Gaseous Pollutant Monitoring Program
Quality Assurance Project Plan (QAPP)

Prepared for the

NATIONAL PARK SERVICE
AIR RESOURCES DIVISION
12795 West Alameda Parkway
Denver, CO 80228

Prepared by

Air Resource SPECIALISTS

1901 Sharp Point Dr., Suite E
Fort Collins, CO 80525
970-484-7941
www.air-resource.com

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A1 TITLE AND APPROVAL SHEET

QUALITY ASSURANCE PROJECT PLAN
FOR THE
NATIONAL PARK SERVICE
AIR RESOURCES DIVISION
GASEOUS POLLUTANT MONITORING PROGRAM

Approved by:

National Park Service, Air Resources Division — Date 10/8/2015
Gaseous Pollutant Monitoring Program
Program Manager, Barkley Sive

National Park Service, Air Resources Division — Date 10/8/2015
Chief, Research and Monitoring Branch, John Vimont

Air Resource Specialists, Inc. — Date 10/8/15
Program Manager, Joe Adlhoch

Air Resource Specialists, Inc. — Date 10/08/2015
Quality Assurance Manager, Emily Vanden Hoek

ACRONYMS AND ABBREVIATIONS

ARS	Air Resource Specialists, Inc.
AQS	Air Quality System (EPA)
CASTNET	Clean Air Status and Trends Network
CD	Compact Disc
CFR	Code of Federal Regulations
CI	Checklist Instruction
COR	Contracting Officer's Representative
DCS	Data Collection System
DQI	Data Quality Indicator
DQO	Data Quality Objective
EPA	Environmental Protection Agency
GPMP	Gaseous Pollutant Monitoring Program
IMC	Information Management Center
IMPROVE	Interagency Monitoring of Protected Visual Environments
IT	Information Technology
MDN	Mercury Deposition Network
MOU	Memorandum of Understanding
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NAMS	National Air Monitoring Stations
NIST	National Institute of Standards and Technology
NPAP	National Performance Audit Program (EPA)
NPS ARD	National Park Service Air Resources Division
OAQPS	Office of Air Quality Planning and Standards (EPA)
PAMS	Photochemical Assessment Monitoring Stations
$PM_{2.5}$	Particulate Matter less than 2.5 Micrometers
PM_{10}	Particulate Matter less than 10 Micrometers
PSD	Prevention of Significant Deterioration
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
SLAMS	State and Local Air Monitoring Stations
SOP	Standard Operating Procedure
TI	Technical Instruction
TSA	Technical Systems Audit

A PROJECT MANAGEMENT

This section describes project management for the National Park Service Gaseous Pollutant Monitoring Program (NPS GPMP), including project history and objectives, roles and responsibilities of the participants, and document disposition. This section includes the following subsections:

A1 Title and Approval Sheet
A2 Table of Contents
A3 Distribution List
A4 Project/Task Organization
A5 Problem Definition and Background
A6 Project Description and Schedule
A7 Quality Objectives and Criteria for Measurement Data
A8 Special Training Requirements/Certification
A9 Documentation and Records

The following guidance has been used in the development of this Quality Assurance Project Plan (QAPP):

- 40 CFR 50, *National Primary and Secondary Ambient Air Quality Standards*
- 40 CFR 50, Appendix A-1. *Reference Measurement Principle and Calibration Procedure for the Measurement of Sulfur Dioxide in the Atmosphere (Ultraviolet Fluorescence Method)*
- 40 CFR 50, Appendix C. *Measurement Principle and Calibration Procedure for the Measurement of Carbon Monoxide in the Atmosphere (Non-Dispersive Infrared Photometry)*
- 40 CFR 50, Appendix D. *Measurement Principle and Calibration Procedure for the Measurement of Ozone in the Atmosphere*
- 40 CFR 50, Appendix F. *Measurement Principle and Calibration Procedure for the Measurement of Nitrogen Dioxide in the Atmosphere (Gas Phase Chemiluminescence)*
- 40 CFR 50, Appendix J. *Reference Method for the Determination of Particulate Matter as PM10 in the Atmosphere*
- 40 CFR 50, Appendix L. *Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere*
- 40 CFR 53, *Ambient Air Monitoring Reference and Equivalent Methods*

- 40 CFR 58, Appendix A. *Quality Assurance Requirements for SLAMS, SPMs and PSD Air Monitoring*

- 40 CFR 58, Appendix C. *Ambient Air Quality Monitoring Methodology*

- 40 CFR 58, Appendix D. *Network Design Criteria for Ambient Air Quality Monitoring*

- 40 CFR 58, Appendix E, *Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring*

- 40 CFR 58, Appendix G. *Uniform Air Quality Index (AQI) and Daily Reporting*

- *EPA Quality Assurance Handbook for Air Pollution Measurement Systems:*
  - Volume I, A Field Guide to Environmental Quality Assurance (EPA/600/R-94/038a, April 1994)
  - Volume II, Ambient Air Quality Monitoring Program (EPA-454/B-13-003, May 2013)
    - Part 2.12 Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods. (November 1998)
  - Volume IV, Meteorological Measurements (EPA-454/B-08-002, March 2008)

- EPA *Compendium Method IO-1.2. Determination of PM_{10} in Ambient Air Using the Thermo Environmental Instruments (formerly Wedding and Associates) Continuous Beta Attenuation Monitor.* (EPA/625/R-96/010a, June 1999)

- EPA *Compendium Method IO-1.3. Determination of PM_{10} in Ambient Air Using a Continuous Rupprecht & Patashnick (R&P) TEOM® Particle Monitor*. (EPA/625/R-96/010a, June 1999).

- *EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005, February 2000).

- *EPA Guidance for Quality Assurance Project Plans (QAPPs)* EPA QA/G-5 (EPA/240/R-02/009, December 2002).

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A3 DISTRIBUTION LIST

The following individuals and/or organizations will receive copies of the approved Quality Assurance Project Plan and any subsequent revisions:

National Park Service Air Resources Division (NPS ARD)
Barkley Sive, Gaseous Pollutant Monitoring Program, Program Manager*
John Vimont, Chief, Research and Monitoring Branch

U.S. Environmental Protection Agency (EPA)
Gary Lear, Technical Monitor, CASTNET Program
Melissa Puchalski, Project Officer, CASTNET Program
Tim Sharac, Technical Monitor, CASTNET Program

AMEC
H. Kemp Howell, Project Manager
Marcus O. Stewart, QA Manager
Kevin P. Mishoe, Field Operations Manager
Gary L. Price, Laboratory Operations Manager
Christopher M. Rogers, Data Management and Reporting Manager

Air Resource Specialists, Inc. (ARS)
Joe Adlhoch, Program Manager
Mike Slate, Network Operations Section Manager
Jessica Ward, Information Management Center (IMC) Manager
Emily Vanden Hoek, Quality Assurance Manager*

NPS park units with monitoring sites
Park air quality supervisors
NPS site operators

* Indicates individual who will maintain an official, approved QAPP.

The QAPP will also be distributed and available on the National Park Service Web site, at *http://www.nature.nps.gov/air* and on the GPMP Project Web site, at *http://ard-request.air-resource.com/project*. The QAPP will be reviewed at least annually, or at any time that major network changes are implemented, and updated as necessary.

A4 PROJECT/TASK ORGANIZATION

The U.S. Department of the Interior, National Park Service, established and manages the Gaseous Pollutant Monitoring Program (GPMP). Air Resource Specialists, Inc. (ARS) is the prime contractor for this monitoring effort, the primary objective of which is to measure existing levels of air pollution in National Park Service (NPS) units. The principle components are the measurements of ozone and meteorological parameters representative of the ambient air quality in NPS units; however, other gases, particulates, deposition, and other air quality-related parameters are measured at specific sites throughout the network. A project organizational chart

is provided as **Figure 1** and responsibilities of the key project participants are listed in **Table 1**. Full contact information for project participants is included on the project Web site at *http://ard-request.air-resource.com/project*.

A5 PROBLEM DEFINITION AND BACKGROUND

The primary objective of the Gaseous Pollutant Monitoring Program is to measure existing levels of air pollution in National Park Service units. This objective is mandated by the Clean Air Act of 1963 (including the 1970, 1977, and 1990 amendments) and the Organic Act of 1916, which assign the Federal Land Managers the responsibility of protecting the natural resources in national parks. Data on the concentrations of air pollutants in the parks are needed to support the permit review, biological effects, and research functions of the National Park Service Air Resources Division and to assist parks in evaluating their resource management needs. Accordingly, the Air Resources Division (ARD) has established a network of stations to monitor ozone (O_3) and meteorological conditions in a large number of parks, with additional monitoring of other gaseous pollutants including sulfur dioxide (SO_2), carbon monoxide (CO), and oxides of nitrogen (NO_x); and particulate matter ($PM_{10,}$ $PM_{2.5}$) in selected parks. This QAPP specifically addresses these longer-term trend GPMP monitoring sites. Many of these sites are also designated as Clean Air Status and Trends Network (CASTNET) sites. The NPS and CASTNET have cooperated since the early 1990s to provide broader coverage of rural air quality, particularly in the western United States. Note that the NPS ARD also conducts shorter-term air quality monitoring including portable ozone and special studies monitoring in selected parks. In addition, ARD cooperates with other national and state programs that monitor ambient gases, meteorology, deposition chemistry, particulate matter, ultraviolet radiation, and visibility. The GPMP monitoring sites in each park are selected to represent the air within the park. Other monitoring objectives of the network are to:

- Establish existing, or baseline, concentrations in NPS units;
- Assess trends in air quality in NPS units;
- Judge compliance with national air quality standards for ozone;
- Assist in the development and revision of national and regional air pollution control policies for rural areas;
- Provide data for national and regional pollution control policies;
- Provide data for atmospheric model development and evaluation;
- Provide data to primary national EPA data repositories and presentation media including AIRNow and the Air Quality System (AQS);
- Cooperate with other national, regional, and state air monitoring and analysis programs related to park resource issues; and
- Identify those air pollutants with the potential to injure or damage park biological resources, monitor these pollutants, and correlate measurable effects to these resources to existing ambient levels of these pollutants.

These objectives are the foundation of a network design in accordance with EPA regulations 40 CFR, Part 50, Appendix D (ozone) as well as Appendices A-1, C, F, J and L.

Although addressing primarily health-effects based monitoring in areas of high population, these protocols are generally pertinent to the Gaseous Pollutant Monitoring Program.

A6 PROJECT DESCRIPTION AND SCHEDULE

A6.1 Network Description

The gaseous, particulate, and meteorological parameters measured by the NPS Gaseous Pollutant Monitoring Program are listed below. Nearly all sites collect meteorological parameters. Selected sites monitor other atmospheric gases and particulate matter concentrations.

Gaseous - Ozone, sulfur dioxide, carbon monoxide, and oxides of nitrogen data are collected and validated using documented protocols to yield a quality assured digital data set. Ozone is the primary pollutant measured throughout the network and is the only gas monitored specifically in accordance with EPA protocols and certified annually by the NPS to the EPA. This QAPP supports the certification of the ozone measurements conducted using EPA reference or equivalent methods. Note that the GPMP also collects ozone data using non-equivalent instrumentation at selected portable ozone monitoring (POMs) sites for air pollution screening purposes. In addition, sulfur dioxide, carbon monoxide, and oxides of nitrogen are monitored in selected park units primarily for research purposes, but may or may not meet EPA reference or equivalent methods. On occasion, selected data sets for these parameters may be submitted to the EPA by the NPS for certification. **Table 4** presents collected parameters at each site, along with the sponsoring agency and pollutant certification status.

Particulate Matter - At selected park units, both EPA equivalent method and non-equivalent method monitors are used to measure particulates (PM_{10}, $PM_{2.5}$). Data are validated and reported as 1-hour concentrations.

Meteorology - Ambient temperature, delta temperature, relative humidity, wind speed, wind direction, precipitation, wetness, solar radiation, and barometric pressure data are collected and validated using documented protocols to yield a quality assured digital data set.

This QAPP specifically addresses the procedures used by the NPS to operate and certify ozone measurements at NPS-operated sites with EPA-certified analyzers. Methods and procedures for measuring other pollutants of interest are included for informational purposes.

Table 3 lists the site specific location information and AQS site identification codes. **Table 4** presents all parameters monitored at each site, and **Table 5** presents which parameters are certified in AQS annually. Note that the number and location of sites in all categories may change slightly from year to year.

A6.2 Task Descriptions

Work performed for the program has been divided into six (6) tasks as detailed below:

1) Equipment Procurement and Inventory – Ambient air quality and meteorological instrumentation, data logging and communication systems, monitoring shelters, and support systems including towers are employed at the monitoring sites. ARS is responsible for acquiring all necessary monitoring equipment. Equipment purchased for this project meet the following guidelines:

- Compatible with network objectives and existing systems
- Meets established acceptance criteria where appropriate, such as EPA equivalency
- Proven durability and reliability
- Cost-effective through all project phases

Upon receipt, equipment orders are verified for completeness and any inconsistencies are resolved with the supplier. Prior to installation in the field, equipment components are assembled in the ARS air quality laboratory and tested to ensure proper operation. Instrumentation is calibrated using certified standards. A record of all purchased capital items is kept by ARS and maintained in a site-specific equipment inventory database. All purchase, testing, calibration, and inventory procedures are documented in standard operating procedures (SOPs).

2) Site Selection and Installation – ARS works closely in conjunction with the National Park Service to select appropriate monitoring sites and coordinate the installation of necessary utilities. Sites are generally located within NPS park units. Select sites are not located within or near park units, but operate under separate site-specific Quality Assurance Plans in cooperation with NPS and other federal or state agencies. See **Table 4** for more information. These sites are selected to be:

- Representative of the study area
- Accessible and secure
- Well-exposed to regional air flow
- Isolated from nearby pollution sources
- Available for long-term use

3) Network Operations – All routine on-site servicing operations are performed by NPS site operator(s) or contract site operator(s) on a weekly basis. Site operators receive training on equipment operation, maintenance, and data collection/documentation, including the use of DataView[1], Operational SOPs, technical instructions (TIs), and checklist instructions (CIs). ARS collects data daily and reviews the operational status of the network daily, including data quality assurance indicators (zeros, spans, and precisions), provides site operator technical support, initiates corrective actions to address any identified inconsistency, and performs and tracks any

[1] DataView – Internal proprietary software developed by ARS to access site status logs and other site specific operations dedicated for the site operator(s) and field specialist.

required remedial maintenance on all program monitoring instrumentation and support equipment.

All semiannual maintenance and calibration activities are performed by ARS field specialists at each site every six months. All transfer standards used to perform these verification checks are maintained, handled, stored and managed in a manner that maintains their integrity (i.e. certified annually and traceable to NIST). Following the initial verification checks, all systems receive required maintenance and are fully calibrated in accordance with EPA guidance, including fully documented and traceable multipoint calibrations of all gas analyzers. The calibrations are verified to ensure they meet network acceptance criteria and the as-left performance is documented.

4) Data Management and Reporting – A custom designed data collection system automatically retrieves air quality and meteorological data and system documentation from the monitoring systems by telephone or IP modem every hour. The data analysts and the field specialist (assigned technician-of-the-week) independently review the incoming data to verify proper operation of the monitoring systems. Suspected instrument malfunctions are investigated immediately and corrective actions are implemented. All network data are managed in an Oracle database (IMC database). The comprehensive database includes monitoring site metadata, raw data, validated data, associated validity codes, quality assurance references, and other important data. Reports and other data deliverables are generated from this database. All raw and validated data are archived in the IMC database and on CD. Additionally, data for the previous month is added to one of two external hard drives containing all historical data. The hard drive is provided to the GPMP Program Manager monthly. All validated data are also uploaded monthly to the EPA national Air Quality System (AQS) database and are made available on the NPS Data Request Web page. In addition, raw hourly gaseous, particulate, and meteorological data are automatically retrieved and uploaded to EPA's AIRNow Web site. Raw data are also uploaded hourly on the NPS data request Web page for near real-time display.

5) Quality Assurance and Control – GPMP QA/QC procedures are used to assess the various components of the program and their compliance with the QAPP and referenced QA documents. These project assessments include:

- Quality Assurance/Quality Control documentation, prepared and maintained by ARS includes but is not limited to: Quality Management Plan (QMP), Quality Assurance Project Plan (QAPP), Standard Operating Procedures (SOPs), Technical Instructions (TIs) and Checklist Instructions (CIs). ARS also maintains all transfer standards and equipment used in semi-annual maintenance visits.

- Quality Control Field Operations Assessments performed by ARS: Data (including automatic gaseous zeros, precisions, and spans) are reviewed each business day by ARS to assess instrument operation at every site. Site operators visit the station once each week and complete the digital DataView documentation. If an operator notices a problem they immediately call ARS and the problem is addressed and logged in the electronic Site Status Log. Corrective actions are instituted in response to any noted

problem. Supplemental training occurs during each semiannual field visit by ARS as required.

