UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4

Laboratory Services and Applied Science Division
Quality Assurance and Program Services Branch
980 College Station Road
Athens, Georgia 30605-2720

February 5, 2021

Mr. Patrick Butler
North Carolina Department of Environmental Quality
Division of Air Quality (DAQ)
Green Square Office Complex
217 West Jones Street
Raleigh, NC 27699-1641

SESD Project Number: 19-0186

Mr. Butler:

We have reviewed the following document submitted for approval:

Quality Assurance Project Plan (QAPP) for the North Carolina Division of Air Quality NCore Monitoring Program, Revision 1, January 26, 2021.

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. In multiple sections, the QAPP indicates that the agency's quality system and/or technical monitoring procedures are currently being revised or restructured and that the QAPP will be revised and resubmitted to EPA once those changes are finalized. Therefore, EPA approval of this document is conditionally granted. Please be aware that conditional approval of this QAPP does not constitute a waiver from any regulatory requirements. Your agency remains accountable for ensuring that the NCore monitoring project adheres to all the applicable requirements detailed in 40 CFR Parts 50, 53, and 58, and that the data generated is of sufficient quality to be used for its intended purposes. Conditional approval of the QAPP is granted for 2 years from the date of this letter; the QAPP must be revised and resubmitted to EPA by February 2023.

If you have any questions, please contact Stephanie McCarthy at 706-355-8745 or via email at mccarthy.stephanie@epa.gov.

Sincerely,

LAURA ACKERMAN

Digitally signed by LAURA ACKERMAN
Date: 2021.02.05 12:57:42 -05'00'

Laura Ackerman, Chief
Quality Assurance Section

Enclosure

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
MICHAEL A. ABRACZINSKAS
Director

NORTH CAROLINA
Environmental Quality

QUALITY ASSURANCE PROJECT PLAN
FOR THE NORTH CAROLINA DIVISION OF AIR QUALITY
NCORE
MONITORING PROGRAM

Revision 1

Prepared for:

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EPA Region IV Director, Air and Radiation Division
U. S. Environmental Protection Agency
Region IV
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Submitted by:

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North Carolina Department of Environmental Quality
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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
AMTIC – Ambient Monitoring Technology Information Center
AQI – Air Quality Index
AQS - Air Quality System (EPA's Air database)
ARM – Air Resources Manager
ASC – Aerosol Sample Conditioner
ASTM – American Society for Testing and Materials
AT – Ambient temperature
BAM – Beta attenuation monitor
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
CSN – Chemical Speciation Network
CV – Coefficient of variation
DAQ – North Carolina Division of Air Quality
DAS – Data Acquisition System
° 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
FTP – File Transfer Protocol
FTS – Flow Transfer Standard
HEPA – High-efficiency particulate air
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
NCore- National Ambient Air Monitoring Strategy - National Core Monitoring
NIST – National Institute of Standards and Technology
NO – Nitric oxide
NO_2 – Nitrogen dioxide
NO_x – Oxides of nitrogen (NO plus NO_2)
NO_y – reactive oxides of nitrogen
NPAP – National Performance Audit Program
O_3 – ozone
OSHA – Occupational Safety and Health Administration
Pb – lead
PDF – portable document format
PEP – Performance evaluation program
PFA – Perfluoroalkoxy
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
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
SLAMS – State and Local Air Monitoring Station
SO_2 – Sulfur dioxide
SOP – Standard Operating Procedure
SPM – Special Purpose Monitor
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
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 1*

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 D5013FED0218423... Date 1/29/2021
Air Quality Division Director

2) Signature: DocuSigned by: Patrick Butler 4290A7E2D2A0429... Date 1/29/2021
Quality Assurance Manager
(Ambient Monitoring Section Chief)

3) Signature: DocuSigned by: Jim Bowyer C96894826C9B41D... Date 1/29/2021
Laboratory Analysis Branch Supervisor

4) Signature: DocuSigned by: B278F8186CEC4DC... Date 1/26/2021
Projects and Procedures Branch Supervisor

5) Signature: DocuSigned by: Kay Roberts BE4009EE242941D... Date 1/26/2021
Primary QAPP Author

6) Signature: LAURA ACKERMAN Digitally signed by LAURA ACKERMAN Date: 2021.02.05 12:58:51 -05'00' Date
EPA Region 4 Designated Approving Official

2.0 Table of Contents

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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, analyst and chemist,
- The Raleigh Central Office, or RCO, chemists and statistician; and
- Any other personnel involved with this project.

The Ambient Monitoring Section 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/Title	Address	Telephone/e-mail
Michael Abraczinskas, Director	Division of Air Quality 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8447 michael.abraczinskas@ncdenr.gov
Patrick Butler, Ambient Monitoring Section Chief and Quality Assurance Manager	DAQ, Ambient Monitoring Section 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8719 patrick.butler@ncdenr.gov
Taylor Hartsfield, Acting Raleigh Regional Office Air Quality Supervisor	DAQ, Raleigh Regional Office 3800 Barrett Drive Raleigh, NC 27609	(919) 791-4200 taylor.hartsfield@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, Ambient Monitoring Section 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/Title	Address	Telephone/e-mail
Ryan Brown, EPA Region 4 North Carolina State Contact	U.S. Environmental Protection Agency, Region 4 Air and Radiation Division 61 Forsyth Street, SW Atlanta, GA 30303	(404) 562-9147 Brown.Ryan@epa.gov
Laura Ackerman, Quality Assurance Section Chief	U.S. Environmental Protection Agency, Region 4 Laboratory Services and Applied Science Division 980 College Station Road Athens, GA 30605-2720	706-355-8776 Ackerman.laura@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 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 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 Ambient Monitoring Section into three main branches: The Projects and Procedures Branch, or PPB, the LAB and the 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 Ambient Monitoring Section shares the monitoring responsibilities with the RRO.

Figure 4.1 shows the organizational structure for the implementation of this monitoring program. The following information lists the specific responsibilities of each significant position within the DAQ Ambient Monitoring Section and RRO.

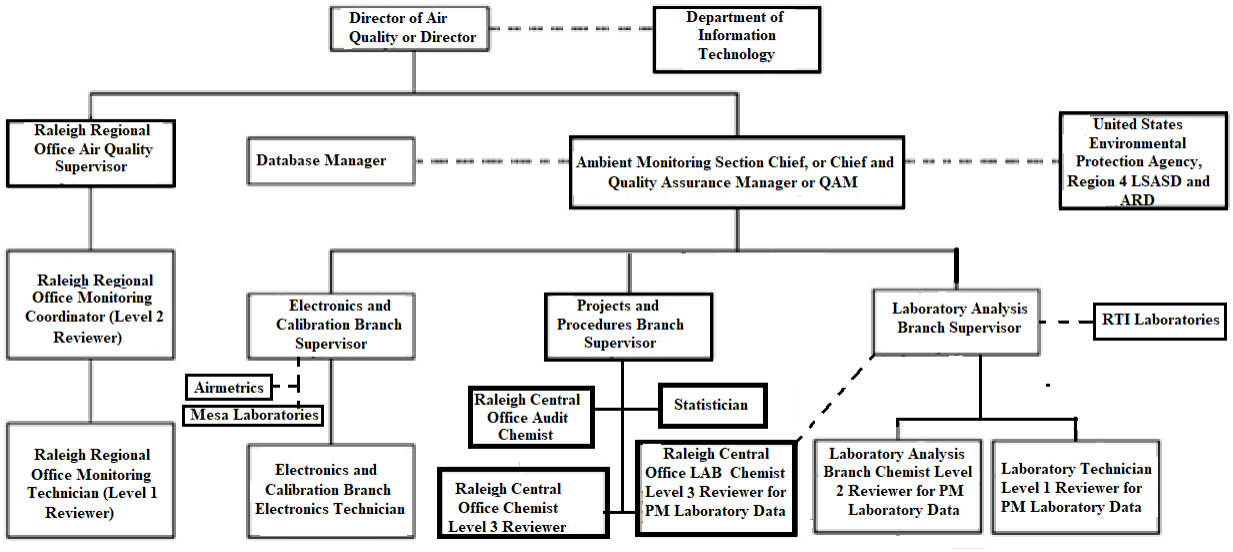


Figure 4.1 Project Organizational Chart

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. 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, the North Carolina Department of Information Technology or DIT and with other regional air-monitoring agency organizations.

4.2 Ambient Monitoring Section

The Ambient Monitoring Section 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 Ambient Monitoring Section 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 tie-breaker 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 DAQ's NCore ambient air monitoring

database management. 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 data for each hour of every day;
- Acting as the data-acquisition system manager for the DAQ NCore monitoring program;
- Ensuring correct data is 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
- 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 Ambient Monitoring Section 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: The RCO chemists report to the PPB supervisor and are responsible for coordinating the activities of the DAQ NCore monitoring program. The RCO chemist's duties include the following:

- Assessing the effectiveness of the network system;
- Writing and ensuring timely and appropriate SOP and QAPP updates;
- 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;
- Maintaining QA/QC records, flagging suspect data and assessing and reporting on data quality;

- Conducting quarterly completeness evaluations and audits of data quality;
- Participating in systems audits;
- Conducting internal systems audits, as needed;
- 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:

- Composing all PM weigh lab SOPs and ensuring timely and appropriate SOP updates;
- 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;
- Participating in systems audits;
- Providing training and certification to appropriate personnel;
- Identifying data quality problems and initiating actions that result in solutions; and
- 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 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 quality assurance/quality control (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;
- Participating in systems audits;
- Conducting internal systems audits, as needed;
- Identifying data quality problems and initiating actions that result in solutions;
- Providing training and certification to appropriate personnel; and
- Performing other duties as assigned.

RCO Statistician: The statistician 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;
- Planning and conducting data quality assessments, or DQAs, based on interpretation of data;
- 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;
- Uploading data to AQS; and
- 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 analyst operating the particle filter-weighing laboratory and the LAB chemist 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;
- Maintaining oversight of all PM laboratory activities, including corrective actions and their effectiveness;
- Directing the activities of the DAQ PM Laboratory Staff;
- Approving all SOPs and QAPPs for the PM monitoring laboratory and verifying their implementation;
- Acting as the liaison to RTI Laboratories if and when PM media and analysis is outsourced;
- Preparing budgets, contracts, and proposals;
- Ordering supplies and consumables when needed, procuring equipment for the PM lab;
- Participating in systems audits;
- Ensuring training availability and utilization for the DAQ PM Laboratory Staff; and
- Other duties as assigned.

Laboratory Analysis Branch Technician: The LAB technician, also referred to as chemistry technician in Figure 4.1 or lab analyst in this QAPP, reports to the LAB supervisor. The laboratory technician's duties include the following:

- Preparing, shipping, receiving, weighing and tracking all sequential PM air sampling media;
- Writing all PM laboratory SOPs and QAPPs and ensuring timely and appropriate SOP and QAPP updates;
- Performing all required laboratory QC;
- As the Level 1 data reviewer, maintaining QA records, flagging suspect data and/or samples and verifying laboratory data quality;

- As the Level 1 data reviewer, verifying the weigh sessions data, ensuring the lab method has been followed appropriately;
- Maintaining the PM laboratory's weighing database including periodic functional testing of the spreadsheets used;
- Retaining the filter data sheets and chain of custody, or COC;
- Tracking inventory and ordering supplies and consumables when needed, procuring equipment for the PM lab;
- Participating in systems audits;
- Ensuring the implementation of laboratory SOPs and sections of QAPPs as they pertain to filter processing and sample analysis;
- Serving as the sample custodian for all filter samples;
- Performing and documenting all maintenance of laboratory equipment;
- Identifying laboratory quality problems and initiating corrective action which results in solutions; and
- Performing other tasks as assigned.

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

- Verifying data by serving as the level 2 reviewer for the PM laboratory;
- Verifying that all required QA and quality control, or QA/QC, activities are performed and that measurement quality standards are met for the PM laboratory;
- Reviewing and verifying the PM laboratory's weighing database including the periodic functional testing of the spreadsheets used;
- 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 Laboratories: RTI Laboratories communicates with the LAB Supervisor. In the case of a failure of the DAQ PM laboratory (such as laboratory closure, equipment failure, fire or natural disaster), RTI will be contracted to provide PM filter media and analysis for the DAQ PM monitoring program.

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 PM monitoring. The ECB supervisor has the responsibility and authority to:

- Identify quality problems and initiate corrective action which results in solutions;
- Schedule and document audits 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 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 and certifying 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 annual 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-08-001.1, 2.7.1, 2.12.1, 2.17.1, 2.24.1, 2.34.1, 2.36.1, 2.37.1, 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 of 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 of 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 that 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; and
- Supervising and delineating duties for the RRO monitoring coordinator and technicians.

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 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
- 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;
- 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, 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 Ambient Monitoring Section; 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 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 director 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 Air and Radiation Division director 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 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 Clean Air Act 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 Clean Air Act 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 [NO2], 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
	Annual Arithmetic Mean	0.053 ppm (100 µg/m^3) [e]	Primary and Secondary	Annual Mean
Ozone (O_3)	8-hour average	0.070 ppm (205 µg/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 µg/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	Annual Arithmetic 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, O3, 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 a number of 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 will be replacing the photolytic NO_2 monitor at Millbrook with a CAPS monitor and adding 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 in particular 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. The DAQ is streamlining its documentation procedures for documenting annual QAPP and SOP review.

This DAQ NCore QAPP is the first revision to the original, base document, and is Revision 1. The original QAPP is available in IBEAM. 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 designed to achieve a high percentage of valid data samples (>75 percent) while maintaining integrity and accuracy. This QAPP clearly and thoroughly establishes QA protocols and QC criteria required to successfully implement and maintain the NCore 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. At some point before June 1, 2021, DAQ plans to replace 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
Nitric oxide	37-183-0014-42601-3	Millbrook, Raleigh, NC	RRO
Nitrogen dioxide	37-183-0014-42602-1	Millbrook, Raleigh, NC	RRO
Oxides of nitrogen	37-183-0014-42603-3	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
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	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
	37-183-0014-81102-5		
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

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 of 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/NO/NO_x, 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. 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, 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.

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.

6.3 Laboratory Activities

The DAQ PM Laboratory Staff will perform those activities that support continued successful operation of the statewide particulate monitoring network with the exception of filter-based fine particle speciation sampling, which is handled by a national contract laboratory and covered under a different QAPP. Additionally, where analysis of samples is required, the laboratory personnel shall perform those duties such that the data quality provided meets or exceeds EPA QA requirements. Laboratory personnel shall be responsible for preparing sequential filters for field use. This may include, but not be limited to:

- Scheduling, preparing, weighing, shipping and receiving, and archiving filters for particulate sampling;
- Preparing and analyzing control samples (e.g. trip blanks, field blanks and lab blanks);
- Maintaining consumable inventories;
- Maintaining COC and filter data sheet records;
- Conducting microbalance daily weight checks, quarterly weight checks and semi-annual weight checks;
- Maintaining temperature and humidity data records for the laboratory; and
- Periodic auditing the temperature and humidity data loggers, micro balance, weights and other laboratory equipment.

Currently, the RTI Laboratory serves as a backup laboratory. RTI will weigh filters for DAQ should an emergency arise such that the DAQ gravimetric laboratory is unable to operate for an extended period. However, DAQ is in the process of developing a contract to handle the routine weighing of all filters for its program. When that contract is in place, the DAQ will update and resubmit this QAPP.

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
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/maintenance records
Raw data	Any original data (routine and QC) including data entry forms
Data reporting	Air quality index reports Annual data certification Data/summary reports
Data management	Data algorithms Data management plans/flowcharts Data management systems
Quality assurance	Network reviews and assessments Control charts Data quality assessments EPA Technical system audit reports Internal systems audit reports Response/corrective action documentation Annual performance evaluation reports Certification documentation

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. Section The field manometers will have their own certification. The ECB re-verifies or recertifies them at least annually against the local primary pressure standard or auditor's transfer standard, to within 1 millimeters 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 discusses certification frequency of the mass flow controllers. The zero air unit maintenance schedule is discussed in Section 15.3.2 Inspections of Field Items. For more information on corrective actions when a routine zero check exceeds acceptance criteria see Section 14.2.1 One-Point QC Checks.

The EPA and DAQ use precision, bias, sensitivity, completeness, comparability and representativeness as the principle data quality indicators, or DQIs, that provide qualitative and quantitative descriptions 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 being sampled. 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 methodologies in the QAPP 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.

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

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 a decision error due to uncertainty in the data.

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),
- Oxides of nitrogen (NOx),
- 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 DAQ 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 (including NO and NO_x), 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;
- Locational measurements (geographical, topological, 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. 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
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.

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

- ***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 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 are included in the reference methods (40 CFR Part 50).
- ***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, DAQ developed acceptance criteria using various parts of 40 CFR Parts 50, 53 and 58 and EPA-supplied guidance documents. Tables 7.2 through 7.14 list the MQOs for North Carolina's NCore monitoring program. The DAQ 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, NO_2 and NO_x 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 7.14 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 making a determination about the validity of the sample or samples, i.e., operational criteria; and
- Criteria that indicate a potentially systematic problem with the environmental data collection activity that may impact the ability to make decisions with the data, i.e., systematic criteria.

For each criterion, the tables include: (1) the requirement, (2) the frequency with which compliance is to be evaluated, (3) the acceptance criteria and (4) information where the requirement can be found or additional guidance on the requirement.

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 DAQ defines warning limits as the level of allowable imprecision before a RRO monitoring technician must calibrate an analyzer or take other corrective action. The DAQ set the warning limits lower than the MQOs or control limits to reduce imprecision and bias and enhance data recovery.

