



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION 4**

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Division of Air Quality (NC DAQ)  
North Carolina Department of Environmental Quality  
217 West Jones Street  
Raleigh, North Carolina 27603

LSASD Project Number: 22-0087

Mr. Butler:


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

**Quality Assurance Project Plan (QAPP) for the North Carolina Division of Air Quality  
Ozone Ambient Air Quality Monitoring Program, Revision No. 1, March 25, 2022.**

The quality assurance and technical elements within this QAPP were compared to EPA regulations and current guidance. The stated procedures appear to be clear, sound, and appropriate as written, to the extent they can be evaluated. EPA approval of this document is granted. Please be aware that approval of this QAPP does not constitute a waiver from any regulatory requirements. Your agency remains accountable for ensuring the ozone ambient air 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 regulatory decision-making purposes. This QAPP should be reviewed internally by NC DAQ on an annual basis and revised when procedures change; at a minimum, the QAPP must be revised within five years.

If you have any questions, please contact Tony Bedel at 706-355-8552 or via email at [bedel.anthony@epa.gov](mailto:bedel.anthony@epa.gov).

Sincerely,

**KEVIN  
SIMMONS**  Digitally signed by KEVIN  
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Kevin Simmons, Acting Chief  
Quality Assurance Section

*Mission: To provide sound Science to our customers through superior environmental evaluation.*

*Vision: To be a solutions-oriented organization and seen as a leader in sound science through innovation, responsive customer service, and cutting-edge expertise.*

Roy Cooper  
*Governor*  
Elizabeth Biser  
*Secretary*  
Michael A. Abraczinskas  
*Director*



**DAQ-01-004**  
**Quality Assurance Project Plan**  
**for the North Carolina Division of Air Quality**  
**Ozone Ambient Air Quality Monitoring Program**

Prepared for:

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Submitted by:

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**DISCLAIMER**

This Quality Assurance Project Plan, or QAPP, covers the ozone ambient air quality monitoring network for the North Carolina Department of Environmental Quality, or DEQ, Division of Air Quality, or DAQ, and the Asheville-Buncombe Air Quality Agency, or ABAQA. Throughout this document where it states “DAQ” this local program is included by reference.

## Quality Assurance Project Plan Acronym Glossary

ABAQA – Asheville-Buncombe Air Quality Agency  
ADQ - Audit of Data Quality  
AMTIC – Ambient Monitoring Technology Information Center  
AQI – Air Quality Index  
AQS - Air Quality System, EPA's ambient air quality database  
ARD – United States Environmental Protection Agency Air and Radiation Division  
ARM – Air Resources Manager  
ARO - Asheville Regional Office  
CAPA – Corrective action preventative action  
CASTNET – Clean Air Status and Trends Network  
CFR – Code of Federal Regulations  
Chief – Ambient Monitoring Section chief  
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  
DIT – North Carolina Department of Information Technology  
DQA - Data quality assessment  
DQI - Data quality indicator  
DQO - Data quality objective  
e-log – electronic logbook  
ECB – Electronics and Calibration Branch  
EPA – United States Environmental Protection Agency  
FEM – Federal equivalent method  
FEP – Fluorinated ethylene propylene  
FRM – Federal reference method  
FRO – Fayetteville Regional Office  
IBEAM – Internet-Based Enterprise Application Management  
km – kilometers  
LMS – North Carolina Learning Management System  
LSASD – Laboratory Services and Applied Science Division  
m – meters  
MDL – Method detection limit  
MRO – Mooresville Regional Office  
MQO – Measurement quality objective  
MSA – Metropolitan Statistical Area  
NAAQS - National Ambient Air Quality Standards  
NCSOP - North Carolina standard ozone photometer  
NIST - National Institute of Standards and Technology  
nm - nanometer  
NPAP - National performance audit program  
OAQPS – EPA’s Office of Air Quality Planning and Standards  
pdf = portable document format

PFA – Perfluoroalkoxy

POC – parameter occurrence code

ppb – parts per billion

± - plus or minus

PPB – Projects and Procedures Branch

ppm – parts per million

PQAO – Primary quality assurance organization

PSD – Prevention of significant deterioration

PTFE – polytetrafluoroethylene

PZS – precision zero span

QA – Quality assurance

QA Handbook - [EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II](#)

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

RRO – Raleigh Regional Office

RTP – United States Environmental Protection Agency - Research Triangle Park

SD – Standard deviation

SLAMS - State and local air monitoring station

SOP - Standard operating procedure

SPM - Special purpose monitor

SRP – EPA standard ozone reference photometer

SQL – Structured Query Language

TSA - Technical systems audit

USB – Universal serial bus

UV - ultraviolet

VIP – Value in Performance

VOC – Volatile organic compound

WARO – Washington Regional Office

WIRO – Wilmington Regional Office

WSRO – Winston-Salem Regional Office


# 1.0 Approval Sheet

**Title:** DAQ-01-004 Quality Assurance Project Plan for the North Carolina Division of Air Quality Ozone Ambient Air Quality Monitoring Program, Revision 1

The DAQ hereby recommends this *DAQ-01-004 Quality Assurance Project Plan for the North Carolina Division of Air Quality Ozone Ambient Air Quality 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.

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North Carolina Department of Environmental Quality,  
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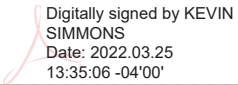
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United States Environmental Protection Agency  
Region 4 Designated Approving Official

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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 ABAQA monitoring staff, regional monitoring technicians, regional monitoring coordinators, Electronics and Calibration Branch, or ECB, electronics technicians, Raleigh Central Office, or RCO, chemists and statistician and any other personnel involved with this project have read and understood this QAPP. The Ambient Monitoring Section chief, or chief, will post the official QAPP after it receives 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 Ozone Monitoring Program Quality Assurance Project Plan Distribution List –DAQ and ABAQA Personnel**

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**Table 3.1 DAQ Ambient Air Quality Ozone Monitoring Program Quality Assurance  
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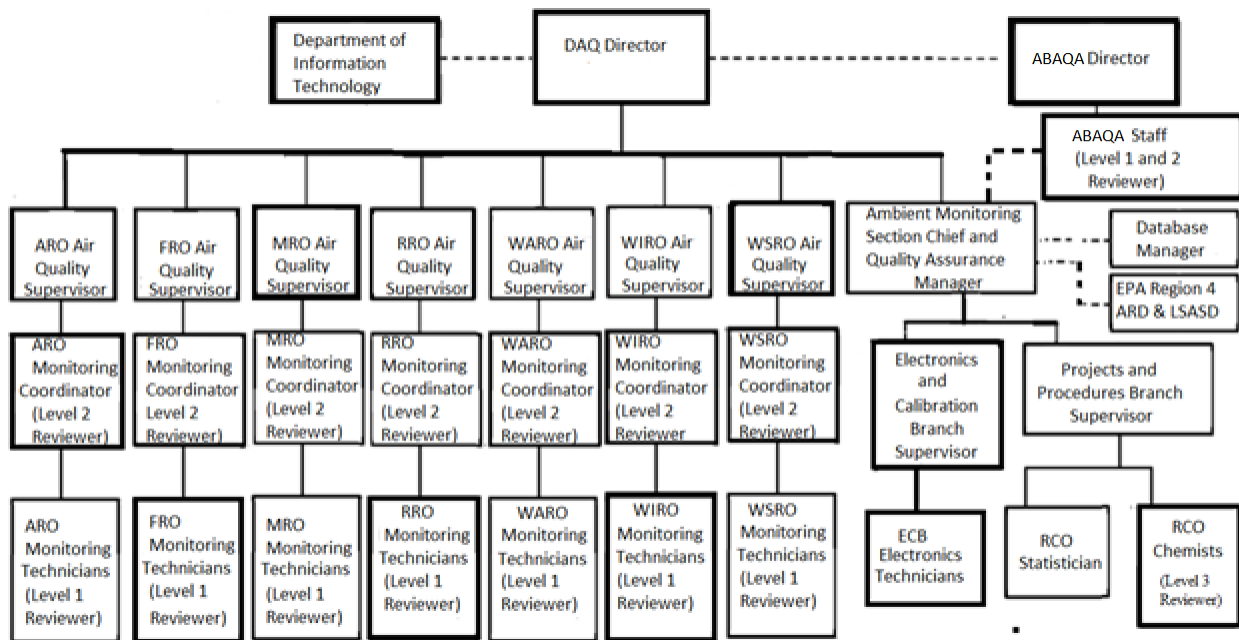
## 4.0 Project/Task Organization

The State of North Carolina Division of Air Quality, or DAQ, ambient air monitoring program is an independent primary quality assurance organization, or PQA, as defined in the Code of Federal Regulations, or CFR, 40 Part 58, Appendix A, Section 1.2. The DAQ operates the ozone air quality monitoring program as part of the DAQ PQA. The DAQ director organized the Ambient Monitoring Section into three main branches, two of them relevant to the scope of this project: The Projects and Procedures Branch, or PPB, and the Electronics and Calibration Branch, or ECB. The chief has responsibility for managing these branches according to stated policy. The chief delegates the responsibility and authority to develop, organize and maintain and implement quality programs to the supervisors of each branch, in accordance with the EPA-approved quality management plan, or QMP. The supervisors have direct responsibility for assuring data quality. The Ambient Monitoring Section shares the monitoring responsibilities with monitoring staff in the seven regional offices as well as with the ABAQA.

DAQ will be responsible for the final validation and data submittal steps for data collected from all ozone ambient air quality monitoring sites, as DAQ is the PQA for DAQ and ABAQA.

Figure 4.1 outlines the organizational structure for the implementation of the monitoring program. The figure also shows the relationship between the DAQ and ABAQA technical and review staff. The following subsections list the specific responsibilities of each significant position within the Ambient Monitoring Section, regional offices and ABAQA.

**Figure 4.1 Project Organizational Chart**



## 4.1 DAQ Director

The DAQ director supervises the chief and regional office supervisors. The DAQ director is responsible for ensuring adequate human and financial resources are available to support DAQ's ozone monitoring program. The director has authority to stop or resume work. In the event of an emergency or inclement weather the director implements the Continuity of Operations Plan, including the hurricane readiness procedures. The director also serves as a liaison with other divisions in DEQ, with the North Carolina General Assembly, the North Carolina Department of Information Technology, or DIT, and with other regional air-monitoring agency organizations.

## 4.2 DAQ Ambient Monitoring Section

The Ambient Monitoring Section contains the PPB and the ECB and is responsible for coordinating the quality assurance, or QA, data collection and data processing aspects of the ozone ambient air quality monitoring program.

Besides the monitors operated by DAQ and ABAQA, local program agencies in Forsyth and Mecklenburg Counties, Clean Air Status and Trends Network, or CASTNET, and the Eastern Band of Cherokee Indians operate their own ozone monitoring programs under their own PQAOs and quality assurance project plans or QAPPs. The RCO chemist and statistician in the ambient monitoring section review the raw polled data collected by these organizations each business day and provide comments to these sister agencies when they notice problems. The ambient monitoring section also performs annual performance evaluations on these monitors.

**Ambient Monitoring Section Chief:** The chief serves as the QA manager, or QAM, and has direct access to the DAQ director on all matters relating to DAQ's ozone ambient air quality monitoring 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.
- Collaborating with DEQ staff in developing, administering and maintaining the QMP.
- Assuring that QAPPs are established and effectively implemented for each project as applicable.
- Supervising the ambient monitoring staff and delegating responsibilities as appropriate.
- Serving as the liaison to EPA Region 4 monitoring staff.
- Maintaining overall responsibility for the monitoring network design and review, subject to the director's approval, including oversight and approval of the annual network plan and five-year assessment.
- Authorizing the installation and discontinuation of monitors within the network.
- Approving and distributing division standard operating procedures, or SOPs, and QAPPs to the personnel listed in Table 3.1.
- Serving as the tiebreaker in the event of an impasse on how to handle corrective actions or make a final judgment call on data validity.
- Overseeing training for the ambient monitoring staff.
- Certifying the data every year in accordance with 40 CFR Section 58.15.
- Reviewing the quarterly QA reports and quality control, or 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.
- Preparing budgets, contracts, and proposals; and
- Reviewing budgets, contracts, grants, and proposals.

The chief also serves as a liaison with EPA Region 4, the local programs, tribal program and CASTNET program, coordinating whether and when DAQ will perform annual performance evaluations on monitors operated by these programs and working to resolve any communication or data quality issues that might arise. When the chief 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, the database manager has direct access to the chief on all matters relating to DAQ's ozone ambient air quality 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 and minute data for each hour of every day as well as automated check data for each day.
- Ensuring correct data is being transferred from the ABAQA Bent Creek site;
- Uploading environmental data from DAQ and ABAQA operated sites to the Air Quality System, or AQS and AirNow-Tech databases.
- 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.
- 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. 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
- 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 ozone ambient air quality monitoring program. The RCO chemists' duties include the following:

- Validating data by serving as the level 3 data reviewer.
- Assessing the effectiveness of the network system.
- Writing new SOPs and QAPPs and ensuring timely and appropriate SOP and QAPP updates.
- Organizing the collection, verification, validation and reporting of data.
- Participating in systems audits.
- Verifying all required QA/QC activities are performed and that measurement quality objectives, or MQOs, are met through data validation and by performing annual system audits.
- Identifying quality problems and initiating action which results in solutions.
- Assessing the efficacy of corrective actions to operational errors.
- Providing training and certification to appropriate personnel; and
- 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 ozone-monitoring program. The RCO audit chemist's duties include the following:

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

**Raleigh Central Office Statistician:** The RCO statistician reports to the PPB supervisor and provides statistical programming support to the branch supervisor and other staff of the central and regional offices, including:

- Assisting the branch supervisor with responding to consulting and data requests;
- 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;
- Preparing and delivering data to the regional offices and DAQ;
- Participating in systems audits;
- Consulting on statistical analyses and approaches with the regional offices and DAQ;
- Responding to public records requests and statistical consulting requests;
- Serving as the backup to the database manager, as needed;
- Uploading data to AQS; and
- Other duties as assigned.

#### 4.2.2 Electronics and Calibration Branch

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

- Identify quality problems and initiate corrective action which results in solutions.
- Schedule and document annual performance evaluations and standard certifications.
- Review and approve QAPPs and SOPs for the ECB.
- Supervise the ECB electronics technicians.
- Participate in systems audits.
- Document training and certification activities.
- Provide training and certification to field personnel; and
- Other tasks as assigned.

The Field Services Program Manager for the ABAQA reports to the ABAQA Director. This manager will be responsible for coordinating with the ECB supervisor to ensure cooperation in meeting all the responsibilities given to the ECB supervisor and ECB electronics technicians.

**Electronics and Calibration Branch Electronics Technician and ABAQA Air Quality Staff:**

The ECB electronics technicians report to the ECB supervisor. The ABAQA Air Quality staff report to the ABAQA director, They have the following responsibilities:

- Conducting annual performance evaluations for the continuous gaseous monitoring networks;
- Installing all field equipment and monitoring sites;
- Purchasing, maintaining and tracking an inventory of spare parts, spare equipment and consumable supplies to prevent unnecessary downtime;
- Calibrating and certifying all transfer standards to ensure quality calibrations;
- Assuring all certifications are National Institute of Standards and Technology (NIST) traceable and properly and securely documented and stored;
- Assisting in prescribing corrective actions;
- Participating in systems audits;

- Recommending changes, when needed, in the QA/QC program;
- Performing and documenting all maintenance and repairs of field equipment as described by [DAQ-10-001.1](#); and
- Other tasks as assigned.

### 4.3 Regional Offices and ABAQA Local Program

**Regional Office Air Quality Supervisors:** The regional office air quality supervisors report to the DAQ director. They and the director for the ABAQA local program have direct access to the DAQ director and chief on all matters relating to the ozone ambient air quality monitoring operation. The regional office air quality supervisors' and ABAQA director's duties include:

- Assuring that division policies are maintained at the regional office or local program level.
- Acquiring needed regional or local monitoring resources.
- Verifying implementation of quality programs.
- Recommending changes when needed in the QA/QC program.
- Participating in the annual network plan and 5-year assessment by providing and approving regional and local program input for the design and documentation of the monitoring network.
- Supervising and delineating duties for the regional or local program monitoring coordinators and technicians; and
- Other duties as assigned.

**Regional Ambient Monitoring Coordinators:** Regional ambient monitoring coordinators report directly to the regional office air quality supervisor. Regional ambient monitoring coordinators have the overall responsibility of ensuring the implementation of the QA/QC program at the regional level. They coordinate the activities of the regional monitoring technicians. The responsibilities of the regional ambient monitoring coordinators and ABAQA air quality staff include:

- Coordinating and reviewing the collection of environmental data;
- Performing level 2 data verification activities and flagging suspect data;
- Implementing the DAQ QA/QC program within the region;
- Acting as conduits for information to regional monitoring staff;
- Training staff and other regional monitoring coordinators in the requirements of the QAPP and SOPs;
- Providing a backup to the regional monitoring staff;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Providing regional input on the design and documentation of the monitoring network;
- Ensuring that monitoring personnel follow the QAPP and associated SOPs by reviewing data and logbooks and through personal observation of procedures;
- Documenting and assessing corrective actions; and
- Other tasks as assigned.

**Regional Monitoring Technicians and ABAQA Air Quality Staff:** The regional monitoring technicians report directly to the regional office air quality supervisors and work under the

direction of the regional monitoring coordinator to ensure DAQ meets all monitoring requirements. The ABAQA air quality staff report to the ABAQA director. Their duties include:

- Ensuring that monitoring programs implement the QA/QC elements of SOPs and QAPPs.
- Reviewing environmental data prior to submittal.
- Assisting in the acquisition of resources.
- Calibrating and maintaining equipment.
- Maintaining a supply of expendable monitoring items.
- Participating in training and certification activities.
- Performing all required QC activities and meeting MQOs as prescribed in the QAPP and SOPs.
- Performing corrective actions to address any activities that do not meet acceptance criteria as prescribed in the QAPP and SOPs.
- Documenting deviations from established procedures and methods.
- Reporting nonconforming conditions and corrective actions to the regional monitoring coordinator and the regional supervisor.
- Performing level one data verifications and flagging suspect data.
- Conducting 40 CFR Part 58, Appendix E siting criteria evaluations annually as part of the annual network review process.
- Recommending changes, when needed, in the QA program.
- Participating in and providing hands-on training as needed of new regional coordinators, monitoring technicians and RCO chemists in the requirements of the SOPs.
- Preparing corrective action reports for the Ambient Monitoring Section when needed; and
- Other tasks as assigned.

The air quality staff at ABAQA performs the roles of both the regional monitoring coordinators and the regional monitoring technicians.

#### 4.4 Department of Information Technology

The DIT provides security for the ambient monitoring computers. They manage in cooperation with the regional monitoring and ECB electronics technicians and database manager the computers located at the monitoring sites 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

EPA is responsible for developing National Ambient Air Quality Standards (NAAQS), defining the quality of the data necessary to make comparisons to the NAAQS, and identifying a minimum set of quality control samples from which to judge data quality. State and local ambient air quality monitoring organizations are responsible for taking this information and

developing and implementing a quality assurance program that will meet the data quality requirements. It is the responsibility of the EPA and the monitoring organizations to assess the quality of the data and take corrective action, when appropriate. The DAQ's PQAO operates within the jurisdiction of EPA Region 4 and collaborates with EPA Region 4, as necessary, to ensure the PQAO's ozone monitoring network meets or exceeds regulatory requirements.

The DAQ will operate the ozone monitors as either state and local air monitoring stations, or SLAMS, or special purpose monitors, or SPMs, 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 or his or her designee will review, comment on and respond to the network plan each year. Likewise, the chief will include the data from these monitors in the annual certification request. The EPA Region 4 Air and Radiation Division director or his or her designee will review and apply concurrence codes in AQS in response to DAQ's data certification request. The chief will also submit a QAPP to the EPA Region 4 Laboratory Services and Applied Science Division, or LSASD, for EPA approval. The EPA Region 4 LSASD will include the ozone monitors in the National Performance Audit Program, or 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 (industrial) sources and mobile sources. This act initiated four major regulatory programs affecting stationary sources: The NAAQS, State Implementation Plans, New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants. The NAAQS is codified in 40 CFR Part 50 and is the regulation followed by state and local air monitoring programs. The Clean Air Act of 1970 also established ozone as a criteria pollutant subject to the NAAQS.