- Quality Control Data Management Assessments performed by ARS: Monthly plot reviews, attended by the GPMP program manager, and ARS section managers serve as a monthly assessment of data management and validation procedures. During the plot reviews, data summaries of all gaseous and particulate data for each site, as well as weather summaries for the month are reviewed on a project-specific data review web site. A detailed discussion about network-related actions and plans follows the actual plot review.

- Independent Field Performance Audits – It is a network goal to have independent performance audits performed on all network sites each calendar year. These audits will generally be performed by:

  - State Agencies – Generally, units where ozone levels are near or above standards receive state independent audits as often as annually.

  - CASTNET Program Auditor – All NPS sites that participate in the CASTNET program receive an independent audit by the CASTNET auditor annually.

  - EPA National Performance Audit Program (NPAP) – The NPS GPMP sites are suitable for participation in the NPAP. Visits are periodically scheduled to non-CASTNET NPS sites to perform a full independent performance audit, to be conducted at least once every five (5) years.

  All of the independent audits noted above follow EPA performance audit protocols and apply traceable audit standards that yield consistent results. The results of all audits made available to the NPS are reviewed, filed, and incorporated into the validation process. All independent audit results are also entered into the EPA AQS as a quality assurance reference for network accuracy and to meet data certification requirements.

- Technical Systems Audits (TSAs) – The NPS will work with EPA (either EPA Regions or the Office of Air Quality Planning and Standards (OAQPS)) to ensure that the GPMP receives an independent TSA a minimum of every three years.

6) Program Management and Administration – Overall program coordination is provided by the GPMP program manager who communicates directly with ARS management staff. Monthly meetings in conjunction with the plot review establish and define near and long-term project objectives and actions. Day-to-day coordination of overall project management and reporting requirements are performed by the network operations section manager, IMC manager, and ARS program manager. Weekly e-mail progress reports are sent to the GPMP program manager, Research and Monitoring Branch Chief, and ARS staff. Monthly data reports, twice-annual contract status reports, and annual data reports are sent to the GPMP program manager and Research and Monitoring Brach Chief, the ARS program manager, the network operations section

manager, the IMC manager, site operators, and park air quality supervisors. In addition, each of these reports, along with a variety of other network documentation, is posted on the GPMP project Web site.

Coordination with the CASTNET program occurs annually at the CASTNET Summit Meeting and in monthly conference calls or otherwise as needed. Coordination with cooperating agencies is performed as needed by telephone, e-mail, or written communications. In addition, all validated NPS data collected at CASTNET-configured sites are sent monthly by ARS to the CASTNET contractor.

All contract administration between the NPS and ARS is performed by the NPS Contracting Office. The NPS Contracting Office also coordinates memorandums of understanding (MOUs) with cooperating agencies and distributes funding to individual parks for site operations.

A6.3 Schedule

The Gaseous Pollutant Monitoring Program schedule is presented in **Table 2**.

A6.4 Reporting Requirements

Reporting requirements for the program are summarized in the project schedule in **Table 2**. In general, reporting products include:

- Hourly Data Uploads to AIRNow
- Status Log Updates as Needed
- Weekly Progress Reports
- Data Reports (monthly and annual)
- Monthly Data Uploads to AQS
- Monthly Ozone Exceedance Tables
- Monthly CASTNET Data Uploads
- Quarterly Precision and Accuracy Uploads to AQS
- Annual Network Performance Summary Report
- Annual Data Summary Tables and Maps
- Twice-Annual Contract Status Reports
- Site Visit Reports
- Quality Assurance Documentation
- Data Archives
- Annual AQS Ozone Data Certification Packet

A6.5 Resource Constraints

The NPS Air Resources Division is the principal source of funding for this network. Limited additional funding is occasionally available from individual parks for special projects. The NPS ARD provides funding directly to park units to support site operators. ARS is the prime contractor for the monitoring program. An interagency agreement exists between NPS and EPA related to the CASTNET components of the monitoring program. Agreements with state agencies generally consist of memorandums of understanding with no direct exchange of funding. The program budget is developed yearly by NPS ARD and is dependent on agency funding levels and priorities. In addition, the NPS cooperates with state agencies to both operate additional in-park monitoring sites and to perform independent audits at selected sites.

A7 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

A7.1 Data Quality Objectives

The GPMP data quality objectives (DQOs) are comprised of quantitative and qualitative statements that define performance measures and goals to ensure that the type, quantity, and quality of collected data meet the objectives of the network, as specified in Section A5. The DQOs specify that the highest quality defensible data be available from NPS park units to support air quality related decisions and policies of the National Park Service. The GPMP DQOs are summarized in **Tables 8a through 8b**.

The valid data recovery objective for the GPMP is 75% per calendar quarter for all parameters. Measurement uncertainty is controlled through daily data reviews, weekly operator visits, semi-annual calibration and maintenance, and monthly data validation. Achieving a 75% collection objective allows users to be confident when comparing collected data to other, nearby monitoring stations which use the same instrumentation and same data validation procedures, for the same period of time. Collected data are representative of local conditions in the area, as documented on the IMC New Site/Site Relocation Form provided in **Appendix B**.

A7.2 Data Quality Indicators

Data quality indicators (DQIs) describe the general framework for ensuring that network data are of known and documented quality and available in a timely manner to meet the DQOs. These indicators are discussed below. The DQIs specific to the GPMP are detailed in **Table 9**.

Zero and Span

All gas analyzers are automatically subjected to a zero and span sequence to provide routine checks on instrument performance. Pollutant-free zero air generated by an on-site zero air system establishes the zero point. The span value is generated by the gas dilution system using EPA-protocol gas cylinders or use of an ozone transfer standard.

Precision

Precision is a measure of mutual agreement among individual measurements of the same property usually under prescribed similar conditions. Precision is an estimate by various

statistical techniques calculated as either the range or as the standard deviation. This calculation is performed on aggregated 1-point QC checks, which are performed in a similar manner to span checks.

Bias
Bias is the systematic or persistent distortion of a measurement process which causes error in one direction. Bias will be determined by estimating the positive and negative deviation from the true value as a percentage of the true value. This calculation is performed on aggregated 1-point QC checks, which are performed in a similar manner to span checks.

Detection Limit
The detection limit is the determination of the low range critical value of a characteristic that method specific procedures can reliably discern.

Representativeness
The representativeness of measurements is the degree in which data accurately and precisely represents a characteristic of a population, parameter variation at a sampling point, a process condition, or an environmental condition.

Completeness
Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions.

Comparability
Comparability is a measure of confidence with which one data set can be compared to another.

The GPMP DQIs for precision, bias, accuracy and completeness are detailed in **Table 9.** Representativeness is determined qualitatively by siting and exposure conditions of the monitoring site(s) described in Section B1, and in consultation with The National Park Service.

Comparability and detection limit objectives are achieved by using USEPA-approved methods and equivalent method instrumentation (detailed in the Standard Operating Procedures listed in **Appendix A**) and by following USEPA monitoring guidance as described in this QAPP.

Appropriate calibration and validation levels for the air quality and meteorological instrumentation, as well as EPA acceptance criteria, are listed in **Tables 10 through 11**.

A8 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

ARS staff members working on this project are experienced in ambient air quality and meteorological monitoring systems. Members of the IMC hold at least a Bachelor's degree from an accredited university in a physical science, mathematics or engineering discipline. IMC data

analysts are trained on all data collection, validation, and reporting software tools used in data management as part of their routine job duties.

ARS field specialists also hold at least a Bachelor's degree from an accredited university in a physical science, mathematics or engineering discipline. Field specialists are trained on all maintenance, calibration and troubleshooting responsibilities specific to equipment and procedures utilized for this project. Field specialists are required to undergo annual tower training and maintain current First Aid and CPR certifications.

Site operators are trained by field specialists on routine maintenance and troubleshooting procedures during site initialization and during semiannual maintenance visits. All instrumentation and support equipment function is thoroughly explained and all required site operator procedures are discussed, as detailed in the on-site quality assurance documents (QAPP, SOPs, TIs, and CIs). Site operators are encouraged to ask questions during these training sessions, and are advised to call ARS anytime a question or problem arises that needs solving or clarification.

A9 DOCUMENTATION AND RECORDS

All hardcopy records, digital data, DataView documentation, and other documents for the current and previous monitoring years reside in the IMC database and archive files. The current and most recent past year of hard copy records are housed in the IMC. The preceding five years of hardcopy records are housed in an off-site storage facility. The GPMP program manager has the final authority for the storage, access to, and final disposition of all data and records. The following types of documentation and records are used in the program:

- Field documentation, including DataView documentation files, log sheets, daily summaries, audit results, calibration results, quality control checks, records of procedures and maintenance performed, and site equipment inventories.

    - DataView documentation files are archived in the project database and used for operational checks and data validation. Files are archived with network data.
    - Manual site documentation including manual log sheets and hard copies of independent audit results are filed by site and archived annually.
    - Documentation of corrective action reports including problem identification and resolution is recorded by site and time in the network Site Status Log, a computer record of network operations. Manual notes, plots, data listings, written operator correspondence, and other hard copy products associated with problem resolution are filed by site.
    - Equipment inventory is tracked in the GPMP Equipment Inventory Database. The inventory is checked and updated after each semiannual visit. Inventory reports are submitted to the GPMP program manager twice annually. The database can also yield reports on demand.
    - Standards certification documentation for all calibration systems are maintained in hardcopy files, organized by instrument type, in the IMC.

- Project data (raw and validated) resides in the IMC database and is available for use during the life of the project. The database also tracks all actions performed on all data and assigns validation level codes and action codes to all entries. The database contains a series of validation screens which allow the data analyst to code validation levels, apply corrections, or invalidate data. For example, if the database must be supplemented by digital or manual entry of data from a non-network source, the data are entered, time-tagged, and coded appropriately. All actions are logged and coded to ensure a traceable, reproducible path back to the raw data files. All raw data are also kept independently in the database. All raw and validated data are automatically backed up nightly and raw and validated data are archived quarterly on CD, and delivered to the National Park Service Air Resources Division, and stored on- and off-site at ARS. The NPS ARD has the ultimate responsibility for ensuring the security of all data. Raw and validated data are uploaded hourly and monthly respectively to the NPS Data Request Web site (*http://ard-request.air-resource.com*). Additionally, data for the previous month is added to one of two external hard drives containing all historical data. The hard drive is provided to the GPMP Program Manager monthly. Final validated data are also uploaded monthly to the EPA AQS database for public access and archive and to the CASTNET contractor for use in the deposition model.

- Weekly project status reports are brief, written weekly reports that summarize network status, actions, and reports that occurred during the previous week and are planned to the current week. The report is e-mailed to the GPMP program manager, Research and Monitoring Branch Chief, QA manager, and all ARS staff participating in the project. The report references network products and Web sites where additional information is available.

- A project Web site is maintained as a communication tool among project participants (*http://ard-request.air-resource.com/project*). The Web site includes copies of project schedules, project reports, contact information, and other documentation.

- Twice-Annual Contract Status Reports are generated to document the history of contract task orders and modifications and delivered to the GPMP program manager and network quality assurance manager. No technical information is included in these reports.

- The Monitoring History Database contains the metadata for all NPS units over time. The metadata includes site names, abbreviations, AQS codes, coordinates, elevations, monitoring start and stop times, monitored parameters, responsible agencies, and other pertinent information. The database is reviewed and updated twice annually (spring and fall). The contents are accessible through the GPMP Data Request Web site.

- Monthly and annual data reports summarize the validated data and network performance criteria. Monthly reports only include data from NPS-operated sites. Annual reports include data summaries from NPS and cooperating agency sites.

Monthly and annual data reports are provided according to the schedule defined in **Table 2**.

- Ozone exceedance tables are generated monthly during the ozone season (April – October) and forwarded to NPS ARD for public display on the NPS Web site.

- An Annual Operational Performance Summary Report is generated each year to summarize how the network performed as compared to overall network performance goals.

- Project-related standard operating procedures, technical instructions, and checklist instructions are controlled documents that are maintained in the ARS Quality Assurance Documentation Library. A copy of the documents is maintained at each monitoring site (in both hardcopy and digitally on DataView). This Quality Assurance Project Plan (QAPP) and the Quality Management Plan (QMP) are also controlled documents. The ARS quality assurance manager is responsible for keeping the document current and maintaining a distribution list (see Section A3). Parties on the distribution list receive updated versions of the plan as they are made.

B MEASUREMENT/DATA ACQUISITION

This section describes the project design and implementation, including collecting, handling, analyzing, managing, and validating the data. This section includes the following subsections:

B1 Sampling Process Design
B2 Sampling Methods Requirements
B3 Sample Handling and Custody Requirements
B4 Analytical Methods Requirements
B5 Quality Control Requirements
B6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements
B7 Instrument Calibration and Frequency
B8 Inspection/Acceptance Requirements for Supplies and Consumables
B9 Data Acquisition Requirements for Non-Direct Measurements
B10 Data Management

B1 SAMPLING PROCESS DESIGN

The sampling procedures have been designed according to National Park Service Gaseous Pollutant Monitoring Program protocols for gaseous, particulate, and meteorological monitoring. The sampling frequencies and instrumentation are described in **Tables 6 through 7**.

The program is designed to collect gaseous, particulate, and meteorological data in selected national park units throughout the United States, including Alaska and Hawaii.

The NPS ARD has the ultimate responsibility for selecting which national parks receive monitoring stations and specifying what will be monitored within the selected parks. This selection process, however, involves cooperation among the NPS ARD, park units, and cooperating agencies, to consider:

1) Clean Air Act designation of park units
2) Existing air quality conditions
3) Potential for changes in air quality
4) Ecological region representativeness
5) Park/state/regional priorities
6) Park special designations
7) Participation in other NPS research programs
8) Other monitoring networks

These considerations are also influenced by funding levels, logistics, technology, and other factors.

This strategy and the resulting monitoring program has evolved over the years and the current configuration and direction is presented on the NPS Web site (*http://www.nature.nps.gov/air/monitoring/*). The network objectives, design, and current configuration of the ozone and meteorology components are described on the Web site. The

overall guidance for network design is to collect data throughout the U.S. to serve as the primary source of air quality information to guide NPS air resource management decisions.

Selection of a site or sites within a park unit must address EPA siting criteria and park-specific considerations. The primary guidance for siting and monitoring systems is to adhere to 40 CFR Part 58 Appendix E requirements, and follow SOP 3050, *Siting of Ambient Air Quality Monitoring Stations*. This is generally possible, but some sites present challenges resulting from power availability, resource impacts, site access, logistics, and other considerations, particularly in heavily vegetated park units with rugged terrain. However, currently all GPMP regulatory sites meet the EPA siting criteria.

The monitoring sites selected within park units are considered to be representative of overall park air quality. This can pose certain challenges in park units that have multiple ecozones and extend across several air basins. In general, funding levels restrict most park units to one monitoring site, which is chosen to be most representative of the unit. However, some of the larger park units, those with sensitive resources requiring additional information, or those needing to support broader research programs may operate more than one station.

B2 SAMPLING METHODS REQUIREMENTS

Sampling methods for gaseous, particulate, and meteorological monitoring, based on 40 CFR Part 58 Appendix E requirements, are fully detailed in the network SOPs, TIs, and CIs. The primary parameters monitored and sampling methods applied are:

Gaseous – Ozone data are collected at nearly all GPMP sites and are certified in the EPA's AQS. Other gaseous data including sulfur dioxide, carbon monoxide, and oxides of nitrogen are collected at a limited number of sites to support NPS research. These data may or may not be collected to meet EPA primary or equivalent protocols and are generally not certified by the NPS in AQS. Ozone and other gaseous data are collected hourly via telephone or IP modem from the on-site datalogger. Data from site-specific raw data files are uploaded and stored in the IMC database. If communications service is not available, data are manually downloaded weekly via the on-site laptop computer using DataView and transferred to ARS. Raw data stored on the datalogger and in the database hourly and 1-minute averages for gaseous parameters. Although in some cases, 5-minute, or 15-minute data are collected and stored in the database along with hourly averages.

Particulate Matter – Continuous particulate data are collected at selected GPMP sites using a range of instrumentation. These data generally include hourly average concentrations of PM_{10} or $PM_{2.5}$ which are further compiled into 24-hour averages. These data may or may not be collected to meet EPA equivalent protocols and are generally not certified by NPS in AQS. Data are stored in site-specific daily raw data files are uploaded and stored in the IMC database. If communications service is not available, data are manually downloaded weekly from the instrument's memory or DataView files and forwarded to ARS. Data are retrieved hourly via telephone or IP modem. Speciated aerosol samples collected from the CASTNET filter packs are analyzed and reported by the CASTNET program. Flow data from the 7-day integrated samples are collected and validated under the GPMP program, and validated data files are provided to the analytical laboratory for use in aerosol concentrations calculations.

