Wisconsin Department of Natural Resources/Air Monitoring
Quality Assurance Project Plan for Ozone SLAMS Network
QAPP 6.0

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By the signatures below, the Wisconsin Department of Natural Resources/Air Monitoring certifies that the information contained in this document is complete and accurate at the time of submittal to EPA Region 5

Name: Jason Treutel
Author
Signature: Jason Treutel ***Date:*** 7/28/16

Name: Jason Treutel
Quality Assurance Coordinator
Signature: Jason Treutel ***Date:*** 7/28/16

Name: Katie Praedel
Air Monitoring Section Chief
Signature: Katie Praedel ***Date:*** 7/28/16

Name: Gail Good
Air Management Bureau Director
Signature: Gail E Good ***Date:*** 7/28/2016

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A.3 Overview

A.3.1 Disclaimers

This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. This guidance does not establish or affect legal rights or obligations and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any party in litigation with the State of Wisconsin or the Department of Natural Resources. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

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A.3.2 Definitions & Acronyms

TABLE 1.

Term	Definition
AGM	Air Guidance Module
AQS	Air Quality System maintained by EPA
CAA	Clean Air Act
CFR	Code of Federal Regulations
CL	Confidence Limit; one boundary of a confidence interval, which is defined by two CLs (upper and lower); see 95% CL below
CV	Coefficient of Variation; the ratio of the standard deviation and the mean; also known as the relative standard deviation (RSD)
Design value	Value used to assess compliance with the National Ambient Air Quality Standards (NAAQS)
EPA	Environmental Protection Agency
FEM	Federal Equivalent Method
FRM	Federal Reference Method

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Term	Definition
IZS tower	Internal Zero/Span tower; a tower inside the ozone analyzer used to conduct automated nightly zero/span checks
LSP	Laboratory Standard Photometer (Level 2)
MDR	Missing Data Records
NAAQS	National Ambient Air Quality Standards
NAMS	National Air Monitoring Stations
NIST	National Institute of Standards and Technology
NPAP	National Performance Audit Program
OTN	Out of Tolerance Notice
PAMS	Photochemical Assessment Monitoring Stations
ppb	Parts Per Billion
ppm	Parts Per Million
PQAO	Primary Quality Assurance Organization
QA	Quality Assurance
QAC	Quality Assurance Coordinator
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
RDA	Retention Disposal Authorization
RSD	Relative Standard Deviation; see definition for CV above
SIP	State Implementation Plan
SLAMS	State and Local Air Monitoring Stations
SOP	Standard Operating Procedure
Span	Pollutant concentration equal to 80% of the range of the instrument
SPMS	Special Purpose Monitoring Stations
SRP	Standard Reference Photometer
TAPI	Teledyne/Advanced Air Pollution Instruments
TTP	Through The Probe
WDNR	Wisconsin Department of Natural Resources
90% CL CV	Upper confidence limit (CL) of a 90% confidence interval of the coefficient of variation (CV); used for evaluation of precision (as used in Table 6)
95% CL	Upper confidence limit (CL) of a 95% confidence interval of the mean absolute value of the percent differences (as used in Table 6)

A.3.3 Distribution List

- Quality Assurance Office – US EPA Region 5
- Bureau of Air Management Director - WDNR
- Air Monitoring Section Chief - WDNR
- Air Monitoring Quality Assurance Coordinator (QAC) – WDNR [controlled copy]
- Air Guidance Module Manager – WDNR [electronic controlled copy]
- Air Monitoring Section Members - WDNR
- Site Assistants - WDNR

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- Potawatomi Site Contacts – Tribal Partner
- Bad River Site Contacts – Tribal Partner

A.4 Project/Task Organization

A.4.1 Organization Chart

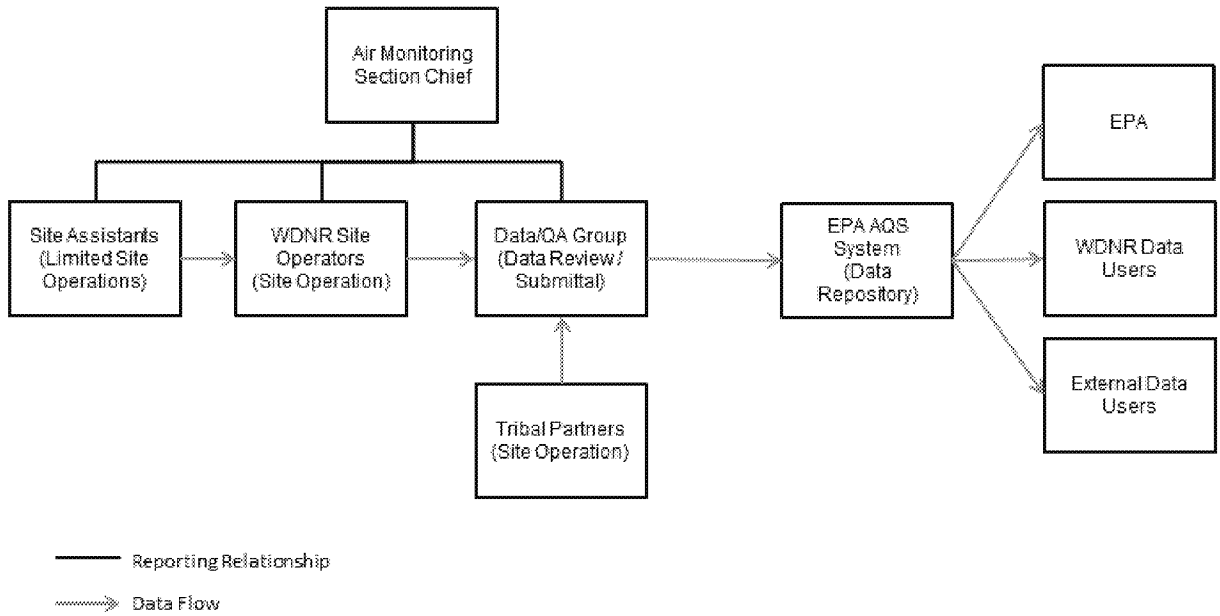

Figure 1. Organization chart showing relationships between individuals, groups or organizations involved in the collection, quality assurance or use of ozone data

A.4.2 Roles/Responsibilities

- Air Monitoring Section Chief facilitates many aspects of the ozone network including: management of Air Monitoring staff; data certification signatory; coordination of agreements with external partners, equipment purchasing, network review; primary EPA liaison
- Site assistants work under the direction of WDNR site operators at some sites (mainly remote from WDNR offices) and are responsible for limited site operations which may include: routine data collection, quality control (QC) checks
- WDNR site operators are assigned as the primary lead for each WDNR-operated site and are responsible for: routine data collection, QC checks, instrument maintenance, coordination of activities of site assistants when involved in site operations
- Tribal partners operate independently of WDNR as site operators for tribal sites and are responsible for: routine data collection, QC checks, equipment maintenance and purchases
- Data/QA Group is involved in many aspects of the network outside of site operations including: data review/submittal, QC review/submittal, management of documentation

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structure and systems including QC records QMP/QAPPs/SOPs, data certification preparation, annual independent audit program, equipment inventory

- EPA is the primary user of ozone data and is involved in: concurrence of data certification, evaluation of data QC/completeness, attainment/non-attainment determinations, definition of criteria for FRM and FEM samplers, definition of network requirements, concurrence on network plans
- WDNR Data Users may use monitoring data in a variety of ways including: making cases for attainment/non-attainment decisions, developing SIPs, including in modeling analysis, developing trends reports
- External Data Users may access monitoring data as a public record and may use monitoring data in a variety of ways in cooperation with, or independent of the WDNR for a variety of purposes including: scientific research, issue advocacy, health-related studies

A.5 Problem Definition/Background

In 1970, the federal Clean Air Act (CAA) was signed into law. The CAA provided the regulations and framework for the monitoring of criteria pollutants (sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, lead, and particulate matter) by state and local organizations through the establishment of a national Air Quality Monitoring Program.