Primary NAAQS are set at a level adequate to protect public health within an acceptable margin of safety, while secondary standards are set at a level that is requisite to protect public welfare. The Clean Air Act and its amendments provide the framework for the monitoring of criteria pollutants (e.g., ozone) by state, local, and tribal ambient air monitoring organizations. Under the area designations process, data from ambient air monitors are typically used to characterize air pollutant concentrations for identification of areas that are either meeting or violating a particular pollutant standard. Monitors used for comparisons against a NAAQS are typically designated as SLAMS monitors and must meet the requirements stipulated in 40 CFR Parts 50, 53, and 58. For ozone, three consecutive years of valid, quality-assured data are needed for comparison against the NAAQS.

On July 18, 1997, the EPA revised the NAAQS for ozone based on its review of the available scientific evidence linking exposures to ambient ozone to adverse health and welfare effects at levels allowed by the ozone standards that were current at that time. This revision replaced the 1-hour primary standard with an 8-hour standard at a level of 0.08 parts per million, ppm, with a form based on the 3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area. This primary standard provided increased protection to the public, especially children and other at-risk populations, against a wide range of ozone-induced health effects. These health effects include decreased lung function, primarily in children active outdoors; increased respiratory symptoms, particularly in highly sensitive individuals; increased hospital admissions and emergency room visits for respiratory causes, among children and adults with pre-existing respiratory disease such as asthma; inflammation of the lung and possible long-term damage to the lungs. This revision also replaced the 1-hour secondary standard current at that time with an 8-hour standard identical to the primary standard.

On Mar. 27, 2008, the EPA again revised the primary and secondary NAAQS for ozone to provide protection of public health and welfare. The administrator based the revision on EPA's review of the air quality criteria for ozone and related photochemical oxidants. For the primary ozone standard, the EPA revised the level of the 8-hour standard to a level of 0.075 ppm, to provide increased protection for children and other "at risk" populations against an array of ozone-related adverse health effects. For the secondary standard for ozone, EPA revised the standard to make it identical to the revised primary standard.

On Oct. 26, 2015, based on EPA's review of the air quality criteria for ozone and related photochemical oxidants, EPA revised the levels of both the primary and secondary standards.

EPA revised the primary and secondary ozone standard levels to 0.070 ppm and retained their indicators (ozone), forms (fourth-highest daily maximum, averaged across three consecutive years) and averaging times (eight hours).

EPA made corresponding revisions in:

- Data handling conventions for ozone.
- Changes to the Air Quality Index, or AQI.
- Regulations for the prevention of significant deterioration, or PSD, program.
- Establishing exceptional events schedules; and
- Providing implementation information for the new standards.

The ozone ambient air quality monitoring network is a long-term on-going program. The program started operation around 1972 and has operated continuously since. The goals of the Network/Program are to provide health and sustainability of the State of North Carolina's population by identifying any violations of the ozone NAAQS and to locate the highest ozone concentrations in the area(s) and to determine the ozone background concentrations. Region 4 agencies may only shut down ozone monitors following guidance in the CFR including but not limited to 40 CFR 58.14, after providing the public a 30-day public comment period to make comments on the decision and after obtaining permission from the EPA Region 4 administrator.

The purpose of this QAPP is to prescribe requirements, procedures, and guidelines for the ozone ambient air quality monitoring program. This version of the QAPP is the first revision to the original document, conditionally approved by EPA in July 2019. A copy of the original QAPP is retained in IBEAM. The DAQ intends the QAPP to serve as a reference document for implementing and expanding the QA program and to provide detailed operational procedures for measurement processes used by the DAQ. Operators, chemists, project officers and program managers responsible for implementing, designing, and coordinating air pollution monitoring projects should find the QAPP particularly beneficial. The QAPP is a compilation of QA requirements, procedures and guidelines applicable to air pollution measurement systems. They are designed to achieve a high percentage (>75 percent) of valid hours and days of ozone data while maintaining integrity and accuracy. This QAPP clearly and thoroughly establishes QA protocols and QC criteria required to successfully implement and maintain the state of North Carolina's ozone ambient air quality monitoring program. Additional details and technical specifications are set forth in SOPs utilized by DAQ and ABAQA for each aspect of the ozone monitoring program, such as instrument operations (see Table 11.2). Though both ABAQA and DAQ personnel operate the monitoring stations, DAQ administers the monitoring program. It is the responsibility of DAQ to ensure that the ABAQA and DAQ personnel implement and adhere to the QA programs for the field and data processing phases of the monitoring program.

The RCO chemists will review the QAPP and its associated SOPs annually and update them as needed or at least every five years. The RCO chemist will document the annual review of the QAPP by recording his or her name, signature, date and review results on the QAPP annual review documentation form. The DAQ and ABAQA will adhere to the principles and procedures herein, unless a special project requires more stringent requirements. If any special project requires more stringent requirements, the QAPP will be revised or, depending on the purpose and

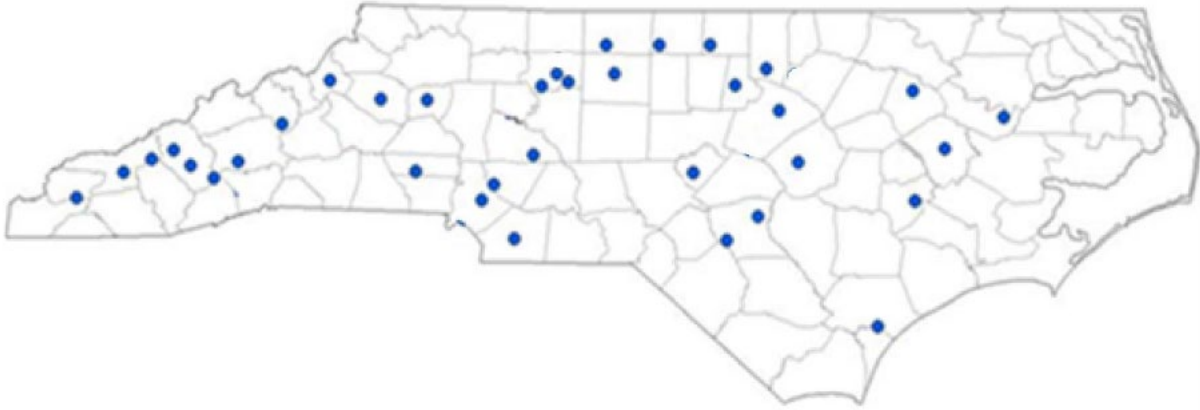
scope of the project, a separate QAPP will be developed to address the requirements of the special project.



## 6.0 Project/Task Description

The DAQ developed this QAPP to ensure the DAQ and ABAQA ozone ambient air quality monitoring network shown in Figure 6.1 (along with the other local program and tribal monitors that are not covered by this QAPP) fulfills the CFR requirements and collects ozone data that meet or exceed EPA QA requirements. The database manager uploads these data into the EPA AQS database.

**Figure 6.1 Ozone Monitoring Network (includes local program and tribal monitors)**



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. The DAQ ozone ambient air quality monitoring network is designed to support these objectives as well as the following specific goals:

- Characterize maximum hourly ozone concentrations in urban areas with populations over 350,000.
- Measure background concentrations.
- Measure transport of ozone between urban areas and in and out of the state.
- Measure welfare impacts; and
- Provide real-time air quality measurements for the public.

The DAQ assigns each monitor operated a scale of representativeness based on the definitions of 40 CFR Part 58, Appendix D. The spatial scale of representativeness describes the physical dimensions of a parcel of air, in which pollutant concentrations are reasonably homogeneous throughout. Based upon the monitoring objective and the site locations, the data collected at the ozone ambient air quality monitoring sites will be representative of the hourly ozone concentrations on either a neighborhood (seven sites), urban (15 sites) or regional scale (six sites). Neighborhood scale defines air volumes within an area of a city that has relatively uniform land use with dimensions in the 500 to 4,000 meters, or m, (0.5 to 4 kilometer, or km) range. Urban scale describes air volumes within cities with dimensions on the order of 4,000 m to 50,000 m (4.0 km to 50 km). Regional scale describes air volumes associated with rural areas of reasonably homogeneous geography that extends for tens to hundreds of kilometers. Please see

the annual network plan (<https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan>) for each DAQ or ABAQA ozone monitor's spatial scale of representativeness.

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

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

Towards this end, DAQ work products also include a series of assessments and reports to ensure the network and resulting data continuously meet or exceed regulatory requirements as specified in 40 CFR Parts 50 and 58. 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

Field operations personnel will perform those activities that support continued successful operation of the statewide ozone ambient air quality monitoring network. Personnel will perform field activities that include, but are not limited, to conducting calibrations and routine QC checks, periodic preventative maintenance and servicing equipment located at the ozone ambient air quality monitoring sites. Operational servicing activities may include, but may not be limited to, recording pertinent field data and restocking consumables, such as particulate filters, at the monitoring sites. Additional field activities could include relocating sites when the property owner evicts DAQ or locating additional suitable monitoring sites when the population in an area grows or DAQ decides to add additional monitoring sites to the network. Section 4.3 Regional Offices and ABAQA Local Program provides a more complete description of the field activities that regional monitoring technicians and ABAQA air quality staff may perform. The ECB electronics technicians also perform annual performance evaluations on the deployed monitors.

## 6.2 ECB and AQAQA Monitoring Staff Activities

The DAQ ECB electronics technicians and ABAQA monitoring staff will perform those activities necessary to support the successful operation of the ozone ambient air quality 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 and ABAQA monitoring staff will perform any functions necessary to support the

deployed field equipment. Section 4.2.2 Electronics and Calibration Branch provides a more complete description of the activities the ECB electronics technicians may perform.

### 6.3 Project Assessment Techniques

An assessment is an evaluation process used to measure the performance or effectiveness of a system and its elements. As used here, “assessment” is an all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection or surveillance. Section 20.0 Assessments and Response Actions discusses the details of assessments. Table 6.1 provides information on the parties implementing assessments and their frequency.

**Table 6.1 Assessment Schedule**

<b>Assessment Type</b>	<b>Assessment Agency</b>	<b>Frequency</b>
EPA technical systems audit	EPA Region 4	DAQ-Every 3 years ABAQA-Every 6 years
Network assessment	EPA Region 4, DAQ	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
DAQ internal technical systems audit	DAQ	Annually
Quarterly data completeness and audit of data quality	DAQ	Quarterly
Annual data certification	DAQ	Annually
Quality Assurance Project Plan Review and Updates	DAQ	Review annually Update at least every 5 years
Standard operating procedures reviews	DAQ	Review annually Update at least every 5 years
Data quality assessment	DAQ	Quarterly and Annually
National performance audit program	EPA designated contractor	20 percent of sites per year/each site once every 6 years
DAQ annual performance evaluation	DAQ	All sites, including local program, tribal and CASTNET sites/every year

Efforts will be made to ensure that National Performance Audit Program, NPAP, audits, which have to be performed at each site once every 6 years, are conducted at any new ozone ambient air quality monitoring sites within the first three years of site startup.

### 6.4 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**

<b>Categories</b>	<b>Record/Document Type</b>
Site information	Network descriptions Site files Site maps Site pictures
Environmental data operations	Quality assurance project plans Standard operating procedures Field notebooks and logbooks Inspection/maintenance records
Raw data	Any Original Data (routine and quality control) 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 Data quality assessments Quality assurance reports EPA Technical systems audit reports Internal systems audit reports Response/corrective action documentation Annual performance evaluation reports Certification documentation E-mails related to QA activities and assessments

The DAQ director has the ultimate authority for the ozone ambient air quality monitoring sites listed in Table 6.3 except for Bent Creek. The ABAQA director has the ultimate authority for the ozone ambient air quality monitoring site at Bent Creek.

**Table 6.3 North Carolina Ozone Ambient Air Quality Monitoring Locations**

<b>Ozone Ambient Air Quality Monitoring Site Name</b>	<b>Air Quality System Site Identification Number</b>	<b>Location</b>	<b>Operator</b>
Taylorsville-Liledoun	37-003-0005	Taylorsville, NC	MRO
Linville Falls	37-011-0002	Linville, NC	ARO
Bent Creek	37-021-0030	Asheville, NC	ABAQA
Lenoir	37-027-0003	Lenoir, NC	ARO
Cherry Grove	37-033-0001	Reidsville, NC	WSRO
Durham Armory	37-063-0015	Durham, NC	RRO
Leggett	37-065-0099	Tarboro, NC	RRO

**Table 6.3 North Carolina Ozone Ambient Air Quality Monitoring Locations**

<b>Ozone Ambient Air Quality Monitoring Site Name</b>	<b>Air Quality System Site Identification Number</b>	<b>Location</b>	<b>Operator</b>
Wade School	37-051-0011	Wade, NC	FRO
Honeycutt	37-051-0010	Fayetteville, NC	FRO
Joanna Bald	37-075-0001	Kilmer, NC	ARO
Butner	37-077-0001	Butner, NC	RRO
Mendenhall	37-081-0013	Greensboro, NC	WSRO
Waynesville Elementary School	37-087-0008	Waynesville, NC	ARO
Frying Pan	37-087-0035	Canton, NC	ARO
Purchase Knob	37-087-0036	Waynesville, NC	ARO
West Johnston	37-101-0002	Clayton, NC	RRO
Lenoir Community College	37-107-0004	Kinston, NC	WARO
Crouse	37-109-0004	Lincolnton, NC	MRO
Jamesville	37-117-0001	Jamesville, NC	WARO
Castle Hayne	37-129-0002	Castle Hayne, NC	WIRO
Bushy Fork	37-145-0003	Hurdle Falls, NC	RRO
Pitt County Ag Center	37-147-0006	Greenville, NC	WARO
Bethany	37-157-0099	Reidsville, NC	WSRO
Rockwell	37-159-0021	Rockwell, NC	MRO
Bryson City	37-173-0002	Bryson City, NC	ARO
Monroe	37-179-0003	Monroe, NC	MRO
Millbrook	37-183-0014	Raleigh, NC	RRO
Mount Mitchell	37-199-0004	Burnsville, NC	ARO

Note: These are the locations at the time of this QAPP revision. For current locations please see the network plan: <https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan>.

## 7.0 Data and Measurement 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 the regional monitoring technicians and ABAQA air quality staff obtain and maintain acceptability in the generated ozone 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 the regional monitoring technicians and ABAQA air quality staff collect data of known and acceptable precision, bias, completeness, comparability, sensitivity, and representativeness within its ambient air quality monitoring program.

The EPA and DAQ use precision, bias, sensitivity, completeness, comparability, and representativeness as the principal 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). 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 sampled area. This includes consideration of siting criteria, spatial scales, monitoring objectives, climatic change, source configurations and the duration of the study.

All individuals must adhere to the written procedures and methods in the QAPP and its associated SOPs for operating air monitoring instruments and handling data to assure quality data for purposes of DAQ's air quality designations with regards to attainment of the NAAQS. The designated methodology used by DAQ complies with the EPA approved federal equivalent method, or FEM, requirements for ozone monitoring.

### 7.1 Data Quality Objectives

This section provides a description of the data quality objectives, or DQOs, for the ozone monitoring program for the state of North Carolina. Data quality objectives are qualitative and quantitative statements that:

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

### 7.1.1 Intended Use of Data

DAQ will use the data collected in its ozone monitoring network to:

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

### 7.1.2 Type of Data Needed

The DAQ determines the type of data needed by its intended use. Because the DAQ will primarily use the ozone monitoring data for comparison to the NAAQS, the DAQ must collect the data in accordance with 40 CFR Parts 50, 53 and 58 requirements and must collect data of such quality that decision makers can make comparisons to the NAAQS with confidence and certainty. Title 40 CFR Section 58.16 specifies the data reporting requirements the DAQ will follow and [40 CFR Part 50, Appendix U](#) explains the data handling conventions and computations necessary for determining whether the NAAQS is met for ozone. The DAQ ozone monitoring network will operate and collect data in accordance with the schedules codified in 40 CFR 58.12. The ambient ozone concentration data will be collected by monitors that have been designated as Federal Reference Method (FRM) or Federal Equivalent Method (FEM), in accordance with 40 CFR Part 58, Appendix C, Section 2.1.

The DAQ will collect ozone data for comparison to the NAAQS using hourly concentration data with each hour considered valid if the monitor reports at least 45 valid one-minute readings for the hour.

Necessary for the fulfillment of the ozone ambient air quality monitoring goals are:

- Continuous hourly averaged ozone concentration data;
- One-minute average ozone concentration data for each valid hour;
- Continuous shelter temperature measurements for ensuring conformity to environmental requirements of the ozone monitors;
- Precision measurements (daily one-point QC checks);
- Bias measurements (from the daily one-point QC checks, annual performance evaluations and periodic NPAP evaluations);
- Site and monitor metadata for AQS; and,
- Locational measurements (geographical, topographical, etc.).

The following list provides more detail regarding the specifications on the type of ozone data needed for this project. This information summarizes the data needed to compare DAQ design values to the ozone NAAQS:

- Keep each hourly data point (with at least 45 valid minutes for the hour) with at least three decimal places in units of ppm, with additional digits to the right truncated.



- Calculate average values for every rolling 8-hour period of the day.
- An 8-hour average shall be considered valid if at least 6 of the hourly concentrations for the 8-hour period are available.
- Determine the highest 8-hour average from each day (there might be some 8-hour averages that overlap through midnight).
- Daily maximum 8-hour average ozone concentrations are determined for each day with ambient ozone monitoring data. The daily maximum 8-hour average ozone concentrations for a given day is the highest of the 17 consecutive 8-hour averages beginning with the 8-hour period from 7:00 a.m. to 3:00 p.m. and ending with the 8-hour period from 11:00 p.m. to 7:00 a.m. the following day (i.e., the 8-hour averages for 7:00 a.m. to 11:00 p.m.).
- A daily maximum 8-hour average ozone concentration shall be considered valid if valid 8-hour averages are available for at least 13 of the 17 consecutive 8-hour periods starting from 7:00 a.m. to 11:00 p.m.
- The highest 8-hour averages in each year are ranked, and the fourth-highest value is used in each year.
- The 4th-highest values in 3 consecutive years are averaged to produce the design value that is compared with the standards.

Specific information on the ozone NAAQS calculation is found in 40 CFR Part 50, Appendices I, P, and U.

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 DQOs are provided in 40 CFR Part 58, Appendix A, Section 2.3.1. For the ozone-monitoring program, the DAQ has adopted EPA's DQOs listed in Table 7.1, with the acceptable precision, measured by coefficient of variation (CV), and acceptable bias.

**Table 7.1 Acceptable Precision as Measured by Coefficient of Variation, or CV, and Bias for the Ozone Ambient Air Quality Monitoring Program**

Pollutant	Acceptable Precision	Acceptable Bias
<i>Ozone</i>	upper 90 percent confidence limit for the CV of $\leq 7$ percent	upper 95 percent confidence limit for the absolute bias of $\leq 7$ percent

## 7.2 Measurement Quality Objectives

As air pollution 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 measurement systems.



Once a DQO is established, the DAQ evaluates and controls the quality of the data to ensure that the DAQ maintains data quality within the established acceptance criteria. The EPA designed the 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 EPA defines the MQOs for the ozone ambient air quality monitoring program in terms of the following DQIs:

- **Precision:** a measure of agreement between two replicate measurements of the same property, under prescribed similar conditions. (US EPA QA/G-5, Appendix B) The DAQ calculates this agreement using percent differences as described in 40 CFR Part 58, Appendix A, Section 4. This is the random component of error.
- **Bias:** 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.
- **Representativeness:** 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 DAQ made in situ or other measurements 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:** 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 [40 CFR Part 50, Appendix U \(https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50/appendix-Appendix%20U%20to%20Part%2050\)](https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50/appendix-Appendix%20U%20to%20Part%2050).
- **Comparability:** 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 in regard to the measurement of a specific variable or groups of variables. (US EPA QA/G-5, Appendix B)
- **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). Currently, the DAQ does not perform annual MDL studies but relies on manufacturer’s specifications for instrument detection limit 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. Table 7.2 lists the MQOs for the ozone ambient air quality monitoring program. The DAQ based this table on the validation templates in the [EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II](#), referred to in this document as the QA Handbook. As described in the QA Handbook and implemented here, for ozone, Table 7.2 lists 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 datum or data, 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.