Meteorology - Meteorological data are retrieved hourly via telephone or IP modem from the on-site datalogger. Data are stored in site-specific daily raw data files are uploaded and stored in the IMC database. If communications service is not available, data are manually downloaded weekly from the on-site laptop using DataView and transferred to ARS. Raw data can include ambient temperature (ºC), ambient relative humidity (%), scalar wind speed (m/s), vector wind speed (m/s), wind direction (º), standard deviation of wind direction (º), precipitation (mm/hr), solar radiation (W/m^2), and/or barometric pressure (mmHg). Raw data stored on the datalogger and in the database are hourly averages.

DataView stores one-minute and hourly gaseous and hourly meteorological and particulate data raw data for up to 90 days. These data can be accessed remotely to support site troubleshooting and data validation decisions.

In the event of prolonged communication failure at a site, the operator (upon direction from the IMC) can download all digital hourly average raw data from the DataView computer to an external storage device. The DataView computer can store 90 days or more of hourly average data. DataView continuously backs up the datalogger. The operator can periodically (generally weekly) transfer the data files to the IMC for processing. If there is a prolonged power outage at the site, the operator can ship the DataView laptop computer to the IMC for data retrieval up to the time of the power outage. A backup laptop is shipped to the site in exchange.

Note that the NPS also participates in the AIRNow program which requires hourly raw data uploads, displays and provides hourly raw data from a number of the GPMP sites on the NPS Web site, and allows selected users to access hourly data via an FTP site. Once data collection is complete, an automated process creates a file of the most recent data for transfer to AIRNow. This process occurs every hour and is a part of the automated data collection process.

Any proposed changes to sampling procedures are thoroughly reviewed and tested. If approved by the GPMP program manager, procedural changes are made to the appropriate quality assurance references, SOP, TI, and CI. ARS field specialists are trained in the new procedure. Hardware, datalogger programs, DataView programs, data management programs, and other required changes are made. Network-wide implementation of field-related procedural changes primarily occur in two ways:

1) Implementation and operator training during semiannual site visits.
2) Direct communication and telephone training of each site operator by ARS.

Centralized data management of field specialist-related procedures are implemented when all ARS staff are trained and the procedural change is technically ready to be implemented and approved by the GPMP program manager.

B3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

All sample handling is performed automatically via telephone or IP modem from the on-site datalogger to ARS. Data files are backed up each business day and are stored at ARS: each Friday tape is stored off-site in a fireproof vault. Data are also stored on the on-site computer for

90 days, and may be retrieved via cellular modem or written to a USB flash drive. These methods are discussed in SOP 3350, *Collection of Ambient Air Quality and Meteorological Monitoring Data.*

Handling and custody of CASTNET filters, NADP, MDN, IMPROVE, or other media collocated at GPMP sites are addressed in independent, project-specific QAPPs and SOPs.

B4 ANALYTICAL METHODS REQUIREMENTS

There are no analytical laboratory methods applied in the GPMP. Laboratory methods of CASTNET filters, NADP, MDN, IMPROVE, or other samples collocated at GPMP sites are addressed in independent, project-specific QAPPs and SOPs.

B5 QUALITY CONTROL REQUIREMENTS

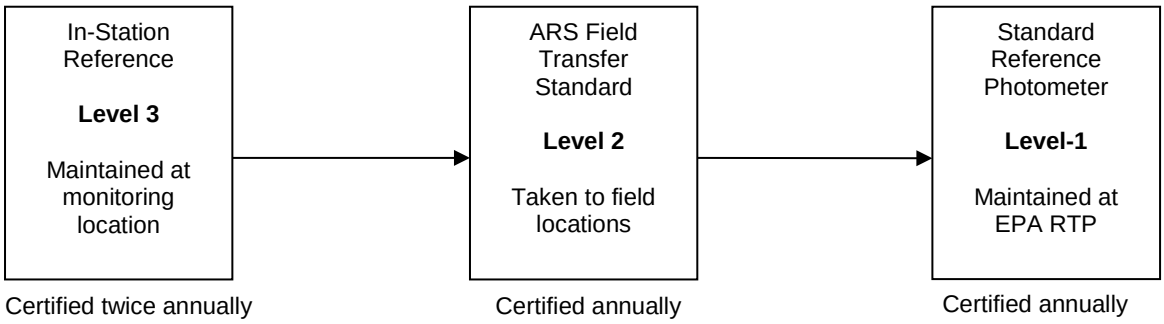
Quality control requirements for data collected at GPMP sites are discussed below. Site operator visits are scheduled to occur on a weekly basis for routine operations. **Tables 10 through 10c** present data validation and action level criteria for each monitored parameter. Action level criteria are generally set lower than validation criteria to indicate when an instrument may require recalibration or other maintenance before the loss of data occurs. Quality control checks are performed according to the instrument manufacturer's recommendations.

B5.1 Ozone Monitors

Verification and Calibration of Ozone Systems

Calibration of the ozone analyzers will be performed upon initial installation and during routine calibrations visits according to the schedule presented in **Table 2**. Additional calibrations will be performed on an as-needed basis, such as in the event of equipment repair or replacement. Calibrations will be performed in accordance with manufacturer's recommendations and consistent with USEPA guidance. The calibration method and acceptance criteria for ozone are summarized in **Table 10a**. In general, action level criteria are set to one-half the acceptance criteria listed in **Table 10a**.

The ambient analyzer and Level 3 station reference photometer are checked against a Level 2 transfer standard twice-annually for CASTNET sites. The Level 2 standard is certified annually against the NIST standard reference photometer at EPA's RTP laboratories.



The ozone analyzer and Level 3 station reference photometer are verified by a linearity check using five test concentrations and the zero value. A calibration on the ozone analyzer and station reference is then performed (if warranted) at the 0 and 80% of full-scale levels, followed by another linearity check.

Certification of the Level 2 transfer standards occurs annually at EPA laboratories. Routine calibration verification checks on the Level 2 transfer standards are performed in the ARS laboratory to verify the instruments continue to operate within expected limits. The process involves a six-point verification check (1-by-6 calibration verification). If certification is unsuccessful, the instrument undergoes troubleshooting, corrective action, and the certification process is repeated.

Calibration of the 2B ozone analyzer used at the Portable Ozone Monitoring Systems (POMS) is performed at the ARS laboratory prior to deployment. Site verification visits are performed in a similar fashion to standard sites, without the presence of a station reference. The on-site ambient analyzer is verified using the Level 2 transfer standard. If the instrument does not meet acceptance criteria in the field it is replaced with a recently serviced unit.

Performance Audits

Independent network performance assessments are performed by cooperating air quality agencies, (including state agencies or local air quality districts, who perform annual independent field performance audits), or the CASTNET auditor. Audit equipment and reference standards are provided by the auditor and will be traceable to NIST standards. Audit acceptance criteria for are summarized in **Table 10a**. Audit procedures and techniques follow established EPA audit guidelines. Audit challenge ranges and acceptable criteria for the analyzers are presented in **Table 16a**. Auditors select at least three audit levels which best bound and reflect measured concentrations at the site.

Completeness

A valid hour must have at least 45 minutes of valid data. 8-hour ozone averages must have 6 valid hours for a valid 8-hour running average.

B5.2 Other Gaseous Monitors

Verification and Calibration of Other Gaseous Analyzers

A linearity check and calibration of other gas analyzers is performed using a similar method to the ozone methodology. Mass flow controllers in the on-site gas dilution system are calibrated and leak checked by the field specialist with a NIST-traceable dry-piston-type flow meter corrected to standard temperature and pressure. A zero air supply system is used to produce the required volume of pollutant-free air to the dilution system. The linearity check is performed by generating five test concentrations using a gas dilution system calibrator that mixes zero air with and a known concentration of EPA protocol calibration gas in the appropriate proportions.

Following the linearity verification of the oxides of nitrogen analyzer, a gas phase titration (GPT) calibration is conducted. This GPT calibration uses the EPA protocol gas, gas

dilution system and ozone generator to determine the analyzer's molybdenum converter efficiency, and confirms the response of the instrument to NO_2.

The calibration method and acceptance criteria for each of the other gaseous parameters are summarized in **Table 10b**. In general, action level criteria are set to one-half the acceptance criteria listed in **Table 10b.**

Performance Audits

Independent network performance assessments are performed by cooperating air quality agencies, (including state agencies or local air quality districts, who perform annual independent field performance audits). Audit equipment and reference standards are provided by the auditor and will be traceable to NIST standards. Audit acceptance criteria for are summarized in **Table 10b**. Audit procedures and techniques follow established EPA audit guidelines. Audit challenge ranges and acceptable criteria for the analyzers are presented in **Table 16b**. Auditors select any three audit levels they choose, while selecting levels that best reflect measured concentrations at the site.

Completeness

A valid hour must have at least 45 minutes of valid data.

B5.3 Particulate Monitors

Verification and Calibration of Particulate Matter Systems

The site operator manually checks the particulate system weekly for proper operation. Field specialists calibrate the systems with NIST-traceable flow, temperature, and pressure standards upon acceptance testing of a new instrument, upon installation or removal from a monitoring location, whenever control limits are exceeded, and prior to and following any corrective action or maintenance that affects operations. Servicing procedures are identical to calibration check procedures (i.e., temperature and pressure check, flow leak check, etc.). Specific control limits of these servicing procedures are presented in SOP 3200, *Calibration and Maintenance of Continuous Particulate Samplers.*

The CASTNET mass flow controller is verified during each semi-annual maintenance and calibration visit, and calibrated if necessary. Calibration and data validation criteria are presented in **Table 10c**.

The calibration method and acceptance criteria for each of the particulate parameters are summarized in **Table 10c**. In general, action level criteria are set to one-half the acceptance criteria listed in **Table 10c.**

Performance Audits

Routine audits are not performed on the particulate monitors; however, state agencies do perform audits at some sites.

Completeness

A valid hour must include at least 45 minutes of valid data. Rolling 24-hour PM_{10}, or $PM_{2.5}$ concentrations must include at least 18 valid hours for a valid 24-hour running average.

B5.4 Meteorological Monitors

Verification and Calibration of Meteorological Systems

Instrument calibration checks will be performed using standards documented to NIST and performed according to the schedule presented in **Table 2**. Acceptance criteria and calibration method for each meteorological parameter are provided in **Table 11**. In general, action level criteria are set to one-half the acceptance criteria listed in **Table 11**.

Performance Audits

Independent network performance assessments are performed by the CASTNET auditor every other year. Audit equipment and reference standards are provided by the auditor and will be traceable to NIST standards. Audit acceptance criteria for are summarized in **Table 11**.

Completeness

A valid hour must include at least 45 minutes of valid data.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

B6.1 Inspection and Acceptance Testing

All newly purchased equipment will be inspected and acceptance tested at ARS laboratories. Analyzers are accepted if documentation of the calibration is received with the analyzer and after successful operational verification and calibration at ARS laboratories. Instrument performance is based on manufacturer's published specifications. Analyzers are also operationally verified and calibrated at time of field installation.

Monitoring support systems, such as shelters, zero air pumps, gas cylinders, regulators, racks, signal and power systems, computers, etc. are fully specified before ordering from selected manufacturers. All newly procured systems are fully inspected, loaded with required software, and are bench tested prior to acceptance.

If any instrument fails acceptance testing or is found in unacceptable condition upon receipt from the manufacturer, it is returned to the manufacturer for repair or replacement. Any instrument received from the manufacturer after repair undergoes acceptance testing procedures again.

There are numerous vendors for identical or near-identical supplies and consumables to support the gaseous measurements. Choice between vendors is determined based on cost and availability at the time of purchase.

B6.2 Maintenance of Measurement Systems

The NPS site operators perform regular gas analyzer and particulate monitor maintenance weekly. The operator performs a visual inspection of the meteorological system to determine the reasonableness of the data.

ARS staff performs scheduled semi-annual maintenance and calibrations on all instrumentation. These maintenance procedures are detailed in the SOPs listed in **Appendix A**. **Tables 12 through 15** summarize the maintenance procedures for the gas analyzers, particulate monitors, meteorological sensors and communication systems.

If an instrument does not meet calibration acceptance criteria, the issue will be resolved on-site if possible. All corrective actions are documented in the maintenance and calibration reports and reported to ARD in the weekly reports and during the monthly plot review meeting. If an instrument cannot be repaired while on-site appropriate corrective action will be taken under direction from GPMP managers.

B6.3 Replacement Parts Inventory

An inventory of replacement parts is maintained at ARS to allow for timely response to field malfunctions. This inventory minimizes downtime and data loss. When a problem is noted that could be resolved by sending a replacement system or part to the site operator for field installation, ARS notifies the operator, ships the part by express carrier, works with the operator by telephone to install the system, and verifies its operation. The site operator subsequently sends the malfunctioning system to ARS for repair. If a replacement part of the system was not readily available, the operator may be asked to ship the system to ARS for repair. Once repaired, the system is shipped to the operator for reinstallation. If field replacement or repair by the site operator is not practical, ARS informs the GPMP program manager of the need for an emergency site visit. If approved by the GPMP program manager, ARS travels to the site to correct the problem.

B7 INSTRUMENT CALIBRATION AND FREQUENCY

The purpose of calibration is to establish a relationship between the ambient conditions and an instrument's response. Challenging the instrument with known values and adjusting the instrument to respond properly to those values constitutes a calibration. An initial verification check of each gas analyzer is performed upon installation. Routine calibration is performed in accordance with the schedule presented in **Table 2**.

Semi-annual on-site activities generally consist of:

1. Performing as-found pre-maintenance checks or multi-point verifications.
2. Routine instrument maintenance.
3. Re-calibration or replacement of instruments, if required.
4. Post-calibration multi-point verification checks.
5. Final zero/span checks for gas analyzers.

Acceptable ranges for each parameter are listed in **Tables 10 through 11**. Additional calibrations are performed on an as-needed basis, such as in the event of equipment repair or replacement, or following a performance audit that indicates an instrument's accuracy limits have been exceeded. If an instrument does not meet calibration acceptance criteria, the issue will be resolved on-site if possible. All corrective actions are documented in the maintenance and calibration reports, and reported to ARD in the weekly reports and during the monthly plot

review meeting. If an instrument cannot be repaired while on-site appropriate corrective action will be taken under direction from GPMP managers.

All verification checks and calibrations are performed using certified reference standards traceable to NIST. All traceability records are maintained at ARS. The specific traceability of the exact standard used for a calibration is included on the calibration-specific computer-based calibration form. This allows all standards used for an individual calibration to be traced to NIST standards. These computer-based forms record all calibration values, make all calculations, and compare the calibration results to acceptance criteria, providing immediate feedback of calibration results. Within 30 days of each site visit, the forms and any additional supplemental explanations are compiled into a written report.

All calibrations performed on the gaseous analyzers are based on the guidance provided in 40 CFR part 50 Appendices, A-1, C, D and F, part 58 Appendix A; the *QA Handbook for Air Pollution Measurement Systems*, and/or manufacturer's recommendations. All calibrations performed on the particulate monitor are based on the guidance provided in 40 CFR part 50 Appendices J and L, part 58 Appendix A, the *QA Handbook for Air Pollution Measurement Systems*, and/or manufacturer's recommendations.

Gaseous analyzers are automatically challenged routinely with known zero, span, and precision checks. Any changes in analyzer response can be readily identified in the daily data review and weekly plots. All calibrations are based on the guidance provided in 40 CFR part 50 Appendices A-1, C, D and F, part 58 Appendix A, the *QA Handbook for Air Pollution Measurement Systems*, and/or manufacturer's recommendations.

Monthly checks of particulate samplers for flow, temperature, and pressure are performed and documented by the local site operator.

Refer to SOP 3100, *Calibration of Ambient Air Quality Analyzers*, SOP 3200, *Calibration Procedures for Continuous Particulate Samplers*, and SOP 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems* for detailed calibration procedures.

B8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

The gaseous analyzers use Teflon® particulate filters to keep the analyzer clean. These filters are replaced by the site operator monthly. These supplies do not require acceptance testing.

The gas dilution calibration uses zero air and calibration gas to deliver known concentrations of CO, NO or SO_2 to challenge the respective analyzer. The contents of calibration gas cylinders are certified EPA protocol gases. The calibration gas cylinder is replaced as needed, generally every two years. The zero air supply requires activated charcoal and Purafil® to provide zero air. This media is replaced annually or as needed. The required supplies do not require acceptance testing.

The ozone source for calibration checks, which resides in the ambient ozone analyzer, requires zero air. The zero-air is supplied by the same process mentioned above.

Consumable continuous particulate sampler supplies are dependent on the specific analyzer and a manufacturer-supplied annual consumable pack and do not require acceptance testing. Spare filter tapes are left on-site for periodic operator replacement.