The DAQ defines control limits as the level of allowable imprecision before data invalidation and corrective actions are required. The DAQ cannot set control limits higher than the MQOs. The DAQ uses these limits when validating ambient air measurements against single point precision checks. The use of control limits strengthens the precision of these measurements and improves the data validation practices to meet regulatory requirements. Tables 7.2 through 7.12 include both the warning and 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 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;
- 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 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 (NO_y)	**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			
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 ± 3 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
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
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 ±6 ppb 70 ppb must be 70 ±4 ppb 15 ppb must be 15.0 ±1.5 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) 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 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 ± 3 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 Multi-point calibration (0 and 4 upscale points) 40 CFR Part 50, Appendix D, section 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
Ozone Level 2 Standard			

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**
Certification/recertification to Standard Reference Photometer (Level 1)	1/365 days and 1/calendar year	single point difference ≤ ± 3.0 percent	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 ±1 ppb 120 ±1 ppb 65 ±1 ppb 50 ±1 ppb 0 ±1 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 ±1 ppb 120 ±1 ppb 65 ±1 ppb 50 ±1 ppb 0 ±1 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 (O_3) (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. Replacement or cleaning is suggested 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 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.) < ± 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 expected1-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 ≤ ± 0.045 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	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
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving Calibration 1/365 days / *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 ± 0.5	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) *Verification/Calibration procedures are being revised at the time of this QAPP revision)*
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)

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
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	1/365 days and 1/ calendar year	***≤ 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 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)
Sample Residence Time Verification	1/365 days and 1/ calendar year	< 20 seconds	1, 2, and 3) Recommendation. (See DAQ ECB CO 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 not a reactive gas but suggest following same methods as other gaseous criteria pollutants. FEP and PFA have been accepted 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

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
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			
Pre-sampling	***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 if value < 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 goal 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, 2.24 Fine Particles, Section 2, Operator Responsibilities 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, 2.24 Fine Particles, Section 2, Operator Responsibilities 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
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

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**
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
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			

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
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
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

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
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.
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	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12, Section 4.2.2 and Table 4-1

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
	calendar year		
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 $PM_{2.5}$ Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One BAM 1020, Local Conditions)

1) Criteria ($PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA - $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ Continuous, BAM 1020, Local Conditions			
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	1. Must be the firmware (or later version) as identified in the published method designation summary. 2. Firmware settings must be set for flowrate to operate and report at "local conditions" (i.e., not STP).	1, 2 and 3) 40 CFR Part 50, Appendix N, section 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 Instrument			
PM_{10} Inlet (for both PM_{10} and $PM_{2.5}$ monitors)	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, 2 and 3) 40 CFR Part 50, Appendix L, Figures L-2 through L-19
$PM_{2.5}$ second stage separator (for $PM_{2.5}$ monitor only)	At setup	Must be a BGI Incorporated Very Sharp Cut Cyclone (VSCC^{TM}) or Tisch TE-PM2.5C particle size separator.	1, 2 and 3) FRM/FEM method list
Average Flow Rate	every 24 hours of operation, each hour can be checked	average within ± 5 percent of 16.67 liters/minute at local conditions	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	1/30 days, separated by 14 days (DAQ's 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's warning limit goal for percent of transfer standard and flow design value is 3 and 4 percent respectively)	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 and 3.3.1 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 3.3.1, and *DAQ BAM 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
OPERATIONAL CRITERIA - $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ Continuous, BAM 1020, Local Conditions			
Routine Verifications			

Table 7.7 $PM_{2.5}$ Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One BAM 1020, Local Conditions)

1) Criteria ($PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
One-Point Temperature Verification	1/30 days	< ± 2.1 °C	1)) 40 CFR Part 50 Appendix L, Section 9.3 2) Method 2.12 Section 7.4.5 and Table 6-1 3) DAQ BAM SOP Section 4.1
Pressure Verification	1/30 days	< ± 10.1 millimeters mercury	1) 40 CFR Part 50 Appendix L, Section 9.3 2) DAQ BAM SOP Section 4.1 3) DAQ BAM SOP Section 4.1
Leak Check	every 30 days	< 1.0 LPM	1) 40 CFR Part 50 Appendix L, Section 7.4.6.1 2) Recommendation 3) DAQ BAM SOP Section 4.1
Annual Multi-Point Verifications and Calibrations			
Temperature Multi-point Verification or Calibration	On installation, then 1/365 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 6.4.4
Pressure Verification or Calibration	On installation, then 1/365 days and 1/calendar year	≤ ± 10.1 millimeters mercury	1) 40 CFR Part 50 Appendix L, Section 9.3 2 and 3) 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 Verification or 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 and Table 6-1 3) DAQ BAM SOP
Precision			
Collocated Samples	every 12 days for 15 percent of sites in the PQAO by method designation	CV < 10.1 percent of samples ≥ 3 µg/m^3	1) and 2) Part 58 App 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	Every 180 days and at time of flowrate audit (DAQ goal is 1/90 days)	< ± 2.1 °C	1, 2 and 3) Method 2.12 Section 11.2.2
Pressure Audit	Every 180 days and at time of flowrate audit (DAQ goal is 1/90 days)	< ±10.1 millimeters mercury	1, 2 and 3) Method 2.12 Section 11.2.3
Semi-Annual Flow Rate Audit	Twice a calendar year and 5 to 7 months apart (DAQ goals 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) 40 CFR Part 58, Appendix A, Section 3.2.2 and 3.3.3 2) 40 CFR Part 58, Appendix A, Section 3.2.2 and 3.3.3 and DAQ BAM SOP Section 5.0. 3) Method 2.12 Section 11.2.1 and DAQ BAM SOP Section 5.0

Table 7.7 $PM_{2.5}$ Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One BAM 1020, Local Conditions)

1) Criteria ($PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Shelter Temperature			
Temperature Range	At set-up	Per operator manual	
Temperature Control	Daily (hourly values)	< 2.1° C SD** over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Temperature Device Check	Every 180 calendar days and twice a calendar year	< ± 2.1° C	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Monitor Maintenance			
$PM_{2.5}$ Separator (VSCC) (for $PM_{2.5}$ only)	Every 30 days	Cleaned or changed	1,2 and 3) Method 2.12, Section 8.3.3
Inlet Cleaning	Every 30 days	Cleaned or changed	1,2 and 3) Method 2.12, Section 8.3
Downtube Cleaning	every 90 days	cleaned	1,2 and 3) Method 2.12 Section 8.4
Filter Housing Assembly Cleaning	Every 30 days	cleaned	1,2 and 3) Method 2.12, Section 8.3
Circulating Fan Filter Cleaning	Every 30 days	cleaned	1,2 and 3) Method 2.12, Section 8.3
Manufacturer-Recommended Maintenance	per manufacturers' operation manual	per manufacturers' operation manual	1, 2, and 3) Per operator manual
BAM Specific Operational Criteria			
Cleaning Nozzle and Vane (BAM)	Every 30 days or more often as needed	cleaned	1, 2 and 3) DAQ BAM SOP Section 6.0
Replace or Clean Pump Muffler	1/182 days and 2/calendar year	cleaned or changed	
Internal/External Data Logger Data (BAM)	Every month highest value on three randomly selected days	agree exactly (digital) and < ± 1 µg/m^3 (analog)	1) DAQ BAM SOP Section 8 2) DAQ practice 3) DAQ BAM SOP Section 8
Capstan shaft and pinch roller cleaning (BAM)	Every 30 days	cleaned	1, 2 and 3) DAQ BAM SOP Section 6.0
Smart Heater Test	1/30 days	heater turns on when forced off	1, 2 and 3) DAQ BAM SOP Section 6.0
BAM check of membrane span foil	Daily	Average < + 5.1 percent of ABS	1, 2 and 3) Per BAM 1020 operator manual
BAM electrical grounding	At setup	1. Ground the chassis of the BAM 2. Ground the downtube to the chassis	1, 2, and 3) Per operator manual

Table 7.7 $PM_{2.5}$ Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One BAM 1020, Local Conditions)

1) Criteria ($PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
		at the collar (i.e., with setscrews)	
Clean/replace internal filter	1/365 days and 1/calendar year		
48 to 72-Hour zero filter test	At installation and 1/365 days	Standard deviation of the data from a 48 to 72-hour zero test < 2.4 µg/m^3	1, 2 and 3) DAQ BAM SOP Section 5.0
SYSTEMATIC CRITERIA - $PM_{2.5}$ Continuous, BAM 1020, 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	24-hour averages	≥ 75 percent of hours in a day	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 4.2 (a) and (b)
	Annual standard ($PM_{2.5}$ only) 24-hour standard($PM_{2.5}$ only)	***≥ 75 percent of scheduled sampling days in each quarter***	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 4.2 (a) and (b)
Reporting Units	all hourly and 24-hour values	µg/m^3 at AT/pressure	1, 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b)
Rounding convention for data reported to AQS	all hourly averages	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 Design Value Calculation ($PM_{2.5}$ only)			
24-hour averages	all concentrations	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)
Annual 3-yr average	all concentrations	nearest 0.1 µg/m^3 (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Sec. 3 and 4
24-hour, 3-year average	all concentrations	nearest 1 µg/m^3 (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Sec. 3 and 4
Precision			
Single analyzer (collocated monitors)	1/91 days.	CV* < 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) Recommendation to provide early (quarterly) evaluation of achievement of DQOs.
Primary Quality Assurance Organization	Annual and 3 year estimates	90 percent confidence limit of CV* ≤ 10.0 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 and 2.3.1.1.
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 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 3.2.4, 4.2.5 and 2.3.1.1

Table 7.7 $PM_{2.5}$ Measurement Quality Objectives: $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ (Continuous Met One BAM 1020, Local Conditions)

1) Criteria ($PM_{2.5}$, PM_{10}, $PM_{10-2.5}$ LC)	2) Frequency	3) Acceptable Range	Information /Action
Recertification of Standard Verifications and Calibrations - All standards should have multi-point certifications against NIST-Traceable standards			
Flow Rate Transfer Standard	1/365 days and 1/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 Section 4.2.3 and 6.3.3 3) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2
Field Thermometer	1/365 days and 1/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 1/calendar year	± 1-millimeters mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Manometer	1/365 days and 1/calendar year	± 0.1 inches water resolution, ± 1.0 inch water accuracy	1, 2 and 3) Method 2.12, Table 4-1
Clock/timer Verification	1/30 days	± 1 minute/month	1and 2) Method 2.12 Table 8-1 3) 40 CFR Part 50 Appendix L Section 7.4.12
***CV= Coefficient of Variation **SD = Standard Deviation AT = ambient temperature**			

Table 7.8 PM_{10} Measurement Quality Objectives: PM_{10} (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)

1) Criteria (PM_{10} STP)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA - PM_{10} Continuous, BAM 1020, 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	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 STP***.	1, 2 and 3) 40 CFR Part 50, Appendix J, Section 2.2
Data Reporting Period	Report every hour	1. For the BAM 1020 bases the calculation of a valid hour of data on the collection of 42 valid minutes of data per hour. 2. A 24-hour period is calculated in AQS if 18 or more valid hours are reported for a day	1 and 2) 40 CFR Part 50 Appendix N, Section 3 (c) 3) See BAM 1020 operator's manual and 40 CFR Part 50 Appendix N, Section 3 (c) Hourly data are always reported as the start of the hour on local standard time
Sampling Instrument			
PM10 Inlet	At setup	Must be a Louvered PM10 size selective inlet as specified in 40 CFR Part 50, Appendix L, Figures L-2 through L-19	1, 2 and 3) 40 CFR Part 50, Appendix L, Figures L-2 through L-19
Average Flow Rate	every 24 hours of operation, each hour can be checked	average within ± 5 percent of 16.67 LPM at local conditions	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
Verification/Calibration			
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 (DAQ's warning limit goal is ≤± 3 percent of transfer standard) < ± 5.1 percent of flow rate design value (DAQ's warning limit goal is ≤± 4 percent of flow rate design value)	1 and 2) 40 CFR Part 58, Appendix A, Section 3.3.1 and *DAQ BAM SOP*, Section 7.0 3) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1 and *DAQ BAM SOP*, Section 7.0

Table 7.8 PM_{10} Measurement Quality Objectives: PM_{10} (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)			
1) Criteria (PM_{10} STP)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Design Flow Rate Adjustment	***after multi-point calibration or verification***	***< ± 2.1 percent of design flow rate***	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.6
OPERATIONAL CRITERIA - PM_{10} Continuous, BAM 1020, STP			
Annual Multi-Point Calibrations and Verifications			
Tape/Sample Stream Temperature Multipoint Verification or Calibration	On installation, electromechanical maintenance or transport or 1/365 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 6.4.4
One-point Pressure Verification or Calibration	On installation, electromechanical maintenance or transport or 1/365 days and 1/calendar year	< ± 10.1 millimeters mercury	1) 40 CFR Part 50 Appendix L, Section 9.3 2 and 3) 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 Verification or Calibration	On installation, electromechanical maintenance or transport or 1/365 days and 1/calendar year	<±10.1 % of design value (DAQ goal is <± 2.1 percent of transfer standard)	1) 40 CFR Part 50 App J Sec. 8.0 2 and 3) Method 2.10 Sec. 2.2.4
Routine One-point Verifications			
Leak Check	1/30 days	< 1.0 LPM	1) 40 CFR Part 50 Appendix L, Section 7.4.6.1 2) DAQ BAM SOP Section 4.1 3) DAQ BAM SOP Section 4.1
One-point Temperature Verification	1/30 days	< ± 2.1 °C	1)) 40 CFR Part 50 Appendix L, Section 9.3 2) Method 2.12 Section 7.4.5 and Table 6-1 3) DAQ BAM SOP Section 4.1
One-point Pressure Verification	1/30 days	< ± 10.1 millimeters mercury	1)) 40 CFR Part 50 Appendix L, Section 9.3 2) DAQ BAM SOP Section 4.1 3) DAQ BAM SOP Section 4.1
Accuracy			
Temperature Audit	Every 180 days and at time of flow rate audit	< ± 2.1 °C	1) Method 2.12 Section 11.2.2 2) Method 2.12 Section 11.2.2 (and DAQ BAM SOP

Table 7.8 PM_{10} Measurement Quality Objectives: PM_{10} (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)

1) Criteria (PM_{10} STP)	2) Frequency	3) Acceptable Range	Information /Action
	(DAQ goal is 1/91 days)		Section 5.0) 3) Method 2.12 Section 11.2.2
Pressure Audit	Every 180 days and at time of flow rate audit (DAQ goal is 1/91 days)	< ±10.1 millimeters mercury	1) Method 2.12 Section 11.2.3 2) Method 2.12 Section 11.2.3 (and DAQ BAM SOP Section 5.0) 3) Method 2.12 Section 11.2.3
Semi-Annual Flow Rate Audit	Twice a calendar year and 5 to 7 months apart (DAQ goal is 1/91 days)	< ± 4.1 percent of audit standard; < ± 5.1 percent of design flow rate (DAQ's warning limit goal for percent of transfer standard and flow design value is ≤±3.0 and ≤±4.0 percent respectively)	1) 40 CFR Part 58, Appendix A, Section 3.3.3 2) 40 CFR Part 58, Appendix A, Section 3.3.3 (and DAQ BAM SOP Section 5.0 3) Method 2.12 Section 11.2.1 (and DAQ BAM SOP Section 5.0)
Cabinet Temperature			
Temperature Range	At set-up	0 to 50 °C	1, 2 and 3) BAM 1020 Operation Manual
Temperature Control	Hourly values	Within ± 2 °C	1, 2 and 3) BAM 1020 Operation Manual
Temperature Device Check	Every 180 calendar days and twice a calendar year	< + 2.1 °C	1, 2 and 3) QA Handbook Volume 2 Section7.2.2
Monitor Maintenance			
Inlet Cleaning	Every 30 days	cleaned	1,2 and 3) Method 2.12, Section 8.3.1
Downtube Cleaning	Every 90 days	cleaned	1,2 and 3) Method 2.12 Section8.4
Filter Housing Assembly Cleaning	Every 30 days	cleaned	1,2 and 3) Method 2.12, Section 8.3.4
Circulating Fan Filter Cleaning	1/30 days	cleaned/changed	1,2 and 3) Method 2.12, Section 8.4.3
BAM Specific Operational Criteria			
Check of membrane span foil	Daily	Avg. < + 5.1 percent of ABS	1, 2 and 3) BAM 1020 Operations Manual
BAM electrical grounding	At setup and once per year	1. Is the chassis of the BAM grounded? 2. Is the downtube grounded to the chassis at the collar (i.e., with setscrews)	1, 2 and 3) BAM 1020 Operations Manual
Cleaning Nozzle and Vane	Every 30 days or more often as needed	cleaned	1, 2 and 3) DAQ BAM SOP Section 6.0
Replace or Clean Pump Muffler	1/182 days and 2 per calendar year	cleaned or changed	1, 2 and 3) DAQ BAM SOP

Table 7.8 PM_{10} Measurement Quality Objectives: PM_{10} (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)

1) Criteria (PM_{10} STP)	2) Frequency	3) Acceptable Range	Information /Action
Internal/External Data Logger Data (BAM)	Every month highest value on three randomly selected days	agree exactly (digital) and < ± 1.1 µg/m^3 (analog)	1) DAQ BAM SOP Section 8 2) DAQ practice 3) DAQ BAM SOP Section 8
Capstan shaft and pinch roller cleaning (BAM)	Every 30 days	cleaned	1, 2 and 3) DAQ BAM SOP Section 6.0
Smart Heater Test	1/30 days	heater turns on when forced off	1, 2 and 3) DAQ BAM SOP Section 6.0
Internal filter	1/365 days and 1/calendar year	Clean/replace	1, 2 and 3) DAQ BAM SOP
Zero filter test	At installation and 1/365 days	Standard deviation of the data from a 48 hour zero test < 2.4 µg/m3	1, 2 and 3) DAQ BAM SOP Section 5.0
Beta detector count rate	1/365 days	between 600,00 and 1,000,000	1, 2 and 3) BAM SOP Section 10.4.4
SYSTEMATIC CRITERIA - PM_{10} Continuous, BAM 1020, 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 3) 40 CFR Part 58, Appendix E, sections 2-6
Data Completeness	24-hour averages quarterly	≥ 75 percent of hours per day and scheduled sampling days in each quarter	1, 2 and 3) 40 CFR Part 50 Appendix K, Sec. 2.3a
Reporting Units	all hourly and 24-hour values	µg/m^3 at STP	1. 2 and 3) 40 CFR Part 50, Appendix K
Rounding convention for data reported to AQS	all hourly averages	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 design value calculation			
24-hour, 3-year average	Quarterly	nearest 10 µg/m^3 (≥ 5 round up)	1,2 and 3) 0 CFR Part 50, Appendix K, Section 1
Precision (using flow rate verifications–no collocation is required for continuous PM_{10})			
Primary Quality Assurance Organization	Annual and 3 year estimates	90 percent confidence limit of CV*** ≤ 10 percent for values > 3 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 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	≤ ±10.0 percent for total bias	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 2.3.1.1, 4.2.2 and 3.3.1
Field Activities			
Flow Rate Transfer Standard	1/365 days and once per 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 Section 4.2.3 and 6.3.3 3) 40 CFR Part 50 Appendix L Section 9.1 and 9.2
Field Thermometer	1/365 days and once per	± 0.1° C resolution,	1, 2 and 3) Method 2.12 Section 4.2.2

Table 7.8 PM_{10} Measurement Quality Objectives: PM_{10} (Continuous Met One BAM 1020, Standard Temperature and Pressure, or STP)			
1) Criteria (PM_{10} STP)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
	calendar year	± 0.5° C accuracy	
Field Barometer	1/365 days and once per calendar year	± 1-millimeters mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.12 Section 4.2.2
Field Manometer	1/365 days and once per 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	1and 2) Method 2.12 Table 4-1 3) 40 CFR Part 50 Appendix L Section 7.4.12
***CV= Coefficient of Variation			

Table 7.9 Nitrogen Oxides Measurement Quality Objectives: Measurement Quality Objective Parameter –Nitrogen Dioxide (NO2) (Chemiluminescence).

