



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4**

**Laboratory Services and Applied Science Division
Quality Assurance and Program Services Branch
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September 16, 2019

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Division of Air Quality (DAQ)
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SESD Project Number: 18-0687

Mr. Butler:

We have reviewed the following document submitted for approval:

**Quality Assurance Project Plan (QAPP) for the North Carolina Division of Air Quality
Population-Weighted Sulfur Dioxide Monitoring Program, Revision 0, September 5, 2019.**

The quality assurance and technical elements within this QAPP were compared to EPA regulations and current guidance. The stated procedures appear to be clear, sound, and appropriate as written, to the extent they can be evaluated. In multiple sections, the QAPP indicates that the agency's quality system and/or technical monitoring procedures are currently being revised or restructured and that the QAPP will be revised and resubmitted to EPA once those changes are finalized. Therefore, EPA approval of this document is conditionally granted. Please be aware that conditional approval of this QAPP does not constitute a waiver from any regulatory requirements. Your agency remains accountable for ensuring that the population-weighted sulfur dioxide 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. Conditional approval of the QAPP is granted for 2 years from the date of this letter; the QAPP must be revised and resubmitted to EPA by September 2021.

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

Sincerely,

A handwritten signature in blue ink, which appears to read "Laura Ackerman", is written over a horizontal line.

Laura Ackerman, Chief
Quality Assurance Section

Enclosure

Quality Assurance Project Plan For the North Carolina Division of Air Quality Population-Weighted Sulfur Dioxide Monitoring Program

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DISCLAIMER

This Quality Assurance Project Plan (QAPP) covers the population-weighted emission index (PWEI) sulfur dioxide (SO₂) monitoring network for the North Carolina Department of Environmental Quality (DEQ) Division of Air Quality (DAQ).

Quality Assurance Project Plan Acronym Glossary

ADQ - Audit of data quality
AMTIC – Ambient Monitoring Technology Information Center
AQS - Air Quality System (EPA's Air database)
ARM – Air Resources Manager
CAA – Clean Air Act
CBSA – Core-Based Statistical Area
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
Director – Division of Air Quality Director
DIT – North Carolina Department of Information Technology
DQA - Data quality assessment
DQI - Data quality indicators
DQO - Data quality objectives
ECB – Electronics and Calibration Branch
e-log – electronic logbook
EPA – United States Environmental Protection Agency
FEM – Federal equivalent method
FEP – Fluorinated ethylene propylene
FRM – Federal reference method
IBEAM – Internet-Based Enterprise Application Management
LMS – North Carolina Learning Management System
LSASD – Laboratory Services and Applied Science Division
MQO – Measurement quality objective
MSA – Metropolitan Statistical Area
NAAQS - National ambient air quality standards
NEI – National Emissions Inventory
NIST - National Institute of Standards and Technology
NPAP – National Performance Audit Program
OAQPS – Office of Air Quality Planning and Standards
pdf – portable document format
PFA - Perfluoroalkoxy
ppb – Parts per billion
PPB – Projects and Procedures Branch
ppm – Parts per million

PWEI – Population-Weighted Emission Index

PQAO – Primary quality assurance organization

PZS – Precision/zero/span

QA – Quality assurance

QA/QC - Quality assurance/quality control

QA Handbook - EPA Quality Assurance Handbook for Air Pollution Measurements Systems, Volume II

QAPP - Quality assurance project plan

QC – Quality control

RCO – Raleigh central office

RRO – Raleigh Regional Office

SLAMS - State and local air monitoring station

SO₂ – Sulfur dioxide

SOP - Standard operating procedure

TSA - Technical systems audit

UV – Ultraviolet

VIP – Value in performance

1.0 Quality Assurance Project Plan Identification and Approval Sheet

Title: Quality Assurance Project Plan for the North Carolina Division of Air Quality
Population-Weighted Emission Inventory Sulfur Dioxide Monitoring Program

The Division of Air Quality recommends the attached *Quality Assurance Project Plan for the North Carolina Division of Air Quality Population-Weighted Emission Inventory Sulfur Dioxide Monitoring Program* for approval. This plan commits the State of North Carolina, Department of Environmental Quality, Division of Air Quality to follow the elements described within.

1) Signature: M. J. A. [Signature] Date: 9/9/19
DEQ, Air Quality Division Director

2) Signature: [Signature] Date: 9/9/19
DAQ Quality Assurance Manager
(Ambient Monitoring Section Chief)

3) Signature: [Signature] Date: 9/5/2019
Projects and Procedures Branch Supervisor

4) Signature: [Signature] Date: 9/05/19
Primary Quality Assurance Project Plan Author

5) Signature: [Signature] Date: 09/16/19
EPA Region 4 Designated Approving Official

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3.0 Distribution

Table 3-1 lists the primary recipients of this quality assurance project plan, or QAPP. In accordance with the organizational chart presented in Figure 4.1, the people on this distribution list ensure and document that the RRO monitoring technicians and coordinator, 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 approval from the United States Environmental Protection Agency, or EPA, 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 PWEI SO₂ Monitoring Program QAPP Distribution List

Name/Position	Address	Phone/e-mail
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Table 3.1. DAQ Ambient Air Quality PWEI SO₂ Monitoring Program QAPP Distribution List

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4.0 Project/Task Organization

The EPA is responsible for developing the national ambient air quality standards or NAAQS, defining the quality of data necessary to make comparisons to the NAAQS and identifying a minimum set of quality control measurements from which to judge the data quality. The state and local air monitoring organizations are responsible for using this information to develop and implement a quality assurance, or QA, program that will meet the data quality requirements. It is the responsibility of the EPA and the monitoring organizations to assess the quality of the data and take corrective action, when appropriate.

The State of North Carolina Division of Air Quality (DAQ) ambient air monitoring program is an independent primary quality assurance organization (PQAO) as defined in 40 Code of Federal Regulations, or CFR, Part 58, Appendix A, Section 1.2. The DAQ operates the PWEI SO₂ monitoring program as part of the DAQ PQAO. The DAQ director, or director, has organized the Ambient Monitoring Section into three main branches: The Projects and Procedures Branch, or PPB, the Laboratory Analysis Branch and the ECB. The chief has responsibility for managing these branches per 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. These supervisors have direct responsibility for assuring data quality. The DAQ currently does not use the services of the Laboratory Analysis Branch to implement this monitoring program. The Ambient Monitoring Section shares the monitoring responsibilities with the RRO monitoring technicians and coordinator.

Figure 4.1 presents the organizational structure for the implementation of the monitoring program. The following information lists the specific responsibilities of each significant position within the Ambient Monitoring Section and the regional offices.

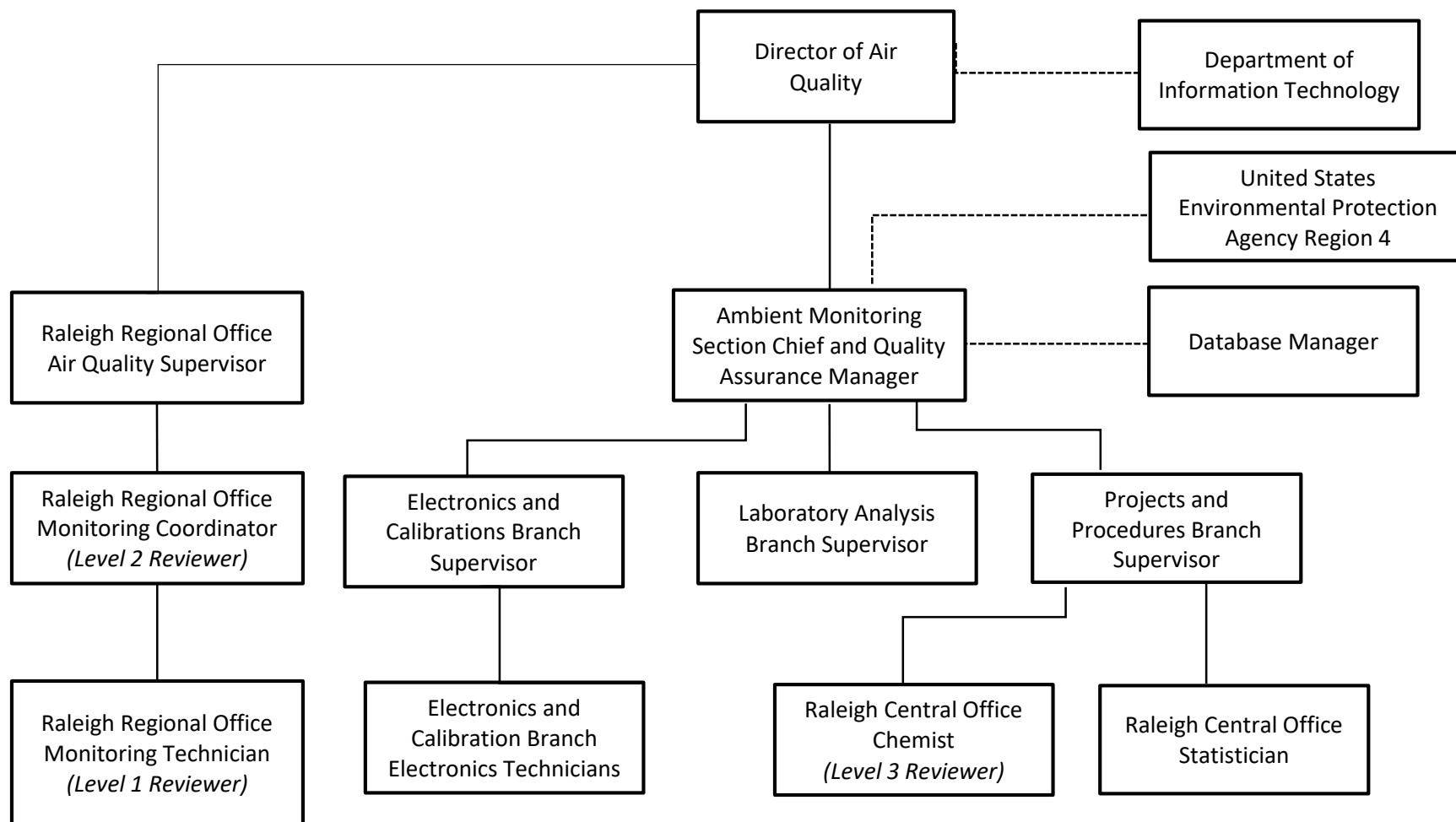
4.1 Division of Air Quality Director

The director supervises the chief and Raleigh Regional Office, or RRO, supervisor. The director is responsible for ensuring adequate human and financial resources are available to support DAQ's population-weighted emission index, or PWEI, monitoring program. The director has ultimate responsibility and final authority on all aspects of the PWEI SO₂ 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, the Laboratory Analysis Branch (not involved in PWEI sulfur dioxide, or SO₂, monitoring) and the ECB and is responsible for coordinating the quality assurance, or QA, data collection, and data processing aspects of this monitoring program.

Figure 4.1 Project Organizational Chart



Ambient Monitoring Section Chief: The chief serves as the QA manager, or QAM, and reports to and has direct access to the director on all matters relating to DAQ's PWEI SO₂ ambient 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;
- 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;
- Approving and distributing division standard operating procedures (SOPs) and QAPPs to the personnel listed in Table 3.1;
- Serving as the tie-breaker in the event of an impasse on how to handle corrective actions or make a final judgment call on data validity;
- Collaborating with DEQ staff in developing, administering and maintaining the quality management plan;
- Certifying the data every year in accordance with 40 CFR Section 58.15;
- Reviewing the quarterly QA reports and the quality control, or QC, summaries to ensure the bias and precision limits are attained;
- Serving as the document custodian by managing the agency's documents and records;
- Overseeing training for the ambient monitoring staff;
- Participating in systems audits;
- Assuring that QAPPs are established and effectively implemented for each project as applicable;
- Tracking corrective actions and determining their success; and
- Reviewing budgets, contracts, grants and proposals.

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

Database Manager: Although the database manager does not report directly to the chief, he has direct access to the chief on all matters relating to DAQ's PWEI SO₂ ambient-air monitoring database management. The database manager's duties include, but are not limited, to the following:

- Ensuring correct data is being transferred to the DAQ Internet-Based Enterprise Application Management, or IBEAM, database and DAQ real-time air quality data webpage;
- Participating in systems audits;
- Uploading environmental data to the EPA's Air Quality System, or AQS, and AirNow-Tech databases;
- Serving as the AQS administrator for DAQ;

- Maintaining the RCO data polling station (i.e., Envista Air Resources Manager, or ARM), ensuring it polls hourly, minute and 5-minute data for each hour of every day as well as automated check data for each day;
- Maintaining and updating the RCO data polling software and AQS database when sites and monitors are established or shut down; and
- Completing other duties as assigned.

4.2.1 Projects and Procedures Branch

Projects and Procedures Branch Supervisor: The PPB supervisor reports to the chief. 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
- Completing other duties as assigned.

Raleigh Central Office Chemists: The RCO chemists report to the PPB supervisor and are responsible for the oversight of the DAQ PWEI SO₂ monitoring program. The RCO chemists' duties include the following:

- Assessing the effectiveness of the network system;
- Coordinating with the RRO monitoring technicians and coordinator and ECB electronics technicians on the writing, revising and maintaining of SOP updates, including documenting annual SOP and QAPP reviews;
- Validating data by serving as the level 3 reviewer;
- Verifying that all required quality assurance/quality control, or QA/QC, activities are performed and that measurement quality standards are met;
- Maintaining QA/QC records, flagging suspect data, and assessing and reporting on data quality;
- Conducting quarterly completeness evaluations and audits of data quality;
- Participating in systems audits;
- Conducting internal systems audits, as needed;
- Identifying data quality problems and initiating corrective actions that result in solutions;
- Providing training and certification to appropriate personnel; and
- Completing other duties as assigned.

Statistician: The statistician, who reports to the PBB supervisor, 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;
- Planning and conducting data quality assessments, or DQAs, based on interpretation of data;
- Participating in systems audits;
- Preparing and delivering data and statistical interpretation of the data to the regional offices and RCO;
- Responding to public records requests and statistical consulting requests;
- Uploading data to AQS; and
- Completing 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. The ECB supervisor 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;
- Supervise the ECB electronics technicians;
- Participating in systems audits;
- Provide and document training and certification of field personnel; and
- Completing other tasks as assigned.

Electronics and Calibration Branch Electronics Technicians: The ECB electronics technicians report to the ECB supervisor and have the following responsibilities:

- Installing and replacing 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, certifying and tracking all transfer standards or sending them to the vendor to be recertified;
- Returning "local primary standards" to the vendor or EPA for recertification and periodically checking the calibration of backup "local primary standards" to ensure quality calibrations;
- Ordering calibration gases and ensuring DAQ participation in the gas verification program operated by the EPA;

- Maintaining documentation on all transfer standard, “local primary standard” and calibration gas certifications;
- Conducting annual performance evaluations;
- Assisting in prescribing corrective actions;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Performing and documenting all major maintenance and repair of field equipment as described by SOP Section 2.8.1 ECB Responsibilities Sulfur Dioxide Standard Operating Procedure Revision 10, Nov. 1, 2016; and
- Completing other tasks as assigned.

4.3 Raleigh Regional Office

Raleigh Regional Office Air Quality Supervisor: The RRO air quality supervisor reports to the director and has direct access to the chief and director on all matters relating to DAQ’s PWEI SO₂ monitoring program. The RRO air quality supervisor’s duties include:

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

Raleigh Regional Office Monitoring Coordinator: The RRO monitoring coordinator, or coordinator, reports directly to the RRO air quality supervisor. The coordinator has the overall responsibility of ensuring the implementation of the QA/QC program at the regional level. The coordinator coordinates the activities of the RRO monitoring technicians. The coordinator’s responsibilities include:

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

- Overseeing transfer standard certifications to ensure equipment is returned for recertification before expiration and that all certification documents are appropriately filed and archived;
- Documenting and assessing corrective actions to ensure they are appropriate and effective; and
- Completing other duties as assigned.

Raleigh Regional Office Monitoring Technicians: The RRO monitoring technicians report directly to the RRO air quality supervisor and work under the direction of the RRO monitoring coordinator to ensure DAQ meets all monitoring requirements. The RRO monitoring technicians' duties include:

- Performing all required QC activities and ensuring that measurement quality objectives are met as prescribed in the QAPP and SOPs;
- Performing corrective actions to address any activities that do not meet the acceptance criteria as prescribed in the QAPP and SOPs;
- Ensuring that monitoring programs implement the QA/QC elements of SOPs and QAPPs;
- Participating in and providing hands-on training as needed of new regional monitoring coordinators and technicians and RCO chemists in the requirements of the QAPPs and SOPs;
- Operating and completing preventative maintenance on all monitoring equipment;
- Calibrating monitors;
- Maintaining equipment;
- Maintaining a supply of expendable monitoring items;
- Performing level 1 data verification activities and flagging suspect data;
- Participating in training and certification activities;
- Documenting deviations from established procedures and methods;
- Reporting nonconforming conditions and corrective actions to the RRO monitoring coordinator and the RRO air quality supervisor;
- Conducting 40 CFR Part 58, Appendix E siting criteria evaluations annually as part of the annual network review process;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Preparing corrective action reports, when needed, for the Ambient Monitoring Section; and
- Completing other duties as assigned.