The wind sensors require replacement bearings and potentiometers on a routine basis. These items are acceptance tested when they are installed in the sensor during maintenance performed at ARS.

There are numerous vendors for identical or near-identical supplies and consumables to support the measurements performed at this station. Choice between vendors is determined based on cost and availability at the time of purchase.

B9 DATA ACQUISITION REQUIREMENTS FOR NON-DIRECT MEASUREMENTS

No non-direct measurements are used in this network. Note that the Gaseous Pollutant Monitoring Program includes data collected in national parks by agencies other than the National Park Service in its annual report. These data are retrieved by ARS from the EPA Air Quality System (AQS) database and included in the National Park Service Gaseous Pollutant Monitoring Program annual report.

B10 DATA MANAGEMENT

All air quality and meteorological data are collected each hour via telephone, cellular or IP modem. Collected data are appended hourly to the IMC database. The IMC data analysts verify that all data are received and data are reviewed each business day to identify operational problems and data inconsistencies. Raw data from selected sites are uploaded hourly to AIRNow and posted to an FTP for downloads by the NPS and other approved users for specific Web displays. Raw data are also uploaded daily for access from the NPS data request Web site. Complete data validation is performed on a monthly basis. Archiving of all raw data is performed quarterly. All files are in ASCII format. Files are stored in their original formats (non-compressed) on computer hard drives and on CD. Validated data are also submitted to the EPA Air Quality System (AQS) database and uploaded to the NPS Data Request Web site. Requests for data can be made via the Internet at *http://ard-request.air-resource.com.* Hardcopies of supporting documentation are archived on a continual basis. Complete procedures for data collection, processing, and archiving are presented in SOP 3350, *Collection of Ambient Air Quality and Meteorological Monitoring Data.* The validation process including data review, data transformations, data replacements, validation acceptance criteria, validation procedures, verification procedures, validation codes, and other related validation functions are presented in SOP 3450, *Ambient Air Quality and Meteorological Monitoring Data Validation.*

C ASSESSMENT/OVERSIGHT

This section describes the activities for assessing the implementation of the Gaseous Pollutant Monitoring Program and associated quality assurance/quality control (QA/QC) activities. This section includes the following subsections:

C1 Assessments and Response Actions
C2 Reports to Management

C1 ASSESSMENTS AND RESPONSE ACTIONS

Network operations, data quality, and data completeness of the monitoring system are assessed each business day by ARS. If a problem occurs upon daily data review, the IMC data analysts notify the IMC manager, and the GPMP program manager if warranted, about the problem, its severity and probable resolution. This situation is documented in the Site Status Log. If the problem is data management-related, the data analysts will correct the problem in the IMC. If the problem requires on-site resolution, the site operator documents the occurrence and resolution in the DataView computer. ARS responds immediately to any inconsistencies noted in the data.

Assessments of the project include daily data review along with on-site instrument checks by the site operator weekly, during field calibration visits by ARS staff (semiannually), and during annual auditing of the instrumentation by the Independent auditor. Field assessments are performed as discussed below.

The site operator visits the station weekly to observe the status of equipment and replaces filters and consumable supplies as needed. Regular physical inspection of the instrumentation is critical to collection of quality assured data.

ARS staff performs pre-maintenance checks of the gaseous analyzers and particulate monitors prior to any service or adjustment. This verification is used to assess the “as found” response of the analyzers. Equipment is serviced upon acceptance testing of a new instrument, upon installation or removal from a monitoring location, whenever control limits are exceeded, prior to and following any corrective action or maintenance that affects its operation, or on a semi-annual schedule. A leak check and flow verification of particulate instruments is also performed monthly by the site operator. If an instrument does not meet calibration criteria, the issue will be resolved on-site if possible. All corrective actions are documented in the maintenance and calibration reports and reported to GPMP managers in the weekly reports. If an instrument cannot be repaired while on-site, GPMP managers will be notified and appropriate corrective action will be taken under direction from GPMP.

The O_3 analyzer is calibrated using a Level 2 ozone transfer standard. Other gaseous instrumentation is calibrated using a lab-certified, EPA protocol gas bottle and calibrated gas dilution calibrator. The gas bottle is certified upon purchase and as required thereafter. The gas dilution calibrator is flow-calibrated semi-annually using NIST-traceable flow standards, which are certified annually.

Independent network performance assessments are performed by cooperating air quality agencies, (including state agencies or local air quality districts, who perform annual independent field performance audits), or the CASTNET auditor. Non-CASTNET sites will receive a federal NPAP audit at least once every five years. Audit procedures and techniques follow established EPA audit guidelines. Audit challenge ranges and acceptable criteria for the analyzers are presented in **Tables 16a and 16b.** Auditors select at least three audit levels which best bound and reflect measured concentrations at the site.

The NPS will work with the EPA to ensure an independent Technical Systems Audit (TSA) is performed a minimum of once every three years. The NPS will arrange the audits as appropriate with individual EPA regions, EPA OAQPS, or state agencies. The results of the TSAs will be provided to the GPMP program manager who will be responsible for implementing systematic adjustments to address all audit suggestions.

Monthly plot reviews are performed each month after the data have been validated. These plot reviews, attended by the GPMP program manager and ARS staff, provide a means of assessing the overall quality of the validated data for each month. Problems from individual data points to systematic inconsistencies are addressed and corrective actions initiated.

Results of all calibration assessments are documented on ARS' computer-based calibration worksheets. If the field specialist determines that the instrument is operating outside of project accuracy goals they will take immediate action to correct the noted problem during site maintenance and calibration. Field assessments are performed as discussed in Section B and **Appendix A**.

C2 REPORTS TO MANAGEMENT

Reports to management include weekly and semiannual status reports, as well as monthly and annual data reports. The schedule of distribution of these reports is presented in **Table 2**. ARS delivers the following reports to NPS ARD.

Weekly Progress Reports - Weekly progress reports (via e-mail) contain technical information regarding network status and detail any network issues, resolution to those issues, site visits, reporting and data requests, any changes in contract information, and any significant events of note.

Monthly Data Reports - Monthly data reports are delivered via e-mail within 35 days of month end and include a monthly summary of gaseous, particulate, and meteorological data by site, and the monthly data collection statistics for all collected parameters for each site.

Ozone Exceedance Tables - Generated monthly during the ozone season (April – October) – within 5 days of a completed month.

Semiannual Contract Status Reports - Quarterly contract status reports are delivered via e-mail and summarize the status of each contract Task Order and Task Order amendment. No data are included in the reports. The reports are delivered twice per year.

Annual Data Reports - Annual data reports are delivered once per year and include site specification information, data collection statistics, summary of gaseous, particulate, and meteorological data, comparison of collected gas concentrations to the National Ambient Air Quality Standards.

Annual Network Performance Summary Report - Prepared each year to summarize how the network performed as compared to overall Network Performance Goals.

Annual AQS Ozone Data Certification Packet – Prepared annually. The packet includes data and QA/QC summaries from AQS. The packet is signed by the NPS and forwarded to the EPA.

Site Visit Reports - Site visit maintenance reports contain detailed information regarding procedures performed and conditions found during semiannual and emergency site visits. They also contain completed calibration forms for all parameters checked.

Project Web Site - The project Web site contains information of interest to project participants including copies of all project reports, site visit documentation, site visit schedules, contact information, and other important information. Portions of the Web site are updated weekly and other, more static portions are updated monthly.

Data Request Web Site – Raw data are uploaded hourly and validated data are uploaded monthly to the publicly accessible Data Request Web Site. Data may be retrieved in spreadsheet-ready ASCII files, or in graphical format (such as stacked time series plots and wind roses).

D DATA VALIDATION AND USABILITY

This section describes the activities that occur after the data collection phase of the Gaseous Pollutant Monitoring Program is completed. This section includes the following subsections:

D1 Data Review, Validation, and Verification Requirements
D2 Validation and Verification Methods
D3 Reconciliation with User Requirements

D1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

All data will undergo specific validation procedures detailed in SOP 3450, *Ambient Air Quality and Meteorological Monitoring Data Validation* and SOP 3456, *Continuous Particulate Monitoring Data Validation.* Ambient data are processed through several levels of validation by ARS staff. Data are reviewed daily and validation is performed monthly. Specific data validation criteria used for all monitored parameters are listed in **Tables 10 through 11**. It is important to note that further investigation is required before invalidating data on the basis of quality assurance checks.

D2 VALIDATION AND VERIFICATION METHODS

Analytical methods for gaseous, particulate matter, and meteorology data collection for the Gaseous Pollutant Monitoring Program are discussed below. Detailed procedures can be found in SOP 3450, *Ambient Air Quality and Meteorological Monitoring Data Validation* and SOP 3456, *Continuous Particulate Monitoring Data Validation.* Validation of all parameters includes three validation levels: Level 0, Preliminary, and Final (Level-1); a flowchart detailing these procedures is presented as **Figure 2**. ARS personnel validate all data.

Level 0 data validation:

The data validation process begins with a visual review and automated screening. The data analysts:

- Collect data via a telephone or IP modem communication system.
- Visually review daily numeric raw data.
- Initially screen the daily data for anomalies.
- Visually review graphed raw data on stackplots on a daily basis.
- Review site documentation from the site operators.
- Check calibration data (zero and span values) for the expected range.

If an error occurs in the daily file download, or a problem exists in the ASCII raw data file, the download is automatically retried twice more. If a problem still exists and a complete file is not obtained, the data analysts attempt a manual download, and if necessary, confer with Information Technology staff as to the problem. The data analyst and Information Technology staff will work in conjunction until the daily file is obtained.

After data for the hour are verified, they are screened for anomalies by a computer program. This program applies anomaly flags (Level 0 validation codes), that are added to any datalogger flags that were loaded with the raw data from the datalogger. Once the data have been verified, screened, and all problems reported, the data are stored in the project database. Corrective action is initiated to resolve any noted inconsistencies and the problem and actions are entered in the Site Status Log.

Preliminary data validation:

Preliminary validation determines whether each data value meets validation acceptance criteria. The data analysts:

- Review site documentation and site visit reports.
- Review the ARS Site Status Log.
- Record and review comments on the raw data stackplots.
- Review daily summaries.
- Review calibration plots.
- Enter and review any independent performance audit data received for the site/month into the database.
- Enter validation codes into and adjust values in the database as needed.
- Update the ARS Data Validation Log.
- Review validated data stackplots.

Validation acceptance criteria and the methods for determining if a data value meets the criteria are usually related to one of the following events or limitations:

- Data are out of instrument specifications.
- Data exceed minimum or maximum expected value.
- Data exceed minimum or maximum expected rate of change.
- Station temperature is out of specified limits.
- Zero and span check data are outside of specified limits.
- Data are affected by calibration check.
- Less than 45 minutes of data are available (hourly averaging period).
- Instrument or datalogger was affected by acts of nature.
- Instrument or datalogger was affected by power failure.
- Data capture was affected by a datalogger failure.
- Data were affected by operator maintenance or calibration check.
- Data were affected by site operator error.
- Data were affected by instrument malfunction or failure.
- Data were below lower detectable limit.

During the Preliminary validation process, validation codes are applied to each hourly average value for each parameter in the database. The codes entered are guided by the datalogger and anomaly screening and datalogger flags that are already in the database. A

validation code is entered for each data point in a field separate from the datalogger and anomaly screening flags.

Final (Level-1) data validation:

Data analysts:

- Participate in a group plot review that includes input from the NPS program manager, ARS program manager, the section managers. The review is used to resolve all questionable validation issues.
- Make necessary validation code changes in the IMC database based on the group plot review discussion.
- Generate and review monthly data reports.
- Resolve all inconsistencies and label the data as final.

If a validation error is found after the data are labeled as final, the following steps are taken:

- The necessary changes are made in the IMC database.
- A detail log record explaining the changes made is added to the Data Validation Log for the site/month.
- Data are corrected in the NPS Data Request Web site and EPA AQS systems, and re-delivered to CASTNET personnel if the data are from a CASTNET site.

D3 RECONCILIATION WITH USER REQUIREMENTS

The National Park Service Air Resources Division established the Gaseous Pollutant Monitoring Program to measure existing levels of air pollution in the National Park Service units. Gaseous, particulate, and meteorological monitoring systems were installed to provide scientifically defensible air quality data.

The monitoring program was designed to collect gaseous, particulate, and meteorological data to characterize the extent, frequency of occurrence, and magnitude of air quality impacts. Data are expected to provide a true representation of air quality in National Park Service units, and fulfill the NPS ARD goals and objectives, which are defined in Section A5.

Evaluation of the data collected as related to the network DQO is provided in the annual data report. This report includes both data and analyses (prepared by NPS ARD) that apply and interpret the data relative to the DQO.

All validated data are also uploaded to the EPA AQS and the NPS Web sites where they are available for universal application. All data considered valid meet the defined network acceptance criteria, as verified by all of the quality assurance procedures and documentation applied in the data validation process. These procedures include calibrations, automated and manual precision accuracy tests, independent performance audits, technical systems audits, and

all other methods used to ensure data quality. Ozone data from most sites are certified annually to the EPA as formalized in a letter from the GPMP program manager to the EPA. The letter and required support documentation states that to the best of the NPS' knowledge, all data posted on AQS and the NPS Web sites are valid as defined by the stringent GPMP program QA/QC requirements and EPA guidelines.

REFERENCES

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NPS ARD Web site (http://www.nature.nps.gov/air)

GPMP Project Web site (http://ard-request.air-resource.com/project)

NPS Data Request Web site (http://ard-request.air-resource.com)

NPS GPMP Standard Operating Procedures and Technical Instructions (see Appendix A)

Table 1 Key Program Personnel and Responsibilities

Key Role	Personnel	Responsibilities
Gaseous Pollutant Monitoring Network (GPMP) National Park Service (NPS)		
Program Manager	Barkley Sive	Directs the technical aspects of the Gaseous Pollutant Monitoring Program, including reviews of ARS performance, analyzing and approving data from the NPS GPMP, and reviewing and approving quality assurance procedures. He serves as the Contracting Officer's Representative (COR) for the program.
Chief, Research and Monitoring Branch	John Vimont	Directs the overall NPS air quality monitoring programs. Ensures that NPS monitoring is relevant to resource management needs of the service. Ensures that NPS monitoring meets quality goals and can withstand scientific scrutiny.
Park Air Quality Supervisors	Various	Park air quality supervisors coordinate with the NPS ARD to receive funding and provide support (including a site operator) of the GPMP monitoring site(s) in their NPS units.
Site Operators	Various	Responsible for routine operation of the monitoring equipment. He/she reports to the ARS project manager and is trained by ARS staff. He/she is available to assist the ARS visits.
AMEC		
Project Manager	H. Kemp Howell	Provides overall leadership and direction for the CASTNET program, including review and approval of all CASTNET deliverables, monthly reports and is accountable for compliance with project scope, schedule and budgets. He has the authority to stop-work on any or all activities and allocated resources and personnel.
Quality Assurance Manager	Marcus O. Stewart	Responsible for reviewing all reports and supporting analysis, oversees the CASTNET audit program, prepares annual and quarterly QA reports, approves implemented corrective actions and stops delivery of all products and reports that do not meet QA requirements.
Clean Air Status and Trends Network (CASTNET)		
Program Technical Monitor	Gary Lear (EPA)	Works with the GPMP program manager to coordinate cooperation between the GPMP and CASTNET programs.

Table 1 Key Program Personnel and Responsibilities (continued)

Air Resource Specialists, Inc. (ARS)		
Program Manager	Joe Adlhoch	The primary point of contact between National Park Service Air Resources Division and Air Resource Specialists, Inc., and is responsible for all contracting activities, project technical and fiscal reporting.
IMC Manager	Jessica Ward	Oversees and coordinates the daily schedule of the IMC, including data collection, validation, reporting, archive, and review of site visit and audit documentation.
Data Analyst / IMC Team Lead	Emily Wiechman	Leads the Information Management Center (IMC) team, which performs daily collection, review, and preliminary validation of all data. They also prepare reports, deliverable data files, and data archive.
Network Operations Manager	Mike Slate	Responsible for coordinating field activities; maintenance, and calibration visits; field service visits; operator support and training; instrument and support system procurement.
Technical Assistant	Genevieve Lariviere	Responsible for purchasing equipment and maintaining the network equipment inventory, maintaining the project Web site, assisting with technical progress reports, monthly financial reports, monthly and annual data and inventory reports, and maintaining a variety of network and field support documentation.
Field Specialists	David Beichley Nick Dummer Will Yahr Graham Ewing Mike Farinacci	Perform field activities including equipment procurement, integration and testing, installation, operator training, and twice annual calibration and maintenance visits. They provide site operator technical support.
Quality Assurance Manager	Emily Vanden Hoek	Manages all quality control and quality assurance activities for the project. They are also responsible for maintaining the official, approved QAPP, and project-related standard operating procedures, support system procurement; repair and verification of all calibration standards; and preparation, review, and implementation of field-related quality control (QC) and quality assurance (QA) procedures.
Quality Assurance Officer	Christian Kirk	

Table 2 Program Schedule

Task	Task Description	Performance Period/Due Date
Network Operations	Equipment procurement and site selection	As needed
Quality Assurance	Develop a quality system	QAPP Revision 3 (March 2015)
Equipment Operations	Inspection of equipment	Weekly (NPS Site operator)
	Maintenance and calibration visits	Semiannually (ARS)
	Independent Audits	Annually (Cooperating agencies/CASTNET Auditor)
	Emergency Maintenance	Contingent
Data Management and Reporting	Data Collection and AIRNow uploads	Hourly
	Progress Reports - Network issues - Site status log entries - Site visitation schedule - Reporting and data requests - Pending contract information	Every Tuesday
	Data Reports - Summary data tables - Data comparisons against NAAQS - Data collection statistics	Monthly within 35 days
	Ozone Exceedance Tables	5th of the month during ozone season
	EPA AQS Data uploads	Monthly within 60 days
	CASTNET Data uploads	Monthly within 90 days
	Formal data and program review (ARS and GPMP personnel)	Monthly
	Validated Data Reports - Summary data tables and products - Data comparison against NAAQS - Data collection statistics - Data precision statistics	Annually

Table 3 Gaseous Pollutant Monitoring Program Site Specifications.