Air quality data are generally collected for one or more of the following purposes:

1. To judge compliance with and/or progress made towards meeting the NAAQS
2. To develop, modify or activate control strategies that prevent or alleviate air pollution episodes
3. To observe pollution trends throughout the region, including non-urban areas
4. To provide a database for research and evaluation of air pollution effects

With the end use of the air quality data as a prime consideration, various networks can be designed with sites located to meet one of six basic monitoring objectives listed below:

- Determine the highest concentrations to occur in the area covered by the network
- Determine representative concentrations in areas of high population density
- Determine the impact on ambient pollution levels of significant source or source categories
- Determine general background concentration levels
- Determine the extent of regional pollutant transport among populated areas, and in support of secondary standards
- Determine welfare-related impacts in more rural and remote areas

In 1971, the first National Ambient Air Monitoring Standard (NAAQS) was established for ozone. The ozone NAAQS has subsequently been updated in 1979, 1993, 1997, 2008 and most recently in 2015 (Table 2).

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TABLE 2. The 2015 ozone NAAQS.

Parameter	Standard type	Averaging time	Standard	Design value
Ozone	primary and secondary	8 hours	70 ppb	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years

The WDNR operates a network of ozone analyzers to address the problem of determining ozone concentrations across the state. Ozone networks needs to meet criteria established by EPA with respect to network design as well as data collection, completeness and quality. The background and rationale for the implementation of the ozone ambient air monitoring network can be found in the Code of Federal Regulations (CFR Title 40 Part 50). The reference method for sampling ozone is found in CFR Title 40 Part 50, Appendix D. The method for interpreting ozone standards are found in CFR Title 40 Part 50, Appendices H, I, P and U.

The WDNR currently operates an ozone network that includes State and Local Air Monitoring Stations (SLAMS), Special Purpose Monitoring Stations (SPMS) and Photochemical Assessment Monitoring Stations (PAMS). Historically, WDNR also maintained ozone monitors in support of National Air Monitoring Stations (NAMS) network. The NAMS network has been discontinued and associated monitors have been shut down or incorporated into the SLAMS network. The current network design is maintained according to the Environmental Protection Agency (EPA) requirements and with consideration for the monitoring objectives listed above.

The SLAMS ozone monitors are primarily used for comparing ozone concentrations to the NAAQS (Table 2 above). These comparisons are used by EPA to determine attainment/non-attainment designations across the state and the nation. The majority of WDNR ozone analyzers are dedicated to this network.

In addition to SLAMS, WDNR operates several smaller ozone networks. At SPMS, ozone monitoring may be performed in suspected problem areas or for special studies, usually for periods of one or more years. At PAMS, monitors are operated to better understand ozone precursor levels and regional transport. The PAMS stations are dependent on EPA network requirements and funding. They may be discontinued in the future or delegated as SLAMS or enhanced ozone monitors. Industrial monitoring for ozone is currently not performed in Wisconsin due to the regional nature of ozone.

A.6 Project/Task Description

The WDNR operates ozone analyzers in accordance with EPA requirements and in consideration of available guidance provided by EPA, equipment manufactures and WDNR operational experience. In order to provide defensible ozone data:

- Analyzers used are Federal Equivalent Method (FEM) instruments
- Equipment maintenance is performed on a prescribed schedule
- Ozone data are collected per the prescribed SLAMS and PAMS seasons or as approved in waivers

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- QC checks are performed on a prescribed schedule
- Data are reviewed using defined processes
- Data are submitted to EPA's Air Quality System (AQS)
- Data are evaluated for adherence with specified statistical guidelines (bias/precision)
- Data are certified annually

All ozone data obtained from SLAMS and PAMS monitors are reported to EPA's AQS and are subject to the requirements of this QAPP. In contrast, ozone data obtained at SPMS and industrial monitors may or may not be reported to AQS and may not be subject to all requirements of this QAPP at the discretion of the WDNR.

A.7 Quality Objectives and Criteria

Quality assurance objectives identified by EPA include assessment of measurement uncertainty, completeness, representativeness and comparability. Ozone data collected in the Wisconsin ozone network described above will be assessed in terms of these objectives.

A.7.1 Assessment of Measurement Uncertainty

The EPA requires all reporting organizations which operate SLAMS ozone monitoring networks to determine measurement uncertainty of the monitoring data using three mechanisms: one-point QC checks, annual performance evaluation, and National Performance Audit Program (NPAP). The results of these procedures are used by WDNR and EPA to screen ozone data for excessive bias or imprecision. The EPA will also use these results for reporting measurement uncertainty for all reporting organizations.

A.7.1.1 One-point QC Checks (evaluation of precision and bias)

One-point QC checks were historically referred to as precision checks. The WDNR typically performs these checks as part of biweekly 3-point checks that also include points taken at zero and span levels. Additional types of checks may also include points that can be considered for submittal to EPA as one-point QC checks as long as they include an as-found point at a concentration similar to the one-point QC check. These include: 90-day verifications, out of tolerance notice (OTN) checks, and shutdown verifications.

A one-point QC check involves challenging an analyzer with a gas of known ozone concentration (typically at or around the level of the NAAQS) produced by a certified photometer. The concentration measured by the analyzer (measured) is then compared to the actual concentration reported by the photometer (audit) using Equation 1:

$$\%\,\text{difference} = \frac{(\text{measured} - \text{audit})}{\text{audit}} * 100 \qquad \text{Eq. 1}$$

One-point QC checks are also used for evaluations both annually at the site level, and over three years at the network level (the same number of years upon which the ozone design value is based; Table 2). The WDNR reports results of one-point QC checks to EPA's Air Quality System (AQS) where precision and bias of the ozone monitoring sites and network are calculated

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according to the requirements of CFR Title 40 Part 58, Appendix A. The WDNR is committed to meeting EPA's goals for network accuracy, which are as follows:

- Precision: coefficient of variation (CV) 90% confidence interval upper limit of 7%
- Bias: absolute bias 95% confidence interval upper limit of 7%

A.7.1.2 Annual Performance Evaluation (evaluation of bias)

Ozone monitoring stations are audited each calendar year on a schedule determined by the QAC. Audits are conducted by QA personnel or by site operators trained in auditing practices that are not responsible for the routine operation of the site being audited. Audits utilize independent standards (photometers and zero air sources) not used for one-point QC checks at the audited site or for the calibration of the analyzer being audited.

Annual performance audits should consist of a zero point and five non-zero audit points. These audit points should cover five of ten different audit levels established by EPA (audit levels 2, 4, 5, 6 and 7 or according to the most recent direction provided by the QAC). The audit photometer is connected to the analyzer utilizing as much of the sampling path as practical. This typically does not include the inlet of the sample line.

Each non-zero audit point is evaluated using Equation 1 above. The WDNR reports non-zero points of the annual performance audit to AQS. Each audit point should be within 10% of the audit concentration or within the zero drift criteria of the analyzer of ±3 ppb, whichever is greater.

Based on the results of these audits, the accuracy of the WDNR's ozone monitoring network will be calculated according to the requirements of CFR Title 40 Part 58, Appendix A. The WDNR is committed to meeting EPA's goal for network bias: absolute bias 95% confidence interval upper limit of 7%.

A.7.1.3 National Performance Audit Program (evaluation of bias)

Ozone analyzers are evaluated for bias using results of an independent National Performance Audit Program (NPAP). The WDNR elects to have EPA Region 5 or their designated contractor perform these audits.

- Evaluation requirements are to have 20% of gaseous monitoring sites audited per year performed by an independent program.
- Sites evaluated rotate through the network year to year. Every primary ozone analyzer in a PQAO is expected to be subject to a NPAP once every six years.

- Roles/Responsibilities:
    - The EPA Region 5 or their designated contractor is responsible for selecting sites, as well as scheduling and performing audits on an annual proposed schedule
    - The WDNR and operational partners are responsible for confirming the schedule, providing access to sites and conducting routine monitoring activities during NPAP audits

- The NPAP audits are conducted through the probe (TTP) to evaluate the entire sampling path where logistically feasible
- Unsuccessful audits may be rescheduled at the discretion of EPA Region 5 or their designated contractor

Audit results are reported to AQS by EPA Region 5 or their designated contractor. Preliminary and official results should be communicated to the QAC by EPA Region 5 or their designated contractor.

Each non-zero audit point is evaluated using Equation 1 above. Additional statistical analyses may also be done to aggregate results across the network or over intervals of time. The WDNR's analysis of these results is tied to the review of AQS reports typically done during the data certification process.