4.4 Department of Information Technology

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

4.5 United States Environmental Protection Agency, Region 4

The DAQ operates the PWEI monitors as SLAMS monitors following the procedures in 40 CFR Part 58. As a result, the chief includes information on these monitors in the annual network-monitoring plan and the five-year network assessment and the EPA Region 4 Air and Radiation Division director will review, comment on and respond to the network plan each year. Likewise, the chief will include the data from these monitors in the annual certification request. The EPA Region 4 Air and Radiation Division director will review and apply concurrence codes in AQS in response to DAQ's data certification request. The chief will also submit a QAPP to the EPA Region 4 Laboratory Services and Applied Science Division, or LSASD for EPA approval. The chief will also request that the EPA Region 4 LSASD include the PWEI SO₂ monitors in the National Performance Audit Program (NPAP).

5.0 Problem Definition and Background

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

The EPA sets primary standards at a level adequate to protect public health within an acceptable margin of safety, while it sets secondary standards at the level needed to protect public welfare. The CAA and its amendments provide the framework for the monitoring of these criteria pollutants by state, local, and tribal air monitoring organizations. Under the area designations process, the EPA and states typically use data from ambient air monitors to characterize air concentrations for identification of areas that either meet or violate the standard for a specific pollutant. The EPA and states typically designate monitors used for comparisons against a NAAQS as state and local air monitoring stations, or SLAMS, monitors. These SLAMS monitors must meet the requirements stipulated in 40 CFR Parts 50, 53 and 58. For most of the criteria pollutants, the EPA and states need three years of valid, quality-assured data for comparison against the NAAQS.

In 2010, the EPA changed the monitoring regulations for SO₂ to support the lower SO₂ national ambient air quality standards, or NAAQS, provided in Table 5.1.¹ For the SO₂ monitoring network the EPA developed the PWEI. The EPA calculates the PWEI for each core-based statistical area, or CBSA, by multiplying the population of each CBSA by the total amount of SO₂ in tons per year emitted within the CBSA. The EPA uses the most current census data or estimates for the population of each CBSA and an aggregate of the most recent county level emissions data available in the national emissions inventory, or NEI, for each county in each CBSA for the SO₂ emissions. Dividing the resulting product by 1,000,000 provides a PWEI value with the units of million person-tons per year. For any CBSA with a calculated PWEI value equal to or greater than 1,000,000, a minimum of three SO₂ monitors are required within that CBSA. For any CBSA with a calculated PWEI value equal to or greater than 100,000, but less than 1,000,000, a minimum of two SO₂ monitors are required within that CBSA. For any CBSA with a calculated PWEI value equal to or greater than 5,000, but less than 100,000, a minimum of one SO₂ monitor is required within that CBSA.

Table 5.1 National Ambient Air Quality Standards for SO₂

Pollutant	Standard Value	Standard Form	Standard Type
Sulfur Dioxide (SO₂)			
1-hour average	75 ppb ^a	99 th percentile of 1-hour daily maximum concentrations, averaged over 3 years	Primary

¹ Primary National Ambient Air Quality Standard for Sulfur Dioxide, Final Rule, Federal Register, Vol. 75, No. 119, Jun. 22, 2010, available on the worldwide web at <https://www3.epa.gov/ttn/naaqs/standards/so2/fr/20100622.pdf>, accessed on May 13, 2017.

Table 5.1 National Ambient Air Quality Standards for SO₂

Pollutant	Standard Value	Standard Form	Standard Type
Sulfur Dioxide (SO₂)			
Annual Arithmetic Mean	0.5 ppm ^b	Not to be exceeded more than once per year ^d	Secondary
^a Parts per billion ^b Parts per million			

The SO₂ monitoring site required because of the calculated PWEI in each CBSA satisfies the minimum monitoring requirements if:

- The monitor is sited within the boundaries of the parent CBSA; and
- The monitor is one of the following site types as defined in section 1.1.1 of 40 CFR Part 58, Appendix D:
 - Population exposure;
 - Highest concentration;
 - Source impacts;
 - General background; or
 - Regional transport.

The SO₂ monitors at NCore stations may satisfy minimum monitoring requirements if that monitor is located within a CBSA that is required to have one or more PWEI monitors.

In 2011, the DAQ and the MCAQ proposed the following monitoring sites to meet the PWEI requirements:

- Garinger as a population exposure monitor in the Charlotte-Concord-Gastonia Metropolitan Statistical Area, or MSA;
- Durham Armory as a population exposure monitor in the Durham MSA; and
- New Hanover as a population exposure/highest concentration monitor in the Wilmington MSA.

The EPA Region 4 administrator approved these locations in 2011.

In the 2011 network plan the DAQ proposed doing PWEI monitoring at five additional sites, located in the Asheville, Charlotte-Concord-Gastonia, Greensboro-High Point, Hickory and Winston-Salem MSAs. After DAQ wrote the network plan, the EPA developed revised PWEI lists, which no longer included required PWEI monitors for the Asheville, Greensboro-High Point, Hickory and Winston-Salem MSAs. The revised list also required only one PWEI monitor in the Charlotte-Concord-Gastonia MSA instead of two. Thus, the DAQ did not add PWEI monitors to the Waynesville Elementary School, Mendenhall School and Hickory sites and the EPA approved the revised 2013-network plan, reflecting a smaller PWEI network.

The 2010 SO₂ monitoring requirements required North Carolina to add by Jan.1, 2013, three PWEI SO₂ monitors to three MSAs in North Carolina: Charlotte-Concord-Gastonia, Durham-Chapel Hill and

Wilmington. The DAQ operated the Durham-Chapel Hill and Wilmington locations while other PQAOS within the state monitored the other locations.

In December 2016, the EPA released version 1 of the 2014 NEI.² In April 2017, DAQ calculated new PWEI values for each MSA using the 2014 NEI and 2016 population estimates.³ Table 5.2 presents the newest PWEI values using the 2014 NEI and 2016 population estimates. Due to drastically lower emissions in the Wilmington area, the Wilmington PWEI monitor was no longer required and shut down at the end of 2017. However, the Winston-Salem MSA is now required to have a PWEI monitor. The local program in Winston-Salem currently operates an SO₂ monitor in this MSA that meets the PWEI requirements.

Figure 5.1 shows the locations of the three required PWEI SO₂ monitoring sites based on the 2014 NEI and 2016 population estimates.

Table 5.2 Population-Weighted Emission Indices Using the 2014 National Emissions Inventory and 2016 Population Estimates for North Carolina: Metropolitan Statistical Areas

Metropolitan Statistical Area^a	SO₂ Emissions, tons^b	Estimated Population, July 1, 2016	Population Weighted Emission Index	Number of SO₂ Monitors Required
Asheville	9,260.05	452,319	4,188.497	0
Burlington	98.64	159,688	15.75	0
Charlotte-Gastonia-Concord	7,624.02	2,474,314	18,864.23	1
Durham Chapel Hill	21,473.57	559,535	12,015.21	1
Fayetteville	377.73	380,389	143.69	0
Goldsboro	136.72	124,150	16.97	0
Greensboro-High Point	914.49	756,139	691.48	0
Greenville	134.05	177,220	23.76	0
Hickory	6,515.13	364,187	2,372.73	0
Jacksonville	1,120.84	187,136	209.75	0
Myrtle Beach-Conway-North Myrtle Beach	4,836.85	449,295	2,173.17	0
New Bern	1,383.04	126,111	174.42	0
Raleigh	797.44	1,302,946	1,039.03	0
Rocky Mount	164.93	147,323	24.30	0
Virginia Beach-Norfolk-Newport News	25,045.32	1,726,907	43,250.94	1
Wilmington	732.89	282,573	207.09	0
Winston-Salem	8,101.27	662,079	5,363.68	1

^a Office of Management and Budget, OMB BULLETIN NO. 13-01: Revised Delineations of Metropolitan Statistical Areas, Micropolitan Statistical Areas and Combined Statistical Areas and Guidance on Uses of the

² 2014 National Emission Inventory, Version 1, All Sectors: National-County/Tribe aggregated, Released December 2016, available on the World Wide Web at <https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data>. Accessed Jan. 4, 2017.

³ Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2016, U.S. Census Bureau, Population Division, Released March 23, 2017, available on the worldwide web at <http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>.

Delineations of These Areas, Feb. 28, 2013, available on the worldwide web at <https://obamawhitehouse.archives.gov/sites/default/files/omb/bulletins/2013/b13-01.pdf>, accessed May 18, 2017.

^b Source: 2014 National Emission Inventory, Version 1, All Sectors: National-County/Tribe aggregated, Released December 2016, available on the World Wide Web at <https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data>. Accessed Jan. 4, 2017.

^c Source: Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2016, U.S. Census Bureau, Population Division, Released March 23, 2017, available on the World Wide Web at <http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>.

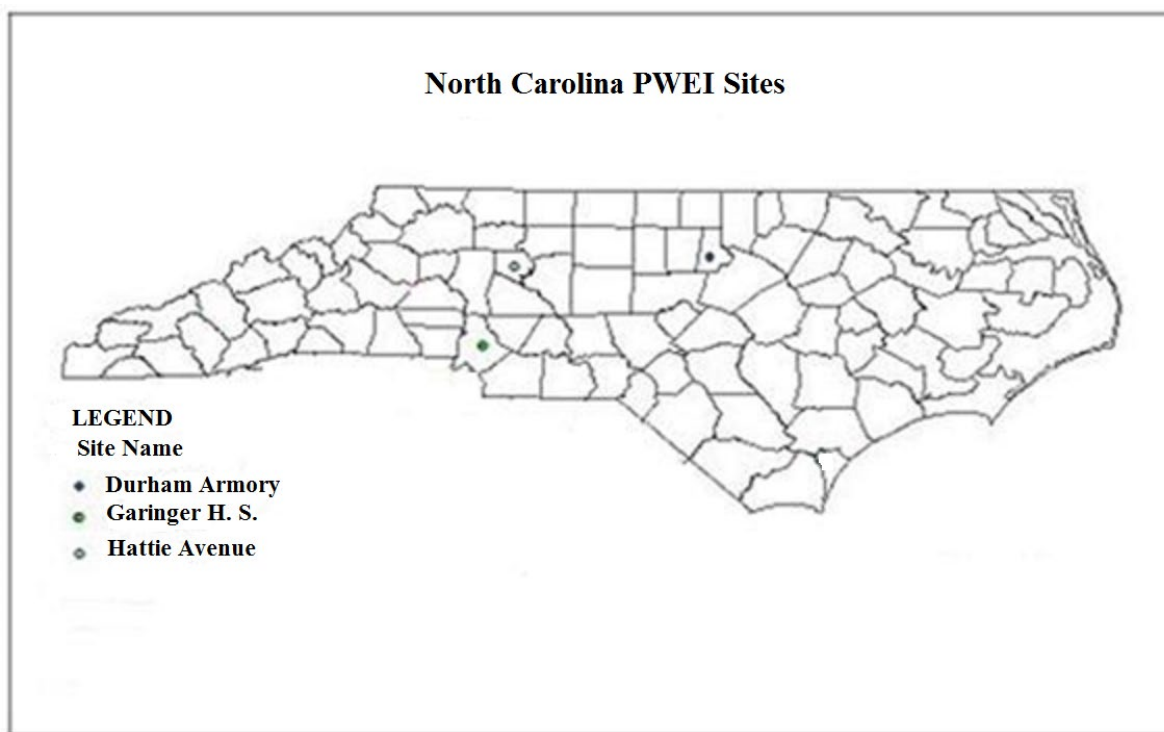


Figure 5.1 Location of North Carolina PWEI SO₂ monitors in 2019

The DAQ has a written agreement with the Virginia Department of Environmental Quality, VDEQ, Office of Air Quality Monitoring. This agreement establishes the Virginia Beach-Norfolk-Newport News MSA Criteria Pollutant Air Quality Monitoring Agreement between DAQ and VDEQ to meet collectively EPA minimum monitoring requirements for criteria pollutants deemed necessary to meet the needs of the MSA. The VDEQ currently operates two SO₂ monitors in the Virginia Beach-Norfolk-New Port News MSA. Because of the written agreement and VDEQ already operating SO₂ monitors in the MSA, the DAQ does not need to add a PWEI monitor in the Virginia Beach-Norfolk-New Port News MSA.

Thus, DAQ operated two PWEI SO₂ monitors from 2013 to 2017. As of Jan. 1, 2018, DAQ operates one PWEI SO₂ monitor. Table 5.3 provides information about these monitors and monitoring stations. The PWEI SO₂ monitoring project is an on-going project. The PWEI monitoring stations sometimes change as the SO₂ emissions change or as the population changes.

Table 5.3 North Carolina PWEI SO₂ Monitoring Locations and Monitors

Site Name	AQS Identifier	Types of Monitors	Operator	Years of Operation
Durham Armory	37-063-0015	Thermo 43i SO ₂	Raleigh Regional Office	2013 to present
New Hanover	37-129-0006	Thermo 43i SO ₂	Wilmington Regional Office	2013-2017

Note: These are the locations at the time of this QAPP revision. For current locations, please see the network plan.

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

The purpose of this QAPP is to prescribe requirements, procedures and guidelines for the DAQ PWEI SO₂ monitoring program. The DAQ intends this QAPP to serve as a reference document for implementing and expanding the QA program and provides detailed operational procedures for measurement processes used by DAQ. The QAPP should be particularly beneficial to the RRO monitoring technician, regional coordinator and RCO chemists responsible for implementing, designing and coordinating the PWEI SO₂ monitoring project. The QAPP is a compilation of QA requirements, procedures and guidelines that are applicable to air pollution measurements systems. They are designed to achieve a high percentage of valid data (>75 percent) while maintaining integrity and accuracy. This QAPP clearly and thoroughly establishes QA protocols and QC criteria required to successfully implement and maintain this monitoring program. It is the responsibility of the chief to ensure the RRO monitoring technicians and coordinator, ECB electronics technicians and RCO chemists implement and adhere to the QA programs for the field and data processing phases of 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.

Before DAQ implemented this QAPP, the PWEI SO₂ monitoring program was included in the Criteria Pollutant QAPP.

6.0 Project/Task Description

The chief developed this QAPP to ensure DAQ's PWEI SO₂ monitoring network collects ambient data that meet or exceed EPA QA requirements. The EPA and DAQ use the criteria pollutant data collected by DAQ for regulatory decision-making purposes, i.e., determining compliance with the NAAQS. The DAQ enters all these data into the EPA AQS database.

The PWEI site is a SLAMS so it must meet the three objectives in 40 CFR Part 58, Appendix D, Section 1.1:

- (a) Provide air pollution data to the public in a timely manner.
- (b) Support compliance with ambient air quality standards and emissions strategy development.
- (c) Support for air pollution research studies.

The PWEI-monitor will characterize hourly SO₂ concentrations in CBSAs with both high SO₂ emissions and large populations. The DAQ will also use the data from this site to provide the public with air pollution data in a timely manner by displaying the data on the DEQ and AirNow websites. Section 10.1 provides additional objectives for the PWEI network. The chief designed DAQ's PWEI monitoring network to support these objectives as well as the following specific goal: to meet minimum monitoring requirements in 40 CFR Part 58 Appendix D.

On Jan. 1, 2013, the DAQ established the PWEI SO₂ monitoring stations to characterize hourly SO₂ concentrations in areas of the state with both high population and high SO₂ emissions to ensure these areas are attaining the NAAQS. The EPA, DAQ and other data users may also use the data from these monitors to validate and refine models.

The chief with input from the RRO monitoring coordinator and PPB supervisor assigns the monitors operated at the PWEI sites 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 on the monitoring objective and site location, the data collected at these sites will generally be representative of the background SO₂ concentrations on either a neighborhood or an urban scale. The neighborhood scale defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range while the urban scale defines the concentrations within an area of city-like dimensions, approximately 4 to 50 kilometers.

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

- Establishing a monitoring network that has:
 - Appropriate density, location, and sampling frequency; and
 - Accurate and reliable data recording equipment, procedures and software.
- Developing encompassing documentation for:
 - Data and report format, content and schedules;
 - Quality objectives and criteria; and
 - SOPs providing activities and schedules for:

- Equipment operation and preventative maintenance; and
- Instrument calibrations, zero, span, and precision and accuracy evaluations.
- Establishing assessment criteria and schedules.
- Verifying and validating data, according to the criteria and schedules established in this QAPP.
- Certifying data.

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

6.1 Field Activities

DAQ personnel will perform those activities that support continued successful operation of this monitoring network. Personnel will perform field activities that include, but are not necessarily limited to, conducting calibrations and routine QC checks, performing periodic preventative maintenance and servicing equipment located at the PWEI SO₂ air monitoring stations. Operational servicing activities may include, but may not be limited to, recording pertinent field data and restocking consumables at the monitoring sites. Additional field activities include relocating sites and/or locating suitable monitoring sites for possible expansion of the network if CBSA boundaries change, CBSA populations grow or SO₂ emissions for a CBSA increase. Section 4.3 Raleigh Regional Office provides a more complete description of the field activities that RRO monitoring technicians may perform to support the PWEI monitoring program. The ECB electronics technicians also perform annual performance evaluations on the deployed SO₂ monitors.