NPS-Operated Gaseous Pollutant Monitoring Program (GPMP) Sites					
Site Name and Abbreviation		AQS-ID	Latitude	Longitude	Elevation
Acadia National Park - McFarland Hill	ACAD-MH	23-009-0102	44.3472	68.2278	466
Big Bend National Park	BIBE-KB	48-043-0101	29.3027	-103.1778	1057
Canyonlands National Park	CANY-IS	49-037-0101	38.4583	-109.8213	1794
Carlsbad Caverns National Park	CAVE-MA	35-015-3001	32.1783	-104.4406	1349
Chiricahua National Monument	CHIR-ES	04-033-8001	32.0094	-109.3891	1569
Craters of the Moon National Monument and Preserve	CRMO-VC	16-023-0101	43.4621	-113.5620	1801
Death Valley National Park	DEVA-PV	06-027-0101	36.5089	-116.8477	133
Denali National Park and Preserve	DENA-HQ	02-290-0003	63.7232	-148.9676	663
Dinosaur National Monument	DINO-WE	49-047-4002	40.4372	-109.3047	1456
Escalante National Monument	ESCA-VC	49-017-0004	37.7718	-111.6154	1806
Everglades National Park - Beard Center	EVER-BC	12-086-0030	25.3912	-80.6808	1
Fort Donelson National Battlefield	FODO-GB	N/A	36.4817	-87.8569	158
Fort Laramie National Historic Site	FOLA-NB	56-015-0004	42.2091	-104.5487	1298
Glacier National Park	GLAC-WG	30-029-8001	48.5103	-113.9968	964
Grand Canyon National Park	GRCA-AS	04-005-8001	36.0586	-112.1836	2070
Grand Teton National Park	GRTE-SS	56-039-0008	43.6709	-110.5994	2035
Great Basin National Park	GRBA-MY	32-033-0101	39.0051	-114.2159	2058
Great Smoky Mtns. NP - Cades Cove	GRSM-CC	47-009-0102	35.6042	83.7831	564
Great Smoky Mtns. NP - Clingmans Dome (seasonal)	GRSM-CD	47-155-0102	35.5620	-83.4975	2082
Great Smoky Mtns. NP - Cove Mountain	GRSM-CM	47-155-0101	35.6967	-83.6097	1243
Great Smoky Mtns. NP - Look Rock	GRSM-LR	47-009-0101	35.6335	-83.9416	801
Great Smoky Mtns. NP - Look Rock NCore	GRSM-LN	47-009-0101	35.6335	-83.9416	801
Haw aii Volcanoes National Park - Observatory	HAVO-OB	15-001-0007	19.4204	-155.2878	1250
Haw aii Volcanoes National Park - Visitors Center	HAVO-VC	15-001-0005	19.4309	-155.2580	1201
Joshua Tree NP - Black Rock	JOTR-BR	06-071-9002	34.0696	-116.3889	1243
Joshua Tree NP - Cottonw ood Canyon	JOTR-CC	06-065-0008	33.7413	-115.8204	991
Joshua Tree NP - Pinto Wells	JOTR-PW	06-065-1004	33.9397	-115.4108	326
Kings Mountain National Military Park	KIMO-BM	45-021-0003	35.1314	-81.4050	340
Lassen Volcanic National Park	LAVO-ML	06-065-1004	40.5400	-121.5765	1755
Mammoth Cave National Park	MACA-HM	21-061-0501	37.1318	-86.1430	230
Meeker	MEEK-PS	08-103-0005	40.0039	-107.8475	2007
Mesa Verde National Park	MEVE-MY	08-083-0101	37.1984	-108.4905	2170
Mojave National Preserve	MOJA-KM	06-071-1001	35.1019	-115.7767	1212
Petrified Forest National Park	PEFO-SE	04-017-0119	34.8225	-109.8925	1712
Pinnacles National Monument	PINN-SE	06-069-0003	36.4832	-121.1569	317
Rangely	RANG-GC	08-103-0006	40.0869	-108.7614	1647
Rocky Mountain National Park - Longs Peak	ROMO-LP	08-069-0007	40.2781	-105.5456	2742
Sequoia/Kings Canyon National Parks - Ash Mountain	SEKI-AS	06-107-0009	36.4895	-118.8292	510
Sequoia/Kings Canyon National Parks - Low er Kaw eah	SEKI-LK	06-107-0006	36.5661	-118.7777	1932
Shenandoah National Park	SHEN-BM	51-113-0003	38.5231	-78.4347	1068
Shiloh National Military Park	SHIL-RT	N/A	35.1572	-88.3394	137
Theodore Roosevelt National Park	THRO-VC	38-007-0002	46.8948	-103.3777	840
Voyageurs National Park	VOYA-SB	27-137-0034	48.4125	-92.8292	427
Walden	WALD-CR	08-057-0003	40.8824	-106.3062	2417
Wind Cave	WICA-VC	46-033-0132	43.5576	-103.4839	1288
Yellow stone National Park - Old Faithful Snow Lodge	YELL-OS	56-039-1013	44.4582	-110.8253	2251
Yellow stone National Park - Water Tank	YELL-WT	56-039-1011	44.5654	-110.4003	2430
Yellow stone National Park - West Entrance	YELL-WS	30-031-0013	44.6578	-111.0908	2027
Yosemite National Park	YOSE-TD	06-043-0003	37.7133	-119.7062	1599
Zion National Park	ZION-DW	49-053-0130	37.1984	-113.1507	1217

Table 4 National Park Service Gaseous Pollutant Monitoring Program Monitoring Sites and Parameters Measured

NPS-Operated Gaseous Pollutant Monitoring Program (GPMP) Sites										
Site Name	Abbreviation	Monitoring Category	Air Quality Parameters							Meteorology
			O_3	PM	SO_2	CO	NO_X	NO_Y	Filter Pack	
Acadia National Park - McFarland Hill	ACAD-MH	CASTNET	S	S					N	S
Big Bend National Park	BIBE-KB	CASTNET	N						N	N
Canyonlands National Park	CANY-IS	CASTNET	N						N	N
Carlsbad Caverns National Park	CAVE-MA	POMS	N							N
Chiricahua National Monument	CHIR-ES	CASTNET	N						N	N
Craters of the Moon National Monument and Preserve	CRMO-VC	FEM	N							N
Death Valley National Park	DEVA-PV	FEM	N							N
Denali National Park and Preserve	DENA-HQ	CASTNET	N						N	N
Dinosaur National Monument	DINO-WE	CASTNET	N						N	N
Escalante National Monument*	ESCA-VC	Other	S							S
Everglades National Park - Beard Center	EVER-BC	CASTNET							N	N
Fort Donelson National Battlefield	FODO-GB	POMS	N							N
Fort Laramie National Historic Site	FOLA-NB	FEM		N						N
Glacier National Park	GLAC-WG	CASTNET	N						N	N
Grand Canyon National Park	GRCA-AS	CASTNET	N						N	N
Grand Teton National Park	GRTE-SS	FEM	N							N
Great Basin National Park	GRBA-MY	CASTNET	N						N	N
Great Smoky Mtns. NP - Cades Cove	GRSM-CC	FEM	S							N
Great Smoky Mtns. NP - Clingmans Dome (seasonal)	GRSM-CD	FEM	N							N
Great Smoky Mtns. NP - Cove Mountain	GRSM-CM	FEM	N							N
Great Smoky Mtns. NP - Look Rock	GRSM-LR	CASTNET	N	S					N	N
Great Smoky Mtns. NP - Look Rock NCore	GRSM-LN	FEM			N	N		N		
Hawaii Volcanoes National Park - Observatory	HAVO-OB	Other		N	N					N
Hawaii Volcanoes National Park - Visitors Center	HAVO-VC	Other			N					N
Joshua Tree NP - Black Rock	JOTR-BR	CASTNET	N						N	N
Joshua Tree NP - Cottonwood Canyon	JOTR-CC	FEM	N	N						N
Joshua Tree NP - Pinto Wells	JOTR-PW	POMS	N							N
Kings Mountain National Military Park	KIMO-BM	POMS	N							N
Lassen Volcanic National Park	LAVO-ML	CASTNET	N						N	N
Mammoth Cave National Park	MACA-HM	CASTNET	N	S	N	N	N		N	N
Meeker*	MEEK-PS	Other	S	S			S			S
Mesa Verde National Park	MEVE-MY	CASTNET	N						N	N
Mojave National Preserve	MOJA-KM	POMS	N							N
Petrified Forest National Park	PEFO-SE	CASTNET	N						N	N
Pinnacles National Monument	PINN-SE	CASTNET	N						N	N
Rangely*	RANG-GC	Other	S	S			S			S
Rocky Mountain National Park - Longs Peak	ROMO-LP	CASTNET	N						N	N
Sequoia/Kings Canyon National Parks - Ash Mountain	SEKI-AS	CASTNET	N	S					N	N
Sequoia/Kings Canyon National Parks - Lower Kaweah	SEKI-LK	FEM	N							N
Shenandoah National Park	SHEN-BM	CASTNET	N	S					N	N
Shiloh National Military Park	SHIL-RT	POMS	N							N
Theodore Roosevelt National Park	THRO-VC	CASTNET	S	S	S				N	N
Voyageurs National Park	VOYA-SB	CASTNET	N						N	N
Walden*	WALD-CR	Other	S				S			S
Wind Cave	WICA-VC	CASTNET	S	S	S		S		N	N
Yellowstone National Park - Old Faithful Snow Lodge	YELL-OS	Other		N		N				N
Yellowstone National Park - Water Tank	YELL-WT	CASTNET	N						N	N
Yellowstone National Park - West Entrance	YELL-WS	FEM		N		N				N
Yosemite National Park	YOSE-TD	CASTNET	N						N	N
Zion National Park	ZION-DW	FEM	N							N

N = Operated by NPS ARD
S = Operated by other agency

Footnotes
* Site operates under another QAPP and is not governed by this QAPP

Air Quality Parameters
O3 - Ozone
PM - Particulates
SO2 - Sulfur Dioxide
CO - Carbon Monoxide
NOX - Oxides of Nitrogen
NOY
Filter Pack

Table 5 National Park Service Gaseous Pollutant Monitoring Program Ozone Monitoring Sites for Data Certification

NPS-Operated Gaseous Pollutant Monitoring Program (GPMP) Sites		
Site Name	**Abbreviation**	**Monitoring Category**
Big Bend National Park	BIBE-KB	CASTNET
Canyonlands National Park	CANY-IS	CASTNET
Carlsbad Caverns National Park	CAVE-MA	POMS
Chiricahua National Monument	CHIR-ES	CASTNET
Craters of the Moon National Monument and Preserve	CRMO-VC	FEM
Death Valley National Park	DEVA-PV	FEM
Denali National Park and Preserve	DENA-HQ	CASTNET
Dinosaur National Monument	DINO-WE	CASTNET
Glacier National Park	GLAC-WG	CASTNET
Grand Canyon National Park	GRCA-AS	CASTNET
Grand Teton National Park	GRTE-SS	FEM
Great Basin National Park	GRBA-MY	CASTNET
Great Smoky Mtns. NP - Clingmans Dome (seasonal)	GRSM-CD	FEM
Great Smoky Mtns. NP - Cove Mountain	GRSM-CM	FEM
Great Smoky Mtns. NP - Look Rock	GRSM-LR	CASTNET
Joshua Tree NP - Black Rock	JOTR-BR	CASTNET
Joshua Tree NP - Cottonwood Canyon	JOTR-CC	FEM
Lassen Volcanic National Park	LAVO-ML	CASTNET
Mammoth Cave National Park	MACA-HM	CASTNET
Mesa Verde National Park	MEVE-MY	CASTNET
Petrified Forest National Park	PEFO-SE	CASTNET
Pinnacles National Monument	PINN-SE	CASTNET
Rocky Mountain National Park - Longs Peak	ROMO-LP	CASTNET
Sequoia/Kings Canyon National Parks - Ash Mountain	SEKI-AS	CASTNET
Sequoia/Kings Canyon National Parks - Lower Kaweah	SEKI-LK	FEM
Shenandoah National Park	SHEN-BM	CASTNET
Voyageurs National Park	VOYA-SB	CASTNET
Yellowstone National Park - Water Tank	YELL-WT	CASTNET
Yosemite National Park	YOSE-TD	CASTNET
Zion National Park	ZION-DW	FEM

Table 6a Equipment and Measurement Methods – Ozone

Parameter	Typical Sample Height	Sample Frequency	Averaging Period	Manufacturer/Model	Measurement Range	Detection Limit	Precision	Measurement Method
Ozone	10meters or 4 meters	Continuous	1-hour 8-hour	Teledyne-API 400A	0-250 ppb	≤ 0.6 ppb	0.5% of reading	USEPA automated equivalent method EQOA-0992-087
				TEI 49C, 49i	0-250 ppb	1.0 ppb	1.0 ppb	USEPA automated equivalent method EQOA-0880-047
				2B Technologies Model 202	0-250 ppb	3.0 ppb	1.5 ppb or 2%	Not operated as USEPA equivalent method

Table 6b Equipment and Measurement Methods – Other Gaseous Parameters

Parameter	Typical Sample Height	Sample Frequency	Averaging Period	Manufacturer/Model	Typical Measurement Range	Detection Limit	Precision	Measurement Method*
Carbon Monoxide	4 meters	Continuous	1-hour	Teledyne-API M300EU	0-10 ppm	<20 ppb	<1% of reading or 20 ppb	USEPA automated reference method RFCA-1093-093
				TEI 48i-TLE	0-5 ppm,0-2 ppm	40 ppb	N/A	USEPA automated reference method RFCA-0981-054
Oxides of Nitrogen	4 meters	Continuous	1-hour	TEI 42C	0-100 ppb	0.4 ppb	0.4 ppb	USEPA automated reference method RFNA-1289-074
				TEI 42C-Y, 42i-Y	0-200 ppb	50 ppt	N/A	Not a USEPA reference or equivalent method
				Teledyne-API T500U	0-200 ppb	40 ppt	0.5% reading above 5 pbb	USEPA automated equivalent method EQNA-0514-212
Sulfur Dioxide	4 meters	Continuous	5-minute 1-hour	TEI 43C	0-1000/10000 ppb	2 ppb	1% of reading or 0.2 ppb	USEPA automated equivalent method EQSA-0486-060
				TEI 43i-TLE	0-200 ppb	50 ppt	1% of reading or 0.2 ppb	USEPA automated equivalent method EQSA-0486-060

*Equipment may or may not be run as reference or equivalent method. See site specification tables for which sites/parameters are operated with equivalency

Table 6c Equipment and Measurement Methods – Particulate Parameters

Parameter	Typical Sample Height	Sample Frequency	Averaging Period	Manufacturer/Model	Measurement Range	Detection Limit	Precision	Measurement Method
$PM_{2.5}$	3 meters	Continuous	1-hour 24-hour	MetOne BAM-1020	0 - 1000 µg/m^3	≤ 4 µg/m^3 (1-hr)	± 0.1 µg/m^3	USEPA automated equivalent method EQPM-0308-170, not run equivalently
				MetOne E-Sampler	0 - 65,000 µg/m^3	N/A	3 µg/m^3or 2%	Not a USEPA reference or equivalent method
				TEI 5014i BAM	0 - 1,000 µg/m^3	≤ 4 µg/m^3 (1-hr)	± 2 µg/m^3 (<80 µg/m^3)	USEPA automated equivalent method EQPM-0609-183
				TEI FH62C14	0 - 1,000 µg/m^3	≤ 4 µg/m^3 (1-hr)	± 2 µg/m^3 (<80 µg/m^3	Not run as a USEPA reference or equivalent method
				TSI DustTrak DRX 8533	0 - 150 mg/m^3	N/A	N/A	Not a USEPA reference or equivalent method
PM_{10}	3 meters	Continuous	1-hour 24-hour	TSI DustTrak DRX 8533	0 - 150 mg/m^3	N/A	N/A	Not a USEPA reference or equivalent method
				MetOne E-Sampler	0-65,000 µg/m^3	N/A	3 µg/m^3or 2%	Not a USEPA reference or equivalent method

