and 7.8. The RRO monitoring technician documents the semi-annual flow rate audit in the e-log. If a monitor does not pass the evaluation, the RRO monitoring staff will take appropriate action to identify why the monitor failed the evaluation and to correct the situation. See CFR 40 Part 58, Appendix A, Sec. 3.2.2 and 3.3.2 for more information regarding required PM flow rate audits.

20.5 Quarterly Completeness Assessment

After the database manager uploads to AQS all data for a quarter, an RCO chemist assesses the data to ensure all data made it through the upload process and into AQS. The RCO chemist accomplishes the quarterly completeness assessment by running the AMP430 Completeness Report, the AMP350 Raw Data Report and the AMP251 QA Data Report. The RCO chemist compares the data in AQS with the data that should be in AQS based on the monitoring schedule. When the RCO chemist identifies missing data or some other problem, he or she informs the Level 3 reviewer and database manager who act to resolve the issue. The RCO chemist archives the AMP251, AMP350 and AMP430 reports used for the quarterly completeness review in the Laserfiche Ambient Monitoring Module. If the monitor does not meet the 75 percent completeness requirements in the grant commitment, the chief contacts EPA Region 4 providing information on what occurred and what actions DAQ plans to take to keep the event from reoccurring.

20.6 Annual Data Certifications

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 the NCore site meet criteria in 40 CFR Part 58, Appendix A from Jan. 1 to Dec. 31 of the previous year. Along with the certification letter, the chief 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 NCore data for the previous calendar year. The DAQ verifies and validates data monthly, as discussed in Section 23.0 Verification and Validation Methods. Additionally, an RCO chemist assesses the data on a quarterly basis when an RCO chemist generates specific AQS reports to assess the DQIs as discussed in Section 20.8 Data Quality

Assessments. With these assessments ongoing throughout the year, annual data 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 the data reviewers did not previously identify. The annual data certification process starts with running and reviewing AMP reports contained in AQS. The reports typically queried include the following:

- AMP350 Raw Data
- AMP251 QA Data
- AMP430 Data Completeness
- AMP600 Certification Evaluation
- AMP256 Data Quality Indicator
- AMP504 Extract QA Data
- AMP450 Quicklook Criteria Parameters
- AMP450NC Quicklook All Parameters

An RCO audit chemist and the PPB supervisor review these reports and confirm everything is complete and accurate. The RCO audit chemist and PPB supervisor also review the reports to ensure the statistical results indicate the monitoring data were in control over the course of the entire year and met the DQOs. If they identify problems, the RCO audit chemist investigates them in accordance with Section 24.0 Reconciliation with Data Quality Objectives.

Ultimately, this process verifies that the NCore monitoring data submitted to AQS are correct and complete. Once the RCO chemists, statistician and database manager complete any necessary corrections, additions, or deletions in AQS and the RCO chemists and PPB supervisor finalize the dataset, the chief officially recommends the data for certification to EPA Region 4. The data certification package provided to EPA includes a signed copy of the AMP600 report, along with a letter signed by the chief, certifying that the ambient concentration and QA data in AQS are complete and accurate, taking into consideration the QA findings, to the best of his or her knowledge.

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

20.7 Audit of Data Quality

An RCO chemist who does not validate the data conducts the audit of data quality, or ADQ, which reveals how the level 1 to 3 reviewers handled data, what judgments they made, whether they made uncorrected mistakes and if records exist to support the decisions made. An ADQ can often identify the means to correct systematic data reduction errors. Sufficient time and effort will be devoted to this activity so that the RCO chemist has a clear understanding and complete documentation of data flow. The RCO chemist shall perform this assessment quarterly in accordance with the quarterly data review described in SOP 2.39. The DAQ ensures the level 1 to 3 reviewers maintain data collection and handling integrity via the quarterly data review. If the RCO chemist finds a problem during the ADQ, the RCO chemist will work with the level 1 to 3 reviewers to correct the situation and modify the procedures to ensure the problem does not reoccur. See Section 23.0 of this document for more information related to the data review process, which occurs monthly and/or quarterly.

20.8 Data Quality Assessments

A DQA is the statistical analysis of environmental data to determine whether the data meet the assumptions under which the DQOs and data collection design were developed and whether the total

error in the data is tolerable. The DAQ will estimate measurement uncertainty for both automated and manual data recording methods. Calculations for DQA activities shall follow the requirements and equations identified in 40 CFR Part 58, Appendix A, Section 4. The regulations within 40 CFR Part 58, Appendix A define and explain the terminology associated with measurement uncertainty.

An RCO chemist will evaluate the data quality on a quarterly basis using the AQS AMP256 and AMP600 reports. Since the NCore network has only one site, the DAQ bases the evaluation of the data quality on single monitors for this network. The DQAs will be sent to the QAM via email, for information and to allow corrective action to be taken. Copies of the AQS AMP256 and AMP600 files in PDF format are provided upon request. For the annual data certification, the NCore site is combined with monitors from other DAQ-supported networks to determine an estimate of data quality for the agency or PQAO overall. The chief reports the individual results of these tests for each method or analyzer to the EPA annually as part of the AQS AMP600 report.

Level 1 data reviewers use the FRM and continuous flow rate control charts in the e-log semimonthly to identify unusual variations in the flow rates. The Level 1 data reviewers must take corrective action when the control chart shows the flow rate reaching the warning level. The RCO chemist reviews control charts of the daily auto zero, span and 1-point-QC check for NO_y, NO_2, NO, and CO every business day. The RCO chemist also control charts the daily auto zero, span, and 1-point-QC check as well as shelter temperature and maximum SO2 values for SO2 every business day. When the control chart indicates the zero, span or 1-point-QC check drifted out of range, the RCO chemist contacts the RRO operator and asks him or her to take corrective action as specified in each monitor's SOP.

For Ozone, no control charts are created; however, an RCO chemist reviews the daily download from the statistician, which includes the PZS data. The RCO chemist creates a daily review table (control table without graph) which is reviewed daily for each site. The RCO chemist follows up daily should any of the PZS values 'drift' to near or past the acceptance limits (i.e. +/- 2 for Zero, +/-3 for Precision, and +/-5 for Span). Additionally, the RCO chemist colors the cells on any value that is even close to the limits such that it stands out on a day-to-day basis. The RCO chemist also investigates if an anomaly occurs and populates the 'Comments' column of the spreadsheet to be able to follow up on and have for potential invalidation codes should they be needed. The RCO chemist also maintains these spreadsheets on a secure drive with a back-up copy kept in a separate memory device. The RCO chemist reviews these tables again during the following month level 3 validation check for consistency and to assure the level 1 and 2 reviewers coded appropriately. Figure 20.1 provides an example. Around 7/22-7/24 the zero drift on the monitor is highlighted. Fortunately, in this instance, it turned out to be 'drift', but the daily review makes it stand out and beg for attention or follow up with the site operator at a minimum.

	Building Tempera-ture			O3 Concentration				**O3 Calibration Drift (ppb) iPs**			**Monitor**			Auto cal always runs at midnight and into the 1:00 hr
Date	Min	Max	Avg.	Min	Max	Avg	8 hr Avg Max	Span0	Span2	Span4	Span0	Span2	Span4	Comments
7/1/2020	21.90	23.70	23.16	26	47	35.09	40.63							Bad ZAP, replaced on 7/2
7/2/2020	22.70	23.70	23.24	38	55	46.77	50.50							

7/3/2020	22.70	23.80	23.30	36	53	42.65	47.43	0	65	225	1	66	226	
7/4/2020	23.20	24.00	23.62	35	49	43.26	44.25	0	65	225	1	66	226	
7/5/2020	22.80	25.30	23.92	29	50	38.17	39.00	0	65	225	1	65	225	
7/6/2020	24.40	25.30	24.78	31	43	34.74	37.50	0	65	225	0	65	225	
7/7/2020	23.80	24.60	24.05	26	38	32.57	35.63	0	65	225	0	65	224	
7/8/2020	23.30	24.90	23.91	28	40	31.61	31.57	0	65	225	0	64	224	
7/9/2020	24.30	24.90	24.60	25	39	32.57	33.71	0	65	225	0	64	224	
7/10/2020	24.20	25.00	24.57	32	47	38.91	42.38	0	65	225	0	65	224	
7/11/2020	23.40	24.70	23.93	42	54	46.78	46.71	0	65	225	0	64	223	
7/12/2020	22.80	24.30	23.57	35	**71**	54.09	**62.14**	0	65	225	0	64	223	
7/13/2020	23.60	24.60	24.07	39	**63**	51.57	55.88	0	65	225	0	64	223	
7/14/2020	23.60	25.70	24.38	40	54	46.83	47.86	0	65	225	0	64	223	
7/15/2020	25.20	27.10	25.89	42	55	47.78	51.29	0	65	225	0	64	224	
7/16/2020	26.30	27.00	26.57	40	52	44.31	43.80	0	65	225	0	65	224	
7/17/2020	25.90	26.70	26.24	38	52	44.23	#DIV/0!	0	65	225	0	64	224	**bad modem**
7/18/2020														**bad modem**
7/19/2020														**bad modem**
7/20/2020														**bad modem**
7/21/2020														**bad modem**
7/22/2020	24.70	25.60	25.19	31	45	35.67	39.20	0	65	225	**-1**	64	223	
7/23/2020	24.30	25.30	24.70	30	41	35.00	34.75	0	65	225	**-1**	64	223	
7/24/2020	23.40	24.30	23.68	27	43	35.83	37.71	0	65	225	**-1**	63	223	

Figure 20.1 Example Ozone Daily Review Table

20.9 EPA Technical Systems Audits

A TSA is a thorough, independent, and systematic on-site qualitative assessment, where an auditor examines facilities, equipment, personnel, training procedures, protocols and recordkeeping for conformance with the regulatory requirements and this QAPP. The EPA Region 4 QA staff conducts a TSA of DAQ every 3 years, in accordance with 40 CFR Part 58, Appendix A, Section 2.5. The EPA reports its findings to the DAQ director and chief. The chief regularly monitors progress on corrective actions required by TSA findings and communicates progress to the director and EPA Region 4.