6.2 ECB Activities

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

6.2 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

Assessment Type	Assessment Agency	Frequency
EPA Technical Systems Audit	EPA Region 4	Every 3 years
DAQ Internal Systems Audit	State	As needed
Network Assessment	EPA Region 4 State	Every 5 years
Network Review (40 CFR Part 58, Appendix A, D and E evaluations)	EPA Region 4 State	Annually
Network Plan	EPA Region 4 State	Annually
Quarterly Data Completeness	State	Quarterly
Annual Data Certification	State	Annually
Quality Assurance Project Plan Review and Updates	State	Review annually Update as needed and every 5 years
Standard Operating Procedures Reviews	State	Review annually Update as needed but at least every 5 years
Data Quality Assessment	State	AMP256 and AMP600 Review Quarterly and Annually Control Chart Review Daily and Monthly
Annual Performance Evaluation	State	At least once per calendar year and every 365 days
National Performance Audit Program	EPA designated contractor	20 percent of PQAO sites per year/each PQAO site once every six years

6.3 Project Records

DAQ will establish and maintain procedures for the timely preparation, review, approval, issuance, use, control, revision and maintenance of documents and records. Table 6-2 presents the categories and types of records and documents that are applicable to document control for ambient air quality information. Section 9.0 Documentation and Records explains information on key documents in each category in more detail.

Table 6.2 Critical Documents and Records

Categories	Record/Document Type
Site Information	Network Descriptions

Table 6.2 Critical Documents and Records

Categories	Record/Document Type
	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 QC) Including Data Entry Forms
Data Reporting	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 (AMP600 and AMP256) EPA Technical System Audit Reports DAQ Internal System Audit Reports Response/Corrective Action Documentation Annual Performance Evaluation Reports Certification Documentation

7.0 Quality Objectives and Criteria for Measurement Data

The DAQ operates under an EPA-approved quality management plan 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 DAQ implements to assure that the RRO monitoring technicians obtain and maintain acceptability in the generated data set. Quality control procedures, when properly executed, provide data that meet or exceed the minimally acceptable quality criteria established to assist management in making confident decisions. The policy of DAQ is to implement a QA program to assure the RRO monitoring technicians collect data of known and acceptable precision, bias, sensitivity, completeness, comparability and representativeness within its ambient-air-quality monitoring program.

Defined in Section 7.2 Measurement Quality Objectives, precision, bias, sensitivity, completeness, comparability and representativeness are the principal data quality indicators, or DQI, that provide qualitative and quantitative descriptions used in interpreting the degree of acceptability of data. Establishing acceptance criteria for these DQIs sets quantitative goals for the quality of data generated in the measurement process. Of the 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 area studied. This includes consideration of siting criteria, spatial scales, monitoring objectives, climatic change, source configurations and the duration of the study.

All individuals must adhere to the written procedures and methods in the QAPP for operating air monitoring instruments and handling data to assure quality data for purposes of ensuring continued compliance with the NAAQS. EPA approved federal reference methods, or FRMs, are the designated methods and basis for operating pollutant monitoring equipment, although the EPA allows the use of federal equivalent methods, or FEMs, as well.

7.1 Data Quality Objectives

This section provides a description of the data quality objectives, or DQOs, for the PWEI SO₂ 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 an erroneous decision due to uncertainty in the data.

The goal of this monitoring program is to determine the one-hour SO₂ concentrations in the areas of North Carolina with high population and high SO₂ emissions to ensure these areas meet the NAAQS.

The data necessary to meet the goals of this monitoring program are:

- Continuous hourly averaged SO₂ concentration data;
- Continuous shelter temperature measurements for ensuring conformity to environmental requirements of the SO₂ monitor;
- Precision measurements;
- Bias measurements;
- Locational measurements (geographical, topographical, etc.); and
- Minute and five-minute data for SO₂.

40 CFR Part 50, Appendix T explains the data reporting and handling conventions for SO₂. DAQ will adhere to those reporting conventions.

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

The DAQ and EPA will use these data to evaluate compliance with the NAAQS, determine trends over time and provide real-time data to the public.

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 the NAAQS when in fact, due to random deviations in the data, the monitor did exceed the NAAQS. Using the formal DQO process, EPA determined the objectives to control precision and bias to reduce the probability of decision errors. The regulations at 40 CFR Part 58, Appendix A, Section 2.3.1 provide the DQOs. The PWEI SO₂ monitoring program has established the acceptable precision, as measured by coefficient of variation (CV), and acceptable bias for each pollutant as listed in Table 7.1.

Table 7.1. Acceptable Precision as Measured by Coefficient of Variation (CV) and Bias

Pollutant	Acceptable Precision	Acceptable Bias
SO ₂	upper 90 percent confidence limit for the CV of ≤10 percent	Upper 95 percent confidence limit for the absolute bias of ≤10 percent

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

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 DAQ maintains data quality within the established acceptance criteria. Measurement quality objectives evaluate and control various phases (sampling, preparation, analysis) of the measurement process to ensure total measurement uncertainty is within the range prescribed by the DQOs. The DAQ defines the MQOs for North Carolina's PWEI SO₂ monitoring program in terms of the following DQIs:

- **Precision** - "Precision is a measure of agreement between two replicate measurements of the same property, under prescribed similar conditions. (US EPA QA/G-5, Appendix B)." This is the random component of error. The DAQ calculates this value using percent difference as described in 40 CFR Part 58, Appendix A, Section 4.
- **Bias** - "Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction (US EPA QA/G-5, Appendix B)." Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.
- **Comparability** - "Comparability is the qualitative term that expresses the confidence that two data sets can contribute to a common analysis and interpolation. Comparability must be carefully evaluated to establish whether two data sets can be considered equivalent regarding the measurement of a specific variable or groups of variables (US EPA QA/G-5, Appendix B)."
- **Representativeness** - "Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point or for a process condition or environmental condition. Representativeness is a qualitative term that DAQ should evaluate to determine whether in situ or other measurements are made in such a manner that the resulting data appropriately reflect the media and phenomenon measured or studied (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 method detection limit, or MDL, studies but relies on manufacturer's specifications for instrument detection limit, or IDL, or something similar.
- **Completeness** - Completeness is a metric quantifying the amount of valid data obtained from a measurement system compared to the expected amount obtained under correct, normal conditions. The DAQ expresses completeness as a percentage. Data completeness requirements are included in 40 CFR Part 50, Appendix T.

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 PWEI SO₂ monitoring program. The DAQ based these tables on the validation templates in the EPA Quality Assurance

Table 7.2 Sulfur Dioxide Measurement Quality Objectives Parameter – Sulfur Dioxide (SO₂) (Ultraviolet Fluorescence).

1) Requirement (SO ₂)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- SO₂			
<i>Sampler/Monitor</i>	Not applicable	<i>Meets requirements listed in FRM/FEM designation</i>	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
<i>1-Point-QC Check Single analyzer</i>	<i>1/14 days is required (The DAQ goal is daily checks)</i>	DAQ Warning Limit: ≤ 7.0 percent (percent difference) EPA Control Limit: < ± 10.1 percent (percent difference) or < ± 1.5 ppb difference, whichever is greater	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.1 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A Section 2.3.1.5 (see DAQ SO ₂ SOP 2.8.2 for details) QC Check Concentration range 5 – 80 ppb relative to mean or median monitor concentration.
Zero/span check	<i>1/14 days is required (The DAQ goal is daily checks)</i>	Zero drift < ± 3.1 ppb (24 hours) < ± 5.1 ppb (>24hours-14 day) (The DAQ Warning limit is <± 1.5 ppb (24 hour) and <± 2.5 ppb (>24 hour – 14 days) Span drift < ± 10.1 percent (The DAQ Warning limit is < ± 5 percent)	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO (see DAQ SO ₂ SOP for details)
Shelter Temperature Range	Daily (hourly values)	20.0 to 30.0° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2 and FRM/FEM method list
OPERATIONAL CRITERIA- SO₂			
Shelter Temperature Control	Daily (hourly values)	< ± 2.1° C Standard deviation over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	Every 180 days and 2/calendar year	< ± 2.1° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
<i>Annual Performance Evaluation Single Analyzer</i>	<i>Every site 1/365 days and 1/calendar year</i>	Percent difference of audit levels 3-10 ≤ ±15.0 percent; audit levels 1 and 2 <± 1.5 ppb difference or <±15.1 percent, whichever is greater	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC Technical Memo
<i>Federal Audits (NPAP)</i>	100 percent of sites every 6 years; 20 percent of sites audited each year	Audit levels 1 and 2 <± 1.5 ppb difference; all other levels percent difference <± 15.1 percent	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.3 3) NPAP QAPP/SOP
<i>Verification/Calibration</i>	Upon receipt/adjustment/repair/ installation/moving; When 1-point-QC check is > 7.0 percent difference; 1/365 days and 1/calendar year	Span/Span2 within ± 5.0 percent of expected 1-point-QC check ≤ 7.0 percent difference Zero within ± 1.0 ppb of expected Slope of best fit line = 1 ± 0.05 and each point within 2 percent of best fit line or ± 1.5 ppb, whichever is greater	1) 40 CFR Part 50, Appendix A-1, Section 4 2 and 3) Recommendation: See SO ₂ Operator SOP Multi-point calibration (0 and 3 upscale points)
<i>Gaseous Standards</i>	<i>All gas cylinders</i>	NIST Traceable (e.g., EPA Protocol Gas)	1) 40 CFR Part 50, Appendix A-1, Section 4.1.6.1 2) Not applicable Green Book 3) 40 CFR Part 50, Appendix A, Sections 2.2 and 4.1.6.1 Producers must participate in Ambient Air Protocol Gas Verification Program 40 CFR Part 58, Appendix A, Section 2.6.1

Table 7.2 Sulfur Dioxide Measurement Quality Objectives Parameter – Sulfur Dioxide (SO₂) (Ultraviolet Fluorescence).

1) Requirement (SO ₂)	2) Frequency	3) Acceptance Criteria	Information /Action
<i>Zero Air/ Zero Air Check</i>	Chemicals changed 1/365 days and 1/calendar year	Concentrations below LDL < 0.1 ppm aromatic hydrocarbons	1) 40 CFR Part 50, Appendix A-1, Section 4.1.6.2 2) Recommendation: See SO ₂ ECB SOP 2.8.1 3) Recommendation and 40 CFR Part 50, Appendix A-1, Section 4.1.6.2
<i>Gas Dilution Systems</i>	Certified 1/365 days and 1/calendar year or after failure of 1-point-QC check or performance evaluation	<i>Accuracy <± 2.1 percent</i>	1) 40 CFR Part 50, Appendix A-1, section 4.1.2 2) Recommendation: See DAQ ECB SO ₂ SOP 2.8.1 3) 40 CFR Part 50, Appendix A-1, section 4.1.2
Detection (FEM/FRMs) Noise and Lower Detectable Limits (LDL) are part of the FEM/FRM requirements			
<i>Noise</i>	Verified by manufacturer at purchase	$\leq 0.001 \text{ ppm (standard range)}$ $\leq 0.0005 \text{ ppm (lower range)}$	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) See DAQ ECB SO ₂ SOP 2.8.1 3) 40 CFR Part 53.20 Table B-1
<i>Lower detectable level</i>	Verified by manufacturer at purchase	$\leq 0.002 \text{ ppm (standard range)}$ $\leq 0.001 \text{ ppm (lower range)}$	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation: See DAQ ECB SO ₂ SOP 2.8.1 3) 40 CFR Part 53, Table B-1
SYSTEMATIC CRITERIA- SO₂			
<i>Standard Reporting Units</i>	<i>All data</i>	<i>ppb (final units in AQS)</i>	1, 2 and 3) 40 CFR Part 50, Appendix T, Section 2 (c)
<i>Rounding convention for design value calculation</i>	<i>All routine concentration data</i>	<i>1 place after decimal with digits to right truncated</i>	1, 2 and 3) 40 CFR Part 50, Appendix T, Section 2 (c) The rounding convention is for averaging values for comparison to the NAAQS and not for reporting individual hourly values to AQS.
<i>Completeness</i>	<i>1-hour standard</i>	<i>Hour – ≥ 75 percent of hour</i> <i>Day- ≥ 75 percent of hourly concentrations</i> <i>Quarter- ≥ 75 percent complete days</i> <i>Years-4 complete quarters</i> <i>5-minute values - ≥ 75 percent of minutes</i> <i>5-minute maximum value reported only for valid hours</i>	1, 2 and 3) 40 CFR Part 50, Appendix T, Section 3 (b), (c) More details in CFR on acceptable completeness.
<i>Sample Residence Time Verification</i>	At installation, 1/365 days and 1/calendar year	<i>< 20 seconds</i>	1) 40 CFR Part 58, Appendix E, section 9 (c) 2) See DAQ SO ₂ SOPs 2.8.1 and 2.8.2 3) 40 CFR Part 58, Appendix E, section 9 (c)
<i>Sample Probe, Inlet, Sampling train</i>	<i>All sites</i>	<i>Borosilicate glass (e.g., Pyrex®) or Teflon®</i> (The EPA has accepted FEP and PFA as equivalent material to Teflon.)	1, 2 and 3) 40 CFR Part 58, Appendix E, section 9 (a) Replace 1 / 2 years; more frequently if pollutant load or contamination dictate
<i>Siting</i>	1/365 days and 1/calendar year	<i>Meets siting criteria or waiver documented</i>	1) 40 CFR Part 58, Appendix E, sections 2-6 2) See DAQ Network Review SOP 2.43 3) 40 CFR Part 58, Appendix E, sections 2-6

Table 7.2 Sulfur Dioxide Measurement Quality Objectives Parameter – Sulfur Dioxide (SO₂) (Ultraviolet Fluorescence).

1) Requirement (SO₂)	2) Frequency	3) Acceptance Criteria	Information /Action
<i>Precision (using 1-point-QC checks)</i>	<i>Calculated annually and as appropriate for design value estimates</i>	<i>90 percent confidence limit $CV \leq 10$ percent</i>	1) 40 CFR Part 58, Appendix A, section 2.3.1.5 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.2
<i>Bias (using 1-point-QC checks)</i>	<i>Calculated annually and as appropriate for design value estimates</i>	<i>95 percent confidence limit $\leq \pm 10$ percent</i>	1) 40 CFR Part 58, Appendix A, section 2.3.1.5 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.3

Handbook for Air Pollution Measurement Systems, Volume II, referred to as the QA Handbook. As described in the QA Handbook and implemented here, for SO₂, 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 determining the validity of the data, i.e., operational criteria; and
- Criteria that indicate a potentially systematic problem with the environmental data collection activity that may affect 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 SO₂ monitoring. The DAQ defines warning limits as the level of allowable imprecision before the RRO monitoring technician must calibrate an analyzer or take other corrective action. The DAQ sets the warning limits lower than the MQOs or control limits to reduce imprecision and bias and enhance data recovery.

The DAQ defines control limits as the level of allowable imprecision before data invalidation and corrective actions are required. The DAQ cannot set control limits higher than the MQOs. The DAQ uses these limits when validating ambient air measurements against single point precision checks. The use of control limits strengthens the precision of these measurements and improves the data validation practices to meet regulatory requirements. Table 7.2 includes both the warning and control limits.

Other elements, as well as the SOPs associated with this QAPP that are specific to the SO₂ monitor provide more detailed descriptions of these MQOs and how they will be used to control and assess measurement uncertainty.

7.3 Type of Data Needed

- All data should be traceable to a National Institute of Standards and Technology, or NIST, primary standard.
- All data shall be of a known and documented quality. Two major measurements used to define quality are precision and bias. Refer to Section 7.2 Measurement Quality Objectives for definitions of the metrics 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 should achieve this goal.
- All data shall be representative of the parameters measured with respect to time, location, and the conditions from which DAQ obtains the data. The use of approved standard methodologies should ensure that the data generated are representative.
- All data shall be as complete as possible and DAQ will supplement the data, as needed, using either a collocated data logger for shelter temperature or data stored in the monitor for SO₂; and

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

7.4 Overall Project Objectives

The purposes of the PWEI SO₂ monitoring in North Carolina are to:

- Determine one-hour average concentrations of SO₂ to ensure the daily maximum hourly average NAAQS for SO₂ of 75 parts per billion, or ppb, (99th percentile of 1-hour daily maximum concentrations averaged over 3 years) is not exceeded in areas of the state with both high population and high SO₂ emissions.
- Determine one-hour average concentrations of SO₂ to ensure the three-hour average NAAQS for SO₂ of 0.5 parts per million, or ppm, (maximum three-hour average for the year) is not exceeded in areas of the state with both high population and high SO₂ emissions.

8.0 Training Requirements

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. DAQ personnel will meet the educational requirements, accountability standards and training requirements for their positions. DAQ requires all staff to take specific, mandatory governmental training courses, such as safety training, defensive driving and harassment awareness courses, among others. The DAQ maintains records on personnel qualifications and training in several locations, dependent upon the applicability of the information. For example, staff may maintain copies of certificates received from classes or workshops, whereas human resources will keep records of personnel qualifications.

The DAQ aims ambient air monitoring training at increasing the effectiveness of employees as well as the effectiveness of DAQ. In general, training for the ambient-air monitoring program consists of a combination of required reading, monthly ambient monitoring workgroup calls, active cross training amongst staff, completion of EPA-led training classes and attendance at DAQ and EPA workshops and conferences. Observations made during internal systems audits or EPA technical systems audits, 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 typically document required reading on a form indicating the employee has read and understood the QAPP or SOP; however, at the time of this QAPP revision the chief is working with DEQ to develop alternate procedures.

All positions have a training guide that provides suggested training for employees to complete to achieve competency in that position. The DAQ makes efforts to ensure the 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 RCO chemists to provide hands-on training. The employee documents this training in the employee's VIP or the North Carolina Learning Management System, or LMS.