North Carolina has adopted and implemented EPA Region 4's LSASD recommended warning limits or an even stricter warning limit for ozone monitoring. The RCO chemists define warning limits as the level of allowable imprecision before a regional monitoring technician or ABAQA air quality staff member must calibrate an analyzer or take other corrective action. The RCO chemists set the warning limits lower than the MQOs or control limits to reduce imprecision and bias and enhance data recovery.

The 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 both warning and control limits strengthens the precision of these measurements and improves the data validation practices meeting regulatory requirements. Table 7.2 includes control limits and DAQ established warning or action limits.

The SOPs associated with this QAPP that are specific to ozone monitoring provide more detailed descriptions of these MQOs and describe how the DAQ will use them to control and assess measurement uncertainty.

### 7.2.1 General Data Quality Objectives

- All data should be traceable to a NIST primary standard.
- All data shall be of a known and documented quality. Two major measurements used to define quality are precision and bias. Please reference Section 7.2 for a definition of precision and bias.
- All data shall be comparable. This means the DAQ shall produce all data in a similar and scientific manner. The use of the standard methodologies for sampling, calibration, auditing, etc. referenced in the QAPP and its associated SOPs should achieve this goal.
- All data shall be representative of the measured parameters with respect to time, location and the conditions from which DAQ obtained the data. The use of approved standard methodologies should ensure that the data generated are representative. Support in achieving representativeness is also provided through adhering to the requirements prescribed in 40 CFR Part 58, Appendices D and E.
- All data shall be as complete as possible and DAQ will supplement the data, as needed, using either a collocated data logger for shelter temperature or data stored in the monitor for ozone.

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

#### 7.2.2 Specific Data Quality Objective

- Determine whether an area exceeds the 8-hour average NAAQS for ozone of 0.070 ppm (annual 4<sup>th</sup> highest daily maximum 8-hour concentration, averaged over 3 years).

<b>Table 7.2 Ozone Measurement Quality Objectives.</b>			
<b>Measurement Quality Objective Parameter – Ozone (O<sub>3</sub>) (Ultraviolet Photometric).</b>			
<b>1) Requirement (O<sub>3</sub>)</b>	<b>2) Frequency</b>	<b>3) Acceptance Criteria</b>	<b>Information /Action</b>
<b>CRITICAL CRITERIA-OZONE</b>			
<i>Monitor/ Transfer and Calibration Standard</i>	NA	<i>Meets requirements listed in FRM/FEM designation</i>	1) 40 CFR Part 58, Appendix C, Section 2.1 2) NA 3) 40 CFR Part 53 and <a href="#">FRM/FEM method list</a>
<i>One Point QC Check Single analyzer</i>	1/ 14 days <i>(The DAQ goal is daily checks)</i>	< ± 7.1 percent difference-(4.6 ppb) or < ±1.5 ppb, whichever is greater <b>(DAQ goal is 65 ppb ± 3 ppb)</b>	1 and 2) <a href="#">40 CFR Part 58, Appendix A, Section 3.1.1</a> 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 days <i>(The DAQ goal is daily checks)</i>	<b>(Zero drift &lt;3.1 ppb (24hr) &lt; ± 5.1 ppb (&gt;24 hr-14 day)</b> (DAQ goal is <b>0 ppb ± ≤2 ppb</b> ) <b>(Span (225) drift &lt; ± 7.1 percent---225 x .071 = 15.9 ppb)</b> (DAQ goal is <b>225 ppb ± ≤ 5 ppb</b> )	1 and 2) <a href="#">QA Handbook Volume 2</a> Section 12.3 3) Recommendation and related to DQO
Shelter Temperature Range (Ozone only approved for 5-40 ° C)	Daily (hourly values)	<b>5.0 to 40.0° C.</b> (Hourly average)	1, 2 and 3) <a href="#">QA Handbook Volume 2</a> Section 7.2.2
<b>OPERATIONAL CRITERIA -OZONE</b>			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2.0° C SD over 24 hours	1, 2 and 3) <a href="#">QA Handbook Volume 2</a> Section 7.2.2
Shelter Temperature Device Check	1/182 days and 2/calendar year	≤ ± 2.0° C of standard	1, 2 and 3) <a href="#">QA Handbook Volume 2</a> Section 7.2.2
<i>Annual Performance Evaluation Single analyzer</i>	<i>Every site 1/365 days and 1/calendar year within period of monitor operation</i>	Zero must be 0 ± ≤ 3 ppb 100 ppb must be 100 ± ≤ 7 ppb (7 %) 70 ppb must be 70 ± ≤ 4.9 ppb (7 %) 15 ppb must be 15 ± ≤ 1.4 ppb	1 and 2) 40 CFR Part 58, Appendix A, section 3.1.2 3) Recommendation- 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 <a href="http://www.epa.gov/ttn/amtic/cpreldoc.html">http://www.epa.gov/ttn/amtic/cpreldoc.html</a>
<i>Federal Audits, i.e., NPAP</i>	100 percent of PQAO sites every 6 years; 20 percent of PQAO sites audited each year	Audit levels 1 and 2 <± 1.5 ppb difference all other levels percent difference <± 10.1 percent	1 and 2) 40 CFR Part 58, Appendix A section 3.1.3 3) NPAP QAPP/SOP
<b>Verification/Calibration</b>	Upon receipt/adjustment/repair/installation/moving and repair and recalibration of standard of higher level 1/365 days and 1/calendar year	All calibrator points within ± 2 ppb of expected value and all monitor points within ± 2 ppb of calibrator All points < ± 2.1 % or ≤ ±1.5 ppb difference of best-fit straight line whichever is greater, and slope is 1 ± 0.05	1) 40 CFR Part 50, Appendix D 2) Recommendation 3) Recommendation- Linearity error 40 CFR Part 50, Appendix D Section 4.5.5.6 Multi-point calibration (0 and 4 upscale points) 40 CFR Part 50, Appendix D, section 4.5.2.3 and <a href="#">QA Handbook Volume 2</a> Section 12.3
<i>Zero Air/Zero Air Check</i>	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
<b>Ozone Level 2 Standard</b>			

**Table 7.2 Ozone Measurement Quality Objectives.  
Measurement Quality Objective Parameter – Ozone (O<sub>3</sub>) (Ultraviolet Photometric).**

<b>1) Requirement (O<sub>3</sub>)</b>	<b>2) Frequency</b>	<b>3) Acceptance Criteria</b>	<b>Information /Action</b>
<i>Certification/recertification to Standard Reference Photometer (Level 1)</i>	1/365 days and 1/calendar year	single point difference $\leq \pm 0.002$ ppb	1) 40 CFR Part 50, Appendix D, Section 4.5 2 and 3) <a href="#">Transfer Standard Guidance EPA-454/B-13-004</a> Level 2 standard (formerly called primary standard) usually transported to EPA Region4 or RTP SRP for comparison
<i>Level 2 and Greater Transfer Standard Precision</i>	1/365 days and 1/calendar year	<i>Standard Deviation less than 0.005 ppm or 3 percent whichever is greater</i>	1) <a href="#">40 CFR Part 50, Appendix D, Section 4.3.1</a> 2) Recommendation, part of reverification 3) <a href="#">40 CFR Part 50, Appendix D, Section 4.3.1</a>
(if recertified via a transfer standard)	1/365 days and 1/calendar year	Regression slopes = $1.00 \pm 0.03$ and two intercepts are $0 \pm 3$ ppb	1, 2 and 3) <a href="#">Transfer Standard Guidance EPA-545/B-10-001</a>
<b>Ozone Transfer standard (Level 3 and greater)</b>			
Qualification	Upon receipt of transfer standard	$\pm 3$ ppb	1, 2 and 3) <a href="#">Transfer Standard Guidance EPA-545/B-13-004</a>
Certification	After qualification and upon receipt/adjustment/repair	5 levels: 225 $\pm 2$ ppb 120 $\pm 2$ ppb 65 $\pm 2$ ppb 50 $\pm 2$ ppb 0 $\pm 2$ ppb	1, 2 and 3) <a href="#">Transfer Standard Guidance EPA-545/B-13-004</a> 1
Recertification to higher level standard	1/365 days and 1/calendar year (EPA guidance is beginning and end of O <sub>3</sub> season or every 182 days and 2/calendar year whichever is less)	5 levels: 225 $\pm 2$ ppb 120 $\pm 2$ ppb 65 $\pm 2$ ppb 50 $\pm 2$ ppb 0 $\pm 2$ ppb	1, 2 and 3) <a href="#">Transfer Standard Guidance EPA-545/B-13-004</a> recertification test that DAQ then adds to the most recent 5 tests. If does not meet acceptability certification fails
<b>Detection for FEM/FRMs</b>	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.		
<i>Noise</i>	upon receipt (based on manufacturer's specifications and testing)	$\leq 0.0025$ ppm (standard range) $\leq 0.001$ 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
<i>Lower detectable level</i>	upon receipt (based on manufacturer's specifications and testing)	$\leq 0.005$ ppm (standard range) $\leq 0.002$ ppm (lower range)	1) 40 CFR Part 53.23 (b) (definition and procedure) 2) Recommendation 3) 40 CFR Part 53 Table B-1
<b>SYSTEMATIC CRITERIA-OZONE</b>			
<b>Standard Reporting Units</b>	<b>All data</b>	<b>ppm (final units in AQS)</b>	1, 2 and 3) 40 CFR Part 50, Appendix U, Section 3(a)
<b>Rounding convention for data reported to AQS</b>	<b>All data</b>	<b>3 places after decimal with digits to right truncated</b>	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 7.2 Ozone Measurement Quality Objectives.  
Measurement Quality Objective Parameter – Ozone (O<sub>3</sub>) (Ultraviolet Photometric).**

<b>1) Requirement (O<sub>3</sub>)</b>	<b>2) Frequency</b>	<b>3) Acceptance Criteria</b>	<b>Information /Action</b>
<i>Completeness (seasonal)</i>	<i>3-Year Comparison</i>	<i>≥ 90 percent (average) daily max available in ozone season with min of 75 percent in any one year.</i>	1,2 and 3) 40 CFR Part 50, Appendix U, Section 4(b)
	<i>8- hour average</i>	<i>≥ if at least 6 of the hourly concentrations for the 8-hour period are available</i>	1) 40 CFR Part 50, Appendix U 2 and 3) 40 CFR Part 50, Appendix U, Section 3(b)
	<i>Valid Daily Max</i>	<i>≥ if valid 8-hour averages are available for at least 13 of the 17 consecutive 8-hour periods starting from 7:00 a.m. to 11:00 p.m. local standard time</i>	1) 40 CFR Part 50, Appendix U 2 and 3) 40 CFR Part 50, Appendix U, Section 3(d)
<i>Sample Residence Time Verification</i>	1/365 days and 1/calendar year	<i>&lt; 20 seconds</i>	1) 40 CFR Part 58, Appendix E, section 9 (c) 2) Recommendation 3) 40 CFR Part 58, Appendix E, section 9 (c)
<i>Sample Probe, Inlet, Sampling train</i>	All sites	<i>Borosilicate glass (e.g., Pyrex®) or Teflon®</i>	1) <a href="#">40 CFR Part 58, Appendix E, section 9 (a)</a> 2) Recommendation 3) 40 CFR Part 58, Appendix E, section sec 9 (a) The EPA has accepted FEP and PFA as an equivalent material to Teflon. Although the EPA suggests replacement or cleaning as 1/year and more frequent if pollutant load or contamination dictate, the DAQ replaces the probe line every other year.
<i>Siting</i>	1/365 days	<i>Meets siting criteria or waiver documented</i>	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	Regression slope = 1.00 ± 0.01 and intercept < 3 ppb	1,2 and 3)) <a href="#">Transfer Standard Guidance</a> EPA-454/B-13-004 This is usually done at RTP or at Region 4 and is compared against the traveling SRP
<i>Precision (using 1-point QC checks)</i>	<i>Calculated annually and as appropriate for design value estimates</i>	<b>90 percent confidence limit CV ≤ 7.0 percent</b>	1) 40 CFR Part 58, Appendix A 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
<i>Bias (using 1-point QC checks)</i>	<i>Calculated annually and as appropriate for design value estimates</i>	<b>95 percent confidence limit ≤ ± 7.0 percent</b>	1) 40 CFR Part 58, Appendix A 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



## 8.0 Training Requirements

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

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

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

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

DAQ makes efforts to ensure staff receives 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, PPB supervisor or equivalent typically arranges for this training. In some cases, the chief calls upon other regional offices, the ECB electronics technicians and PPB chemists to provide hands-on training. The employee documents this training on the provided training forms

(obtained from IBEAM), which are archived in IBEAM as well as in the employee's VIP. Before 2021, the employee may also have archived training records in the LMS.

Each ABAQA employee records his training annually as part of the annual performance evaluation ABAQA submits for the air planning agreement. The agency keeps this training record for each employee and stores it on the ABAQA server.

The DAQ and ABAQA supervisors actively encourage all employees to pursue training activities whenever possible and as needed, because the chief continually evaluates DAQ's ozone monitoring network to ensure it continues to meet its objectives. Because of these evaluations, the chief adds new equipment, procedures or new personnel to the project. The DAQ provides vendor-based training for its personnel when DAQ obtains new equipment. The employees document this training on the provided training form and archive it in IBEAM. Employees may also archive the training records in the LMS if they choose to do so. Additionally, personnel are encouraged to periodically identify, request and attend pertinent courses and seminars. The DAQ may provide these courses and seminars as videotapes, closed circuit transmission, web based real-time interactive formats 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 employees document this training on the appropriate form and archive it in IBEAM. The air quality supervisors ensure the air monitoring personnel reporting to them have sufficient training to currently perform necessary functions at an acceptable level.

The DAQ supervisors also evaluate employee proficiency, based on performance and feedback from peers and other coworkers. During the VIP review, the supervisors recommend any refresher training the employee may need and develop a plan for the employee to receive the needed training. The LMS provides and archives certificates of completion for any course work taken through the LMS.

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

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

Monitoring staff provides new monitoring personnel and local station operators the necessary on the job training for their individual monitoring tasks. These include data review, verification, and validation. Upon completion of training, the trainee will be performance tested on knowledge, skills, and abilities in the field and at the office. Upon successful demonstration of initial competency, the trainer will complete Form DAQ-16-022 DAQ Initial Demonstration of Competency. Continuing demonstration of competency is noted during VIP reviews and internal TSAs and documented using Form DAQ-16-019 DAQ Continuing Demonstration of Competency. The employee documents all on-the-job training on the appropriate form and archives it in IBEAM. Ongoing proficiency is reviewed on an as needed basis. No certificates



are provided to the trainee and trainee proficiency is documented as part of the on-the-job training process and documentation.

The chief invites all regional monitoring coordinators and technicians, along with technicians from ABAQA, to the DAQ Ambient Monitoring Workshop held each year. This workshop provides an opportunity to discuss and train on the ozone ambient air quality monitoring project and the QC and QA processes, including data review and verification, to ensure the collection of valid data for the project. A senior staff member provides hands-on instruction with the analyzers as on the job training when new employees are hired. The vendor(s) may provide training when DAQ purchases new monitors and other equipment. The DAQ and EPA staff provides training annually during the monitoring workshop. All available presentations and materials generated at the workshop are maintained on the RCO group drive or in SharePoint for archival purposes. The agenda is attached to the attendance record and is stored in IBEAM. No formal training evaluation forms are collected during or after the workshop.

### **DEQ - DAQ Training Links**

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

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

## 9.0 Documentation and Records

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

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

Microsoft SharePoint is utilized as an access-restricted document and records storage repository by the seven regional offices. The regional ambient monitoring coordinator is responsible for all ambient monitoring documents and/or records stored on their specific SharePoint site. Access to each SharePoint page is restricted to its respective regional office personnel. Regional records and/or documents are stored on the regional SharePoint sites and the regions retain their records and/or documents according to the retention schedule. RCO chemists do not have access to the regional SharePoint sites. Therefore, any document and/or record requiring RCO review is placed on the RCO group drive for the RCO chemist to review and approve. The RCO chemists are assigned specific program areas for which they are responsible. For instance, each chemist is responsible for a specific criteria pollutant, such as ozone, particulate matter, sulfur dioxide, nitrous oxides, and carbon monoxide. Also, a specific RCO chemist is assigned to meteorology data and a specific RCO Chemist is assigned to air toxics data. These chemists are responsible for the final approved records that are stored on the RCO group drive.

Documents and records are also archived in the internal access restricted IBEAM. The RCO staff also utilize SharePoint to share information such as reference materials, meeting notes, draft copies of documents, news articles, workshop materials, presentations, and other miscellaneous information. The RCO SharePoint page is for internal division usage by the Ambient Monitoring Section and access is restricted to specific North Carolina air quality and DAQ staff but it is not the official location of the approved QMP, QAPPs and SOPs. The approved QMP, QAPPs and SOPs are posted to the DEQ/DAQ website (<https://deq.nc.gov/about/divisions/air-quality/air-quality-monitoring/quality-assurance-documents>) for the ease of access for all State, Local and Tribal staff at any location where internet access can be utilized, such as the monitoring sites. All approved documents are posted to the website under strict approval processes and protocols.

DIT routinely creates backups of all data stored on the RCO group drive and IBEAM. Files stored in the "General Documents" module of IBEAM are protected from deletion; any file a user attempts to delete remains in the database but is hidden from view. A supervisor can restore

that file to its previous location via a request to the IBEAM administration staff. As a cloud-based file storage location, SharePoint file backups are facilitated by Microsoft, Inc.; all files are backed up twice daily and Microsoft provides a 90-day window for recovery of documents from inadvertent editing or deletion.

The DAQ secures all electronic documents by utilizing encrypted laptops or password protected computers and by storing paper documents in limited access areas. 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	(RCO) Raleigh, NC – DAQ Raleigh Central Office  Asheville, NC –ABAQA
	Quality management plan	<a href="https://deq.nc.gov/media/27829/open">DEQ Website (https://deq.nc.gov/media/27829/open)</a>
	Organizational structure	Ambient Monitoring Administration Page on <a href="#">SharePoint</a>
	Personnel qualifications and training	DEQ HR and DAQ Training page on <a href="#">SharePoint</a>
	Training records and certification	Learning Management System, IBEAM general documents module and Value In Performance
Site Information	Network descriptions Site files Site maps Site pictures	Raleigh, NC – Central Office group drive and Regional Office SharePoint page IBEAM General Documents Module Asheville, NC –ABAQA
Environmental Data Operations	Quality assurance project plans Standard operating procedures QA bulletins	<a href="#">DEQ Website</a> for official repository. Other file locations may include IBEAM General Documents Module for archived versions, NC Ambient Monitoring Section QAPP page on <a href="#">SharePoint</a> or Raleigh Central Office group drive (see below)
	Field and site notebooks	Raleigh, NC – Central Office group drive Regional Offices SharePoint page Monitoring sites

**Table 9.1 Documentation and Records Information**

Categories	Record/Document Type	File Locations
		Asheville, NC –ABAQA
	Inspection, equipment and maintenance records	Raleigh, NC – Central Office group drive and ECB Regional Offices SharePoint page Asheville, NC –ABAQA
Raw Data	Any original data (routine and QC) including data entry forms	Raleigh, NC – Central Office, ECB Regional Offices Asheville, NC –ABAQA
Data Reporting	Air quality index reports	<a href="#">DAQ Website</a> , IBEAM General Documents Module
	Annual data certification report	IBEAM General Documents Module
	Data/summary reports	<a href="#">DAQ Website</a> , IBEAM General Documents Module
	Journals/articles/papers /presentations	Raleigh, NC – Central Office group drive IBEAM General Documents Module Asheville, NC –ABAQA
Data Management	Data algorithms Data management plans and flowcharts Data management systems	Raleigh, NC – Central Office Asheville, NC –ABAQA
	Pollutant data Minute data	Envista ARM database
	Meteorological data	Envista ARM database Raleigh Central Office group drive, Regional Office group drive, IBEAM
Quality Assurance	Network reviews and assessments Control tables Certification documentation Data quality assessments Quality assurance reports EPA Technical system audit reports Internal systems audit reports Response/corrective action reports Annual performance evaluation reports E-mails related to QA activities and assessments	Raleigh, NC – Raleigh Central Office, ECB and Regional Offices IBEAM General Documents Module Asheville, NC –ABAQA

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

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

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

Section 19.0 Data Management contains detailed information regarding how DAQ will manage data from the ozone 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. Documents in this category include:

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

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

As of this QAPP revision, DAQ is in the process of purchasing and implementing a new document and record storage database (pending funding), which may result in changes to these

procedures and locations. When these changes are made, this QAPP and relevant SOPs will be revised to reflect new procedures and document and record locations.