A.7.2 Completeness

Data are considered complete if a prescribed percentage of the total expected number of measurements has been obtained. The EPA requires 75% of expected measurements be present for data to be considered complete. Ozone data are reported to EPA as hourly averages. The WDNR considers a valid hourly average to consist of at least 45 minutes of discrete valid observations within the same clock hour. All hourly averages consisting of less than 45 minutes of discrete observations will be invalidated in WDNR's database and be reported as to AQS as invalid.

The 2015 ozone NAAQS is based on rolling 8-hr averages. For an 8-hr average to be considered valid, it must have six to eight valid hours.

The 2008 and 2015 ozone rules determine daily completeness differently.

- The 2008 rule required a minimum of 75% (18) of the 24 possible rolling 8-hr averages to be valid for the day to be considered valid.
- The 2015 rule only considers seventeen rolling 8-hr periods per day (starting at 07:00). For a day to be considered valid, at least 75% (13) of the 17 periods must be valid.
- NOTE: Exceptions to the above rules are made where an exceedance of the NAAQS is calculated based on incomplete 8-hr averages or incomplete days.

To calculate a complete 3-year design value EPA requires ≥ 90% of valid daily max 8-hr values over all ozone seasons with each ozone season ≥ 75%. The 75% criterion is a minimum goal when data completeness is reviewed monthly. However, data are not discarded if the 75% completeness criterion is not met. The WDNR will consider a goal of 90% daily completeness over the course of an ozone season. Sites that do not meet this goal annually will be evaluated for root cause of data loss and whether a corrective action is appropriate.

A.7.3 Representativeness and Comparability

All measurements must be made so that results are representative of the monitoring objectives of the site. Ozone is a regional pollutant; therefore monitoring sites may be selected to obtain data

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representative of ozone concentrations. Toward that end, all monitoring sites must meet EPA's siting criteria described in CFR Tile 40 Part 58, Appendix E.

All data must be reported in units consistent with other organizations reporting similar data to allow comparability of data among organizations. AQS allows for the submission of data in ppm or ppb. The WDNR will report all ambient ozone data to EPA as hourly averages in ppb.

A.8 Special Training/Certification

Training requirements vary depending on the role being performed. Training should include but is not limited to:

- The WDNR Data/QA Group members working on ozone data: Familiarity with the ozone QAPP, ozone instrument SOP(s), CFR Title 40 Part 50 and Part 58, EPA Data Validation template for ozone, AQS data submittal (if involved).
- The WDNR site operators and tribal partners operating ozone samplers: Familiarity with the ozone QAPP, ozone instrument SOP(s) and manual, training with an experienced mentor on site operations
- Site assistants: Familiarity with ozone instrument SOP(s), training with an experienced mentor on site operations

New WDNR employees have specific training requirements identified in individual training/orientation plans. Existing WDNR employees go through an annual review process where training plans are an element. Annual audits may identify specific needs for additional training.

Training on new procedures or emphasis on problem issues is conducted at routine meetings.

A.9 Documents and Records

The WDNR-related documents (A.9.1-A.9.4) are created and maintained per WDNR's Retention Disposal Authorization (RDA) document and Documentation SOP.

A.9.1 QMP/QAPPs/SOPs

Final electronic versions of the QMP/QAPPs/SOPs are maintained on an electronic file share (airmon) which is accessible to WDNR employees with access to the shared network. Additionally, electronic copies are stored on the Air Guidance Module (AGM) documentation management system. This system has both internet and intranet facing capabilities. Control of these documents is managed by the Air Monitoring QAC or designee. Archived versions of retired documents will be maintained in these systems as well.

When a new or revised document is finalized, it is sent as an attachment to all appropriate personnel, or a notification is sent identifying where the document may be accessed.

Only one paper copy is retained by the QAC for the purpose of maintaining a record of signatures of finalized documentation. It is the responsibility of the holder of any other paper

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copies to replace them when updated versions of the document are announced via email.

A.9.2 Monthly Data Packet

During the course of monthly data review, a data packet is generated that contains at a minimum:

- Monthly Completeness Summary [paper/electronic]
- Monthly Data Review Spreadsheet [electronic only]
    - Review of QC checks
    - Review of reasonableness of min/max values
    - Review of email-related items
    - Review of data holes identified and filled during monthly review

Physical and electronic data packets are maintained for at least six years.

A.9.3 Photometer Certification Forms

Photometers are used for the calibration and verification of ozone analyzers. Photometers are verified by comparing them to a higher authority standard. Records of the verifications are maintained on airmon. These records consist of a spreadsheet form specific to each photometer that traces its certification back to EPA's SRP. Records of these certifications are also maintained in the instrument's logbook.

Physical and electronic records of photometer certifications are maintained for at least six years after a photometer is permanently taken out of service.

A.9.4 Instrument Logbooks

Instrument logbooks are maintained for photometers and analyzers. Logbooks contain information on history of the equipment's location, maintenance, verification checks and diagnostics.

Instrument logbooks are maintained for at least six years after a photometer or analyzer is permanently taken out of service.

B. Data Generation and Acquisition

B.1 Sampling Process Design (Experimental Design)

Ozone analyzers are operated in a statewide network. Samplers are primarily located in areas that have had historically elevated ozone concentrations (Lake Michigan counties) and population centers per EPA requirements, but additional sites are operated to establish rural background concentrations, provide statewide coverage and for specific areas of interest such as tribal lands.

Network design and sampler siting are established based on CFR Title 40 Part 58, Appendix D and Appendix E.

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Data are generated continuously and averaged into hourly values. Data are retrieved hourly by a centralized server system. Data are reviewed regularly and submitted by month to AQS.

The ozone network is reviewed annually and approved by EPA Region 5 as part of the Annual Network Plan. This plan includes maps showing the current distribution of ozone network sites.

B.2 Sampling Methods

Sampling equipment and procedures follow CFR Title 40 Part 50, Appendix D. Specific instructions on technical aspects of these procedures can be found in WDNR SOPs and the sampler manual. All documentation considers CFR documentation and the validation templates found in EPA's QA Handbook for Air Pollution Measurement Systems.

B.2.1 Sampling Equipment

The WDNR utilizes samplers that meet established Federal Reference Method (FRM) or Federal Equivalent Method (FEM) requirements for ozone measurement. The WDNR operates FEM ozone analyzers that utilize the ultraviolet photometry detection method. Historically, WDNR has employed a variety of models of ozone analyzer but currently operates a network made up entirely of Teledyne/Advanced Air Pollution Instruments (TAPI) analyzers (Table 3).

TABLE 3. Historic and current methods of measuring ozone in the WDNR network

Method	Designation No.	Method Code	Notes
Monitor Labs 8810	EQOA-0881-053	053	Historic
Dasibi 1008RS	EQOA-0383-056	056	Historic
Environics 300B	EQOA-0990-078	078	Historic
API 400, 400A	EQOA-0992-087	087	Historic
TAPI 400E, T400	EQOA-0992-087	087	Current Network

B.2.2 Sampling Procedure

Ambient air is pulled continuously from an elevated probe inlet through a sample line and through the ozone analyzer and into a sampling cell. The intensity of an ultraviolet light source is measured after it passes through this sampling cell, where it is absorbed in proportion to the amount of ozone present. Every three seconds, a switching valve alternates measurement between a gas stream containing ozone and a stream that has been scrubbed of ozone.

The analyzer also measures the ambient temperature and pressure of the gas being measured. Using results of these measurements and the Beer-Lambert Law, the ozone analyzer calculates the amount of ozone present in the sample gas.

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B.2.3 Missing/Invalid Data Periods

Due to the nature of continuous measurement, it is not possible to replace missing or invalid data; therefore, it is vital to monitor that data being generated are of good quality and completeness. Ozone data collected by WDNR are primarily verified through biweekly checks using certified photometers (as described in section A.7.1.1), but are also checked nightly using an analyzer's internal zero/span source (IZS). Data are reviewed daily to ensure they are sensible and that the nightly check is within set tolerances. Data are further reviewed daily to identify any periods of missing or invalid data; formal evaluations of data completeness for ozone are determined monthly.