An EPA TSA team or an individual TSA auditor may segregate TSA activities into multiple categories. The auditor may audit each category independently or may combine them. Possible categories may include:

- Field activities – Monitor installation, calibration and operation and sample handling.
- Laboratory activities – Pre-sampling filter weighing, filter delivery and receiving, post-sampling filter weighing, filter archiving and associated QA/QC activities.

- Data and document management activities – Collecting, flagging, editing and uploading data, providing data security and storing documentation to support the decisions made.

During the audit, the auditors will interview key personnel with responsibilities for planning, field operations, laboratory operations, QA/QC, data management and reporting.

Upon completion of the audit, EPA verbally alerts the DAQ director and chief of any deficiencies or findings during a TSA exit briefing. This briefing allows DAQ staff to begin formulating or implementing corrective actions. The EPA typically distributes a draft TSA report 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 EPA receives comments from DAQ, EPA finalizes the TSA report and resubmits the report to the director and chief. The director and chief must complete and submit to EPA Region 4 within 30 days a formal response to address the TSA findings. The chief will communicate with EPA routinely after submitting the corrective action plan to provide progress updates on a periodic basis until DAQ has completed the corrective actions.

EPA shall conduct TSAs once during every three-year period that the NCore monitoring program collects data verifying compliance with the NAAQS.

20.10 Internal Technical Systems Audits

The RCO audit chemist will perform an internal TSA on the NCore program at least once every three years, and ideally every year, which may include the RRO, ECB and RCO activities. An internal audit is like a TSA performed by the EPA. It is a thorough and systematic qualitative audit, where an auditor examines facilities, equipment, personnel, training procedures, protocols and record keeping for conformance with established regulations and statewide policies governing the collection, analysis, validation, and reporting of ambient air quality data. Audit checklists are detailed in SOP DAQ-15-004.5, currently under development.

A systems audit team or an individual systems auditor may separate systems audit activities into two categories for systems audits. The auditor or audit team may audit the categories independently or together. The categories include:

- Field activities – performing routine maintenance of equipment, maintaining certification records, performing associated QA/QC activities, etc.
- Laboratory activities - pre-sampling filter weighing, filter shipping and receiving, post-sampling filter weighing, filter archiving and associated QA/QC activities.
- Data and document management activities – collecting, flagging, editing, and uploading data, providing data security and storing documentation to support the decisions made.

The auditor will interview the key personnel responsible for planning, field operations, QA/QC, data management and reporting.

Internal TSAs will focus on siting criteria, the adequacy of the quality system, compliance with quality system documents, and interviews of staff responsible for data generation, equipment and instrument calibration, day-to-day operations including sample collection (handling and custody), meteorology, and data management (such as records management and data verification, validation, and reporting). TSA reports will be submitted to monitoring agency management and a copy sent to the EPA Regional Representative.

Laboratory TSAs will focus on the quality system, compliance with the quality system documents, performance of analytical methods, sample handling and custody, and data review, verification, and reporting. The TSA audit team will distribute the TSA report to the RTI and DAQ management. The RTI management will notify DAQ management of corrective actions, root cause analysis, and demonstrate return to conformance for audit findings deemed to impact data quality. Such reports will identify the affected data. DAQ will subsequently notify EPA Region 4 of the outcomes of the annual PAMS TSA, including any corrective actions taken by DAQ.

The results of the internal systems audit may result in additional or refresher training for air monitoring staff. Training may be provided in the form of additional communications regarding DAQ's approved practices along with discussions of the elements necessary to satisfy these requirements. It may also be in the form of hands-on technical training.

20.11 Reporting and Resolution of Issues

The communication process regarding necessary corrective actions within DAQ's NCore monitoring program because of the previously mentioned assessments is detailed in SOP DAQ-15-002. The NC DAQ AMS – Hurricane Readiness Task List provides emergency/contingency plans that should be implemented when a hurricane or tropical storm is approaching North Carolina.

21.0 Reports to Management

This section describes the quality-related reports and communications to management necessary to support SLAMS/NCore network operations and the associated data acquisition, validation, assessment, and reporting. Besides the reports discussed in this section, staff meetings occur regularly on either a weekly, biweekly or a monthly schedule depending on the part of the organization involved. In addition, DAQ holds as-needed meetings with the affected parties to address any additional issues that may arise. See Section 20.0 of this document for additional information regarding the types of reports generated from AQS used to inform management of QA issues. Unless otherwise indicated, all reports will contain monitoring data for the list of pollutants provided in Table 5.2. Raw data reports may also contain data for shelter temperature.

Reports to management required for the NCore program are the same as those for the SLAMS program which are discussed in various sections of 40 CFR Parts 50, 53 and 58. The EPA's Air Quality Assessment Division within the Office of Air Quality Planning and Standards (OAQPS) provides guidance for management report format and content. The sections below describe the reports to management used by DAQ.

21.1 Quarterly Data Reports

The DAQ monitoring staff will edit, validate, and upload air quality data submitted for each reporting period to AQS using the procedures described in the EPA's AQS User Guide, EPA's *AQS Data Coding Manual*[3] and DAQ's data handling and validation SOPs DAQ-15-005.5 and 2.63.4. The level 1 to 3 reviewers review and validate the concentration data in the Envista ARM database.

Each quarter, DAQ uploads to AQS the results of all valid precision, bias, and accuracy tests it carried out during the previous quarter. The database manager submits data to AQS consistent with the data reporting requirements specified for air quality data as set forth in 40 CFR Part 58, Appendix A. DAQ reports the required QA data on the same schedule as quarterly monitoring data submittals. The chief is responsible for ensuring that the level 1 to 3 reviewers use the results of QA data to validate concentration data. In accordance with 40 CFR Section 58.16(b), DAQ submits data to the AQS database no later than 90 days following the end of the quarter in which DAQ collected the data. Table 21.1 provides the dates by which the DAQ uploads the previous quarter's data.

Table 21.1 Required AQS Data Reporting Periods

Quarter	Reporting Period	Last Day to Upload Data to AQS
Q1	Jan. 1 to March 31	June 29
Q2	April 1 to June 30	Sept. 28
Q3	July 1 to Sept. 30	Dec. 29
Q4	Oct. 1 to Dec. 31	March 30 or 31 (of following year)

After the database manager uploads all data for the quarter to AQS, an RCO chemist retrieves and reviews the following quarterly reports from AQS: the AMP251, AMP256, AMP350, AMP350MX,

[3] Available at http://www.epa.gov/ttn/airs/airsaqs/manuals/AQS%20Data%20Coding%20Manual.pdf.

AMP430 and AMP600. After reviewing the reports, the RCO chemist archives the reports in the Laserfiche Ambient Monitoring Module and sends an e-mail to the Level 3 reviewer summarizing the review and any corrective action needed.

When data capture for a monitor falls below 75 percent for the quarter, an RCO chemist prepares for the chief a memo explaining why and the corrective action taken. Otherwise, the PPB supervisor documents that the quarterly data submittal is complete and the data meets 75 percent completeness by sending an e-mail to the chief.

21.2 Annual Performance Evaluations

The ECB electronics technicians conduct performance evaluations, sometimes referred to as audits, of the gaseous monitors at least once every 365 days and each calendar year, using specially designated audit equipment. All gaseous transfer standards used in the air-monitoring network must be traceable to a primary standard such as a NIST standard reference material or an EPA/NIST-approved certified reference material.

The ECB electronics technicians document the results of each performance evaluation on the AQ-121 form. After the ECB supervisor reviews and approves the form, he routes the form to the PPB Supervisor for review and approval. After the PPB supervisor reviews and approves the form, the PPB supervisor distributes the form to the RRO supervisor, coordinator and RCO chemists.

21.3 Annual Network Review

By Oct. 31 of each calendar year, the RRO monitoring technicians conduct an annual network review of the site documenting the information requested on the annual site review forms, which is part of DAQ's overall annual network review. SOP 2.43.2 describes this process. This network review determines if the monitoring site and probe locations meet the siting requirements and monitoring objectives defined in 40 CFR Part 58, Appendices A, D and E. The review identifies any needed modifications to the site and network including termination or relocation of unnecessary stations or monitors or establishment of new stations or monitors. The RRO monitoring technician completes the annual network review form described in SOP 2.43.2 and submits the form to the coordinator, who reviews the form and submits it to the RCO by Dec. 31. The PPB supervisor or a designee archives the network review forms in the Laserfiche Ambient Monitoring Module and provides them to the public and the EPA as appendices to the annual network-monitoring plan.