Table 7 Equipment and Measurement Methods – Meteorological Parameters

Parameter	Sample Height	Sample Frequency	Averaging Period	Manufacturer/Model	Accuracy	Reported Decimals	Measurement Range	Measurement Method
Ambient Temperature	2 meters	Continuous	1-hour	Climatronics 100093	±0.1°C (at 23°C)	0.0	-40ºC – 60ºC	Platinum resistive temperature device (RTD)
				Vaisala HMP45/45AC	±0.2°C (@ 20°C)	0.0	-40°C – 60°C	Platinum resistive temperature device (RTD)
				R.M. Young 41342/41342VC	±0.1°C	0.0	-50°C – 50°C	Platinum resistive temperature device (RTD)
				Climatronics AIO	±0.2°C	0.0	-40°C – 50°C	
Relative Humidity	2 meters	Continuous	1-hour	Rotronic MP601A/MP101A	±1% (@ 20°C)	0.0	0% - 100%	Hygromer
				Vaisala HMP45/45AC	±1% (@ 20°C)	0.0	0% - 100%	Hygromer
				Climatronics AIO	±3%	0.0	0% - 100%	
Wind Speed	10 meters	Continuous	1-hour	Climatronics 100075	±0.07 m/s or 1.0%	0.0	0 – 65 m/s	Propeller, Starting threshold = 0.22 m/s
				R.M. Young 05305	±0.2 m/s or 1%	0.0	0 – 50 m/s	Propeller, Starting threshold = 0.4 m/s
				R.M. Young 05103	±0.3 m/s or 1%	0.0	0 – 100 m/s	Propeller, Starting threshold = 1.0 m/s
				R.M. Young 05106	±0.3 m/s or 1%	0.0	0 – 100 m/s	Propeller, Starting threshold = 1.1 m/s
				Climatronics AIO	±0.5 m/s or 5%	0.0	0 – 50 m/s	Sonic
Wind Direction	10 meters	Continuous	1-hour	Climatronics 100076	±2°	0.0	0º - 360º	Vane, Starting threshold = 0.22 m/s
				R.M. Young 05305	±3°	0.0	0º - 360º	Vane, Starting threshold = 0.5 m/s
				R.M. Young 05103	±3°	0.0	0º - 360º	Vane, Starting threshold = 1.1 m/s
				R.M. Young 05106	±3°	0.0	0º - 360º	Vane, Starting threshold = 1.1 m/s
				Climatronics AIO	±5°	0.0	0º - 360º	Sonic

Table 7 Equipment and Measurement Methods – Meteorological Parameters (continued)

Parameter	Sample Height	Sample Frequency	Averaging Period	Manufacturer/Model	Accuracy	Reported Decimals	Measurement Range	Measurement Method
Standard Deviation of Wind Direction	N/A	Continuous	1-hour	N/A	N/A	0.0	N/A	Calculated using the standard deviation of the wind direction (Yamartino method)
Precipitation	1 meter	Continuous	1-hour cumulative	Met One 370/375	±0.5%	0.00	0.254 mm/tip	Tipping bucket (heated)
				Climatronics 100508/100097	±1.0%	0.00	0.1 mm/tip OR 0.254 mm/tip	Tipping bucket (heated)
				Texas Electronics 525-various	±1.0%	0.00	0.1 mm/tip OR 0.254 mm/tip	Tipping bucket (heated)
Solar Radiation	2 meters	Continuous	1-hour	LiCor Pyranometer (various styles)	±3-5%	0	0-2000 W/m^2	Silicon photovoltaic detector
Barometric Pressure	2 meters	Continuous	1-hour	R.M. Young 61302	±0.05%	0.0	375-825 hPa	Silicon capacitive pressure sensor
				Vaisala PTB101B	±0.3 mmHg	0.0	450-795 mmHg	Silicon capacitive pressure sensor
				Climatronics AIO	±0.3 mmHg	0.0	450-825 hPa	

Table 8a Data Quality Objectives, NPS Gaseous Pollutant Monitoring Program (Ozone)

Category	Objective	Required Data / Considerations and Limitations
Ozone Measurements	• Establish baseline concentrations of air pollution in national parks • Assess trends in air quality • Determine compliance with national ambient air quality standards • Provide data for the development and revision of national and regional air pollution control policies that are protective of park resources • Provide data for atmospheric model development and evaluation	Hourly average concentrations of ambient ozone measured with EPA reference or equivalent methods that adhere at a minimum to EPA method requirements 40 CFR Part 50, reference and equivalent requirements in 40 CFR Part 53, and QA requirements in 40 CFR Part 58 Appendix A. The NPS submit the ozone data annually for certification and all ozone data are posted to the EPA AQS and made directly available to the public via the Internet by the NPS.

Table 8b Data Quality Objectives, NPS Gaseous Pollutant Monitoring Program (Other).

Category	Objective	Required Data / Considerations and Limitations
Other Ambient Gas (SO_2, CO, and NO_x) Measurements	Measure ambient concentrations of SO_2, CO, and NO_x in a selected number of national park units to address a specific research need.	Hourly or shorter duration averages of ambient gas concentrations. The sampling design may vary based on specific park issues and research objectives. High quality instrumentation will be applied, but may not meet EPA reference or equivalent standards. For example, gas concentrations may be measured at lower concentrations than the instrument's EPA certification as an equivalent method allows.
Particulate Measurements (PM_{10}, $PM_{2.5}$)	Measure continuous ambient concentrations of PM_{10}, or $PM_{2.5}$ in a selected number of national park units to address site-specific or research needs	Hourly and/or 24-hour particulate concentrations. The sampling design may vary depending on specific issues and research objectives. High quality instrumentation will be applied; but may not meet EPA reference or equivalent methods.
Meteorological Measurements	Measure meteorological conditions associated with ozone measurements in national park units throughout the U.S. to help understand ozone concentrations and for potential use in air quality models.	Hourly average measurements of selected parameters with EPA protocol methods that adhere at a minimum to EPA guidelines set forth in 40 CFR 58, Appendix A, in EPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV, Meteorological Measurements, and in EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications. All meteorological data are posted with ozone data to the EPA AQS and NPS Web site.

Table 9 Data Quality Indicators, NPS Gaseous Pollutant Monitoring Program.

Category	Performance Measure	Criteria	Applicable Equations and Regulatory Citation
Precision	Automatic one-point QC checks performed at least once every 14 days	Ozone Precision ≤ ± 7% Ozone CV ≤ 7% CO Precision <± 10% CO CV ≤ 10% NO_2 Precision ≤ ± 15% NO_2 CV ≤ 15% SO_2 Precision ≤ ± 10% SO_2 CV ≤ 10%	$d_i = \frac{analyzer\ \ response\ \ - input\ \ conc.\ x100}{input\ \ conc.}$ $CV = \sqrt{\frac{n \cdot \sum_{i=1}^{n} d_i^2 - \left(\sum_{i=1}^{n} d_i\right)^2}{n(n-1)}} \cdot \sqrt{\frac{n-1}{x^2_{0.1,n-1}}}$ 40 CFR Part 58, Appendix A
	$PM_{2.5}$ monthly flow verifications	Flow rate ±4% of transfer std ±5% of design	
	PM_{10} monthly flow verifications	Flow rate ±7% of transfer std	
Accuracy	Independent audits	Annual Performance Evaluation Single Analyzer O_3, CO, NO_2, SO_2 ≤ ± 15% Federal Audits (NPAP) Ozone ≤± 10% CO, NO_2, SO_2 ≤± 15% $PM_{2.5}$: Flow rate ±4% of transfer std ±5% of design PM_{10}: Flow rate ±10% of transfer std	$d_i = \frac{meas - audit}{audit} \times 100$ 40 CFR Part 58, Appendix A
Bias	Automatic one-point QC checks performed at least once every 14 days	Ozone Bias CV ≤ ± 7% CO, SO_2 Bias ≤ ± 10% NO_2 Bias ≤ ± 15%	$\lvert bias \rvert = AB + t_{0.95,n-1} \cdot \frac{AS}{\sqrt{n}}$ $AB = \frac{1}{n} \cdot \sum_{i=1}^{n} \lvert d_i \rvert$ $AS = \sqrt{\frac{n \cdot \sum_{i=1}^{n} \lvert d_i \rvert^2 - \left(\sum_{i=1}^{n} \lvert d_i \rvert\right)^2}{n(n-1)}}$ 40 CFR Part 58, Appendix A
Completeness	All parameters	The valid data recovery objective for the project is 75% per calendar quarter for all parameters.	$Completeness = 100 \times \frac{D_X - D_C}{D_C}$ 40 CFR Part 58, Appendix A

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Table 9 (continued) Data Quality Indicators, NPS Gaseous Pollutant Monitoring Program.

Category	Performance Measure	Criteria	Applicable Equations and Regulatory Citation
Representativeness	Site selection	Representativeness for this project is achieved by following specified siting criteria, standardization in equipment procurement and deployment and consistent implementations of all SOP's.	40 CFR Part 58, Appendix E
Comparability	All parameters	Comparability is achieved through uniform siting, equipment specifications, monitoring protocols, and validation and reporting procedures. All data are reported in standard units.	

Notes:
d_i = percent difference
meas = instrument response
audit = actual concentration or true value
$X^2_{0.1, n-1}$ = 10^{th} percentile of a chi-squared distribution with n-1 degrees of freedom
D_x = number of samples for each species that valid results are obtained
D_c = number of samples scheduled to be collected and analyzed during the year

Table 10a Calibration and Acceptance Criteria – Ozone

Measurement	Calibration Method	Frequency	Challenge	ARS Calibration Acceptance and Action Level Criteria	ARS Data Validation Acceptance Criteria*	Audit Acceptance Criteria
Ozone	Comparison by ultraviolet (UV) photometer transfer standard (traceable to EPA)	Semi-annually	% difference during multipoint challenge	≤±3%	≤±10%	≤±10%[1],≤±15%[2]
		Semi-annually	linearity	≤1%	≤2%	N/A
		1 per 2 weeks	One Point QC check (precision check)	≤±4%	≤±7%	N/A
		1 per 2 weeks	Zero Check (drift)	≤±1.5 ppb	N/A	N/A
		1 per 2 weeks	Span Check (drift)	≤±4%	≤±7%	N/A

[1]CASTNET and EPA NPAP Audits performed "through-the-probe"
[2]Other audits performed by state and local agencies in accordance with the *EPA Quality Assurance Handbook, Volume II*

Table 10b Calibration and Acceptance Criteria – Other Gaseous Parameters

Measurement	Calibration Method	Minimum Frequency	Challenge	ARS Calibration Acceptance and Action Level Criteria	ARS Data Validation Acceptance Criteria*	Audit Acceptance Criteria
Oxides of Nitrogen	Comparison by gas flow dilution of EPA protocol gas and gas phase titration of ozone and NO for NO_2 converter check	Semi-annually	% difference during multipoint challenge	≤±5%	≤±15%	≤±15%
		Semi-annually	linearity	≤1%	≤2%	N/A
		Semi-annually	Converter Efficiency	Between 96%-104%	Between 96%-104%	Between 96%-104%
		1 per 2 weeks	One Point QC check (precision check)	≤±8%	≤±15%	N/A
		1 per 2 weeks	Zero Check (drift)	≤±1.5 ppb	N/A	N/A
		1 per 2 weeks	Span Check (drift)	≤±5%	≤±10%	N/A
Carbon Monoxide	Comparison by gas flow dilution of EPA protocol gas	Semi-annually	% difference during multipoint challenge	≤±5%	≤±10%	≤±15%
		Semi-annually	linearity	≤1%	≤2%	N/A
		1 per 2 weeks	One Point QC check (precision check)	≤±5%	≤±10%	N/A
		1 per 2 weeks	Zero Check (drift)	≤±0.03 ppm	N/A	N/A
		1 per 2 weeks	Span Check (drift)	≤±5%	≤±10%	N/A
Sulfur Dioxide	Comparison by gas flow dilution of EPA protocol gas	Semi-annually	% difference during multipoint challenge	≤±5%	≤±10%	≤±15%
		Semi-annually	linearity	≤1%	≤2%	N/A
		1 per 2 weeks	One Point QC check (precision check)	≤±5%	≤±10%	N/A
		1 per 2 weeks	Zero Check (drift)	≤±1.5 ppb	N/A	N/A
		1 per 2 weeks	Span Check (drift)	≤±5%	≤±10%	N/A

Table 10c Calibration and Acceptance Criteria – Particulate Parameters

Measurement	Calibration Method	Minimum Frequency	Challenge	ARS Calibration Acceptance and Action Level Criteria	ARS Data Validation Acceptance Criteria*	Audit Acceptance Criteria
$PM_{2.5}$ (FEM)	NIST-traceable standards	monthly	Leak Check (Met One BAM-1020)	≤1.0 LPM	≤1.5 LPM	N/A
		monthly	Leak Check (Thermo 5014i BAM)	≤±2.0%	≤±2.5%	N/A
		monthly	Flow Rate Verification (transfer standard)	≤±2%	≤±4%	N/A
		monthly	Flow Rate Verification (design)	≤±2%	≤±5%	N/A
		Semi-annually	Leak Check (Met One BAM-1020)	≤1.0 LPM	≤1.5 LPM	≤1.0 LPM
		Semi-annually	Leak Check (Thermo 5014i BAM)	≤±2.0%	≤±2.5%	≤±2.5%[1]
		Semi-annually	Flow Rate Verification (transfer standard)	≤±2%	≤±4%	≤±4%
		Semi-annually	Flow Rate Verification (design)	≤±2%	≤±5%	≤±5%
		Semi-annually	Temperature Difference	≤±2°C	N/A	≤±2°C
		Semi-annually	Pressure Difference	≤±10 mmHg	N/A	≤±10 mmHg
$PM_{2.5}$ (non-FEM)	NIST-traceable standards	Semi-annually	Leak Check (Met One BAM-1020)	≤1.0 LPM	≤1.5 LPM	≤1.0 LPM
		Semi-annually	Leak Check (Thermo 5014i BAM)	≤±2.0%	≤±2.5%	≤±2.5%[1]
		Semi-annually	Flow Rate Verification (transfer standard)	≤±2%	≤±4%	≤±4%
		Semi-annually	Flow Rate Verification (design)	≤±2%	≤±5%	≤±5%
		Semi-annually	Temperature Difference	≤±2°C	N/A	≤±2°C
		Semi-annually	Pressure Difference	≤±10 mmHg	N/A	≤±10 mmHg

Table 10c Calibration and Acceptance Criteria – Particulate Parameters (continued)

Measurement	Calibration Method	Minimum Frequency	Challenge	ARS Calibration Acceptance and Action Level Criteria	ARS Data Validation Acceptance Criteria*	Audit Acceptance Criteria
PM_{10} (non-FEM) (continued)	NIST-traceable standards	Semi-annually	Leak Check	≤±2.0%	≤±2.5%	≤±2.5%[1]
		Semi-annually	Flow Rate Verification (transfer standard)	≤±4%	≤±7%	≤±10%
		Semi-annually	Flow Rate Verification (design)	≤±4%	≤±10%	≤±10%
		Semi-annually	Temperature Difference	≤±2°C	N/A	≤±2°C
		Semi-annually	Pressure Difference	≤±10 mmHg	N/A	≤±10 mmHg
Particulate Matter Speciated Aerosol (CASTNET)	Comparisons against flow standard	twice-annually	% difference of each MPC level	±2% of transfer standard	±5% of transfer standard	±5% of transfer standard*

[1] Originally, the manufacturer did not recommend leak checks on these machines. There is an audit method available, but not all auditors perform leak checks.