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

Also, at the time of this QAPP revision, RCO uses the RCO group drive and SharePoint as repositories for working documents. Regional offices use SharePoint as a repository for working documents, and transfer completed documents to the RCO group drive. Draft documents will be watermarked as \*DRAFT\* so that no confusion arises as to the finality of the document. The QAM or designee receives final versions for review and approval. Once all approvers sign the QAPPs and SOPs, the QAM or designee will upload or assign someone to upload the document to the website and IBEAM. The QAM will notify staff of the issuance of the new document via email and during the next ambient monitoring monthly meeting. The chief and RCO chemists may change these procedures when the new document and record storage database is implemented and will revise the QAPP if changes are made at that time.

## 9.2 Data Collection Records and Logbooks

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

All ABAQA monitoring staff, regional monitoring technicians and coordinators, ECB electronics technicians, 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

Each ABAQA monitoring staff or monitoring technician will be responsible for obtaining, maintaining, and documenting the appropriate logbook(s) or associated QA/QC data forms. Each ozone monitor has an electronic logbook, or e-log, created for that specific monitor type. The e-log contains all data entry forms required by ABAQA staff or a regional monitoring technician to



document all routine operations. After each use, the ABAQA monitoring staff or regional 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 regional monitoring technician will transfer the e-log to the respective Regional SharePoint page for the regional monitoring coordinator to review. The ABAQA monitoring staff or regional monitoring technician will use these e-logs to record information about the site operations, as well as document routine operations. The e-logs are editable, but the original e-logs remain on the access-restricted Regional SharePoint page, which tracks changes and edits and are recoverable in the event of inadvertent deletion. Once the Regional monitoring coordinator has reviewed and approved an e-log, they upload it to the RCO group drive, which is the official repository of these records. The ECB electronics technicians will fill out instrument maintenance logs, Air Quality Section Maintenance Order or AQ-109 forms, and Continuous Monitor Performance Audit Report or AQ-121 forms. The original AQ-109 forms are retained at the ECB facility. The AQ-121 forms are scanned and stored in IBEAM; hard-copies are stored in a filing cabinet at RCO.

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

**Field Logbooks** – The DAQ uses a combination of bound paper logbooks and e-logs for recordkeeping for each sampling site, sampling instrument, specific program or individual. Each paper logbook should be hardbound and paginated. The ABAQA monitoring staff, regional monitoring and ECB electronics technicians use the paper site logbooks to document site visits and other activities, including who is at a site, when and why. Every visitor must sign the site logbook. The logbooks generated and maintained by ABAQA or regional office staff are filed and archived at the appropriate ABAQA or regional office once completed. Logbooks generated and maintained by ECB staff are filed and archived at the ECB once completed. The e-logs capture monitor maintenance and QA/QC activities, including calibrations

### 9.2.2 Electronic Data Collection

The ozone analyzers, along with the data acquisition systems, or DAS, provide an automated means for collecting information that DAQ would otherwise record on data entry forms. Section 19.0 Data Management details information on these systems. To reduce the potential for data entry errors, the DAQ will use automated systems where appropriate and will record the same information the monitoring technician would record on data entry forms. ABAQA ozone data will also be polled and transmitted to DAQ on an hourly basis.

To provide a backup, the PPB staff will store electronic copies of the data collected electronically (daily poll) from the DAQ and ABAQA-operated sites for an appropriate time frame on the RCO group drive. Electronic backup copies of automated data collection information will also be stored on the site computers.

### 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/span/precision checks,
- Verification and calibration procedures,
- Maintenance activities,
- Annual performance evaluations,
- EPA performance audits such as NPAP,
- 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 activities, including e-mails, Excel spreadsheets, fillable PDF data forms, worksheets, and data management systems such as Envidas Ultimate and Envista ARM, both developed by the software developer, Envitech. The associated SOPs 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.

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. 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 RCO group drive and also on local computer hard drives in the certification room. Records for internal certifications of the photometers and calibrators used in the field and for audits are stored electronically on the RCO 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 division is in the process of evaluating and purchasing a database for generating and archiving these types of records. When the database is obtained, the chief and RCO chemists will review the new record generating and retention processes and will revise the QAPP.

#### 9.4 Reference Materials

Because of the technical nature of ambient air monitoring, DAQ requires numerous reference materials to administer the ozone monitoring program effectively. This category includes publications such as instrument operation manuals, troubleshooting guides, EPA guidance documentation, EPA technical memoranda and various other reports. DAQ maintains access to applicable reference materials if DAQ has an administrative need for them. DAQ retains these documents at the RCO, in the IBEAM general documents module, or on the RCO group-drive.

#### 9.5 Data Archiving and Retrieval

The DAQ classifies documentation according to its intended use, future applicability, and regulatory requirement for retention. DAQ follows the state of North Carolina's functional schedules for files. Files used and created by DAQ will be kept for a minimum amount of time set by these functional schedules. To meet DAQs contractual obligation to the EPA, DAQ will retain all the information listed in Table 9.1 for a minimum of four complete calendar years from



the date of collection in accordance with [2 CFR Section 200.334](#). ABAQA will retain all of the information listed in Table 9.1 for four complete calendar years from the date of collection as well. DAQ will also maintain copies of all logbook and certification data produced by ABAQA over the course of the ozone ambient air quality monitoring project.

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, until the end of the regular four-year period, or until the minimum time required by the state of North Carolina functional schedules, whichever is later. The records custodians are responsible for ensuring these retention times are met and disposing of records after their retention period has elapsed.

DAQ stores electronic records within the data management systems located at the ozone sites, or Envistas Ultimate, the RCO, or Envista ARM, and on network servers in the regional offices, ABAQA and RCO. The database manager regularly backs up the Envista ARM database following the procedures in Section 5.7 of DAQ-05-001.5 Ambient Monitoring Section Database Manager Standard Operating Procedure.

## 10.0 Network Description

The primary function of the ozone ambient air quality monitoring program is to verify compliance with the NAAQS. Other purposes for the program include (1) determining trends over time, (2) determining effects on air quality from adjustments to source emissions, (3) developing algorithms based on historical air quality and other conditions which will forecast air quality, (4) verifying air quality modeling programs, (5) providing real-time ozone data to the public and (6) correlating health effects to air quality.

Ozone sampling network design and monitoring site selection comply with 40 CFR Part 58, Appendices D, E, and G. Appendix A to Part 58 prescribes requirements for collocating regulatory particulate matter monitors, which are covered under separate DAQ QAPPs. Appendix A does not require gaseous pollutant monitors to be collocated.

### 10.1. Network Objectives

In addition to the three basic monitoring objectives and specific goals listed in Section 6.0 of this QAPP, the ozone ambient air quality monitoring network is designed to meet the following monitoring objectives:

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

The ozone ambient air quality monitoring network uses the network design criteria specified in 40 CFR Part 58, Appendix D, to establish the appropriate network configuration necessary to meet these objectives.

The DAQ assigns each monitor within DAQ's ozone ambient air quality monitoring network one or more of the following monitoring objective designations:

- **Population exposure** - the monitor is in an area associated with high population density (7 monitors).
- **Background** - the monitor is located where manmade pollutant emissions are minimal (14 monitors General Background and 2 Upwind Background).
- **Regional Transport** - the monitor is located to measure pollutants transported from other areas (3 monitors).
- **Highest or maximum ozone concentration** - the monitor is located where a high concentration of the pollutant is expected, often based on results of receptor models (6 monitors Highest Concentration and 2 monitors Maximum Ozone Concentration).

- **Welfare Related Impacts** - the monitor provides data primarily to measure air pollution impacts on visibility, vegetation damage or other welfare-based impacts (4 monitors).

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 hourly ozone concentrations measured with the spatial scale most appropriate for the monitoring objective of the station. Population exposure and highest or maximum ozone concentration monitors are generally neighborhood or urban scale whereas background, regional transport and welfare related impact monitors are generally urban or regional scale. For a description of these representative measurement scales, see Section 6.0. Ozone monitoring sites may include SLAMS monitors intended to address specific air quality management interests, as well as SPM monitors (e.g., short-term ozone study). The annual network plan includes monitoring objective, spatial scale of representativeness, operating schedule (see Section 10.4), and site type information for each DAQ and ABAQA ozone monitor. The annual network plan may be accessed on the DEQ website at the following link: (<https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan>).

## 10.2 Site Selection

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

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

The DAQ evaluates each monitoring site to assure it adheres to the site selection criteria specified in 40 CFR Part 58, Appendix E.

### 10.2.1 Site Location

The DAQ considers 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.). If such problems cannot be remedied through using standard measures such as additional lighting, fencing, etc., then an attempt to locate the site as near to the preferred location as possible shall be made.
- **Logistics** - This process includes procurement, maintenance and transportation of material and personnel for the monitoring operation. The logistics process requires full knowledge of all aspects of the data collection operation: planning, reconnaissance, training, scheduling, safety, staffing, procuring goods and services, communications, and inventory management.
- **Atmospheric Considerations** - These considerations may include spatial and temporal variability of pollutants and their transport. Effects of buildings, terrain and heat sources or sinks on air trajectories can produce localized anomalies of pollutant concentrations. The chief 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 properly locate many monitoring sites (e.g., siting either to detect or avoid emissions from specific sources).
- **Topography** - The chief must complete an evaluation of the local topography based upon land use maps, U.S. Geological Survey topographic maps and other available resources. The chief must also identify and evaluate minor and major topological features that impact both the transport and diffusion of air pollutants. Minor features may include an adjacent tree lined stream or tall structures either upwind or downwind of a point source, each of which may exert small influences on pollutant dispersion patterns. Major features include river canyons or deep valleys, mountain ranges and large lakes. Major features significantly impact the prevailing wind patterns or create their own local weather such as katabatic or anabatic winds.
- **Pollutant Considerations** - The monitoring site location for a specific pollutant may or may not be appropriate for another pollutant. The DAQ monitoring staff must evaluate the changes that pollutants undergo temporally and spatially to determine the applicability of each site for a specific pollutant. An example would be the temporal delay in peak concentrations of reactive oxides of nitrogen and volatile organic compounds, or VOCs, compared to the peak concentration of resulting ozone. A micro scale site near a roadway may be appropriate for measuring ozone precursors, such as VOCs and reactive oxides of nitrogen, but entirely inappropriate for measuring ozone itself. Due to the time delay in the creation of the secondary pollutant, ozone, a more distant neighborhood- or urban-scale monitoring site may be appropriate for directly monitoring ozone.

An interdependence exists between all the factors listed above. Consequently, the DAQ and ABAQA must use an iterative procedure to successfully select appropriate sites that can provide the data necessary to accomplish the project's stated objectives. In situations where the sites do

not specifically meet the requirements necessary to obtain the project objectives, reevaluation of the project 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. These responsibilities are shared amongst the Ambient Monitoring Section staff as well as other DAQ staff.

### 10.2.2. Monitor Placement

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

### 10.3 Probe Siting Criteria

General probe and monitoring path siting criteria for analyzers at the ozone ambient air quality monitoring sites shall adhere to the requirements listed in 40 CFR58, Appendix E and the instructions outlined below.

The probe intake is to be located from 2 to 15 m above the ground. The probe is to be more than 1 m horizontally or vertically away from any supporting structures. It should be at least 20 m but must be at least 10 m away from any trees or shrubs. Because of their ability to alter normal wind flow patterns and provide surfaces for adsorption or reactions (the scavenging effect of vegetation is greater for ozone than for the other criteria pollutants), trees and shrubs shall not be located between a nearby source and the monitor. The ECB electronics technicians and ABAQA air quality staff measure the distance from the dripline or outside edge of the crown, not the trunk. For monitors operated at the same site for several years, it is best to allow some additional space for vegetation growth. In situations where the EPA or DAQ considers trees or shrubs as an obstruction, the trees or shrubs must be at least 10 m from the probe. The distance between the probe and any obstacle must be at least twice the height that the obstacle extends above the probe.

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

### 10.4 Sampling Frequency

The EPA establishes minimum sampling frequencies in [40 CFR 58.12](#), which DAQ and ABAQA follow. The monitors used in the ozone ambient air quality monitoring network sample ambient air continuously.

As prescribed by [40 CFR Part 50](#), the DAQ and ABAQA collect at least the minimum number of hours and days of ozone data required for appropriate summary statistics. At least 75 percent of the total possible observations must be present before summary statistics are calculated. The exact requirements appear below in Table 10.1. The sampling schedule and frequency for ozone ambient air quality monitoring data is hourly data collected 24-hours a day, 7-days a week. Most of the ozone ambient air-quality monitoring stations operate on a seasonal basis from March 1 to Oct. 31. The high-altitude sites operate on a seasonal basis with the season to start as soon as possible after March 1 but no later than April 1. Several monitors operate on a year-round basis.

**Table 10.1 Requirements for Calculating Ozone Summary Statistics**

<b>Time Frame</b>	<b>Completeness Requirement * (percent)</b>
3-Year Comparison	≥ 90 percent (average) daily maximum concentrations available in ozone season with a minimum of 75 percent in any one year.
8- hour average	≥ if at least 6 of the hourly concentrations for the 8-hour period are available
Valid Daily Maximum	≥ if valid 8-hour averages are available for at least 13 of the 17 consecutive 8-hour periods starting from 7:00 a.m. to 11:00 p.m.
Valid hour	≥ 45 valid 1-minute averages are available for the 60-minute period from the top of the hour to 59 minutes past the hour

\* Five sites are exempt from the March 1 ozone-season start date in years when the weather prevents access to the sites. Thus, EPA calculates completeness for these sites based on data collected from April 1 through October 31. The five sites are: Linville Falls, 37-011-0002, Joanna Bald, 37-075-0001, Frying Pan, 37-087-0035, Purchase Knob, 37-087-0036, and Mount Mitchell, 37-199-0004.

## 11.0 Sampling Methods Requirements

### 11.1 Sampling 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 FRM or FEM. Towards that end, DAQ uses only EPA-approved FRM or FEM ozone monitors at the SLAMS sites within the ozone ambient air quality monitoring network. Ozone analyzer methods that have received FRM or FEM status have been rigorously tested, in accordance with 40 CFR Part 53 requirements, and been found to meet (or be comparable to) the EPA reference methods (codified in 40 CFR Part 50 – see Section 13.0 of this QAPP). For the detailed specifications upon which a specific monitoring method (i.e., analyzer type) has received its FRM/FEM status, see the List of Designated Reference and Equivalent Methods, issued by the EPA Office of Research and Development, which can be found on the AMTIC website (<https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants>) as of the date of this QAPP). DAQ will operate each FRM/FEM ozone analyzer in accordance with these designation specifications. To ensure adherence to such specifications, procedures set forth in associated SOPs (see Table 11.2 of this QAPP) will be followed.

The ozone ambient air quality monitoring network uses the Thermo 49i analyzer with the Thermo 49i-PS as the calibrator. The physical principle used to measure ozone relies on the absorption of ultraviolet (UV) radiation by the ozone molecule. The ozone molecule has an affinity for specific wavelengths between 240 nanometers (nm) and 320 nm. The affinity peaks in the UV range at approximately 254 nm. Using this phenomenon and employing the Beer-Lambert relationship, one can measure the quantity of ozone present in the air by determining the quantity of UV radiation absorbed along a specified path length.

To employ these concepts, a UV photometer splits the ambient air stream. The photometer directs the first stream into a measurement cell, while passing the second stream through a catalytic converter to remove all traces of ozone. 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 ambient air flow rate, to insure a clean, uniform amount of ambient air is present in the cell. The analyzer takes a measurement of this ambient air over the subsequent, equal time span. Next, the instrument cycles the catalyzed ambient air into the cell, using the same time spans to insure a clean, ozone-free sample exists in the cell, prior to measuring the ozone-free UV attenuation level. The analyzer then repeats the cycle with new ozone containing ambient air.

DAQ and ABAQA maintain copies of the Thermo instrument manuals at the sites, at the regional and local offices and at the ECB facility.

Table 11.1 lists the analyzers used in the ozone ambient air quality monitoring network. When the current monitors used in the network become obsolete, the ECB supervisor and electronics technicians in consultation with the chief, RCO ozone chemist and regional and ABAQA monitoring staff will select a new monitor type to replace the existing monitor type used throughout the network. Rollout of the new monitor type will be coordinated by the chief with input from the ECB, RCO and regional monitoring staff.



**Table 11.1 DAQ Ozone Ambient Air Quality Monitoring Network Analyzers**

<b>Pollutant</b>	<b>Analyzer</b>	<b>EPA Reference/Equivalence</b>
Ozone	Thermo Environmental Instruments, Inc. Model 49i	EQOA-0880-047
Indoor Shelter Temperature	Comet Temperature Sensor Model T0310	AQS Method Code 013, No FRM or FEM

## 11.2 Monitoring Technology/Methodology

Table 11.2 lists specific SOP titles used in the network.

**Table 11.2 List of SOPs Associated with this Quality Assurance Project Plan**

<b>DAQ Standard Operating Procedures</b>	
Section 2.7.2	Thermo Scientific Model 49i Ozone Monitoring System Standard Operating Procedures for Operator Responsibilities, Revision 9, March 17, 2022
Section 2.39.4	SOP for Quarterly Completeness Data Review, Revision 1.0, June 12, 2020
Section 2.43.2	SOP for Completing the Annual Network Review for the DAQ, Revision 2, September 29, 2017
DAQ-05-001.5	Envista Database Management Procedures, Revision 0, March 5, 2021
<a href="#">DAQ-10-001.1</a>	Thermo Scientific Model 49i Ozone Monitoring System Standard Operating Procedures for the Electronics and Calibration Branch, Revision 7.3, March 15, 2022
DAQ-14-001.5	SOP for Preparing SOPs for the DAQ, Rev. 2.0 May 21, 2021
DAQ-14-002.5	SOP and QAPP Tracking Database Procedures, RCO Responsibilities, Revision 0, Dec. 1, 2020
DAQ-14-003	Document Retention Procedure (currently under revision)
DAQ-15-001.1	Standard Operating Procedure DAQ-15-001.1 Verification of Ambient Monitoring Thermometers Version 0.0 Nov. 13, 2020
DAQ-15-002	Corrective Action Process Revision 0, Dec. 1, 2021
DAQ-15-005.5	Data Validation for Continuous Gaseous Monitors and Meteorological Data, Raleigh Central Office Responsibilities, March 9, 2022

Electronic data collection is possible through the ozone ambient air quality monitoring network's data acquisition system, or DAS, which is currently Envistas Ultimate, and wireless modems. This equipment is in the shelters where the DAS records the data history and the modems provide a path to download the data for analysis.

The database manager configures the computers in the state's RCO, managed by DIT, to connect automatically to the station at least hourly to retrieve both hourly and minute data for analysis. Envista ARM also automatically retrieves any nightly checks the hour after they are run. Monitoring personnel can contact the stations manually to retrieve data or determine the status of the systems, if needed.

The Envista ARM data software sends all data automatically 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.



## 11.3 Support Facilities

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

### 11.3.1 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 regional monitoring technicians and ABAQA monitoring staff, who operate the site, to safely and easily service and maintain the equipment. The chief considers winter and hurricane weather conditions during site selection to meet the station safety and serviceability requirements.