In the event that data are incomplete due to a logger or telemetry failure, work is done to make sure that communications are working properly and that data may be backfilled. If a logger has failed to collect the data, data may still be available by downloading the analyzer's onboard memory.

In the event that a sampler is not producing valid data (determined by a failed biweekly check, nightly check or when data reviewed are incomplete or not sensible), a site operator is responsible for determining the root cause of the problem and correcting it. Corrective activities may include any of the following:

- Rebooting analyzer
- Performing analyzer maintenance (e.g., pump replacement, lamp adjustment, etc.)
- Recalibrating analyzer
- Replacing analyzer with a working spare

The WDNR will report a valid value, or an invalid reason code, for each hour of data expected to be collected during the ozone season, or year round for samples that run on this schedule.

B.3 Sample Handling and Custody

No actual ambient air samples are retained because all measurements are made using continuous monitors that exhaust the air sample after analysis. However, the response of the monitors to ambient air is stored on data loggers and the onboard memory of the analyzers. The data loggers are queried hourly by the central data system.

B.4 Analytical Methods

Due to the nature of continuous sampling, no ambient air samples are collected and there is no offsite analysis performed. Continuous measurement methods are detailed in section B.2.1.

B.5 Quality Control

The ozone network has numerous QC criteria that are evaluated on a routine basis (Table 4). Failures to meet QC limits may result in any or all of the following:

- Reevaluation of analyzer with second standard

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- Recalibration of equipment
- Repair of equipment
- Replacement of equipment
- Flagging/invalidating routine data observations related to QC failures

TABLE 4. Quality control procedures to support ozone measurement

Criteria	Frequency	Acceptable Range	Corrective Action

Annual Verification/Calibration	Yearly at startup of ozone season or first 90-day check of the year for analyzers operating year round	Consists of a zero point and five non-zero points, ideally spread between five audit levels
		• Zero
		  ○ ≤ ±1 ppb
		• Non-zero points
		  ○ ≤ ±5%
			• Corrective action must be taken before placing online

Biweekly 3-Point Checks	Biweekly	• Zero
		  ○ Warning Limit: ±3 ppb
		  ○ Control Limit: ±5 ppb
		• Non-zero points
		  ○ Warning Limit ±5%
		  ○ Control Limit ±7%
			• Corrective action should be taken if warning limit is exceeded
			• Corrective action must be taken if control limit is exceeded
			• Consider data for invalidation if control limit is exceeded

Automated Zero/Span Check	Nightly	• Zero
		  ○ Warning Limit: ±3 ppb
		  ○ Control Limit: ±5 ppb
		• Span
		  ○ Warning Limit: ±5%
		  ○ Control Limit: ±7%
			Investigate
			• Whenever a control limit is exceeded
			• Whenever a warning limit is exceeded for two or more days
			Perform manual check if instrumental problem is not ruled out

Annual Performance Evaluation	Yearly, at least one analyzer/quarter in the network	Consists of a zero point and five non-zero points, ideally spread between five audit levels • Zero and audit levels 1&2: ±3.0 ppb difference or ±15% • Audit levels 3-10: percent difference is within ±10%	Evaluate weight of evidence to determine if: • corrective action is required • any associated data should be flagged or invalidated
Federal Audits (NPAP)	Yearly at selected sites, 20% of sites audited annually; all sites audited within 6 years	• Audit levels 1&2: ± 1.5 ppb difference • All other levels: percent difference ±10%	Evaluate weight of evidence to determine if: • corrective action is required • any associated data should be flagged or invalidated

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Criteria	Frequency	Acceptable Range	Corrective Action
Zero Air/Zero Air Check	Yearly by cross-checks of ZAS during annual audits and annual analyzer calibrations	Zero concentration < 3 ppb different between zero air sources	• Perform any necessary corrective before using for calibrations/ verifications
Level 2 Ozone Photometer certified against EPA SRP	Yearly	• Slope 1.00 ±0.03 • Intercept 0 ±3 ppb	• Perform corrective action and redo certification
Level 3 Ozone Photometer certified against Level 2 photometer qualification	Upon receipt or after major maintenance	• ±4% or ±4 ppb, whichever is greater • RSD of six slopes < 3.7% • Std. Dev. of six intercepts < 1.5	• Perform corrective action and redo certification
Level 3 Ozone Photometer certified against Level 2 photometer recertification	Twice per year • After annual maintenance prior to field deployment (pre) • After field deployment (post)	• New slope ± 0.05 of previous and • RSD of six slopes < 3.7% • Std. Dev. of six intercepts < 1.5 ppb	• Perform corrective action and redo certification • Consider if any associated data may have been significantly impacted
Sample Residency Time Check	At least yearly • Start of ozone season/ installation of new sample line • Annual Audit	• < 20 seconds	• Modify system so residency time is met
Shelter Temperature Range/Control Check	Daily	• Operating temp 5-40 °C ○ Optimal operating range 20-30 °C	• Adjust shelter temperature if possible if outside of optimal range • Consider data for flagging if temperature exceedances are excessive
Shelter Temperature Check	Yearly	• ±2 °C of standard	• Repair or replace sensor if outside of acceptable range

Corrective actions indicated in the Table 4 above may be modified at the QAC's discretion depending on weight of evidence analysis. This typically involves reducing an invalid status to flagged status in situations such as:

- Hard failure of equipment is identified between QC checks
- Comparisons with nearby network sites show reasonable agreement
- Exceedances of daily standards occurred
- Missing QC checks but existing QC and network analysis indicates comparable data

Deviations from validation template

- Shelter temperature control is not routinely evaluated for standard deviation; technology in use compensates for temperature fluctuation
- Shelter temperature is officially verified only once per year, not twice
- The WDNR utilizes 3 ppb instead of 1.5 ppb as the criteria when evaluating low verification/audit points (below 30 ppb) because this is the zero drift action level used for the network; additionally WDNR considers that low verification/audit points may not be produced reliably or defensibly due to current limitations of photometers and traceability at these levels
- The WDNR utilizes 10% for upscale measurements instead of 15% for audits as an action level for determining if corrective action and possible data evaluation are required
- Level 3 and greater photometers are not recertified within six months; the WDNR considers photometers to be independent standards and based on years of experience has concluded that annual startup and shutdown certifications are sufficient to demonstrate their accuracy along with cross-checks that occur at sites during audits if a QC check indicates questionable results

B.6 Instrument/Equipment Testing, Inspection and Maintenance

B.6.1 Ozone Analyzers

When a new analyzer is received, it is evaluated and tested to confirm it is operational before field use. Site operators or shop staff may be involved in these activities. This evaluation will include:

- Download of factory settings
- Configuration of the sampler to field deployable conditions
- Calibration of instrument using a WDNR certified photometer
- Check of zero stability
- Check of normal operations including data collection and nightly internal zero/span
- Download of electronic data records; verification of data accuracy and format consistency with that used in field deployed units
- Verification of analyzer calibration across six points on four separate days of testing (4x6)

During field deployment of the analyzer, routine maintenance and field checks are expected to occur per the Ozone SOP including:

- Routine QC checks detailed in section B.7
- Particulate filter change – at least every 90 days or more frequent if site conditions require it
- Review and recording of analyzer diagnostics
- Automated and manual data downloads
- Limited corrective field maintenance
    - Pump replacement
    - Lamp replacement/adjustment

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Preventative maintenance is performed annually on ozone analyzers. This work occurs primarily during the non-ozone season. Sites that operate ozone analyzers year round usually swap out ozone analyzers annually so that maintenance may be performed at centralized shop locations and downtime can be minimized. Annual maintenance includes:

- Verification of analyzer response to certified photometer
- Verification of operational diagnostics
- Leak checks of several flow paths
- Pump maintenance
- Replacement of charcoal scrubber, inline particulate filter, sintered filters and O-rings
- Cleaning of critical orifice; replacement if needed
- Inspection of photometer absorption tube; cleaned if needed
- Adjustment of UV lamp; replacement if needed
- Verification of pressure and flow readings with NIST traceable standards; calibration if needed
- Dark calibration
- Ozone generator calibration
- Adjusted calibration using shop photometer referenced back to Level 2 LSP

B.6.2 Ozone Photometers

When a new photometer is received, it is evaluated and tested to confirm it is operational before field use. This work is completed at the Air Standards Lab. This evaluation will include:

- Download of factory settings
- Configuration of the photometer to field deployable conditions
- 6x6 Verification of the photometer to the Level 2 LSP.