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
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_2 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 ≤ ± 10.0 percent	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO (see DAQ NO_2 SOP for details)
Converter Efficiency	During multi-point calibrations, span and audit 1/ 14 days	***(≥96 percent)*** 96 – 104.1 percent	1) 40 CFR Part 50 Appendix F Section 1.5.10 and 2.4.10 2) Recommendation (see DAQ NO_2 SOP) 3) 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.
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- 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
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 < ±15.1 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 NO2 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 whichever is greater	1) 40 CFR Part 58, Appendix A, section 3.1.3 2) NPAP adequacy requirements on AMTIC 3) NPAP QAPP/SOP

Table 7.9 Nitrogen Oxides Measurement Quality Objectives: Measurement Quality Objective Parameter –Nitrogen Dioxide (NO_2) (Chemiluminescence).

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
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*	> 10.0 percent excess NO Span within ± 3.0 percent of expected Precision point within ± 5.0 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 Appendix F 2 and 3) Recommendation based on instrument manual and experience (see DAQ NO2 SOP) Multi-point calibration (0 and 2 upscale points) *(Verification/Calibration procedure being revised at the time of this QAPP revision - Slope criteria is a recommendation)*
Gaseous Standards	All gas cylinders	**NIST [a] Traceable** (e.g., EPA Protocol Gas) 10-25 ppm [b] of NO in Nitrogen with < 1 ppm NO_2	1) 40 CFR Part 50 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 photolytic monitor DAQ found using 10 to 25 ppm works better (see EPA Technical Note-Clarifications and Guidance on Gaseous Pollutant Methods 1/30/2018) 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	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
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, 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, 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	***All data***	***1 place after decimal with digits to right***	1, 2 and 3) 40 CFR Part 50, Appendix S, Section 4.2

Table 7.9 Nitrogen Oxides Measurement Quality Objectives:
Measurement Quality Objective Parameter –Nitrogen Dioxide (NO2) (Chemiluminescence).

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
reported to AQ S		***truncated***	(a)
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	***≤ 20 seconds***	1) 40 CFR Part 58, Appendix E, section 9 (c) 2) Recommendation (See DAQ NO_2 SOP 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
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

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

Table 7.10. Nitrogen Oxides 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
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 < ±15.1 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 7.10. Nitrogen Oxides 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 NO_2	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)
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)

Table 7.10. Nitrogen Oxides 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
	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	*≥ 500 cm^3/min and ≤ 1000 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 7.11. $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Measurement Quality Objectives: $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ (Continuous T640X Local Conditions)

Note: At the time of the revision of this QAPP, EPA has not yet provided an approved MQO table for the T640 series of monitors. At the time when such tables become available, the DAQ will adopt the criteria therein as its own.

1) Criteria (PM T640X LC)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA - $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Continuous T640X, Local Conditions			
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 each hour can be checked	average within 10 percent of 5.0 LPM for sample flow, average within 5 percent of 11.67/16.67 LPM for bypass/total flow	1, 2 and 3) *DAQ T640X SOP*, Section 7.0
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	1/30 days, separated by 14 days (DAQ goal is 2/month separated by 14 to 18 days)	± 10 percent of standard for main flow ± 5 percent of standard for bypass/total flow	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 A, Section 3.2.3 and 3.3.2 3) *DAQ T640X SOP*, Section 7.0
OPERATIONAL CRITERIA - $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Continuous T640X, Local Conditions			
Routine Verifications			
Mid-Month Flow Rate Verification	1/30 days	± 10 percent of standard for main flow ± 5 percent of standard for bypass/total flow	1) 40 CFR Part 50, Appendix L, Section 9.2.5 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0
Temperature Verification	1/30 days	± 2°C	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0
Pressure Verification	1/30 days	± 10 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0
Leak Check	every 30 days	0.0 µg/m3	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0. DAQ designates this as an operational criterion.
Annual Multi-Point Calibrations			
Pressure Calibration	On installation, electromechanical maintenance or transport or 1/365 days and 1/calendar year	± 10 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) 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

Table 7.10. $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Measurement Quality Objectives: $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ (Continuous T640X Local Conditions) – Continued

1) Criteria (PM T640X LC)	2) Frequency	3) Acceptable Range	Information /Action
Flow Rate Multi-Point Calibration	Electromechanical maintenance or transport or 1/365 days and 1/calendar year	± 2 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 Table 6-1 3) 40 CFR Part 50, Appendix L, Section 9.2.5
Accuracy			
Temperature Audit	1/90 days	± 2°C	1, 2 and 3) Method 2.12, Section 11.2.2
Pressure Audit	1/90 days	±10 millimeters mercury	1, 2 and 3) Method 2.12, Section 11.2.3
Semi-Annual Flow Rate Audit	1/90 days	± 10.1 percent of standard for main flow, ± 5.1 percent of standard for bypass/total flow	1 and 2) 40 CFR Part 58, Appendix A, Section 3.3.3 3) Method 2.12 Section 11.2.1
Monitor Maintenance			
Clean PM_{10} Head	Every 30 days	cleaned	1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0
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
Clean Optical Chamber	1/182 days	cleaned or changed	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 $\mu g/m^3$ (analog)	1) DAQ T640X SOP Section 9.0 2) DAQ practice 3) DAQ T640X SOP Section 9.0
ASC Test	1/30 days	heater turns when forced off	1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0
Check Pump Performance	As needed		1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0
Replace DFU's	As needed		1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0

Table 7.10. $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Measurement Quality Objectives: $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ (Continuous T640X Local Conditions) – Continued

1) Criteria (PM T640X LC)	2) Frequency	3) Acceptable Range	Information /Action
SYSTEMATIC CRITERIA - $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ Continuous T640X, 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	24-hour averages	≥ 75 percent	40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
Reporting Units	all hourly and 24-hour values	µg/m^3 at AT/pressure ($PM_{2.5}$)	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b)
Rounding convention for data reported to AQS	all 1-hour averages	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)
Annual 3-yr average	all concentrations	nearest 0.1 µg/m^3 (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4 Rounding rule for AQS data is a recommendation
24-hour, 3-year average	all concentrations	nearest 1 µg/m^3 (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Section 3 and 4 Rounding rule for AQS data is a recommendation
Precision			
Single analyzer (collocated monitors)	1/91 days.	CV ≤ 10 percent for values > 3 µg/m^3	1, 2 and 3) Recommendation to provide early (quarterly) evaluation of achievement of DQOs.
Primary Quality Assurance Organization	Annual and 3 year estimates	90 percent confidence limit of CV* ≤ 10 percent for values > 3 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 and 2.3.1.1.
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/m^3	1,2 and 3) 40 CFR Part 58, Appendix A, Section 3.2.4, 4.2.5 and 2.3.1.1
Field Activities			
Flow Rate Transfer Standard	1/365 days and once per calendar year	± 2 percent of NIST-Traceable Standard	1) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2 2) Method 2-12 Section 4.2.2 and 6.4.3 3) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2
Field Thermometer	1/365 days and once per 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 per 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 per calendar year	± 0.1 in H_2O resolution, ± 1.0 in H_2O accuracy	1, 2 and 3) Method 2.12, Table 4-1
Clock/timer Verification	1/30 days	± 1 minute/month	1and 2) Method 2.12 Table 3-1 3) 40 CFR Part 50, Appendix L, Section 7.4.12
ASC = Aerosol Sample Conditioner AT = ambient temperature			

Table 7.12. PM_{10} Measurement Quality Objectives: PM_{10} (Continuous T640X STP)

Note: At the time of the revision of this QAPP, EPA has not yet provided an approved MQO table for the T640 series of monitors. At the time when such tables become available, the DAQ will adopt the criteria therein as its own.

1) Criteria (PM T640X STP)	2) Frequency	3) Acceptable Range	Information /Action
CRITICAL CRITERIA - PM_{10} Continuous T640X, 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
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, 2 and 3) 40 CFR Part 50, Appendix L, Figures L-2 through L-19
Average Flow Rate	every 24 hours of operation, each hour can be checked	average within 10 percent of 5.0 LPM for sample flow, average within 5 percent of 11.67/16.67 LPM for bypass/total flow	1, 2 and 3) *DAQ T640X SOP*, Section 7.0
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)	± 10 percent of standard for main flow ± 5 percent of standard for bypass/total flow	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 A Section 3.2.3 and 3.3.2 3) *DAQ T640X SOP*, Section 7.0
OPERATIONAL CRITERIA - CRITICAL CRITERIA - PM_{10} Continuous T640X, STP			
Routine Verifications			
Mid-Month Flow Rate Verification	1/30 days	± 10 percent of standard for main flow ± 5 percent of standard for bypass/total flow	1) 40 CFR Part 50, Appendix L, Section 9.2.5 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0
Temperature Verification	1/30 days	< ± 2.1 °C	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0
Pressure Verification	1/30 days	< ± 10.1 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0
Leak Check	every 30 days	0.0 µg/m3	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) Recommendation 3) *DAQ T640X SOP*, Section 7.0. DAQ designates this as an operational criterion.

Table 7.12. PM_{10} Measurement Quality Objectives: PM_{10} (Continuous T640X STP)– Continued			
1) Criteria (PM T640X STP)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Annual Multi-Point Calibrations			
Pressure Calibration	On installation, electromechanical maintenance or transport or 1/365 days and once per calendar year	≤+ 10.1 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2 and 3) 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 Table 6-1 3) 40 CFR Part 50, Appendix L, Section 9.2.5
Accuracy			
Temperature Audit	1/90 days	± 2°C	1, 2 and 3) Method 2.12, Section 11.2.2
Pressure Audit	1/90 days	±10 millimeters mercury	1, 2 and 3) Method 2.12, Section 11.2.3
Semi-Annual Flow Rate Audit	1/90 days	± 10.1 percent of standard for main flow, ± 5.1 percent of standard for bypass/total flow	1 and 2) 40 CFR Part 58, Appendix A, Section 3.3.3 3) Method 2.12 Section 11.2.1
Monitor Maintenance			
Clean PM_{10} Head	Every 30 days	cleaned	1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0
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
Clean Optical Chamber	1/182 days	cleaned or changed	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/m^3 (analog)	1) DAQ T640X SOP Section 9.0 2) DAQ practice 3) DAQ T640X SOP Section 9.0

Table 7.12. PM_{10} Measurement Quality Objectives: PM_{10} (Continuous T640X STP) – Continued			
1) Criteria (PM T640X STP)	**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
Check Pump Performance	As needed		1) DAQ T640X SOP Section 8.0 2) DAQ practice 3) DAQ T640X SOP Section 8.0
Replace DFU's	As needed		1 and 3) DAQ T640X SOP Section 8.0 2) DAQ practice
SYSTEMATIC CRITERIA - CRITICAL CRITERIA - PM_{10} Continuous T640X, 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	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)
Reporting Units	all hourly and 24-hour values	$\mu g/m^3$ at STP	1. 2 and 3) 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	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b) Rounding rule for AQS data is a recommendation
24-hour, 3-year average	All 24-hour averages	nearest 10 $\mu g/m^3$ (≥ 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.
Precision (using flow rate verifications –no collocation is required for continuous PM10)			
Primary Quality Assurance Organization	Annual and 3 year estimates	90 percent confidence limit of CV* ≤ 10 percent	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 and 2.3.1.1.
Bias (using flow rate verifications –no NPAP or PEP is available for PM10)			
Primary quality assurance organization	Annual and 3-year estimates	≤ ±10.0 percent for total bias	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 2.3.1.1, 4.2.2 and 3.3.1
Verification/Calibration Standards and Re-certifications - 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 J, Section 7.3 2) Method 2.11 Section 1.1.3 3) 40 CFR Part 50, 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

Table 7.12. PM_{10} Measurement Quality Objectives: PM_{10} (Continuous T640X STP) – Continued			
1) Criteria (PM T640X STP)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
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 H_2O resolution, ± 1.0 in H_2O 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
ASC = Aerosol Sample Conditioner			

Table 7.13. Ambient Temperature Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Ambient Temperature (AT) (Thermistor)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-AT			
Accuracy	At purchase Every 182 days	± 0.5°C	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C
Time Constant	At purchase	≤ 1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Volume 4, Appendix C
Operating Range	At purchase	-30 – 50	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Resolution	At purchase	0.1	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/182 days	3 pt. Water Bath with NIST traceable thermistor or thermometer. All points within ± 0.5 ºC of standard.	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final) Table 0-4 NCore Calibration & Accuracy Criteria
OPERATIONAL CRITERIA-AT			
Calibration and audit standards	Purchase, recertify 1/365 days or per NIST/ASTM certification frequency	Thermistor with measurement range -50°C to + 40°C; Accuracy ≤±0.2°C NIST traceable certified over -30°C to +30°C; and Resolution ≤±0.1°C	1, 2 & 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV: Meteorological Measurements, Ver. 2.0 (Final) Table 0-4 NCore Calibration & Accuracy Criteria
Annual Accuracy Evaluation	Every site 1/365 days	3 pt. Water Bath with NIST traceable thermistor or thermometer. All points within ± 0.5 ºC of standard.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-4 NCore Calibration and Accuracy Criteria
Minimum Sample Frequency	Every site Every work day	Hourly	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Raw Data Collection Frequency	Every site Every work day	1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Hourly Recorded 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 7.13. 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	1.25 to 2 meters	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors
Recommended Ground Cover	At installation/moving 1/365 days	Non-irrigated or un-watered short grass, or natural earth at least 9 m in diameter. The surface should not be concrete, asphalt or oil-soaked. Reflection from these surfaces may affect sensor performance.	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0.12 Siting and Exposure for Meteorological Sensors

Table 7.13. Ambient Temperature Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Ambient Temperature (AT) (Thermistor)

1) Requirement (AT)	2) Frequency	3) Acceptance Criteria	Information /Action
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 7.14. NCore Wind Speed Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Speed (WS) (Cup, prop or sonic anemometer)

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

Table 7.14. 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
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; replace sensor bearings	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Routine maintenance	1/182 days	Application of cleaning and protective lubricants to mounting hardware	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Visual Inspection	1/7 days (or every site visit if site visited less than weekly)	Moving freely, no visual damage	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.1
DAS Clock/timer Verification	1/7 days (or every site visit if site visited less than weekly)	< ± 1 minute NIST EST	1, 2 and 3) Recommendation
Data Acquisition System (internal battery back-up)	1/182 days	Check Battery Back-up, Replace as needed	1, 2 and 3) Recommendation
SYSTEMATIC CRITERIA-WS			
Sensor/Monitor	At purchase/installation	Meets requirements listed in QA Handbook	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Standard Reporting Units	All data	Meters per second (final units in AQS)	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Rounding convention for data reported to AQS	All data	1 decimal place	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives

Table 7.14. 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
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 7.15. NCore Wind Direction Measurement Quality Objectives.
Measurement Quality Objectives Parameter – NCore Wind Direction (WD) (Vane or sonic anemometer)

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

Table 7.15. 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 work day	1 minute	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Hourly Recorded WD	Every workday 1/30 days	0°≥ WD ≤ 360°, WD varies ≥ 1°/3 consecutive hours, or per site specific climatology criteria	1, 2 and 3) EPA -454/R-99-005 Feb 2000, Chapter 8,Table 8-4
Preventative maintenance	1/182 days	Follow manufacturer's instructions; replace sensor bearings	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Routine maintenance	1/182 days	Application of cleaning and protective lubricants to mounting hardware	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.2.1
Visual Inspection	1/7 days (or every site visit if site visited less than weekly)	Moving freely, no visual damage	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Section 2.6.1
DAS Clock/timer Verification	1/7 days (or every site visit if site visited less than weekly)	< ± 1 minute NIST EST	1, 2 and 3) Recommendation
Data Acquisition System (internal battery back-up)	1/182 days	Check Battery Back-up, Replace as needed	1, 2 and 3) Recommendation
SYSTEMATIC CRITERIA-WD			
Sensor/Monitor	At purchase/installation	Meets requirements listed in QA Handbook	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Standard Reporting Units	All data	Degrees (final units in AQS)	1, 2 and 3)) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives
Rounding convention for data reported to AQS	All data	1 decimal place	1, 2 and 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, Version 2.0 (Final) Table 0-3 NCore Meteorological Measurement Quality Objectives

Table 7.15. 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
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

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. 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.