21.4 Annual Data Certification

By May 1 of each year, the chief and PPB supervisor will prepare for the chief's signature a data certification package, which is submitted to the Director, ARD, US EPA Region 4. The report will consist of a letter, for signature, along with AQS generated summaries of NCore concentration data collected during the previous year and all applicable QA data. The OAQPS and EPA Region 4 specify the exact AQS reports for the chief to submit. Generally, the chief submits an AMP600 and AMP450NC report.

The EPA requires state and local programs to report periodic assessments of SLAMS data quality for the PM network to EPA (40 CFR Part 58, Appendix A, Section 1.4). The DAQ issues the annual data certification report to meet this requirement. This document describes the quality objectives for measurement data as well as how DAQ met those objectives.

21.5 Annual Network Monitoring Plan

Following the requirements in 40 CFR 58.10(a) DAQ prepares and submits to the EPA Region 4 regional administrator an annual monitoring network plan by July 1 of each year. The plan is reviewed and submitted by the chief. It is composed by the regional air quality supervisors and coordinators, RCO chemists, the AMS supervisors, and the chief. The plan provides documentation for the establishment and maintenance of an air-quality surveillance system consisting of a network of SLAMS monitoring stations. The plan includes: (1) a statement of purpose for each monitor and (2) evidence that siting and operation of each monitor meets the requirements of appendices A, C, D and E of 40 CFR Part 58, where applicable. For the NCore network, the plan would ensure compliance with 40 CFR Part 58, Appendix D, Sections 2 and 3, and assess any possible or required monitor or site changes to the network. Before submission to the EPA by the July 1 due date, the DAQ makes the annual monitoring network plan available for public inspection and comment for at least 30 days.

As required by 40 CFR Part 58, Appendix A, Section 5.1, DAQ provides a list of all monitoring sites and their AQS site identification codes to EPA Region 4 each year in the network plan. The database manager keeps AQS up to date by creating site data records with the date a site was established and other pertinent info. DAQ also sends any appropriate data to AirNow-Tech. Whenever there is a change in this list of monitoring sites or in a reporting organization between network plans, DAQ reports this change to EPA Region 4 via electronic mail and to AQS and AirNow-Tech by updating the appropriate site records.

21.6 Five-Year Network Assessment

DAQ conducts and submits to the EPA regional administrator an assessment of the air quality surveillance system every 5 years, which is due on July 1. At a minimum, this assessment determines if the network meets the monitoring objectives defined in appendix D to 40 CFR Part 58, whether DAQ needs to add new sites, whether DAQ no longer needs existing sites and can terminate them and whether new technologies are appropriate for incorporation into the ambient air monitoring network. In the network assessment, DAQ considers the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma). For any sites that DAQ proposes for discontinuance, DAQ also considers the effect on users of the data, other than the agency itself, such as nearby states and tribes or health effects studies. For $PM_{2.5}$, the assessment also identifies needed changes to population-oriented sites. The chief submits a copy of this 5-year assessment, along with a revised annual network plan, to the EPA regional administrator by July 1 every 5 years, beginning with July 1, 2015, for the NCore network.

21.7 Internal Systems Audit Reports

The RCO audit chemist will perform an internal systems audit once every three years to verify that the NCore program meets the data MQOs outlined in section 7.2. The RCO audit chemist will distribute copies of the systems audit report to the RRO, RCO chemists, ECB supervisor, the PPB supervisor, and the chief.

21.8 Response/Corrective Action Report

Currently, the RRO monitoring technician documents any corrective action taken at the site in an e-log. These e-logs are not sent to management but are reviewed by the RRO monitoring coordinator

and RCO chemists. When the corrective action needed is beyond what the RRO monitoring technician can handle at the site, the RRO monitoring technician contacts the RRO monitoring coordinator and ECB electronics technicians. The ECB electronics technicians document all corrective actions taken on an Air Quality Section Maintenance Order or AQ-109 Form which is reviewed by the ECB and PPB supervisors. When corrective action is needed to correct data reported to AQS, the changes are documented on a data correction form (see DAQ-15-005.5 Appendix A). If the corrective action affects more than two or three days or months-worth of data, involves systemic issues, or endangers meeting completeness, the corrective action is documented in a memo to the chief and copied to the RRO supervisor. SOP DAQ-15-002, describes when a need exists for a formal corrective action preventative action (CAPA) process that documents the root cause analysis, investigates solutions, and confirms that the solution was effective.

22.0 Data Validation and Usability

Data review is the in-house examination to ensure that all the equipment and people involved have recorded, transmitted, and processed the data correctly. It includes completeness checks to determine if there are any deficiencies such as missing data or lost integrity. The level one through three data reviewers should compare the data under evaluation to actual events, as per guidance (*Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8)). In addition, DAQ expects that some of the QC checks will indicate that the data fail to meet the acceptance criteria. The level one to three data reviewers shall invalidate or flag data identified as suspect, or which does not meet the acceptance criteria, with AQS codes prior to upload to AQS.

Data verification is the process for evaluating the completeness, correctness, and conformance or compliance of the data set against method, procedural and contractual specifications. The EPA and DAQ further define verification as confirmation, through provision of objective evidence, that the data collection process fulfilled all specified requirements for that type of data. The verification process also involves the inspection and acceptance of the field samples.

Data validation is a routine process designed to ensure that reported values meet the quality goals of the environmental data operations. The EPA and DAQ further define data validation as examination and provision of objective evidence that the data collection process fulfilled the particular requirements for a specific *intended use*. The primary intended use for the DAQ NCore data set is NAAQS compliance. Thus, the DAQ must use a progressive, systematic approach to data validation to ensure and assess the quality of data. Data validation includes the review of the DAQ NCore data sets against the individual pollutant MQOs. Reviewing data long-term (over a monthly or quarterly period) provides information about the structure of the data and may identify patterns, relationships, or potential anomalies. If the RCO chemist finds a problem or discrepancy, he or she will conduct further investigations to find the source of the error and then correct it. Deviations from operational procedures or QA requirements that do not result in data invalidation may require that data be qualified with QA qualifier flags prior to upload to AQS.

22.1 Sampling Design

The EPA must approve sampling network and monitoring site selection for SLAMS monitors. The EPA approves the monitoring site selections when the EPA approves the network plan. In selecting the location of NCore sites, DAQ must comply with, and EPA must verify that DAQ has complied with the following:

- 40 CFR Part 58, Appendix A - Quality Assurance Requirements for Monitors Used in Evaluations of National Ambient Air Quality Standards
- 40 CFR Part 58, Appendix D - Network Design Criteria for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring.
- Technical Assistance Document for Precursor Gas Measurements in the NCore Multi-Pollutant Monitoring Network - Version 4

Guidance on Choosing a Sampling Design for Environmental Data Collection (EPA QA/G-5S) provides additional guidance.

The RRO monitoring technician shall thoroughly document any deviations from the minimum siting criteria (e.g., shelter location, probe, and inlet placement and/or monitor sight path requirements) in

the site's QC documentation and annually on the annual network review form. Examples of deviations include, but are not limited to, insufficient distance from roadways (i.e., marginal terrain criteria) and insufficient distance from influencing objects (e.g., dripline of an adjacent tree or a cell phone tower installed after establishment of the monitoring site).

22.2 Data and Sample Collection Procedures

Section 11.0 Sampling Methods Requirements outlines data and sample collection procedures for the FRMs and FEMs used at the NCore site. The Envidas Ultimate DAS routinely identifies potentially unacceptable data points in the database through electronic application of Envidas-Ultimate applied general status flags. Each instrument-specific flag is associated with a unique error. The level 1, 2 and 3 reviewers routinely review these Envidas-Ultimate applied status flags as part of the data validation process. This activity assists in identifying suspect or potentially bad data points that could invalidate the resulting averaging periods. A similar process, although manual, is performed with the filter-based samples, including the weigh lab. Table 22.1 presents a compilation of the AQS qualifier flags and null codes. A current list of AQS error flags and null codes can be found at EPA's AQS webpage.