During field deployment of photometers, field maintenance is limited primarily to:

- Review and recording of photometer diagnostics
- Cross-checks with alternate photometers

Preventative maintenance is performed annually on ozone photometers. This primarily occurs during the non-ozone season. Sites that operate ozone photometers year round usually swap out ozone photometers annually so that maintenance may be performed at the Air Standards Lab with minimal disruption to site activities. Annual maintenance includes:

- Shutdown 1x6 verification of the photometer to the Level 2 LSP
- Verification of operational diagnostics
- Inspection of charcoal and fine filters; replacement if needed
- Verification of pressure and flow readings with NIST traceable standards; calibration if needed
- System leak check
- Adjustment of UV lamp; replacement if needed
- Ozone generator calibration
- Startup 1x6 verification of the photometer to the Level 2 LSP

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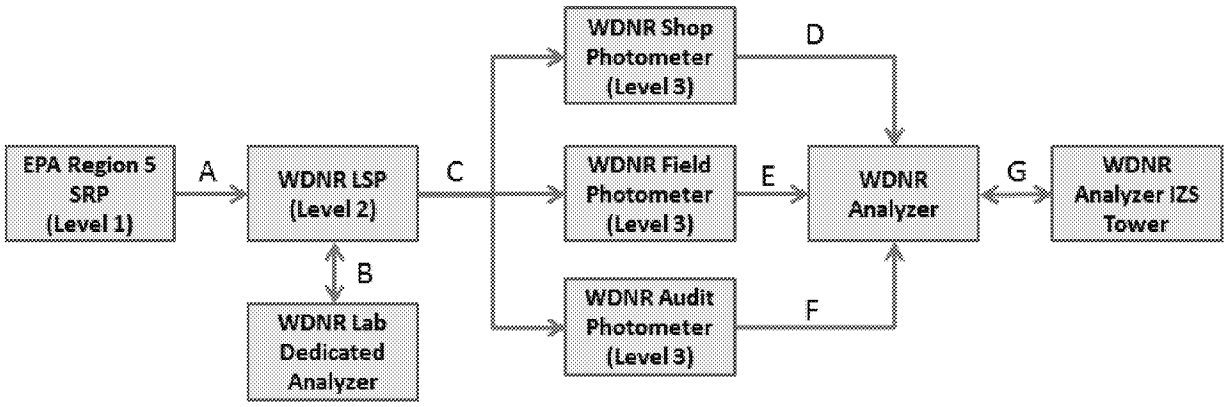
B.7 Instrument/Equipment Calibration and Frequency

The certification of photometers and calibrations/verifications of analyzers consists of a series of relationships and cross-checks demonstrated in Figure 2 below.



A = Annual Reverification
B = Cross-checked before and after removal from the Air Standards Lab
C = Conducted twice/year; Startup (after maintenance, before deployment) and Shutdown (after deployed use)
D = Annual Calibration Verification – done in shop after analyzer preventative maintenance
E = Startup/Biweekly/90 Day/Shutdown Verifications
F = Annual Audit; may also be used for periodic cross-checks
G = Nightly Zero/Span; IZS calibrated internally after manual verification of analyzer with a photometer

Figure 2. Relationship between photometers and analyzers used in the WDNR ozone network; the calibrations and verifications of each type of instrument are also noted

The WDNR considers its UV-Photometers to be independent standards. It is therefore the WDNR practice to verify photometers through a sequence of inter-comparisons without adjusting the slope and offset settings of the photometers (Slope = 1; Offset = 0). The exception to this is the Level 2 photometers where limited adjustments have been made to maintain traceability to previous Level 2 standards or to optimize agreement with the EPA Region 5 SRP when put into service. It is WDNR experience that photometers are very stable over time and no adjustment is necessary. Any issues with poor certification results will be addressed by maintenance instead of calibration.

The WDNR maintains one or more Level 2 Laboratory Standard Photometers (LSP)

- Taken to the EPA Region 5 office annually for recertification
- Before and after it is removed from the Air Standards Lab, it is inter-compared with a Lab Dedicated Analyzer to ensure that no issues occurred during transport

The WDNR maintains a supply of Level 3 photometers which may be used for a variety of purposes. They are typically assigned to shops, field use, or audit use.

- These photometers are verified against the Primary LSP
    - Upon initial receipt and after any major maintenance, six-point certification runs are conducted on six separate days to accept the photometer (6x6 verification)
    - While in service, Level 3 photometers are certified with a single six point check (1x6 verification) twice a year
        - Upon return from shop/field/audit use

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        - After annual preventative maintenance has been completed before being redeployed for shop/field/audit use

The WDNR maintains a supply of analyzers for use in its ozone network. These analyzers are very stable and rarely require any adjusted calibrations during the course of an annual or ozone-season deployment. Any issues with routine verifications are typically a sign that maintenance is recommended or that there was a problem in performing the check. A cross-check is conducted whenever possible if an issue is identified. Verifications/calibrations of ozone analyzers include:

- Annual calibration/verification
    - Performed using a Level 3 photometer
    - Done using adjusted points referenced back to the Level 2 photometer (effectively calibrating all analyzers to the Primary LSP)
    - Done in the regional shops after annual preventative maintenance has been conducted.
        - Analyzer may be calibrated (slope/offset adjustment) at this time

- Startup verification at field site
    - Performed using Level 3 photometer
    - Done using unadjusted points
    - If there are any concerns with the startup verification, the analyzer may be swapped for another, or an analyzer calibration can be performed at the site; if an adjusted calibration is done, it is done:
        - using adjusted points referenced back to the Level 2 photometer (effectively calibrating all analyzers to the Primary LSP)
        - with a photometer other than the one typically used for field use at that site

- Biweekly 3-point check
    - Conducted at least once every two calendar weeks (Sunday to Sunday)
    - Done manually using the field deployed photometer; can be done onsite or remotely
    - Associated one-point QC check result is reported to AQS
    - May include a particulate filter change

- 90-day verification
    - Conducted at least once every 90 days
    - Done manually on site with the field deployed photometer plumbed directly to the back of the analyzer
    - Associated one-point QC check result is reported to AQS
    - Includes an extra point near the lowest level run during audits
    - Includes a particulate filter change if it has not been changed more recently

- Shutdown verification
    - Conducted within the two weeks following the end of ozone season
    - Done manually using the field deployed photometer; can be done on site or remotely

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    - Associated one-point QC check result reported to AQS
    - Includes an extra point near the lowest level run during audits

- Annual audit
    - Conducted once per year
    - Done manually using an audit photometer
        - Can be any Level 3 photometer
        - Must be independent:
            - Not used at the audited site for field operations
            - Not the one used to calibrate the analyzer

- Nightly zero/span
    - Conducted automatically nightly using the analyzer's IZS tower
    - Results reviewed every business day by Data/QA Group
    - Zero/span charting is available on electronic systems to document trends
    - Failures of these checks do not automatically cause invalidation of the data; triggers investigation
        - Determine if analyzer has any error messages
        - Determine if the check was run correctly
        - If problem is not apparent, perform an OTN Check (can be either a manual zero/span or 3-point check); can be done on site or remotely
        - If manual check shows good results, data are likely fine and additional work should be done to correct automated check
        - If an OTN check includes one-point QC check point, it can qualify as a biweekly 3-point check and the one-point QC check results may be reported to AQS
    - If nightly zero/span check is not functioning properly for a prolonged period, frequency of manual 3-point checks should be increased to weekly

The WDNR analyzers typically operate with an IZS tower. This internal ozone generator provides a pulse check and cross-check of the calibration system. Failures of this check do not directly impact the validity of data, but trigger additional checks as necessary. Nightly zero/span checks may be considered as part of the weight of evidence to validate or invalidate a period of data. Typical operations include:

- Runs nightly to provide a pulse check of the instrument
- If IZS is determined to need adjustment, the setting may be adjusted or an O3 Gen Cal procedure may be performed
    - O3 Gen Cal uses the analyzer's UV-Photometric bench to calibrate the IZS; should only be done after a manual verification confirming the analyzer is in proper working order
    - IZS tower is not considered a certified ozone source, but it can be useful in troubleshooting and cross-checking photometers

The WDNR maintains a supply of zero air sources (ZASs). The ZASs are used with photometers for all purposes including: photometer certification, shop use, field use, and auditing.

