GASEOUS POLLUTANT MONITORING PROGRAM QUALITY ASSURANCE PROJECT PLAN (QAPP)

Prepared for the

NATIONAL PARK SERVICE
AIR RESOURCES DIVISION
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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 Gaseous Pollutant Monitoring Program Program Manager, John D. Ray	01/03/07 Date
National Park Service, Air Resources Division Network Quality Assurance Manager, David Maxwell	01/03/07 Date
U.S. Environmental Protection Agency, Clean Air Markets Division Technical Monitor CASTNet Program, Gary Lear	Date
Air Resource Specialists, Inc. Program Manager, David Dietrich	01/03/07 Date
Air Resource Specialists, Inc. Quality Assurance Coordinator, Gloria Mercer	01/03/07 Date
U.S. Environmental Protection Agency OAQPS, Michael Papp	6/6/07 Date

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
COTR	Contracting Officer's Technical 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	EPA's National Performance Audit Program
NPS ARD	National Park Service Air Resources Division
OAQPS	EPA's Office of Air Quality Planning and Standards
PAMS	Photochemical Assessment Monitoring Stations
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 D. *Measurement Principle and Calibration Procedure for the Measurement of Ozone in the Atmosphere*
- 40 CFR 58, Appendix A. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*
- 40 CFR 58, Appendix B. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*
- *EPA Quality Assurance Handbook for Air Pollution Measurement Systems:*
  - Volume I, A Field Guide to Environmental Quality Assurance
  - Volume II, Ambient Air Quality Monitoring Program Quality System Development
  - Volume IV, Meteorological Measurements
- *EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications*
- *EPA Guidance for Quality Assurance Project Plans (QAPPs)*

A2 TABLE OF CONTENTS

Section			Sec No./Page	Revision	Date
A	**PROJECT MANAGEMENT**		**A / 3**	**0**	**02/07/07**
A1	Title and Approval Sheet		A / 1	0	02/07/07
	Acronyms and Abbreviations		A / 2	0	02/07/07
A2	Table of Contents		A / 4	0	02/07/07
A3	Distribution List		A / 8	0	02/07/07
A4	Project/Task Organization		A / 8	0	02/07/07
A5	Problem Definition and Background		A / 11	0	02/07/07
A6	Project Description and Schedule		A / 12	0	02/07/07
	A6.1	Network Description	A / 12	0	02/07/07
	A6.2	Task Descriptions	A / 12	0	02/07/07
	A6.3	Schedule	A / 17	0	02/07/07
	A6.4	Reporting Requirements	A / 17	0	02/07/07
	A6.5	Disaster Recovery and Data Backup Plan	A / 17	0	02/07/07
	A6.6	Resources and Time Constraints	A / 19	0	02/07/07
A7	Quality Objectives and Criteria for Measurement Data		A / 19	0	02/07/07
	A7.1	Data Quality Objectives	A / 19	0	02/07/07
	A7.2	Data Quality Indicators	A / 19	0	02/07/07
		A7.2.1 Precision	A / 19	0	02/07/07
		A7.2.2 Accuracy	A / 20	0	02/07/07
	A7.3	Criteria for Measurement Data	A / 20	0	02/07/07
		A7.3.1 Measured Parameters	A / 20	0	02/07/07
		A7.3.2 Data Collection System	A / 20	0	02/07/07
A8	Special Training Requirements/Certification		A / 22	0	02/07/07
A9	Documentation and Records		A / 22	0	02/07/07
B	**MEASUREMENT/DATA ACQUISITION**		**B / 1**	**0**	**02/07/07**
B1	Sampling Process Design		B / 1	0	02/07/07
B2	Sampling Methods Requirements		B / 2	0	02/07/07
B3	Sample Handling and Custody Requirements		B / 3	0	02/07/07
B4	Analytical Methods Requirements		B / 3	0	02/07/07
B5	Quality Control Requirements		B / 4	0	02/07/07
B6	Instrument/Equipment Testing, Inspection, and Maintenance Requirements		B / 4	0	02/07/07
	B6.1	Inspection and Acceptance Testing	B / 4	0	02/07/07
	B6.2	Maintenance of Measurement Systems	B / 5	0	02/07/07
	B6.3	Replacement Parts Inventory	B / 6	0	02/07/07
B7	Instrument Calibration and Frequency		B / 6	0	02/07/07

A2 TABLE OF CONTENTS (continued)

Section		Sec No./Page	Revision	Date
B8	Inspection/Acceptance Requirements for Supplies and Consumables	B / 8	0	02/07/07
B9	Data Acquisition Requirements for Non-Direct Measurements	B / 8	0	02/07/07
B10	Data Management	B / 8	0	02/07/07
C	**ASSESSMENT/OVERSIGHT**	**C / 1**	**0**	**02/07/07**
C1	Assessments and Response Actions	C / 1	0	02/07/07
C2	Reports to Management	C / 4	0	02/07/07
D	**DATA VALIDATION AND USABILITY**	**D / 1**	**0**	**02/07/07**
D1	Data Review, Validation, and Verification Requirements	D / 1	0	02/07/07
D2	Validation and Verification Methods	D / 1	0	02/07/07
D3	Reconciliation With User Requirements	D / 3	0	02/07/07
REFERENCES		**Ref / 1**	**0**	**02/07/07**
APPENDIX A – National Park Service Gaseous Pollutant Monitoring Program Standard Operating Procedures, Technical Instructions, and Checklist Instructions		**Apdx A / 1**	**0**	**02/07/07**

Figure		Sec No./Page	Revision	Date
A4-1	National Park Service Gaseous Pollutant Monitoring Program Organizational Chart	A / 25	0	02/07/07
A6-1	National Park Service Gaseous Pollutant Monitoring Program Monitoring Locations	A / 26	0	02/07/07
A6-2	Summary of Gaseous Pollutant Monitoring Program Tasks	A / 27	0	02/07/07
A7-1	Typical NPS Data Collection System Configuration	A / 28	0	02/07/07
D2-1	Gaseous Pollutant Monitoring Program Data Validation Flowchart	D / 5	0	02/07/07
D3-1	Letter to EPA Certifying 2005 GPMP Data	D / 6	0	02/07/07

A2 TABLE OF CONTENTS (continued)

Table		Sec No./Page	Revision	Date
A6-1	National Park Service Gaseous Pollutant Monitoring Program Monitoring Sites and Parameters Measured	A / 29	0	02/07/07
A6-2	Gaseous Pollutant Monitoring Program Site Specifications	A / 30	0	02/07/07
A6-3	Gaseous Pollutant Monitoring Program Project Assessments	A / 31	0	02/07/07
A6-4	Gaseous Pollutant Monitoring Program Project Schedule and Reporting Products	A / 32	0	02/07/07
A7-1	Data Quality Objectives, NPS Gaseous Pollutant Monitoring Program	A / 36	0	02/07/07
A7-2	Data Quality Indicators, NPS Gaseous Pollutant Monitoring Program	A / 37	0	02/07/07
A7-3	Gaseous Pollutant Monitoring Program Sensor and Sampling Specifications	A / 40	0	02/07/07
B2-1	Sampling Methods Reference Table	B / 10	0	02/07/07
B4-1	Certification of Transfer Standards and Verification of Primary Standard for the Gaseous Pollutant Monitoring Program	B / 11	0	02/07/07
B5-1	Gaseous Pollutant Monitoring Program Measurement-Related Quality Control Criteria	B / 12	0	02/07/07
B6-1	Gaseous Monitoring System Routine Operations and Maintenance Requirements	B / 15	0	02/07/07
B6-2	Meteorological System Routine Operations and Maintenance Requirements	B / 16	0	02/07/07
B6-3	Gaseous Pollutant Monitoring Program Replacement Parts Inventory	B / 17	0	02/07/07
B7-1	Calibration Methods for the Monitored Parameters in the Gaseous Pollutant Monitoring Program	B / 18	0	02/07/07
B7-2	Calibration Acceptance Criteria in the Gaseous Pollutant Monitoring Program	B / 19	0	02/07/07

A2 TABLE OF CONTENTS (continued)

Table		Sec No./Page	Revision	Date
C1-1	Gaseous Analyzers Audit Ranges and Acceptance Criteria	C / 5	0	02/07/07
D1-1	Validation Acceptance Criteria for the Gaseous Pollutant Monitoring Program	D / 7	0	02/07/07

A3 DISTRIBUTION LIST

The Quality Assurance Project Plan (QAPP) for the National Park Service (NPS) Gaseous Pollutant Monitoring Program (GPMP) satisfies the EPA requirements for QAPPs (EPA QA/R-5). The QAPP serves as an important reference for GPMP participants and data users. This QAPP and supporting and referenced quality assurance documents ensure that all monitoring systems are operated according to established standards and that all network data are of known quality and are documented, reproducible, and comparable with data from other quality assured monitoring programs.

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)
John Ray, Gaseous Pollutant Monitoring Program, Program Manager
David Maxwell, Network Quality Assurance Manager *

U.S. Environmental Protection Agency (EPA)
Gary Lear, Technical Monitor CASTNet Program
Scott Faller, Network Quality Assurance Advisor

Air Resource Specialists, Inc. (ARS)
David Dietrich, Program Manager
John Faust, Network Operations Section Manager
Joe Adlhoch, Information Management Center (IMC) Section Manager
Gloria Mercer, Quality Assurance Coordinator

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

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

The QAPP will also be distributed and available on the National Park Service Web site, at *http://www2.nature.nps.gov/air* and on the GPMP Project Web site, at *http://ard-request.air-resource.com/project* (password-protected). 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 background for the program and project description are presented in Sections A5 and A6. The principle components are the measurements of ozone and meteorological parameters in NPS units. A project organizational chart is provided as Figure A4-1 and responsibilities of the key project participants are listed below. Full contact information for project participants is included on the project Web site at *http://ard-request.air-resource.com/project* (password-protected).

Gaseous Pollutant Monitoring Program (GPMP) Program Manager – Under the guidance and direction of NPS ARD management (Associate Director of Natural Resource Stewardship and Science, Michael Soukup, Ph.D.; Division Chief of the Air Resources Division Natural Resource Program Center, Christine Shaver; and Branch Chief of Resource and Monitoring, John Vimont), John Ray (NPS) 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 Technical Representative (COTR) for the program.

Network Quality Assurance Manager – David Maxwell (NPS) is responsible for overall network and program quality assurance including review and approval of all program quality assurance (QA) documentation, periodic assessment of program products and results against program quality objectives, and providing overall quality assurance guidance. He also serves as the Contracing Officer's Representative (COR) for the program.

Network Quality Assurance Advisor – Scott Faller (Environmental Protection Agency), as an EPA quality assurance expert, will provide quality assurance information and guidance to the network quality assurance manager upon request. In addition, Mr. Faller is the CASTNet quality assurance manager and will participate in any GPMP and CASTNet cooperative monitoring applications to help ensure coordination and consistency between programs.

CASTNet Program Technical Monitor – Gary Lear (Environmental Protection Agency Clean Air Markets Division) works with the GPMP program manager to coordinate cooperation between the GPMP and CASTNet programs. This cooperation includes selecting monitoring sites, instrumentation, and procedure; exchanging data and analytical results (including EPA deposition calculations); and reviewing quality assurance protocols.

Cooperating State Air Quality Agencies – A number of state agencies cooperate with the GPMP to provide monitoring assistance and air quality data in selected national parks. In addition, several state agencies perform independent field performance audits on GPMP monitoring sites. These agencies include:

Monitoring Cooperation
Maine Department of Environmental Protection (Acadia NP)
Massachusetts Department of Environmental Protection (Cape Cod NS)
North Carolina Department of Environment and Natural Resources (Great Smoky Mountains NP)
North Dakota Department of Health (Theodore Roosevelt NP)
Pima County Health Department (Saguaro NP)
South Carolina Department of Health and Environmental Control (Cowpens NB and Congaree NP)
South Dakota Department of Environmental Protection (Badlands and Wind Cave NPs)
Tennessee Division of Air Pollution Control (Great Smoky Mountains NP)
Tennessee Valley Authority (Great Smoky Mountains and Mammoth Cave NPs)
Texas Commission on Environmental Quality (Chamizal NMem.)

Independent Field Performance Audits (on NPS-operated sites)
California Air Resources Board
Colorado Department of Public Health and Environment
Kentucky Department of Environmental Protection
Tennessee Division of Air Pollution Control
Virginia Department of Environmental Quality

Program Manager – David Dietrich (ARS) is 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, and quality assurance operations.

Quality Assurance Coordinator – Gloria Mercer (ARS) is responsible for preparation and internal control of all quality control and quality assurance documentation for the program.

Network Operations Section Manager – John Faust (ARS) is responsible for coordinating field activities; semiannual site internal audit, maintenance, and calibration visits; field service visits; operator support and training; instrument and 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.