The DAQ supervisors actively encourage all employees to pursue training opportunities whenever possible and as needed, because the chief continually evaluates DAQ's PWEI SO₂ monitoring network to ensure it continues to meet its objectives. Because of these evaluations, the chief could add new equipment, procedures or new personnel to the project. DAQ provides vendor-based training for its personnel when DAQ obtains new equipment. The employees document this training in the LMS. Additionally, personnel are encouraged to periodically identify, request, and attend pertinent courses

and seminars. The DAQ may provide these courses and seminars as videotapes, web based real-time interactive formats, closed circuit transmissions, live instruction or a combination of one or more. Organizations that provide these training opportunities include local and regional universities, the Air and Waste Management Association, the Mid Atlantic Regional Air Management Association, and EPA. The DAQ supervisors track this training for their employees in the LMS to ensure air-monitoring personnel have sufficient training to perform necessary functions at an acceptable level. The DAQ supervisors also track and document this training in the VIP. They also evaluate employee proficiency based on performance and feedback from peers. During the VIP review, they also recommend any refresher training that the employee might 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 documented in the LMS.

Monitoring staff provides new monitoring personnel and regional monitoring technicians the necessary on the job training for their individual monitoring tasks, including data review, verification and validation. The employee documents all on-the-job training in the LMS. The chief invites the regional monitoring coordinator and technicians to the North Carolina DAQ ambient monitoring workshop held each year. This workshop provides an opportunity to discuss and train on monitoring and the QC and QA processes, including data review and verification, to ensure the collection of valid data. A senior staff member provides hands on instruction with the analyzers as on the job training when new employees are hired. The vendor provides training when DAQ purchases new monitors and other equipment. The DAQ and EPA staff provides training annually during the monitoring workshop.

DEQ - DAQ Training Links

Air Monitoring: <http://www.epa.gov/ttn/amtic/training.html>
Professional Skills: <http://oshr.nc.gov/state-employee-resources/training>

9.0 Documentation and Records

The following information describes DAQ's management of documents and records, including this QAPP, for the PWEI SO₂ monitoring program. The chief serves as the document custodian by managing the documents and records. The chief must approve QAPP and SOP revisions, including changes to forms, before monitoring personnel use them. The DAQ also ensures adequate document control of all these records. The DAQ secures all electronic documents on encrypted laptops or password protected computers and 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	Raleigh Central Office
	Quality Management Plan	DEQ Website
	Organizational structure	Ambient Monitoring Administration Page on SharePoint
	Personnel qualifications and training	DEQ HR and DAQ Training page on SharePoint
	Training records and certification	Learning Management System and Value In Performance
Site Information	Network descriptions Site files Site maps Site pictures	Raleigh Central Office group drive, Raleigh Regional Office group drive or SharePoint page, IBEAM General Documents Module
Environmental Data Operations	Quality Assurance Project Plans	DEQ Website for official repository. Other file locations may include IBEAM General Documents Module for archived versions, North Carolina Ambient Monitoring Section QAPP page on SharePoint or Raleigh Central Office group drive (see below)
	Standard Operating Procedures	DEQ Website , IBEAM General Documents Module (see below)

Table 9.1. Documentation and Records Information

Categories	Record/Document Type	File Locations
	Field and site notebooks	Raleigh Central Office group drive, Raleigh Regional Office group drive or SharePoint page, Durham Armory Site
	Inspection, Maintenance and Equipment Records	Raleigh Central Office group drive, Raleigh Regional Office group drive or SharePoint page, ECB
Raw Data	Any original data (routine and QC) Including data entry forms	Raleigh Central Office, Raleigh Regional Office, ECB
Data Reporting	Air Quality Index Reports	DAQ Website , IBEAM General Documents Module
	Annual Data Certification Report	IBEAM General Documents Module
	Data/summary reports	DAQ Website , IBEAM General Documents Module
	Journals/articles/papers/presentations	Raleigh Central Office group drive, IBEAM General Documents Module
Data Management	Data algorithms Data Management Plans/Flowcharts Data Management Systems	Raleigh Central Office
	Pollutant data	Envista ARM database
	Meteorological data (from North Carolina State Climate Office) Traffic data (from North Carolina Department of Transportation)	Raleigh Central Office group drive, Raleigh Regional Office group drive, IBEAM
Quality Assurance	Network reviews Control charts Certification Documentation Data Quality Assessments Quality Assurance Reports EPA Technical System Audits Response/corrective action reports Site audits E-mails relating to QA activities and assessments	Raleigh Central Office, Raleigh Regional Office and ECB, IBEAM General Documents Module

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

Most documentation and records produced by DAQ's PWEI SO₂ monitoring program consist of data and information gathered to support the data collection activities. Documentation and records include:

- QAPPs;

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

Section 19.0 Data Management contains detailed information regarding how DAQ will manage data from the PWEI SO₂ network, including information on data recording, transmittal, storage and retrieval.

9.1 Statewide Policy and Procedure Documentation

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

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

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

In addition, at the time of this QAPP revision, DAQ uses the P drive and SharePoint as repositories for working documents. Draft documents will be watermarked as *DRAFT* so that no confusion arises as to the finality of an SOP. The QAM or designee receives final versions for review and approval. Once 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 on the next ambient monitoring work group call. The chief and RCO chemists are streamlining these procedures and will revise the QAPP when they implement a new framework.

The chief electronically distributes all these records and documents to the PWEI SO₂ monitoring team and posts them to IBEAM in the “general documents” module, SharePoint and/or on the DAQ website. When a newer version of a document supersedes an older version, the replacement document clearly states the effective date of the document. The chief notifies all members of the PWEI SO₂ monitoring team of the availability of a new version and its location in IBEAM, on the DAQ website and in SharePoint.

DAQ retains copies of current program policy and procedure documents in electronic portable document format, or pdf, in the IBEAM general documents module. The DAQ limits access to a read only status. When the chief replaces an older version with a newer version, the older version is clearly marked as being obsolete in IBEAM and retained for archival purposes. In this manner, DAQ keeps

available older versions of the policy or procedure, in case someone needs to revisit procedures from a specific period in the past.

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 Data Collection Method Requirements for additional information.

The RRO monitoring technicians and coordinator, ECB electronics technicians, RCO chemists and other DAQ personnel shall fill out information in the e-log and the site visit logbook. The monitoring staff will fill out the site logbook in indelible ink. In addition, the ECB electronics technicians will fill out in indelible ink field-data records, including instrument maintenance logs and 109 forms. 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

The RRO monitoring technician will be responsible for obtaining, maintaining and documenting the appropriate logbooks or associated QA/QC data forms. The PWEI SO₂ monitor has an e-log created specifically for that monitor. The e-log contains all data entry forms required by a RRO monitoring technician to document all routine operations. After each use, the RRO monitoring technician uniquely numbers these e-logs by giving them a specific file name before saving them to a storage device such as a laptop computer. From the laptop computer, the RRO monitoring technician will transfer the e-log to the RRO group drive or SharePoint page. The RRO monitoring technician will use these e-logs to record information about the site operations, as well as document routine operations. The ECB electronics technicians will fill out instrument maintenance logs and 109 forms.

The RRO monitoring and ECB electronics technicians must complete e-logs, instrument maintenance logbooks and 109 forms associated with all routine environmental data operations, are required even when the site logbooks contain all appropriate and associated information required for the performed routine operation.

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 RRO 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 e-logs capture monitor maintenance and QA/QC activities, including calibrations.

9.2.2 Electronic Data Collection

The SO₂ analyzer can 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 RRO monitoring technician would record on data entry forms. To provide a backup, the PPB staff will store electronic copies of the automated data collection information (daily poll) for an appropriate period on the RCO group drive. Electronic backup copies of automated data collection information will also be stored on the site computers, in the regional offices and in the RCO or the western data center operated by the DIT.

9.3 QA/QC Records

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

- Technical systems audits,
- Internal systems audits,
- One-point-QC checks,
- Zero and span checks,
- Verification/calibration procedures,
- Maintenance activities,
- Annual performance evaluations,
- EPA performance audits such as the National Performance Audit Program, or 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 Excel spreadsheets, fillable PDF data forms, worksheets and data management systems such as Envidas 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. The DAQ corrects records either by crossing out the incorrect information with a single line and entering the correct information followed by the person's initial or by creating a revised form from the original with the correct information, retaining both forms. The RRO monitoring technician or coordinator names the revised document following naming conventions in SOP 2.8.2.

However, for some of the QA/QC activities described above – such as the traceability certifications – the ECB retains many of those records at the ECB shop located at 670 Maywood Avenue, Raleigh, NC. For example, the vendors typically provide the certificates of analyses that accompany gas cylinders in paper format, which the ECB stores in a file in the office. Records for internal certifications of the calibrators used in the field and for audits are stored electronically on the group drive. The chief and RCO chemists

are currently reviewing this record retention process and will revise the QAPP when they implement a new process.

9.4 Reference Materials

Because of the technical nature of ambient air monitoring, DAQ requires numerous reference materials to administer the PWEI SO₂ 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 network-server group-drive.

9.5 Data Archiving and Retrieval

The DAQ classifies documentation according to its intended use, future applicability and regulatory requirement for retention. The DAQ will retain all the information listed in Table 9.1 for four complete calendar years from the date of collection in accordance with [2 CFR Section 200.333](#). However, if any litigation, claim, negotiation, audit or other action involving the records has been started before the expiration of the four-year period, DAQ will retain the records until completion of the action and resolution of all issues that arise from it, or until the end of the regular four-year period, whichever is later.

DAQ stores electronic records within the data management systems located at the PWEI SO₂ site, or Envidas, the RCO, or Envista ARM, and on network servers in the RRO and RCO. The DIT backs up data stored in Envista ARM as well as records on the network server in the RRO and RCO nightly and stores these back-ups off-site. The database manager regularly backs up the Envista ARM database to the RCO network drive.

10.0 Network Description

The primary function of the PWEI SO₂ monitoring program is to measure the one-hour averaged concentrations of SO₂ in the areas of North Carolina with high population and high SO₂ emissions to verify compliance with the NAAQS. The program also provides real-time data to the public and the EPA and DAQ may use the data to determine trends over time.

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

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

10.1 Network Objectives

The chief designed the PWEI SO₂ monitoring network to determine the concentrations of SO₂ in CBSAs with both high SO₂ emissions and large populations and to meet the monitoring objectives provided in Section 6.0 Project/Task Description. The PWEI SO₂ monitoring network uses the siting criteria specified in 40 CFR Part 58, Appendices D and E, to establish the appropriate monitoring location necessary to meet these objectives.

The DAQ has assigned the State and Local Air Monitoring Station, or SLAMS, monitor within the PWEI SO₂ monitoring network both of the following monitoring objective designations: General Background and Population Exposure.

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 data obtained with the spatial scale most appropriate for the monitoring objective of the station. For a discussion of the representative measurement scale for the PWEI SO₂ monitoring sites, see Section 6.0 Project/Task Description.

10.2 Site Selection

Currently, DAQ is only required to operate one PWEI SO₂ site. This site is located at the Durham Armory, AQS ID 37-063-0015, located at latitude 36.032955 and longitude -78.904037 and is for the monitoring of the Durham-Chapel Hill MSA. The Durham Armory site also monitors for ozone and particulate matter. Figure 10.1 shows an aerial view of the location. The monitoring probe is located 41 meters south of Stadium Drive and 3.87 meters above the ground. The closest permitted source of sulfur dioxide to the Armory site is Carolina Sunrock, located 3.25 kilometers southeast of the site. Carolina Sunrock reported emitting 2.7 tons of sulfur dioxide in 2016. The network plan contains additional information on the site.



Figure 10.1 Durham CBSA PWEI SO₂ Monitoring Station Location, purple balloon

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

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

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

10.2.1 Site Location

The DAQ considered four criteria when evaluating potential PWEI SO₂ monitoring sites:

- Location of potential pollution sources,
- Topography of the area,
- Predominant wind direction in relation to any potential pollution sources, and
- Potential population exposure.

Selection per these criteria requires detailed information concerning the types and location of pollutant sources, geographic variability of ambient pollutant concentrations in the background environment, meteorological conditions and population density. The calculated PWEI index for each CBSA determines the number, geographic locations and types of PWEI SO₂ stations. 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 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 DAQ considers meteorology in determining the geographic location of a PWEI site as well as the height, direction and extension of sampling probes. Evaluation of a local wind rose is essential to locate PWEI monitoring sites properly.
- **Topography** – The DAQ evaluated the local topography based upon land use maps, U.S. Geological Survey topographic maps, and other available resources. The DAQ also identified and evaluated minor and major topological features that affect both the transport and diffusion of SO₂. Minor features may include an adjacent tree lined stream or tall structures upwind or downwind of a point source, each of which may exert small influences on SO₂ dispersion patterns. Major features include river canyons or deep valleys, mountain ranges, and large lakes. Major features significantly affect the prevailing wind patterns or create their own local weather such as katabatic or anabatic winds.
- **Pollutant Considerations** – The monitoring site location for a specific pollutant may or may not be appropriate for another pollutant. The DAQ evaluated the changes that SO₂ undergoes temporally and spatially to determine the applicability of each potential PWEI site for SO₂.

An interdependence exists between all the factors listed above. Consequently, the DAQ employed an iterative procedure to select appropriate sites that can provide the data necessary to accomplish the 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. The Ambient Monitoring Section shares these responsibilities with staff throughout DAQ.

10.2.2. Monitor Placement

General inlet siting criteria for monitors at PWEI SO₂ monitoring sites shall adhere to the requirements in 40 CFR Part 58, Appendix E. Final placement of a monitor at a selected site is dependent on physical obstructions and activities in the immediate area. The ECB electronics technicians must place monitors away from obstructions such as trees and fences to avoid their effects on airflow. To prevent sampling bias, airflow around monitor sampling probes must be representative of the general airflow in the area. In addition, the availability of utilities (i.e., electricity and telephone services) is critical.

10.3. Data Collection Frequency

The EPA establishes the minimum sampling frequencies of the monitors. The DAQ follows the EPA's requirements for the sampling frequencies of monitors. The monitors used in the PWEI SO₂ monitoring project collect a measurement every minute. The data acquisition system, or DAS, aggregates the minute averages into five-minute and hourly averages. The DAQ ensures each monitor collects at least the minimum amount of data required to calculate the appropriate summary statistics. At least 75 percent of the total possible observations must be present before summary statistics are calculated. The exact requirements appear 40 CFR Part 50, Appendix T and in Table 10.1. Table 10.2 provides the sampling schedule and frequency.

Table 10.1 Requirements for Calculating Summary Statistics.

Pollutant	Completeness Requirement	Time Frame
SO ₂	75 percent	Per 5-minutes, hour, day, quarter and year

Table 10.2. Monitoring Sampling Schedule and Frequency

Pollutant	Time Frame	Frequency
SO ₂	Hourly (60 minutes/hour) and 5-minute averages	24 hours a day/7 days a week

10.4. Rationale for DAQ's Population-Weighted Emission Inventory Sulfur Dioxide Monitoring Network

The primary rationale for the operation of the PWEI SO₂ monitoring network is to measure hourly concentrations of SO₂ to determine compliance with the NAAQS and provide the public with information on current air quality.

11.0 Data Collection Method Requirements

11.1 Data Collection Method for Sulfur Dioxide

In accordance with 40 CFR Part 58, Appendix C, Section 2.1, a criteria pollutant monitoring method used for making NAAQS decisions at a SLAMS site must be a reference or equivalent method. Towards that end, the DAQ uses only EPA-approved FRM or FEM instrumentation to measure SO₂ at the PWEI SO₂ monitoring site currently in operation. Criteria pollutant analyzer methods that have received FRM or FEM status have been rigorously tested, in accordance with 40 CFR Part 53 requirements, and found to meet or be comparable to the EPA reference methods codified in 40 CFR Part 50. For the detailed specifications upon which a specific monitoring method has received its FRM or FEM status, see the [List of Designated Reference and Equivalent Methods](#), issued by the EPA Office of Research and Development and available on the Ambient Monitoring Technology Information Center, or [AMTIC website](#). The DAQ will operate the SO₂ analyzer in accordance with these designation specifications. To ensure the monitor meets these specifications DAQ uses the criteria in the validation template in Table 7.2. This data collection method uses real-time or near real-time (continuous) analysis of the ambient air. As a result, the DAQ does not collect physical samples. The analyzer performs “in situ” analysis of the composition of the ambient air within the analyzer itself using a specific method. This subsection describes the data collection method used in the PWEI SO₂ monitoring network. Table 11.1 lists the analyzer used in the PWEI monitoring network. The SO₂ monitor is designated as a FEM.

Table 11.1. DAQ PWEI SO₂ Monitoring Network Analyzers

Pollutant	Analyzer	EPA Reference/Equivalence
Sulfur dioxide	Thermo Environmental Instruments, Inc. Model 43i	EQSA-0486-060
Indoor Shelter Temperature	Comet temperature transmitter, primary HOBO as backup	No FRM or FEM

11.1.1. Sulfur Dioxide (Ultraviolet Fluorescence)

The PWEI SO₂ monitoring network uses Thermo 43i SO₂ analyzers. These analyzers use ultraviolet, or UV, fluorescence. The physical principle used in SO₂ measurement relies on exciting an electron shell of a SO₂ molecule, which occurs in the presence of a specific wavelength (214 nanometers) of UV radiation, and the subsequent relaxation, which produces a photon of light. A photo multiplier tube measures the light emissions as the SO₂ molecule returns to the ground state. The intensity of this light is proportional to the quantity of SO₂ present in the ambient air. A reference detector continuously monitors the intensity of the UV lamp, used to excite the SO₂, and allows use of a ratio metric measurement technique that compensates for lamp degradation. A hydrocarbon scrubbing system, containing no consumable material, removes interfering hydrocarbons prior to the ambient air entering the measurement chamber.