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- The ZAS preventative maintenance schedule is established in the ZAS SOP
- The ZASs are effectively cross-checked because different ZASs will be used for photometer certification, annual calibrations, field use and audits

B.8 Inspection/Acceptance of Supplies and Consumables

Gaseous analyzers such as those used to measure ozone utilize very little in terms of supplies and consumables. The WDNR typically purchases replacement parts directly from the manufacturer or a distributor when parts are commonly available. Site operators or shop staff may purchase spare parts as needed or through a coordinated purchase. Parts ordered may include but are not limited to:

- Pumps
- Pump rebuild kits
- Pump bearings
- UV lamps
- O-rings
- Valves
- Particulate filters
- Sintered filters
- Critical orifices

B.9 Non-Direct Measurements

The ozone network does not rely on the use of non-direct measurements. Ozone data are reported to AQS in units that can be directly used for evaluation of the sample data set against the NAAQS for the purpose of determining attainment/non-attainment and developing design values.

B.10 Data Management

Data records are generated throughout the data collection and QA process (Table 5). Data are generated by analyzers, logged by an on-site computer program, transmitted to a central server for review and processing and ultimately sent to AQS.

TABLE 5. Data records generated through the data collection and QA process

Record	Use	Data Flow	Retention
Analyzer On-board Memory [Electronic]	• Backup of data if logger computer/program does not automatically poll data	• Generated by analyzer • Automatically downloaded to logger computer nightly • Site operator can download manually if needed • Analyzer calculates hourly average using 60 discrete readings	On-board memory overwrites itself as space is filled; configured to maintain at least six months of data

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Record	Use	Data Flow	Retention
Logger Database [Electronic]	• Logger polls readings from analyzer every 5 sec and integrates into 1-min, 5-min and 1-hr averages • Logger e-forms capture data points and diagnostic information during routine QC checks • Logger records missing data records (MDRs) • Logger database includes a site log	• Logger requests data reading from analyzers every 5 seconds • Integrates readings and stores them in a database and text files • E-forms collect data based on user entry, analyzer and calibrator readings • Central server polls loggers hourly and retrieves the hourly average data, QC check information, analyzer diagnostics, calibrator settings, MDRs and site-log entries	Logger database of hourly measurements and QC records retained at least 2 years
Central Server Database [Electronic]	• The WDNR central repository of hourly ozone data, ozone QC records, MDRs and site-log entries	• Site data are polled hourly by central server • Data are reviewed and processed by Data/QA Group • Data are submitted to AQS	Central Server data maintained at least 6 years
AQS [Electronic]	• The EPA central repository of ozone data and ozone QC data	• Ozone data are submitted to AQS in monthly batches • QC data are submitted in quarterly batches and during data certification	AQS data are maintained indefinitely
Data Completeness Report [Paper]	• Provides summary of days not meeting data completeness criteria	• Generated by Data/QA Group during monthly data review	Data packets including this report are maintained at least 6 years
Photometer Certification Records [Paper / Electronic]	• Used to establish certification and traceability to NIST standards	• Generated at the Air Standards Lab • Paper copies maintained in instrument logbooks • Electronic copies maintained in electronic files on airmon file share	Records are maintained at least 6 years after equipment is taken out of service
Analyzer/ Photometer Preventative Maintenance Forms [Paper]	• Forms used as a checklist for annual maintenance • Provides documentation record of maintenance	• Generated by site operators or shop staff performing annual maintenance • Paper copy inserted into instrument logbook	Records are maintained as part of logbooks (see below)
Instrument Logbooks [Paper]	• Provide documentation of instrument calibration/ certification, maintenance and deployment	• Entries are written or appended into logbook	Logbooks are maintained at least 6 years after equipment is taken out of service

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C. Assessment and Oversight

C.1 Assessments and Response Actions

The WDNR utilizes several assessment procedures to identify and correct issues (Table 6). The corrective action process may include a formal or informal communication and response.

TABLE 6. Assessment procedures associated with the WDNR ozone network

Assessment	Conducted By	Frequency	Goals
Review of data completeness	Data/QA Group using AQS AMP430	Final review done annually during data certification	Each month > 75% Season > 90%
Review of routine QC checks (Field Startup, Biweekly, 90-day, Shutdown)	Data/QA Group using AQS AMP251	Final review done annually during data certification	All valid data periods bookended by checks where: • Zero ±5 ppb • Non-zero points ±7% of photometer actual
Review of annual instrument/site audit	Data/QA Group using AQS AMP251	Final review done annually during data certification	Whichever is greater • ±3.0 ppb or • 10% of photometer actual
Precision calculated from one-point QC checks	Data/QA Group using AQS AMP600	Yearly	90% CL CV ≤ 7%
Bias calculated from one-point QC checks	Data/QA Group using AQS AMP600	Yearly	95% CL within ±7%
National Performance Audit Program	Data/QA Group using AQS AMP600	Yearly at 20% of sites, all sites audited every 6 years	• Audit levels 1&2: ±1.5 ppb • Audit levels 3-10: ±10%
Review of Air Standards Lab photometer certifications	QAC	Yearly	• Verify documentation is being properly maintained • Review summary statistics of network photometers
Technical System Audit – includes evaluation of WDNR sites, data processes and WSLH	EPA regional personnel	Once every 3 years	CFR requirements

C.2 Reports to Management

C.2.1 Continuous Data Completeness Summary Report

The QAC or designee creates and distributes a monthly summary report of all continuously generated data that had incomplete days (75% valid hours, or applicable averages) due to missing or invalid data. These reports are distributed to the monitoring Section Chief, site operators, site assistants, tribal partners, EPA state lead, and select internal and external data users. This report is submitted once data have been quality assured and fully prepared for submittal to AQS. This report is submitted via email and retained by the Data/QA Group.

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C.2.2 Annual Certification Package

The Data/QA Group reviews data submitted to AQS annually. Reports are prepared for and reviewed by the Section Chief and submitted to EPA. The WDNR recommends whether data should be certified. The EPA determines concurrence with the certification request. During this review, many site and network reviews are done including:

- Data completeness
- QC completeness
- Precision and bias statistics
- Data outliers
- NPAP audit results
- QAPP revision date

Evaluations are provided for any of the above criteria that are out of specification as identified by AQS or WDNR.

D Data Validation and Usability

D.1 Data Review, Verification and Validation

Many of the criteria used to review and validate data have been detailed in the above sections, primarily in sections B.5 and C.1. The WDNR Data/QA Group utilizes the established QAPP, analyzer SOP and EPA data validation template to determine data validity. Informal documentation summarizing this information is also utilized. Completion of a formal data coding manual is a future effort that will be undertaken as time and resources allow.

D.2 Verification and Validation Methods

D.2.1 Data Verification and Validation Process

The WDNR Data/QA Group verifies and validates data during a thorough monthly data review and annual certification processes. Informal documentation detailing the processing of continuous data is utilized. Completion of a formal data processing SOP is a future effort that will be undertaken as time and resources allow.

The monthly review process entails:

- Review of daily network evaluations and related communications
- Review of automated and manual QC Checks
- Review of network data completeness
- Graphical review of parameter data looking for
    - Abnormal minimum/maximum data values
    - Abnormal patterns in data
    - Agreement with nearby network sites
- Root cause analysis of missing/invalid data

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- Final coding of invalid or flagged data
- Creation of monthly data completeness report
- Submittal of data to AQS

The data certification process includes the review of AQS reports, primarily the AMP600, AMP430, AMP251 and AMP256 reports. These are reviewed to verify:

- Data completeness in AQS is complete and accurate
- QC submittal is complete and accurate
- QC statistical analysis is acceptable
- QAPP listing is up to date and accurate

Deficiencies identified during these reviews are noted and root causes identified and documented. Final decisions regarding coding and data submittal are the responsibility of the QAC.

D.2.2 Data Retention and Accessibility

Data are retained in two primary locations: the WDNR centralized data management system and AQS.