Table 11 Calibration and Acceptance Criteria – Meteorological Parameters

Measurement	Comparison Method	Frequency	Verification / Calibration Acceptance Criteria	Data Validation Acceptance Criteria	Audit Acceptance Criteria
Ambient Temperature	water bath	Semi-annually	±0.5°C	±1.0°C	±1.0°C
Ambient Temperature	collocated comparisons	Semi-annually	±1.0°C	±1.0°C	±1.0°C
Relative Humidity	collocated comparisons	Semi-annually	±5%	±10%	±10%
Barometric Pressure	collocated comparison	Semi-annually	±3 mmHg	±3 mmHg	±3 mmHg
Wind Speed- Accuracy	anemometer drive	Semi-annually	±0.25 m/s @ ≤5 m/s, ±5% @ > 2 m/s	±0.25 m/s @ ≤5 m/s, ±5% @ > 2 m/s	±0.25 m/s @ ≤5 m/s, ±5% @ > 2 m/s
Wind Speed- Starting Threshold	torque disk	Semi-annually	sensor dependent	N/A	sensor dependent
Wind Direction- Reference Alignment	compass using the solar azimuth method	Semi-annually	±2° from true	N/A	N/A
Wind Direction- Total Alignment	compass using the solar azimuth method	Semi-annually	±5° from true	±5° from true	±5° from true
Wind Direction- Starting Threshold	torque disk	Semi-annually	sensor dependent	N/A	sensor dependent
Solar Radiation	collocated comparisons	Semi-annually	±5%	±10%	±10%
Precipitation	known volume challenge	Semi-annually	±5%	±10%	±10%
Station Temperature	collocated comparison	Semi-annually	± 1.0°C	± 2.0°C	± 2.0°C

Table 12 Maintenance Procedures – Gaseous Instrumentation

Procedure	Frequency
REGULAR MAINTENANCE (Site Operator) • General site/system inspection • Document the visit and pertinent events in the station log • Review DataView alarms and digital strip charts since the last visit • Complete the DataView Station Visit Checklist • Verify adequate supply of expendables (desiccant, charcoal, sample filters) • Verify station temperature stayed in correct range since the last visit; adjust thermostat if necessary • Verify that the automated zero, span, and precision checks were within tolerance • Check the gaseous analyzers' Teflon® inlet filters; change if required	Weekly
SCHEDULED MAINTENANCE (ARS Field Specialist) • Pre-adjustment multipoint calibration check on all gas analyzers • Maintenance, leak checks, and calibration of gas analyzers, dilution system, and zero air system • Post-adjustment multipoint calibration check on all gas analyzers • Verify that site operator is performing all duties; retrain as required • Document all audits, maintenance, calibrations, and actions on ARS computer-based maintenance and calibration spreadsheets • Replace calibration gas bottles as required • Inventory all equipment at the site • Prepare written trip report within 30 days of visit	Twice-annually
• Change zero air supply system media	Annually
AUTOMATIC CALIBRATION REFERENCES Gas calibrations occur regularly and are automatically controlled by the datalogger. Spans are set to challenge each analyzer at 80% of each analyzer's full scale or site-specific scale. Precisions are set to challenge each analyzer at representative ambient concentrations and are between 10 and 100 ppb per Code of Federal Regulations (CFR). Ozone is generated in the O_3 analyzer and measured by both the analyzer and the reference. NO_X concentrations are obtained by mixing clean air and NIST-traceable concentrations of bottled gas in the gas dilution system. NO_2 concentrations are obtained using the gas phase titration (GPT) function of the gas dilution system.	Sample ranges indicated below (dependent on datalogger program and direction from NPS-ARD)

Table 13 Maintenance Procedures – Continuous Particulate Instruments

Procedure	Frequency
REGULAR MAINTENANCE (Site Operator) • General system inspection • Check screen for status codes	Weekly
• Flow / Temperature / Pressure check • Perform leak check • Clean the PM_{10} head or $PM_{2.5}$ Very Sharp Cut Cyclone (VSCC)	Monthly
• Replace filter or filter tape	As required
SCHEDULED MAINTENANCE (ARS Field Specialist) • General system inspection • Pre-maintenance flow, temperature, and pressure calibration check of monitor • Maintenance and calibration of monitor • Post-calibration checks immediately following service • Instrument time verification • Leak check instrument	Semi-annually

Table 14 Maintenance Procedures – Meteorological Sensors

Procedure	Frequency
REGULAR MAINTENANCE (Site Operator) • General system inspection • Observe freedom of wind vane and anemometer cups • Document observed weather conditions • Verify that all meteorological measurements appear reasonable • Perform leak check; add known volume of water to the rainfall bucket • Complete DataView checklist for each instrument • Document the station site visit and pertinent events in the DataView station log	Weekly
SCHEDULED MAINTENANCE (ARS Field Specialist) • General system inspection • Pre-maintenance calibration check all meteorological sensors • Perform system maintenance: – Clean systems – Replace wind potentiometer (if necessary) and bearings • Post-maintenance calibration of all sensors • Exchange relative humidity sensor with NIST-traceable calibrated unit	Semi-annually

Table 15 Maintenance Procedures – Data Acquisition Systems

Procedure	Frequency
REGULAR MAINTENANCE (Site Operator) • Inspect overall system, cables, and connections • Inspect the satellite dish, mounting, and cables	Weekly
SCHEDULED MAINTENANCE (ARS Field Specialist) • Inspect overall system, cables, and connections • Verify datalogger functionality • Install required security and update software • Install operating system critical update software • Check and clean physical system components	Semiannually

Table 16a Audit Ranges and Acceptance Criteria - Ozone

Audit Level	Concentration Range, ppm	Acceptance Criteria (difference between audit test gas concentration and analyzer response)
	O_3	
1	0.004-0.0059	±1.5 ppb difference or ±15% difference, whichever is greater
2	0.006-0.019	±1.5 ppb difference or ±15% difference, whichever is greater
3	0.020-0.039	±15% for any point
4	0.040-0.069	±15% for any point
5	0.070-0.089	±15% for any point
6	0.090-0.119	±15% for any point
7	0.120-0.139	±15% for any point
8	0.140-0.169	±15% for any point
9	0.180-0.189	±15% for any point
10	0.190-0.259	±15% for any point

(Table based on EPA's expanded list of audit levels, February 2011)

Table 16b Audit Ranges and Acceptance Criteria – Other Gaseous Parameters

Audit Level	Concentration Range, ppm			Acceptance Criteria (difference between audit test gas concentration and analyzer response)
	CO	NO/NO_2	SO_2	
1	0.020-0.059	0.0003-0.0029	0.0003-0.0029	±1.5 ppb difference or ±15% difference, whichever is greater
2	0.060-0.199	0.0030-0.0049	0.0030-0.0049	±1.5 ppb difference or ±15% difference, whichever is greater
3	0.200-0.899	0.0050-0.0079	0.0050-0.0079	±15% for any point
4	0.900-2.999	0.0080-0.0199	0.0080-0.0199	±15% for any point
5	3.000-7.999	0.0200-0.0499	0.0200-0.0499	±15% for any point
6	8.000-15.999	0.0500-0.0999	0.0500-0.0999	±15% for any point
7	16.000-30.999	0.1000-0.2999	0.1000-0.1499	±15% for any point
8	31.000-39.999	0.3000-0.4999	0.1500-0.2599	±15% for any point
9	40.000-50.000	0.5000-0.7999	0.2600-0.7999	±15% for any point
10	50.000-60.000	0.8000-1.000	0.8000-1.000	±15% for any point

(Table based on EPA's expanded list of audit levels, February 2011)

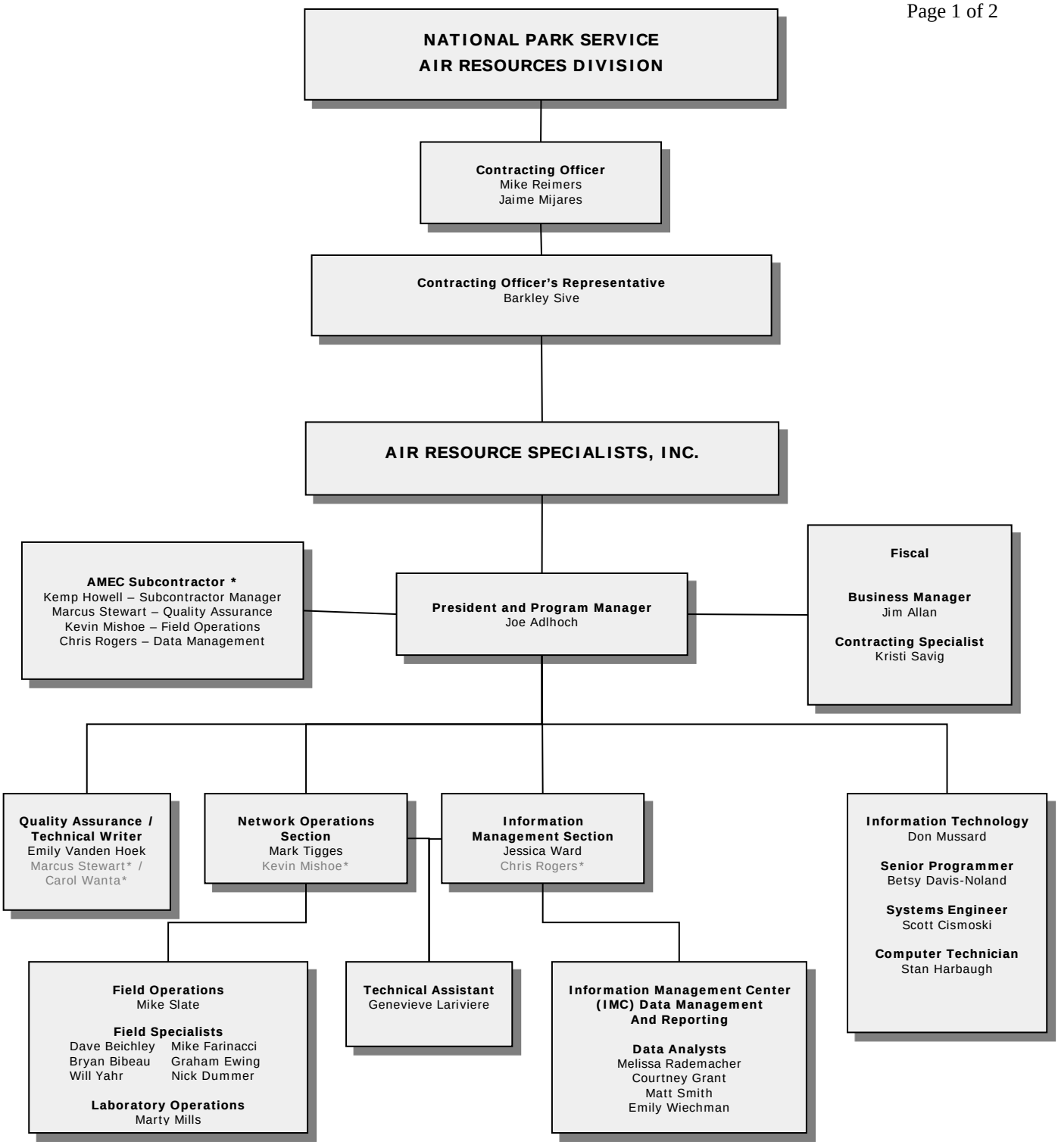

Figure 1. National Park Service Gaseous Pollutant Monitoring Program Organizational Chart.

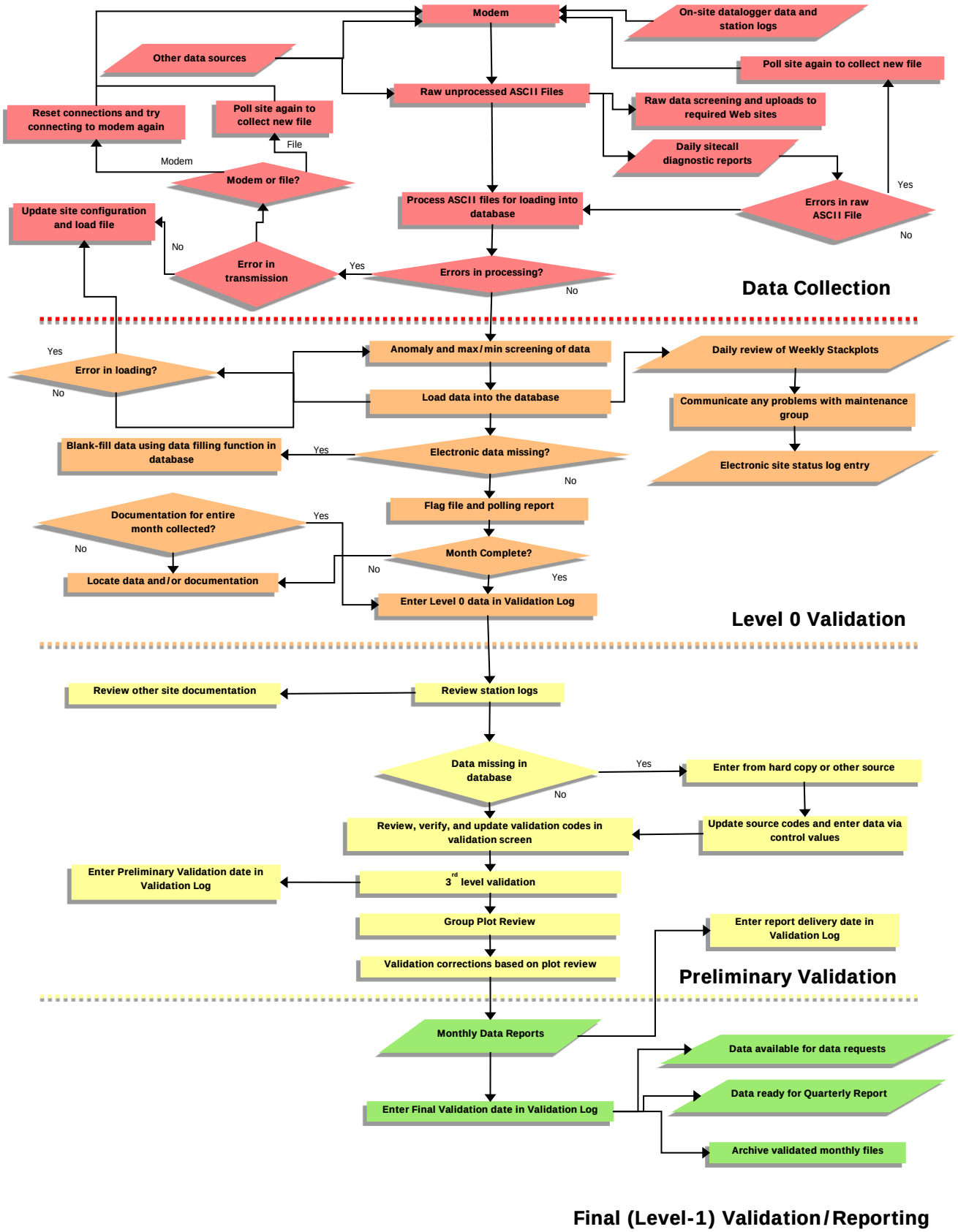

Figure 2. Gaseous Pollutant Monitoring Program Data Validation Flowchart.

APPENDIX A

NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING PROGRAM

STANDARD OPERATING PROCEDURES,
TECHNICAL INSTRUCTIONS,
AND
CHECKLIST INSTRUCTIONS

APPENDIX A – Standard Operating Procedures, Technical Instructions, and Checklist Instructions

The following standard operating procedures (SOPs), technical instructions (TIs), and checklist instructions (CIs) are used in executing this program. These documents were written by Air Resource Specialists, Inc. Please note that project-specific SOPs and TIs have not been written; this project relies in part on documents that have been prepared to support other field studies. The general policies and instructions outlined in these procedures, however, are relevant to the National Park Service Gaseous Pollutant Monitoring Program, and as such, the listed SOPs and TIs are suitable for this particular study.