11.1.4. Indoor Shelter Temperature

The DAQ measures shelter temperature using a Comet temperature transmitter. The sensor measures temperature in the range of - 30 to + 80 °C with an accuracy of ± 0.4 °C and resolution of 0.1 °C. The DAQ collects shelter temperature measurements every minute. The DAQ collects backup temperature measurements using a HOBO data logger and temperature sensor. The RRO monitoring technician downloads data from the HOBO at least once a month and archives the data. The data verifiers and validators only use the HOBO data when the Comet data are unavailable.

11.2 Data Collection Methodology

Table 11.2 lists the specific SOP titles used in the network.

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

Section 2.3.3 Certification and Accuracy Check of Field Barometers and Thermometers, Revision 7, Nov. 1, 2011
Section 2.3.4 Thermo Environmental Model 146C Calibrator Certification, Revision 12.2, Sept. 17, 2014
Section 2.3.5 Zero Air Pack Certification and Auditing, Revision 14, September 1, 2018
Section 2.3.6 Protocol Gas Verification for Compressed Gas Cylinders Containing Either SO ₂ , NO or CO, Revision 0, Nov. 30, 2009
Section 2.8.1 Sulfur Dioxide SOP for the Electronics and Calibration Branch, Revision 10, Nov. 1, 2016
Section 2.8.2 Sulfur Dioxide SOP for Operators, Revision 12, Nov. 1, 2016
Section 2.39 SOP for Preparing SOPs for the DAQ, Revision 0, Nov. 1, 2010
Section 2.41.3 Regional Office Polling and Data Review: Envidas set-up; Retrieval, Review, Correction and Storage of Data; Report Submission; QA SOPs, Revision 0, March 31, 2018
Section 2.41.4 Data Review and Validation for Continuous Gaseous and Non-Speciated Particulate Matter Monitors, RCO Responsibilities, Revision 1.6, Oct. 15, 2014
Section 2.43 SOP for Completing the Annual Network Review for the DAQ, Revision 2, Sep. 29, 2017
Section 2.61 SOP for Quarterly Completeness Data Review, Revision 0, February 27, 2019

Electronic data collection is possible for the continuous monitors through the network's DAS, which is currently Envidas Ultimate, and wireless modems. This equipment is in a shelter where the DAS records the data history and the modem provides a path to download the data for analysis. The database manager configures the computers in the state's RCO or in the Western Data Center, managed by DIT, to connect automatically to the station at least hourly to retrieve these data for analysis. Monitoring personnel can contact the station remotely to retrieve data through the DAS or determine the status of the systems. The Envista ARM data software sends all data to AirNow-Tech and the IBEAM database for real time reporting of ambient concentrations and the AQI to the public via EPA's AirNow website and the DEQ real-time web page.

11.3 Support Facilities

This subsection describes the monitoring shelters used in the PWEI SO₂ 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 data collection integrity and allow the RRO monitoring technicians, who operate the site, to safely and easily service and maintain the equipment. The DAQ 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 house the PWEI SO₂ analyzer in a shelter capable of fulfilling the following requirements:

- The RRO monitoring technicians 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 ± 10 percent from 117 alternating current voltage. The ECB electronics technicians should provide some type of voltage regulation to accomplish this, if needed.
- The shelter must protect the instrumentation from precipitation, excessive dust and dirt; provide third wire grounding as in modern electrical codes and meet federal Occupational Safety and Health Administration regulations.
- The RRO monitoring technician must clean the shelter regularly to prevent a buildup of dust.
- The shelter must protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light or radiation.

At the Durham Armory site, the DAQ uses a wooden shelter. The ECB electronics technicians use a single probe line to provide ambient air to the monitor. They insulate and wrap the probe lines in heat tape to reduce condensation. In addition, the ECB electronics technicians attach the probe lines to a PM filter to prevent contaminants from entering the analyzer. Typically, the ECB electronics technicians locate the filter within the protected shelter, between the probe inlet and the analyzer. The analyzer draws ambient air from the probe inlet. The probe material and probe line must be either borosilicate glass or an acceptable inert plastic, such as polytetrafluoroethylene, perfluoroalkoxy, or PFA, or other Teflon™-type materials.

The ECB electronics technicians use Teflon™ probe lines to ensure the probe material is non-reactive with SO₂. The probe, intake vent and interconnecting tubing design must provide a minimum number of bends to avoid particles hitting and sticking to the surfaces. Impacted particles may provide surfaces to which SO₂ 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 analyzer. Any liquid water will absorb pollutants, affecting the SO₂ concentration by removing it from the ambient air, and consequently, yielding inaccurate environmental data.

The residence time in the probe must be 20 seconds or less. The RRO monitoring technician 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 will modify the physical configuration to fix this deficiency. They may accomplish this by reducing the length of interconnecting tubing, increasing the length of tubing and/or decreasing the number of bends in the tubing between the probe and analyzer, or other alterations that allow the system to meet the residence time requirements.

The ECB electronics technicians replace all probes and probe lines at least once every two years or as needed when something damages or contaminates the line. Based on years of monitoring experience and evaluation of the data, DAQ has not observed any problems with probe lines between one and two years except in situations where other problems occurred. Situations that may cause probe problems include 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 Sample Handling and Custody

The PWEI SO₂ monitoring program does not require the RRO monitoring technician to take any samples that would warrant a sample custody procedure. The instrumentation located at the monitoring site directly analyzes the ambient air and reports the SO₂ concentration.

13.0 Analytical Methods

In this document, the DAQ intends the term analytical methods to mean laboratory analytical methods. The PWEI SO₂ monitoring program uses FRMS or FEMS designated as equivalent methods to the FRMs. The reference method is in 40 CFR Part 50, Appendix A-1. The FRMs and FEMs do not use any laboratory analytical methods to complete the analysis of any SO₂ samples. The instrument vendors designed the SO₂ analyzers (Table 11.1) as completely contained monitoring units that do not require additional analytical methods to establish the pollutant's environmental concentrations. The respective operation manuals provide specifics on the SO₂ monitor's analytics. Section 11.1 Data Collection Method also provides a summary of how the monitor works.

14.0 Quality Control Requirements and Procedures

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

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 PWEI SO₂ monitoring network, the DAQ uses QC activities to ensure DAQ maintains measurement uncertainty, as discussed in Section 7.0 Quality Objectives and Criteria for Measurement Data, within acceptance criteria for the attainment of the DQOs. The instrument manual and SOP 2.8.2 provide lists of pertinent QC checks.

The DAQ achieves QC through daily-automated calibration checks, consisting of a zero, span and 1-point-QC check, daily review of instrument measurements, annual, or as needed, multipoint calibrations, monthly operational checks by the RRO monitoring technician, performance evaluations, periodic maintenance, acceptance test procedures, accuracy, bias, precision checks, control charts and other verification techniques. Zero, span and 1-pt QC-checks are required one every fourteen days, but the DAQ chooses to use a goal of daily checks. Data analyzed from monitors in the PWEI SO₂ 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. RRO 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. This multiphase process begins with certifying a calibration or transfer standard against a NIST-traceable authoritative standard. The RRO monitoring technician compares the analytical instrument's measurements to this calibration or transfer standard. If significant deviations, as described in Table 7.2, exist between the instrument's measurements and the calibration or transfer standard's measurements, the RRO monitoring technician adjusts the instrument's response to rectify the analytical instrument's measurements.

The instrument's operations manual and SOP 2.8.2 provide calibration requirements for the critical field equipment. To calibrate the SO₂ analyzer in the PWEI network the DAQ uses a gas dilution system to generate specific upscale calibration points. The ECB electronics technicians established the calibration scales for the SO₂ monitor based on the highest average minute concentrations expected to occur at the site. In Table 14.1 below, the zero and span represent the scale of the monitor. The RRO monitoring technicians generally follow the calibration frequencies in the QA Handbook to calibrate the SO₂

monitors. The selected schedule requires calibration of the SO₂ monitor at installation, when the 1-point-QC check fails, when the monitor is without power for 72-hours, after major maintenance and once every 365 days and calendar year. The RRO monitoring technician adjusts the zero and span points during a calibration. These points have tight acceptance ranges, between which the analyzers' measured values must fall. After the RRO monitoring technician calibrates the monitor by adjusting the zero and span, he or she verifies the calibration by repeating the zero and span points and running two additional points and performing a linearity check. The RRO monitoring technician then performs zero and span checks, ideally automated checks each night, but at least every 14-days to demonstrate the monitor remains calibrated within the specified criteria. The instrument's operations manual and SOP 2.8.2 provide specific calibration requirements for the SO₂ analyzer. Table 14.1 provides a summary of the control limits for these requirements. The zero and span levels in Table 14.1 represents the range over which the DAQ calibrates.

Table 14.1 Acceptance Criteria for Calibrations and Daily Auto-Checks

Sulfur dioxide (SO ₂)					
Operation	Concentration / Acceptance Criteria	Span			
		Zero	Span	Midpoint	1-Point-QC
Daily Auto- Check	Concentration (ppb) ^A	0	400	Not Applicable	20
	Acceptance (+/-)	3.1 ppb	10.1 percent	Not Applicable	10.1 percent
Calibration	Concentration (ppb) ^A	0	400	100	20
	Acceptance (+/-)	1 ppb	5 percent	5 percent	7 percent
	Linearity Test	slope must be 1 ± 0.05 ; each point must be within 2.0 percent of the best fit line or ± 1.5 ppb whichever is greater			

^A Nominal values

Currently, the DAQ SO₂ calibration procedure does not use four upscale points for the linearity verification as recommended by the EPA. For SO₂, the DAQ uses zero and three upscale points. The DAQ will retain the use of three upscale points but has recently revised its procedures to include linear regression analysis. The DAQ is currently reviewing and revising the SOP to incorporate the new calibration procedures. The DAQ will submit QAPP revisions, if needed, after the DAQ completes the revision of the calibration procedures in the SOP.

14.2 Precision Checks

The EPA defines precision as the measure of agreement among individual measurements of the same property, usually under prescribed similar conditions. To meet the DQOs for precision, DAQ will ensure the entire measurement process is within statistical control. The DAQ will employ various tools in evaluating and monitoring precision measurements. For SO₂ and pursuant to 40 CFR Part 58, Appendix A, Section 3.1.1, a one point QC check or auto precision/zero/span or PZS must be performed at least once every 2 weeks on each continuous analyzer used to measure gaseous pollutants. The 1-point-QC

check will provide evidence of deviations from the required precision measurement as described in 40 CFR Part 58, Appendix A, Section 3. The ECB electronics technicians set up equipment at the site to challenge the analyzer with a NIST-traceable, QC check gas of a known concentration that is representative of the mean or median concentrations within the DAQ network of monitors. At the PWEI monitoring site the QC check gas concentration must be between the prescribed range of 5 and 80 parts per billion (ppb) for SO₂ per 40 CFR Part 58, Appendix A.

For SO₂, the DAQ uses only automated checks. The equipment at the site typically performs an auto PZS check daily. The RRO monitoring technicians typically refer to the automated check as either an “auto PZS” or “PZS”, or a 1 point QC. The RCO chemists use all of these terms in the statewide instrument SOPs. Automated checks must include a precision measurement, but also include the span and zero. For each check, the DAS calculates a percent difference and compares it to the acceptance criteria established in Table 7.2 and as specified in the SOP. Table 14.1 summarizes this information. The regulations at 40 CFR Part 58, Appendix A, Section 4.1.1 provide the calculation for the precision measurement (i.e., percent difference) and the RCO chemists also embed this calculation in the e-logs used by the RRO monitoring technicians. Precision checks (1-point QC and PZS) verify or confirm the analyzer is in good working order and therefore support the defensibility of the data.

The RRO monitoring technician must perform a calibration if the 1-point QC check or PZS fails and the calibration and analytical equipment are working properly. Normally, if either of these checks fails, a problem exists within the monitoring system that needs addressing, i.e., the equipment needs maintenance or repair. If the zero check or span check exceed the specifications in Table 14.1, then the RRO monitoring technician will perform a calibration after diagnosing the equipment failure, getting it repaired, and ensuring the instrument operates properly.

However, if a typical slow drift causes the check to fail, no routine maintenance may be necessary. The drift may simply indicate it is time to recalibrate the analyzer. The DAQ staff do not adjust ambient concentration data to correct for zero drift. A failure at the zero or span points will require investigation and if deemed appropriate, based on a weight of evidence approach, the RRO monitoring technician will invalidate the data based on the failed check.

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 or precision and systematic error, or bias. The DAQ will also monitor data integrity with control charts to provide evidence of deviations from the required precision measurement. The instrument’s operations manual and SOP 2.8.2 provide precision requirements for the SO₂ analyzers. Bias calculations follow the procedures described in 40 CFR Part 58, Appendix A, Section 4.1.3.

14.3.1 Annual Performance Evaluations

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 ECB electronics technicians use a different gas cylinder and calibrator to complete the audit than the gas cylinder and calibrator used to calibrate the monitor and complete the daily 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 SO₂ monitor, to do the annual performance evaluations using dedicated QA equipment. The instrument's operations manual and SOP 2.8.1 provide details for implementing annual performance evaluations. The EPA has designed these checks to access the accuracy and measure the bias.

14.3.2 External Agency Audits

The DAQ participates in the EPA Ambient Air Protocol Gas Verification Program and the NPAP. Information regarding the frequencies and acceptance criteria for the NPAP audits is available in Tables 6.1 and 7.2. Information on the NPAP is available at <https://www3.epa.gov/ttn/amtic/npepqa.html>.

14.4 Corrective Actions

All DAQ personnel take corrective action measures as necessary to ensure the DAQ attains the MQOs. Given the diversity of monitoring activities and the complexity of the instrument, a potential exists that issues may arise with the sampling and measurement system. In the PWEI SO₂ monitoring network, the DAQ has anticipated many of the issues in advance, and prepared and equipped its staff to address these issues as they arise.

However, the staff will encounter unexpected or unforeseen circumstances, such as a failed QA/QC check, so they will also need to implement corrective actions on an "as-necessary" basis. The DAQ SOPs contain examples of corrective actions that the staff may need to complete under certain circumstances. The RRO monitoring technician should consult SOP 2.8.2 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 RRO monitoring and ECB electronics technicians and RCO chemists report the need for corrective actions to the appropriate monitoring coordinator or supervisor within two business days and address the issue as soon as possible, ideally within five business days. The RRO monitoring technician, 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	Zero/Span/1-point-QC check exceeds acceptance criteria; Monitor/Program	1) Verify / reproduce performance check findings (e.g. Zero, Span and Precision). Use an alternate transfer standard to confirm failures. 2) Perform alternate performance checks to determine cause (for example – filter change and leak tests). 3) Replace solenoid and send old solenoid to ECB for testing. 4) Recalibrate the monitor using SOP 2.8.2.

	fails to meet operational or critical criteria	5) Identify any required procedural changes to prevent reoccurrence. 6) Document actions on audit worksheet, data sheet or logbook as appropriate. 7) Notify the chief of performance audit failures as soon as practical.
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.
Data Review	Data missing from data acquisition system (DAS)	1) Verify DAS operation. 2) Ensure monitor polling is current. 3) Isolate telecommunications problem by connecting to the monitor using alternate processes. 4) Verify monitor operations remotely. 5) Notify the database manager or ECB, as appropriate. 6) Perform site visit to resolve monitor or telecommunication issues.

14.5 Documentation

The RRO monitoring technicians will document all events including routine site visits, calibrations, analyzer maintenance and calibration equipment maintenance in e-logs. The ECB electronics technicians will document all their activities in the site logbooks and on 109 forms. They will also write in indelible ink field maintenance activities associated with equipment used by the RRO monitoring technician in dedicated instrument logbooks as well, which are stored at the ECB. The records generated by the RRO monitoring technician or at the monitoring site will normally be controlled by the RRO ambient monitoring coordinator and located in the field site when in use or at the regional office when being reviewed or used for data verification. The regional coordinator transfers these records to the RCO group drive for RCO chemists to use to validate the data. At the time of this QAPP revision, the RCO chemists plan to review these processes to improve and streamline them. They will update this QAPP when they finalize the revisions.

15.0 Equipment Testing, Inspection, and Maintenance Requirements

15.1 Purpose/Background

Preventative maintenance is a foundational element to an effective QA program. The ECB in the Maywood facility maintains 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 RRO 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 RRO monitoring and ECB electronics technicians must document and file all instrument inspection and maintenance activities. See Section 9.0 Documentation and Records for details.

15.2 Testing

At the time of this QAPP revision, the DAQ is revising the testing procedures to clarify and streamline them. For all SO₂ monitors used in the PWEI monitoring network the DAQ shall purchase equipment listed on the EPA's List of Reference or Equivalent Methods. Therefore, the DAQ assumes the monitors and procedures used to be of sufficient quality for the data collection operation. Table 11.1 identifies the model designations. For 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 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.

Before the ECB electronics technicians install the monitors at the PWEI SO₂ site, the ECB electronics technicians assemble and operate newly purchased or repaired monitors at the ECB. The analyzer shall successfully undergo zero/span and multi-point calibrations as described in SOP 2.8.1. If the monitor meets the acceptance criteria, the ECB electronics technician allows it to operate in the shop until he can confirm functionality. If any of these checks are out of specification, the ECB electronics technician will contact the vendor for initial corrective action. The ECB electronics technician will not deploy an analyzer to the field until it has successfully passed all required checks. SOP 2.8.1 provides further information on the instrument specific testing those new and recently repaired SO₂ analyzers must undergo. Following site installation, the ECB electronics technicians will initiate, observe and document the successful completion of a zero/span cycle. If the analyzers meet the zero/span acceptance criteria in Table 7.2, the ECB electronics technicians will assume the monitors are operating properly and ready for calibration by the RRO monitoring technician. The ECB electronics technicians will properly document and file these tests in the instrument maintenance logbooks stored at the ECB.