Information Management Center (IMC) Section Manager – Joe Adlhoch (ARS) is responsible for management of all data collection, reduction, validation, archiving, and reporting activities, and for preparation, review, and implementation of data management-related QC and QA procedures.

Information Technologies (IT) Section Manager – Don Mussard (ARS) is responsible for providing and maintaining computer systems including workstations, file servers, and support systems. IT duties also include the purchase, development, implementation, and maintenance of computer software applied to support all phases of the GPMP.

Field Specialists – ARS field specialists are responsible for daily reviews of network operations; site internal audit, maintenance, and calibration visits; assisting site operators with troubleshooting activities; and performing or managing all equipment laboratory repairs, calibrations, and preventive maintenance.

Park Air Quality Supervisors – 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.

NPS Site Operator(s) – NPS staff at individual national parks will service and maintain the monitoring sites. They are responsible for routine operation of the monitoring equipment and field documentation of all collected data in accordance with documented QA procedures.

Contract Operator(s) – At NPS sites with limited staff, ARS may be directed to hire a site operator to service and maintain a monitoring site. This is the exception with only one or two contract operators in the network.

Technical Assistant – The ARS technical assistant is responsible for maintaining the network equipment inventory, project Web page, and for compiling and distributing weekly and quarterly technical progress reports, monthly financial reports, and monthly and annual data reports.

IMC Data Analysts – ARS data analysts are responsible for daily data retrieval activities; identification and communication of operational problems to the network operations section manager; and data validation, data archive, and data reporting.

Database Coordinator – The ARS database coordinator is responsible for all components of the project database.

IT Systems Operations – ARS personnel are responsible for purchasing, configuring, and maintaining all computer hardware that supports the GPMP including workstations, remote data collection computers, DataView computers, file servers, printers, and telephone, satellite, and Internet communications systems.

Software Development – ARS programmers are responsible for purchasing, developing, and maintaining software used by GPMP including data collection, DataView, validation, reporting, database, Internet, and other supporting software.

Additional technical and administrative support personnel may be used as necessary upon direction of the ARS program manager.

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) 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 passive ozone, 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 operational protocols for these unique sites are not included in this QAPP. 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;
- 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; 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, which, although addressing primarily health-effects based monitoring in areas of high population, are generally pertinent to the Gaseous Pollutant Monitoring Program.

A6 PROJECT DESCRIPTION AND SCHEDULE

A6.1 Network Description

The gaseous and meteorological parameters measured by the NPS Gaseous Pollutant Monitoring Program are listed below.

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 of 1-hour averages. 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. Sulfur dioxide, carbon monoxide, oxides of nitrogen, and particulates are monitored in selected park units for primarily research purposes, but may or may not meet EPA reference or equivalent methods. On occasion, selected data sets for these parameters may be certified by the NPS.

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 of 1-hour averages.

Nearly all sites collect ozone, ambient temperature, relative humidity, wind speed, wind direction, precipitation, and solar radiation. Selected sites monitor other atmospheric gases and additional meteorological parameters.

The GPMP consists of 43 monitoring sites in 35 parks. The NPS operates 34 of these sites in 27 parks. This QAPP specifically addresses the procedures used by the NPS to certify the ozone measurements made at these NPS-operated sites. A map showing the GPMP monitoring station locations is provided as Figure A6-1. Table A6-1 lists the specific GPMP parameters monitored at each site. Table A6-2 provides additional metadata for each site.

A6.2 Task Descriptions

Work performed for the program has been divided into six (6) tasks as detailed below and summarized in Figure A6-2:

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 or Prevention of Significant Deterioration (PSD) guidelines
- 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 and are selected to be:

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

Some compromises are required when locating sites at some national parks. After monitoring equipment is tested in the ARS air quality laboratory, it is installed at the monitoring locations, calibrated, and data collection begins.

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. At NPS units with adequate staff, an in-park air quality supervisor coordinates with the NPS ARD to receive funding for a monitoring site operator. The air quality supervisor assigns a site operator who is then trained. Intensive training by ARS occurs upon installation and during a semiannual site visit. When NPS staff is not available, the NPS ARD authorizes ARS to hire and train a local site operator. Contract operators are the exception with only one or two active at any one time. The site operators receive training on equipment operation, maintenance, and data collection/documentation, including the use of DataView (ambient air quality monitoring station management software utilized by the GPMP network; DataView is described in Section A7.3.2). Operational SOPs, technical instructions (TIs), checklist instructions (CIs), and a training CD that explains site operator duties are also left on-site as references. ARS collects data daily and reviews the operational status of the network daily, including data quality assurance indicators (zeros, spans, and precision), provides site operator technical support, initiates corrective actions to address any identified inconsistency, and performs and tracks any required remedial maintenance on all program monitoring instrumentation and support equipment. A site operator newsletter is produced twice annually, generally coinciding with the start and end of the ozone season (April through October). The newsletter includes network news, informative articles, and items designed to train or aid the site operators in their air quality station duties.

4) Data Management and Reporting – The IMC data analysts retrieve gaseous and meteorological data and system documentation from the monitoring systems by telephone modem each day. 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. All validated data are also uploaded monthly to the EPA national Air Quality System (AQS) database and to the NPS Data Request Web page. In addition, raw hourly ozone data from many sites are retrieved and uploaded to EPA's AIRNow Web site during the ozone season (May through September). Raw gaseous and meteorological data are also uploaded to the NPS for near real-time display on the NPS Web site (*http://www2.nature.nps.gov/air/*). These NPS uploads are performed hourly during the ozone season and daily during the remainder of the year.

5) Quality Assurance – GPMP QA procedures include both internal and external systems that are used to assess the various components of the program and their compliance with the QAPP and referenced QA documents. These project assessments, summarized in Table A6-3, include:

- Internal Field Performance Audits – ARS field specialists perform internal performance audits, maintenance, and calibrations of all monitoring systems at each site every six months. This process first documents the as-found performance of each monitoring system as compared to network calibration acceptance criteria for each monitored parameter. Each system either passes or fails this internal audit challenge. The audit challenges of all instruments comply with EPA guidance. All audit standards used to perform these internal audits are certified in current calibration and traceable to NIST. Following this internal audit, 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.

  The performance results of these visits, by parameter, are recorded on digital log sheets, reviewed, filed by site, and are an important component of the data validation process. Any noted problems result in corrective actions that are fully documented. The digital log sheets are also posted on the GPMP project Web site and on the individual station's DataView computer as a QA reference for the next scheduled internal visit or independent audit visit. The internal audit results for each parameter are also entered into the AQS as a quality assurance reference for network accuracy.

- Independent Field Performance Audits – It is a network goal to have independent performance audits performed on at least 20% of the 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. As an example, the following sites received independent state field performance audits in 2005:

Sites Receiving Independent State Audits in 2005	Date	State Agency
Badlands National Park – Visitor Center	02/10/2005	State of South Dakota
Badlands National Park – Visitor Center	06/15/2005	State of South Dakota
Badlands National Park – Visitor Center	09/29/2005	State of South Dakota
Badlands National Park – Visitor Center	12/06/2005	State of South Dakota
Death Valley National Park – Park Village	03/17/2005	California Air Resources Board
Great Smoky Mountains National Park – Cades Cove	08/17/2005	State of Tennessee Dept. of Health
Great Smoky Mountains National Park – Clingmans Dome	08/16/2005	State of Tennessee Dept. of Health
Great Smoky Mountains National Park – Cove Mountain	08/17/2005	State of Tennessee Dept. of Health
Great Smoky Mountains National Park – Look Rock	08/16/2005	State of Tennessee Dept. of Health
Joshua Tree National Park – Black Rock	02/08/2005	California Air Resources Board
Mammoth Cave National Park – Houchin Meadow	04/25/2005	Commonwealth of Kentucky Dept. of Env. Prot.
Mammoth Cave National Park – Houchin Meadow	10/12/2005	Commonwealth of Kentucky Dept. of Env. Prot.
Mesa Verde National Park – Resource Management Area	10/12/2005	State of Colorado Dept. of Public Health and Env.
Pinnacles National Monument – SW of East Entrance Station	03/15/2005	California Air Resources Board
Rocky Mountain National Park – Long's Peak	04/06/2005	State of Colorado Dept. of Public Health and Env.
Rocky Mountain National Park – Long's Peak	10/05/2005	State of Colorado Dept. of Public Health and Env.
Sequoia and Kings Canyon National Parks – Ash Mountain	07/20/2005	California Air Resources Board

- CASTNet Program Auditor – All NPS sites that participate in the CASTNet program receive an independent audit by the CASTNet auditor once every two years.

- EPA National Performance Audit Program (NPAP) – The NPS GPMP is scheduled to participate in the NPAP beginning in 2007. The NPAP will schedule visits periodically to NPS sites to perform a full independent performance audit.

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.

- 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.

- Field Operations Assessments – Data (including automatic daily gaseous zeros, precisions, and spans) are reviewed daily 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. ARS reviews the weekly site operator documentation and contacts each operator by telephone to discuss the site at least once each month. Corrective actions are instituted in response to any noted problem. Observations of the site operator and supplemental training occurs during each semiannual field visit by ARS.

- Data Management Assessments – Monthly plot reviews, attended by the GPMP program manager, network quality assurance manager, ARS section managers, and IMC staff, serve as monthly assessment of data management and validation procedures. During the plot reviews, plots of all gaseous and particulate data for each site and meteorological data from five randomly selected sites collected during the month are posted and thoroughly reviewed by the attendees. The validation discussions made by the data analysts and annotated on the plots are reviewed and discussed along with any other inconsistencies noted by the attending reviewers. A detailed discussion about network-related actions and plans follows the actual plot review. Previously assigned action-items are reviewed and new action items are assigned as appropriate.

- Data Quality Assessments – Data quality are assessed monthly and annually in conjunction with data report preparation. Site-specific and network-wide (systematic) data issues are reviewed and compared to quality objectives. Noted inconsistencies or variances from the desired quality objective are addressed, and explanations, management actions, or procedural changes are applied as appropriate.

The overall quality system for the GPMP is defined in the following documents:

QMP – Quality Management Plan
QAPP – Quality Assurance Project Plan
SOPs – Standard Operating Procedures
TIs – Technical Instructions
CIs – Checklist Instructions

These documents are reviewed and revised (if necessary) annually or at any time an equipment or procedural change is implemented in the network. Many sections of this QAPP provide a brief description of a procedure and explicitly reference the appropriate SOPs, TIs, and CIs as the sources for detailed documentation. Appendix A includes a list of all of the network operations and data management SOPs, TIs, and CIs. Appendix A also includes a cross-reference as to the section of the QAPP that references specific SOPs, TIs, and CIs.

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 section manager, and ARS program manager. Weekly e-mail progress reports are sent to the GPMP program manager, network quality assurance manager, and ARS staff. Monthly data reports, quarterly contract status reports, and annual data reports are sent to the GPMP program manager and network quality assurance manager, the ARS program manager, the network operations section manager, the IMC section manager, site operators, and park air quality supervisors. In addition, each of these reports, along with a variety of other network documentation, are posted on the GPMP project Web site.

Coordination with the CASTNet program occurs monthly in a scheduled conference call or otherwise as needed. Coordination with cooperating agencies is performed as needed by telephone 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 A6-4.

A6.4 Reporting Requirements

Reporting requirements for the program are summarized in the project schedule in Table A6-4. In general, reporting products include:

- Weekly Progress Reports
- Data Reports (monthly and annual)
- Quarterly Contract Status Reports
- Site Visit Reports
- Web Sites
- Monitoring History Database
- Site Operator Newsletter
- CASTNet Conference Call
- Quality Assurance Documentation
- Data Archives

A6.5 Disaster Recovery and Data Backup Plan

As specified in an ARS security plan, the ARS computer system has comprehensive protection and levels of security to protect against external and internal attacks. The security systems are under continuous review and upgrade to meet changes in technology. To be fully prepared in the event of a natural disaster or malicious attack, ARS developed and currently maintains a clearly defined disaster recovery plan to ensure recovery from catastrophic computer system failure. Details of this plan are summarized below.

Raw Data Acquisition - In the event of a network file server failure, multiple IMC workstations are configured for stand-alone data collection. Daily automated data polls and auxiliary data acquisition can be made from any of these workstations. ARS owns several laptop computers loaded with similar software, and network sites can be called from off-site locations if necessary.

Backup and Archive of Data, Software, and Documentation - Using current-state-of-the-art technology, backups of data, operating system, and application software are created as follows:

- Nightly tapes Monday through Friday
- Each Friday tape is stored off-site for 6 weeks
- Each month-end tape is stored off-site (at a separate but nearby ARS facility) and is never overwritten

The procedure is industry standard to ensure the level of integrity necessary for recovering from a significant computer or disk failure.