Number	Title
SOP 3000	**Procedures for Semiannual Maintenance Visits to a National Park Service Ambient Air Monitoring Station**
SOP 3050	**Siting of Ambient Air Quality Monitoring Stations**
SOP 3100	**Calibration of Ambient Air Quality Analyzers**
TI 3100-2003	Calibration and Routine Maintenance of API Model 400 Series Ozone Analyzers
TI 3100-2004	Calibration and Routine Maintenance of Thermo Environmental Instruments Model 49C or 49*i* Ozone Analyzers
TI 3100-2005	Calibration and Routine Maintenance of 2B Technologies, Inc. Model 202 Ozone Analyzers
TI 3100-2021	Calibration and Routine Maintenance of Thermo Environmental Instruments Model 43C, 43*i*, or 43*i*TL Sulfur Dioxide Analyzers
TI 3100-2031	Calibration and Routine Maintenance of Thermo Environmental Instruments Model 42C or 42*i* Oxides of Nitrogen Analyzers
Ti 3100-2032	Calibration and Routine Maintenance of API Model 200E Oxides of Nitrogen Analyzers
TI 3100-2041	Calibration and Routine Maintenance of Thermo Environmental (TEI) 48C CO Analyzers

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Number	Title
SOP 3150	**Calibration and Routine Maintenance of Meteorological Monitoring Systems**
TI 3150-2020	Calibration and Routine Maintenance of Campbell Scientific CS105 Barometric Pressure Sensors
TI 3150-2022	Calibration and Routine Maintenance of R.M. Young Model 61202 Barometric Pressure Sensors
TI 3150-2100	Calibration and Routine Maintenance of Climatronics F460 or Qualimetrics 12XX Wind Speed and Direction Sensor Systems
TI 3150-2102	Calibration and Routine Maintenance of Climatronics F460 Wind Speed and Wind Direction Sensors Used With a Campbell Scientific 21XL Datalogger
TI 3150-2103	Calibration and Routine Maintenance of R.M. Young Model 05305 Wind Monitor-AQ Wind Speed and Direction Sensor Systems
TI 3150-2105	Calibration and Routine Maintenance of Climatronics or Qualimetrics Temperature/Delta Temperature Systems
TI 3150-2113	Calibration and Routine Maintenance of R.M. Young Temperature/Delta Temperature Systems
TI 3150-2114	Laboratory Calibration and Repair of Rotronic MP-101A AT/RH Sensors, Rotronic MP-601A Relative Humidity Sensors, or Vaisala 45AC AT/RH Sensors
TI 3150-2115	Field Calibration and Routine Maintenance of Rotronic MP-101A AT/RH Sensors or Rotronic MP-601A Relative Humidity Sensors
TI 3150-2116	Field Calibration and Routine Maintenance of Vaisala HMP 45 AC AT/RH Sensors
TI 3150-2120	Field Calibration and Routine Maintenance of an R.M. Young Solar Radiation System
TI 3150-2123	Field Calibration and Routine Maintenance of LI-COR Model LI-200 Pyranometers
TI 3150-2130	Field Calibration and Routine Maintenance of Climatronics 100097-1-90 Precipitation Gauge
SOP 3160	**Calibration of Data Acquisition Systems**
TI 3160-2100	Calibration of ESC 8816 or 8832 Analog Input Card

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Number	Title
SOP 3176	**Station Operator Maintenance Procedures for Meteorological Monitoring Sites Using the DataView System**
CI 3176-3100	Weekly Station Visit Wind Speed / Wind Direction Sensor (Climatronics)
CI 3176-3101	Weekly Station Visit Wind Speed / Wind Direction Sensor (R.M. Young)
CI 3176-3102	Weekly Station Visit Wind Speed / Wind Direction Sensor (R.M. Young cups)
CI 3176-3103	Weekly Station Visit Wind Speed / Wind Direction Sensor (Climatronics – No Translator)
CI 3176-3105	Weekly Station Visit Temperature (Climatronics)
CI 3176-3110	Weekly Station Visit Temperature / Delta Temperature Sensor (Climatronics)
CI 3176-3111	Weekly Station Visit Temperature / Delta Temperature Sensor (R.M. Young)
CI 3176-3115	Weekly Station Visit Air Temperature and Relative Humidity Sensor (Rotronic)
CI 3176-3116	Weekly Station Visit Air Temperature and Relative Humidity Sensor (Vaisala)
CI 3176-3120	Weekly Station Visit Relative Humidity Sensor (Rotronic)
CI 3176-3121	Weekly Station Visit Relative Humidity Sensor (Vaisala)
CI 3176-3130	Weekly Station Visit Solar Radiation Sensor (Climatronics)
CI 3176-3131	Weekly Station Visit Solar Radiation Sensor (R.M. Young)
CI 3176-3132	Weekly Station Visit Solar Radiation Sensor (Licor)
CI 3176-3150	Weekly Station Visit Precipitation Sensor (Climatronics)
CI 3176-3151	Weekly Station Visit Precipitation Sensor (Texas Electronics)
CI 3176-3153	Weekly Station Visit Precipitation Sensor (RM Young)
CI 3176-3155	Monthly Check Precipitation Sensor (various)
CI 3176-3160	Weekly Station Visit Barometric Pressure Sensor (Various)
CI 3177-3100	Weekly Station Visit R&P TEOM Model 1400a Continuous Particulate Sampler

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Number	Title
SOP 3178	**Station Operator Maintenance Procedures for Gaseous Monitoring Sites Using the DataView System**
CI 3178-3115	Weekly Station Visit, Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C)
CI 3178-3116	Weekly Station Visit, Ozone analyzer (TEI 49C) Ozone Calibrator (TEI 49C) CASTNET Dry Deposition
CI 3178-3117	Weekly Station Visit, Sulfur Dioxide Analyzer (TEI 43C TL), Carbon Monoxide Analyzer (TEI 48C), Oxides of Nitrogen Analyzer (TEI 42C), and Gas Dilution Calibrator (TEI 146)
CI 3178-3118	Weekly Station Visit, Oxides of Nitrogen Analyzer (TEI 42C), Sulfur Dioxide Analyzer (TEI 43C), Carbon Monoxide Analyzer, (TEI 48C), Ozone Analyzer (TEI 49C), and Gas Dilution Calibrator (TEI 146C)
CI 3178-3120	Weekly Station Visit, Oxides of Nitrogen Analyzer (TEI 42 and 42*i*), Sulfur Dioxide Analyzer (TEI 43C and 43*i*), Ozone Analyzer (TEI 49C and 49*i*), Ozone Calibrator (TEI 49C and 49*i*) and Gas Dilution Calibrator (TEI 146C and 146*i*)
CI 3178-3123	Weekly Station Visit, Ozone Analyzer (API 400E) Ozone Calibrator (API 703E)
CI 3178-3127	Weekly Station Visit, Ozone Analyzer (2BTechnologies), Meteorology
CI 3178-3128	Weekly Station Visit, Ozone Analyzer (2BTechnologies), Simultaneous Ozone Analyzer (2BTechnologies), Meteorology, CASTNET Dry Deposition
CI 3178-3219	Weekly Station Visit, Ozone Analyzer (2BTechnologies), Simultaneous Ozone Analyzer (2BTechnologies), Meteorology
CI 3178-3130	Weekly Station Visit, Carbon Monoxide Analyzer (TEI 48C) Ozone Calibrator (TEI 146C)
CI 3178-3140	Weekly Station Visit, Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C) Oxides of Nitrogen Analyzer (TEI 42C) Gas Dilution Calibrator (TEI 146C)
CI 3178-3154	Weekly Station Visit, Ozone Analyzer (TEI43C) Ozone Calibrator (TEI 146)
CI 3178-3157	Weekly Station Visit, Oxides of Nitrogen Analyzer (TEI 42C) Gas Dilution Calibrator (TEI 146C)
CI 3178-3311	Multipoint Calibration, Ozone Analyzer (TEI 149), Ozone Calibrator (TECO 146C)

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Number	Title
CI 3178-3315	Multipoint Calibration, Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C)
CI 3178-3330	Multipoint Calibration, Carbon Monoxide Analyzer (TEI48C) Gas Calibrator (TEI 146C)
CI 3178-3340	Multipoint Calibration, Oxides of Nitrogen Analyzer (TEI 42C) Gas Calibrator (TEI 146C)
CI 3178-3350	Multipoint Calibration, Sulfur Dioxide Analyzer (TEI 43C) Dynamic Gas Calibrator (TEI 146C)
CI 3178-3351	Multipoint Calibration, Sulfur Dioxide Analyzer (TEI 43C) Dynamic Gas Calibrator (TEI 146C) (Version 2)
CI 3178-3352	Multipoint Calibration, Sulfur Dioxide Analyzer (TEI 43C) (0ppb-500ppb) Dynamic Gas Calibrator (TEI 146)
CI 3178-3353	Multipoint Calibration, Sulfur Dioxide Analyzer (TEI 43C) (0ppb-100ppb) Dynamic Gas Calibrator (TEI 146)
CI 3178-3354	Multipoint Calibration, Sulfur Dioxide Analyzer (TEI 43CTL) (0-500ppb Range) Dynamic Gas Calibrator (TEI 146)
CI 3178-3355	Multipoint Calibration, Sulfur Dioxide Analyzer (TEI 43C) Dynamic Gas Calibrator (TEI 146C) Auto 5-Point Multipoint
CI 3178-3356	Multipoint Calibration, Sulfur Dioxide Analyzer (TEI 43C) (760ppb-840ppb) Dynamic Gas Calibrator (TEI 146)
SOP 3180	**Calibration of Mass Flowmeters and Mass Flow Controllers**
TI 3180-2000	Calibration of a Thermo Scientific 146C or 146*i* Gas Dilution Calibrator
SOP 3200	**Calibration Procedures for Continuous Particulate Samplers**
TI 3200-2000	Calibration and Maintenance of Thermo Scientific (formerly known as R&P) TEOM Model 1400ab Continuous Particulate Samplers
SOP 3230	**Routine Operations Procedures for Continuous Particulate Samplers**
TI 3230-3000	Routine Operations for TEOM Model 1400ab Continuous Particulate Samplers
SOP 3300	**Certification of Ozone Transfer Standards**
SOP 3340	**Information Management Center (IMC) Concept and Configuration**

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Number	Title
SOP 3345	**Day to Day Network Operations Technical Support for the National Park Service Gaseous and Meteorological Monitoring Program**
SOP 3350	**Collection of Ambient Air Quality and Meteorological Monitoring Data**
TI 3350-4000	Collection of Ambient Air Quality and Meteorological Monitoring Data
TI 3350-4005	Collection of DataView Files
SOP 3450	**Ambient Air Quality and Meteorological Monitoring Data Validation**
TI 3450-5000	Ambient Air Quality and Meteorological Monitoring Data – Level 0 Validation
TI 3450-5010	Ambient Air Quality and Meteorological Monitoring Data – Preliminary Validation
TI 3450-5020	Ambient Air Quality and Meteorological Monitoring Data – Final Validation
SOP 3456	**Continuous Particulate Monitoring Data Validation**
SOP 3550	**Ambient Air Quality and Meteorological Monitoring Data Reporting**
TI 3550-5000	Ambient Air Quality and Meteorological Monitoring Data Monthly Reporting
TI 3550-5100	Ambient Air Quality and Meteorological Monitoring Data Annual Reporting
TI 3550-5200	Handling Requests for Ambient Air Quality and Meteorological Monitoring Data
TI 3550-5300	Submitting Ambient Air Quality and Meteorological Monitoring Data to the EPA AQS Database
SOP 3650	**IMC Manager's Maintenance Responsibilities for the Ambient Air Quality Data Base Management System (AQDBMS)**
SOP 3750	**Meteorological Monitoring Sensor Audit Procedures**
TI 3750-6116	Rotronic MP-100F or MP-101A AT/RH Sensor Audit Procedures (IMPROVE Protocol)
SOP 3780	**Audit Procedures for Continuous Particulate Samplers**
TI 3780-6000	Audit Procedures for Rupprecht & Patashnick TEOM Model 1400ab Continuous Particulate Samplers

APPENDIX B

NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING PROGRAM

IMC NEW SITE/SITE RELOCATION FORM

Today's Date:		Change Effective Date:		Submitted by:	

Site Name:				Site Abbrev:		AQDB Site No.	
Street Address:							
City:				County:			
State:		Time Zone:		AQS ID: (XX-XXX-XXXX)			
Latitude:			Longitude:		Elevation:		m / ft
Camera:	Y / N	If Y, azimuth:	°	Station Type: (SLAMS/PSD/NCore/etc.)			

Location Setting: (circle one)	Urban / Suburban / Rural	Method of determining lat/long:	
Nearest Road:	Name:		Approximate Traffic Count:
Type: (circle one)	Arterial / Expressway / Freeway / Through Street or Highway Local Street or Highway / Major Street or Highway		

	Predominant Land Use:	Obstructions:		Topographic Features:	General Terrain:
	(Industry, Residential, Commercial or Agriculture)	Height (m)	Distance (m)	(hills, valleys, rivers, etc.)	(flat, rolling, rough, etc.)
North					
East					
South					
West					

Datalogger Type:		Comm Type:	
Telephone Number or IP Address(es):			
Logger IP Address:			
DataView IP Address:			
Camera IP Address:			
Other/phone number:			

Notes:

Collected Parameters:					
Name:	Abbrev:	Units:	AQDB ParCode:	Channel Type: (analog, RS232, etc.)	

Cardinal Direction Photos From Site	
From North	From East
From South	From West

Cardinal Direction Photos To Site	
To North	To East
To South	To West

Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood Scale Carbon Monoxide

Roadway average daily traffic, vehicles per day	Minimum separation distance[1] for probes or 90% of a monitoring path (meters)
≤ 10,000	10
15,000	25
20,000	45
30,000	80
40,000	115
50,000	135
≤ 60,000	150

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood and Urban Scale Ozone and Nitrogen Dioxide

Roadway average daily traffic, vehicles per day	Minimum separation distance[1] in meters
≤ 10,000	10
15,000	20
20,000	30
40,000	50
70,000	100
110,000	250

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

Separation Distance Between Pb Stations and Roadways (Edge of Nearest Traffic Lane)

Roadway average daily traffiic, vehicles per day	Separation distance between roadways and stations, in meters		
	Microscale	Middle Scale	Neighborhood urban regional scale
≤10,000	5-15	[1]> 15-50	[1]>50
20,000	5-15	> 15-75	>75
≥40,000	5-15	> 15-100	>100

[1] Distances should be interpolated based on traffic flow.

Site Evaluation in Conformance with EPA Requirements:

Site Name: _____ Observed by: _____

Make and Model #:

Carbon Monoxide Monitor: _____

Nitrogen Dioxide Monitor: _____

CRITERIA	REQUIREMENTS*	CRITERIA MET?	
		Yes	No
CARBON MONOXIDE			
Horizontal and Vertical Probe Placement (Par. 4.1)	3 ± 1 ½ m for microscale		
	3-15 m for middle and neighborhood scale		
Spacing from Obstructions (Par. 4.2)	≥ 270° or 180° if on side of building		
Spacing from Roads (Par. 4.3)	2-10 m from edge of nearest traffic lane for microscale; ≥ 10 m from intersection, preferably at midblock		
	See Table 1 for middle and neighborhood scale		
Spacing from Trees (Par 4.4)	Should be ≥ 10 m from dripline of trees, if tree is ≥ 5m above sampler and is between the probe and the road.	N/A	
Comments:			

NITROGEN DIOXIDE			
Vertical Probe Placement (Par. 6.1)	3-15 m above ground		
Spacing from Supporting Structure (Par. 6.1)	Greater than 1 m		
Obstacle Distance (Par. 6.2)	≥ Twice the height the obstacle protrudes above probe		
Unrestricted Airflow (Par. 6.2)	Must be 270° or 180° if on side of building		
Spacing between Station and Roadway (Par. 6.3)	See Table 2		
Spacing from Trees (Par. 6.4)	Should be ≥ 20 m from dripline of trees	N/A	
	Must be ≥ 10 m from dripline, if trees are an obstruction **		
Probe Material (Par. 9)	Teflon or pyrex glass		
Residence Time (Par. 9)	Less than 20 seconds		
Comments:			

* Citations from 40 CFR 58, Appendix E.
** A tree is considered an obstruction if it protrudes above the height of the probe by 5 meters or more.

Site Evaluation in Conformance with EPA Requirements:

Site Name: _____ Observed by: _____

Make and Model #:

Ozone Monitor: _____

Sulfur Dioxide Monitor: _____

CRITERIA	REQUIREMENTS*	CRITERIA MET?	
		Yes	No
OZONE			
Vertical Probe Placement (Par. 5.1)	3-15 m above ground		
Spacing from Supporting Structure (Par. 5.1)	Greater than 1 m		
Obstacle Distance (Par. 5.2)	≥ twice the height the obstacle protrudes above probe		
Unrestricted Airflow (Par. 5.2)	Must include predominant wind. 180° if on side of building. Otherwise 270°.		
Spacing between Station and Roadway (Par. 5.3)	See Table 3		
Spacing from Trees (Par. 5.4)	Should be ≥ 20 m from dripline	N/A	
	Must be ≥ 10 m if blocking daytime wind from urban core		
Probe Material (Par. 9)	Teflon or pyrex glass		
Residence time (Par. 9)	Less than 20 seconds		
Comments:			

SULFUR DIOXIDE			
Horizontal and Vertical Probe Placement (Par. 3.1)	3-15 m above ground		
	> 1 m from supporting structure		
	Away from dirty, dusty areas		
	If on side of building, should be on side of prevailing winter wind	N/A	
Spacing from Obstructions (Par. 3.2)	≥ 1 m from walls, parapets, penthouses, etc.		
	If neighborhood scale, probe must be at a distance ≥ twice the height the obstacle protrudes above probe		
	≥ 270°arc of unrestricted airflow around vertical probes, and wind during peak season must be included in arc		
	180° if on side of building		
	No furnace or incineration flues or other minor sources of SO_2 should be nearby	N/A	
Spacing from Trees (Par. 3.3)	Should be ≥ 20 m from dripline of trees	N/A	
	≥ 10 m when trees act as an obstruction		
Comments:			

* Citations from 40 CFR 58, Appendix E.