15.3 Inspection

Several items periodically require field inspection. The operations manual and SOPs 2.8.1 and 2.8.2 present detail on these items and procedures. In general, the following inspection activities are used:

- The RRO monitoring and ECB electronics technicians inspect monitoring shelters, probe inlets and other enclosures routinely 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 PWEI SO₂ monitoring station. The calibrator blends zero air with calibration gases to dilute them to the necessary concentrations for conducting routine calibrations, precision checks, including 1-point-QC checks and zero-span-precision checks, and performance evaluations or audits. Zero air systems used by DAQ for conducting these QA/QC checks and audits should be able to deliver 10 liters per minute of air that is free of ozone, NO, NO₂, SO₂, CO and non-methane hydrocarbons to below the instruments' method detection limits. Zero air supplies do not have to be NIST traceable but will be inspected and serviced annually by the ECB electronics technicians to ensure they remain free of contaminants.
- The RRO monitoring technicians and coordinator and RCO chemists and statistician review data collection and data quality each business day. They inspect the data for trends and signs of problems. Data trends that signal inspection would include issues such as frozen numbers for multiple hours in a row or erratic spikes or valleys in 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 RRO monitoring and ECB electronics technicians, who document equipment-operating parameters on the zero-span-precision, calibration and maintenance tracking forms within the e-logs, as well as on performance-evaluation audit forms. During each site visit the regional monitoring technician also does a probe- line integrity check to ensure the probe line remains attached to the monitor, is intact, dry and clear of debris and insects.
- The RRO monitoring technician reviews the site and monitor annually to ensure continuing compliance with 40 CFR Part 58, Appendix E. The RRO monitoring technician documents the review on the site review form.
- The ECB electronics technicians test and inspect spare equipment at the time of purchase or after major repairs and before deployment to the field. When the equipment passes the tests and inspections, the ECB electronics technicians certify it as field ready and store it on a shelf or monitoring bench until deployment.

15.4 Routine Maintenance

The following are general routine maintenance protocols:

- The ECB electronics technicians maintain a limited supply of critical spare parts in the ECB maintenance / 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 RRO monitoring and ECB electronics technicians schedule preventative maintenance ahead of time so they have all parts and tools easily available to complete the tasks and thereby minimize data loss.
- The RRO monitoring technicians typically perform preventative maintenance activities in the field, although the ECB electronics technicians may complete some activities in the shop.

The equipment user manual and SOP 2.8.2 detail routine preventive activities and schedules. The RRO monitoring technicians perform diagnostic checks and document them before and after preventive maintenance. They document these diagnostic checks in the e-log. The RRO monitoring technicians replace all SO₂ instrument particulate matter filters at least monthly.

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, in either the instrument or the software, occurred. The EPA recommends that RRO 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 14.0 Quality Control Requirements and Procedures discusses calibrations in more detail. SOP 2.8.2 describes calibration procedures for the SO₂ analyzer.

The regulations at 40 CFR Part 58, Appendix A, Section 2.6 require that gaseous standards (i.e., gas cylinders) and flow rate standards used in the ambient-air monitoring network be traceable to NIST. The ECB electronics technicians procure and maintain dedicated NIST-traceable standards for the certification of the ambient air quality monitoring systems. These standards provide a direct link to established national standards, i.e. NIST, and are the foundation for the collection of the highest quality ambient air pollution data possible in accordance with current procedures and existing federal regulations and guidelines. 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. The operation manual and SOPs 2.8.1 and 2.8.2 provide specific calibration procedures for and timeframes for certifications of field equipment.

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

- Devices are re-certified at least annually. The DAQ keeps records of these certifications at the ECB and in the regional office.
- Where applicable, in-house certification procedures (i.e., certifying a transfer standard against a certified primary standard - i.e., one of higher authority) are performed using SOPs 2.3.3, 2.3.5 and 2.3.6. The ECB maintains documentation of these procedures in the ECB shop on appropriate forms.
- The RRO monitoring coordinator maintains records of all instrument calibrations, using the traceable standards (with instrument identification numbers clearly documented), on the appropriate group network drives in the RRO and RCO.

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

The following summarizes the standards used in the DAQ network and their recertification process. The RRO monitoring and ECB electronics technicians monitor all certification periods to ensure the RRO monitoring technicians do not use equipment beyond the documented certification expiration dates. The RRO monitoring technicians are responsible for verifying the equipment they use is within certification and contacting ECB at least 30 days prior to being out of certification.

16.1 Calibration of Local Primary Standards

A primary standard has sufficient accuracy such that it does not require calibration by and is not subordinate to other standards. The DAQ uses primary standards to calibrate other standards referred to as working standards. The DAQ uses “local primary standards” or standards certified against NIST-traceable standards and kept in the ECB shop for the sole purpose of certifying transfer standards used in the field to calibrate equipment and verify equipment calibrations. The DAQ owns two “local primary standards” for each type of device. The ECB sends each “local primary standard” to the vendor for recertification in alternate years ensuring that one local primary standard is always available for use and has been certified within 365 days. The vendor provides the DAQ with a certificate of authentication. DAQ staggers the rotation of standards such that one device always remains in certification. The ECB electronics technicians compare the “local primary standard” that did not return to the vendor to the one that did return to the vendor to certify it and use it to certify equipment for the next year.

16.1.1. “Local Primary Temperature Standard”

The ECB uses an Omega Digital Thermometer DPT-1 with a bridge sensor 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.

16.1.2. “Local Primary Flow Rate Standard”

The ECB uses dedicated Alicat mass flow meters as a “local primary flow standard” used to certify the accuracy of the calibrator mass flow meters. This “local primary flow rate standard” is a dedicated unit, and as such, the ECB electronics technicians use it only to certify the accuracy of mass flow meters used in the field. An ECB electronics technician sends them to the vendor for recertification every 365 days.

16.2 Calibration of Transfer Standards

The ECB electronics technicians or device vendor certify all transfer standards against either a primary standard or the “local primary standard.” This establishes the traceability of the calibration.

16.2.1 Temperature Transfer 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 RRO monitoring and ECB electronics technicians expect to use the temperature standard.

16.2.2 Calibrators

The field calibrators are transfer standards that will have their own certification against “local primary standards.” The ECB electronics technicians use Thermo 146i calibrators as the field calibration device and as the audit device for SO₂ monitoring. The ECB electronics technicians certify the mass flow controllers within field calibrators every 12 months and audit calibrators every nine months using Alicat flow measurement units. SOP 2.3.4 Thermo Environmental Model 146C Calibrator Certification contains further details on the certification procedure.

16.3 Calibration Gases

All SO₂ calibration gases must be EPA Protocol (NIST-traceable) and include the following information:

- Cylinder serial number,
- SO₂ concentration,
- Recertification status,
- Gas type,
- Cylinder pressure (double checked upon receipt),
- Impurity concentration, and
- Expiration date.

The ECB electronics technicians service the zero air generators, used at the PWEI SO₂ monitoring site, annually, or more frequently if needed. The calibration gas standards will have their own certifications and will be re-verified or recertified every four years for SO₂ standards by the vendor.

16.4 Documentation

See SOP 2.8.2 for field QC checks that include frequency and acceptance criteria and references for calibration and verification tests of analyzer concentration responses. The analyzer verification checks include 1-point-QC checks at least every 14 days (DAQ does daily checks) and multipoint calibrations at least annually, as documented by tracking on control charts.

The RRO monitoring technicians will document all these events, as well as analyzer and calibration equipment maintenance, in field data records and logbooks and annotate these events with appropriate flags. The RRO monitoring technicians will also keep field activities associated with the equipment they use in record logbooks as well. The RRO monitoring coordinator will normally control the records, which are located in the field site when in use or at the RRO when being reviewed or used for data validation.

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

17.0 Inspection and Acceptance of Supplies and Consumables

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

The RRO monitoring technicians track supplies and consumables (e.g., in-line particulate matter filters); when they need replacements, they notify the ECB. The ECB then supplies the needed items out of its inventory or purchases what the RRO monitoring technician needs. 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 products 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.

Probe 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. A consumable that is critical to the successful operation of the gaseous monitors are the gas cylinders used for calibration and QC checks of SO₂ analyzers, as well as gas cylinders used to conduct internal performance audits. Gas cylinders ordered by DAQ are EPA Protocol Cylinders. The ECB electronics technicians review certificates of analyses upon receipt of new gas cylinders to ensure the cylinder meets purchase specifications. The certificates indicate the expiration date of the gases contained within the cylinders. DAQ abides by these expiration dates; the ECB electronics technicians track dates and usage, replacing cylinders when the RRO monitoring technicians notify them that less than 500 psi remains in the cylinder or before they expire. Additionally, DAQ participates in the EPA Ambient Air Protocol Gas Verification program. This program allows the independent assessment of gas cylinders to ensure their integrity and that of the supplier.

18.0 Non-Direct Measurements

This section addresses data not obtained by direct measurement from the PWEI SO₂ monitoring program. This includes data provided by outside sources and historical monitoring data. The EPA has defined in the regulations some types of data needed for the PWEI SO₂ monitoring program. These types of data and information include:

- CBSA boundaries;
- Census data;
- SO₂ emissions from latest NEI;

In addition to the above types of data, DAQ may also need the following types of data to support the PWEI SO₂ monitoring program:

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

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

19.0 Data Management

19.1 Purpose/Background

The primary work product of the PWEI SO₂ monitoring program is data. Thus, the DAQ requires formalized procedures to ensure successful data management. The following sections describe these procedures. Data management describes an inter-related set of standardized processes used to acquire, transmit, transform, reduce, analyze, store and retrieve data. When documented and followed, a data management system helps maintain the integrity and validity of the data throughout its entire life cycle. DAQ's air monitoring data follows a documented flow path. The data life cycle starts before data collection begins and ends with use of the data. The following subsections identify the processes and procedures the DAQ follows 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 PWEI SO₂ RRO monitoring technicians and coordinator, RCO chemists and statistician and database manager acquire and process the PWEI SO₂ monitoring data. Section 4.0 Project/Task Organization describes staff responsibilities.

19.2 Data Collection and Recording

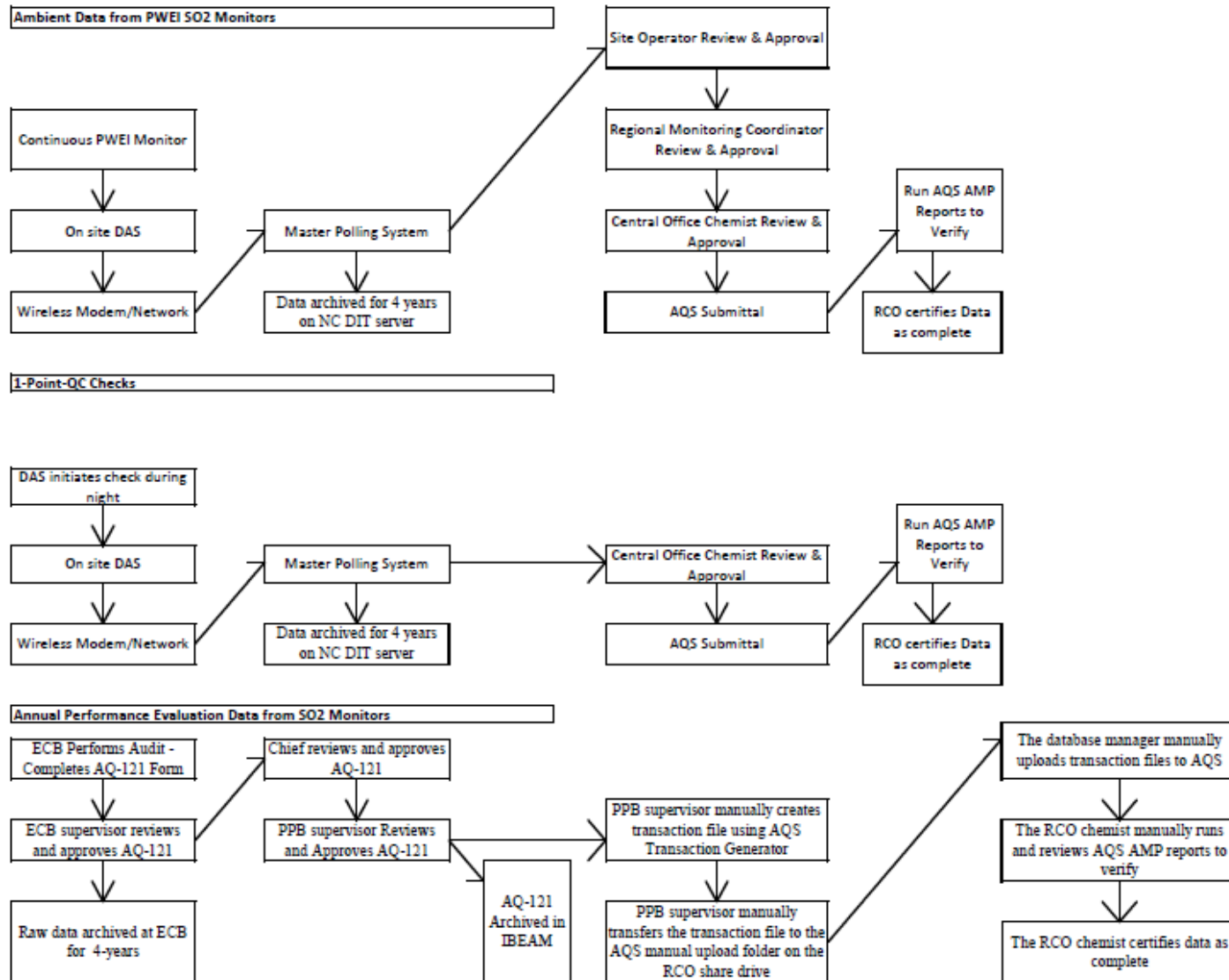
The DAQ will use ambient air monitoring analyzers, which the EPA has designated as FRMs or FEMs to collect data in the PWEI network. Upon installation and at regular intervals as specified, the RRO monitoring technicians calibrate the ambient air monitoring instrumentation in accordance with the SOPs identified in Table 11.2 of this QAPP. Note: When DAQ establishes a new site, the coordinator and ECB electronics technicians manually collect metadata for the site (GPS coordinates, etc.). The database manager maintains the metadata and uploads it into AQS, as appropriate. The RRO monitoring technicians and coordinator review the metadata annually during the network review and update it as needed.

For the DAQ PWEI SO₂ network, DAQ records all raw data electronically. The site computer is equipped with a DAS, called Envidas Ultimate, and a wireless modem used to transmit data to the master polling system, i.e., the Envista ARM data storage database, which is a separate software package located on a state server. The DAS and site computer have the capability to record the output of the monitors at the site, perform any required data transformation and format the resulting data in preparation for downloading to the Envista ARM database or a Microsoft Excel spreadsheet. The Envidas and Envista ARM database do not allow the deletion of raw (i.e., original) data. The DAQ uses the Envista ARM database for data verification, validation and reporting. The database uses replicate versions of the raw data to avoid violating the integrity of the original dataset. The Envidas and Envista ARM databases do not allow the deletion of data and track all changes made to the data. The RRO monitoring technicians and coordinator, RCO chemists and database manager can modify, flag or void data stored in the

Envista ARM “edit” database as needed. The DAS records and makes available an edit history to track changes made to the data.

For all paper documents, the PPB supervisor creates a transaction file manually and archives a scanned copy of the paper document in IBEAM. 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 database manager electronically transfers the data using the transaction file to AQS.

Figure 19.1 PWEI SO₂ Monitoring Data Flow Path



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 sub categories as appropriate. The DAQ defined security at the module level with a range of security options appropriate to staff requirements. Although IBEAM displays systems in a modular format, it stores the data in the background in an integrated data structure managed by the Oracle Relational Database Management System, or RDBMS. This means no duplication of data or data entry and a single point source for reporting and information dissemination.

When DAQ establishes a new site, the RRO monitoring coordinator and ECB electronics technicians collect metadata for the site. The database manager maintains the metadata. The RRO monitoring technician and coordinator review the metadata annually during the network review and update it as needed.

19.3 Data Transmittal and Transformation

Data transmittal is accomplished using wireless communication to access a site modem. Downloading collected data does not delete data from the DAS. The Envidas software removes data from the site computer by overwriting data on a first-in, first-out basis. This configuration requires the Envista ARM software to extract data from the site computer on a regular basis to prevent any data loss. If communications problems arise, the Envista ARM software retrieves the data from the Envidas system when it can once again communicate with the site. The RRO monitoring technician must make a site visit if the database manager or ECB electronics technician informs them that he cannot correct the communications problems in a timely fashion.

The DAS reads instantaneous SO₂ 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 the SO₂ monitors within this monitoring network. The monitors, themselves, as well as the Envidas system averages the stored 1-minute averages to form averaged hourly values, as well as 5-minute block averages, which are the blocks of ambient SO₂ measured concentrations that the database manager submits to the EPA. Envidas transmits all these values to Envista ARM for retention.

19.4 Data Verification and Validation

Data verification and validation is an important routine process that involves several steps to ensure the RRO monitoring technician, coordinator and RCO chemist 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 exceedances, for further analysis or for modeling. Once the RRO or RCO has identified these problems, the RCO chemists, RRO monitoring technicians and coordinator can correct, flag or invalidate the data. If necessary, the RRO monitoring and ECB electronics technicians can take corrective actions. Section 23 contains additional information on data verification and validation.