DAQ aims ambient air monitoring training at increasing the effectiveness of employees as well as the effectiveness of DAQ as a whole. In general, training for the ambient air monitoring program consists of a combination of required reading, monthly ambient monitoring workgroup calls, active cross-training amongst staff, completion of EPA-led training classes and attendance at DAQ and EPA workshops and conferences. 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.

Regarding required reading, 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 typically document required reading on a form indicating the employee has read and understood the QAPP or SOP; however, at the time of this QAPP revision the DAQ is working with DEQ management to develop alternate procedures.

All positions have a training guide that provides suggested training for each employee to complete for competency in that position. 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 in their Value in Performance (VIP) or the North Carolina Learning Management System, or LMS.

Additionally, the chief invites the RRO monitoring coordinator and 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 to ensure the collection of valid data. DAQ and EPA personnel provide training annually during the monitoring workshop.

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 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. 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 in the LMS. Air monitoring personnel have enough 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 to receive the needed training. The LMS provides and archives certificates of completion for any course work documented in the LMS.

DEQ - DAQ Training Links:

Air Monitoring: http://www.epa.gov/ttn/amtic/training.html

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

9.0 Documentation and Records

The following information describes DAQ's management of documents and records, including this QAPP, for the NCore Ambient Air Quality Monitoring Program. The 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 of 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 and Value In Performance
Site Information	Network descriptions Site files Site maps Site pictures	RCO group drive, Raleigh Regional Office group drive, IBEAM General Documents Module
Environmental Data Operations	Quality assurance project plans	DEQ Website for official repository. Other file locations include IBEAM General Documents Module, NC Ambient Monitoring Section QAPP page on SharePoint or RCO group drive (see below)
	Standard operating procedures	DEQ Website, IBEAM General Documents Module (see below)
	Field and site notebooks	RCO group drive, Raleigh Regional Office group drive, Millbrook site
	Laboratory notebooks Sample handling/custody records	RCO
	Inspection/maintenance records	RCO group drive, Raleigh Regional Office group drive, ECB

Table 9.1. Documentation and Records Information

Categories	Record/Document Type	File Locations
Raw Data	Any original data (routine and QC) including data entry forms	Raleigh, NC – RCO, Raleigh Regional Office, ECB
Data Reporting	Air quality index reports	DAQ Website, IBEAM General Documents Module
	Annual data certification report	IBEAM General Documents Module
	Data/summary reports	DAQ Website, IBEAM General Documents Module
	Journals/articles/papers/presentations	RCO group drive, IBEAM General Documents Module
Data Management	Data algorithms Data management plans/flowcharts Data management systems	Raleigh, NC – RCO
	Pollutant data Meteorological data	Envista ARM database
Quality Assurance	Network reviews and assessments Control charts Certification documentation Data quality assessments EPA technical systems audit reports Internal systems audit reports Response/corrective action reports Site audits e-mails related to QA activities and assessments	Raleigh, NC – RCO, ECB and Raleigh Regional Office IBEAM General Documents Module

The state of North Carolina considers all e-mails official records and 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 IBEAM.

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.

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 document; and
- QA and technical notes, which provide air monitoring policy interpretations or best practices.

As of this QAPP revision, DAQ is in the process of revising the document and record storage procedures and locations. The DAQ currently uses IBEAM for an internal locale for new and past revisions of SOPs and QAPPs. In IBEAM archived documents are marked as *OBSOLETE* in the title so that staff know not to use them for procedures. The QAM or his designee is responsible for changing the title to *OBSOLETE* when a new version is approved. The DEQ website is the official DAQ repository for controlled documents, i.e., current approved versions. All other documents not on the website are uncontrolled and therefore not considered official.

In addition, at the time of this QAPP revision, DAQ uses the group drive and SharePoint as repositories for working documents. Draft documents will be watermarked as *DRAFT* so that no confusion arises as to the finality of an SOP. The QAM or designee receives final versions for review and approval. Once the QAM signs the QAPPs and SOPs, the QAM or designee will upload the document to the website and IBEAM. 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 DAQ is currently streamlining these procedures and will revise the QAPP when DAQ implements a new framework.

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 or on data forms included in the field; see Section 11.0 Sampling Methods Requirements.

All 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. 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 group drive. The RRO monitoring technician will use these e-logs to record information about the site and laboratory operations, as well as document routine operations.

Completion of e-logs, instrument maintenance logbooks and Air Quality Section Maintenance Order or AQ-109 forms, and Continuous Monitor Performance Audit Report or AQ-121 forms associated with all routine environmental data operations, are required 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 and/or e-logs for record keeping for each sampling site, sampling instrument, specific program or individual. Each paper logbook should be hardbound and paginated. The DAQ uses paper logbooks to document site visits and other activities, including who is at a site, when and why. Every visitor must sign the site logbook. The e-logs capture monitor maintenance and QA/QC activities, including calibrations.
- ***Lab Logbooks*** – A combination of bound paper logbooks and electronic databases exist in which the state laboratory retains all records pertaining to PM gravimetric analysis.

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

The RRO monitoring technicians collect PM samples from the sequential samplers and deliver them to the DAQ gravimetric laboratory for analysis. The PM LAB technician retains COC records at the RCO and at the RRO. Currently, the PM LAB technician sends a COC form with each batch of filters to the RRO.

The RRO monitoring technician retains these LAB-generated forms. In addition, the RRO monitoring technician produces a COC form when returning the sampled filters. The RRO monitoring coordinator retains these regional forms at the RRO. 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 once recorded 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 or the western data center operated by the DIT.

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/calibration procedures;
- Maintenance activities;
- Annual performance evaluations;
- EPA performance audits such as the NPAP 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 and Envista ARM. 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, 2.17.2, DAQ-12-002.2, 2.36.2, 2.37.2, 2.38.2, 2.44.2, 2.45.2, 2.46.2, 2.47.2 and 2.62.2.

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 file in the office. Certifications for PM equipment provided by the vendors are stored in the RRO and in IBEAM. 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 group drive. Records for internal certifications of the photometers and calibrators used in the field and for audits are stored electronically on the group drive. The DAQ is currently reviewing this record retention process and will revise the QAPP when a 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 IBEAM general documents module or on SharePoint.

9.5 Data Archiving and Retrieval

The DAQ classifies documentation according to its intended use, future applicability and regulatory requirement for retention. The DAQ will retain all the information listed in Table 9.1 for four

complete calendar years from the date of collection in accordance with 2 CFR 200.333. 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, whichever is later.

DAQ stores electronic records within the data management systems located at the NCore site, or Envidas, the RCO, or Envista ARM, and on network servers in the RRO and RCO. The DIT backs up data stored in Envista ARM as well as records on the network server in the RRO and RCO nightly and stores these back-ups off-site. The database manager regularly backs up the Envista ARM database to SharePoint. 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 located 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 of the 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 in the near future. 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.

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 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 through the use of 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 Ambient Monitoring Section shares these responsibilities amongst its members as well as with other DAQ staff.

10.2.2 Monitor Placement

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 DAQ places 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.

The ECB electronics technicians shall mount the wind speed and direction sensors approximately 1 meter apart, on opposite ends of a cross-arm. The cross-arm is attached to a mounting arm and the mounting arm is attached to the tower at height of 10 meters above ground level. The wind sensors must have 360-degree clearance for the cup and wind vane to move freely without any obstruction. 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.

Temperature sensors and RH sensors must be mounted inside a radiation shield to limit solar interference. 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 drip-line 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 and Humidity Sensors

The AT and RH sensors shall be attached to the tower with a mounting arm so that the AT and RH sensors are located over an open plot of short grass or natural earth (not concrete or asphalt) at a height of approximately 2-meters above ground-level. At the writing of this QAPP, DAQ is testing new sensor technology that will allow 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 AT and RH 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 AT and RH sensor 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 RH and AT sensors at a height of approximately 2-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 drip-line of the nearest trees, but must be 10 m from the drip-line.

The sampler must be located away from obstacles such as buildings, so that the distance between the obstacle and the sampler 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

EPA establishes minimum sampling frequencies, which DAQ follows. The sampling frequencies of monitors are based on EPA's requirements in 40 CFR 58.12. 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 minimum number of samples required for appropriate summary statistics should be taken. At least 75 percent of the total possible observations must be present before summary statistics are calculated. The exact requirements appear in 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
$PM_{10-2.5}$	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.

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 (Trace-Level)	Thermo Electron Model 43i TLE	560	EQSA-0486-060
PM_{10} continuous (STP)	Met One Instruments BAM 1020 (with PM10 head alone)	122	EQPM-0798-122
	Teledyne T640x (with PM10 head)	239	EQPM-0516-239
PM_{10} local conditions, continuous	Met One Instruments BAM 1020 (with PM10 head alone)	122	EQPM-0798-122
	Teledyne T640x (with PM_{10} head)	238	EQPM-0516-238

Table 11.1 DAQ NCore Ambient Air Monitoring Network Analyzers

Parameter	Analyzer	AQS Method Codes	EPA Reference/Equivalence Method
$PM_{2.5}$ filter-based	Rupprecht and Patashnick Partisol®-Plus Model 2025(i) Sequential Air Sampler (with PM_{10} Head and VSCC) Or Thermo Model 2025 i Sequential Air Sampler (with PM_{10} head and VSCC)	145	RFPS-1006-145
$PM_{2.5}$ local conditions, continuous	Met One BAM 1020 (with PM10 head and VSCC) Teledyne T640x (with PM10 head)	170 240	EQPM-0308-170 EQPM-0516-240
$PM_{10-2.5}$, local conditions continuous	Met One BAM 1020 (one unit with PM10 head and VSCC paired with a unit with PM10 head alone) Teledyne T640x (with PM10 head)	185 238	EQPM-0709-185 EQPM-0516-238
$PM_{2.5}$ speciated	Met One Super SASS URG	811, 812 846	Not Applicable
Nitrogen Dioxide	Teledyne-Advanced Pollution Instruments T200UP Teledyne Model T500U	200 212	EQNA-0512-200 EQNA-0514-212
Indoor Shelter Temperature	Comet Temperature Sensor Model T0310	013	No FRM or FEM
Wind Speed Wind Direction Temperature Relative Humidity Solar Radiation Rain/Melt Precipitation	Met One AIO2 All-in-one weather sensor Met One 010C – (Wind Speed - Resultant) Met One 020C – (Wind Direction - Resultant) Met One 062 – (Temperature) Rotronics HC-2 – (Relative Humidity) Pyranometer Tipping bucket precipitation sampler	069 021 021 041 011 011 011	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 photo-conductor. This solid-state device, coupled with its support circuitry, amplifies the signal generated by the modulated IR radiation beam and outputs a modulated voltage. This voltage is de-modulated resulting in two voltage signals associated with the reference and measurement pulses. The ratio of the de-modulated voltage signals is indirectly proportional to the concentration of CO in the 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, BAM)

A beta attenuation monitor, or BAM, is composed of sensing and control units. The carbon 14 beta radiation source and glass-fiber filter tape form the heart of the sensing unit and combine in a measurement technique for making near-real-time direct measurement of particle mass collected on the filter tape. This measuring equipment can determine the fine changes in mass that accumulate on the filter tape as a constant stream of air passes through it. The ECB electronics technicians configure the Met One BAM 1020 to operate on 1-hour cycles. During this one-hour cycle, the unit makes two 8-minute beta measurements (one for the background or blank and one for the sample) and collects

one 42-minute sample for a combined total of 58 minutes. The monitor uses the remaining 2-minutes of each hour for filter tape and nozzle movements. The combination of the difference between blank and sample radiation counts, coupled with the air's known volumetric flow rate, yields an accurate method of determining the concentration of PM in the air. The equipment can calculate the 1-hour, 8-hour and 24-hour averages. The control unit employs a microprocessor system, flow control hardware, temperature and humidity sensors, transformers and power supplies and a software algorithm to determine when to advance the filter tape.

Initially, an inertial separator filters the air stream. The EPA specifically designed the inertial separator to eliminate particles with aerodynamic diameters either greater than 10 micrometers or greater than 2.5 micrometers, depending upon the desired data to be collected. This equipment draws in 16.7 LPM (1.0 cubic meters per hour) of air. After the air stream exits the inertial separator, the stream passes through a defined spot on the filter tape. The mass transducer is a radiation scintillation counter. The system measures the accumulated mass every hour. Information required for installing and maintaining the BAM PM monitor is available in the DAQ SOP 2.37.1 and the Met One BAM 1020 Continuous PM Monitor manual.

11.2.7 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 PM10 inlet. The EPA approved this configuration as an FEM for PM_{10}, $PM_{2.5}$ and $PM_{10-2.5}$. The monitor reports sample volume in actual conditions by using the instrument's AT and barometric pressure sensor data.

11.2.8 Nitrogen Oxides (Chemiluminescence)

Nitrogen oxides, or NO_x, is the sum of NO and NO_2. The principle of measurement is based upon the reaction of a NO molecule with an internal source of O_3 in an evacuated reaction cell that results in the emission of light. Single channel instruments divide the sample into two streams. The first stream passes the sample directly to the evacuated reaction cell. A reaction between the NO present in the sample and the analyzer-supplied O_3 occurs. The 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 converter. For NO_x, a photolytic converter selectively reduces the NO_2 to NO. This second stream, containing NO from both the reduction of NO_2 and the original NO, cycles through the evacuated reaction cell where the new augmented concentration of NO is measured. The measurement of the untreated sample provides an NO concentration, while the measurement of the converted sample provides a measurement of the NO_x concentration. Subtracting the NO concentration from the NO_x concentration yields the NO_2 concentration. Periodically, the detector takes a background measurement to correct the zero offset of the instrument to maintain zero stability.

11.2.9. 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 produces 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 translated 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.

11.2.10 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.

11.2.11 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.

The Met One 010C mechanical wind speed sensor uses a lightweight three-cup anemometer to determine horizontal wind speeds. The Met One 020C sensor uses a lightweight airfoil vane that is directly coupled to a single precision potentiometer to provide azimuth wind directions.

The Met One 062 AT sensor is a thermistor. The thermistor is encapsulated in silicone-oil to provide very high resistance sensitivity.

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

Section 2.3.3 Certification and Accuracy Check of Field Barometers and Thermometers, Revision 7, Nov. 1, 2011
DAQ-15-001.1 Verification of Ambient Monitoring Thermometers Version 0.0, November 13, 2020
Calibration of the Dwyer and SPER Manometers, Revision 2020, February 18, 2020
DAQ-13-004.1 Calibrator Certification Standard Operating Procedures, under development
Section 2.3.4 Thermo Environmental Model 146C Calibrator Certification, Revision 12.2, Sept. 17, 2014
Section 2.3.6 Protocol Gas Verification for Compressed Gas Cylinders Containing Either SO2, NO or CO, Revision 0, Nov. 30, 2009
Section 2.7.1 Thermo Scientific Model 49i Ozone Monitoring System Electronics and Calibration Branch Responsibilities, Revision 7.1, July 1, 2016
Section 2.7.2 Thermo Scientific Model 49i Ozone Monitoring System Operators' Responsibilities, Revision 8.0, Feb. 21, 2020
Section 2.12.1 National Core (NCore) and State and Local Air Monitoring Station (SLAMS) Meteorological Monitoring Electronics and Calibration Branch Responsibilities, Revision 1.5, July 1, 2015
Section 2.17.1 Teledyne Model T200UP Nitrogen Dioxide Monitoring System SOPs for the Electronics and Calibration Branch, Revision 1.1, April 22, 2016
Section 2.17.2 Model T200UP Nitrogen Dioxide Monitoring System SOPs for Operators, Revision 1.1, Nov. 2016
Section 2.24.1 Particulate Matter 2.5 Standard Operating Procedures for the Electronics and Calibration Branch, Revision 2011, Jan. 1, 2011
Section 2.24.3 Particulate Matter 2.5 Standard Operating Procedures for Laboratory Responsibilities, Revision 2017, Jan. 1, 2017
Section 2.24.4 Particulate Matter 2.5 Standard Operating Procedures for Raleigh Central Office, Revision 1, Sept. 1, 2002
Section 2.34.1 ECB Responsibilities Trace Level Sulfur Dioxide Standard Operating Procedure Revision 2, Feb. 15, 2016
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
Section 2.36.2 Trace-Level Carbon Monoxide SOPs for Operator Responsibilities, Revision 4.5, Dec. 31, 2016
DAQ-11-002.1 Installation, Calibration, Maintenance and Audit Responsibilities of the Electronics and Calibration Branch for the Met One Instruments Beta Attenuation Monitor (under development)
Section 2.37.1 Installation, Calibration and Maintenance Responsibilities of the Electronics and

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

Calibration Branch for the Met One Instruments Beta Attenuation Monitor, Revision 0, Oct. 8, 2008
Section 2.37.2 Site Operator's Responsibilities for the Operation of the Met One Instruments Beta Attenuation Monitor, Revision 4, Jan. 5, 2015
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
Section 2.39 SOP for Preparing SOPs for the DAQ, Revision 0, Nov. 1, 2010
DAQ-14-002.5 Quality Assurance Project Plan and Standard Operating Procedure Tracking Database Procedure, Revision 0, under development
Section 2.41.4 Data Review and Validation for Continuous Gaseous and Non-Speciated PM Monitors, RCO Responsibilities, Revision 1.6, Oct. 15, 2014
Section 2.43 SOP for Completing the Annual Network Review for the DAQ, Revision 2, Sep. 29, 2017
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
Section 2.45.2 Particulate Matter 2.5 SASS Speciation Operator Responsibilities, Revision 2020, Dec. 16, 2019
Section 2.46.2 Thermo Scientific 2025i Standard Procedures for Operators, Revision 2020, Dec. 5, 2019
Section 2.47.2 Teledyne Model 640X Standard Procedures for Operators, Revision 2020, Dec. 16, 2019
Section 2.49.2 BGI TetraCal Standard Procedures for Operators, Revision 2020, Dec. 16, 2019
Section 2.61 SOP for Quarterly Completeness Data Review, Revision 1, June 12, 2020
DAQ-08-001.1 Model T500U Nitrogen Dioxide (NO_2) Monitoring System ECB Responsibilities, Under Development
Section 2.62.2 Model T500U Nitrogen Dioxide (NO_2) Monitoring System Operator Responsibilities, Revision 0, July 27, 2020
Section 2.63.4 Standard Operating Procedures for Validation of Particulate Matter, Revision 0, August 15, 2020

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 or in the Western Data Center, managed by DIT, to connect automatically to the station at least hourly to retrieve these data for analysis. Monitoring personnel can contact the station manually to retrieve data 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 real-time web page.