Table 22.1 Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
IA	African Dust	Informational only	To provide information on events that influenced the measured values.
IB	Asian Dust	Informational only	
IC	Chemical Spills and Industrial 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	
IU	Wildland Fire Use Fire-U. S.	Informational only	
J	Construction/Demolition	Informational only	
1c	A 1-Point-QC check is invalid and has been excludedBut there is compelling evidence that the analyzer data is valid.	Missing QA/QC Check	Void the data and submit the code in its place.
1F	A 1-Point QC check has failed and there is compelling evidence that analyzer data is invalid.	Failed QA/QC Check	
AA	Sample Pressure Out of Limits	Null data qualifier	
AB	Technician Unavailable	Null data qualifier	
AC	Construction/Repairs in Area	Null data qualifier	

Table 22.1 Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
AD	Shelter Storm Damage	Null data qualifier	
AE	Shelter Temperature Outside of Limits	Null data qualifier	
AF	Scheduled But Not Collected	Null data qualifier	
AG	Sample Time Out of Limits	Null data qualifier	
AH	Sample Flowrate or CV Out of Limits	Null data qualifier	
AI	Insufficient Data (Cannot Calculate)	Null data qualifier	
AJ	Filter Damage	Null data qualifier	
AK	Filter Leak	Null data qualifier	
AL	Voided by Operator	Null data qualifier	
AM	Miscellaneous Void	Null data qualifier	
AN	Machine Malfunction	Null data qualifier	
AO	Bad Weather	Null data qualifier	
AP	Vandalism	Null data qualifier	
AQ	Collection Error	Null data qualifier	
AR	Lab Error	Null data qualifier	
AS	Poor Quality Assurance Results	Null data qualifier	
AT	Calibration	Null data qualifier	
AU	Monitoring Waived	Null data qualifier	
AV	Power Failure	Null data qualifier	
AW	Wildlife Damage	Null data qualifier	
AX	Precision Check	Null data qualifier	
AY	QC Control Points (Zero/Span)	Null data qualifier	
AZ	QC Audit	Null data qualifier	
BA	Maintenance/Routine Repairs	Null data qualifier	
BB	Unable to Reach Site	Null data qualifier	
BC	Multi-Point Calibration	Null data qualifier	
BD	Automatic Calibration	Null data qualifier	
BE	Building/Site Repair	Null data qualifier	
BF	Precision/Zero/Span	Null data qualifier	
BG	Missing Ozone Data Not Likely to Exceed Level of Standard	Null data qualifier	
BH	Interference/Co-Elution/Misidentification	Null data qualifier	
BI	Lost or Damaged In Transit	Null data qualifier	
BJ	Operator Error	Null data qualifier	
BK	Site computer/data logger down	Null data qualifier	
BL	QA Audit	Null data qualifier	
BM	Accuracy check	Null data qualifier	
BN	Sample Value Exceeds Media Limit	Null data qualifier	
BR	Sample Value Below Acceptable Range	Null data qualifier	
CS	Laboratory Calibration Standard	Null data qualifier	
DA	Aberrant Data (Corrupt Files, Aberrant Chromatography,	Null data qualifier	
DL	Detection Limit Analyses	Null data qualifier	
EC	Exceeds Critical Criteria	Null data qualifier	
FI	Filter Inspection Flag	Null data qualifier	
MB	Method Blank (Analytical)	Null data qualifier	
MC	Module End Cap Missing	Null data qualifier	
QV	Quality Control Multi-Point Verification	Null data qualifier	

Table 22.1 Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
SA	Storm Approaching	Null data qualifier	
SC	Sampler Contamination	Null data qualifier	
ST	Calibration Verification Standard	Null data qualifier	
SV	Sample Volume out of limits	Null data qualifier	
TC	Component Check and Retention Time Standard	Null data qualifier	
TS	Holding Time Or Transport Temperature Is Out Of Specs.	Null data qualifier	
XX	Experimental Data	Null data qualifier	
1	Deviation From a CFR/Critical Criteria Requirement	Quality Assurance Qualifier	Flag indicating the quality of the data. In some cases, the data may not meet all of the criteria but are still valid.
1V	Data Reviewed and Validated	Quality Assurance Qualifier	
2	Operational Deviation	Quality Assurance Qualifier	
3	Field Issue	Quality Assurance Qualifier	
4	Lab Issue	Quality Assurance Qualifier	
5	Outlier	Quality Assurance Qualifier	
6	QAPP Issue	Quality Assurance Qualifier	
7	Below Lowest Calibration Level	Quality Assurance Qualifier	
9	Negative value detected - zero reported	Quality Assurance Qualifier	
CB	Values have been Blank Corrected	Quality Assurance Qualifier	
CC	Clean Canister Residue	Quality Assurance Qualifier	
CF	Canister Bias: NATTS/UATMP Data for compounds that have failed certification for the canister.	Quality Assurance Qualifier	
CL	Surrogate Recoveries Outside Control Limits due to analytical interferences	Quality Assurance Qualifier	
DI	Sample was diluted for analysis.	Quality Assurance Qualifier	
DN	DNPH peak less than NATTS TAD requirement, reported value should be considered an estimate.	Quality Assurance Qualifier	
EH	Estimated; Exceeds Upper Range	Quality Assurance Qualifier	
FB	Field Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
FX	Filter Integrity Issue.	Quality Assurance Qualifier	
HT	Sample pick-up hold time exceeded; data questionable	Quality Assurance Qualifier	
LB	Lab blank value above acceptable limit	Quality Assurance Qualifier	
LJ	Identification Of Analyte Is Acceptable; Reported Value Is An Estimate	Quality Assurance Qualifier	
LK	Analyte Identified; Reported Value May Be Biased High	Quality Assurance Qualifier	
LL	Analyte Identified; Reported Value May Be Biased Low	Quality Assurance Qualifier	
MD	Value less than MDL	Quality Assurance Qualifier	
MS	Value reported is 1/2 MDL substituted.	Quality Assurance Qualifier	
MX	Matrix Effect	Quality Assurance Qualifier	
ND	No Value Detected	Quality Assurance Qualifier	
NS	Influenced by nearby source	Quality Assurance Qualifier	
PQ	Values Between PQL And MDL.	Quality Assurance Qualifier	
QP	Pressure Sensor Questionable.	Quality Assurance Qualifier	
QT	Temperature Sensor Questionable.	Quality Assurance Qualifier	
QX	Does not meet QC criteria.	Quality Assurance Qualifier	
SB	Sampler Bias: NATTS/UATMP Data for compounds that have failed certification for the sampler.	Quality Assurance Qualifier	
SP	NATTS/UATMP data with Spike Recovery outside acceptance limits.	Quality Assurance Qualifier	
SQ	Values Between SQL and MDL	Quality Assurance Qualifier	

Table 22.1 Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
SS	Value substituted from secondary monitor	Quality Assurance Qualifier	
SX	Does Not Meet Siting Criteria	Quality Assurance Qualifier	
T	Multiple PM2.5 Validity Flags.	Quality Assurance Qualifier	
TB	Trip Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
TT	Transport Temperaure is Out of Specs.	Quality Assurance Qualifier	
V	Validated Value	Quality Assurance Qualifier	
VB	Value below normal; no reason to invalidate	Quality Assurance Qualifier	
W	Flow Rate Average Out of Specification	Quality Assurance Qualifier	
X	Filter Temperature Difference or Average Out of Specification	Quality Assurance Qualifier	
Y	Elapsed Sample Time Out of Specification	Quality Assurance Qualifier	
RA	African Dust	Request Exclusion	Applied only after application process completed and accepted by AQS for data eligible to be excluded as an exceptional event.
RB	Asian Dust	Request Exclusion	
RC	Chem. Spills and Industrial Accidents	Request Exclusion	
RD	Cleanup After a Major Disaster	Request Exclusion	
RE	Demolition	Request Exclusion	
RF	Fire - Canadian	Request Exclusion	
RG	Fire - Mexico/Central America	Request Exclusion	
RH	Fireworks	Request Exclusion	
RI	High Pollen Count	Request Exclusion	
RJ	High Winds	Request Exclusion	
RK	Infrequent Large Gatherings	Request Exclusion	
RL	Other	Request Exclusion	
RM	Prescribed Fire	Request Exclusion	
RN	Seismic Activity	Request Exclusion	
RO	Stratospheric Ozone Intrusion	Request Exclusion	
RP	Structural Fire	Request Exclusion	
RQ	Terrorist Act	Request Exclusion	
RR	Unique Traffic Disruption	Request Exclusion	
RS	Volcanic Eruptions	Request Exclusion	
RT	Wildfire-U. S.	Request Exclusion	

Informational only = Exceptional or unusual natural occurance, data not requested to be excluded
Null data qualifier = invalid data.
Quality Assurance Qualifier = data does not meet all acceptance criteria but is not believed to be invalid.
Request Exclusion = Exceptional or unusual natural occurance, data requested to be excluded

Data collection procedures must adhere to those procedures documented in the SOPs listed in Table 11.2. Any time the RRO monitoring technician or coordinator uses a code to void or flag data, he or she should document the reason for using the code in the appropriate logbook and must document any deviation from the established data or sample collection plan in the appropriate logbook or data sheet. Accurate and complete documentation of any data or sample collection deviations will assist in any subsequent investigations or evaluations.

22.3 Sample Handling

The RRO monitoring technician records pertinent deviations from established sample-handling protocols for each sample physically retrieved from the monitoring site and equipment. The monitoring technician shall record these deviations on the sample custody sheet assigned to each filter for PM and in the applicable electronic database for all other pollutants. The lab analyst, likewise, records deviations in samples and sample handling in the appropriate data sheet or electronic database.

22.4 Analytical Procedures

Data reviewers shall ensure that the gravimetric analysis of filter-based samples has been performed in accordance with regulatory requirements found in Appendix L, Section 8. To do this, data reviewers will review lab data manually and through electronic means to ensure all method specifications are met as detailed in Table 7.6 of this QAPP. Lab data that does not meet these requirements will be voided or flagged as suspect.