Each of the network's analytical instruments employed to measure the ambient concentrations of the criteria pollutants undergoes periodic audits, 1-point-QC checks and calibrations. SOPs 2.8.1 and 2.8.2 outline these procedures. Audits and checks ascertain the accuracy, precision and repeatability of each instrument in performing its required function.

The instrument-generated data are stored on site in the DAS. When Envista ARM accesses the data through the wireless modem, it downloads the data into its database, where the data undergo verification, reduction and analysis (level 0). The RRO 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 RRO monitoring technician flags data as questionable, level 2 (preliminary) and 3 (final) reviewers evaluate the flagged data to identify underlying causes and decide whether the data are valid. If the data are invalid, DAQ and the EPA do not use them in calculations. If the data are valid, but flagged due to some extenuating circumstance, then DAQ and the EPA may use the data in calculations, accompanied by a comment documenting the situation.

At the time of this QAPP revision, DAQ is in the process of updating and streamlining its data review procedures and developing new SOPs. The DAQ will revise this QAPP once DAQ implements the new procedures.

19.5 Data Reduction and Analysis

As described in the subsections above, data reduction activities take place throughout the entire data management process. The on-site DAS gathers data from the monitors at the 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 SO₂ data does not require special aggregation. The EPA compares submitted results to the NAAQS for SO₂. The regulations at 40 CFR Part 50 define the quantity of valid data points required within a data set. For most pollutants, the EPA requires a minimum data capture of 75 percent of the interval – hour, day, quarter – for the EPA to consider the interval valid for use in NAAQS comparisons. Table 7.2 summarizes the 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, the RRO monitoring and ECB electronics technicians can download data from Envistas directly into Microsoft Excel spreadsheets. The RRO monitoring technicians, coordinator, RCO chemists and statistician use Microsoft Excel spreadsheets solely for data analysis and in-depth study of the data. For example, each business day the statistician prepares a tabulation of the raw hourly data from the previous day, evaluating it for missing data, trends, and data higher or lower than Tukey's fences for that day, as well as 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 the statistician accomplish these tasks by retrieving several reports, such as the AMP256, AMP430, AMP450 and AMP600, from the AQS database and analyzing the results.

19.6 Data Submission

After the RRO monitoring technician, coordinator and RCO chemist complete all three levels of verification and validation for a month of data, as described in Section 23.0 Verification and Validation Methods, the database manager uploads the data to the AQS database. In addition to hourly data, the database manager or statistician also upload to AQS 5 minute data, annual performance evaluations, and one-point-QC checks. At the end of each quarter, an RCO chemist runs the AMP251, AMP256, AMP350, AMP430 and AMP600 reports on AQS and verifies that the database manager and statistician successfully entered all hourly, annual performance evaluation, and 1-point-QC check data.

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

Upon completion of the certification review, the chief certifies the data by submitting the AQS AMP600 report to the US EPA. The chief submits this report before the annual May 1 due date.

19.6.1 Quarterly Data Submittal to AQS

DAQ shall submit quarterly data, as specified in [40 CFR Part 58](#), to EPA directly via AQS data entry. The database manager and statistician shall submit these data 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, or POC;
- The results of all valid precision, bias and accuracy tests performed during the quarter; and
- The hourly and 5-minute averaged ambient air quality data obtained for SO₂.

The DAQ will also notify the EPA if a monitor does not meet the completeness requirements summarized in Table 7.2.

19.6.2 Annual Summary Reports Submitted to EPA

DAQ shall submit to the EPA an annual AMP600 summary report of all the PWEI SO₂ monitoring data from all PWEI SO₂ monitoring stations designated as a SLAMS in accordance with [40 CFR Section 58.15](#). The DAQ will also submit a signed certification letter on DAQ agency letterhead signed by the chief. The chief will submit the report by May 1 of each year for the data collected from Jan. 1 through Dec. 31 of the previous year. The chief, or designee, must certify the report as accurate to the best of his or her knowledge. The chief will base this certification on the various assessments and reports performed by DAQ, including the annual QA report discussed in Section

21.0 Reports to Management 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 un-alterable record of instrument measurements for a period of months to years depending on the number of monitors operated at the site. The RCO Envista ARM database system automatically accesses data stored in the on-site Envidas system.

The archiving system used by DAQ makes possible the storage and retrieval of the air quality monitoring data. Backup and recovery procedures exist to ensure the RRO 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. He does not routinely test 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. When storage space limits the amount of data that DAQ can keep in the database, procedures exist for moving the data into an archive database. Presently, the database manager backs up data weekly using Zip File. The database manager keeps the most recent copy available on SharePoint. Envidas polls data older than one week directly from the site computer. In the future, the DAQ will house the main database in DIT's Western Data Center using a Virtual Server and will mirror the database to the current database computer. The DAQ keeps all data real time. Note that the RRO monitoring technicians also download backup site temperature data and store it on the RRO group drive for archival purposes.

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, 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 database manager may dispose of the storage media or recycle it. 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 PWEI SO₂ monitoring network and its sites, the pertinent QAPP and various measurement phases of the data operation. The DAQ also uses assessments to determine whether the monitoring staff has implemented the ambient air-quality monitoring program in accordance with the approved QAPP. To ensure the adequate performance of the quality system, DAQ will perform the following assessments:

- Network reviews and assessments
- External performance evaluations
- Internal performance evaluations
- Quarterly completeness assessments
- Annual data certification
- Data quality audits
- Data quality assessments
- Technical systems 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 PWEI SO₂ monitoring network as set forth in 40 CFR Part 58, Appendices A, C, D and E are determined through annual network reviews of the ambient air quality monitoring systems, as required by 40 CFR Section 58.10(a). The chief uses the network review to determine if the PWEI SO₂ monitoring network collects adequate, representative and useful data in pursuit of its air monitoring objectives. Additionally, the annual network review may identify possible network modifications to enhance the system or correct deficiencies in attaining network objectives.

Before implementing an annual network review, the RRO monitoring technician compiles and evaluates significant data and information pertaining to the network and PWEI SO₂ site. Such information might include:

- Network files (including metadata, updated site information and site photographs);
- AQS reports, especially the AMP380 and AMP390 reports;
- Network monitors' five-year air quality summaries;
- Latest National Emission Inventory, or NEI, SO₂ emissions for major MSAs;
- Traffic data; and
- National Weather Service or State Climate Office summaries for the monitoring network area.

Upon receiving the information, the RRO monitoring technician will check it to ensure it is current. The RRO monitoring technician will note discrepancies and resolve them during the review. The RRO monitoring technician will also identify and update files and photographs that need updating during the review. The DAQ emphasizes several categories of information during network reviews, such as

the monitor location, nearby pollution sources, potential changes to nearby pollution sources, population density, changes in nearby land use and other pertinent information.

During the annual network review, the RRO monitoring technician 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 RRO monitoring technician will propose changes to rectify the discrepancy. The RRO and RCO monitoring staff will then act to correct the information in AQS, relocate the monitors or site, or move the site to a more suitable location, if needed.

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

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

20.1.1 PWEI Network Reviews

The RRO monitoring technician completes a network review of the PWEI SO₂ site and submits a network review form to the RCO every year. EPA regions are also required to perform these reviews. The RRO monitoring technician considers the following criteria:

- 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 PWEI SO₂ monitors required, depending upon the measurement objectives.

20.1.2 Five-Year Network Assessment

The five-year network assessment is a more extensive evaluation of the air-monitoring network. The assessment determines at a minimum:

- If the PWEI SO₂ network meets the monitoring objectives defined in 40 CFR Part 58 Appendix D,
- Whether DAQ must add another PWEI SO₂ site,
- Whether the existing PWEI SO₂ site is no longer needed and can be terminated, and
- Whether new technologies are appropriate for incorporation into the ambient-air monitoring network.

During the five-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. The DAQ submits a copy of the five-year network assessment, along with a revised annual network plan, to the EPA Region 4. These assessments began in 2015 for the PWEI SO₂ network and are due to EPA every five years on July 1.

For more information about the PWEI monitoring location, please see the annual network plan at <https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan>.

20.2 External Performance Evaluations

DAQ addresses performance evaluation activities by participating in the EPA's NPAP. Only qualified and authorized personnel execute performance audits. The NPAP program audits 20 percent of an agency's gaseous pollutant sites per year and each site every six years. Since DAQ has 35 sites, including the PWEI site, the EPA may only audit the PWEI SO₂ site once every six years. If the monitor does not pass the evaluation, the RRO monitoring and ECB electronics technicians will take appropriate action to identify why the monitor failed the evaluation and to implement corrective action to resolve the situation.

20.3 Annual Performance Evaluations

The ECB electronics technicians, who do not operate the monitors, conduct performance evaluations at least once each calendar year and every 365 days on the SO₂ monitors by challenging the monitor with known concentrations of gas using an independent NIST-traceable calibrator and gas standard. The ECB electronics technicians certify the audit system and the monitor's calibration system using the same primary standard for both. Likewise, the ECB purchases the gas standards for the audit system and monitor's calibration system from the same vendor at the same time, so both come from the same lot of gas. The ECB electronics technicians follow the audit procedures in SOP 2.8.1. They document the results of these audits on the AQ-121 form. If a monitor does not pass the evaluation, the RRO monitoring and ECB electronics technicians will take appropriate action to identify why the monitor failed the evaluation and to correct the situation.

20.4 Quarterly Completeness Assessment

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

20.5 Annual Data Certifications

In accordance with 40 CFR Section 58.15, an annual air monitoring data certification letter is required to certify that the data from Jan. 1 to Dec. 31 of the previous year, collected by the FRM/FEM monitor at the PWEI SO₂ site, meet 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 PWEI SO₂ data for the previous calendar year. The DAQ verifies and validates data monthly, as discussed in Section 23.0 Verification and Validation Methods. Additionally, an RCO chemist assesses data on a quarterly basis when an RCO chemist generates specific AQS reports to assess the DQIs as discussed in Section 20.9 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 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 chemist and the PPB supervisor review these reports and confirm everything is complete and accurate. The RCO 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 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 is correct and complete. Once the RCO chemists, statistician and database manager complete any necessary corrections, additions or deletions in AQS and the RCO chemist has 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 chemist who does not review the data conducts the audit of data quality, or ADQ, which reveals how the level 1 to 3 reviewers handled data, what judgments they made and whether they made uncorrected mistakes and records exist to support the decisions made. An ADQ can often identify the means to correct systematic data reduction errors. Enough time and effort will be devoted to this activity so that the RCO chemist has a clear understanding and complete documentation of data flow. The RCO chemist shall perform this assessment quarterly. Pertinent ADQ questions appear in the SOP on quarterly data review, which the RCO chemist shall use in executing an ADQ. The DAQ ensures the level 1 to 3 reviewers maintain data collection and handling integrity via the quarterly data review. The ADQ will serve as an effective framework for organizing the extensive amount of information gathered during the audit of field monitoring and support functions within the agency. If the RCO Chemist finds a problem during the ADQ, the RCO Chemist will work with the level 1 to 3 reviewers to correct the situation and modify the procedures to ensure the problem does not reoccur. See Section 23.0 Verification and Validation Methods of this document for more information related to the data review process, which occurs monthly and/or quarterly.

20.7 Data Quality Assessments

A DQA is the statistical analysis of environmental data to determine whether the data meet the assumptions under which the DQOs and data collection design were developed and whether the total error in the data is tolerable. Calculations for DQA activities shall follow the requirements and equations identified in 40 CFR Part 58, Appendix A, Section 4. *Data Quality Assessment - A Reviewer's Guide* (EPA QA/G-9R) describes in detail the DQA process. The regulations at 40 CFR Part 58, Appendix A provide terminology associated with measurement uncertainty.

An RCO chemist will calculate estimates of the data quality on a quarterly basis using the AQS AMP256 and AMP600 reports. Since the PWEI SO₂ network has only one site, the DAQ bases the estimates of the data quality on single monitors for this network. For the annual data certification, the PWEI SO₂ site is combined with monitors from other DAQ-supported networks to determine an estimate of data quality for the agency or PQAQ overall. The chief reports the individual results of these tests for each method or analyzer to the EPA annually as part of the AQS AMP600 report.

The RCO chemist reviews control charts of the daily auto zero, span and 1-point-QC check for SO₂ every business day. When the control chart indicates the zero, span, or 1-point-QC check drifted out of range, the RCO chemist contacts the RRO monitoring technician and asks them to take corrective action as specified in SOP 2.8.2.

20.8 Technical Systems Audits

A 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. EPA Region 4 QA staff conducts a TSA of DAQ every three 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 because of TSA findings and communicates progress to the director and EPA Region 4.

An EPA TSA team or an individual TSA auditor may segregate TSA activities into categories. The auditor may audit the categories independently or together. Possible categories include:

- Field activities – Monitor installation, calibration and sampling.
- Data management activities – Collecting, flagging, editing, and uploading data and providing data security.

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

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

EPA shall conduct TSAs once during every three-year period that the PWEI SO₂ monitoring program collects data verifying compliance with the NAAQS.

20.9 Internal Technical Systems Audits

At the time of this QAPP revision, the DAQ is not completing internal technical systems audits on the PWEI monitoring network. However, DAQ is considering implementing a schedule in the future. Ideally, an RCO chemist performs an internal TSA on the PWEI SO₂ program, which may include the RRO, ECB and RCO activities. An internal audit is similar to a TSA performed by the EPA. It is a thorough and systematic qualitative audit, where an auditor examines facilities, equipment, personnel, training procedures, protocols and record keeping for conformance with established regulations and statewide policies governing the collection, analysis, validation, and reporting of ambient air quality data.

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

- Field activities – performing routine maintenance of equipment, maintaining certification records, performing associated QA/QC activities, etc.
- Data management activities – collecting, flagging, editing and uploading data and providing data security, etc.

The auditor will interview the key personnel responsible for planning, field operations, QA/QC, data management and reporting. The following subsections lists the reporting and corrective actions, which follow an internal TSA.

20.10.1 Post-Audit Activities

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

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

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

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

The report will document problems with specific areas and recommend corrective actions for the monitoring staff to implement.

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

If the RRO, ECB or RCO has written comments or questions concerning the audit report, the auditor will review and incorporate them as appropriate. Subsequently, the auditor will prepare a modified report and submit it to the audited unit or units, management and the chief in final form within 30 days of receipt of the written comments. The report will include an agreed-upon schedule for corrective action implementation.

20.10.2 Follow-up and Corrective Action Requirements

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

auditor, who reviews and accepts or rejects the corrective action. Within 30 days of acceptance of the audit report, the parties involved will complete the audit response form.

The results of the internal systems audit may result in additional or refresher training for air monitoring staff. The chief may provide the training in the form of additional communications regarding DAQ's approved practices along with discussions of the elements necessary to satisfy these requirements. It may also be in the form of hands-on technical training. Section 21.8 Response/Corrective Action Report of this QAPP contains additional information on corrective actions.

20.10.3 Audit Schedule

The DAQ will perform an internal TSA anytime senior staff feels it is appropriate to assist in identifying deficiencies and providing timely corrective actions.

21.0 Reports to Management

This section describes the quality-related reports and communications to management necessary to support PWEI SO₂ network operations and the associated data acquisition, validation, assessment, and reporting. Besides the reports discussed in this section, staff meetings occur regularly on 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. Unless otherwise noted all reports will contain monitoring data for the SO₂ and shelter temperature.

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

21.1 Quarterly Data Submittal 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*⁴ and DAQ's data handling and validation SOPs 2.41.3 and 2.41.4. The level 1 to 3 reviewers review and validate the concentration data in the Envista ARM database. When data capture for a monitor falls below 75 percent for the quarter, an RCO chemist prepares for the chief a memo explaining why and the corrective action taken. Otherwise, the PPB supervisor documents that the quarterly data submittal is complete and that the data meets 75 percent completeness by sending an email to the chief.

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, Section 5. DAQ reports the required QA data on the same schedule as quarterly monitoring data submittals. The chief is responsible for ensuring that the level 1 to 3 reviewers use the results of QA data to validate concentration data.

In accordance with 40 CFR Section 58.16(b), DAQ submits data to the AQS database no later than 90 days following the end of the quarter in which DAQ collected the data. Table 21.1 provides the dates by which the DAQ uploads the previous quarter's data. After the database manager uploads all quarterly data to AQS, an RCO chemist retrieves and reviews the following quarterly reports from AQS: the AMP251, AMP256, AMP350, AMP350MX, AMP360, AMP430 and AMP600. After reviewing the reports, the RCO chemist archives the reports in the IBEAM general documents module and sends an email to the Level 3 reviewer summarizing the review and any corrective action needed.

⁴ 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 SO₂ monitors at least once each calendar year, using specially designated audit equipment. All gaseous transfer standards used in the air-monitoring network must be traceable to a primary standard such as a NIST standard reference material or an EPA/NIST-approved certified reference material.

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

21.3 Annual Network Review

By Oct. 31 each year, the RRO monitoring technicians conduct an annual network review of the site following SOP 2.43; therefore, for the PWEI SO₂ network review the RRO monitoring technician performs this assessment and generates the subsequent report. 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 needed modifications to the site and network including termination or relocation of unnecessary stations or monitors or establishment of new stations or monitors. The RRO monitoring technician completes the annual network review form described in SOP 2.43; the coordinator reviews the form and submits it to the RCO by Dec. 31. The PPB supervisor archives the network review forms in the IBEAM general documents module and provides them to the public and the EPA as appendices to the annual network-monitoring plan.