11.4 Support Facilities

11.4.1 Monitoring Station Design

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

11.4.2 Shelter Criteria

The DAQ houses 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 117 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. The shelter has roof access. The continuous PM monitors are housed inside small shelters 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 analyzer draws sample 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 DAQ uses 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 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. They typically locate the filter within the protected shelter, between the probe inlet and the analyzer. The ECB electronics technicians protect the NOy sample-transfer line from light using a plastic coated flex provided by the vendor.

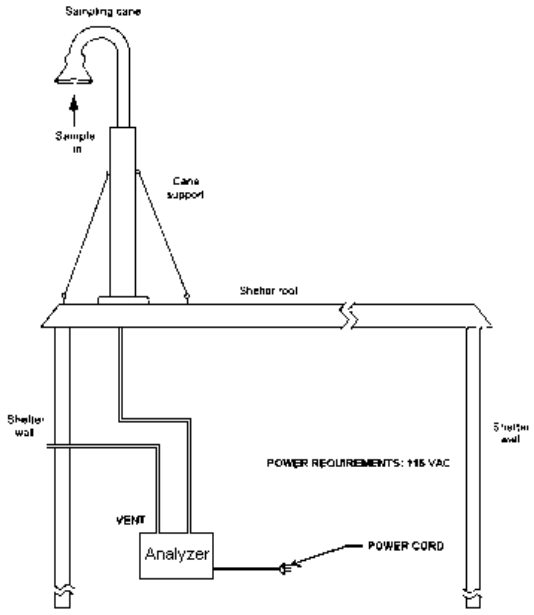


Figure 11.1 Teflon® Sampling Configuration

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, affecting the concentration by removing the pollutant from the sample and consequently, yielding inaccurate environmental data.

The residence time in the probe must be less than 20 seconds 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 DAQ cannot meet both constraints simultaneously, then the ECB electronics technicians modify the physical configuration to fix this deficiency. They may accomplish this by reducing the length of interconnecting tubing, increasing the tubing outer wall thickness and/or decreasing the number of tube bends 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. Problems that cause probe problems include the monitor pulling rain or other precipitation into the probe, insects getting into the probe or a cold spot developing along the probe that causes condensate to form in the probe.

The ECB electronic technicians should house the BAM 1020 and T640X in a cabinet shelter capable of fulfilling these requirements:

- As is recommended by DAQ, the shelter temperature should be maintained between 28 and 32 ° C (not necessary for the T640X);
- 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 Occupational Safety and Health Administration (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

At the time of this QAPP revision, DAQ currently uses an in-house gravimetric laboratory. The DAQ is currently working on establishing a contract with an outside laboratory to take over these responsibilities. Once that contract is in place, DAQ will revise the QAPP to describe any changes in sample handling and custody that result from implementing that contract. The discussion below describes the current process.

The DAQ network collects intermittent, filter-based $PM_{2.5}$ samples from the sequential samplers and ships them to the DAQ gravimetric laboratory, where the lab analyst conducts the analysis following EPA regulations (40 CFR Part 50, Appendix L), and in accordance with this QAPP and SOP 2.24.3. Due to the potential use of data for comparison to the NAAQS and the requirement for extreme care in sample collection, the lab analyst and RRO site operators must follow sample custody procedures. Figures 12.1 and 12.2 present examples of the COC record forms used to track the stages of filter handling throughout the data collection operation. The PM LAB technician supplies the site operators with these forms when necessary. The individual SOPs 2.46.2 and 2.24.3 detail custody procedures. At the time of this QAPP revision, the PM LAB technician and RCO LAB QA chemist are modifying and streamlining some of these procedures to provide a COC that is a true, bona fide, unbroken COC.

12.1 Pre-Sample Custody

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

After the initial (tare) weighing, the analyst will prepare the $PM_{2.5}$ filters for field use, including any blanks. The lab analyst will place filters into filter support cassettes, and then place the filter cassettes into a sample magazine(s). The lab analyst then places the magazine(s) into a cooler and prepares the cooler for transport to the RRO. The lab analyst provides a COC Record Form (Figure 12.1) with the shipment that contains the identification numbers for all filters in the magazine(s). The RRO site operator signs and dates the COC upon receipt.

The RRO monitoring technician inspects the FRM $PM_{2.5}$ filters received from the DAQ Lab for possible shipping and handling damage or other atypical characteristics. The RRO monitoring technician does not use compromised or damaged filters to collect samples in the field. Evidence of compromised or damaged filters include visible damage noted on the filter substrate (e.g. - pinholes, rips, etc.), damage to the filter screen, or damage to the filter cassette. The RRO monitoring technician returns compromised or damaged filters to the DAQ weighing laboratory.

12.2 Post-Sample Custody

RRO site operators collect $PM_{2.5}$ samples using procedures outlined in the DAQ SOP Section 2.46.2 Thermo Scientific 2025i Standard Procedures for Operators. In general, site operators collect exposed $PM_{2.5}$ samples from the FRM samplers in the field within 177 hours of sample collection. The RRO monitoring technician removes the samples from the samplers in the protective magazines

and then transfers the samples in the protective magazine into a cooler containing frozen blue ice packs (or equivalent). From there, the RRO monitoring technician takes the samples to the RRO. Site operators observe the exposed filters for possible instrument processing or sample handling damage. The RRO monitoring technician notes compromised or damaged filters on the associated filter data sheet (Figure 12.2). If it is determined that damage to the filter is significant, such as a breach in the filter substrate, the sample is invalidated.

Using the $PM_{2.5}$ e-logs, the RRO monitoring technician prepares shipment reports for the filters going back to the laboratory, along with the completed and signed COC. (The RRO monitoring technician prints a separate shipment report for each individual filter shipped back to the laboratory – see Figure 12.2.) However, if the RRO monitoring technician or coordinator is not going to ship the filters back immediately, then he or she stores the filters in a designated refrigerator in the RRO, along with the paperwork, until it is time to ship them. Table 7.9 of this QAPP provides filter-holding requirements for the samples.

When preparing the exposed samples for shipment, the site operator places a digital thermometer into the shipment cooler, along with the sample magazines (in their metal transport boxes), surrounded by frozen ice packs. The RRO operator signs the shipment report(s) and includes it in the cooler. The RRO operator then seals the cooler with duct tape and hand delivers it to the lab analyst.

Upon receipt, the PM LAB technician documents the date he or she received the samples and records the cooler shipment temperature using an IR gun to measure it. The PM LAB technician will determine the analytical holding time, which is dependent 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 analyst also inspects the samples for damage. The lab analyst notes compromised or damaged filters and notifies the RRO regarding filters he or she deems significantly affected by damage or other atypical characteristics. The lab analyst also notifies the RRO if out-of-specification conditions occurred in the laboratory. The lab analyst provides filter-conditioning information, and other weigh session data, to the RRO in the form of a $PM_{2.5}$ weigh lab summary Excel spreadsheet.

A RRO monitoring technician may miss scheduled samples due to a variety of situations including sampler malfunction; power outage; and filter problems, among others. Adequate numbers of PM2.5 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., make-ups) to help monitoring organizations achieve desirable data capture goals.

DAQ collects intermittent, filter-based PM2.5 samples in accordance with the schedule specified in 40 CFR 58.12. The national sampling schedule is set each year by EPA. A “make-up” sample becomes a replacement for a scheduled day. The number of make-up samples permitted by EPA in any calendar quarter is limited to five samples. When make-up samples are necessary, RRO 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.

Figure 12.1 Supply Chain of Custody (COC) Record Form for PM2.5 FRM Particle Samples

North Carolina Division of Air Quality
Ambient Monitoring Section
Particulate Filter Chain of Custody

Chain of Custody Instructions

Laboratory Staff: Fill out the "Relinquish Information" and "Samples in Shipment" sections of this form. Save a copy of the form under P:\PM25\COC. Print this form, sign it, and place it in the cooler with the samples being released.
Regional Staff: Fill out the "Receipt Information" section of this form. Ensure that each filter listed is included in the shipment. Inspect each filter for damage. File this form at your regional office (records retention schedule is 5 years).

Relinquish Information

Date of Shipment:	03/07/2017	**Shipment Origin:**	Green Square Particulate Lab
Time of Shipment:	12:22	**Destination:**	Mooresville Regional Office
Relinquished by:	Nathan Miller	**Signature:**	[signature]

Samples in Shipment

Filter Weigh Date: 3/7/17

T6596037
T6596038
T6596039
T6596041
T6596042
T6596043
T6596044
T6596045

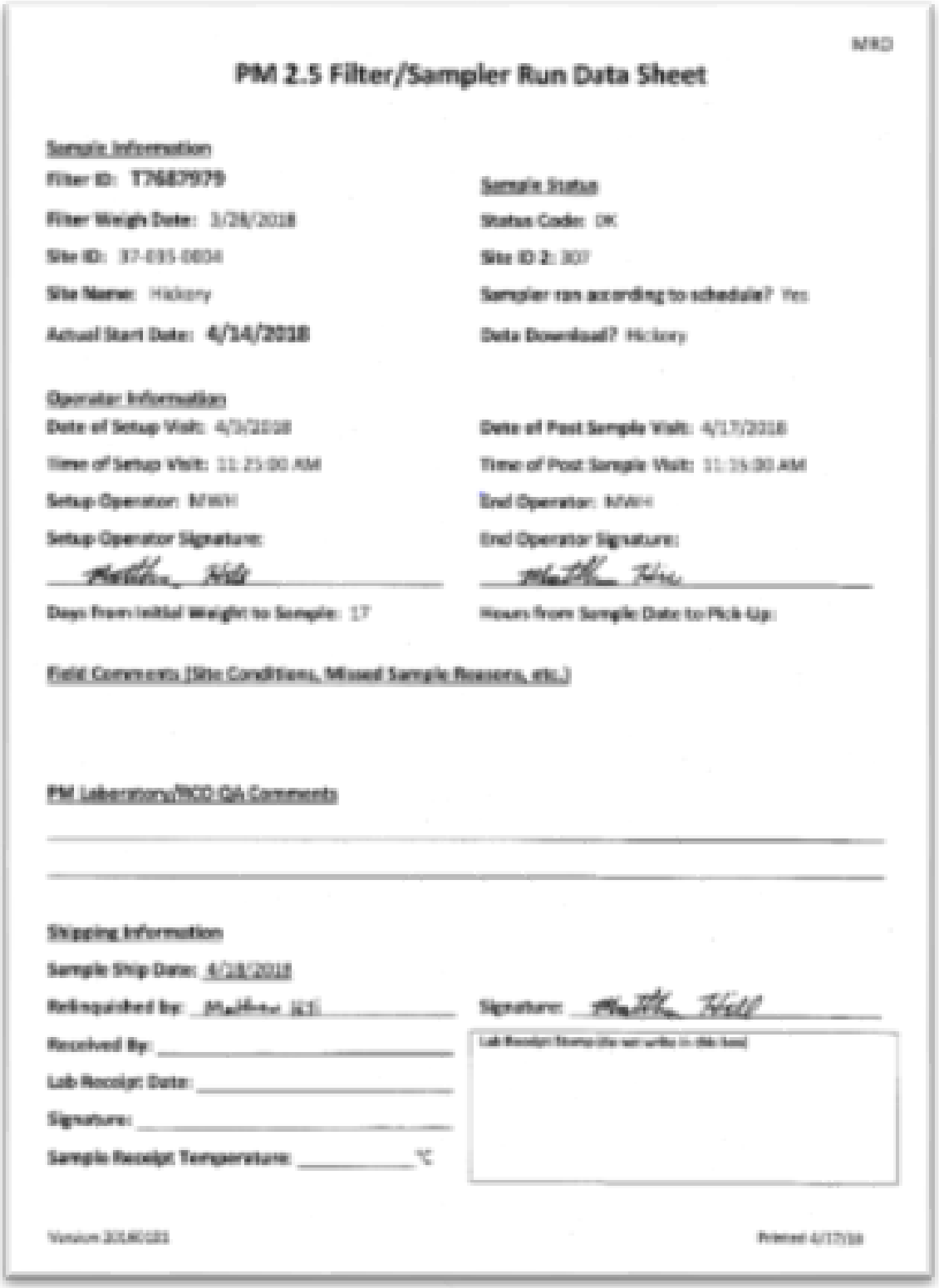
Receipt Information

Date Received:	3-8-17	**Filters Inspected:**	☑ Yes ☐ No
Time Received:	8:30 AM	**Filters Damaged:**	☐ Yes ☑ No
Received by:	ROBERT JAY PAGANO	**Signature:**	[signature]

Contact the Particulate Laboratory at (919) 707-8013 with questions.

Version 05/16/2011

Figure 12.2 Return Chain of Custody (COC) Record Form for PM2.5 FRM Particle Samples



MRO

PM 2.5 Filter/Sampler Run Data Sheet

Sample Information

Filter ID: T76837979

Filter Weigh Date: 3/28/2018

Site ID: 37-035-0004

Site Name: Hickory

Actual Start Date: 4/14/2018

Sample Status

Status Code: OK

Site ID 2: 307

Sampler ran according to schedule? Yes

Data Download? Hickory

Operator Information

Date of Setup Visit: 4/13/2018

Time of Setup Visit: 11:25:00 AM

Setup Operator: MWH

Setup Operator Signature:

Date of Post Sample Visit: 4/17/2018

Time of Post Sample Visit: 11:15:00 AM

End Operator: MWH

End Operator Signature:

Days from Initial Weight to Sample: 17

Hours from Sample Date to Pick-Up:

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

PM Laboratory/RCO QA Comments

Shipping Information

Sample Ship Date: 4/18/2018

Relinquished by:

Signature:

Received By:

Lab Receipt Date:

Signature:

Sample Receipt Temperature: ____ °C

Lab Receipt Notes (Do not write in this box)

Version 2014/01

Printed 4/17/18

Preferred choice for make-up sampling day: Sample before the next scheduled 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 Filter Archive

The PM LAB technician archives the $PM_{2.5}$ filters in a refrigerator in the DAQ laboratory for one year and then moves them to a DAQ indoor storage location for an additional four years.

13.0 Analytical Methods

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 PM monitoring sites. 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 AMTIC website (https://www3.epa.gov/ttn/amtic/criteria.html) 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 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.

This section identifies the equipment and analytical methods required to complete the analyses of the $PM_{2.5}$ samples obtained by the sequential samplers. Please note that continuous PM monitors do not generate physical samples that the RRO monitoring technicians send to a laboratory for analysis. The DAQ uses one analytical method for analyzing all filters collected using a $PM_{2.5}$ sequential monitor: Appendix L to 40 CFR Part 50—Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere. More information regarding the physical collection, transport and preservation of intermittent, filter-based PM2.5 samples may be found in Section 12.0 Sample Handling and Custody of this QAPP.

At the time of this QAPP revision, DAQ currently uses an in-house gravimetric laboratory. The DAQ is currently working on establishing a contract with an outside laboratory to take over these responsibilities. Once that contract is in place, DAQ will revise the QAPP to describe any changes in analytical methods that result from implementing that contract. The discussion below describes the current process.

13.1 Purpose/Background

The analytical method employed for PM evaluation is dependent upon the monitoring technology used. The monitoring equipment required for the NCore network is listed in Table 11.1. The PM criteria pollutants, PM_{10}, and $PM_{2.5}$ and $PM_{10-2.5}$ require a separate analytical method to evaluate the captured sample to establish the pollutant concentrations present in the environment when sequential sampling methods are used; however, at this time the DAQ only uses sequential sampling methods for $PM_{2.5}$.

The low volume sequential $PM_{2.5}$ FRM monitors employed for PM monitoring use gravimetric analyses. The Green Square laboratory will conduct these analyses. The method requirements for $PM_{2.5}$ monitoring, which include both the field and laboratory (analytical) components, are detailed in 40 CFR Part 50, Appendix L. A filter's net weight gain identifies the sample characteristic of interest, captured PM mass. The laboratory analyst obtains this net weight gain by subtracting the initial filter weight from the final weight of the exposed filter. Once calculated, the RCO PM chemist combines the net weight gain with the total filter volume to calculate the concentration for comparison to the daily and annual NAAQS. Since the method is non-destructive, and due to possible interest in sample composition (e.g., subsequent chemical analyses), the analyst archives the filters for a minimum of five years, after final gravimetric analyses have occurred.

13.2 Preparation of Samples

The analyst will follow 2.24.3 Particulate Matter 2.5 Standard Operating Procedures for Laboratory Responsibilities, Revision 2017, Jan. 1, 2017, outlining activities associated with preparing pre-sample batches. In addition to the sample filters, field blanks, lab blanks, and trip blank filters will also be prepared as required in 40 CFR Part 50, Appendix L Section 8.3.7.