Database Recovery - Database tables are backed up each night after the database is automatically downed for a 'cold archive' ensuring synchronization of all tables and fail-safe recovery. Should the database server fail, a backup server can be quickly configured using this database table backup and the data can be efficiently restored from the nightly, weekly, or monthly backup data tapes. In addition, as a final fail-safe, the raw data files collected from the sites during each daily data acquisition step are written quarterly to three writable CDs, along with ASCII fixed-length columnar format files of all validated data. One set of CDs is delivered to the NPS for off-site storage at NPS ARD, a second set is stored on-site at ARS, and a third set is stored at off-site ARS facilities in Fort Collins. Should the ARS computer system fail or the database files become corrupted, any of these system backups can be used.

Computer Hardware Maintenance Support - ARS maintains extended warranty service for up to 3 years on all file servers with on-site service within 24 hours. Beyond the 3-year coverage, ARS relies on long-standing relationships with reliable vendors for fast response in parts replacement. ARS' computer staff is experienced in on-site hardware maintenance.

Facilities - In the event a catastrophic event destroys or disables ARS offices and the IMC (such as flood or fire), it will be necessary to expediently reestablish operations. ARS has established strong working relationships with office equipment suppliers, computer suppliers, and office space owners, and has a sound credit rating. Available lines of credit are in-place so that office space, equipment, and computers can be leased or purchased quickly. In addition, insurance to cover catastrophic events allows the company to quickly reestablish operations at ARS' current offices or an alternate location. Hardcopy site documentation could be destroyed in a catastrophic event. This documentation could be retrieved directly from monitoring sites that keep long-term records.

Personnel - Although the GPMP contract represents a very important part of the ARS workload, as least 15 other employees at ARS have similar backgrounds and expertise. ARS sufficiently cross-trains employees to ensure complete coverage of work even under normal operating schedules of vacation, sick leave, holiday, and extended leave. ARS collects data from over 100 air quality stations daily and has a consistent record of service to its clients.

A6.6 Resources and Time 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. The program has been consistently funded allowing the continuation of a long-term monitoring effort; however, there are funding limitations. For example, to maintain the broadest number and distribution of stations with available funds, semiannual internal audits, calibration, and maintenance of gas analyzers are performed rather than quarterly visits. Daily automatic zero, span checks, and daily data review compensates for this compromise (see Section B.7). In addition, the NPS cooperates with state agencies to both operate additional in-park monitoring sites and to perform independent audits at selected sites.

There are no significant time constraints related to this ongoing program. Hourly data are collected, validated, and distributed in a timely manner. In recent years, selected raw data are being made available in real-time to support Web displays and programs such as AIRNow.

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 Table A7-1.

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 include precision, accuracy, bias, completeness, representativeness, comparability, and other related criteria. The GPMP DQIs are detailed in Table A7-2.

A7.2.1 Precision

Gaseous monitoring precision checks are performed by challenging each pollutant analyzer with a known concentration of gas (18% of instrument, full scale) from the on-site gas dilution calibrator or transfer standard. The percent difference between the analyzer and the input concentration is then calculated as:

$$Percent\ difference = \frac{analyzer\ response - input\ concentration}{input\ concentration} x100$$

The pollutant analyzer must respond within 10% of the input concentration. To meet EPA criteria a successful precision check must be completed at least every 14 days of operation. The majority of GPMP monitoring stations perform precision checks daily. At some sites, due to configuration limitations, precision checks are performed once per week.

Precision checks on meteorological instruments are not performed in this network. Manufacturer's specifications define instrument precision.

A7.2.2 Accuracy

The accuracy of gaseous field measurements is determined by challenging each instrument with known concentrations of gas (at zero and multiple up-scale points) from a source other than the on-site calibrator. This source must be traceable to NIST (National Institute of Standards and Technology) standards. Meteorological instruments are also challenged with standards traceable to NIST. ARS maintains documentation of NIST-traceability for all applicable equipment and monitoring standards. The accuracy checks on all systems occur during the semiannual internal field performance audit, maintenance, and calibration visits or during an independent performance audit.

A7.3 Criteria for Measurement Data

A7.3.1 Measured Parameters

Table A7-3 presents sampling specifications for each parameter. Each parameter has specific measurement performance criteria.

Gaseous - Gaseous data must be collected in accordance with EPA reference method, equivalent method, or primary standard protocols. Detailed discussions of gaseous measurement performance criteria are presented in SOP 3100, *Calibration of Ambient Air Quality Analyzers.*

Meteorology - Meteorological measurements are made with high quality instrumentation with calibrations traceable to NIST standards. Detailed discussions are presented in SOP 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems.*

A7.3.2 Data Collection System

All data are captured on-site by a data collection system (DCS). A typical DCS configuration in the GPMP network is represented in Figure A7-1 and consists of a datalogger, telephone and modems, DataView computer, printer, and supporting hardware. The primary datalogger used in the network is the ESC 8816. Several sites with power restrictions use Campbell Scientific 21X or 23X dataloggers.

Telephone modems provide a remote link to the sites for data and documentation collection and operational status assessment. The DataView system is comprised of a laptop computer, supporting hardware, and a comprehensive suite of software tools for reviewing air quality data and documenting operations at air quality monitoring sites. DataView supplements (but is independent of) the datalogger and helps ensure high quality network operations and data by performing the following functions:

- DataView provides the site operator with a "window to air quality" that offers a rich, windows-based graphic environment to review current and recent past air quality data, guides the operator through calibration, maintenance, operation, and troubleshooting procedures, and serves as the primary on-site quality assurance documentation archive.

- The DataView computers are easy to use. The screens and displays are clear and concise. The checklist instructions on DataView that guide the operator through weekly site visits are specifically configured for the instruments installed at each site. Changes to DataView can be remotely uploaded to accommodate any changes to monitoring instrument manufacturers or station configurations.

- Operator station visit documentation (including calibration results, log notes, etc.), is entered into DataView and the Information Management Center (IMC) downloads this information twice each week by telephone modem. The site operator has the option to print hardcopies of the computer screens; however, there is no regular exchange of paperwork from the site operator to the IMC. In the event of computer failure, hardcopy backup forms identical to the DataView screens are available on-site to be completed by the operator and faxed to the IMC.

- DataView screens and displays are programmed to include site-specific defaults (i.e., date, time, site name), calculation routines, comparisons with past data, and other algorithms that will help ensure the most efficient and complete site documentation. Based on collected data, programs automatically post messages, flags, or alarms on the computer screen to inform the operator of issues that require action.

- Hardcopy strip charts and handwritten log sheets and forms of continuous gas analyzer data are no longer required for data validation. If the diagnostic parameters indicate a problem, the IMC can remotely log on to DataView and/or the datalogger to review electronic strip charts and individual data points to help resolve problems. Selected data or plots resident on DataView can be downloaded by the IMC to document and evaluate problems.

- The DataView computer is capable of storing a minimum of three months of continuous gas analyzer data (1-minute data) and three months of hourly data for all parameters. This information is used to support on-site data displays and remote access for validation, troubleshooting, or emergency data recovery.

- DataView contains digital versions of the QMP, QAPP, and all appropriate SOPs, TIs, and Checklist Instructions as a ready reference to assist with operation guidance, troubleshooting, and refresher training.

The specifics of DataView applications are described in the Introduction to DataView and the related checklist instructions.

A8 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

ARS staff working on this project are experienced in ambient air quality and meteorological monitoring systems. Field specialists are required to undergo tower training by a certified instructor (ARS' fall protection safety plan manager) and First Aid/CPR certification, which is conducted annually by an independent instructor. These certifications must be kept current. Certifications are maintained in the employee's personnel file. The ARS network operations section manager is responsible for verifying all staff members are fully informed on the specific monitoring and data management configurations for this program. Staff are informed/trained on a one-to-one basis. NPS site operators are trained on-site by ARS field staff.

IMC data analysts are fully trained by the section managers on the operational properties and expectations of all monitoring instrumentation, data acquisition systems, and calibration and maintenance procedures. The data analysts are also trained on all data collection, DataView, validation, and reporting software tools used in network data management. Their primary expertise resides in their ability to review data for quality and completeness and to perform the highest quality validation. No specific professional certifications of IMC data analysts are required, but the data analysts are thoroughly trained in all aspects of their job requirements.

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. This desktop relational database is linked to the purchasing software package (Purchasing Plus) used by ARS. 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. Validated data are also uploaded to the NPS Data Request Web site (*http://12.45.109.6/*) and EPA AQS database for public access and archive.

- A disaster recovery and data backup plan for all NPS data files is in place, as defined in Section A6.5.

- 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, network quality assurance manager, 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 is password-protected from undocumented access by the general public. The Web site includes copies of project schedules, project reports, contact information, and other documentation.

- Quarterly 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 (winter and summer). 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. The annual reports also include the results of data analyses, such as trend analyses, performed by NPS ARD.

  Monthly and annual data reports are provided according to the schedule defined in Section A6.3.

- Project-related standard operating procedures and technical 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 network 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.

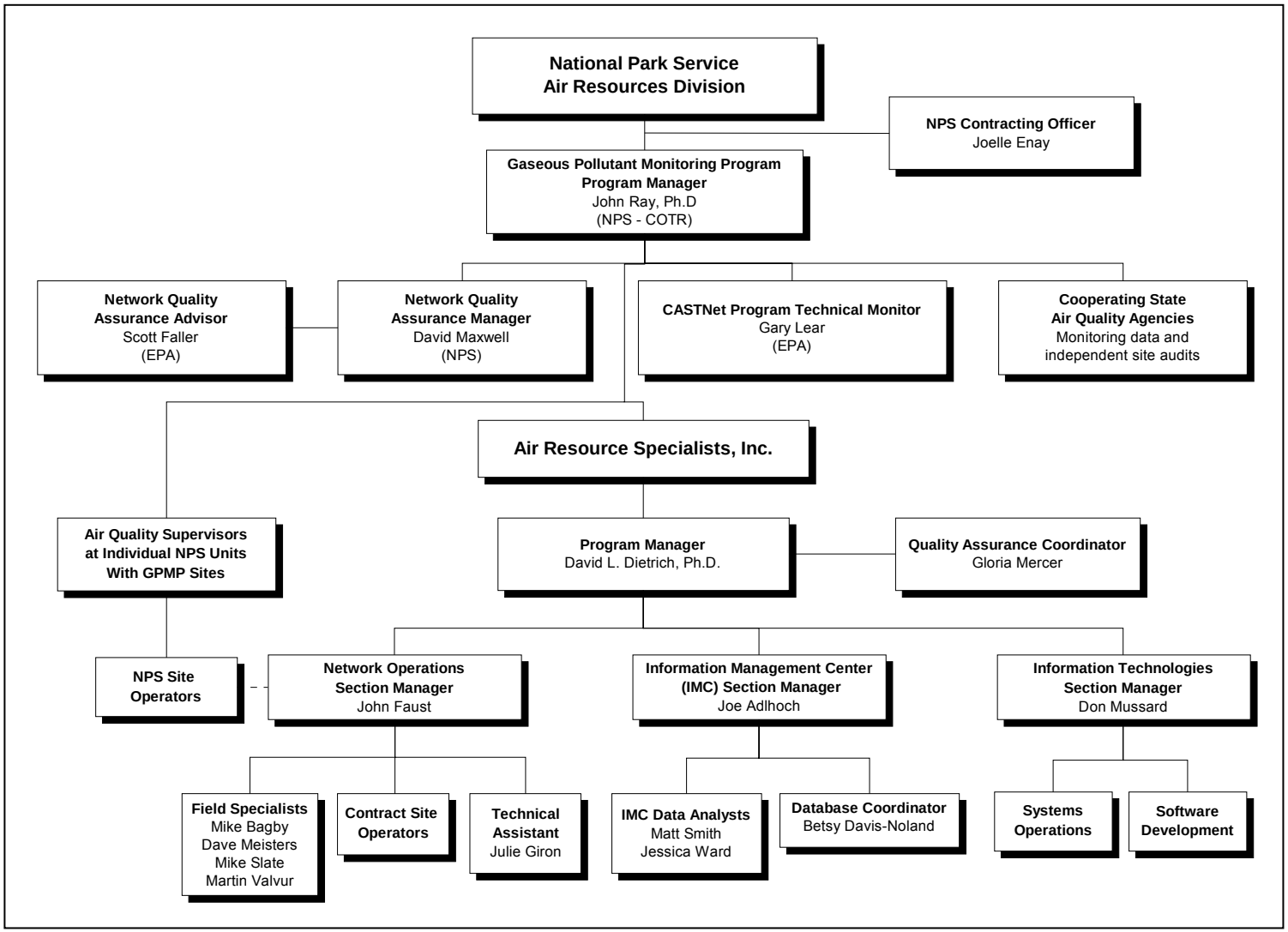

Figure A4-1. National Park Service Gaseous Pollutant Monitoring Program Organizational Chart.