### 11.3.2 Shelter Criteria

The ECB electronics technicians and ABAQA monitoring staff house air pollution analyzers in a shelter capable of fulfilling the following requirements:

- The regional monitoring technicians and ABAQA monitoring staff must maintain the shelter temperature at a temperature that meets the reference or equivalency method requirements for all instrumentation that it contains.
- The shelter power supply should not vary more than  $\pm 10$  percent from 117 alternating current voltage. The ECB electronics technicians or ABAQA monitoring staff should provide some type of voltage regulation to accomplish this, if needed.
- The shelter must protect the instrumentation from precipitation and excessive dust and dirt, provide third wire grounding as in modern electrical codes and meet federal Occupational Safety and Health Administration regulations.
- The regional monitoring technician and ABAQA monitoring staff must clean the shelter regularly to prevent a buildup of dust; and
- The shelter must protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light, or radiation.

The ECB electronics technicians or ABAQA monitoring staff use insulated heat-tape wrapped single probe lines to provide ambient air to the monitor. In addition, the ECB electronics technicians or ABAQA monitoring staff attach the probe lines to a particulate matter 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 monitor is calibrated through the particulate matter filter. The 1-point-QC checks also enter the monitor via the particulate matter filter. The analyzer draws sample from the probe inlet. The annual performance evaluation is also conducted through the probe inlet. The probe material must be either borosilicate glass or an acceptable inert plastic, such as polytetrafluoroethylene, perfluoroalkoxy (PFA), or other Teflon™-type material.

The ECB electronics technicians or ABAQA monitoring staff use Teflon™ probe lines to ensure the probe material is non-reactive with ozone. The probe, intake vent and interconnecting tubing design must provide a minimum number of bends to avoid particles hitting and adhering to the surfaces. Impacted particles may provide surfaces to which ozone may adsorb or, if the impacted particle is metallic, catalyze to a non-criteria species. Additionally, the ECB electronics technicians use 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, influencing the ozone concentration by removing it from the sampled ambient air, and consequently, yielding inaccurate environmental data.

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

The ECB electronics technicians or ABAQA monitoring staff 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. Issues 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.

## 12.0 Sampling Handling and Custody

The ozone ambient air quality monitoring program does not require the monitoring technician or ABAQA monitoring staff to take any samples that would warrant a sample custody procedure.

The instrumentation set at each monitoring location directly analyzes the ambient air and reports the ozone concentrations for each minute and hour.

## 13.0 Analytical Methods

The ozone ambient air quality monitoring network does not use any laboratory analytical methodologies to complete the analysis of any hourly ozone measurements. Title 40 CFR Part 50, Appendix D provides the FRM for ozone ambient air quality monitoring. Designated FEMs may also be used for ozone air monitoring within the DAQ network. Section 11.1 Sampling Methodology in this QAPP provides a summary of the ozone analyzer's analytics.

## 14.0 Quality Control Requirements and Procedures

To assure the quality of data from air monitoring measurements, the DAQ must perform two distinct and important interrelated functions. 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, calibration checks, etc.

Quality control is the overall system of technical activities that measure the attributes and performance of a process, item or service against defined standards to verify they meet the stated requirements established by the end user. For the ozone-ambient-air-quality monitoring network, the DAQ uses QC activities to ensure DAQ maintains measurement uncertainty, as discussed in Section 7.0 Data and Measurement Quality Objectives and Criteria for Measurement Data, within acceptance criteria for the attainment of the DQOs. The SOPs [DAQ-10-001.1](#) and [2.7.2](#) and instrument manuals provide lists of pertinent QC checks.

Quality control activities will include, but not be limited to, the following:

- Daily automated calibration checks consisting of a zero, span and 1-pt QC check;
- Daily review of instrument measurements;
- Annual or seasonal multipoint calibrations (or as needed);
- Monthly operational checks by the regional monitoring technician or ABAQA air quality staff;
- Routine maintenance as specified per the SOP; and
- Performance evaluations by DAQ, as determined by their schedule.

Data analyzed from monitors in the DAQ ozone ambient air quality monitoring 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-logs. The ABAQA monitoring staff, regional monitoring and ECB electronics technicians do not compute any calculations by hand. The RCO chemists derived the formulas from relevant sections of 40 CFR Part 58 and the appendices to 40 CFR Part 50. Table 7.2 provides 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 or measurement of higher accuracy, to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustment. This multiphase process begins with certifying a transfer standard against an authoritative NIST-traceable standard. The ABAQA monitoring staff and regional monitoring technicians then compare the ozone analyzer's measurements to this transfer standard. If significant deviations exist between the analyzer's measurements and the transfer standard's measurements, an adjustment of the analyzer takes place to rectify the analyzer's measurements. Before any adjustments are made to a calibrated analyzer, the ABAQA monitoring staff or regional monitoring technician must ensure the data are bracketed by either an automated or manual 1-point QC check. The ABAQA monitoring staff and regional monitoring technicians perform an adjusted calibration of the monitor at the beginning of the ozone season or following an equipment failure, when the power is out for more than 72 hours or when the calibrator and/or

critical equipment is replaced (i.e., monitor, probe line, etc.). To be clear, the routine frequency for calibrations is 1/365 days and 1/calendar year.

The ABAQA monitoring staff and regional monitoring technicians use a transfer standard to calibrate all analyzers within the ozone ambient air quality monitoring network. In Table 14.1 the acceptance criteria listed for the calibrator is the acceptance range between what the calibrator read and the theoretical concentration. The zero and span values of the calibration have tight acceptance ranges, between which the values measured by the analyzer must fall. The acceptance criteria listed in Table 14.1 for the monitor is the acceptance range between what the calibrator reads and what the monitor reads. The ABAQA monitoring staff person or regional monitoring technician then verifies these calibrations by the zero and span checks that occur nightly. SOP 2.7.2 and the instrument's operations manual provide specific calibration requirements for the ozone analyzer. Table 14.1 provides a summary of these requirements as well as QC requirements, which the next subsection will discuss in detail. The zero and span levels in Table 14.1 represent the range over which the DAQ calibrates. This calibration range represents the concentrations of ozone typically measured in ambient air throughout North Carolina.

**Table 14.1 Acceptance Criteria for Calibrations and Daily Auto-Checks**

Theoretical Concentration (ppb)	Calibration		Daily Auto - Calibration Check		Manual Calibration Check	
	Calibrator	Monitor	Calibrator	Monitor	Calibrator	Monitor
0	$\leq \pm 2$ ppb	$\leq \pm 2$ ppb	$\leq \pm 2$ ppb	$\leq \pm 2$ ppb	$\leq \pm 2$ ppb	$\leq \pm 2$ ppb
65 <sup>B</sup>	$\leq \pm 2$ ppb	$\leq \pm 2$ ppb	$\leq \pm 3$ ppb	$\leq \pm 3$ ppb	NA	NA
120 <sup>A</sup>	$\leq \pm 2$ ppb	$\leq \pm 2$ ppb	NA	NA	NA	NA
180 <sup>A, C</sup>	$\leq \pm 2$ ppb	$\leq \pm 2$ ppb	NA	NA	NA	NA
225	$\leq \pm 2$ ppb	$\leq \pm 2$ ppb	$\leq \pm 3$ ppb	$\leq \pm 5$ ppb	$\leq \pm 2$ ppb	$\leq \pm 5$ ppb

<sup>A</sup> 120 and 180 ppb for Daily Auto Calibration is not used

<sup>B</sup> One-point QC check value must be between 5 and 80 ppb per EPA

<sup>C</sup> Calibration point added in 2020 per EPA requirements (zero + 4 points)

DAQ updated SOP 2.7.2 to include using a 5-point regression line best-fit exercising the criteria: slope  $1 \pm 0.05$  and each point being within 2 percent or 1.5 parts per billion (ppb) of the best fit line. These criteria comprise the new calibration standard for ozone, which was incorporated into ozone SOP 2.7.2 Revision 8, promulgated on Feb. 21, 2020.

## 14.2 Precision Checks

The EPA defines precision as the measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. To meet the DQOs for precision, DAQ will ensure that the entire measurement process is within statistical control. The DAQ will use various tools in evaluating and monitoring precision measurements. The DAQ challenges the instrument's precision with a 1-point QC or daily auto precision zero span or PZS check that will provide evidence of deviations from the required precision measurement.

Pursuant to 40 CFR Part 58, Appendix A, Section 3.1.1, a 1-point QC check must be performed at least once every 2 weeks on each continuous analyzer used to measure the gaseous criteria pollutants. The 1-point QC check is made by challenging the ozone analyzer with a QC check

gas of a known concentration that is between the prescribed range of 5 and 80 parts per billion (ppb). The 1-point QC check for all analyzers within the DAQ ozone ambient air quality monitoring network is at 65 ppb. The DAQ chose 65 ppb with the objectives of the ozone ambient air-quality monitoring project in mind. The DAQ chose this value because it is close to the NAAQS and is near the median concentration level for the network.

When the daily auto PZS falls outside the DAQ warning limits two days in a row, the regional monitoring technicians or ABAQA monitoring staff must investigate to determine if the check is a valid check. A check may be invalid due to a problem with the ozone calibrator or zero air system, a bad solenoid, or a power failure. If a valid check falls outside the DAQ warning limits twice or when some type of anomaly occurs, the regional monitoring technicians or ABAQA monitoring staff are required to at a minimum do an unadjusted manual calibration check consisting of a zero, span and intermediate concentration level.

The SOPs and instrument operations manual provides 1-point QC check and precision requirements for the ozone analyzer.

### 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). PZS checks can provide data capable of identifying bias for gaseous monitors.

The DAQ will monitor data integrity with control tables to provide evidence of deviations from the required precision measurement. SOP [Thermo Scientific Model 49i Ozone Monitoring System Section 2.7.2: Operator Responsibilities Revision 9.0 \(3/17/2022\)](#) and the instrument operations manual provide accuracy and bias requirements for the ozone instrumentation.

#### 14.3.1 Annual Performance Evaluations

The ECB electronics technicians will perform an annual performance evaluation at least every 365 days and once per calendar year and whenever requested by the chief. The ECB electronics technicians perform these evaluations by comparing the analyzer measurements to independent standards or references. The ECB electronics technicians determine the audit concentrations following requirements in 40 CFR Part 58, Appendix A, Section 3.1.2.1. 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 99<sup>th</sup> percentile of the data within the network. The ECB electronics technician uses a different ozone standard/calibrator to complete the audit than the ozone standard/calibrator used to calibrate the monitor and complete the daily automated 1-point 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 ozone monitors, to do the annual performance evaluations using dedicated QA equipment. The instrument operations manual and SOP [Thermo Scientific Model 49i Ozone Monitoring System Electronics and Calibration Branch Responsibilities Revision 7.3 \(DAQ-10-001.1, 3/15/2022\)](#) provide details for implementing annual performance evaluations. The EPA has designed these checks to assess the accuracy and measure the bias.

### 14.3.2 External Agency Audits

The DAQ participates in the National Performance Audit Program (NPAP). Information on the NPAP is available at <https://www.epa.gov/amtic/national-performance-audit-program-npap-gaseous-monitoring>.

### 14.4 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 ozone monitoring network, the DAQ has anticipated many of the 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 (see Table 11.2) contain examples of corrective actions that the staff may need to complete under certain circumstances. Regional monitoring technicians and ABAQA monitoring staff should consult SOP [2.7.2](#) 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 ABAQA monitoring staff, regional monitoring and ECB electronics technicians and RCO chemists report the need for corrective actions to the appropriate regional monitoring coordinator or supervisor within two business days and address the issue as soon as possible, ideally within five business days. The ABAQA monitoring staff, regional 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 14.2 Corrective Actions**

Activity	Problem	Likely Actions
QA/QC Check	Out of specification;	<ol style="list-style-type: none"> <li>1) Verify / reproduce performance check findings (e.g., PZS). Use an alternate transfer standard to confirm failures.</li> <li>2) Perform alternate performance checks to determine cause (for example – leak tests to aid in flow rate issues).</li> <li>3) Recalibrate monitor using SOPs.</li> <li>4) Identify any required procedural changes to prevent reoccurrence.</li> <li>5) Document actions on audit worksheet or logbook as appropriate.</li> <li>6) Notify the chief of performance audit failures as soon as practical.</li> </ol>
Probe Line Integrity Check	Probe wet or contaminated	<ol style="list-style-type: none"> <li>1) Verify probe inlet is intact and protectors from rain, insects and dirt are in place.</li> <li>2) Check line for cold spots and bends or low points where water could accumulate.</li> </ol>



**Table 14.2 Corrective Actions**

<b>Activity</b>	<b>Problem</b>	<b>Likely Actions</b>
		3) Blow line out with zero air and dry for several hours if needed. 4) Document cause and any actions in e-log or site logbook as appropriate.
Power	Loss or interruptions	1) Verify power supply integrity. 2) Verify circuit breaker and fuse integrity. 3) Document cause and actions taken in e-log or site logbook as appropriate.
Annual 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 operator so the operator can recalibrate the monitor. 5) Document cause and actions taken on audit data sheets.
Data Review	Data missing from data acquisition system, or 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 or ECB, as appropriate. 6) Perform site visit to resolve monitor or telecommunication issues.
8-Hour Exceedance Verification	Exceedance based on less than 8-hours of data	1) Verify reason for the loss of one or two hours of data. 2) Evaluate whether the data loss was avoidable. 3) Implement measures to avoid data loss in the future such as starting maintenance earlier in the day, not doing maintenance when the forecast is above a certain amount, doing maintenance within a 28-minute window between 14 minutes before the hour to 14 minutes after the hour.

### 14.5 Documentation

The ABAQA monitoring staff and regional monitoring technicians will document all events, including routine site visits, calibrations, and analyzer maintenance in e-logs or site logbooks. The ECB electronics technicians will document all events including site visits, annual performance evaluations, equipment installs and removals and monitoring and calibration equipment maintenance on 109 forms and in site logbooks. The ECB electronics technicians will also record field maintenance activities associated with equipment used by the regional monitoring technicians in dedicated instrument logbooks as well, which are stored at the ECB. The records generated by the regional monitoring technicians or ABAQA monitoring staff at the monitoring site will normally be controlled by the regional monitoring coordinators or ABAQA staff and located in the field sites when in use or at the regional or the ABAQA office when

being reviewed or used for data verification. The regional monitoring coordinator transfers these records to the RCO group drive for the RCO chemist to use to validate the data.

## 15.0 Instrument/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 readiness certification of equipment. This section discusses the procedures ABAQA monitoring staff, regional monitoring and ECB electronics technicians use to maintain all instruments and equipment, including spare analyzers, in sound operating condition and verify 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 ABAQA monitoring staff, regional 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

The DAQ shall only purchase ozone monitors to use in the ozone ambient air-quality monitoring network that adhere to EPA equivalent or reference methods. Therefore, the DAQ assumes the monitors and procedures used to be of sufficient quality for the data collection operation. For indoor shelter temperature 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 ABAQA monitoring staff or ECB electronics technicians install the ozone monitors in the field, they assemble and operate newly purchased or repaired monitors at the ABAQA office or ECB until they certify the equipment as field ready. For the ozone monitors and spares, the analyzers shall successfully undergo at least one zero, span and multi-point calibration. If any of these checks are out of specification, the ABAQA monitoring staff or ECB electronics technician will contact the vendor for initial corrective action. If the monitor meets the acceptance criteria, the ABAQA monitoring staff or ECB electronics technician allows it to operate in the shop until he can confirm functionality. Following site installation, the ABAQA monitoring staff or ECB electronics technicians will initiate, observe, and document the successful completion of a zero and span cycle. If the analyzers meet the zero and span acceptance criteria, the ABAQA monitoring staff or ECB electronics technicians will assume the monitors are operating properly and ready for calibration by the ABAQA monitoring staff or regional monitoring technician. The ABAQA monitoring staff or ECB electronics technician will properly document and file these tests in the instrument maintenance logbooks stored at the ABAQA office or ECB.

### 15.3 Inspection

There are several items that periodically require field inspection. The applicable equipment SOPs [2.7.2](#) and [DAQ-10-001.1](#) (see Table 11.2 for SOP titles) and operations manuals present greater detail on these items and procedures. In general, the following inspection activities are used:

- The ABAQA monitoring staff and regional monitoring technicians inspect monitoring shelters, sample inlets and other enclosures during each site visit and at least once per 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 per 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 ozone monitoring station. The calibrator blends zero air with ozone to dilute the ozone concentration from the ozone generator to the necessary concentrations for conducting routine calibrations, PZS checks, and performance evaluations or audits. Zero air systems used by ABAQA and DAQ for conducting these QA/QC checks and audits should be able to deliver 10 liters per minute of air that is free of ozone, nitric oxide, nitrogen dioxide, sulfur dioxide, carbon monoxide 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 annually by the ABAQA monitoring staff and ECB electronics technicians to ensure they remain free of contaminants.
- The ABAQA monitoring staff, regional monitoring technicians and 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 the need for further inspection would include issues such as frozen numbers for multiple hours in a row or erratic spikes or valleys in 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 ABAQA monitoring staff, regional monitoring and ECB electronics technicians, who document equipment operating parameters on the PZS, calibration, and maintenance tracking forms within the e-logs, as well as on performance evaluation audit forms. During each site visit the ABAQA monitoring staff or regional monitoring technician also does a probe line integrity check to ensure the probe line is attached to the monitor, is intact, dry and clear of debris and insects.
- The ABAQA monitoring staff and ECB electronics technicians test and inspect spare equipment at the time of purchase or after major repairs and before deployment to the field. The ABAQA monitoring staff and ECB electronics technicians certify equipment as field ready and store it on a shelf or monitoring bench (typically at the ABAQA office or ECB) until deployment.
- The ABAQA monitoring staff and regional monitoring technicians review the sites and monitors annually to ensure continuing compliance with 40 CFR Part 58, Appendices A, D and E. They document their review on the DAQ site review forms.

#### 15.4 Routine Maintenance

The following are general routine maintenance protocols:

- The ABAQA monitoring staff and ECB electronics technicians maintain a limited supply of critical spare parts in the ABAQA office or ECB maintenance / repair shop to aid in rapid response to issues. For example, pump rebuild kits, spare pumps, filters, and other expendable supplies are routinely on hand.

- The ABAQA monitoring staff and regional monitoring and ECB electronics technicians schedule preventative maintenance ahead of time so they easily can have available all parts and tools to complete the tasks, so data loss is kept at a minimum.
- The ABAQA monitoring staff and monitoring technicians typically perform preventative maintenance activities in the field, although the ECB electronics technicians may complete some activities in the shop.

The specific equipment SOPs [DAQ-10-001.1](#) and [2.7.2](#) supplemented by the equipment user manuals detail the routine preventive activities and schedules. The ABAQA monitoring staff and monitoring technicians replace all gaseous instrument particulate matter filters at least monthly.

All ozone monitors undergo routine maintenance as part of the monthly site visit. If necessary, DAQ technicians may contact the DAQ ECB for specific non-routine maintenance. ABAQA technicians may contact either personnel within the ABAQA organization or personnel at the DAQ ECB for assistance. SOP [2.7.2](#) describes the procedure for the routine site visit and maintenance.

## 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 ABAQA monitoring staff and regional monitoring technicians minimize adjustments to prevent introducing measurement uncertainty and 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 14.1 Calibrations discusses calibrations in more detail.

40 CFR Part 58, Appendix A, § 2.6.2 requires that ozone transfer standards used in the ambient air monitoring network be traceable to the NIST. The ABAQA monitoring staff and ECB electronics technicians maintain dedicated level 2 and level 3 transfer standards for the certification of the ozone 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. Traceable is defined in 40 CFR Parts 50 and 58 as meaning that a local standard, i.e., one maintained by a monitoring organization, has been compared and certified, either directly or via not more than one intermediate standard, to a primary standard such as a NIST Standard. Similarly, traceability is the property of a measurement result whereby DAQ or an auditor 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/certifications. SOP [DAQ-10-001.1](#) and [2.7.2](#), and the Thermo 49i operation manual provide specific calibration procedures and timeframes for certifications of field equipment. (See Table 7.2 for applicable certification frequencies and acceptance criteria.)

The following summarizes the standards used in the DAQ network and their recertification process. The ABAQA monitoring staff, regional monitoring and ECB electronics technicians monitor all certification periods to ensure the ABAQA monitoring staff and regional monitoring technicians do not use equipment beyond the documented certification expiration dates. The ABAQA monitoring staff or regional monitoring technician is responsible for verifying the equipment he or she is using is within certification. The regional monitoring technician is responsible for contacting the ECB at least 30 days before the certification expires.