Upon delivery of EPA-approved filters as specified in 40 CFR Part 50, Appendix L Section 6, the analyst will document their receipt and store the filters in the conditioning/weighing room. The analyst will label each box of filters with the date of receipt, will open each box one at a time and use each box completely before opening another. The analyst will use all filters in a lot before opening a case containing another lot. The analyst will visually inspect filters according to 2.24.3 Particulate Matter 2.5 Standard Operating Procedures for Laboratory Responsibilities.

13.3 Analysis Method for Gravimetric Samples

The DAQ uses an analytical instrument (analytical microbalance) that meets the requirements of 40 CFR Part 50, Appendix L Section 8.1. An outside vendor sets up the microbalance when needed and calibrates it yearly under an ongoing maintenance contract.

The primary support facility for the DAQ gravimetric network is the filter conditioning and semi-clean weighing room at the Green Square laboratory. The DAQ uses this laboratory to conduct pre-exposure weighing and post-exposure weighing of each PM filter sample as required in Appendix L, Section 8.2 of 40 CFR Part 50.

The laboratory is an environmentally controlled room with temperature and humidity controls. The DAQ keeps the temperature between 20 and 23 ° C and controls the RH between 35 and 40 percent. This RH range is not the criteria found in 40 CFR Part 58, Appendix L. The DAQ has opted for a set of constraints more rigorous than the constraints found in 40 CFR Part 50, Appendix L to provide an additional measure to meet the pre and post 5 percent criterion. The DAQ measures and records temperature and RH every 5 minutes. The internally grounded analytical microbalance is located on a marble slab and is protected from or located out of the path of any sources of drafts. It is also collocated with an ionizing bar for additional static control measures.

13.4 Internal Quality Control and Corrective Actions for Measurement Systems

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

At the beginning of each weighing session, for both filter pre-sampling weigh and post-sampling weigh, the analyst will zero and calibrate the analytical balance and weigh the working standards before the filters. The analyst will weigh one lab blank and one field blank for every 10 pre-samples weighed. The analyst will weigh a minimum of one lab and one field blank per each pre-weighing session. The balance will be re-zeroed between each pre or post-weighing. After every tenth filter weighing, the analyst will reweigh one of the working standards. The analyst will record the zero, working standard and blank measurements in the laboratory QC Excel spreadsheet. If the working standard measurements differ from the certified values or the pre-exposure values by more than 3 micrograms (µg), the analyst will repeat the working standard measurements. If the blank

measurements differ from the pre-exposure values by more than 15 µg, the analyst will repeat the blank measurements. If the two measurements still disagree, the analyst will contact the LAB supervisor, who may direct the analyst to:

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

Laboratory personnel will take corrective action measures in the $PM_{2.5}$ systems to ensure good quality data. Filter weighing must not occur if the weigh-room does not meet climate control conditions, and may only resume once the analyst satisfactorily implements appropriate corrective actions. Section 14.0 Quality Control Requirements and Procedures of this QAPP covers more of the lab QC.

At the time of this QAPP revision, lab procedures are being revised to more closely align with EPA Method 2.12.

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 and the specific instruments' operation manuals 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;
- Monthly operational checks by the RRO site operators;
- Performance evaluations;
- Periodic maintenance;
- Flow rate verifications and audits;
- Acceptance test procedures;
- Collocated instruments;
- Control charts; and
- Other verification techniques.

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 7.12 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, 2.17.2 Section 2.1, DAQ-12-002.2 Section 5.5, 2.36.2 Section 2, 2.37.2, 2.38.2 Section 3, 2.45.2, 2.46.2, 2.47.2 and 2.62.2 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 (desired) flowrate of low-volume particle samplers is 16.67 LPM, which is equivalent to 1 cubic meter per hour.

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 validation must be within ± 2 percent for the calibration to be successful.

Besides calibrating the monitors, the DAQ maintains a vendor-contract for calibration of the DAQ gravimetric laboratory analytical microbalance. At least once a year, the vendor examines the microbalance and performs a calibration. The calibration meets both DAQ and vendor requirements.

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. Calibrations are performed 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, 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. For the CO and NO_2 monitors, which are nonlinear, the zero and either two or three upscale points are adjusted during a calibration. These adjusted points have tight acceptance ranges, between which the analyzers' measured values must fall.

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, 2.17.2 Section 2.1, DAQ-12-002.2 Section 5.5, 2.36.2 Section 2, 2.38.2 Section 3 and 2.62.2 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. At the time of this QAPP revision some of these procedures and terminology used to describe them are being modified and streamlined.

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	Mid-Range	
One Point QC Check (1/14 days)	Concentration (ppb)	0	180	36	100	
	Acceptance (±)	1 ppb	6 percent	15 percent	8 percent	
Calibration	Concentration (ppb)	0	425	60	100	
	Acceptance (±)	1 ppb	3 percent	10 percent	3 percent	

Nitrogen Dioxide (NO_2) Nitric Oxide (NO) and Oxides of Nitrogen (NO_x) Channels (Chemiluminescence)						
Operation	Concentration / Acceptance Criteria	Zero	Span	Precision		Mid-Range
One Point QC Check (1/14 days)	Concentration (ppb)	0	425	60		Not applicable
	Acceptance (±)	1 ppb	10 percent	10 percent		
Calibration	Concentration (ppb)	0	425	60		
	Acceptance (±)	1 ppb	3 percent	5 percent		

Nitrogen Dioxide (NO_2) Channel (Cavity Attenuated Phase Shift Spectroscopy)						
Operation	Concentration / Acceptance Criteria	Zero	Span	Span 5	Span 2	Span 4
One Point QC Check (1/14 days)	Concentration (ppb)	0	180			20 [B]
	Acceptance (±)	<1.5 ppb	<10.1 percent (percent difference)			<10.1 percent (percent difference)
Calibration and Multi-Point Verification	Concentration (ppb)	0	200	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

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

	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	Precision	Low Mid-Range	Mid-Range
One Point QC Check (1/14 days)	Concentration (ppb)	0	4000	500	Not applicable	2000
	Acceptance (±)	60 ppb	5 percent (200 ppb)	7 percent (35 ppb)	Not applicable	5 percent (100 ppb)
Calibration (see comment) Verification	Concentration (ppb)	0	4000	3000	1000	2000
	Acceptance (±)	≤ ±30 ppb	< ± 2.1 % ***or*** *30* ppb of best fit line	< ± 2.1 % ***or*** *30* ppb of best fit line	< ± 2.1 % ***or*** *30* ppb of best fit line	< ± 2.1 % ***or*** *30* ppb of best fit line
Sulfur Dioxide (SO_2)						
Operation	Concentration / Acceptance Criteria	Zero	Span	Precision		Mid-Range
One Point QC Check (1/14 days)	Concentration (ppb)	0	85	7		N/A
	Acceptance (±)	>1 ppb	< 5%	< 7%		N/A
Calibration Verification	Concentration (ppb)	0	85	7		45
	Acceptance (±)	>1 ppb	< 5%	< 7%		< 5%
Ozone (O_3)						
Operation	Concentration / Acceptance	Zero	Span	Precision		Mid-Range

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

	Criteria					
One Point QC Check (1/14 days)	Concentration (ppb)	0	225	65		N/A
	Acceptance (±)	3 ppb	5 ppb	3 ppb		N/A
Calibration Verification	Concentration (ppb)	0	225	65		120
	Acceptance (±)	2 ppb	2 ppb	2 ppb		2 ppb

At this time for some pollutants, the DAQ calibration criteria differs from the EPA criteria of the slope being 1 ± 0.05 and each point being within ± 2 percent of the best-fit line. Also, for some pollutants the DAQ calibrations do not use four upscale points as recommended by the EPA or required by some of the appendices in 40 CFR Part 50. Ozone and CO use a linear regression analysis during the calibration / verification procedure, which includes a zero and 4 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 three upscale points for the NO and NO_y calibration and does one gas-phase titration. For NO_2, the DAQ uses zero and two upscale points for the NO and NO_x calibration and does two gas-phase titrations to calibrate the NO_2 channel as described in the instrument manual. The DAQ is currently reviewing and revising these procedures. The DAQ will submit QAPP revisions after DAQ develops these new procedures.

14.2 Precision Checks

Precision is defined 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 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 QC check is made by challenging the trace-level analyzer with a 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 7.12, 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 of time to be accurate enough for an official, reportable check.

Table 14.2 Acceptance Criteria for Nightly Precision-Zero Span Checks

Nitric Oxide (NO) and Oxides of Nitrogen (NO_x) Channels (Chemiluminescence)			
Concentration/Acceptance Criteria	Span		
	Precision	Zero	Span
Concentration (ppb)	425	0	60
Acceptance (±) [1]	10 percent	1 ppb	10 percent
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 is embedded in the E-logs used by field technicians.

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

A calibration must be performed if the 1-point QC check or PZS fails and the instrument is found to be in good working order. Normally if either of these checks fail, there is a problem within the monitoring system that needs addressing (i.e., results in equipment maintenance and/or repair). If the zero check 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 – it simply indicates 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 of time. 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 monitoring technician compares the flow rate reported by the transfer standard to the flow rate measured by the sampler. The monitoring technician calculates percent difference for the two readings and compares the results to the acceptance criteria in Tables 7.6 to 7.8 and Tables 7.11 and 7.12. The 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. These QC checks verify (confirm) the PM sampler is in good working order and, therefore, support the defensibility of the data.

14.2.3 Duplicate Filter Weights

In accordance with Quality Assurance Guidance Document 2.12, the analyst must complete a duplicate filter weighing each sampling batch. The analyst randomly selects a duplicate filter from among the routine sample filters to reweigh at the end of the batch. Although the acceptance criteria in 2.12 is that the duplicate weighing must be within 15 micrograms of the initial weighing, DAQ has established more robust criteria for the duplicate weighing of less than a plus or minus five microgram change between the initial and final weights. If the duplicate weight fails the criteria, the analyst will reweigh the last 10 filters. If the reweigh continues to fail, the analyst must contact the LAB Supervisor for additional guidance and corrective action. At the time of this QAPP revision, the PM LAB technician and RCO LAB QA chemist are modifying some of the lab duplicate filter weighing procedures (namely the number of filters per batch) to more closely follow the guidance provided in Method 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 2.37.2, 2.46.2, 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 audit concentrations selected for evaluation include a value at or near the detection limit of the monitor, a value near the level of the 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-08-001.1, 2.7.1, 2.17.1, 2.34.1, 2.36.1 and 2.38.1 (see Table 11.2 for SOP titles) provide details for implementing annual performance evaluations.

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. The applicable instruments' operations manuals and SOPs 2.37.2, 2.45.2, 2.46.2 and 2.47.2 (see Table 11.2) provide details for implementing flow audits.

14.3.3 Meteorological Sensor Checks

At the time of this QAPP, DAQ's NCore monitoring program has not established a quality assurance regime for the meteorological sensors operated at the NCore site. However, the DAQ audits the equipment annually and calibrates it semi-annually to ensure it is functioning correctly. The DAQ takes corrective action when the audits or calibrations fail. The DAQ may flag any affected data. 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 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 only includes 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 exactly the same manner, and then compare the results. Further information on the PEP is available at this link.

14.4 Reference Membrane Span Foil Verification

For the BAM 1020 instruments, the monitor must perform an automated reference-membrane span foil verification once every 24 hours. The reference-membrane span foil verification monitors the stability and performance of the beta counter. If the verification fails, the operator will call the ECB to have the BAM 1020 replaced.

14.5 BAM Background Tests

The operator must perform a zero background test on the BAM, after the initial installation and calibration, as soon as the weather conditions meet the minimum weather requirements: 48 to 72 hours of clear weather with no precipitation forecasted. The ECB electronics technicians may also perform a zero background test indoors before they install the monitor: they do not have to follow the weather requirements in this circumstance, yet they must still use the smart heater. This test corrects the background value to compensate for minor variations caused by local conditions such as grounding and shelter characteristics. The regional monitoring technicians will perform subsequent background tests on an annual basis in early spring (March/April/May) or fall (September/October/November) when dew points are generally at a low point. The test collects data for 48 to 72 consecutive hours having the PM10 and PM2.5 inlets replaced with a high-efficiency particulate air (HEPA) filter (BX-302) on a flow audit adapter. At the end of a completed 48 to 72-hour period, the regional monitoring technician must download the data and statistically analyze it using a spreadsheet template. After the regional monitoring technician has calculated a new background value and compared it with the factory zero, the monitoring technician should audit the new coefficient for 24 hours before resuming normal data collection, especially if the BAM is close to failing the background test.

14.6 Laboratory QC

14.6.1 Balance Checks

Balance checks are frequent checks of the balance working standards against the laboratory balance to ensure precision throughout weighing sessions. The laboratory will use American Society for Testing and Materials class 1 weights for its primary and secondary (working) standards. The analyst will measure both 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.

14.6.2 Quarterly Weight Verifications

Although the analyst has the working standards re-certified annually against a NIST-traceable standard at an accredited metrology laboratory, minimally, the analyst must verify 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. The analyst 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 calibration of the microbalance.

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. In this method, the laboratory analyst 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 analyst 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 analyst 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.

14.6.3 Blank Checks

Collecting blanks is required under 40 CFR Part 50, Appendix L Section 8.3.7.1. As such, DAQ will collect field and trip blank samples as a QC check. A field blank is a filter that is pre-weighed with routine samples, installed in the field sampler without any flow passing over the filter, re-weighed with routine samples, and then initial/final weights compared. The purpose of blanks is to provide an estimate of total measurement system contamination, such as for transport or field activities. Through a comparison of laboratory blanks against field blanks, DAQ can assess contamination from field activities. The acceptance criterion for field blanks is ± 30 micrograms between the initial and final weighing. 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 blanks over the course of a year. The DAQ takes field 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 blank filters. Collecting trip blanks is not a requirement under 40 CFR Part 50, Appendix L; however, collecting trip blanks is a best practice. The site operator treats a trip blank exactly as a field blank, but the operator never places the filter into the sampler or exposes it to the ambient environment. The purpose of the trip blank is to assess possible contamination to filters during packing and transport to and from the laboratory to the sampling location. The acceptance criterion for trip blanks is ± 15 micrograms between the initial and final weighing. If the weight change exceeds 15 micrograms, contamination in the laboratory or during shipping may be occurring. As with field blanks, The DAQ collects trip blanks within its network at a frequency of approximately 10 percent of the sampling runs.

The DAQ gravimetric laboratory issues field blanks and trip blanks to the RRO. The lab analyst prepares batches of and tracks the issuance and number of blanks.

14.6.4 Filter Holding Times

The PM LAB analyst and RCO PM chemist will evaluate all filters to ensure each step of the process met its holding time. 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.

The analyst 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. The analyst must weigh samples shipped at AT within 10 days of the sample date. If shipped at less than the average AT or at less than 4 ° C, the analyst must weigh the sample within 30 days of the collection date. The analyst and PM chemist will void any samples received above 25 ° C.

14.6.5 Filter Conditioning Environment

The analyst 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 21 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 35 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 ± 5.1 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.

As previously mentioned, the DAQ has opted for a set of constraints more rigorous than the constraints found in Appendix L to have an action level for corrective actions.

14.6.6 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.

14.7 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 so they will also need to implement corrective actions on an "as-necessary" basis. The DAQ SOPs 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 14.2 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.

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.
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.

14.8 Documentation

The RRO monitoring and ECB electronics technicians will document all events including routine site visits, calibrations, analyzer maintenance and calibration equipment maintenance on Air Quality Section Maintenance Order or AQ-109 forms and Continuous Monitor Performance Audit Report or AQ-121 forms and in e-logs and site logbooks. The ECB electronics technicians will also record 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 in the weights original spreadsheet and other electronic and bound logs.

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 houses 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 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 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

At the time of this QAPP, the DAQ is revising the testing procedures to clarify and streamline them. 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. For indoor shelter temperature, meteorological sensors and NO_y measurements, where EPA equivalent or reference methods do not exist, DAQ will follow EPA guidance. Table 11.1 identifies the model designations. 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 monitors, the analyzers shall successfully undergo zero/span and multi-point calibrations. If any of these checks are out of specification, the ECB electronics technician will contact the vendor for initial corrective action. Following site installation, the RRO monitoring technicians will initiate, observe and document the successful completion of a zero/span cycle by the ECB electronics technicians installing the equipment. If the analyzers meet the zero/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 **Error! Reference source not found.** 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 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.

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. The SOP 2.24.3 details what to inspect and how to appropriately document the inspections. At the time of this QAPP revision, the PM LAB analyst and RCO LAB QA chemist are revising the inspection procedures to clarify and streamline them, along with providing procedures to document them properly.

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 contaminates.
- 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 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. 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 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 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 routine preventive activities and schedules are detailed in the specific equipment SOPs (see Table 11.2) and supplemented by the equipment user manuals. 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 major piece of equipment in the laboratory is the analytical microbalance. The vendor performs routine maintenance on the microbalance every six months. The DAQ maintains a service contract

for the climate control equipment located in the ceiling of the PM laboratory. The service provider does routine maintenance and service on the equipment as well as repairs when the equipment fails.

The weigh lab itself is cleaned weekly or whenever the lab analyst deems necessary.

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.

The ECB electronics technicians are responsible for procuring and maintaining dedicated 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 2.3.3, 2.3.4, 2.3.5, 2.3.6 and 2.7.1 (see Table 11.2 for SOP titles) or operation manuals.

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

- DAQ recertifies devices at least annually. The DAQ keeps records of these certifications in the PM laboratory, at the ECB and in the regional office.
- 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. The DAQ maintains documentation of these procedures in the PM laboratory or ECB shop on appropriate forms.
- The DAQ maintains records of all instrument calibrations, using the traceable standards (with instrument identification numbers clearly documented), on the RRO or RCO share drives.