21.4 Annual Data Certification

The chief 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 PWEI SO₂ concentration data collected during the previous year, and all applicable QA data. The OAQPS and EPA Region 4 specify the exact AQS reports for the chief to submit. Generally, the chief submits an AMP600 and AMP450NC report.

21.5 Annual Network Monitoring Plan

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. The plan provides for the establishment and maintenance of an air-quality surveillance system consisting of a network of SLAMS monitoring stations. The plan includes: (1) a statement of purpose for each monitor and (2) evidence that siting and operation of each monitor meets the requirements of appendices A, C, D and E of 40 CFR Part 58, where applicable. Before submission to the 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.

21.6 Five-Year Network Assessment

The DAQ conducts and submits to the EPA regional administrator an assessment of the air-quality surveillance system every 5 years on July 1. At a minimum, this assessment determines if the network meets 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 EPA regional administrator.

21.7 Internal Systems Audit Reports

At this time, DAQ is not completing regularly scheduled internal systems audits at the PWEI site. An RCO Chemist will perform an internal systems audit as needed to verify that the PWEI SO₂ program meets the data MQOs outlined in Section 7.2 Measurement Quality Objectives. When completed, the RCO chemist will distribute copies of the internal systems audit report to the RRO air quality supervisor, RCO chemist, ECB supervisor, the PPB supervisor and the chief.

21.8 Response/Corrective Action Report

Currently, regional monitoring technicians document any corrective action taken at the site in an e-log. The regional monitoring technicians do not send these e-logs to management but the regional monitoring coordinator and RCO chemists review them. 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 ECB. The ECB documents all corrective actions taken on a 109 Form, which the ECB and PPB supervisors review. When the level 1, 2 or 3 reviewers need to correct data reported to AQS, they document the changes on a data correction form. If the corrective action affects several days or a month or more of data, involves systemic issues, or endangers meeting completeness, an RCO chemist documents the corrective action in a memo to the chief and carbon copies the DAQ regional office air quality supervisor. At the time of this QAPP revision, these procedures are undergoing review and DAQ may revise them to streamline and improve the process.

22.0 Data Validation and Usability

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

Data verification is the process for evaluating the completeness, correctness, and conformance or compliance of the data set against method, procedural and contractual specifications. The EPA further defines verification as confirmation, through provision of objective evidence, that the dataset has fulfilled specified requirements.

Data validation is a routine process designed to ensure that reported values meet the quality goals of the environmental data operations. The EPA further defines data validation as examination and provision of objective evidence that the reported data fulfills particular requirements for a specific intended use. The primary intended use for the PWEI data set is to provide SO₂ data for comparison to the NAAQS. The DAQ must use a progressive, systematic approach to data validation to ensure and assess the quality of data. Data validation includes the review of the DAQ PWEI data sets against the individual pollutant MQOs. Reviewing data 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 chemists find a problem or discrepancy, he or she will conduct further investigations to find the source of the error and then correct it. Deviations from operational procedures or QA requirements that do not result in data invalidation may require that data be qualified with QA qualifier flags prior to upload to AQS.

22.1 Sampling Design

The EPA must approve sampling network and monitoring site selection for SLAMS monitors. Sampling network and monitoring site selection must comply with the following:

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

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

⁵ Available at: <https://www.epa.gov/sites/production/files/2015-08/documents/g9r-final.pdf>

The RRO monitoring technician 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 establishment of the monitoring site).

22.2 Data Collection Procedures

Section 11.0 Data Collection Method Requirements outlines data collection procedures. The ENVIDAS DAS routinely identifies potentially unacceptable data points in the database through electronic application of ENVIDAS 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-applied status flags as part of the data validation process. This activity assists in identifying suspect (potentially bad) data points that could invalidate the resulting averaging periods. Table 22.1 presents a compilation of the AQS validation flags and null codes.

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	To provide information on events that influenced the measured values.
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	

Table 22.1. AQS Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
1C	A 1-Point-QC check exceeds acceptance criteria but there is compelling evidence that the analyzer data is valid	Null Data Qualifier	Void the data and submit the code in its place.
AA	Sample Pressure out of Limits	Null Data Qualifier	
AB	Technician Unavailable	Null Data Qualifier	
AC	Construction/Repairs in Area	Null Data Qualifier	
AD	Shelter Storm Damage	Null Data Qualifier	
AE	Shelter Temperature Outside 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 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	Void the data and submit the code in its place.
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	

Table 22.1. AQS Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
BG	Missing ozone data not likely to exceed level of standard	Null Data Qualifier	
BH	Interference/co-elution/misidentification	Null Data Qualifier	
BI	Lost or damaged in transit	Null Data Qualifier	
BJ	Operator Error	Null Data Qualifier	
BK	Site computer/data logger down	Null Data Qualifier	
BL	QA Audit	Null Data Qualifier	
BM	Accuracy check	Null Data Qualifier	
BN	Sample Value Exceeds Media Limit	Null Data Qualifier	
BR	Sample Value Below Acceptable Range	Null Data Qualifier	
CS	Laboratory Calibration Standard	Null Data Qualifier	
DA	Aberrant Data (Corrupt Files, Aberrant Chromatography, Spikes, Shifts)	Null Data Qualifier	
DL	Detection Limit Analyses	Null Data Qualifier	
FI	Filter Inspection Flag	Null Data Qualifier	
MB	Method Blank (Analytical)	Null Data Qualifier	
SA	Storm Approaching	Null Data Qualifier	
SC	Sampler Contamination	Null Data Qualifier	
ST	Calibration Verification Standard	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
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	Flag indicating the quality of the data. In some cases, the data may not meet all the criteria but is still valid.
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	

Table 22.1. AQS Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
EH	Estimated; Exceeds Upper Range	Quality Assurance Qualifier	
FB	Field Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
FX	Filter Integrity Issue	Quality Assurance Qualifier	
HT	Sample pick-up hold time exceeded	Quality Assurance Qualifier	
LB	Lab blank value above acceptable limit	Quality Assurance Qualifier	
LJ	Identification of Analyte is Acceptable; Reported Value Is an Estimate	Quality Assurance Qualifier	
LK	Analyte Identified; Reported Value May Be Biased High	Quality Assurance Qualifier	
LL	Analyte Identified; Reported Value May Be Biased Low	Quality Assurance Qualifier	
MD	Value less than MDL	Quality Assurance Qualifier	
MS	Value reported is 1/2 MDL substituted.	Quality Assurance Qualifier	
MX	Matrix Effect	Quality Assurance Qualifier	
ND	No Value Detected	Quality Assurance Qualifier	
NS	Influenced by nearby source	Quality Assurance Qualifier	
QX	Does not meet QC criteria	Quality Assurance Qualifier	
SQ	Values Between SQL and MDL	Quality Assurance Qualifier	
SS	Value substituted from secondary monitor	Quality Assurance Qualifier	
SX	Does Not Meet Siting Criteria	Quality Assurance Qualifier	
TB	Trip Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
TT	Transport Temperature is Out of Specs.	Quality Assurance Qualifier	
V	Validated Value	Quality Assurance Qualifier	
VB	Value below normal; no reason to invalidate	Quality Assurance Qualifier	
W	Flow Rate Average out of Spec.	Quality Assurance Qualifier	
X	Filter Temperature Difference out of Spec.	Quality Assurance Qualifier	
Y	Elapsed Sample Time out of Spec.	Quality Assurance Qualifier	
RA	African Dust	Request Exclusion	Flags data 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	

Table 22.1. AQS Qualifier Code Description and Type

Flag	Flag Description	Flag Qualifier Type	Purpose
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	

Data collection procedures must adhere to those procedures documented in the SOPs listed in Table 11.2. The RRO monitoring technician must document any deviation from the established data collection plan in the appropriate logbook. Accurate and complete documentation of any data collection deviations will assist in any subsequent investigations or evaluations. Investigations and evaluations may be necessary to determine whether the data obtained from a site may qualify as a baseline or indicator for other sites.

22.3 Quality Control

Section 14.0 Quality Control Requirements and Procedures specifies the QC checks that the RRO monitoring technician must perform during data collection and analysis. These include the analysis of daily one-point QC checks, which provide indications of the quality of data produced by specified components of the measurement process. SOP 2.8.2 specifies the procedure, acceptance criteria, and corrective action (and changes) for each QC check. Data validation should document the corrective actions taken, affected sampling days or hours, and the potential effect of the actions on the validity of the data. SOP 2.8.2 provides further information about 1-point-QC checks.

22.4 Calibration

Section 14.0 Quality Control Requirements and Procedures addresses the calibration of the monitors and the information the RRO monitoring technician should present to demonstrate he or she performed the calibrations correctly and the results are acceptable. When a level 1 to 3 reviewer identifies calibration problems, a level 1 to 3 data reviewer should flag or void any data produced between the suspect calibration event and any subsequent recalibration to alert data users. SOP 2.8.2 provides further information about calibrations.

22.5 Data Reduction and Processing

As mentioned in the above sections, the EPA will perform external TSAs and the DAQ will perform ADQs, to ensure the level 1 to 3 data reviewers follow the data reduction and processing activities required 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 chemist, not involved in data collection and processing, will review the data quarterly to ensure that the RRO monitoring and ECB electronics technicians, coordinator and other RCO chemist took appropriate corrective actions.

22.6 Exceptional Events

Although exceptional events for SO₂ are rare in North Carolina, this section describes what is involved regarding requesting an exceptional event exclusion. The regulations at 40 CFR Section 50.14 allows 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 an "exceptional event" caused the exceedance or violation. The regulations at 40 CFR Section 50.1 defines an "Exceptional Event" as an event or events, in which:

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

An exceptional event does not include:

- Air pollution relating to source noncompliance;
- Stagnation of air masses or meteorological inversions; and
- Meteorological events involving high temperatures or lack of precipitation.

Conditions involving natural events such as a volcanic eruption or an unlikely to recur human activity such as a train derailment may lead to exceedances which satisfy 40 CFR Section 50.1 and for which the administrator could grant an exception.

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 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. The DAQ follows the guidance in the QA Handbook regarding the use of these templates and handles the criteria as follows:

- Critical criteria are criteria deemed critical to maintaining the integrity of a datum, ambient air concentration value or group of values. The level 1 to 3 reviewers should invalidate observations that do not meet each criterion on the critical table unless there are compelling reasons and justification for not doing so. The datum or data 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 might 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 data, which do not meet one or more of these criteria, are 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 affect the validity of a datum or the data. An example criterion is that at least 75 percent of the days for each quarter should successfully collect 18 or more valid hours. The DQOs are also included in this table. If the data do not meet the DQOs, this does not invalidate any of the data measurements, but it may affect the confidence in the attainment/non-attainment decision.
- The designation of QC checks as operational or systematic does not imply that the RRO monitoring and ECB electronics technicians do not need to perform these QC checks. Not performing an operational or systematic QC check required by regulation can be a basis for invalidation of all associated data. The DAQ applies the validation templates only to small datasets of single values or a few weeks of information and does not allow a criterion to be in non-conformance simply because it is operational or systematic.

23.1 Validating and Verifying Data

The validation and verification procedures that DAQ will employ for this operation shall conform to the validation SOPs 2.41.3 and 2.41.4 listed in Table 11.2. *Guidance on Environmental Data Verification and Data Validation*, (EPA QA/G-8) also discusses verification and validation issues at length. The RRO monitoring technician and coordinator shall perform all verification activities. The RCO chemists shall provide additional support through a final review of all data reconciling any anomalies through discussions with the RRO monitoring technician and coordinator. Following the final review, the RCO chemist will provide a final validation of all data. The RCO chemists will also provide QA/QC support.

The level 1 to 3 data reviewers should compare data under evaluation to actual events as specified in SOPs 2.41.3 and 2.41.4. However, significant or unusual field events may occur, and field activities may negatively affect the integrity of the data. In addition, the DAQ expects that some of the QC checks will indicate the data fail to meet the acceptance criteria in Table 7.2. The level 1 to 3 reviewers shall void or flag data identified as suspect, or does not meet the acceptance criteria using the null codes and flags 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 the DAQ will maintain the overall measurement uncertainty for the one-year and three-year periods within the precision and bias DQOs.

23.2 Verification

After the previous month of data is available, the level 1 and 2 reviewers conduct a thorough review of the data for completeness and accuracy. Once the database manager enters the data into the Envista ARM database, the RRO monitoring technician will review the data for routine data outliers and conformance to acceptance criteria. The RRO monitoring technician will void or flag appropriately unacceptable or questionable data. The coordinator will verify all voided and flagged data again to ensure that the RRO monitoring technician entered the null codes and flags correctly and that the remaining 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 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. Logbook notes shall have more detailed information regarding the reason a reviewer voided or flagged a measurement.

The DAQ brackets all SO₂ data by 1-point-QC checks or manual calibration checks before and after any invalidated period. This requirement helps to ensure that the SO₂ monitors were in proper operating condition before and after the incident. When a monitor fails, the level 1, 2 and 3 reviewers invalidate any data after the last passing 1-point-QC check.

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

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

- Acquire minute averages from instantaneous averages, 5-minute and hourly averages from minute averages.
- Flag missing and irregular data with pre-programmed, user-defined status flags.

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

- Review daily for anomalies and completeness and acquire missing data if available.
- Verify that all daily precision checks fall within acceptable ranges.
- Invalidate data collected during an hour where the shelter temperature was not within the acceptable range.
- Evaluate automated nightly zero/precision/span checks and take appropriate corrective action if necessary.
- 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 validation codes for hours in which maintenance or calibrations were occurring.

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

- Review site records (RRO monitoring technician logbook, site data sheets).
- Review RRO monitoring technician checks (leak checks, filter changes, monthly flow verifications and 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 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 use of proper null codes by the RRO monitoring technicians and coordinator.

- Ensure the use of appropriate null codes and the correct checks of analyzer accuracy by the RRO monitoring technicians and coordinator to bracket all invalidated data.
- Ensure only valid 5-minute data are reported.
- Ensure all data falls within the acceptable ranges as stated in the MQOs.
- 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 verification, the independent level 3 reviewer determines the validity of the data by reviewing:

- The one minute and hourly values;
- Daily automatic QC checks, any manual checks and the 14-day checks;
- Leak checks after in-line particulate matter filter and probe changes;
- e-logs and the information documented therein;
- Correspondence with the RRO monitoring technician, coordinator and ECB electronics technicians;
- SO₂ concentrations from nearby monitors; and
- The results of DAQ and EPA performance evaluations.

The level 3 reviewer compares all the 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 RCO chemist, RRO monitoring technician and coordinator 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. At the time of this QAPP revision, the RCO chemists are reviewing the data validation SOPs. When they complete this review, they will augment these SOPs to include more detailed and up-to-date procedures. The DAQ will update this QAPP when DAQ completes those SOP revisions.

The Envidas software completes the level 0 review daily. The RRO monitoring technician and coordinator will complete the level 1 and 2 reviews within 20 days from the end of the monitoring month. The RCO chemist will complete the level 3 review 20 days after the level 2 review is completed. Within 40 calendar days after the level 3 review is completed, an independent RCO chemist will complete a review of the validated data once the database manager has uploaded it to AQS.

As discussed earlier, the EPA and DAQ have developed certain criteria based upon federal requirements and RRO monitoring technician 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.

24.0 Reconciliation with Data Quality Objectives

Section 5.0 Problem Definition and Background describes the objectives of the PWEI SO₂ monitoring program. Section 7.0 Quality Objectives and Criteria for Measurement Data describes the DQO's for this monitoring program.

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

An RCO chemist will analyze the results of both the AQS AMP256 and AMP600 reports on a quarterly (Section 20.4 Quarterly Completeness Assessment) and annual basis (Section 20.5 Annual Data Certifications) to ensure that all monitoring stations meet the required DQO's. This chemist documents this review by archiving the AMP256 and AMP600 reports in the IBEAM General Documents module. If the data violates the DQI bias and/or precision limits, then the RCO chemist will investigate to uncover the cause of the violation. Depending on the severity of the violation and weight of evidence, the level 3 reviewer will either void or flag the data in AQS. If all the monitors in the network of a similar type or pollutant violate the DQI, the cause may be at the agency level (regional monitoring technician training) or higher (problems with method designation). If only one monitor or site violates the DQI, the cause is more likely specific to the site (RRO monitoring technician, problem with the site). Tools for determining the cause include reviewing:

- Data from a collocated network (local or tribal program, nearby reporting organizations, national)
- Data from performance audits (DAQ or NPAP)
- 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: 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 caused by a broader problem. 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 DQIs, 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 QAPPs, SOPs and MQOs: When necessary to eliminate future problems, the chief will direct the RCO chemists to update the QAPP, its associated SOPs and the MQOs for the project.

- Adding additional monitoring stations: If the DQOs indicate a need for additional monitoring stations, the chief will work with the director and regional monitoring coordinator to determine the number of additional stations needed and their location.

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

Revision History

The PWEI SO₂ monitoring program was included as part of the criteria pollutant monitoring QAPP and is now being submitted as its own separate QAPP.

The DAQ updated the QAPP to follow EPA's August 2018 guidance document: Guide to Writing Quality Assurance Project Plans for Ambient Air Monitoring Networks: EPA-454/B-18-006, August 2018.

The DAQ also updated the QAPP to include EPA's new validation templates and new QA guidance.

Other updates in the QAPP include a new data acquisition system, agency reorganization and new distribution of responsibilities, changes to the data verification and validation procedures, and different QC criteria for SO₂.

QAPP Annual Review Documentation

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