### 16.1 Ozone Level Two, formerly Primary Standard

At least once every 365 days, the ABAQA monitoring staff and ECB electronics technicians compare the North Carolina standard ozone photometer, or NCSOP or level two standard, and the backup NCSOP to an EPA standard ozone reference photometer, or SRP or level one standard. The EPA maintains SRPs to set the standard for all ambient air ozone measurements made nationwide. The NCSOPs serve as the reference standard for all ambient air ozone measurements made by DAQ. Both NCSOPs remain at the ECB. The ECB electronics technicians use one NCSOP to certify all the ozone level three transfer standards while the other remains on the bench as a reference.

The certification of the level two transfer standard will have its own certification documentation and will be re-verified or recertified at least annually. The EPA provides the certification records for the level two transfer standard. The ECB electronics technicians are responsible for transporting the NCSOP(s) to the EPA labs (usually in November) at RTP and collecting them (usually in December) prior to the following Ozone season start up in March.

## 16.2 Ozone Level Three Transfer Standard also known as the Site Primary Standard

The ECB electronics technicians compare the site primary ozone standard or level three transfer standard to the NCSOP each year to establish a direct response data link to the SRP. During the yearly certification of the site primary-ozone standard, the ECB performs all necessary response adjustments to the site primary ozone standard to duplicate the concentration response of the North Carolina ozone primary photometer. (See Section 1.4 of SOP [DAQ-10-001.1](#) for more information).

The certified site primary ozone standard is the source of known concentration of ozone used in the calibration of the site ambient air ozone monitor. During the calibration procedure, the ABAQA monitoring staff or ECB electronics technician adjusts the site ambient air ozone monitor to duplicate the concentration of ozone produced by the site primary ozone standard. This monitor calibration procedure establishes a direct link to the NCSOP and the EPA SRP. Whenever an ozone transfer-standard fails or needs major maintenance, the ABAQA monitoring staff and ECB electronics technicians must recertify the ozone transfer standard before redeploying to the field.

The certification of the level three transfer standard will have its own certification documentation and will be re-verified or recertified at least annually. The ECB electronics technicians provide Excel spreadsheets of each certification on the RCO group drive.

The North Carolina ozone network does not use any level four standards. All site level standards, including those used by ABAQA, are compared to the level two transfer standard.

## 16.3. “Local Primary Time Standard”

The ABAQA monitoring staff, ECB and regional monitoring technicians use the WWV NIST atomic clock in Boulder, Colorado (telephone number: 1-303-499-7111) as a primary time standard. The correct time can also be obtained via the website <http://nist.time.gov>. ABAQA monitoring staff and regional 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 computers, 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 computers to remain on Eastern Standard Time throughout the year, which is the local standard time for North Carolina.

## 16.4. “Local Primary Temperature Standard”

The ECB uses an Omega Digital Thermometer DP-41 (with resistance temperature detectors) RTD-805-Lab Standard (LS) as a “local primary temperature standard” to verify the accuracy of the shelter temperature sensors. An ECB electronics technician sends the “local primary standard” to the vendor for recertification against a NIST primary standard every 365 days.



## 16.5. Calibration of Transfer Temperature Standards

The field-temperature transfer standards used for auditing the shelter temperature sensors will be mineral thermometers or Tetra-Cals that have their own certification by the vendor. The mineral thermometers will be re-verified/recertified at least annually against the “local primary temperature standard,” or auditor’s transfer standard, to within 1 ° C, over the expected range of ambient temperatures at which the ABAQA monitoring staff, regional monitoring and ECB electronics technicians expect to use the temperature standard. The ABAQA monitoring staff and regional monitoring technicians use the temperature transfer standards to verify the shelter temperature during each site visit. They record the results of their verifications in the e-logs. The ECB electronics technicians audit the shelter temperatures during each annual performance evaluation. They record the results of their audits on the AQ-121 forms.

## 16.6 Documentation

The ECB electronics technicians retain transfer standard and zero air certification documentation for all DAQ operated sites at the DAQ ECB facility in Raleigh, NC. All transfer standard certification documentation for all ABAQA operated sites will be stored at the ABAQA location in Asheville, NC. DAQ will also retain copies of all ABAQA transfer standard certification documentation. Please reference Table 9.1 for the storage location of all documentation.



## 17.0 Inspection/Acceptance of Supplies and Consumables

The DAQ SOPs [DAQ-10-001.1](#), [2.7.2](#), and [DAQ-15-005.5](#) itemize the apparatus, equipment, materials, and supplies required for various monitoring equipment. In general, the ABAQA monitoring staff and ECB electronics technicians procure supplies and consumables directly from the vendor manufacturing the monitors used by ABAQA and DAQ. Most manufacturers' operating manuals itemize parts lists, including recommended replacement schedules, as well. The ABAQA and DAQ use this information to determine the appropriate procurement schedule and volume of consumables required to support continuing operations.

The regional monitoring technicians track supplies and consumables, e.g., ozone monitor in-line particulate filters; when the regional monitoring technicians need replacements, they notify the ECB. The ECB then supplies the needed items out of its inventory or purchases what the regional monitoring technicians need. The ECB electronics technicians maintain an inventory of supplies in the ECB shop for later distribution. The ECB electronics 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 do not retain supplies deemed unsuitable. The ECB electronics technicians 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.

The ABAQA's Field Services Program Manager is responsible for tracking, ordering, and inspecting supplies and consumables for the Agency. When supplies are ordered and received, they are inspected for any damage before use. Any materials that have a specific expiration will be discarded if not used within the acceptable period.

Sampling lines and fittings are important supplies. If used in the sampling train of a reactive gaseous analyzer, they must be fluorinated ethylene propylene (FEP) Teflon™ or equivalent.

## 18.0 Non-Direct Measurements

During the ozone ambient air quality monitoring project, the DAQ may use or evaluate data not obtained by direct measurement from the ozone ambient air quality monitoring program. This includes data from outside sources and historical monitoring data. Currently, the databases and types of data and information that DAQ uses include:

- Ozone site selection modeling information
- Chemical and physical properties data
- Monitor manufacturers' operational literature
- Geographic location data (e.g. site metadata for AQS)
- Historical monitoring information
- External monitoring databases
- Census data (e.g. determining minimum monitoring requirements in a metropolitan statistical area, or MSA)
- National Weather Service data and
- Traffic count data from the North Carolina Department of Transportation (e.g. to assist in identifying minimum separation distances between DAQ ozone analyzer inlets and the nearest roadways)

When using any outside data, the DAQ will QC and assure the data to the extent possible following QA procedures outlined in this document and in applicable EPA guidance documents.

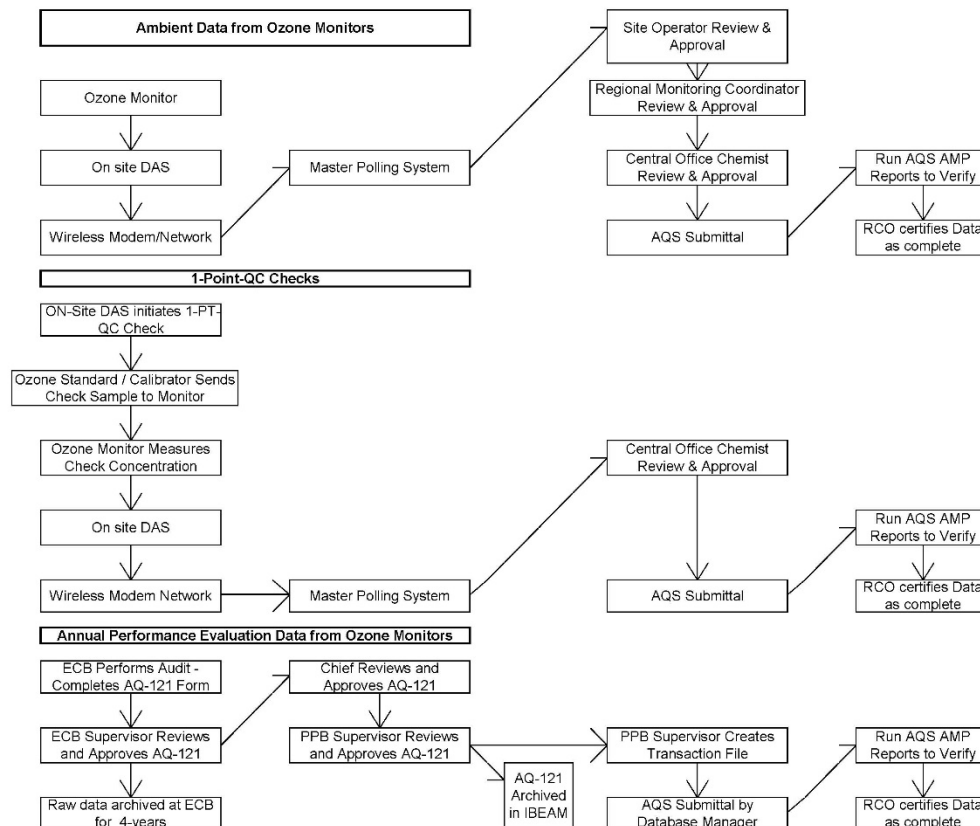
## 19.0 Data Management

### 19.1 Purpose/Background

The primary work product of the DAQ ozone monitoring program is data. Accordingly, the DAQ requires formalized procedures 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 data integrity and validity throughout its entire life cycle. DAQ's air monitoring data follows a documented flow path. The data life cycle starts when the ABAQA monitoring staff or ECB certifies the calibrator and installs the calibrator and monitor in the field and the ABAQA monitoring staff or regional monitoring technician calibrates it and ends with use of the data. The following subsections identify the processes and procedures ABAQA and DAQ 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.

Figure 19.1 displays the generalized flow path of the DAQ ambient air monitoring data, as well as the QA/QC data collected within the network. The ABAQA monitoring staff, regional monitoring technicians and coordinators, RCO chemists and statistician and database manager acquire and process the ozone ambient air monitoring data. Section 4.0 Project/Task Organization describes staff responsibilities.

**Figure 19.1 Ozone Data Flow Path**



## 19.2 Data Collection and Recording

The DAQ will use ambient air monitoring analyzers designated by EPA as FRMs or FEMs to collect data used for NAAQS compliance. Upon installation and at regular intervals as specified, the ABAQA monitoring staff or regional monitoring technician calibrates the ambient air monitoring instrumentation in accordance with the specific pollutant SOPs identified in Table 11.2 of this QAPP. Note: When DAQ or ABAQA establishes a new site, the ABAQA monitoring staff or 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 ABAQA monitoring staff or regional monitoring technician and coordinator review the metadata annually during the network review and update it as needed.

The DAQ records all the ozone data within the DAQ ozone network electronically. Each 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. Each DAS and site computer has the capability to record the monitor's output, perform any required data transformation and format the resulting data in preparation for downloading to the Envista ARM database. The Envidas Ultimate and Envista ARM databases do not allow raw (original) data to be deleted. 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 level 1 to 3 data reviewers can modify, flag, or void data stored in the Envista ARM "edit" database as needed. The database maintains an edit history, which remains available to track changes made to the data.

The DAQ also collects data manually. ABAQA monitoring staff, regional monitoring and ECB electronics 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. It is mandatory that all ABAQA and DAQ site visits be recorded in an e-log. The regional monitoring coordinators transfer the e-logs to the RCO group drive for subsequent incorporation into the data validation process, discussed in Section 23 of this QAPP. The ABAQA monitoring staff email their e-logs directly to the RCO ozone chemist, who transfers them to the RCO group drive for subsequent incorporation into the data validation process, discussed in Section 23.0 of this QAPP. The RCO validation chemist reviews and signs all e-logs during the monthly data validation process. The RCO chemist reviews anomalies, poor checks, invalid checks, mismatched check data (i.e. minute data in checks vs. minutes tabs), incorrect information, instrument failures etc. The RCO chemist often has to follow up with regional monitoring technicians and AQAQA air quality staff to verify, clarify and validate when such instances occur to assure the data being submitted is of the highest quality and integrity.

The AQ-121 reports the performance evaluations, which are paper documents. The PPB supervisor manually creates the records to upload to AQS as described in [DAQ-15-005.5](#), archives a scanned copy of the paper document in IBEAM and files the paper copy in a secured file cabinet in the RCO. The PPB supervisor or database manager electronically uploads the data to AQS as described in DAQ-15-005.5.

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 facility tracking, permits, mobile sources, emission source inventories, ambient monitoring data, forecast data, compliance and enforcement actions, source tests, and facility and DAQ business documents.

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

One-point QC checks for ozone are performed daily in addition to zero and span checks. These data are reviewed daily by a RCO chemist as well as regional staff. Daily variations are observed and acted upon by both RCO chemists as well as regional staff to preclude excessive data loss.

### 19.3 Data Transmittal and Transformation

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

The DAS reads instantaneous ozone values from the monitor and averages each 60-second interval to create a one-minute average. The DAS stores each minute average and this average acts as the base unit for all measurements taken by monitors within the DAQ ozone ambient air quality monitoring network.

The monitors themselves, as well as the Envidas Ultimate system, averages these stored 1-minute averages to form averaged hourly values, which are the blocks of ambient ozone measured concentrations that the database manager submits to the EPA. The Envidas Ultimate system transmits all these values to the Envista ARM for retention. The data are reviewed daily by RCO chemists as well as regional monitoring technicians and ABAQA air quality staff. There exists a dynamic ongoing open communication with the monitoring staff to discuss anomalies, missed data, or observed errant issues with respect to the daily data. In addition, at least once a month during ozone season, the statistician downloads the instantaneous data for at least one hour for three different days from at least three sites and compares these values to the data captured in Envista to verify the data for accuracy.

See Section 7.1.2 for information regarding how the hourly ozone values are aggregated into design values.

## 19.4 Data Verification and Validation

Data verification and validation is an important routine process that involves several steps to ensure the ABAQA monitoring staff, regional monitoring technicians and coordinators 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 determination of compliance with the NAAQS, for further analysis or for modeling. Once the monitoring staff has identified these problems, they can correct, flag, or invalidate the data. If necessary, the ABAQA monitoring staff, regional 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 ozone undergo periodic audits, daily one-point QC checks and annual or seasonal calibrations. SOPs [DAQ-10-001.1](#) and 2.7.2 outline these procedures. Additionally, see Table 11.2 for additional SOPs outlining these procedures. Performance audits and one-point QC 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 the 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 ABAQA monitoring staff or regional 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 level 1 reviewer 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 23.0 of this QAPP discusses the data review process in more detail. SOP DAQ-15-005.5 contains further details on the data verification and validation procedures.

## 19.5 Data Reduction and Analysis

As described in the subsections above, data reduction activities take place throughout the entire data management process. The on-site DAS gathers data from the monitors at each site each hour and transmits them to the Envista ARM database. The data are gathered and transmitted in response to a poll via the wireless modem. The Envista ARM system can aggregate raw data into the hourly and eight-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 ozone, the EPA requires a minimum data capture of 75 percent of the interval – hour, day and season – for the EPA to consider the interval valid for use in NAAQS comparisons. In addition, for ozone the EPA requires 90 percent completeness within each ozone monitoring season, on average, for the three-year period used to define the design value. Table 7.2 summarizes these completeness requirements as well as provides specific references to the CFR.



The DAQ analyzes data periodically throughout the data collection and validation process. For example, data can be downloaded from Envidas Ultimate directly into Microsoft Excel spreadsheets. The ABAQA monitoring staff, regional monitoring technicians and coordinators, RCO chemists and statistician use Microsoft Excel spreadsheets solely for data analysis and in-depth study of the data. For example, each business day the statistician prepares a tabulation of the raw hourly data from the previous day, evaluating it for missing data, data higher or lower than Tukey's fences for that day, 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 this task by retrieving several reports, such as the AMP256, AMP430, AMP450 and AMP600, from the AQS and analyzing the results.

## 19.6 Data Submission

After the ABAQA monitoring staff, regional monitoring technicians and coordinators and RCO chemist completes all three levels of verification and validation for a month of data, as described in Section [23.0 Verification and Validation Methods](#), the database manager uploads the data to the AQS database. This submittal must occur no later than 90 days following the close of each calendar quarter, as specified in [40 CFR Section 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; and
- All ambient air quality data obtained on ozone.

This will include data acquired at any sites operated by ABAQA.

At the end of each quarter, an RCO chemist runs the AMP251, AMP256, AMP350, AMP430 and AMP600 reports in AQS and verifies that all hourly data, annual performance evaluation and 1-point QC check data have been successfully entered. The DAQ will also notify the EPA if a monitor does not meet the completeness requirements summarized in Table 7.2.

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

The chief shall submit to the EPA an annual AMP600 summary report of all the ozone monitoring data from any FRM or FEM SLAMS or special purpose regulatory monitors that meet criteria in appendix A, in accordance with 40 CFR Section 58.15. The chief will also submit a signed certification letter on DAQ agency letterhead signed by the chief. The chief will submit the report by May 1 of each year for the data collected from Jan. 1 through Dec. 31 of the previous year. The chief, or designee, must certify the report as accurate to the best of his or her knowledge. The chief will base this certification on the various assessments and reports performed by DAQ, including the AMP600 report, discussed in Section 21.3, that documents the quality of the ambient air quality data and the effectiveness of the quality system.

## 19.7 Data Storage and Retrieval

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

The DAQ archiving system makes possible the storage and retrieval of the air quality monitoring data. Backup and recovery procedures exist to ensure the ABAQA monitoring staff, regional monitoring and ECB electronics technicians and database manager can recover data in the event of a catastrophic failure. The database manager manually executes a backup of the full database every Friday. Due to the lack of a second structured query language (SQL) database in which to import the backup files, the database manager has not routinely tested procedures for using the backup files; however, he has used backup files to import data into the virtual server's database. The use of backup files worked as expected. The DAQ has recently established a backup computer with Structured Query Language (SQL) software installed to continue data polling operations in the event of a catastrophic failure of the server.

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 a Zip File. The database manager keeps the most recent copy available on SharePoint. Envidas Ultimate polls data older than one week old directly from the site computer. All data will be kept real time.

NOTE: The ABAQA monitoring staff and regional monitoring technicians download backup site temperature data and store it on the local program or regional SharePoint drive for archival purposes. This is achieved via universal serial bus (USB) flash drives, personal computers, or laptops in the field. Since dataloggers are no longer utilized for ozone, a backup HOBO™ temperature monitor is also downloaded monthly as a backup temperature data source.

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



## 20.0 Assessments and Response Actions

An assessment is the process used to measure the performance or effectiveness of the quality system, the ozone ambient air quality monitoring network and its sites and various measurement phases of the data operation. The DAQ also uses assessments to determine whether the monitoring staff has implemented the ambient air quality program in accordance with the approved QAPP. Although not all of these assessments are required, the DAQ follows 40 CFR Part 58, which calls for network plans as well as some of the other assessments listed here. DAQ also evaluated these monitors according to the requirements in Appendix A to 40 CFR Part 58. To ensure the adequate performance of the quality system, DAQ will perform the following assessments:

- Network reviews and assessments
- External performance evaluations
- Annual performance evaluations
- Quarterly completeness assessments
- Annual data certification
- Data quality audits
- Data quality assessments
- EPA technical system audits
- Internal systems audits

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

### 20.1 Network Reviews and Assessments

Conformance with network requirements of the ozone ambient air quality monitoring network as set forth in 40 CFR Part 58, Appendices A, C, D and E and the guidance document: Guideline on Ozone Monitoring Site Selection EPA-454/R-98-002 is determined through annual network reviews of the ozone ambient air quality monitoring system as required by 40 CFR Section 58.10(a). The chief uses the network review to determine if the network collects adequate, representative, and useful data in pursuit of its ozone monitoring objectives. Additionally, the annual network review may identify possible network modifications to enhance the system or correct deficiencies in attaining network objectives.

Before implementing an annual network review, the ABAQA monitoring staff or regional monitoring technician compiles and evaluates significant data and information pertaining to the network and monitoring sites. Such information may 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;
- Emissions information (trends and MSAs), emission density maps and maps delineating an area's major emission sources, particularly for VOCs and oxides of nitrogen;
- Traffic data at or near the monitoring site; and
- National Weather Service or State Climate Office weather summaries from stations nearby the monitoring site.