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

The following summarizes the standards used in the DAQ network and their recertification process. The PM LAB, RRO monitoring and ECB electronics technicians monitor all certification periods to ensure the PM LAB and RRO monitoring technicians 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 at least 30 days prior to being out of certification. Likewise, the PM LAB technician is responsible for ensuring all equipment used in the PM laboratory is within its certification period.

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. DAQ staggers the rotation of standards such that one device remains in certification at all times. 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.

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. SOP Section 2.3.3 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 re-verify 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 re-verifies or recertifies the handheld digital barometers at least annually against the "local primary pressure standard." SOP Section 2.3.3 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 re-verifies or recertifies them at least annually against the local primary pressure standard or auditor's transfer standard, to within 1 millimeters 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 9 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 re-verify 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

The DAQ recertifies the working and primary weights used to calibrate the laboratory microbalance annually. The DAQ sends the weights to a certified metrology lab. The metrology lab documents these actions in a certification and provides a copy of the certificate to the laboratory analyst, who after reviewing the report, files it in a filing cabinet in the gravimetric laboratory. This process is currently undergoing review and revision at the time of this QAPP revision.

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 re-verify or recertify SO_2 standards after four years, NO standards after three years and CO standards after eight years.

16.4 Analytical Balance

The vendor calibrates the analytical microbalance at installation and at least once every 365 days. The analyst verifies the calibration before each weighing session. SOP Section 2.24.3 provides further details on the calibration procedures.

16.5 Lab Temperature and Relative Humidity

The analyst verifies the calibration of the sensors that monitor lab temperature and RH every 182 days with independent traceable devices. 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. SOP Section 2.24.3 provides further details on the calibration procedures. This process is currently undergoing review and revision at the time of this QAPP revision to include proper documentation and recertification of standards leading to a solid traceability.

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, NO_x 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, NO_x 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 technicians will retain calibrator certification documentation at the ECB facility in Raleigh, NC. 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., BAM filter tape and 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 received materials 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: https://www3.epa.gov/ttn/amtic/aapgvp.html. 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 $PM_{2.5}$ Teflon filters are also consumables. Section 13.0 Analytical Methods discusses the filters in more detail.

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 from 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;
- 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 inter-related set of standardized processes used to acquire, transmit, transform, reduce, analyze, store and retrieve data. When documented and followed, a data management system helps maintain the integrity and validity of the data throughout its entire life cycle. DAQ's air monitoring data follows a documented flow path. The data life-cycle starts before 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, as well as the QA/QC data collected within the network. 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 in accordance with 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 (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 run-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 has 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. The Envidas and Envista ARM databases do not allow the deletion of raw (original) data. The DAQ uses the Envista ARM database for data verification, validation, and reporting; the database uses replicate versions of the raw data to avoid violating the integrity of the original dataset. 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 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 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

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

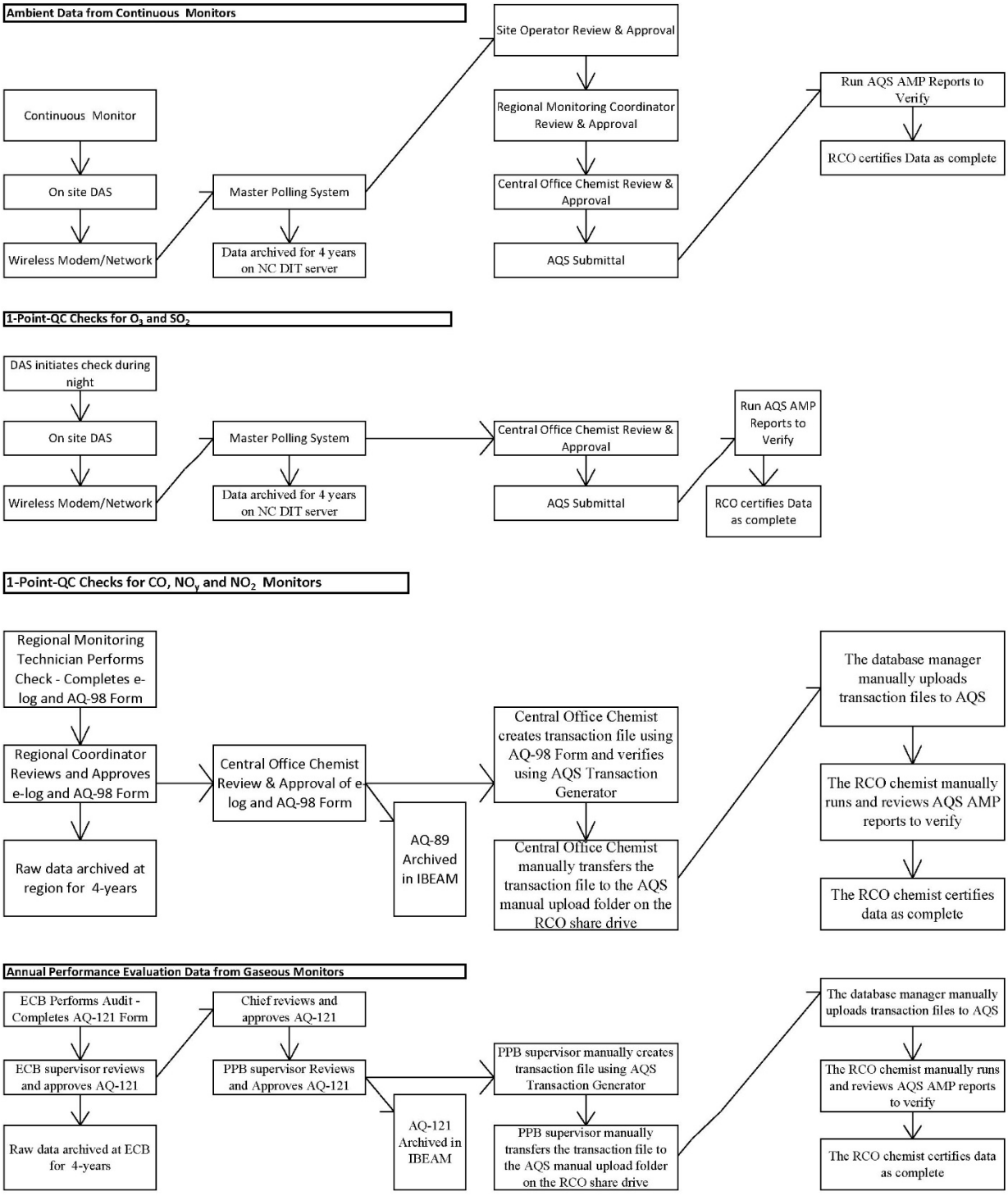
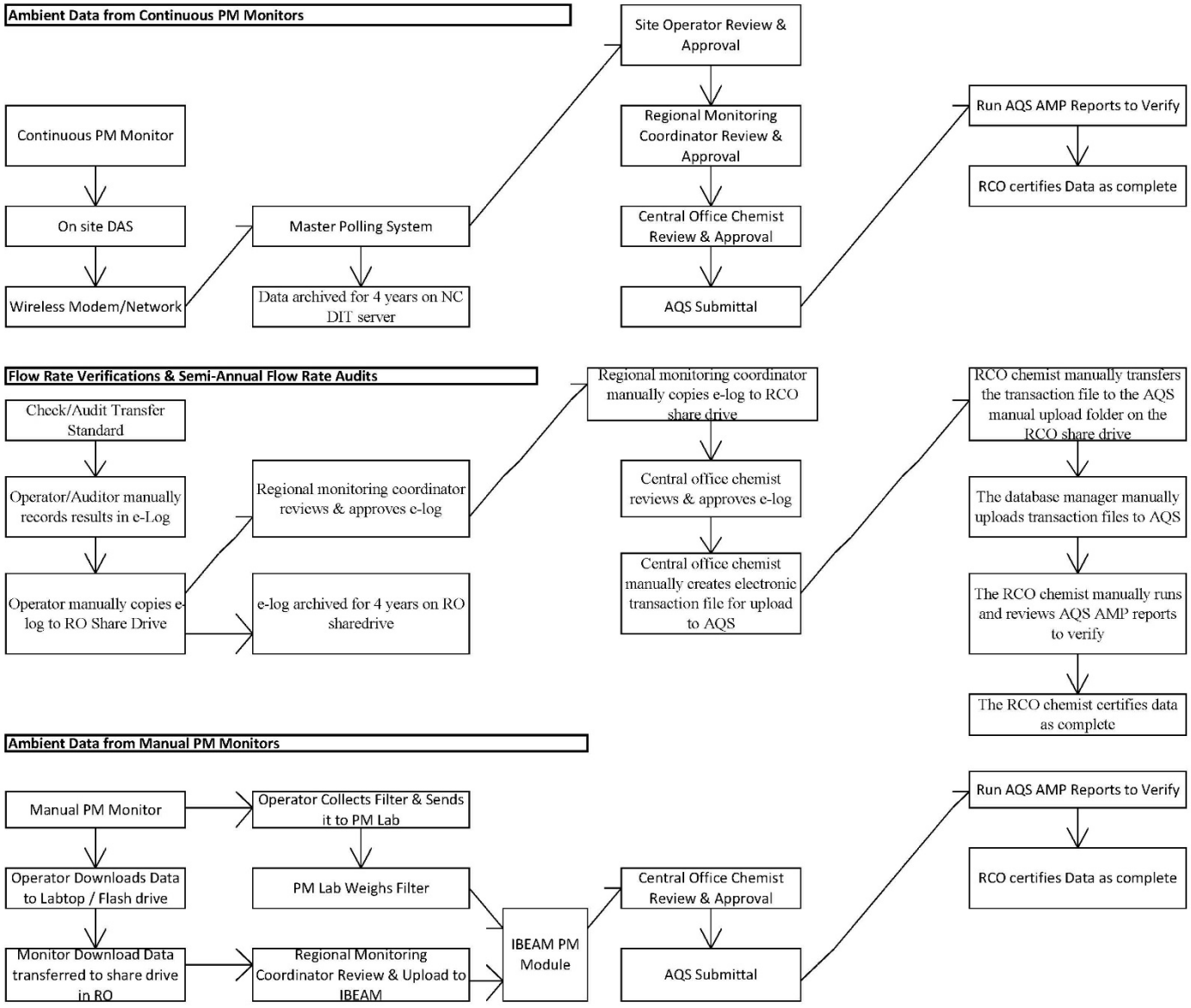


Figure 19.2 NCore Data Flow Path for PM Data



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 all paper documents, that is the reports from the performance evaluations, the PPB supervisor manually creates a transaction file using the AQS Transaction Generator, archives a scanned copy of the paper document in IBEAM 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.

IBEAM is a Java-based web application system used by DAQ as a primary repository and tracking system for many of the division's business processes, including ambient monitoring data, forecast data, and DAQ business documents, among others. 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 Hypertext Markup Language (HTML) and Java Server Pages, or JSP's, in Internet Explorer. The DAQ designed the system in a modular format with each module containing sub categories 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.

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, use Envista ARM to add any missing PZS checks, add null codes where appropriate, and add 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 uploads the transaction files to AQS.

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 IBEAM.

For the intermittent filter-based method, DAQ manually determines 24-hour concentration values. This process combines manually generated data from the gravimetric laboratory activities with data collected by the field instrument during a 24-hour sampling event. For filter-based sampling, the lab analyst enters initial filter weights and climate conditions into the Weights Original Excel spreadsheet at the PM Laboratory. The Weights Original Excel spreadsheet synchronizes with IBEAM, transferring the data into the PM module, which stores and archives it. The operator downloads in-the-field data generated directly from the site sampler; these data represent the conditions of the 24-hour sampling event. The monitoring coordinator transfers these data electronically to IBEAM using a File Transfer Protocol (FTP) twice a month. The operator also manually transfers sampler runtime data unto the filter data sheets (e-logs) and these filter data sheets accompany exposed filters back to the PM Laboratory, as discussed in Section 13 of this QAPP. Once the LAB analyst completes the

post-sampling analysis, IBEAM combines the final weigh data from the Weights Original Spreadsheet with the FTP-transferred field data to determine final concentration values for the filter-based $PM_{2.5}$ samples.

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 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. If communications problems arise, the Envista ARM software retrieves the data from the Envidas system when it can once again communicate with the site. The monitoring technician must make a site visit if the database manager or ECB electronics technician informs him or her that he 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 acts as the base unit for all measurements taken by the gaseous monitors within the DAQ NCore monitoring network. The monitors, as well as the Envidas 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 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. Envidas 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 24-hour values and weighted annual averages.

For the filter-based $PM_{2.5}$ data, the RCO PM chemist extracts the final concentration data (24-hour values) from IBEAM, transferring them to the database manager for subsequent upload into AQS. Note: The IBEAM database electronically grabs information from the Weights Original spreadsheet ($PM_{2.5}$ gravimetric laboratory) once every weekday.

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 monitoring and ECB electronics technicians can take corrective actions to address monitor-related issues identified during the data review process.

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 2.7.1, 2.7.2, 2.12.1, 2.17.1, 2.17.2, 2.34.1, DAQ-12-002.2, 2.36.1, 2.36.2, 2.37.2, 2.38.1, 2.38.2, 2.44.2, 2.45.2, 2.46.2, 2.47.2 and 2.62.2 (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.

At the time of this QAPP revision, DAQ is in the process of updating and streamlining its data review procedures and developing new SOPs. The DAQ will revise this QAPP once DAQ implements the new 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 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 7.12 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 technicians and coordinator, RCO chemists, audit chemist and statistician can download data from Envidas 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. 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, analyzing the results.

19.6 Data Submission

After the monitoring technicians, coordinator and RCO chemists complete all three levels of 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. 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 (including NO and NO_x);
- The ambient air quality data obtained 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), NO_2 (including NO and NO_x) and meteorological parameters.

At the end of each quarter, a RCO chemist runs the AMP251, AMP256, AMP350, AMP430 and AMP600 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 7.12.

Every year before the 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 annual QA 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 un-alterable 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 system.

Because of the DAQ archiving system, the DAQ can store and retrieve the 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 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. 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 polls data older than one week old directly from the site computer. In the future, DAQ may house the main database in DIT's Western Data Center using a Virtual Server mirrored to the current database computer. DAQ keeps all data in real time.

Note that the monitoring technicians also download data directly from instruments to laptops in the field for continuous $PM_{2.5}$ and $PM_{2.5}$ FRM twice a month; these data downloads serve as a backup, as they are uploaded to the RRO group drive for archival. The monitoring technicians also download backup site temperature data and store it on the RRO group drive 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. After the storage period has passed, the storage media may be disposed of or recycled.

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. 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

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 network review may identify possible network modifications to enhance the system or correct deficiencies in attaining network objectives.

Before implementing a 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 discrepancies and resolve them during the review. The RRO monitoring technician will also identify 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 network review, the RRO monitoring technician and coordinator will reconfirm the stated objective for the monitoring site and re-verify 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.

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

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

20.1.1 Five-Year Network Assessment

The five-year network assessment is a more extensive evaluation of the air-monitoring network. 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 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. 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 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. The NPAP program audits 20 percent of an agency's sites per year and each site every six years. Since DAQ has 35 sites, including the NCore site, the EPA may only audit the NCore site once every six years. 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. EPA contractors typically provide the results of NPAP audits immediately following the results of the NPAP audit. 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. 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.

20.3 Annual Performance Evaluations

The ECB electronics technicians 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 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 AQ-121 form. If a monitor does not pass the evaluation, the RRO and ECB monitoring staff will take appropriate action to identify why the monitor failed the evaluation and to correct the situation.

20.4 Semi-Annual Flow Rate Audits

A RRO monitoring technician other than the RRO monitoring technician who routinely operates the $PM_{2.5}$ monitors completes a flow rate audit on the monitors at least once every 182 days and preferably once every quarter or 91 days. This RRO monitoring technician uses different equipment to conduct the audit than the equipment used to calibrate the monitors and do the monthly or semi-monthly flow checks. The RRO monitoring technician follows the audit procedures in SOPs 2.46.2, 2.47.2, 2.37.2, 2.44.2 and 2.45.2. 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.

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 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 IBEAM. If the monitor does not meet completeness requirements, 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, the chief or his designee 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 is 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 audit of data quality, or ADQ, reveals how the level 1 to 3 reviewers handled data, what judgments they made and whether they made uncorrected mistakes and records exist to support the decision. 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 SOP 2.61. 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

The DAQ will estimate measurement uncertainty for both automated and manual data recording methods. 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. 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 semi-monthly 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, NO_x 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
														Bad ZAP, replaced on 7/2
7/1/2020	21.90	23.70	23.16	26	47	35.09	40.63							
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 an on-site 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 similar to 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.

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.

20.10.1 Post-Audit Activities

The major post-audit activity is the preparation of the systems audit report. The report will include:

- Audit title, identification number, date of report and any other identifying information;
- Audit team leaders, audit team participants and audited participants;
- Background information about the project, purpose of the audit, dates of the audit, measurement phase or parameters that were audited and a brief description of the audit process;
- Summary and conclusions of the audit and corrective action required; and
- Attachments or appendices that include all audit evaluations and audit findings.

The auditor will prepare a written report summarizing the findings. The following areas may be included but all reports will include items 3, 4 and 5:

1. Planning,
2. Field operations,
3. QA/QC,
4. Data management and
5. Reporting.

The auditor will document problems with specific areas and will implement corrective actions.

To prepare the report, the auditor will compare observations with collected documents and results of interviews with key personnel. The auditor will also compare expected QAPP implementation with observed accomplishments and deficiencies. The auditor will review audit findings in detail and, within 30 calendar days of the completion of the audit, will generate an audit report and distribute it to senior staff for comment.

If the RRO, ECB or RCO have written comments or questions concerning the audit report, the auditor will review and incorporate them as appropriate. Subsequently, a modified report will be prepared and resubmitted in final form to the RRO, ECB or RCO within 30 days of receipt of the written comments. The report will include an agreed-upon schedule for corrective action implementation.