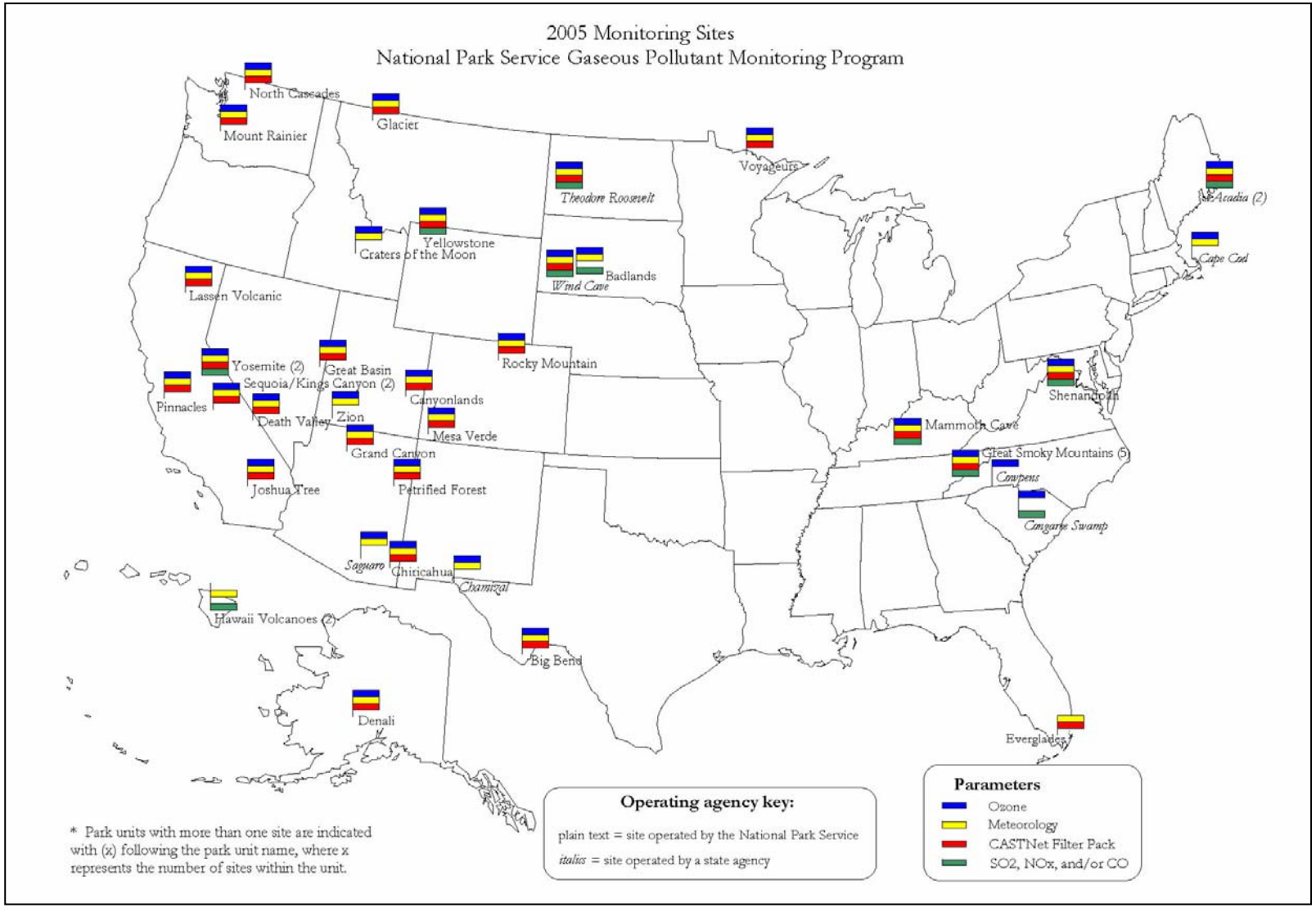

Figure A6-1. National Park Service Gaseous Pollutant Monitoring Program Monitoring Locations.

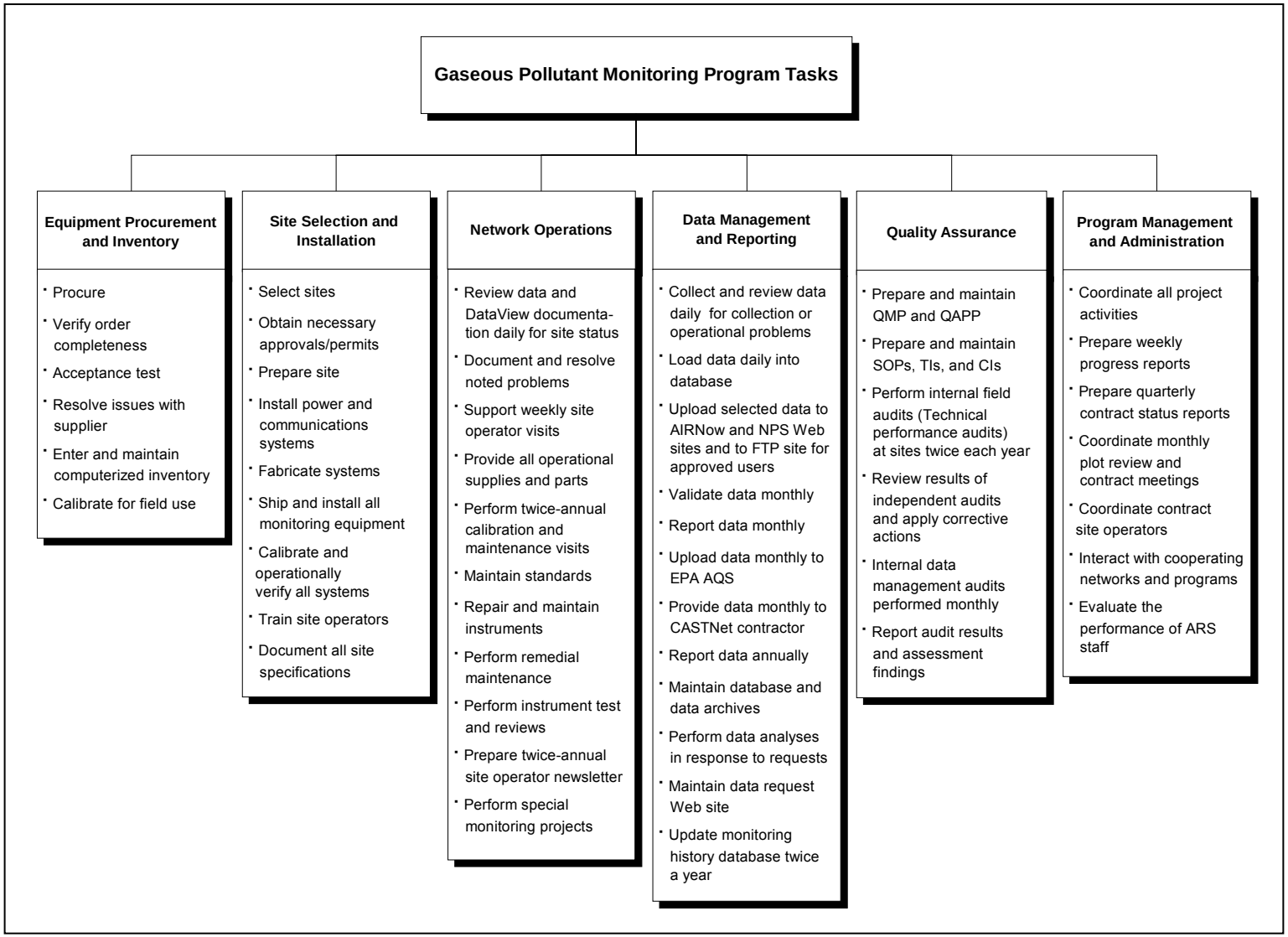

Figure A6-2. Summary of Gaseous Pollutant Monitoring Program Tasks.

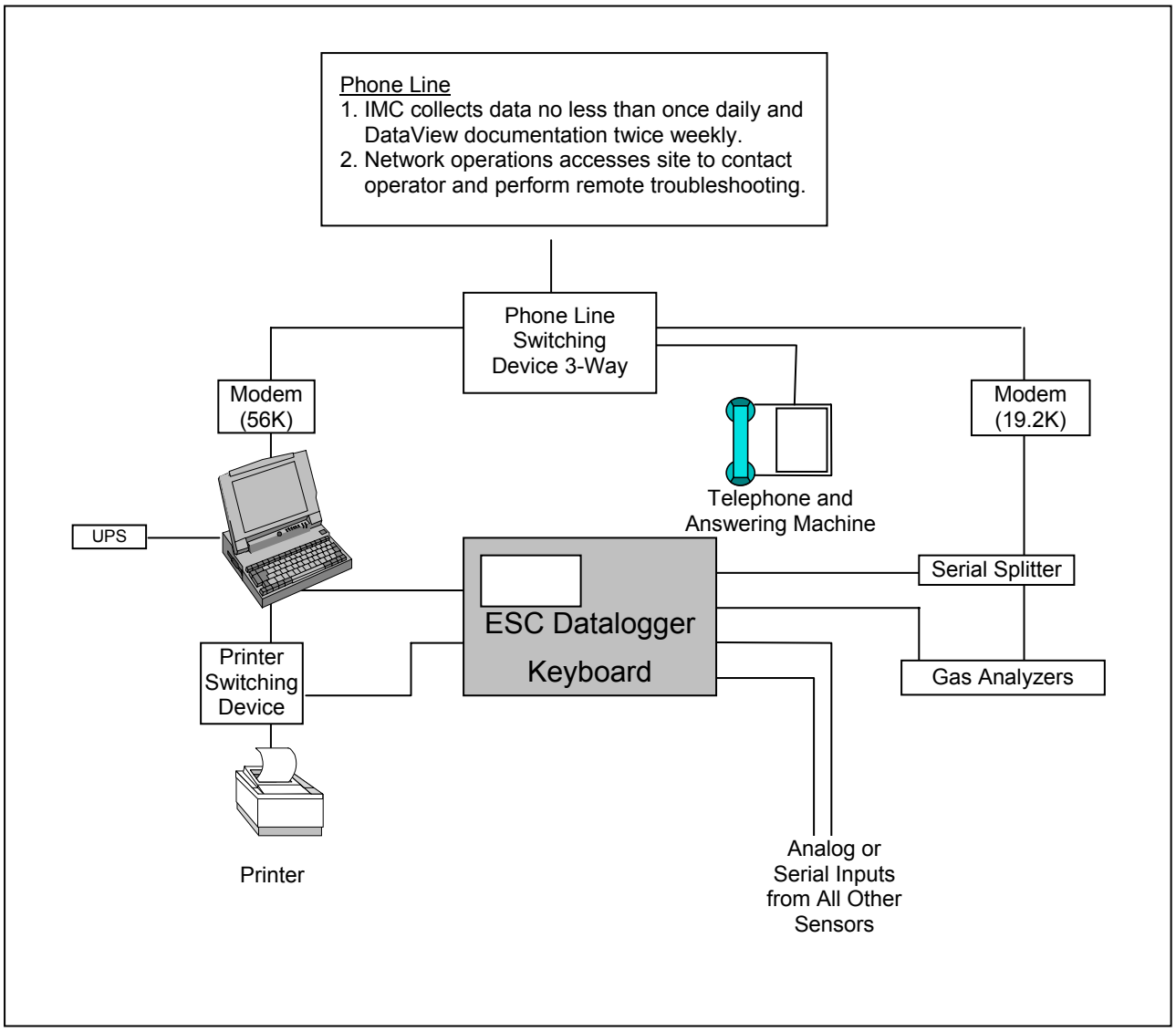

Figure A7-1. Typical NPS Data Collection System Configuration.

Table A6-1. National Park Service Gaseous Pollutant Monitoring Program Monitoring Sites and Parameters Measured.