22.5 Quality Control

Section 14 specifies the QC checks that regional monitoring staff must perform when initially setting up a monitor and periodically throughout the period while the monitor is operating, collecting samples and doing sample analysis. These include the analyses of daily one-point-QC checks, calibration check standards, blanks, replicates, monthly or semimonthly flow rate verifications and collocated monitoring. These checks provide indications of the quality of data produced by specified components of the measurement process. SOPs DAQ-10-001.1, 2.7.2, DAQ-07-003.1, DAQ-08-002.1, DAQ-08-001.2, DAQ-12-001.1, DAQ-12-002.2, 2.36.1, DAQ-04-001.2, 2.38.1, 2.38.2, 2.44.2, 2.45.2 , DAQ-11-001.2, and 2.47.2 (see Table 11.2 for SOP titles) specify the procedure, acceptance criteria and corrective action (and changes) for each QC check. Acceptance criteria are also provided in Tables 7.2 through 7.8. Data validation should document the corrective actions taken, affected PM sampling days or hours and the potential effect of the actions on the validity of the data. The level 1, 2 and 3 data reviewers will:

- Code missing PM and gaseous pollutant data with appropriate AQS null codes,
- Invalidate hourly gaseous pollutant data and hourly 5-minute maximum SO_2 data if less than 45 minutes of valid data are collected within the hour,
- Invalidate gaseous pollutant data when the FEM shelter temperature requirements are not met,
- Bracket valid gaseous pollutant data with valid, 1-point QC checks that meet the MQOs and control limits,
- Invalidate gaseous pollutant data back to the most recent valid, passing 1-point QC check and forward to the completion of appropriate corrective actions and calibration when a valid 1-point QC check exceeds critical criteria,
- Report all valid QA/QC data to AQS, with valid 1-point QC checks that exceed acceptance criteria reported with the "1F" null code and invalid 1-point QC checks reported with the "1C" null code,
- Bracket valid PM data with valid, flow rate verification checks that meet the MQOs and control limits, and

- Invalidate PM data back to the most recent valid, passing flow rate verification check and forward to the completion of appropriate corrective actions and calibration when a valid flow rate verification check exceeds critical criteria.

SOPs 2.7.2, DAQ-08-001.2, DAQ-12-002.2, DAQ-04-001.2, 2.38.2, 2.44.2, 2.45.2, DAQ-11-001.2, and 2.47.2 provide further information about one-point-QC checks and monthly flow rate verifications.

The RTI contract laboratory provides level 1 QC verification for all weigh data associated with the gravimetric PM2.5 program. DAQ personnel perform level 2 QC verification of the RTI data package and Level 3 QA validation for the DAQ gravimetric program once the laboratory and field data have been consolidated. Additional information on the procedures followed by RTI Lab personnel is detailed in Appendix A through D of this QAPP. DAQ personnel perform level 2 QC verification of the RTI data package (see RTI Data Package Checklist) and Level 3 QA validation for the DAQ gravimetric program once the laboratory and field data have been consolidated (see SOP 2.63.4).

22.6 Calibration

Section 14.0 Quality Control Requirements and Procedures addresses the calibration of the monitors, along with the information RRO monitoring technicians should present to demonstrate they performed the calibrations correctly and the results are acceptable. When a level 1 to 3 reviewer identifies calibration problems, a level 1 to 3 data reviewer should flag or void any data produced between the suspect calibration event and any subsequent recalibration to alert data users. SOPs 2.7.2, DAQ-08-001.2, DAQ-12-002.2, DAQ-04-001.2, 2.38.2, 2.44.2, 2.45.2, DAQ-11-001.2, and 2.47.2 (see Table 11.2 for SOP titles) provide further information about calibrations.

22.7 Data Reduction and Processing

As mentioned in the above sections, the EPA will perform external TSAs and the DAQ will perform internal TSAs to ensure the level 1 to 3 data reviewers follow the data reduction and processing activities mentioned in the QAPP. The level 1 to 3 data reviewers will review continuous data monthly and manual PM data quarterly to ensure that associated flags or any other data qualifiers have been appropriately associated with the data. An RCO audit chemist not involved in data collection and processing will review the data quarterly to ensure that the RRO monitoring technicians and coordinator, ECB electronics technicians and other RCO chemists doing the level 3 review have taken appropriate corrective actions.

22.8 Exceptional Events

The regulations at 40 CFR 50.14 allow the EPA Administrator to exclude certain data from use for determinations of exceedances and violations of a NAAQS, if a state or local air monitoring agency demonstrates to the Administrator's satisfaction that an "exceptional event" caused the exceedance or violation. Title 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 that 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.

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

The EPA does not consider data impacted by an exceptional event "representative" of air quality for NAAQS-comparison purposes or calculation of certain summary statistics. The RCO chemist should flag all concentration data impacted by an exceptional event with an AQS information code linked within AQS to an event description. Exceptional event codes and descriptions should be added to AQS during the monthly data review or as soon thereafter as possible, but no later than the schedule established by Federal rulemaking.

It is the responsibility of the RCO chemist with the assistance of the regional office staff and air quality forecasters to analyze the data for potential exceptional events and to add the necessary flags and descriptions into AQS by the applicable regulatory due dates.

To obtain concurrence with an exceptional event, the RCO must notify and cooperate with the EPA Region 4 Regional Office to prepare a demonstration package for the EPA administrator. When the chief submits a demonstration package, the RCO chemist working with the database manager will change the informational flags in AQS to request exclusion flags.

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. Examples of exceptional events at the NCore site might include a natural disaster like an ice storm or forest fire, or a man-made disaster like an event that causes a traffic jam at the site.

23.0 Verification and Validation Methods

Data verification is the process of evaluating the completeness, correctness, and conformance of a specific data set against the method, procedural or contractual requirements, as specified in both the SOPs and 40 CFR Part 58. Data validation is a routine process that extends the evaluation of data beyond method, procedural or contractual compliance (i.e. data verification) to ensure that reported values meet the quality goals of the environmental data operations and that the data can be used for its intended purpose.

As stated in Section 7.2 Measurement Quality Objectives of this QAPP, the DAQ has adopted the consensus-built data validation templates in the QA Handbook and modified them, where appropriate, to reflect the DAQ NCore network. The DAQ uses the validation templates provided in Tables 7.2 to 7.8 for the weight of evidence approach afforded to PQAOs within 40 CFR Part 58, Appendix A, Section 1.2.3. The DAQ follows the guidance in the QA Handbook regarding the use of these templates and handles the criteria as follows:

- Critical criteria are criteria deemed critical to maintaining the integrity of a sample, ambient air concentration value or group of values or samples. The level 1 to 3 reviewers should invalidate observations that do not meet each criterion on the critical table unless there are compelling reasons and justification for not doing so. Basically, the concentration value or sample or group of concentration values or samples that do not meet one or more of these criteria is invalid until proven otherwise. In most cases, the CFR dictates the requirement, the implementation frequency of the criteria and the acceptance criteria, so these criteria are therefore regulatory in nature.
- Operational criteria, which are important for maintaining and evaluating the quality of the data collection system, include situations where violations of a criterion or criteria may be cause for invalidation of the data. The level 1 to 3 reviewers should consider other QC information that may or may not indicate the data are acceptable for the parameter they want to control. Therefore, the datum or sample or data or group of samples, which do not meet one or more of these criteria, is suspect, unless other QC information demonstrates otherwise, and the reviewers have adequate documentation of that information. The level 1 to 3 reviewers should investigate, mitigate or justify the reason for not meeting the criteria.
- Systematic criteria include those criteria which are important for the correct interpretation of the data, but do not usually change the validity of a datum or sample or the data or group of samples. An example criterion is that at least 75 percent of the scheduled samples for each quarter should be successfully collected and validated. The DQOs are also included in this table. If the data do not meet the DQOs, 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 does not imply that the RRO monitoring and ECB electronics technicians do not need to perform these QC checks. Not performing an operational or systematic QC check required by regulation can be a basis for invalidation of all associated data. The DAQ applies the validation templates only to small datasets of single values or a few weeks of information and does not allow a criterion to be in non-conformance simply because it is operational or systematic.

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

23.1 Validating and Verifying Data

23.1.1 Continuously Monitored Data

The validation and verification procedures that DAQ will employ for the continuously monitored data collected shall conform to the validation SOP DAQ-15-005.5 listed in Table 11.2. *Guidance on Environmental Data Verification and Data Validation,* (EPA QA/G-8) also discusses verification and validation issues at length. The RRO monitoring technicians and coordinator shall perform all verification activities. The RCO chemists shall provide additional support through a final review of all data reconciling any anomalies through discussions with the regional office. Following the final review, the RCO chemists will provide a final validation of all data. The RCO chemists will also provide other QA/QC support.