Upon receiving the information, ABAQA monitoring staff or the regional monitoring technician will check it to ensure it is current. The ABAQA monitoring staff or regional monitoring technician will note discrepancies and resolve them during the review. The ABAQA monitoring staff or regional monitoring technician will also identify and update files and photographs that need updating during the review. The DAQ will emphasize several categories during the network reviews, such as the analysis of the monitoring network, monitor locations, siting requirements, and changes in local traffic patterns and nearby land use.

During the annual network review, ABAQA monitoring staff and the regional monitoring technicians 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 ABAQA monitoring staff and regional monitoring technicians will propose changes to rectify the discrepancy. The ABAQA, regional office and RCO monitoring staff will then 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 ABAQA monitoring staff and regional monitoring technicians complete a network review of the ozone-monitoring sites and submit a network review form to the RCO every year. EPA regions are also required to perform these reviews. The ABAQA monitoring staff and regional monitoring technicians consider 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 monitors required, depending on the measurement objectives.

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

### 20.1.1 Five-Year Network Assessment

The five-year network assessment, as required by 40 CFR 58.10(d), is a more extensive evaluation of the ozone-monitoring network prepared by the chief with assistance from the PPB supervisor. The assessment determines at a minimum:

- If the ozone network meets the monitoring objectives defined in 40 CFR Part 58, Appendix D,
- Whether DAQ must add additional ozone-monitoring sites,
- Whether any existing ozone-monitoring sites are no longer needed and can be terminated, and
- Whether new technologies are appropriate for incorporation into the ozone-monitoring network.

During the 5-year network assessment, the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals, for example, children with asthma, as well as the potential impact any sites proposed for discontinuance may have on other data users is considered. As part of the 5-year network assessment, DAQ requests renewals and provides additional information related to applicable waivers for the DAQ ozone monitoring network sites in the network plan submitted with the 5-year network assessment. The DAQ submits a copy of the five-year assessment, along with a revised annual network plan, to the EPA Region 4. These assessments began in 2010 for the ozone-monitoring network and are due to EPA every five years on July 1.

For more information about the ozone monitoring locations, 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

In general, the NPAP is a performance evaluation where quantitative data are collected independently to evaluate the accuracy of the monitoring equipment. In Region 4, a mobile laboratory arrives at a DAQ ozone monitoring site and generates known concentrations of ozone audit gases, used to challenge the on-site ozone analyzer.

DAQ addresses performance evaluation activities for the ozone monitoring network by participating in the EPA's NPAP as described in 40 CFR Part 58, Appendix A, Sections 2.4 and 3.1.3. Only qualified and authorized personnel execute performance audits. See Tables 6.1 and 7.2 for information regarding the frequencies and acceptance criteria related to NPAP audits. The NPAP program audits 20 percent of an agency's sites per year and each site every six years. Since DAQ has 32 sites, the EPA will audit seven sites each year. The EPA reports the NPAP results directly to the site operator after the audit is completed. If a monitor does not pass the evaluation, the regional office, ECB and RCO monitoring staff will take appropriate action to identify why the monitor failed the evaluation and to correct the situation. The NPAP audit results are also reported to AQS by EPA or its support contractor(s).

### 20.3 Annual Performance Evaluations

The ECB electronics technicians, who do not operate the monitors, conduct annual performance evaluations at least once each calendar year and every 365 days within the period of operation on the ozone monitors by challenging the monitor with known concentrations of gas using an

independent photometer. The ECB electronics technicians certify the audit system and the monitor's calibration system using the same primary standard for both. The ECB electronics technicians follow the audit procedures delineated in the ECB SOP [DAQ-10-001.1 R7.3](#) (3/15/2022). The results of these audits are documented on the Continuous Monitor Performance Audit Report AQ-121 form. Acceptance criteria applicable to annual performance evaluations may be found in Table 7.2. If a monitor does not pass the evaluation, the regional monitoring and ECB electronics technicians will take appropriate action to identify why the monitor failed the evaluation and to correct the situation.

See 40 CFR Part 58, Appendix A, Sect. 3.1.2 for more information regarding annual performance audits.

## 20.4 Quarterly Completeness Assessment

After the database manager uploads to AQS all data for a quarter, an RCO audit chemist assesses the data to ensure all the data made it through the upload process and into AQS. The RCO chemist accomplishes the quarterly completeness assessment by running the AMP430 Completeness Report, the AMP350 Raw Data Report and the AMP251 QA Data Report. The RCO chemist compares the data in AQS with the data that should be in AQS based on the monitoring schedule. When the RCO chemist identifies missing data or some other problem, the RCO chemist informs the Level 3 reviewer and database manager who take action 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 75 percent 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.

## 20.5 Annual Data Certifications

In accordance with 40 CFR Section 58.15, the EPA requires an annual air monitoring data certification letter to certify that the regulatory data collected by the FRM and FEM monitors at the ozone sites from Jan. 1 to Dec. 31 of the previous year, meet the criteria in 40 CFR Part 58, Appendix A. 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 ozone monitoring 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 designee assesses the data on a quarterly basis when the RCO audit chemist generates specific AQS reports to assess the DQIs as discussed in Section 20.7 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 DAQ review process 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 monitoring data submitted to AQS are correct and complete. Once the RCO chemists, RCO statistician and database manager complete any necessary corrections, additions, or deletions in AQS and the RCO chemists and PPB supervisor have finalized 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.

## 20.6 Audit of Data Quality

An RCO audit chemist who does not validate the data conducts an audit of data quality, or ADQ, which reveals how the level 1 to 3 reviewers handled data, what judgments they made, whether they made uncorrected mistakes and what records exist to support the decisions made. An ADQ can often identify the means to correct systematic data reduction errors. Sufficient time and effort will be devoted to this activity so that the RCO audit chemist has a clear understanding and complete documentation of data flow. The RCO audit chemist shall perform this assessment quarterly in accordance with the quarterly data review as described in SOP 2.39. The DAQ ensures the level 1 to 3 reviewers-maintained data collection and handling integrity via the quarterly data review. If the RCO audit chemist finds a problem during the ADQ, the RCO audit 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.

## 20.7 Data Quality Assessments

The DQA is the statistical analysis of environmental data to determine whether the data meet the assumptions under which the DQOs and data collection design were developed and whether the total error in the data is tolerable. Calculations for DQA activities shall follow the requirements and equations identified in 40 CFR Part 58, Appendix A, Section 4. The regulations at 40 CFR Part 58, Appendix A provide terminology associated with measurement uncertainty.

An RCO audit chemist will evaluate the data quality on a quarterly basis using the AQS AMP256 and AMP600 reports. The DAQ bases the estimates of the data quality on all the active ozone monitors for this network. For the annual data certification, all active ozone sites are combined

from all active networks to determine an estimate of data quality for the agency or PQAO overall. The RCO audit chemist reports the results to the PPB Supervisor via email. The PPB Supervisor, RCO audit chemist and RCO ozone chemist work together to determine how to address any observed issues and present a proposal to the chief. 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. In addition, box and whisker plots are viewed at least twice a year for the 1-point QC checks.

## 20.8 EPA Technical Systems Audits (TSA)

An EPA TSA is a thorough, independent and systematic on-site qualitative assessment, where EPA auditors examine facilities, equipment, personnel, training procedures, protocols and record keeping for conformance with the regulatory requirements and this QAPP. The EPA Region 4 QA staff conducts a TSA of DAQ every three-years and ABAQA at least once every six 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 as a result of TSA findings and communicates progress to the ABAQA monitoring staff, DAQ director and EPA Region 4.

An EPA TSA team, made up of individuals from EPA Region 4, or an individual TSA auditor, may segregate TSA activities into two categories. The auditors may audit these categories independently or together. The TSA categories are:

- Field activities: monitor installation, calibration, and sampling; and
- Data management activities: collecting, flagging, editing, and uploading data; providing data security.

During the audit, the auditors will interview key personnel with responsibilities for planning, field operations, equipment certification, QA/QC, data and document 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 ABAQA and 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 DAQ director and chief. The DAQ director and chief must complete and submit to the 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.

The EPA shall conduct TSAs once during every three-year period for DAQ and once during every six-year period for ABAQA that the ozone monitoring program collects data verifying compliance with the NAAQS.

## 20.9 Internal Technical Systems Audits

The DAQ is implementing internal technical systems audits on the ozone monitoring network. These audit procedures, complete with audit checklists, are detailed in SOP DAQ-15-004.5, currently under development. The internal TSA will be completed by a team of RCO chemists not currently involved in the routine operations of the ozone monitoring program.

## 20.10 Reporting and Resolution of Issues

The communication process regarding necessary corrective actions within DAQ's ozone monitoring program as a result of the previously mentioned assessments is detailed in SOP [DAQ-15-002](#). The NC DAQ Ambient Monitoring Section - Hurricane Readiness Task List provides emergency/contingency plans that should be implemented when a hurricane or tropical storm is approaching North Carolina.



## 21.0 Reports to Management

This section describes the quality-related reports and communications to management necessary to support ozone ambient air quality 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 monthly schedule, depending on the part of the organization involved. In addition, DAQ holds as-needed meetings with the affected parties to address any additional issues that may arise. See Section 20.0 of this document for additional information regarding the types of reports generated from AQS used to inform management of QA issues. All reports will contain monitoring data for ozone.

Reports to management required for the ozone monitoring program are discussed in various sections of 40 CFR Parts 50, 53 and 58. The EPA's Air Quality Assessment Division within the Office of Air Quality Planning and Standards (OAQPS) provides guidance for management report format and content. The subsections 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*<sup>1</sup> and DAQ's data handling and validation SOP [DAQ-15-005.5](#). The level 1 to 3 reviewers review and validate the concentration data in the Envista ARM database. When a monitor's data capture falls below 75 percent, an RCO chemist prepares for the chief a memo explaining why and the corrective action taken.

Each quarter, DAQ uploads to AQS the results of all valid precision, bias and accuracy tests it carried out during the previous quarter. The database manager submits data to AQS consistent with the data reporting requirements specified for air quality data as set forth in 40 CFR Part 58, Appendix A. The DAQ reports the required annual performance evaluation and 1-point QC check data on the same schedule as quarterly monitoring data submittals. The QAM is responsible for ensuring the level 1 to 3 reviewers use the results of QA data to validate concentration data.

In accordance with 40 CFR Section 58.16(b), DAQ submits data to the AQS database no later than 90 days following the end of the quarter in which DAQ collected the data. Table 21.1 provides the dates by which the DAQ must upload the previous quarter's data. After the database manager uploads all quarterly data to AQS, an RCO chemist obtains 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.

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<sup>1</sup> The AQS Coding Guide is available at <http://www.epa.gov/ttn/airs/airsaqs/manuals/AQS%20Data%20Coding%20Manual.pdf>.



**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)

## 21.2 Annual Performance Evaluations

The ECB electronics technicians conduct performance evaluations, sometimes referred to as audits, of the ozone monitors at least once each calendar year or every 365 days during the time of operation, 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 photometer or an EPA/NIST-approved certified reference photometer.

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

## 21.3 Annual Network Review

By Oct. 31 of each year, the ABAQA monitoring staff and regional monitoring technicians conduct an annual site review of each site, documenting the information requested on the annual site review forms which is part of DAQ's overall annual network review. [SOP 2.43.2](#) describes this process. The network review determines if the monitoring site and probe locations meet the siting requirements and monitoring objectives defined in 40 CFR Part 58, Appendices D and E. The review identifies any needed modifications to the sites and network including termination or relocation of unnecessary stations or monitors or establishment of new stations or monitors. The regional monitoring technicians submit the forms to the regional monitoring coordinators, who review the forms and submit them to the RCO by Dec. 31. The ABAQA submit their forms to the PPB supervisor. 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 QAM will prepare a data certification package for his signature by May 1 of each year. The report will consist of a letter, for signature, along with AQS generated summaries of concentration data collected during the previous year, and all applicable QA data. The EPA OAQPS and EPA Region 4 specify the exact AQS reports for the QAM to submit. Generally, the QAM submits an AMP600 and AMP450NC reports to the EPA Region 4.

## 21.5 Statistical Reports

As needed or when directed by the chief, the RCO statistician will develop and maintain statistical reports, including tabulations of data, statistical analysis and summaries of the data,

graphs, maps, recommendations, and conclusions. The DAQ may use these data to determine data trends, identify background concentrations and provide design values for comparison to the NAAQS and for planning purposes.

### 21.6 Annual Network Monitoring Plans

Following the requirements in 40 CFR Section 58.10(a) the DAQ prepares and submits to the regional administrator an annual monitoring network plan by July 1 of each year. This plan is reviewed and submitted by the chief. It is composed by the regional air quality supervisors and coordinators, ABAQA air quality staff, RCO ozone chemist, the PPB supervisor, and the chief. The plan provides for the establishment and maintenance of an air quality surveillance system consisting of a network of SLAMS and special purpose monitoring stations and will include the ozone ambient air quality monitoring sites. 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 40 CFR Part 58, Appendices A, C, D and E, where applicable. Before submission to EPA, 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. DAQ keeps AQS up to date by creating site data records with the date DAQ established a site 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.

### 21.7 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 whether the network achieves the monitoring objectives defined in 40 CFR Part 58, Appendix D, 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. The chief submits a copy of this 5-year assessment, along with a revised annual network plan, to the regional administrator.

### 21.8 Internal Systems Audit Reports

SOP DAQ-15-004.5, currently under development, describes DAQ's internal systems audit program. An RCO auditor or audit team will perform an internal systems audit to verify that the ozone-monitoring program meets the data MQOs outlined in section 7.2. When completed, the RCO auditor or audit team will distribute copies of the annual systems audit report to the ABAQA monitoring staff, regional offices, RCO chemists, ECB staff, the PPB supervisor, and the chief.

## 21.9 Response/Corrective Action Report

Currently the ABAQA monitoring staff and regional monitoring technicians document any corrective action taken at the site in an e-log. The e-logs are not sent to management but are reviewed by the ABAQA monitoring staff or regional monitoring coordinators and the RCO chemists. When the corrective action needed is beyond what the regional monitoring technician can handle at the site, the regional monitoring technician contacts the regional monitoring coordinator and the ECB. The ECB documents all corrective actions taken on a 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 available as a template in IBEAM. If the corrective action affects several days or a month or more of data, involves systemic issues, or endangers meeting completeness, the corrective action is documented in a memo to the chief and carbon copies to the regional office air quality supervisor. SOP DAQ-15-002 describes when a need exists for a formal corrective action preventative action (CAPA) process that documents the root cause analysis, investigates solutions, and confirms that the solution was effective.

## 22.0 Data Validation and Usability

Data review is the in-house examination to ensure that the data has been recorded, transmitted, and processed correctly. It includes completeness checks to determine if there are any deficiencies such as missing data or lost integrity. The level one to three 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. Level one to three reviewers shall flag data identified as suspect, or that 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/compliance of the data set against method, procedural and contractual specifications. Verification can be further defined as confirmation, through provision of objective evidence, that specified requirements for that type of data have been fulfilled.

Data validation is a routine process designed to ensure that reported values meet the quality goals of the environmental data operations. Data validation is further defined as examination and provision of objective evidence that the particular requirements for a specific *intended use* are fulfilled. The primary intended use for the DAQ ozone data set is NAAQS compliance. A progressive, systematic approach to data validation must be used to ensure and assess the quality of the data. Data validation includes the review of the DAQ ozone data sets against the ozone MQOs (see Table 7.2). 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 and monitoring site selection must comply with:

- 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
- 40 CFR Part 58, Appendix G – Uniform Air Quality Index (AQI) and Daily Reporting
- Guideline on Ozone Monitoring Site Selection EPA-454/R-98-002

The location of each DAQ ozone monitoring site has received EPA approval; thus, data from each ozone monitor will be considered spatially representative as long as the ozone sites continue to meet the requirements set forth in 40 CFR Part 58, Appendix E and in this QAPP.

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

The ABAQA monitoring staff or regional monitoring technicians shall thoroughly document any deviations from the minimum siting criteria (e.g., shelter location, probe placement and/or

monitor sight path requirements) in the site's QC documentation. Examples of deviations include, but are not limited to, insufficient distance from roadways (i.e., marginal terrain criteria) and insufficient distance from influencing objects (e.g., dripline of an adjacent tree or a cell phone tower installed after the monitoring site was established).

## 22.2 Monitor Operating Procedures

Section 11.0 Sampling Methods Requirements outlines monitoring operation procedures. The ozone monitors used by DAQ are designated as FRM or FEM; thus, the methodologies and technologies are considered acceptable for regulatory use. The Envidas Ultimate DAS routinely identifies potentially unacceptable data points in the database through electronic application of Envidas Ultimate-applied status flags. The database manager has associated each instrument-specific flag with a unique error. The level 1 to 3 reviewers routinely review these Envidas Ultimate-applied status flags as part of the data validation process. This activity assists in identifying suspect or potentially bad data points that could invalidate the resulting averaging periods. Table 22.1 presents a compilation of the AQS validation flags and null codes (as of Sept. 15, 2021 see <https://aqs.epa.gov/aqsweb/documents/codetables/qualifiers.html>).

**Table 22.1 AQS Qualifier Code Description and Type**

Flag	Flag Description	Flag Qualifier Type	Purpose
IA	African Dust	Informational Only	To provide information on events that influenced the measured values.
IB	Asian Dust	Informational Only	
IC	Chem. Spills and Industrial Accidents	Informational Only	
ID	Cleanup After a Major Disaster	Informational Only	
IE	Demolition	Informational Only	
IF	Fire - Canadian	Informational Only	
IG	Fire - Mexico/Central America	Informational Only	
IH	Fireworks	Informational Only	
II	High Pollen Count	Informational Only	
IJ	High Winds	Informational Only	
IK	Infrequent Large Gatherings	Informational Only	
IL	Other	Informational Only	
IM	Prescribed Fire	Informational Only	
IN	Seismic Activity	Informational Only	
IO	Stratospheric Ozone Intrusion	Informational Only	
IP	Structural Fire	Informational Only	
IQ	Terrorist Act	Informational Only	
IR	Unique Traffic Disruption	Informational Only	
IS	Volcanic Eruptions	Informational Only	
IT	Wildfire-U. S.	Informational Only	
J	Construction	Informational Only	
1C	A 1-Point-QC check exceeds acceptance criteria but there is compelling evidence that the analyzer data is valid	Missing QA/QC Audit	Codes to account for completeness of 1-Point QC checks where the results are not reportable
1F	No 1 Point QC but need to count for completeness	Missing QA/QC Audit	
AA	Sample Pressure out of Limits	Null Data Qualifier	
AB	Technician Unavailable	Null Data Qualifier	

**Table 22.1 AQS Qualifier Code Description and Type**

<b>Flag</b>	<b>Flag Description</b>	<b>Flag Qualifier Type</b>	<b>Purpose</b>
AC	Construction/Repairs in Area	Null Data Qualifier	Void the data and submit the code in its place.
AD	Shelter Storm Damage	Null Data Qualifier	
AE	Shelter Temperature Outside Limits	Null Data Qualifier	
AF	Scheduled but not Collected	Null Data Qualifier	
AG	Sample Time out of Limits	Null Data Qualifier	
AH	Sample Flow Rate or CV out of Limits	Null Data Qualifier	
AI	Insufficient Data (cannot calculate)	Null Data Qualifier	
AJ	Filter Damage	Null Data Qualifier	
AK	Filter Leak	Null Data Qualifier	
AL	Voided by Operator	Null Data Qualifier	
AM	Miscellaneous Void	Null Data Qualifier	
AN	Machine Malfunction	Null Data Qualifier	
AO	Bad Weather	Null Data Qualifier	
AP	Vandalism	Null Data Qualifier	
AQ	Collection Error	Null Data Qualifier	
AR	Lab Error	Null Data Qualifier	
AS	Poor Quality Assurance Results	Null Data Qualifier	
AT	Calibration	Null Data Qualifier	
AU	Monitoring Waived	Null Data Qualifier	
AV	Power Failure	Null Data Qualifier	
AW	Wildlife Damage	Null Data Qualifier	
AX	Precision Check	Null Data Qualifier	
AY	QC Control Points (zero/span)	Null Data Qualifier	
AZ	QC Audit	Null Data Qualifier	
BA	Maintenance/Routine Repairs	Null Data Qualifier	
BB	Unable to Reach Site	Null Data Qualifier	
BC	Multi-point Calibration	Null Data Qualifier	
BD	Auto Calibration	Null Data Qualifier	
BE	Building/Site Repair	Null Data Qualifier	
BF	Precision/Zero/Span	Null Data Qualifier	
BG	Missing ozone data not likely to exceed level of standard	Null Data Qualifier	
BH	Interference/co-elution/misidentification	Null Data Qualifier	
BI	Lost or damaged in transit	Null Data Qualifier	
BJ	Operator Error	Null Data Qualifier	
BK	Site computer/data logger down	Null Data Qualifier	
BL	QA Audit	Null Data Qualifier	
BM	Accuracy check	Null Data Qualifier	
BN	Sample Value Exceeds Media Limit	Null Data Qualifier	
BR	Sample Value Below Acceptable Range	Null Data Qualifier	
CS	Laboratory Calibration Standard	Null Data Qualifier	
DA	Aberrant Data (Corrupt Files, Aberrant Chromatography, Spikes, Shifts)	Null Data Qualifier	
DL	Detection Limit Analyses	Null Data Qualifier	
EC	Exceeds Critical Criteria	Null Data Qualifier	