Site Operating Information				Pollutant Analyzers					Meteorological Sensors
Site Name	**Abbrev.**	**NPS-Operated**	**State-Operated**	**O_3**	**SO_2**	**CO**	**NO_x**	**CASTNet**	
Acadia NP	ACAD		X	X			X	X	X
Badlands NP	BADL	X		X					X
Big Bend NP	BIBE	X		X				X	X
Canyonlands NP	CANY	X		X				X	X
Cape Cod NS	CACO		X	X					X
Chamizal NMem	CHAM		X	X					X
Chiricahua NM	CHIR	X		X				X	X
Congaree NP	COSW		X	X	X				
Cowpens NB	COWP		X	X					
Craters of the Moon NM	CRMO	X		X					X
Death Valley NP	DEVA	X		X				X	X
Denali NP and Preserve	DENA	X		X				X	X
Everglades NP	EVER	X						X	X
Glacier NP	GLAC	X		X				X	X
Grand Canyon NP	GRCA	X		X				X	X
Great Basin NP	GRBA	X		X				X	X
Great Smoky Mountains NP:	GRSM								
Cades Cove	-CC		X	X					X
Clingmans Dome	-CD	X		X					X
Cove Mountain	-CM	X		X	X	X	X		X
Purchase Knob	-PK		X	X					
Look Rock	-LR	X		X				X	X
Hawaii Volcanoes NP:	HAVO								
Visitors Center	-VC	X			X				X
Observatory	-OB	X			X				X
Joshua Tree NP	JOTR	X		X				X	X
Lassen Volcanic NP	LAVO	X		X				X	X
Mammoth Cave NP	MACA	X		X	X	X	X	X	X
Mesa Verde NP	MEVA	X		X				X	X
Mount Rainier NP	MORA	X		X				X	X
North Cascades NP	NOCA	X		X				X	X
Petrified Forest NP	PEFO	X		X				X	X
Pinnacles NM	PINN	X		X				X	X
Rocky Mountain NP	ROMO	X		X				X	X
Saguaro	SAGU		X	X					X
Sequoia/Kings Canyon NP:	SEKI								
Ash Mountain	-AM	X		X					X
Lower Kaweah	-LK	X		X					X
Shenandoah NP	SHEN	X		X	X			X	X
Theodore Roosevelt NP	THRO		X	X	X		X	X	X
Voyageurs NP	VOYA	X		X				X	X
Wind Cave NP	WICA		X	X	X		X	X	X
Yellowstone NP:	YELL			X				X	X
Water Tower	-WT	X		X				X	X
Old Faithful	-OF	X				X			X
Yosemite NP:	YOSE								
Turtleback Dome	-TD	X		X				X	X
Merced River	-MR	X		X		X	X		X
Zion NP	ZION	X		X					X

Monitoring Site Names
NB - National Battlefield
NP - National Park
NM - National Monument
NMem - National Memorial

Pollutant Analyzers
O_3 - Ozone
SO_2 - Sulfur Dioxide
CO - Carbon Monoxide
NO_2 - Oxides of Nitrogen
CASTNet - Dry Deposition Filter Pack

Table A6-2. Gaseous Pollutant Monitoring Program Site Specifications.

AQ Site	8816 ID	Park Name	Site Name	Site #	AQS #	Lat ºN	Long ºW	Elev. (m)
ACAD*	02	Acadia NP	McFarland Hill	105	23-009-0103	44 22 37	68 15 39	158
BADL	BL	Badlands NP	Visitors center	2	46-071-1001	43 44 37	101 56 29	739
BIBE	BB	Big Bend NP	K-Bar Ranch Rd	24	48-043-0101	29 18 08	103 10 38	1052
CACO*		Cape Cod NS	Fox Bottom Area	60	25-001-0002	41 58 33	70 01 29	41
CANY	CL	Canyonlands NP	Island in the Sky maint yard	52	49-037-0101	38 27 31	109 49 16	1809
CHAM*		Chamizal NMem	Chamizal	61	48-141-0044	31 45 56	106 27 18	1128
CHIR	CH	Chiricahua NM	Entrance station	71	04-003-8001	32 00 33	109 23 21	1570
COSW*		Congaree NP	Congaree Bluff	108	45-079-0021	33 48 53	80 46 52	34
COWP*		Cowpens NB	Cowpens	64	45-021-0002	35 07 49	87 48 59	296
CRMO	CR	Craters of the Moon NM	Visitors center	54	16-023-0101	43 27 38	113 33 44	1815
DENA	DN	Denali NP	Headquarters	5	02-290-0003	63 43 33	148 57 48	661
DEVA	DV	Death Valley NP	Park village	65	06-027-0101	36 30 33	116 50 53	125
EVER	EG	Everglades NP	Everglades	6	12-086-0030	25 23 28	80 40 50	2
GLAC	GL	Glacier NP	W Glacier Horse stables	72	30-029-8001	48 30 37	113 59 44	976
GRBA	GB	Great Basin NP	Park maintenance yard	57	32-033-0101	39 00 19	114 12 57	2060
GRCA	GC	Grand Canyon NP	The Abyss - NDDN	73	04-005-8001	36 03 35	112 10 56	2073
GSCC	CC	Great Smoky Mtns NP	Cades Cove	58	47-009-0102	35 36 15	83 46 59	564
GSCD	CD	Great Smoky Mtns NP	Clingmans Dome	53	47-155-0102	35 33 43	83 29 53	2021
GSCM	CM	Great Smoky Mtns NP	Cove Mountain	10	47-155-0101	35 41 48	83 36 31	1243
GSLR	LR	Great Smoky Mtns NP	Look Rock	34	47-009-0101	35 37 59	83 56 32	793
GSPK*		Great Smoky Mtns NP	Purchase Knob	112	37-087-0036	35 35 24	83 04 39	1500
HAOB	HO	Hawaii Volcanoes NP	Observatory	106	15-001-0007	19 25 13	155 17 17	1123
HAVO	HV	Hawaii Volcanoes NP	Visitors Center	50	15-001-0005	19 25 51	155 15 28	1215
JOYV	JT	Joshua Tree NP	Yucca Valley	59	06-071-9002	34 04 17	116 23 26	1244
LAVO	LV	Lassen Volcanic NP	Monzanita Lake maint yard	15	06-089-3003	40 32 25	121 34 35	1756
MAHM	MH	Mammoth Cave NP	Houchin Meadow	84	21-061-0501	37 07 55	86 08 52	243
MEVE	MV	Mesa Verde NP	Maintenance yard	56	08-083-0101	37 11 54	108 29 25	2165
MORA	MR	Mount Rainier NP	Tahoma Woods	63	53-053-1010	46 45 30	122 07 28	415
NOCA	NC	North Cascades NP	Marblemount Ranger station	77	53-057-0013	48 32 23	121 26 50	109
PEFO	PF	Petrified Forest NP	Horse barn	119	04-017-0119	34 49 21	109 53 31	1723
PINN	PN	Pinnacles NM	East entrance station	17	06-069-0003	36 29 06	121 09 20	335
ROMO	RM	Rocky Mountain NP	Longs Peak Rangers station	30	08-069-0007	40 16 40	105 32 43	2743
SAGU*		Saguaro NP	East Unit	91	04-019-0021	32 10 28	110 44 11	938
SEAS	AM	Sequoia NP	Ash Mountain	104	06-107-0009	36 29 22	118 49 37	457
SELK	LK	Sequoia NP	Lower Kaweah	22	06-107-0006	36 33 57	118 46 38	1890
SHEN	BM	Shenandoah NP	Big Meadows	38	51-113-0003	38 31 23	78 26 05	1073
TRVC *	TR	Theodore Roosevelt NP	Visitors Center	100	38-007-0002	46 53 41	103 22 40	850
VOYA	VY	Voyageurs NP	Sullivan Bay repeater	81	27-137-0034	48 24 46	92 49 45	429
WICA *		Wind Cave NP	Visitors Center	132	46-033-0132	43 31 24	103 28 48	1300
YELL	YS	Yellowstone NP	Water tank	82	56-039-1011	44 33 35	110 24 02	2400
YELL	OF	Yellowstone NP	Old Faithful	122	56-039-1012	44 27 25	110 49 53	2246
YOMR	MR	Yosemite NP	Merced River	115	06-043-0033	37 44 35	119 35 38	1219
YOTD	TD	Yosemite NP	Turtleback Dome	76	06-043-0003	37 42 48	119 42 22	1605
ZION	ZI	Zion NP	Dalton Walsh	130	49-053-0130	37 11 54	113 09 02	1213

* State-operated sites, not submitted to AQS.

Table A6-3. Gaseous Pollutant Monitoring Program Project Assessments.

Assessment	Frequency	Personnel
Internal Field Performance Audits, Calibrations, Maintenance, and Operator Training	Every 6 months at each site	Field specialist Site operator Data analyst Network operations section manager
Independent Field Performance Audits	Approximately 20% of network sites each year, as scheduled by cooperating state agencies, CASTNet program, and EPA NPAP	Independent auditors including State agency staff, CASTNet auditor, or EPA NPAP auditor Site operator
Technical Systems Audits	Every 3 years	EPA systems auditor GPMP staff as identified by the auditor
Field Operations:		
• Review of collected data and automatic gaseous zero, precisions, and spans	Daily	Field specialist Data analyst
• Site operator station checks and documentation review	Weekly	Field specialist Site operator Data analyst
• Response to noted monitoring inconsistencies	As required	Field specialist Site operator Data analyst
Data Management	Monthly at plot reviews	GPMP program manager Network QA manager Program manager Section managers Data analysts
Data Quality	Monthly and annually in conjunction with data report preparation	GPMP program manager Network QA manager Program manager Section managers Data analysts
QMP, QAPP, SOP, TI, and CI Review and Approval	Annually or as needed	GPMP program manager Network QA manager Program manager Section managers QA coordinator
Management Systems Review	Monthly in conjunction with the plot review or as needed Coordination with CASTNet program is done monthly by conference call or as needed	Program manager Section managers GPMP program manager Network QA manager
AQS Data Certifications	Performed annually to certify the validity of all data entered into the AQS	GPMP program manager QA coordinator Network QA manager

Table A6-4. Gaseous Pollutant Monitoring Program Project Schedule and Reporting Products.

Task Description	Due Date	Information Contained	Delivered to	Prepared by
Data collection	Ongoing	All data	IMC database	IMC data analysts
Hourly data uploads	Hourly to AIRNow program and password-protected FTP site for access by NPS ARD Web site and other users	All data	AIRNow NPS ARD analyst Other approved users	IMC data analysts
Site status board updates	Daily to site status notebook Twice each week to digital file	Site issues resolved Site issues unresolved	Hard copy notebook and site files Contained in Weekly Progress Reports and posted on project Web site	Field specialists Technical assistant
Weekly Progress Reports	Weekly – Tuesday following the week of record	Pending network issues Site status board entries Site visitation schedule Reporting and data requests Pending contract information	GPMP program manager Network QA manager Program manager Section managers IMC data analysts All ARS personnel working on the GPMP	Technical assistant
Monthly Data Reports	Monthly – within 45 days of the end of each calendar month	Summary tables and plots of data collected during the monitoring period Data comparisons with national and state standards Data collection statistics for raw and validated data	GPMP program manager Network QA manager Regional AQ coordinators Site operators Section managers NPS Data Request Web site Project Web site	IMC data analysts
Monthly EPA AQS data uploads	Monthly – within 60 days of the end of each calendar month	All data	EPA AQS	IMC data analysts
Monthly CASTNet data uploads	Monthly – within 90 days of each calendar month	All data	CASTNet contractor	IMC data analysts
NPS Data Request Web site updates	Daily for raw data Monthly for validated data; within 45 days of the end of each calendar month	All data	NPS Data Request Web site	IMC data analysts

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Table A6-4. Gaseous Pollutant Monitoring Program Project Schedule and Reporting Products (continued).

Task Description	Due Date	Information Contained	Delivered to	Prepared by
GPMP Project Web site updates	Monthly	Contract information Site visit trip reports Status board entries Site metadata Reports	Project Web site	Technical assistant
Plot reviews and program review	Monthly – last Wednesday of each month	All data for previous month Field and data-related issues Project planning	GPMP program manager Network QA manager Program manager Section managers IMC data analysts	N/A
Monthly raw data CD to NPS ARD	Quarterly within 45 days of the end of each calendar quarter	All raw data collected during the quarter of record	GPMP program manager	IMC data analysts
Quarterly Contract Status Reports	Quarterly – within 15 days of the end of each calendar quarter	Table of pending and completed tasks Contract task orders or modifications actions during the quarter	GPMP program manager Network QA manager Program manager Project Web site	Technical assistant
Monitoring History Database	Twice annually in January and July	Network site metadata	GPMP program manager Delivered to all ARS staff fore review	IMC data analysts
Site operator newsletter	Spring and fall; generally April and October	Network information updates Data collection statistics Feature operator Informative or instructional articles	GPMP program manager Network QA manager Park air quality supervisors Site operators Section managers Field specialists IMC data analysts	QA coordinator with input from network QA manager and network operations section manager

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Table A6-4. Gaseous Pollutant Monitoring Program Project Schedule and Reporting Products (continued).