The level 1 to 3 data reviewers should compare data under evaluation to actual events as specified in SOP DAQ-15-005.5. However, significant, and unusual field events may occur, and field activities may negatively affect the integrity of the data. In addition, the DAQ expects that some of the QC checks will indicate the data fail to meet the acceptance criteria in Tables 7.2 through 7.5 and 7.7 through 7.8. The DAQ shall void or flag data identified as suspect or which does not meet the acceptance criteria, using the null codes and validation flags in Table 22.1.

The DAQ verifies and validates the continuously collected data and the associated QC data monthly. Presently, for the continuously collected data, monthly review is the most efficient period for these verification and validation activities. The DAQ finds that if DAQ can control the measurement uncertainty each month, then DAQ will maintain the overall measurement uncertainty for the one-year and three-year periods within the precision and bias DQOs.

23.1.2 Intermittent PM Data

The validation and verification procedures that DAQ employs for the intermittently collected data conform to SOP DAQ-11-001.2 Thermo Scientific 2025i and PM validation SOP 2.63.4 listed in Table 11.2 of this QAPP and DAQ-16-018.4 RTI Data Package Checklist and DAQ-16-020.5 FRM data validation. Guidance on Environmental Verification and Validation, (EPA QA/G-8) also discusses verification and validation issues at length. The RTI lab staff and DAQ LAB environmental specialist shall perform all verification activities. The RCO PM chemist shall provide additional support through a final review of all data reconciling any anomalies through discussions with the RRO monitoring technicians, coordinator and DAQ LAB environmental specialist. Following the final review, the RCO PM FRM chemist will provide a final validation of all data. The RCO PM FRM chemist will also provide QA/QC support.

The level 1 to 3 data reviewers should compare data under evaluation to actual events as specified in the applicable SOPs. However, significant, or unusual field events may occur, and field activities may negatively affect the integrity of the data. In addition, the DAQ expects some of the QC checks will indicate the data fail to meet the acceptance criteria listed in Table 7.6. The level 1 to 3 data reviewers shall void, or flag data identified as suspect, or which does not meet the acceptance criteria, using the null codes and data validation flags in Table 22.1.

The DAQ verifies the intermittently collected data and its associated QC data as each batch of data is received from the RTI lab and validates the data quarterly. Presently, for the data collected by the

FRM, batchwise is the most efficient period for these verification activities and quarterly is the most efficient period for validation activities. The DAQ finds that if DAQ can control the measurement uncertainty for each batch and each quarter, then the DAQ will also maintain the overall measurement uncertainty for the one-year and three-year periods within the precision and bias DQOs.

23.2 Verification

23.2.1 Continuously Monitored Data

After the previous month of data is available, the level 1 and 2 reviewers conduct a thorough review of the data for completeness and accuracy. Once the database manager enters the data into the Envista ARM database, the RRO monitoring technician will review the data for routine data outliers and conformance to acceptance criteria. The RRO monitoring technician will void or flag appropriately unacceptable or questionable data. The RRO coordinator will verify all voided and flagged data again to ensure that the RRO monitoring technician entered the values correctly and that the data are acceptable for use. Level 1 and 2 reviewers document their review in Envista ARM along with their data review decisions.

23.2.2 Intermittently Collected Data

Verification of intermittent PM data can be characterized into two parts, field data verification and lab data verification. The field data verification occurs after each sample is collected and each batch of laboratory data becomes available. The level 1 and level 2 reviewers conduct a thorough review of the data for completeness and accuracy. The RRO regional monitoring technicians will review the data for routine data outliers and conformance to acceptance criteria. They will void or flag appropriately unacceptable or questionable data. The RRO coordinator will verify all flagged data again to ensure the regional monitoring technicians entered the flags and voids correctly and that the data are acceptable for use. The level 1 and 2 reviewers document their review in e-logs along with their data review decisions (SOP DAQ-11-001.2).

The lab data verification occurs after each batch of laboratory data becomes available. Level 1 and 2 reviewers conduct a thorough review of the data for completeness and accuracy. Prior to submitting lab data to DAQ, the RTI lab will review the data for routine data outliers and conformance to acceptance criteria. The RTI lab submits the data package to DAQ, where the DAQ LAB environmental specialist verifies the lab data to ensure the flags and voids are correct and that the data are acceptable for use (See Checklist DAQ-16-018.4 R0). Afterwards, the DAQ LAB environmental specialist or RCO PM FRM chemist copies and pastes the data into four separate spreadsheets, or uses a macro when one is available, to transform the excel data file from RTI so that the filter weight data will automatically be uploaded into IBEAM. The PM data streams from the field and lab are merged, concentrations calculated, and data are stored in IBEAM. The level 1 reviewer documents his or her review in the data package and the level 2 reviewer documents his or her review in the RTI Data Package Checklist DAQ-16- 018.4.

23.3 Validation

Validation of continuously obtained measurement data requires two stages, one at the measurement value level and another after the previous month of data becomes available. The Envista ARM database retains records of all invalid data. Information shall include a summary of why the level 1 to 3 reviewers invalidated the measurement along with the associated void codes. Logbook notes and

field data sheets shall have more detailed information regarding the reason a reviewer voided or flagged a measurement.

The DAQ brackets all gaseous pollutant data by one-point-QC checks or manual calibration checks before and after any invalidated period. This requirement ensures that the gaseous monitors were in proper operating condition before and after the incident. When a monitor fails, the level 1, 2 and 3 reviewers invalidate any data after the last passing 1-point-QC check. The requirement to bracket the data helps to ensure that the gaseous monitors were in proper operating condition before and after the incident. In the same way, the DAQ brackets PM data by flow rate verifications or a calibration before and after any invalidated period.

Data validation occurs monthly for continuously collected data and quarterly for intermittently collected data. DAQ does not use EPA's Data Assessment Statistical Calculator (DASC) tool to evaluate the data. The discussion below outlines the review, verification, and validation processes. The organizational chart in Figure 4.1 labels the specific roles for review level 1 through 3 within the organization.

23.2.1 Continuous Data Review, Verification and Validation Process

Level 0 Review – The Envidas Ultimate DAS does the level 0 review.

- Acquire minute averages from instantaneous data and five-minute averages and hourly averages from minute averages.
- Flag missing and irregular data with preprogrammed, user-defined status flags.

Level 1 Review – The RRO monitoring technician does the level 1 review.

- Review daily for anomalies and completeness and acquire missing data if available.
- Verify that all daily precision checks fall within acceptable ranges.
- Invalidate data collected during an hour where the shelter temperature was not within the acceptable range.
- Evaluate automated nightly zero/precision/span checks and take appropriate corrective action if necessary.
- Review minute data as needed when completing the level 1 review procedures for outliers and to ensure it is complete.
- Verify maximum daily values for validity and take appropriate action if necessary.
- Review the hourly values for any exceedances and take appropriate action if necessary.
- Assess data for values or outliers outside of the acceptable ranges.
- Flag data as necessary for further investigation.
- Apply necessary AQS codes from Table 22.1 for hours in which maintenance or calibrations were occurring.

Level 2 Review (Verification) – The RRO monitoring coordinator does the level 2 review.

- Review site records (RRO operator logbook, site data sheets).
- Review operator checks (leak checks, filter changes, monthly flow verifications, very sharp cut cyclone or VSCC cleaning, maintenance).
- Assess data for values or outliers outside of the acceptable ranges.
- Review minute data as needed when completing the level 2 review procedures.

- Compare pollutant data with wind direction data.
- Determine if mobile or area source-specific emissions caused any irregularities.
- Flag data as necessary for further investigation.
- Ensure level 1 reviewers used consistent reasons for data invalidation throughout the monitoring period to indicate calibrations, audits, etc.
- Resolve any inconsistencies, anomalies or systemic issues.
- Verify that all daily precision checks fall within acceptable ranges.

Level 3 Review (Validation) – The RCO chemist does the level 3 review.

- Ensure the proper null codes are used.
- Ensure the level 1 and 2 reviewers bracketed all invalidated data with the appropriate void codes and the correct checks of analyzer accuracy.
- Confirm appropriate e-log entries or other documentation exist for all invalidated data.
- Ensure only valid 5-minute maximum values for SO_2 are reported and only for valid 5-minute averages and valid 1-hour averages.
- Ensure all data falls within the acceptable ranges as stated in the MQOs in Tables 7.2 to 7.8.
- Ensure all data are acceptable and can be used for the intended purpose.
- Review the hourly values for CO, NO_y, SO_2, NO_2, O_3 and PM for any unusually high values and hourly CO, NO_2, SO_2 and O_3, 8-hour CO and O_3 and 24-hour PM averages for exceedances and take appropriate action if necessary.
- Review minute data to confirm that 45 minutes of data are available within an hour.
- Add informational AQS flags (from Table 22.1) to describe data that is out of the ordinary but may be considered "valid."
- Provide final validation signature.

23.3.2 Intermittent Data Review, Verification and Validation Process

<u>Field Data</u>

Level 0 Review - The 2025i FRM sampler does the level 0 review:

- Acquire 5-minute-data (interval data), 30-minute data (user data) and collection period or 24- hour data (filter data); and
- Data from the FRM sampler will provide status codes when pre-programed specifications have been exceeded.