20.10.2 Follow-up and Corrective Action Requirements

As part of corrective action and follow-up, the RRO, ECB or RCO will generate an audit finding response form for each finding in the systems audit report with a corrective action report where appropriate. The RRO, ECB or RCO supervisor signs the audit finding response form and sends it to

the auditor, who reviews and accepts or rejects the corrective action. The audit response form will be completed within 30 days of acceptance of the audit report.

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.

20.10.3 Audit Schedule

The RCO audit chemist will perform an internal TSA on the NCore program at least once every three years, and ideally every year.

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. Unless otherwise indicated, all reports will contain monitoring data for the list of pollutants provided in Table 5.2.

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 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 SOP 2.41.4. After the database manager uploads all data for the quarter to AQS, an RCO chemist pulls and reviews the following quarterly reports from AQS: the AMP251, AMP256, AMP350, AMP350MX, AMP430 and AMP600. After reviewing the reports, the RCO chemist archives the reports in the IBEAM general documents 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. 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)

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

21.2 Annual Performance Evaluations

The ECB electronics technicians conduct performance evaluations, sometimes referred to as audits, of the gaseous monitors at least once 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 chief for review and approval. After the chief 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 the year, the RRO monitoring technicians conduct an annual site review documenting the information requested on the annual site review forms, which is part of the agency's overall annual network review. SOP 2.43 describes this process. This 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 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 submits the form to the coordinator, who reviews the form and submits it to the RCO by Dec. 31. The PPB supervisor archives the network review forms in the IBEAM general documents module and provides them to the public and the EPA as appendices to the annual network-monitoring plan.

21.4 Annual Data Certification

The chief and PPB supervisor will prepare a data certification package for the chief's signature by May 1 of each year. 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) the ambient monitoring section prepares and submits to the EPA regional administrator an annual monitoring network plan by July 1 of each year. 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 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. The ECB documents 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. 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 cc'd to the RRO supervisor. At the time of this QAPP, these procedures are undergoing review and may be revised to streamline and improve the process.

22.0 Data Validation and Usability

Data review is the in-house examination to ensure that all of 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 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 data reviewers shall invalidate or flag data identified as suspect, or 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 specified requirements. 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

Sampling network design and monitoring site selection must comply 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 for 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 Sample Collection Procedures

Section 11.0 Sampling Methods Requirements outlines sample collection procedures. The Envidas DAS routinely identifies potentially unacceptable data points in the database through electronic application of Envidas-applied general status flags. Each instrument-specific flag is associated with a unique error. The level 1 to 3 reviewers routinely review these error flags as part of the data validation process. This activity assists in identifying suspect (potentially bad) data points that could invalidate the resulting averaging periods. A 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.

Table 22.1 Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
IA	African Dust	INFORM	To provide information on events that influenced the measured values.
IB	Asian Dust	INFORM	
IC	Chem. Spills and Indust Accidents	INFORM	
ID	Cleanup After a Major Disaster	INFORM	
IE	Demolition	INFORM	
IF	Fire - Canadian	INFORM	
IG	Fire - Mexico/Central America	INFORM	
IH	Fireworks	INFORM	
II	High Pollen Count	INFORM	
IJ	High Winds	INFORM	
IK	Infrequent Large Gatherings	INFORM	
IL	Other	INFORM	
IM	Prescribed Fire	INFORM	
IN	Seismic Activity	INFORM	
IO	Stratospheric Ozone Intrusion	INFORM	
IP	Structural Fire	INFORM	
IQ	Terrorist Act	INFORM	
IR	Unique Traffic Disruption	INFORM	
IS	Volcanic Eruptions	INFORM	
IT	Wildfire-U. S.	INFORM	
IU	Wildland Fire Use Fire-U. S.	INFORM	
J	Construction/Demolition	INFORM	
K	Agricultural Tilling	INFORM	
L	Highway Construction	INFORM	
M	Rerouting of Traffic	INFORM	
N	Sanding/Salting of Streets	INFORM	
O	Infrequent Large Gatherings	INFORM	
P	Roofing Operations	INFORM	
Q	Prescribed Burning	INFORM	
R	Clean Up After a Major Disaster	INFORM	
S	Seismic Activity	INFORM	
U	Sahara Dust	INFORM	

Table 22.1 Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
Z	Other event	INFORM	
1C	A 1-Point-QC check exceeds acceptance criteria but there is compelling evidence that the analyzer data are valid	NULL	Void the data and submit the code in its place.
AA	Sample Pressure Out of Limits	NULL	
AB	Technician Unavailable	NULL	
AC	Construction/Repairs in Area	NULL	
AD	Shelter Storm Damage	NULL	
AE	Shelter Temperature Outside of Limits	NULL	
AF	Scheduled But Not Collected	NULL	
AG	Sample Time Out of Limits	NULL	
AH	Sample Flowrate or CV Out of Limits	NULL	
AI	Insufficient Data (Cannot Calculate)	NULL	
AJ	Filter Damage	NULL	
AK	Filter Leak	NULL	
AL	Voided by Operator	NULL	
AM	Miscellaneous Void	NULL	
AN	Machine Malfunction	NULL	
AO	Bad Weather	NULL	
AP	Vandalism	NULL	
AQ	Collection Error	NULL	
AR	Lab Error	NULL	
AS	Poor Quality Assurance Results	NULL	
AT	Calibration	NULL	
AU	Monitoring Waived	NULL	
AV	Power Failure	NULL	
AW	Wildlife Damage	NULL	
AX	Precision Check	NULL	
AY	QC Control Points (Zero/Span)	NULL	
AZ	QC Audit	NULL	
BA	Maintenance/Routine Repairs	NULL	
BB	Unable to Reach Site	NULL	
BC	Multi-Point Calibration	NULL	
BD	Automatic Calibration	NULL	
BE	Building/Site Repair	NULL	
BF	Precision/Zero/Span	NULL	
BG	Missing Ozone Data Not Likely to Exceed Level of Standard	NULL	
BH	Interference/Co-Elution/Misidentification	NULL	
BI	Lost or Damaged In Transit	NULL	
BJ	Operator Error	NULL	
BK	Site computer/data logger down	NULL	
BL	QA Audit	NULL	
BM	Accuracy check	NULL	
BN	Sample Value Exceeds Media Limit	NULL	
CS	Laboratory Calibration Standard	NULL	
DA	Aberrant Data (Corrupt Files, Aberrant Chromatography, Spikes,	NULL	
DL	Detection Limit Analyses	NULL	
FI	Filter Inspection Flag	NULL	

Table 22.1 Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
MB	Method Blank (Analytical)	NULL	
MC	Module End Cap Missing	NULL	
SA	Storm Approaching	NULL	
SC	Sampler Contamination	NULL	
ST	Calibration Verification Standard	NULL	
TC	Component Check and Retention Time Standard	NULL	
TS	Holding Time Or Transport Temperature Is Out Of Specs.	NULL	
XX	Experimental Data	NULL	
1	Deviation From a CFR/Critical Criteria Requirement	QA	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	QA	
2	Operational Deviation	QA	
3	Field Issue	QA	
4	Lab Issue	QA	
5	Outlier	QA	
6	QAPP Issue	QA	
7	Below Lowest Calibration Level	QA	
CB	Values have been Blank Corrected	QA	
CC	Clean Canister Residue	QA	
CL	Surrogate Recoveries Outside Control Limits due to analytical	QA	
EH	Estimated; Exceeds Upper Range	QA	
FB	Field Blank Value Above Acceptable Limit	QA	
HT	Sample pick-up hold time exceeded; data questionable	QA	
LB	Lab blank value above acceptable limit	QA	
LJ	Identification Of Analyte Is Acceptable; Reported Value Is An	QA	
LK	Analyte Identified; Reported Value May Be Biased High	QA	
LL	Analyte Identified; Reported Value May Be Biased Low	QA	
MD	Value less than MDL	QA	
MX	Matrix Effect	QA	
ND	No Value Detected	QA	
NS	Influenced by nearby source	QA	
SQ	Values Between SQL and MDL	QA	
SS	Value substituted from secondary monitor	QA	
SX	Does Not Meet Siting Criteria	QA	
TB	Trip Blank Value Above Acceptable Limit	QA	
V	Validated Value	QA	
VB	Value below normal; no reason to invalidate	QA	
W	Flow Rate Average Out of Specification	QA	
X	Filter Temperature Difference or Average Out of Specification	QA	
Y	Elapsed Sample Time Out of Specification	QA	
RA	African Dust	REQEXC	Applied only after application process completed and accepted by AQS for data eligible to be excluded as an exceptional event.
RB	Asian Dust	REQEXC	
RC	Chem. Spills and Industrial Accidents	REQEXC	
RD	Cleanup After a Major Disaster	REQEXC	
RE	Demolition	REQEXC	
RF	Fire - Canadian	REQEXC	

Table 22.1 Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
RG	Fire - Mexico/Central America	REQEXC	
RH	Fireworks	REQEXC	
RI	High Pollen Count	REQEXC	
RJ	High Winds	REQEXC	
RK	Infrequent Large Gatherings	REQEXC	
RL	Other	REQEXC	
RM	Prescribed Fire	REQEXC	
RN	Seismic Activity	REQEXC	
RO	Stratospheric Ozone Intrusion	REQEXC	
RP	Structural Fire	REQEXC	
RQ	Terrorist Act	REQEXC	
RR	Unique Traffic Disruption	REQEXC	
RS	Volcanic Eruptions	REQEXC	
RT	Wildfire-U. S.	REQEXC	

INFORM = Exceptional or unusual natural occurance, data not requested to be excluded
NULL = invalid data.
QA = data does not meet all acceptance criteria but is not believed to be invalid.
REQEXC = Exceptional or unusual natural occurance, data requested to be excluded

The RRO monitoring technician must document any deviation from the established sample collection plan in the appropriate logbook or data sheet. Accurate and complete documentation of any 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 recorded in the applicable electronic database for all other pollutants. The lab analyst, likewise, records deviations in samples and sample handling.

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 were met as found 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 during monitoring, sample collection, and analysis. These include the analyses of calibration check standards, blanks, replicates, monthly or semi-monthly flow rate verifications and collocated monitoring, which provide

indications of the quality of data produced by specified components of the measurement process. SOPs 2.7.1, 2.7.2, 2.12.1, 2.17.1, 2.17.2, 2.34.1, DAQ-12-002.2, 2.36.1, 2.36.2, 2.37.2, 2.38.1, 2.38.2, 2.44.2, 2.45.2 , 2.46.2, 2.47.2 and 2.62.2 (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 7.12. 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. SOPs 2.7.2, 2.17.2, DAQ-12-002.2, 2.36.2, 2.37.2, 2.38.2, 2.44.2, 2.45.2, 2.46.2, 2.47.2 and 2.62.2 provide further information about one-point-QC checks, monthly flow rate verifications and PM laboratory QC.

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 any data produced between the suspect calibration event and any subsequent recalibration to alert data users. SOPs 2.7.2, 2.17.2, DAQ-12-002.2, 2.36.2, 2.37.2, 2.38.2, 2.44.2, 2.45.2, 2.46.2, 2.47.2 and 2.62.2 (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 will review the data quarterly to ensure that the RRO monitoring technicians and coordinator, ECB electronics technicians and other RCO chemists took 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 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.

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 7.12 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 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 sample or group of 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 sample 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 impact the validity of a sample 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 2.41.4 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 QA/QC support.

The DAQ compares data under evaluation to actual events as specified in SOP 2.41.4. However, significant and unusual field events may occur and field activities may negatively affect the integrity of samples. 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 – 7.5 and 7.7 – 7.12. The DAQ shall void or flag data identified as suspect or does not meet the acceptance criteria, using the codes in Table 22.1.

The DAQ verifies and validates the continuously collected data and its associated QC data monthly. Presently, for the continuously collected data, monthly 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 the validation template for FRM $PM_{2.5}$ data provided in Table 7.6 of this QAPP. *Guidance on Environmental Data Verification and Data Validation,* (EPA QA/G-8) also discusses verification and validation issues at length. The RCO chemist shall perform all verification activities with assistance from the LAB technician and chemist, the RCO LAB QA chemist, and the RRO monitoring technicians and coordinator. The RCO chemist 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 chemist will provide a final validation of all data. The RCO chemist will also provide QA/QC support.

The DAQ compares the data undergoing evaluation to actual events as specified in Table 7.6. However, significant and unusual field events may occur and field activities may negatively affect the integrity of samples. In addition, the DAQ expects that some of the QC checks will indicate the data fail to meet the acceptance criteria in Table 7.6. The DAQ shall void or flag data identified as suspect or does not meet the acceptance criteria, as indicated in Table 22.1.

The DAQ verifies and validates the intermittently collected data and its associated QC data quarterly for the FRM $PM_{2.5}$ monitor using the form in Figure 23.1. Presently, for the data collected by the FRM, quarterly is the most efficient period for these verification and validation activities. The DAQ finds that if DAQ can control the measurement uncertainty 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.

Filter Sheet and I-BEAM Completeness Review	Yes	No
Filter # and date on data sheet agrees with the field data in I-BEAM?	☑	☐
All sampling occured on a 1:3 or 1:6 schedule? *If not, see Misses Samples section.*	☑	☐
Field blanks: 1/month/sampler? 10/3/18, 11/17/18, 12/5/18	☑	☐
Trip blanks: 1/quarter?site? 10/18/18, 11/29/18	☑	☐
Blanks net mass are within ± 30 µg? *If greater, reweigh filter and review data.*	☐	☐

Lab Data Review	Yes	No
≤ 30 days from initial weighing date to sampling date?	☐	☐
≤ 30 days (or days calculated by lab) from sampling date to final weighing date?	☐	☐
Arrival filter temperature less than 25° C?	☐	☐
Initial weighing %RH within 5% of final weighing %RH?	☐	☐

Field Data Review	Yes	No
Run time 0:00 to 0:00; 23 to 25 hours / 1380 to 1500 minutes? *Otherwise void.*	☐	☐
Flow CV less than 2.0? *Otherwise void.*	☐	☐
Average flow rate 16.7 l/min? *15.9 to 17.5 is acceptable.*	☐	☐
Sample volume in 23 m^3 to 25 m^3?	☐	☐
Maximum temperature difference is < 5° C for no more than 30 minutes?	☐	☐
Average temperature and relative humidity between minimun and maximum values?	☐	☐
Site ID1 and site ID 2 agree?	☐	☐

Electronic Logbook Review	Yes	No
Flow verifications and audits passed?	☐	☐
Leak checks passed?	☐	☐
Prescribed maintenance and cleaning performed?	☐	☐
Filter removed from sampler less than 7 days and 9 hours (177 hours) after sampling?	☐	☐

Missed Samples and Sample Make-Ups			
Sample Date	Reason	Code	Make-up Date

Site Information	
Region:	RRO
Site Name:	Millbrook
AIRS #:	37-183-0014
Site ID2 #:	509
Reviewer(s):	PJC
Passed QA Date:	

1:3 first run day of quarter:	10/2/18
1:6 first run day of quarter:	

3 - Day Schedule	Ran	6 - Day Schedule	Ran
10/2/18	☑	1/0/00	☐
10/5/18	☑	1/6/00	☐
10/8/18	☑	1/12/00	☐
10/11/18	☑	1/18/00	☐
10/14/18	☑	1/24/00	☐
10/17/18	☑	1/30/00	☐
10/20/18	☑	2/5/00	☐
10/23/18	☑	2/11/00	☐
10/26/18	☑	2/17/00	☐
10/29/18	☑	2/23/00	☐
11/1/18	☑	2/29/00	☐
11/4/18	☑	3/6/00	☐
11/7/18	☑	3/12/00	☐
11/10/18	☑	3/18/00	☐
11/13/18	☑	3/24/00	☐
11/16/18	☑		
11/19/18	☑		
11/22/18	☑		
11/25/18	☑		
11/28/18	☑		
12/1/18	☑		
12/4/18	☑		
12/7/18	☑		
12/10/18	☑		
12/13/18	☑		
12/16/18	☑		
12/19/18	☑		
12/22/18	☑		
12/25/18	☑		
12/28/18	☑		
12/31/18	☑		

Comments/Notes:

Figure 23.1. Data Verification and Validation Form for Intermittent Particle Data Collected Using the Federal Reference Method

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.

23.2.2 Intermittently Collected Data

After the previous quarter of data is available for the FRM $PM_{2.5}$ monitor, the RCO chemist conducts a thorough review of the data for completeness and accuracy. Once the RRO monitoring coordinator enters the site data into IBEAM and the LAB technician enters the lab data into IBEAM, the RCO chemist will review the data for routine data outliers and conformance to acceptance criteria. The RCO chemist will void unacceptable data and flag questionable data.

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. 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. 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.

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

- Acquire minute averages from instantaneous averages and hourly averages from minute averages.
- Flag missing and irregular data with pre-programmed, 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 for outliers and to ensure it is complete.
- Verify maximum daily values for validity 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 the correct 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 7.12.
- Ensure all data are acceptable and can be used for its 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.

The RCO LAB QA chemist currently is developing a level 1 through 3 data review approach, along the same form as above, for the laboratory data and will revise this QAPP when the LAB implements it.

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 QC checks, any manual checks and the 14-day checks;
- 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.

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. At the time of this QAPP revision, the DAQ is reviewing the data validation SOPs to augment them with more detailed procedures. The DAQ will update this QAPP when the DAQ completes those revisions.

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. 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.

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. 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 – 7.12). 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. 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.
- Extensively reviewing quarterly data until the DAQ achieves the DQOs: The chief will continue to review extensively the quarterly QA reports and the QC summaries until the DAQ attains the bias and precision limits.

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 EPA, 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.

QAPP Annual Review Documentation

Date of Review	Name of Reviewer	Signature of Reviewer	Results of Review