Task Description	Due Date	Information Contained	Delivered to	Prepared by
CASTNet Conference Call	Monthly – second Wednesday of each month	Coordination between GPMP and CASTNet; pertinent issues	GPMP program manager Network QA manager Program manager Section managers IMC data analysts EPA CASTNet staff CASTNet contractor staff	CASTNet contractor
Annual Data Report	Annually – within 7 months of the end of the calendar year	Summary tables and plots of data collected during the monitoring period Data comparisons with national and state standards Calibration and/or audit results Data collection statistics for raw and validated data Data precision statistics Data analyses and interpretation Web access query Data uploads to EPA AQS and NPS Data Request Web sites	GPMP program manager Network QA manager Park air quality supervisors Site operators NPS ARD Web site Project Web site	IMC data analysts Network QA manager
Internal audits, maintenance, and calibration	Weekly inspection by on-site operator Semiannual internal performance audits, preventive maintenance, and calibrations of gaseous and meteorological systems performed by field specialists at six-month intervals Site visit reports due within 30 days of a site visit	Internal performance audit results Summary of parameter maintenance Notes and observations Completed calibration forms	Weekly Project Reports Project Web site	Technical assistant

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Table A6-4. Gaseous Pollutant Monitoring Program Project Schedule and Reporting Products (continued).

Task Description	Due Date	Information Contained	Delivered to	Prepared by
Independent field performance audits	External audits of gaseous and/or meteorological instruments may be conducted by an independent auditor at any time	Independent performance audit reports	Network QA manager Network operations section manager	Cooperating state agency, CASTNet auditor, or EPA NPAP auditor
Technical systems audits	Every 3 years	Independent assessment of the GPMP QC procedures as they relate to data validity and compliance with CFR	GPMP program manager	EPA systems auditor
Quality assurance documentation review and updates	Annually or as needed	QMP QAPP SOPs TIs CIs	GPMP program manager Network QA manager All holders of applicable documents	Quality assurance coordinator
Data archive	Continuous Nightly backup of all data and project information Raw data placed on deliverable CDs monthly Monthly uploads of validated data to AQS	All raw and validated data Metadata Project documentation QA documentation Software Database files Correspondence All project-related information	ARS on and off-site file storage GPMP program manager AQS	IMC data analysts ARS IT staff
Data certification	Annually	Certification of validity of all GPMP data entered into AQS	AQS manager	GPMP program manager ARS IT staff

Table A7-1. Data Quality Objectives, NPS Gaseous Pollutant Monitoring Program.

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 certify the ozone data annually and all ozone data are posted to the EPA AQS and made directly available to the public via the Internet by the NPS.
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.
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 PSD protocol methods that adhere at a minimum to EPA guidelines set forth in 40 CFR 58, Appendix B, 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 A7-2. Data Quality Indicators, NPS Gaseous Pollutant Monitoring Program.

Category	Performance Measure	Criteria
Precision	Gaseous automatic precision checks (see Section A.7.2.1)	Automatic daily or weekly manual precision on all gas analyzers compiled and reported monthly.
Accuracy	Gaseous automatic zero / span checks; and semiannual internal audits and calibrations, and independent audits for all instruments (see Section A.7.2.2)	Daily automatic zero and span checks on all gas analyzers. All on-site instruments challenged by NIST traceable standards twice a year during internal semiannual site visits. Independent audits performed at least once per year by cooperating state agencies at all sites at or near NAAQS.
Bias	Validation analyses	Bias is evaluated during the validation process.
Completeness	All parameters	The minimum valid data recovery objective for the program is greater than 75% for all gaseous data and 90% for all meteorological data per calendar quarter (or all possible hours during the operational season). Automatic zeros and spans are performed daily on most ambient gas analyzers; data lost during calibrations, maintenance, and audits are considered “not possible”. The calculation of percent valid is based on the number of valid measurements as compared to the number of possible measurements. As a result, the maximum percent valid for ambient gas data typically cannot be greater than 95.8%.
Representativeness	Site selection	Each site is selected to be as representative as possible to the NPS unit. Because of the geographic and biotic diversity and logistic challenges that exists in many NPS units, and the sensitive nature of the units, some compromises in site selection may be required. As much as possible, the network abides by EPA defined ambient air quality and meteorological siting criteria. All site specifications are fully documented. Refer to SOP 3050, *Siting of Ambient Air Quality Monitoring Stations*, for detailed procedures.
Comparability	All parameters	Siting, equipment specifications, and adopted monitoring protocols, and validation and reporting procedures are consistent at NPS-operated sites throughout the network and generally follow EPA guidelines. Sites operated by cooperating state agencies operate under individually adopted state protocols which generally follow EPA guidelines. Data are reported in standard units. Ozone data are certified annually by the NPS and all data are uploaded to EPA AQS and are made available on the Internet by the NPS.
Calibrations, Maintenance, and Audits	Semiannual site visits for internal performance audits, maintenance, calibration, and operator training	All sites are visited twice per year at approximately six-month intervals for internal performance audits, instrument maintenance, and calibrations. All results are fully documented on electronic forms.
	Calibrations	Absolute percent difference for 80% of all calibrations at each site are within 5%, 90% are within 10%, and 100% are within 15%. *Note: Absolute percent difference is defined as the absolute value of difference between calibration’s slope estimate and 1, expressed as a percent.*

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Table A7-2. Data Quality Indicators, NPS Gaseous Pollutant Monitoring Program (continued).

Category	Performance Measure	Criteria
Calibrations, Maintenance, and Audits (continued)	Field performance audits; internal and external	80% of all audits (on a site-parameter basis) have an average absolute percent difference of ≤ 7.5%. All audits (on a site-parameter basis) will have an average absolute percent difference of ≤ 10%. Absolute percent difference of all audit points are ≤ 15%. *Note: Average absolute percent difference is defined as the average of absolute difference (expressed as a percent based on the known value) for each audit point.*
	Independent field performance audits frequency	Agreements have been established with cooperating state agencies to have the agencies audit NPS sites at least once a year and more frequently (as often as quarterly) where possible.
	Audit standards certification	All primary and transfer standards are certified according to EPA criteria; at least once per year. EPA protocol gas standards certifications comply with EPA certification protocols.
	Instrument problems / response	Initial response to all problems within 48 hours (or by close of business Tuesday for problems occurring on weekends). All problems are entered into and tracked by the Site Status Log. Analyzers/Calibrators: Maximum instrument downtime ≤ 10 days. Status Board Entries: 100% manually entered daily to the Network Operations Site Status Logbook and transcribed twice weekly to the digital Site Status Board in the IMC database within 2 working days. Site Visits: All problems identified during semiannual visits are resolved within 7 days.
	Semiannual site visit documentation	Site visit documentation are completed within 30 days of a site visit and posted on the Project Web Site for use in data validation.
Data Management, Validation, and Reporting	Daily data review of all collected data	Data are remotely collected daily. The general quality and completeness of all data is assessed daily by both digital screening programs and IMC and network operations personnel review of plotted data for all parameters. Problems are entered in the Site Status Log for tracking and corrective actions initiated.
	Site operator (DataView) documentation	Site visit documentation and automatic diagnostics compiled by DataView are downloaded twice weekly and thoroughly reviewed by IMC and network operation personnel. Problems are entered in the Site Status Log for tracking and corrective actions initiated.

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Table A7-2. Data Quality Indicators, NPS Gaseous Pollutant Monitoring Program (continued).

Category	Performance Measure	Criteria
Data Management, Validation, and Reporting (continued)	Monthly data validation and reporting	Data are validated through a three-step process and reported monthly. Data from NPS operated sites for each month will reach final validation within 45 days of the end of the month of record. The validation process includes a monthly plot review which is a comprehensive review of all data by the GPMP program manager, network QA manager, and ARS personnel.
	EPA AQS submittals	AQS submittals of final validated data are performed monthly, within 60 days of the end of the month of record.
	Data Request Web Site posting	Final validated data are posted to the Data Request Web Site monthly, within 45 days of the end of the month of record.
	Project Web Site posting	A project Web site is maintained as a communications link among project participants. All information on the project Web site is reviewed and updated monthly.
	Site operator newsletter	A site operator newsletter is prepared twice annually as an information and training aid in station servicing.
	Annual report	The annual report summarizes all data from NPS units collected either by the NPS or a cooperating agency and includes analytical results including trends analysis. The annual report is completed by July 20 of the year following the year of record.
Cooperation With Other Agencies	Cooperating state agencies	The NPS cooperates with other federal agencies, state agencies, and other air quality agencies to the best extent possible to perform and enhance monitoring in NPS units. This cooperation includes operating state sites or instruments within a park unit or performing independent audits on an NPS-operated site. Cooperating agencies must individually certify the quality of the data they collect. The cooperation is normally formalized in a Memorandum of Understanding with each state or agency. The NPS does not provide funding to the agencies.
	Cooperating federal agencies	The NPS maintains an Interagency Agreement with the EPA Clean Air Markets Division to cooperate on the CASTNet Program. The NPS operates a number of CASTNet sites in NPS units, particularly in the western U.S. Supporting data from these sites are delivered monthly to the CASTNet program. The EPA performs deposition calculations for these sites.
	Special projects	The NPS participates in special projects and studies in cooperation with other researchers to investigate particular issues of interest to the NPS or a particular park unit. Data from these projects are generally handled separately.

Table A7-3. Gaseous Pollutant Monitoring Program Sensor and Sampling Specifications.

Parameter	Sensor	Units	Resolution or Minimum Detectable Limit	Sample Frequency	Averaging Period	Method Reference	Comments
Ozone Analyzer	Monitor Labs 8810 Dasibi 1003-AH Dasibi 1003-PC TEI 49 and 49C API Model 400 Series	ppb	Scale: 0 to 500 ppb MDL: 1ppb	1 second	One-minute and hourly	Automated equivalent method	10 m inlet height, Teflon tube inlet (1/4" OD), 5 micron filter at 10 m inlet One-minute averages captured by datalogger for digital stripchart displays on DataView
Ozone Calibrator	TEI 49 and 49C Dasibi 1003-PC	ppb	Scale:0 to 500 ppb MDL: 1 ppb	1 second	5-minute	Automated equivalent method	• Calibration gas tests entire system through 10m inlet • Automatic zero, span, and precisions performed once daily • Independent verification of test atmosphere with second in-station photometer
Sulfur Dioxide	TEI 43C	ppb	Scale: 0 to 1 ppm or 0 to 5 ppm MDL: 1 ppb (60-second average time)	1 second	One-minute and hourly	Automated equivalent method	Generally applied for specific research applications in the GPMP and may or may not be operated within EPA-certified ranges for equivalency
	TEI 43TL	ppb	Scale: 0 to 50 ppb o 0 to 100 ppb MDL: 1 ppb (60-second average time)	1 second	One-minute and hourly	Automated equivalent method	Generally applied for specific research applications in the GPMP and may or may not be operated within EPA-certified ranges for equivalency
Carbon Monoxide	TEI 48C	ppm	Scale: 0 to 20 ppm MDL: 0.1 ppm	1 second	One-minute and hourly	Automated reference method	Generally applied for specific research applications in the GPMP and may or may not be operated within EPA-certified ranges for equivalency
Oxides of Nitrogen	TEI 42C TL	ppb	Scale: 0 to 100 ppb MDL: 0.1 ppb	1 second	One-minute and hourly	Automated reference method	Generally applied for specific research applications in the GPMP and may or may not be operated within EPA-certified ranges for equivalency
Gas Dilution System	TEI 146 TEI 146C	N/A	Better than instrument under test	N/A	N/A	N/A	Generally applied for specific research applications in the GPMP and may or may not be operated within EPA-certified ranges for equivalency

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Table A7-3. Gaseous Pollutant Monitoring Program Sensor and Sampling Specifications (continued).

Parameter	Sensor	Units	Resolution or Accuracy	Sample Frequency	Averaging Period	Method Reference	Comments
Ambient Air Temperature	RM Young 41342 Climatronics 100093 Rotronics MP-101A Vaisala HMP 45C	°C	0.2 °C 0.2 °C 1 °C 1 °C	1 second	Hourly	N/A	• Motor-aspirated shield • Temperatures measured at 10m
Delta Temperature	RM Young Climatronics	°C	0.1 °C 0.1 °C	1 second	Hourly	N/A	• Motor-aspirated shields • Delta temperature at 10m and 2m
Shelter Temperature	ARS	°C	1.5 °C	1 second	Hourly	N/A	• Passively aspirated thermistor mounted near or on instrument rack
Ambient Relative Humidity	Rotronics MP-101A Rotronics MP-601A Vaisala HMP45AC	%	5% RH 5% RH 5% RH	1 second	Hourly	N/A	• Capacitive sensor in motor-aspirated shield
Wind Speed	Climatronics F460 RM Young #05305	m/s m/s	0.2 m/s 0.2 m/s	1 second	Hourly	N/A	• Climatronics anemometer chopper wheel / LED proportional to wind speed • R.M. Young Wind Monitor AQ, magnetic / sine wave frequency proportional to speed
Wind Direction	Climatronics F460 RM Young #05305	degrees true	5° 5°	1 second	Hourly	N/A	• Climatronics: individual cup and vane sensors • R.M. Young: prop and vane sensor
Standard Deviation of Wind Direction	ESC 8816	degrees	1°	1 second	15-minute sub-intervals, hourly averages	Ymartino method	
Precipitation	Climatronics 100097-1-90	mm	0.5 mm	N/A	Hourly totals	N/A	• Heated tipping bucket rain gauge

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Table A7-3. Gaseous Pollutant Monitoring Program Sensor and Sampling Specifications (continued).