Level 1 Review - The RRO monitoring technician does the level 1 review for DAQ:

- Examine (filter data) start date, start time, end time, average flow, CV, volume, max temperature differential, filter damage, and status codes for each sample during each site visit;
- Ensure that the filter IDs match the appropriate sample run date; and
- Update the e-log with any pertinent information regarding each sample.
- Check the Level 0 review and investigate any flags or non-conformities.
- Download the interval, user and filter data and ensure the files are downloaded properly.

Level 2 Review (Verification) - The RRO monitoring coordinator does the level 2 review:

- Verify that the filter, interval and user files have been downloaded and properly archived;

- Verify that each filter record downloaded in the filter file meets the criteria listed in Table 7.6 of this QAPP;
- Verify the Site ID in the filter file matches that of the site;
- Verify filter ID in the filter file matches that of the e-log;
- Verify all sample or sampler issues in the filter file are clearly documented in the e-log;
- Verify all sample dates are accounted for per the EPA sampling calendar;
- Review the interval file as necessary to validate any questionable data in the filter file;
- Review all e-logs for completeness, verifications, audits, calibrations, and sampler problems; and
- Upload reviewed filter files to the IBEAM database.

Level 3 Review (Validation) - The RCO chemist does the level 3 review.

- Complete the DAQ-16-020.5 FRM data validation as described in Section 2.63.4.4 of SOP 2.63.4 Validation of Particulate Matter, which covers the following:
    - Performing a completeness review.
    - Reviewing the data for routine data outliers and conformance to acceptance criteria.
    - Voiding unacceptable data and flagging questionable data.
    - Ensuring all sample dates are accounted for per the EPA sampling calendar and a record for every run date, including field filter and trip filter blanks.
    - Reconciling the filter data in the e-logs to the filter data in IBEAM.
    - Reviewing lab data and field data in IBEAM.
    - Reviewing all e-logs for completeness, verifications, audits, calibrations, and sampler problems.
    - Ensuring all data falls within the acceptable ranges as stated in the MQOs in Table 7.6 of this QAPP.
    - Ensuring all data are acceptable and can be used for its intended purpose.
    - Reviewing downloaded monitor data as needed when completing the level 3 review procedures.
    - Preparing data for AQS including qualifier codes, QA files, etc.
    - Recording comment/notes on the FRM Site Validation Checklist (DAQ-16-020.5).
    - Providing final validation signature.

<u>Lab Data</u>

Level 1 Review - The RTI lab does the level 1 review.

The RTI lab is responsible for supplying gravimetric PM data that has been approved by a Level 1 reviewer.

Note: RTI has an internal verification and validation process they must undergo prior to submitting each data package. The measures used by the Level 1 reviewer are equal to the measures listed in Table 7.6: Laboratory Activities of this QAPP. The data that have not passed the validation criteria in Table 7.6 must have an associated qualifier or null flag with an explanatory note included in the data package.

Level 2 Review (Verification) - The DAQ lab environmental specialist does the level 2 review.

Complete the RTI Data Package Checklist (DAQ-16-018.4 Revision 0), which covers the following:

- o Checking the data package for completeness.
- o Verifying COC forms.
- o Verifying the PM receiving log.
- o Verifying laboratory activities requirements are met as listed on Table 7.6 of this QAPP.
- o Reviewing the filter inventory inspection form.
- o Reviewing the shipping log.
- o Recording comment/notes on the RTI Data Package Checklist.
- o Providing final validation signature.

Level 3 Review (Validation) - The RCO chemist does the level 3 review.

- Complete the FRM validation checklist (DAQ-16-020.5) as described in Section 2.63.4.4 of SOP 2.63.4 Validation of Particulate Matter, which covers the following:

  - o Performing a completeness review.
  - o Reviewing the data for routine data outliers and conformance to acceptance criteria.
  - o Voiding unacceptable data and flagging questionable data.
  - o Ensuring all sample dates are accounted for per the EPA sampling calendar and a record exists for every run date, including field filter and trip filter blanks.
  - o Reconciling the filter data in the e-logs to the filter data in IBEAM.
  - o Reviewing lab data and field data in IBEAM.
  - o Reviewing all e-logs for completeness, verifications, audits, calibrations, and sampler problems.
  - o Ensuring all data falls within the acceptable ranges as stated in the MQOs in Table 7.6 of this QAPP.
  - o Ensuring all data are acceptable and can be used for its intended purpose.
  - o Reviewing downloaded monitor data as needed when completing the level 3 review procedures.
  - o Preparing data for AQS including qualifier codes, QA files, etc.
  - o Recording comment/notes on the FRM Validation Checklist.
  - o Providing final validation signature

The DAQ uses a weight of evidence approach in validating data. After level 1 and 2 verifications, the independent level 3 reviewer determines the validity of the data by reviewing:

- The one-minute, 5-minute maximum (for SO_2 only) and hourly values;
- Daily automatic and 14-day 1-point-QC checks, flow verifications and any additional manual checks;
- Leak checks after in-line PM filter and probe changes;
- e-logs and the information documented therein;
- Correspondence with the RRO monitoring technicians and coordinator and ECB electronics technicians; and
- The results of DAQ and EPA performance evaluations and semimonthly flow rate audits.

The level 3 reviewer compares all the available information to the specifications in Tables 7.2 through 7.11. The weight the reviewer should give to the available evidence depends on factors such as the quality of the data, consistency of results, nature and severity of effects and relevance of the information. The weight of evidence approach requires use of scientific judgment and, therefore, it is essential for the RRO monitoring technicians to provide adequate and reliable documentation.

As a general principle, the more information the RRO monitoring technician provides, the stronger the weight of evidence is. The RRO monitoring technician should present the information in a structured and organized way and the data validator should consider the robustness and reliability of the different data sources to support any justification for validating or invalidating data.

The Envidas Ultimate software completes the level 0 review daily. The RRO monitoring technician and coordinator will complete the level 1 and 2 reviews within 20 calendar days from the end of the monitoring month (for example, the month ends on February 28; the Level 1 and 2 reviews must be complete by March 20). The RCO chemist will complete the level 3 review 20 calendar days after the level 2 review is completed. An independent RCO chemist will complete a review of the validated data after the database manager uploads it to AQS within 40 calendar days after the level 3 review is completed. (Using the prior example, the Level 3 review must be complete by April 10.) When the level 3 reviewers sign off on the data in Envista ARM, their signature indicates the files are accurate and ready for the database manager to upload to AQS.

As discussed earlier, the EPA and DAQ have developed certain criteria based upon federal requirements and field operator judgment that the level 1 to 3 reviewers will use to invalidate a sample or measurement. The level 1 to 3 reviewers shall use the null data codes listed in Table 22.1 to indicate they have invalidated individual measurements or groups of measurements from an instrument.

24.0 Reconciliation with Data Quality Objectives

Section 5.0 Problem Definition and Background describes the objectives of this NCore monitoring program. Section 7.0 Quality Objectives and Criteria for Measurement Data describes the DQO's for the NCore monitoring project.

The AQS AMP256 and AMP600 reports are automated reports based on data uploaded to AQS. These reports provide summary statistics for the data collected. Because the DAQ uses warning limits that are more stringent than EPA's control limits for its data and implements EPA's critical criteria for all monitoring, DAQ should not have to directly calculate confidence intervals annually because all data should statistically meet the DQOs.

To review the results of required statistical analyses codified in 40 CFR Part 58, Appendix A, Section 4, an RCO audit chemist on behalf of the chief will analyze the results of both the AQS AMP256 and AMP600 reports on a quarterly (Section 20.5 Quarterly Completeness Assessment) and annual basis to ensure all monitors meet the required DQOs. This RCO chemist documents the review by archiving the AMP256 and AMP600 reports in the Laserfiche Ambient Monitoring Module. Annual evaluation of measurement uncertainty will occur in conjunction with annual data certification (Section 20.6 Annual Data Certifications) which is to be completed by May 1 of each year. The evaluation will be conducted by the chief. 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 (Tables 7.2 – 7.8). If the data from any of the monitors violates the DQI bias and/or precision limits, then the RCO audit chemist will investigate to uncover the cause of the violation. Depending on the severity of the violation and weight of evidence, the level 3 reviewer will either void or flag the data in AQS. If all the monitors in the DAQ network of a similar type or pollutant violate the DQO, the cause may be at the agency level (operator training) or higher (problems with method designation). If only the monitor at the NCore site violates the DQO, the cause is specific to the site (RRO site operator, problem with the site). Tools for determining the cause include reviewing:

- Data from other DAQ monitors in or near Raleigh, North Carolina, a local or tribal program or nearby reporting organizations;
- Data from performance audits (DAQ, PEP or NPAP); and
- QC trends.

Once DAQ has identified a cause, the chief will implement an appropriate corrective action. Some courses of action include:

- Determining the level of aggregation at which DAQ violated the DQOs: Results of the DQA process tells which monitors are having problems, since the EPA developed the DQOs at the monitor level. To determine the level at which to take corrective action, DAQ must determine whether the violations of the DQOs are unique to one site, multiple sites or a network of similar monitors or if a broader problem caused them. The AQS generates QA reports summarizing bias and precision statistics at the national and reporting organization levels by method designation. Examination of these reports may assist in determining the level at which the DQOs are being violated.
- Communicating with EPA Region 4: If the DAQ finds a violation of the bias and precision DQOs, the chief will remain in close contact with EPA for both assistance and for communication.