**Table 22.1 AQS Qualifier Code Description and Type**

<b>Flag</b>	<b>Flag Description</b>	<b>Flag Qualifier Type</b>	<b>Purpose</b>	
FI	Filter Inspection Flag	Null Data Qualifier		
MB	Method Blank (Analytical)	Null Data Qualifier		
MC	Module End Cap Missing	Null Data Qualifier		
QV	Quality Control Multi-Point Verification	Null Data Qualifier		
SA	Storm Approaching	Null Data Qualifier		
SC	Sampler Contamination	Null Data Qualifier		
ST	Calibration Verification Standard	Null Data Qualifier		
SV	Sample Volume out of limits	Null Data Qualifier		
TC	Component Check and Retention Time Standard	Null Data Qualifier		
TS	Holding Time or Transport Temperature Is Out of Specs.	Null Data Qualifier		
XX	Experimental Data	Null Data Qualifier		
1	Deviation from a CFR/Critical Criteria Requirement	Quality Assurance Qualifier		Flag indicating the quality of the data.  In some cases, the data may not meet all the criteria but is still valid.
1V	Data Reviewed and Validated	Quality Assurance Qualifier		
2	Operational Deviation	Quality Assurance Qualifier		
3	Field Issue	Quality Assurance Qualifier		
4	Lab Issue	Quality Assurance Qualifier		
5	Outlier	Quality Assurance Qualifier		
6	QAPP Issue	Quality Assurance Qualifier		
7	Below Lowest Calibration Level	Quality Assurance Qualifier		
9	Negative value detected - zero reported	Quality Assurance Qualifier		
CB	Values have been Blank Corrected	Quality Assurance Qualifier		
CL	Surrogate Recoveries Outside Control Limits	Quality Assurance Qualifier		
DI	Sample was diluted for analysis	Quality Assurance Qualifier		
EH	Estimated; Exceeds Upper Range	Quality Assurance Qualifier		
FB	Field Blank Value Above Acceptable Limit	Quality Assurance Qualifier		
FX	Filter Integrity Issue	Quality Assurance Qualifier		
HT	Sample pick-up hold time exceeded	Quality Assurance Qualifier		
LB	Lab blank value above acceptable limit	Quality Assurance Qualifier		
LJ	Identification of Analyte is Acceptable; Reported Value Is an Estimate	Quality Assurance Qualifier		
LK	Analyte Identified; Reported Value May Be Biased High	Quality Assurance Qualifier		
LL	Analyte Identified; Reported Value May Be Biased Low	Quality Assurance Qualifier		
MD	Value less than MDL	Quality Assurance Qualifier		

**Table 22.1 AQS Qualifier Code Description and Type**

<b>Flag</b>	<b>Flag Description</b>	<b>Flag Qualifier Type</b>	<b>Purpose</b>
MS	Value reported is 1/2 MDL substituted.	Quality Assurance Qualifier	Flag indicating the quality of the data. In some cases, the data may not meet all the criteria but is still valid.
MX	Matrix Effect	Quality Assurance Qualifier	
ND	No Value Detected, Zero Reported	Quality Assurance Qualifier	
NS	Influenced by nearby source	Quality Assurance Qualifier	
QX	Does not meet QC criteria	Quality Assurance Qualifier	
SQ	Values Between SQL and MDL	Quality Assurance Qualifier	
SS	Value substituted from secondary monitor	Quality Assurance Qualifier	
SX	Does Not Meet Siting Criteria	Quality Assurance Qualifier	
TB	Trip Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
TT	Transport Temperature is Out of Specs.	Quality Assurance Qualifier	
V	Validated Value	Quality Assurance Qualifier	
VB	Value below normal; no reason to invalidate	Quality Assurance Qualifier	
W	Flow Rate Average out of Spec.	Quality Assurance Qualifier	
X	Filter Temperature Difference or Average out of Spec.	Quality Assurance Qualifier	
Y	Elapsed Sample Time out of Spec.	Quality Assurance Qualifier	
RA	African Dust	Request Exclusion	Flags data influenced by an exceptional event for which the agency plans to submit a data exclusion request.
RB	Asian Dust	Request Exclusion	
RC	Chemical Spills and Industry Accidents	Request Exclusion	
RD	Cleanup After a Major Disaster	Request Exclusion	
RE	Demolition	Request Exclusion	
RF	Fire - Canadian	Request Exclusion	
RG	Fire - Mexico/Central America	Request Exclusion	
RH	Fireworks	Request Exclusion	
RI	High Pollen Count	Request Exclusion	
RJ	High Winds	Request Exclusion	
RK	Infrequent Large Gatherings	Request Exclusion	
RL	Other	Request Exclusion	
RM	Prescribed Fire	Request Exclusion	
RN	Seismic Activity	Request Exclusion	
RO	Stratospheric Ozone Intrusion	Request Exclusion	
RP	Structural Fire	Request Exclusion	
RQ	Terrorist Act	Request Exclusion	
RR	Unique Traffic Disruption	Request Exclusion	
RS	Volcanic Eruptions	Request Exclusion	
RT	Wildfire-U. S.	Request Exclusion	



The ABAQA monitoring staff and regional monitoring technicians must document any deviation from the established data collection plan in the e-log or site logbook. Accurate and complete documentation of any data collection deviations will assist in any subsequent investigations or evaluations.

Data collection procedures must adhere to those procedures documented in the SOPs listed in Table 11.2. EPA and internal auditors verify adherence to data collection procedures and the associated SOPs during EPA TSAs and internal systems audits. Any time the ABAQA monitoring staff or regional monitoring technicians or coordinators use a code to void or flag data, they should document the reason for using the code in the appropriate logbook. Accurate and complete documentation of any flagged or voided data will assist in any subsequent investigations or evaluations.

### 22.3 Quality Control

Section 14.0 Quality Control Requirements and Procedures specifies the QC checks that the ABAQA monitoring staff and regional monitoring technicians must perform when initially setting up a monitor and periodically throughout the period while the monitor is operating. These include the analysis of daily one-point QC checks, which provide indications of the quality of the data produced by specified components of the measurement process. SOP Thermo Scientific Model 49i Ozone Monitoring System Section [2.7.2: Operators Responsibilities](#) specifies the procedure, acceptance criteria and corrective action (and changes) for each QC check. Data validation should document the corrective actions taken, affected ozone sampling days or hours and the potential effect of the actions on the validity of the data. Table 7.2 and SOP Thermo Scientific Model 49i Ozone Monitoring System Section [2.7.2: Operators Responsibilities](#) provide further information about one-point QC checks.

This paragraph lists the criteria and describes how DAQ will handle QC/QA data and associated ozone concentration data. DAQ will:

- Code missing ozone data with appropriate AQS null codes;
- Invalidate hourly ozone data when less than 45 minutes of valid data are collected;
- Invalidate ozone data if the FRM/FEM shelter temperature requirements are not met;
- Bracket valid ozone data with valid, 1-pt QC checks that meet the MQOs/control limits;
- Invalidate ozone data back to the most recent valid, passing 1-pt QC check and also forward to the completion of appropriate corrective actions and calibration when a valid 1-pt QC check exceeds critical criteria;
- Report all valid QC/QA data to AQS, with valid 1-pt QC checks that exceed acceptance criteria reported with the "1F" null code; and
- Report invalid 1-pt QC checks with the "1C" null code.

### 22.4 Calibration

Section [14.0 Quality Control Requirements and Procedures](#) addresses the calibration of the ozone analyzer, along with the information ABAQA monitoring staff and regional monitoring technicians should present to demonstrate they performed the calibrations correctly and that the results are acceptable. When a level 1 to 3 reviewer identifies calibration problems, a level 1 to 3 data reviewer should flag or void any data produced between the suspect calibration event and

any subsequent recalibration to alert data users. SOP Thermo Scientific Model 49i Ozone Monitoring System Section [2.7.2](#) Operators Responsibilities provides further information about ozone calibrations.

## 22.5 Data Reduction and Processing

As mentioned in the above sections, the EPA will perform TSAs and DAQ will perform ADQs 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 data monthly to ensure that associated flags or any other data qualifiers have been appropriately associated with the data. An RCO audit chemist not involved in data collection and processing will review the data quarterly to ensure that the ABAQA monitoring staff, regional monitoring technicians and coordinators, ECB electronics technicians and other RCO chemists doing the level 3 review took appropriate corrective actions.

## 22.6 Exceptional Events

Although exceptional events for ozone are rare, this section describes what is involved regarding requesting an exceptional event exclusion. The regulations at 40 CFR Section 50.14 allow the EPA administrator to exclude certain data from use for determinations of exceedances and violations of a NAAQS, so long as a state or local agency demonstrates to the administrator's satisfaction that the exceedance or violation was caused by an "exceptional event." The regulations at 40 CFR Section 50.1 define 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. The RCO chemist should add exceptional event codes and descriptions 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 ABAQA or 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.

The DAQ uses the validation template provided in Table 7.2 for the weight of evidence approach afforded to PQAOs within 40 CFR Part 58, Appendix A. 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 an hourly ozone concentration measurement or group of hourly ozone concentration measurements. The level 1 to 3 reviewers should invalidate observations that do not meet every criterion on the critical table unless there are compelling reasons and justification for not doing so. Basically, the hourly measurement or group of hourly measurements 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 are 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 hourly ozone measurement or group of hourly ozone measurements, which do not meet one or more of these criteria, is suspect unless other QC information demonstrates otherwise, and the reviewers have adequate documentation of that information. The level 1 to 3 reviewers should investigate, mitigate, or justify the reason for not meeting the criteria.
- Systematic criteria include those criteria which are important for the correct interpretation of the data, but do not usually change the validity of an hourly ozone measurement or group of hourly ozone measurements. An example criterion is that at least 75 percent of the scheduled hours for each day 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 hourly ozone measurements, but it may reduce the confidence in the attainment/non-attainment decision.
- The designation of QC checks as operational or systematic does not imply that the ABAQA monitoring staff and regional 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.

### 23.1 Validating and Verifying Data

The validation and verification procedures that DAQ will employ for this operation shall conform to the validation SOPs 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 regions and their designated support staff, along with the ABAQA office staff, 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 offices or ABAQA. Following the final review, the RCO chemists will provide a final validation of all data. The RCO chemists will also provide other QA/QC support.

The DAQ compares the data under evaluation to actual events as specified in applicable SOPs. However, significant, or unusual field events may occur, and field activities may negatively affect the integrity of the ozone concentrations measured in the ambient air. In addition, the DAQ expects that some of the QC checks will indicate the data fail to meet the acceptance criteria in Table 7.2. The DAQ shall void or flag data identified as suspect, as well as voiding data not meeting the acceptance criteria, as indicated in Table 22.1.

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

### 23.2 Verification

After the previous month of data becomes 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 ABAQA monitoring staff and regional monitoring technicians will review the data for routine data outliers and conformance to acceptance criteria. The ABAQA monitoring staff and regional monitoring technicians will void or flag appropriately unacceptable or questionable data. The ABAQA monitoring staff or regional monitoring coordinators will verify all flagged data again to ensure that the level 1 reviewer entered the flags and voids correctly and that the data are acceptable for use. The level 1 and 2 reviewers document their review in Envista ARM along with their data review decisions.

### 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 null codes or flags. Logbook notes shall have more detailed information regarding the reason a reviewer voided or flagged a measurement.

The DAQ brackets all ozone data by one-point QC checks or manual calibration checks before and after any invalidated period. This requirement helps to ensure the ozone monitors were in proper operating condition before and after the incident. When a monitor fails a check, the level 1, 2 and 3 reviewers invalidate any data after the last passing 1-point-QC check.

Data validation occurs monthly. The discussion below outlines the review, verification, and validation processes. The organizational chart in Figure 4.1 labels specific roles for review level 1 through 3 within the organization.

Level 0 Review - The Envidas Ultimate 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 ABAQA monitoring staff and regional monitoring technicians do 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 PZS checks and take appropriate corrective action if necessary.
- Review minute data.
- Verify maximum daily values for validity and take appropriate action if necessary.
- Assess data for values or outliers outside of the acceptable ranges.
- Review the hourly values for any exceedances and take appropriate action if necessary.
- Review minute data as needed when completing the level 1 review procedures.
- 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 regional monitoring coordinators or ABAQA monitoring staff do the level 2 review.

- Review site records (operator logbook, site logbook).
- Review operator checks (leak checks, filter changes, maintenance).
- Assess data for values or outliers outside of the acceptable ranges.
- Review minute data as needed when completing the level 2 review procedures.
- Determine if source specific emissions, such as smoke from wildfires or automobile 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.
- Ensure all data falls within the acceptable ranges as stated in the MQOs in Table 7.2.

- Ensure all data is acceptable and can be used for its intended purpose.
- Review minute data as needed when completing the level 3 review procedures.
- 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 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 and hourly values.
- Daily automatic one-point-QC checks and any manual checks.
- Leak checks.
- e-logs and the information documented therein.
- Correspondence with the ABAQA monitoring staff, regional monitoring technicians and coordinators and ECB electronics technicians.
- Ozone concentrations from nearby monitors; and
- The results of DAQ and EPA performance evaluations.

The level 3 reviewer compares all available information to the specifications in Table 7.2. 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 to provide adequate and reliable documentation.

As a general principle, the more information provided, the stronger the weight of evidence is. The ABAQA monitoring staff regional monitoring technicians and coordinators and RCO chemist should present the information in a structured and organized way and consider the robustness and reliability of the different data sources to support any justification for validating or invalidating data. SOP DAQ-15-005.5 contains detailed data validation procedures.

The Envidas software completes the level 0 review daily. The ABAQA monitoring staff, regional monitoring technicians and coordinator will complete the level 1 and 2 reviews within 20 calendar days from the end of the monitoring month. (Example: The month ends on March 31. The level 1 and 2 reviews must be completed by the 20<sup>th</sup> day of April.) The RCO chemist will complete the level 3 review 20 calendar days after the level 2 review is completed. (Using the prior example, the level 3 review must be complete by May 10). An independent RCO chemist will complete a review of the validated data after the database manager uploads it to AQS and within 40 calendar days after the level 3 review is complete.

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 datum 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.

### 23.4 Validating Exceedances

In the event of an ozone exceedance at an ozone ambient air quality monitor, the operator will take appropriate action to review the data and the operation of the monitor to ensure the exceedance is valid.

If a monitor records an exceedance, the RCO chemist will notify the chief. ABAQA monitoring staff, regional monitoring technicians and coordinators may need to do preliminary investigations to ensure some type of exceptional event did not affect the monitor. The ABAQA monitoring staff, regional monitoring technicians and coordinators will document any information acquired and archive it with the data to demonstrate the exceedance was truly valid or that it was potentially due to an exceptional event.



## 24.0 Reconciliation with Data Quality Objectives

Section 6.0 describes the objectives of this ozone ambient air quality monitoring program. Section 7.0 Data and Measurement Quality Objectives and Criteria for Measurement Data describes the DQO's for the ozone ambient air quality monitoring program.

The AQS AMP256 and AMP600 reports are automated reports based on data uploaded to AQS. These reports provide summary statistics for the ozone ambient air quality 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.

As described in Sections 20.5 and 20.7, an RCO chemist will analyze the results of both the AQS AMP256 and AMP600 reports on a quarterly and annual basis to ensure all monitoring stations are meeting the required DQO's. If, and when, the data from at least one of the monitors violates the DQO bias and/or precision limits, then the RCO chemist will investigate to uncover the cause of the violation. If all the monitors in the ozone network violate the DQO, the cause may be at the agency level (regional monitoring technician and ABAQA monitoring staff training) or higher (problems with method designation). If only one monitor or site violates the DQO, the cause is more likely specific to the site (regional monitoring technician or ABAQA monitoring staff, problem with the site). Tools for determining the cause include reviewing:

- Data from a collocated network, such as a local or tribal program, nearby reporting organizations, or national averages;
- Data from performance audits, both DAQ and NPAP; and
- QC trends.

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

- Determining the level of aggregation at which DAQ violated the DQOs: The results of the DQA process tell which monitors have 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 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 DAQ achieves the DQOs: The chief will continue to review extensively the quarterly QA reports and the QC summaries until DAQ attains the bias and precision limits.
- Updating MQOs and quality assurance documents: If the cause indicates that the MQOs, SOPs associated with this QAPP, or this QAPP need to be updated, the RCO

chemists will inform the chief and PPB supervisor of the needed changes and either the chief or PPB supervisor will assign staff to make the necessary updates.

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 and the director, need to determine if the data collected within the DAQ monitoring network are adequate for meeting the monitoring objectives listed earlier in Section 6.0. The annual data certification process and reports generated as part of the certification provide a quantitative assessment of the measurement uncertainty within the DAQ ozone data set. By controlling uncertainty in the data to the extent prescribed by the DQOs, decision makers can use DAQ's ambient air monitoring data with confidence.

## Revision History

The following revisions were made:

Date	Person Revising Document	Revision	Page No.	Approved by/Date
Nov. 8 and 9, 2021	Jeff Gobel	Cover page header and addressee were updated	1	Joette Steger/ Dec. 20, 2021
		The Western North Carolina Regional Air Quality Agency name was changed to the Asheville-Buncombe Air Quality Agency	2, 5, 13-15, 18, 19, 22, 24, 26, 37-42, 62, 65, 67, 78, 80, 94	
		Acronyms were added to the acronym list	3-4	
		Table 3.1, the distribution list was updated	11-12	
		Minor grammatical and editorial changes were made throughout the document.	15, 16, 18, 24, 25, 28, 30, 31, 49-50, 58-60, 62-63, 67, 71, 86-87, 91, 93-95, 98	
		The Raleigh Central Office Audit Chemist Responsibilities were added	16-17	
		Reference to SOP 2.7.1 was replaced with reference to <a href="#">DAQ-10-001.1</a>	18, 55, 60, 62, 66, 68-70, 72, 77, 82	
		Table 6.3 was updated with information for the new Wade School site.	26	
		Discussion of DAQ warning limits was added	31, 98	
		Section 8 was revised to be accordant with current DAQ policies and procedures	37-38	
		Section 9 was revised to be accordant with current DAQ policies and procedures	39-40, 44-46	
		Table 11.1 was revised to add measurement of indoor (shelter) temperature	52	
		Table 11.2 was revised to list the most current SOPs	54	
Table 14.1 and Section 14.1 were updated with new calibration information for ozone	59			

Date	Person Revising Document	Revision	Page No.	Approved by/Date
		Section 19 was revised to be accordant with current DAQ policies and procedures	71-75	
		Section 20 was revised to be accordant with current DAQ policies and procedures	76-81	
		Section 21 was revised to be accordant with current DAQ policies and procedures	82-85	
		Table 22.1 was updated to contain the new qualifier and null data codes	87-90	
		Section 23.3 was revised to be accordant with current DAQ policies and procedures	96	

## QAPP Annual Review Documentation



QAPP and SOP Tracking Database

### QAPP Tracking

Document ID			Revision Number		
Document Title					
Initial Date Submitted to EPA		EPA Reviewer		EPA Approved?	
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