The WDNR provides access to data in the centralized data management system to internal and external users to a limited degree. Data may not be manipulated except by Data/QA Group members on password-protected systems. Some viewable data may still be in draft form prior to being fully quality assured. Proper disclaimers are provided for this type of data use.

The EPA's AQS is the repository for quality-assured ozone data. The data are certified by WDNR, and EPA provides an evaluation of concurrence annually. Data users may request data from AQS or may be able to access it directly through web viewers. Since these data are quality assured by WDNR before submittal, no additional disclaimers are required.

D.3 Reconciliation with User Requirements

The primary user requirements for the ozone network data are EPA's. By utilizing AQS as the official repository of the data, EPA is able to utilize the data according to their needs. It is EPA's responsibility to maintain and upgrade AQS to continue to meet their needs and requirements with consideration of input from state/local/tribal stakeholders.

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APPENDIX A: References

Code of Federal Regulations Title 40 Part 50 and Appendix D – USA EPA

Code of Federal Regulations Title 40 Part 58 and appendices – USA EPA

QA Handbook for Pollution Measurement Systems – USA EPA

Standard Operating Procedure for Ozone Photometer Certification SOP S.3 – WDNR

Standard Operating Procedure for TAPI T400/400E analyzers SOP 6.1 – WDNR

Standard Operating Procedure for Teledyne Zero Air Sources SOP 52.1 – WDNR

Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone - 2013 – USA EPA

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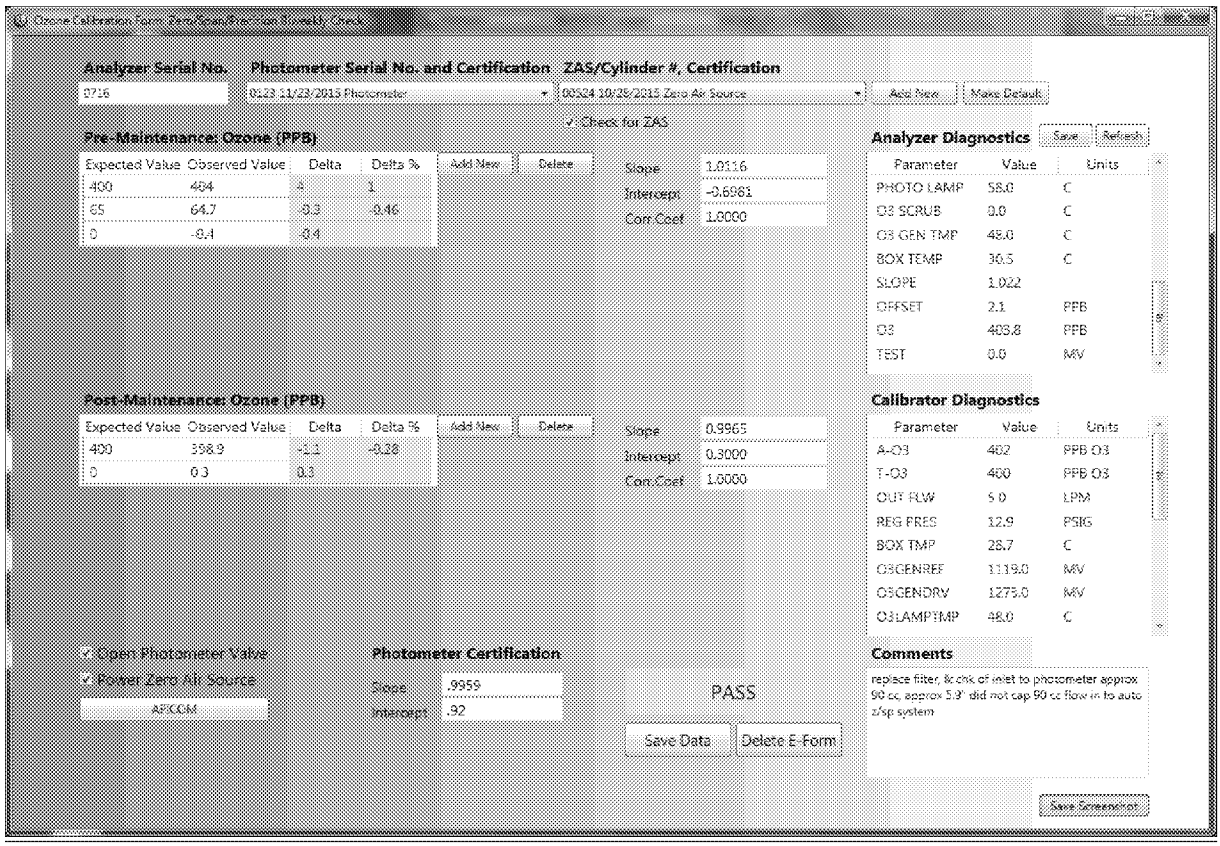
APPENDIX B: Forms

Appendix B.1: Ozone Logger E-form



Appendix B.2: Data Completeness Report

January 2016 Completeness Check - Continuous Data*

Site Name	AQS ID	Parameter	Start Date	End Date	Reason
Bad River	55-003-0010	O3	1/24/16	1/24/16	logger lockup following power outage; backup data unavailable (BK-2)
Bad River	55-003-0010	BP, precip, RH, SR, Temp, WD-R, WS-R	1/04/16	1/05/16	Communication problems due to nonfunctional met station converter (AN-1)
Bad River	55-003-0010	WD-R, WS-R	1/28/16	1/29/16	Wind speed sensor frozen (AO-2)
Horicon	55-027-0001	CO	1/01/16	1/05/16	Failed QC checks + baseline shift from original analyzer (AS-1)
Lake Geneva	55-127-0005	WD-R, WS-R	1/01/16 1/09/16	1/02/16 1/11/16	Wind speed sensor frozen (AO-2)
Madison – East	55-025-0041	SO2	1/06/16	1/06/16	90-d check, calibration, maintenance (BD-1,BF-1, BA-1, BF-2)
Madison - East	55-025-0041	SO2, SO2 (5-min)	1/24/16	1/25/16	Pump failure (AN-1)
Madison – East	55-025-0041	Temp, WD-R, WS-R	1/08/16	1/11/16	logger failure; new logger installed (BK-1)
Milwaukee – 16th St	55-079-0010	Temp	1/01/16	1/31/16	Poor agreement with buddy sites, failed Dec. 2015 audit; wiring problem determined to be root cause (AS-1)
Milwaukee – CA NR	55-079-0056	NOx box	1/07/16	1/07/16	Routine QC check (BF-1)
Milwaukee – CA NR	55-079-0056	NO2(CAPS)	1/01/16	1/31/16	Poor agreement with collocated NO2 (CL), failed various QC checks, ultimately determined to be calibration issue (AS-1)
Milwaukee - SER	55-079-0026	PM2.5, PM10LC, PM10, PMcrs	1/06/16	1/06/16	Tape problem (BA-4)

*Any day reporting < 75% data capture is included; hours missed do not need to be consecutive; all causes of missing data are considered. For ozone only, completeness is determined from 8-hr rolling averages (running forward), using 17 possible averages / day and EPA rules for completeness.