Parameter	Sensor	Units	Resolution or Accuracy	Sample Frequency	Averaging Period	Method Reference	Comments
Wetness	RM Young	On/Off	N/A	N/A	Hourly totals	N/A	• R.M. Young sensor mounted at 2 meters above ground-level
Solar Radiation	LI-COR	Watts/meter^2	90 μA / 1000 Wm^2	1 second	Hourly averages	N/A	• LI-COR pyranometer, silicon photovoltaic sensor generally mounted at 4 meters depending on site-specific exposure
Barometric Pressure	Vaisala PTB100	mmHg	0.4 mmHg	1 second	Hourly averages	N/A	• BAROCAP® sensor mounted at 2 meters above ground-level • Not standard at all sites; only operated at selected locations

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 and meteorological monitoring. The sampling frequencies and instrumentation are described in Section A7.

The program is designed to collect gaseous 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 selecting the monitoring 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/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.

The basis for the overall network design is put forth in a 1991 NPS document titled “1991 NPS Monitoring Strategy”. 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://www2.nature.nps.gov/air/monitoring/*). The network objectives, design, and current configuration of the ozone and meteorology components are described in "Ozone Pollutant Monitoring in the National Parks" found 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 parks present challenges due to availability of power, resource impacts, site access, logistics, and other considerations, particularly in heavily vegetated park units in rugged terrain. The sites are also selected to be as representative as possible of overall park air quality. Again, this can be a challenge in park units that have multiple ecozones and extend across several air basins. In general, funding levels restrict most park units to one site, which is chosen to be most representative of the unit. Some larger or sensitive parks that require additional information to support research programs may operate more than one station.

B2 SAMPLING METHODS REQUIREMENTS

Sampling methods for ozone and meteorological monitoring, based on 40 CFR Part 58 Appendix E requirements, are fully detailed in the network SOPs, TIs, and CIs. A summary of the contents of the primary SOPs is provided in Table B2-1. The primary parameters monitored and sampling methods applied are:

Gaseous – Ozone data are collected at nearly all GPMP sites and are certified to the EPA. 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 to the EPA. Ozone and other gaseous data are collected no less than once daily via telephone modem from the on-site datalogger. Data are stored in site-specific daily raw data files in the IMC database. If telephone service is not available, data are manually downloaded weekly via the on-site laptop computer using DataView and shipped to ARS. Raw data stored on the datalogger and in the database are hourly averages.

Meteorology - Meteorological data are retrieved no less than once daily via telephone modem from the on-site datalogger. Data are stored in site-specific daily raw data files in the IMC database. If telephone service is not available, data are manually downloaded weekly from the on-site laptop using DataView and shipped to ARS. Raw data can include ambient temperature (ºC), delta air 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), wetness (% on 100), 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 data and hourly meteorological 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 telephone line failure at a site, the operator upon direction from the IMC, can create a CD of all digital hourly average raw data on the DataView computer. 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) mail the CD 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 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. To meet this hourly raw data posting requirement, separate IMC computers call selected monitoring sites and download, distribute, and post the raw data. This selective data acquisition process is done independently from the daily IMC site calls that download all network data from all sites.

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

This section is not applicable to the continuous measurements taken for the GPMP.

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.

Certification transfer standards and verification of primary standards used in the calibration of gaseous and meteorology instruments in the GPMP are itemized in Table B4-1.

B5 QUALITY CONTROL REQUIREMENTS

A summary of measurement-related quality control criteria is provided in Table B5-1. This table includes references to other more detailed tables presented in the QAPP and to project SOPs that more fully describe the procedures.

Calibration requirements for GPMP gaseous and meteorology systems are discussed below.

Gaseous - Gaseous analyzers and supporting zero air and gas dilution systems are serviced upon acceptance testing of a new instrument, upon installation or removal from a monitoring location, whenever control limits are exceeded, prior to any corrective action or maintenance that affects its operation, or at a maximum interval of six months. Specific control limits are presented in SOP 3100, *Calibration of Ambient Air Quality Analyzers.*

Meteorology - Meteorological sensors are serviced upon acceptance testing of a new instrument, upon installation or removal from a monitoring location, whenever control limits are exceeded, prior to any corrective action or maintenance that affects its operation, or at a maximum interval of six months. Specific control limits are presented in SOP 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems.*

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

B6.1 Inspection and Acceptance Testing

All instrumentation and equipment procured for the network undergo inspection and/or acceptance testing. Any noted inconsistencies related to the quality of manufacturing or system performance are resolved with the manufacturer. All systems must pass inspection and calibration before being implemented. An inventory of all procured capital equipment is maintained electronically on the GPMP Inventory Database. All hard copy documentation is filed and maintained by instrument type and serial number. The general procedures by equipment category are noted below.

Gaseous - Newly purchased gaseous analyzers and calibrators are calibrated at the manufacturer and are calibrated after receipt at ARS. Sensors are accepted if they are fully operational, documentation of the calibration is received with the analyzer, and after successful calibration at ARS. Refer to SOP 3100, *Calibration of Ambient Air Quality Analyzers,* for calibration procedures.

Meteorology - Newly purchased meteorological sensors are calibrated at the manufacturer. Sensors are accepted if they are fully operational and documentation of the calibration and calibration results are received with the sensor. If there are any questions regarding a sensor, a full calibration is performed on the sensor. The sensor is accepted if it passes the calibration. Refer to SOP 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems,* for calibration procedures.

Monitoring Support Systems - Support systems such as towers, shelters, zero air pumps, gas cylinders, regulators, racks, signal and power systems, etc. are fully specified before ordering from selected manufacturers. The selection process includes technical design, proven performance, operational life, maintenance requirements, quality, price, delivery schedules, and customer service considerations. All orders are inspected for completeness and individual component quality. All certification, calibration, or inspection documents received from the manufacturer are reviewed to ensure compliance with the order and required technical specifications.

Data Acquisition and Management Systems - The primary on-site data acquisition components are the datalogger and DataView computer. ESC dataloggers (8816 or 8832) are primarily used in the network. This datalogger was chosen because it fully meets network requirements. A consistent logger manufacturer is used to improve operational efficiencies. Campbell Scientific dataloggers are used at a limited number of sites where power or logistics limitations restrict the use of an ESC. Upon receipt of a new system, the datalogger performance is verified with a transfer standard voltage source, and all software functions applied in the network are tested. DataView computers were selected to be rugged, reliable, cost-effective, and capable of meeting network requirements. Computer manufacturers change models and specifications frequently. When a new DataView computer is needed, ARS surveys the available market to identify potential models, discusses the options with the GPMP program manager, then procures the one that best meets network requirements. All DataView computers are purchased under the GPMP contract and are NPS-owned. The delivered system is fully tested with DataView software in an operational simulation for a minimum of one week before it is accepted. Refer to SOP 3160, *Calibration of Data Acquisition Systems*, for specific procedures.

Data Management System Computers - The data management computing systems applied in this project are ARS-owned. These systems include workstations, printers, servers, peripherals, and software. Hardware is maintained and updated regularly to keep pace with ever expanding technology. All newly procured systems are fully inspected, loaded with required software, and are bench tested prior to acceptance. All systems are tracked in the IT database and all hard copy documentation, licenses, and original software media are filed and maintained by unit. A general turnaround of no more than 3 years for each hardware component is common. All software licenses are kept current and updates and patches are applied as they become available. Refer to SOP 3340, *Information Management Center (IMC) Concept and Configuration for the National Park Service Gaseous Pollutant Monitoring Program* for general system configurations and specifications.

B6.2 Maintenance of Measurement Systems

Table B5-1 summarizes the primary quality control (QC) procedures applied in the network including maintenance procedures. Tables B6-1 and B6-2 provide more detailed descriptions of the maintenance procedures for the gaseous and meteorology measurement systems.

Regular inspections and scheduled maintenance of the gaseous and meteorological monitoring systems and support systems are performed by the site operator during weekly site visits. Internal audits, calibrations, and preventive maintenance are performed by field specialists during semiannual site visits. Troubleshooting and remedial maintenance is performed by the site operator, as supported and directed by a field specialist, or by a field specialist (see Section B6.3). These maintenance procedures are detailed in the following standard operating procedures and technical instructions:

- Gaseous:
  - SOP 3178 *Station Operator Maintenance Procedures for Gaseous Monitoring Sites Using the DataView System*
  - SOP 3000 *Procedures for Semiannual Maintenance Visits to a National Park Service Ambient Air Monitoring Station*
  - SOP 3100 *Calibration of Ambient Air Quality Analyzers*

- Meteorology:
  - SOP 3176 *Station Operator Maintenance Procedures for Meteorological Monitoring Sites Using the DataView System*
  - SOP 3000 *Procedures for Semiannual Maintenance Visits to a National Park Service Ambient Air Monitoring Station*
  - SOP 3150 *Calibration and Routine Maintenance of Meteorological Monitoring Systems*

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. A summary list of replacement parts and systems, including the individual numbers of items commonly kept in the inventory is provided as Table B6-3.

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 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. Routine calibrations of air quality and meteorology instruments are performed upon initial installation and every six months thereafter. Additional calibrations are performed on an as-needed basis, such as in the event of equipment repair or replacement. The GPMP calibration and maintenance guidance for gas analyzers is provided in SOP 3100, *Calibration of Ambient Air Quality Analyzers*, and meteorological guidance is provided in SOP 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*. Calibration of datalogging systems are provided in SOP 3160, *Calibration of Data Acquisition Systems*. Calibrations are based on the guidance provided in 40 CFR part 50 Appendix D (ozone), part 58 Appendix A (SLAMS), and part 58 Appendix B

(PSD) and/or manufacturer's recommendations. PSD guidelines suggest meteorological calibrations every six months and gaseous calibrations every three months (quarterly). GPMP meteorological calibrations are performed every six months and meet the EPA guidance. GPMP gaseous internal audits and calibrations are also performed every six months due primarily to the fiscal considerations of this broad national network.

The quality of the GPMP gaseous data has not been compromised by this six-month interval for the following reasons. Gas analyzers are automatically challenged daily with known zero and span concentrations. Most sites also undergo an automatic daily precision check. At a few sites, precision checks are performed weekly. The site operator also performs a multipoint calibration once per month. Any changes in analyzer response can be readily identified in the daily data reviews and weekly plots. Note that all ozone sites have both an analyzer (with ozone generator) and calibrator (transfer standard) on site. The daily zero, span, and precision values are measured by both instruments. The independent measurement provided by the calibrator provides a direct on-site reference of the ozone concentrations. Any noted inconsistencies are immediately addressed. If any instrument is suspect, a fully-calibrated replacement instrument or identified replacement part is sent to the site for operator action. If the problem is not resolved by these actions, an emergency repair/calibration trip is performed. This approach has yielded a continuous, traceable method to ensure ongoing high quality instrument performance.

Calibration methods for each of the air quality and meteorological parameters are summarized in Table B7-1. Calibration acceptance criteria for this project are provided in Table B7-2.

All internal audits and calibrations are performed using certified transfer standards or verified primary standards traceable to NIST (see Section B5). 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.

All internal audits and calibration results and all calibration and maintenance actions are fully documented on ARS instrument-specific computer-based calibration spreadsheets. These computer-based forms guide the field specialist through the calibration steps and record all calibration values, make all calculations, and compare the calibration results to acceptance criteria and document the traceability of all standards. The forms provide immediate feedback of calibration results. Additional notes and explanations can also be entered on the forms. The forms are the primary documentation for each maintenance visit. Within 30 days of each site visit, the forms and any additional supplemental explanations are compiled into a written trip report.

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

The meteorology equipment are audited by ARS field specialists during the semiannual servicing visits. Refer to SOP 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems* and SOP 3750, *Meteorological Monitoring Sensor Audit Procedures.*

B8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

A basic list of site consumables is provided in SOP 3000, *Procedures for Semiannual Maintenance Visits to a National Park Service Ambient Air Monitoring Station.* All supplies and consumables are ordered and received by the technical assistant. A supply of consumables are kept on-site for gaseous and meteorological monitoring and include:

Gaseous - Gaseous analyzers use inlet filters, charcoal canisters, desiccant, and span gas. These supplies do not require acceptance testing and they do not have an expiration date. A supply of inlet filters are left on site to be replaced by the site operator every 14 days. The filters are stored on site in a sealed and labeled zip-lock bag and the operator is instructed on their proper handling and provided with disposable gloves and tweezers. All filter replacements are documented on DataView. The charcoal canisters and desiccant are replaced as needed by the site operator from an on-site supply replenished during semiannual visits. The protocol span gas is certified and replaced every two years by ARS during a semiannual visit.