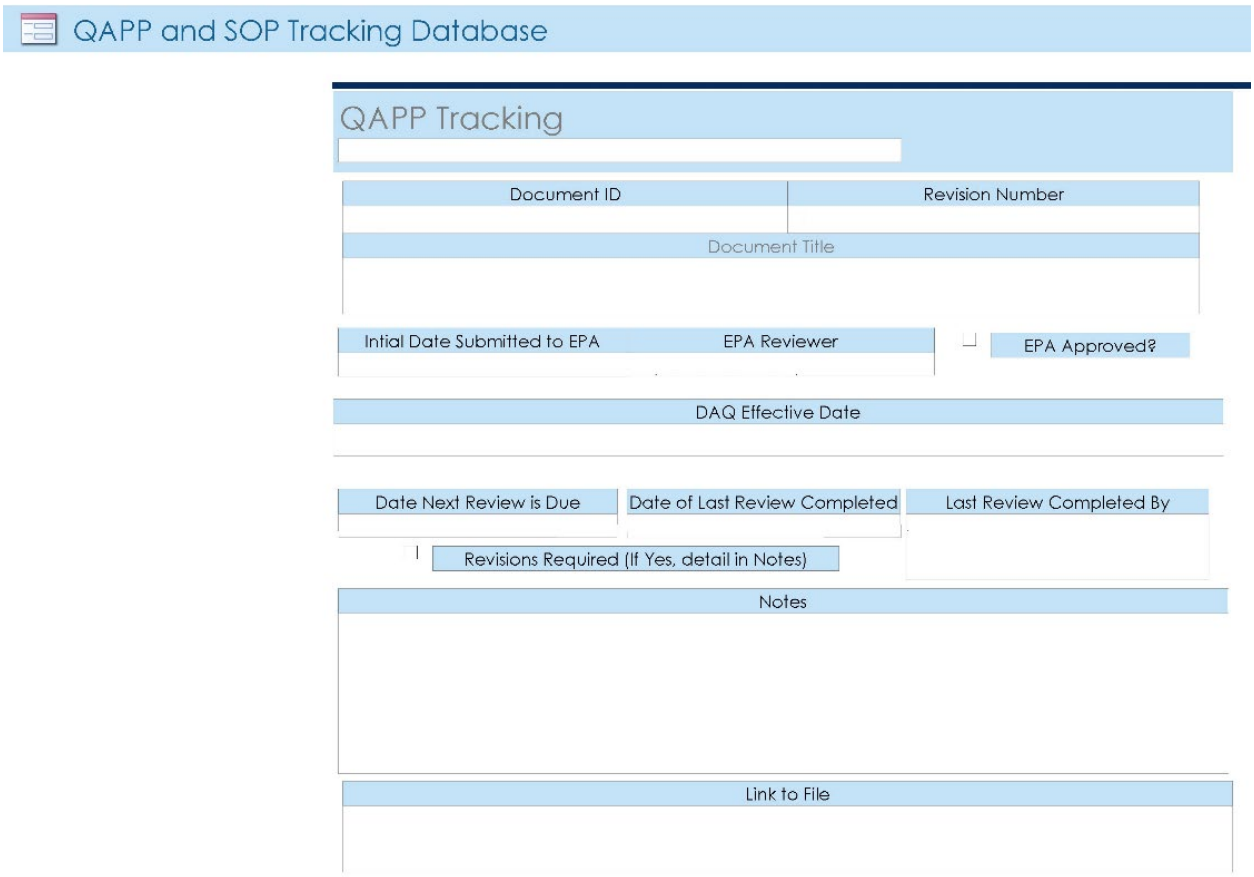
- Routinely reviewing control charts, daily, every other week or monthly, to ensure DAQ achieves the DQOs: The RCO chemists will continue to review extensively the control charts for the monitors until the DAQ attains the bias and precision limits.
- Reviewing quarterly data: Quarterly QA reports address each monitor's progress toward meeting established DQOs. If a deviation from established goals is noted, a corrective action plan is formulated and enacted at that time. The monitor in question, or if systematic, the entire suite of monitors in the DAQ program, is/are thereafter evaluated on a regular basis to determine if the corrective actions have been successful or if additional measures are necessary. The continuing evaluations will include the review of all available DQIs including daily or 14-day QC checks, daily site and monitor electronic readouts, including instrument diagnostic data, additional site audits and increased operator site visits. The evaluations continue until DQOs for bias and precision are brought back within norms. Prior to any decision to shut down a monitor, data from the site is first reviewed to ensure that all DQOs have been met. If DQOs have not been met, the monitor will continue in operation until the required goals have been achieved.
- Updating QAPPs, SOPs and MQOs: When necessary to eliminate future problems, the chief will direct the RCO chemists to update the QAPP, its associated SOPs and the MQOs for the project. Should staff not be readily available to make these updates in a timely fashion, the chief or PPB supervisor will assign staff to make a QA Bulletin addressing the change until such time that the documents associated with this QAPP can be updated.
- Adding additional monitoring stations: If the DQOs indicate a need for additional monitoring stations, the chief will work with the director and regional monitoring coordinator to determine the number of additional stations needed and their location.

Ultimately specifying tolerable error limits reduces the probability of making an error in a decision due to uncertainty in the data. Decision makers, such as the EPA administer and director, need to determine if the data collected within the DAQ NCore 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 DAQ criteria pollutant data set. By controlling uncertainty in the data to the extent prescribed by the DQOs, decision makers can use DAQ's NCore ambient air monitoring data with confidence.

Revision History

Date	Item
Nov. 25, 2020	The QAPP was updated to follow EPA's August 2018 guidance document: Guide to Writing Quality Assurance Project Plans for Ambient Air Monitoring Networks; EPA-454/B-18-006, August 2018.
Nov. 25, 2020	The QAPP was also updated to include EPA's new validation templates and new QA guidance.
Nov. 25, 2020	The QAPP was also updated to remove PM_{10} Pb and $PM_{10-2.5}$ speciation requirements which were removed from the list of NCore requirements in March 2016.
Nov. 25, 2020	The QAPP was also updated to add NO_2 monitoring.
Nov. 25, 2020	Other updates in the QAPP include a new data acquisition system, agency reorganization and new distribution of responsibilities, changes to how data are verified and validated, and different QC criteria for some pollutants.
March 15, 2023	Updated addressee and acronym list. Updated Table 3.1 (the distribution list). Hyperlinks were updated. Minor grammatical and editorial changes were made throughout the document. References to SOP IDs were updated to the new SOP IDs. Changed IBEAM to Laserfiche as storage location for electronic documents. Tables 7.2 through 7.5 and 7.7 were revised to correct for differences from the EPA validation template or DAQ practice. Table 7.8 was revised to update the shelter temperature requirements and to match the EPA validation table for the T640X. Sections 8, 9, 19, 20, 21 and 23 were revised to be accordant with current DAQ policies and procedures. Table 11.2 was revised to list the most current SOPs. Table 14.1 and Section 14.1 were updated with new calibration information for CO. Table 22.1 was updated to add the new qualifier and null data codes.
March 15, 2023	The organizational structure was updated to show the closing of the on-site laboratory and its replacement with the RTI Laboratory. Responsibilities for the DAQ LAB personnel were changed based on new needs due to replacing the on-site lab with the RTI lab. Section 6.3 Laboratory Activities was updated for transition to the RTI lab. Table 7.6 was revised to remove DAQ goals and replace references to DAQ documents to references to RTI documents. Section 9 was revised to add information about RTI documents and records. Sections 12, 13, 19.2, 22.3, 22.5, 22.7, 23.2.2 and 23.3.2 were updated for the transition to the RTI Laboratory. Section 14 was updated to include RTI QC. Section 15.2.1, 15.3, 16.3 and 16.5 were updated to include RTI procedures. Sections 20 and 21 were updated to add RTI TSAs. Section 21 was updated to add RTI corrective action reports.

QAPP Annual Review Documentation



Document ID	DAQ-01-001
Name of Document:	NCore Monitoring Program
Revision Number:	
Effective Date:	

#	Date of Review	Review Completed By
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Appendix A RTI QAPP for the Microgravimetric Weighing of Particulate Filters (revision 16)

Grav QAPP 2023 Version 16 March 2022.pdf

Appendix B RTI SOP for PM Sample Receipt & Log-in Revision 9 Date: March 29, 2022

RTI SOP for PM Sample Receipt and Log-in 2022 Version.pdf

Appendix C RTI SOP for PM Gravimetric Analysis Revision 15 Date: March 29, 2022

RTI SOP for PM Gravimetric Analysis 2022 Version.pdf

Appendix D RTI SOP for PM Chain of Custody Revision 8 Date: March 29, 2022

RTI SOP for PM Chain of Custody 2022 Version.pdf

Appendix E DAQ Instructions and Checklists for review of RTI PM Data Packages

https://deq.nc.gov/media/20850/open

Appendix F Sample RTI Data Package

RTI Example Data Package