Appendix B.3: Level 3 Photometer Verification Form

Reverification for Photometer SN: 213 completed: 01/06/2016 **Year 2016 Cert**

Last checked against DNR Level 2 Photometer SN: 0217
DNR Level 2 Photometer verified against EPA Photometer SN: SRP06 on 11/18/2015

		SN		Point 1	Point 2	Point 3	Point 4	Point 5	Point 6		r-squared	slope (mi)	Intercept (li)
Run 9	Date	0217	Level 2	0	400	250	90	70	40		1.0000	0.9832	0.8028
	01/06/2016	213	Level 3	0	398	249	90	71	41				
			% Diff		-0.5000%	-0.4000%	0.0000%	1.4286%	2.5000%				
Run 8	Date	189	Level 2	0	400	250	90	75	40		1.0000	0.9989	0.1161
	11/06/2015	213	Level 3	0	399	249	90	75	40				
			% Diff		-0.2500%	-0.4000%	0.0000%	0.0000%	0.0000%				
Run 7	Date	189	Level 2	0	400	250	90	75	40		1.0000	0.9897	-1.0288
	01/30/2015	213	Level 3	-1	396	248	88	74	38				
			% Diff		-1.2500%	-1.6000%	-2.2222%	-1.3333%	-5.0000%				
Run 6	Date	189	Level 2	0	400	250	90	75	40		1.0000	0.9990	0.8080
	03/27/2014	213	Level 3	0	400	251	91	76	41				
			% Diff		0.0000%	0.4000%	1.1111%	1.3333%	2.5000%				
Run 5	Date	189	Level 2	0	400	250	90	75	40		1.0000	0.9987	0.8305
	03/26/2014	213	Level 3	0	399	250	91	76	40				
			% Diff		-0.2500%	0.0000%	1.1111%	1.3333%	0.0000%				
Run 4	Date	189	Level 2	0	400	250	90	75	40		1.0000	0.9995	0.2312
	03/25/2014	213	Level 3	0	400	250	91	75	40				
			% Diff		0.0000%	0.0000%	1.1111%	0.0000%	0.0000%				
Run 3	Date	189	Level 2	0	400	250	90	75	40		1.0000	0.9960	-0.2590
	03/21/2014	213	Level 3	0	398	249	89	75	39				
			% Diff		-0.5000%	-0.4000%	-1.1111%	0.0000%	-2.5000%				

Passing Criteria for Level 3 or Greater:
- mi = 0.98 < Average mi < 1.04
- New m = 0.95 m(avg) < new m < 1.05 m(avg)
- Sm = Sm < 3.7%
- Si = Si < 1.5

New Rolling 6 run average:

	r-squared	slope (mi)	Intercept (li)
Average	1.0000	0.9958	0.2598
Sm =	0.38%	Si =	0.6549

Previous Rolling 6 run average:

	r-squared	slope (mi)	Intercept (li)
Average	1.0000	0.9963	0.0626
Sm =	0.38%	Si =	0.8638

Photometer Output Corrections — **CERT DATE**

S/N 213 — **01/06/2016**

Year 2016 Cert
USEPA Cert 11/18/15

	Enter Slope	Enter Y-Intercept ppb	
(m)	0.9958	0.26	(b)

(x)	O3 Expected Concentration	O3 Display Settings	(y)
	400	399	
	250	249	
	120	120	
	90	90	
	70	70	
	40	40	
	0	0	

Solve for: y = m*x + b

Lab variables:
- x = O3 Expectected Concentration (analyzer)
- y = O3 Displayed Setting (photometer)
- m = Cert. Slope
- b = Cert. Y-Intercept

Appendix B.4: Ozone Analyzer Preventative Maintenance Form

O3 Analyzer Maintenance and Calibration Form

This is a universal form to cover 400E and T400 units. Some parameters are not displayed on newer models.

Date	API Model #	Serial Number	Technician	Lab (circle)
				CO SER NER

(PRE) Photometer generated values						
Expected Analyzer Responses						
Actual Analyzer Reponses						

□ Pre maintenance leak check of 4 flow paths:_____cc/min.

Maintenance Done:

□ Pump diaphragm & valve plate change

□ Changed pump bearings

□ Change & conditioned in-line filter

□ Replace sintered filter & O-rings, replace / cleaned critical orifice

□ Photo absorption tube checked (cracks & dirt) and cleaned

□ Charcoal scrubber replaced

□ UV lamp adjusted / replaced, Initial reading:_____mv, Post reading:_____mv.

□ Post maintenance leak check of 4 paths:_____cc/min.

□ Pressure verify / cal done:
Instrument:_____"Hg, NIST Standard:_____"Hg,
Standard SN:_____Cert Date:_____.

□ Flow verify / cal done:
Instrument:_____cc/min, NIST Standard:_____cc/min,
Standard SN:_____Cert Date:_____.

□ Dark Calibration Performed: Pre:_____ Post:_____.

□ Zero / Span Calibrated between Pre/Post

□ O3 Generation Calibration Performed

(POST) Photometer generated values						
Expected Analyzer Responses						
Actual Analyzer Reponses						

Diagnostics Read (PRE/POST):

Parameter	Pre-Observed Value	Post-Observed Value	Units	Acceptable Limits
Range	500	500	PPB	0 – 10,000 PPB
Stability			PPB	< 0.3 PPM
O3 Measure			MV	2500 – 4800
O3 Reference			MV	2500 – 4800
O3 Generator			MV	80 - 5000
O3 Drive			MV	0 - 5000
Pressure			In-Hg-A	Ambient - 1.5"
Sample Flow			cc\min	800 ±10%
Sample Temperature			°C	28 – 45
Photo Lamp Temp			°C	A-52±.5 / E-58 ±1
O3 GEN Temperature			°C	48 +/- 1
Box Temperature			°C	30 ±10
Slope			N/A	1.0 ±0.15
Offset			N/A	0 ±5
Firmware Version			N/A	

Service Notes:

_____
_____
_____
_____.

Calibration performed with Certified Photometer S/N: _____ Certification Date:_____.

API Analyzer Calibration and Maintenance Form0109.doc Created: 11/06/14 A. Nyhus / Revised: 1/25/16 B. Wolf

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Appendix B.5: Ozone Photometer Preventative Maintenance Form

TAPI T703 O3 Photometer Yearly Check For O3 Season _____	S/N: Software Rev:	Checked by:	Date:

- Change charcoal and finite filter, if needed.
- Turn on, Take off cover and look for loose parts or abnormalities.
- Verify Comm/Inet settings

Let unit warm up (Photo Lamp Temp = 58 °C and O3 Lamp Temp = 48 °C)

1. **Record OUTPUT FLOW** _____. (2 - 5 LPM) Adjusted flow from _____ to _____.
   a. If -not in range, adjust the pressure regulator per section 3.4.7 and/or section 8.4.2.
2. **Record REG PRESSURE** _____. (15 ± 2 PSIG @ 5LPM)
   a. If not in range, see section 8.3.2. Use Table 8.2 as a guide.
3. **Record BOX TEMP** _____. (20 - 35 °C)
   a. If not in range, see sections 11.1.2 and 11.4.11.1.
4. **Record 03 GEN REF** _____. (0 ± 5mV)
   a. If not in range, check and adjust IZS lamp and Ref per section 10.7.
5. **Record 03 GEN DRV**_____. (0mV) Record in Standby mode.
6. **Record 03 LAMP TEMP** _____. (48 ± 1 °C).
   a. If not in range, see sections 11.1.2 and 11.4.11.
7. **Record Photo MEAS** _____. (2500 to 4700mV)
   a. If not in range, check and adjust source lamp and detector per section 10.5 and 11.2.
8. **Record Photo REF** _____. (2500 to 4700mV)
   a. If not in range, check and adjust source lamp and detector per section 10.5 and 11.2.
9. **Record PHOTO FLOW** _____. (0.720 – 0.880 LPM) adjusted flow display from _____ to _____.
   Measure w/ BIOS Definer #_____.
   a. Check pneumatics; also see section 8.4.1 and 11.1.
10. **Record PHOTO LAMP TEMP** _____. (58 ± 1 °C)
    a. If not in range, see section 6.10 and 11.1.2
11. **Record PHOTO SPRESS** _____. (-1" Ambient In-Hg-A) Station pressure _____ InHgA.
    a. Check pneumatics, also see section 9.1.2 and check pressure sensor per section 8.3.
12. **Record PHOTO STEMP** _____. (28 – 48 °C)
    a. If not in range, see section 11.1.2 and 11.4.11.
13. **Record PHOTO SLOPE** _____. (1.0) Can be reset in VARS.
14. **Record OFFSET** _____. (0 ± 3 ppb) Can be reset in VARS.

- Perform system leak check per Ops. Manual section 10.2. **Do not exceed 15 psi.**
- Verify proper internal set-up prior to installing the cover.

A. If FSP doesn't pass Air lab tests, a Photometer calibration (sect 8.1.3) and/or an AIN or A /D D/A calibration (sect 6.9.3 or 11.4.8.1) may be needed
B. An IZS ozone generator lamp setup and IZS ozone generator calibration (sect 8.2) should be done if ozone concentrations come in slow or unstable
C. If a UV lamp or UV power supply is changed a Dark Current Adjust (section 8.1.4) should be done. (Pass: 818)

Notes:

Updated 04/06/2016 by TMK. Reference: Teledyne API Operator's Manual Model T703, 10 February 2012

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