Meteorology - Certain components of the meteorological sensors are replaced during each semiannual ARS calibration visit. These include the bearings and potentiometer in the wind sensors. The relative humidity sensor is replaced with a reconditioned, laboratory-calibrated unit. No meteorological consumables are required by the site operator.

Data Acquisition - Printer supplies including paper and ink cartridges are left on site for the operator. Several blank CDs are also left in case a manual download of the data is needed. A DataView installation CD is also left on site.

During each semiannual site visit, ARS inventories the remaining on-site consumables and provides a 7-month supply. The operator is instructed to contact ARS if these supplies run short. ARS continuously maintains approximately a 3-month supply of consumables for the entire network.

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 gaseous and meteorological data are collected each day via telephone modem. Collected data are appended daily 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. Complete data validation is performed on a monthly basis. Archiving of all

raw data is performed monthly. 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://12.45.109.6.* 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.*

Table B2-1. Sampling Methods Reference Table. (See complete listing in Appendix A).

Criteria	Description	SOP Reference
Network Operations		
Station siting	Site selection including installation considerations	SOP 3050
Installation	Procedures parallel semiannual site visit procedures	SOP 3000 / SOP 3100 SOP 3150
Semiannual site visits (internal audit, maintenance, and calibration)	Overall procedures referencing additional SOPs and TIs	SOP 3000
Calibration and maintenance of ambient analyzers	Procedures for internal audits, calibrations, and maintenance of O_3, SO_2, CO, and NO_x analyzers, referring to a series of instrument-specific technical instructions	SOP 3100
Calibration and maintenance of meteorological systems	Procedures for internal audits, calibration, and maintenance of meteorological sensors referring to a series of instrument-specific technical instructions	SOP 3150 / SOP 3750
Calibration of flow systems	Procedures for internal audits, calibration, and maintenance of gas dilution systems, referring to a series of instrument-specific technical instructions	SOP 3180
Calibration of data acquisition systems	Procedures for internal audits, calibration, and maintenance of data acquisition systems	SOP 3160
Certification of ozone transfer standards	Procedures for laboratory certification of standards for use in field operation	SOP 3300
Routine site operator maintenance of meteorological systems	Site operator procedures as guided by DataView referring to a series of Checklist Instructions (CIs)	SOP 3176
Routine site operator maintenance of gaseous monitoring systems	Site operator procedures as guided by DataView referring to a series of Checklist Instructions (CIs)	SOP 3178
Network technical support	Day-to-day technical support procedures to ensure continuing operation of monitoring equipment	SOP 3345
Information Management		
Data management system	Information Management Center (IMC) concept and configuration	SOP 3340
Database concepts	Structure and management of the IMC Air Quality Database Management System	SOP 3650
Data collection	Ambient air quality and meteorology data and DataView documentation collection procedures	SOP 3350
Data validation	Three level data validation procedures	SOP 3450
Data reporting	Data reporting to NPS (monthly and annual reports), EPA AQS, and NPS Data Request Web Site	SOP 3550

Table B4-1. Certification of Transfer Standards and Verification of Primary Standards for the Gaseous Pollutant Monitoring Program.

Parameter / Device	Type	Laboratory	Frequency
Laboratory O_3 Primary Standard (TEI model 49C)	Primary	EPA regional laboratory; multipoint comparison to NIST reference photometer	1/year
Field O_3 Primary Standard (TEI model 49C)	Primary	ARS laboratory	1/year
Protocol gases for SO_2, CO, and NO_x	Primary	Commercial gas suppliers	As needed
Flow standard (BIOS model DC2)	Primary	BIOS International	1/year
Temperature standard (digital) (Eutechnics Model 4400)	Transfer	Eutechnics	1/year
Laboratory solar radiation standard (Eppley Model PSP100)	Transfer	Eppley	1/year
Field solar radiation standard (Licor LI200)	Transfer	ARS laboratory	1/year
Wind speed calibration motor (Model 18802)	Transfer	R.M. Young	1/year
Wind speed torque (R.M. Young Model 18312, torque disc)	Transfer	N/A	Fixed test gauge, no re-calibration required
Wind direction (magnetic compass) (Model 2061)	Primary	Brunton	Upon necessary repair
Wind direction torque (R.M. Young Model 18331, torque gauge)	Transfer	N/A	Fixed test gauge, no re-calibration required
Voltage (digital voltmeter) (Fluke model 187, 8060A)	Transfer	Sypris test and measurement	1/year
Relative humidity (field calibration standard) (Rotronics 101A or Vaisala HMP45C)	Transfer	ARS laboratory	2/year
Relative humidity (laboratory transfer standard) (Rotronics Hygroclips)	Transfer	Rotronics	2/year
Precipitation (Laboratory grade calibration cylinder)	Transfer	N/A	Fixed cylinder, no re-calibration required
Wetness (Resistance decade box, IET, model RS-200)	Transfer	N/A	1/year verification with DVM
Barometric pressure (AIR-HB-1A)	Transfer	Vaisala	1/year

Table B5-1. Gaseous Pollutant Monitoring Program Measurement-Related Quality Control Criteria.

Category	Criteria	Parameter	Acceptance Range	Frequency	SOP, TI, or CI Reference
Critical Criteria	Zero/span check of gas analyzers	O_3 SO_2 CO NO_x	Zero drift ≤ ± 1% of full scale Span drift ≤ ± 15% (at 80% of full scale) Note that SO_2,CO, and NO_x ranges may be different for specific research applications	1/day	CI 3178-3101 through CI 3178-3157
	Precision of gas analyzers	O_3 SO_2 CO NO_x	Precision ≤ ± 10% of value (at 18% of full scale) Note that SO_2, CO, and NO_x ranges may be different for specific research applications	1/day	CI 3178-3101 through CI 3178-3157
Operations	Shelter temperature	Range	20° to 30°C (hourly average) or within EPA designation specifications	Hourly values	SOP 3000
		Control	≤ ± 4°C standard deviation over 24 hours	Daily from hourly values	SOP 3000
	Internal performance audit	Ambient gases	(See QAPP Table C1-1)	Every 6 months at each site	SOP 3100
		Meteorology	(See QAPP Table B7-2)	Every 6 months at each site	SOP 3150
	Independent performance audit	Ambient gases	Same as internal performance audit except as otherwise defined by audit agency	Performed by cooperating state agencies on their schedules. Most NPS sites with ozone levels at or near NAAQS are audited at least 1/year. Some network sites do not receive independent audits.	Audit agency SOP

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Table B5-1. Gaseous Pollutant Monitoring Program Measurement-Related Quality Control Criteria (continued).

Category	Criteria	Parameter	Acceptance Range	Frequency	SOP, TI, or CI Reference
Operations (continued)	Calibrations (including acceptance tests of new instruments)	Multipoint calibration of ambient gas analyzers (O_3, SO_2, CO, and NO_x) (0 and 5 upscale points)	(See QAPP Table B7-2)	Every 6 months or as acceptance test of new instrument. Monthly by site operator. Every 6 months by field specialist (See Section B7)	SOP 3100
		Ozone transfer standard	(See QAPP Table B7-2)	Every 6 months or as acceptance test of new instrument by field specialist (See Section B7)	SOP 3300
		Zero air	(See QAPP Table B7-2)	Every 6 months or as acceptance test of new instrument by field specialist	SOP 3100
		Gas dilution system	(See QAPP Table B7-2)	Every 6 months or as acceptance test of new instrument by field specialist	SOP 3180
		Meteorology	(See QAPP Table B7-2)	Every 6 months or as acceptance test of new instrument	SOP 3150
		Data acquisition system	Conversion to engineering units within 0.01% of input	Every 6 months or as acceptance test of new instrument	SOP 3160
	Primary standards verification and transfer standards certification	Ambient gases and meteorology	(See QAPP Table B7-2)	1/year or as needed	SOP 3300

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Table B5-1. Gaseous Pollutant Monitoring Program Measurement-Related Quality Control Criteria (continued).

Category	Criteria	Parameter	Acceptance Range	Frequency	SOP, TI, or CI Reference
Systematic Criteria	Data quality objectives	All parameters	(See QAPP Table A7-1)	N/A	N/A
	Network performance criteria	All parameters	(See QAPP Table A7-2)	As noted	N/A
	Sample probe configuration	All gas analyzers	Teflon inlet tube , ¼" OD. 5μm particulate filter at inlet height. Inlet shielded by rain cover.	Filters replaced every 2 weeks Tubing cleaned with pure alcohol 1/year Tubing replaced as needed	SOP 3000
	Sample probe and meteorological instrument heights	Ambient gases	Between 3 and 15 meters. All sites with collocated CASTNet monitoring measure ozone at 10m.	N/A	SOP 3050
		Meteorology	Wind measurements at 10m	N/A	
			Temperature at 9 m	N/A	
			Delta temperature 2 to 9 m	N/A	
			Precipitation and solar radiation at 1-2 m	N/A	
			Barometric pressure at 2 m	N/A	
			Wetness at 2 m	N/A	

Table B6-1. Gaseous Monitoring System Routine Operations and Maintenance Requirements.

Ozone, Sulfur Dioxide, Carbon Monoxide and Oxides of Nitrogen Routine Field Procedures

Regular Inspections	Frequency
• General site/system inspection.	Every 7 days by site operator
• Document the site visit and pertinent events in the DataView station log.	
• Check alarm and reminder messages on DataView and respond as required.	
• Check central messages in DataView and/or the phone message system and respond if required.	
• Review the stackplots of individual parameters to identify any downtime or data inconsistencies. Verify station temperature stayed between 20ºC and 30ºC for the previous week; adjust AC or heater if necessary.	
• Complete the DataView station visit checklist for each instrument.	
• Verify adequate supply of expendables (desiccant, charcoal, sample filters).	
• Verify that the previous week's zero, span, and precision checks were in tolerance.	
• Check the gas (O_3, SO_2, CO, and NO_X) analyzer's Teflon inlet filters; change if required.	Every 14 days
• Check sample lines for possible contamination.	
• Complete a multipoint calibration on the O_3, SO_2, CO, and NO_X analyzers.	Monthly, or as required
• Change desiccant in zero air system	As Required
• Contact ARS at any time to resolve questions or obtain assistance.	
Scheduled Maintenance	Semiannual by ARS
• Pre-adjustment multipoint internal performance audit on all gas analyzers.	
• Maintenance, leak checks, and calibration of gas analyzers, the dilution system, and zero air system.	
• Post-adjustment multipoint calibration check on all gas analyzers.	
• Calibration check of the datalogger analog voltage inputs.	
• Change charcoal in zero air system.	
• Inspect and clean or replace sample lines if required.	
• Implement any required datalogger or DataView software upgrades.	
• Inspect all support systems such as the shelter, air conditioner, UPS, racks, etc. and repair or replace as required.	
• 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.	
• Inventory all equipment at the site.	
• Prepare written trip report within 30 days of visit.	
Automatic Calibration References	As indicated below
• Gas calibration checks (zeros, spans, and precisions) occur daily and are automatically controlled by the datalogger (at some sites, due to configuration limitations, precision checks occur weekly). The spans are set to challenge each analyzer at 80% of each analyzer's full scale, and precisions are set to challenge the analyzers at 18% of full scale. Note that three SO_2 instrument configurations are used in the network, each with different full scale values.	

Name of Event	Zero	O_3 Span (ppb)	SO_2Span (ppb)	CO Span (ppm)	NO_x Span (ppb)	O_3 Prec (ppb)	SO_2 Prec (ppb)	CO Prec (ppm)	NO_x Prec (ppb)
Target Concentration	O%	400	40, 80, or 800	15.6	80	90	9, 18, or 90	3.5	18
Full Scale	N/A	500	50, 100, or 1000	20	100	500	50, 100, or 1000	20	100
Frequency	Daily	Daily	Daily	Daily	Daily	Daily or Weekly	Daily or Weekly	Daily or Weekly	Daily or Weekly

Table B6-2. Meteorological System Routine Operations and Maintenance Requirements.

Meteorological System Routine Field Procedures	
Regular Inspections	Frequency
• Inspect overall system.	Weekly
• Complete the DataView station visit checklist for each instrument.	
• Observe freedom of wind vane and anemometer propeller.	
• Document observed weather conditions.	
• Verify that wind, temperature, precipitation, wetness and relative humidity measurements appear reasonable.	
• Perform leak check, 10-tip test on rainfall sensor.	
• Document the station site visit and pertinent events in the DataView station log.	
Scheduled Maintenance	Every 6 months
• Pre-adjustment internal performance audit of all meteorological instruments.	
• Performance system maintenance:	
- Clean systems.	
- Replace wind speed bearings.	
- Replace wind vane potentiometer if required.	
- Replace RH sensor with laboratory calibrated sensor.	
• Post-maintenance calibration of all sensors that were replaced.	
• Inspect all support systems including towers, safety systems, power systems, etc. and repair or replace as required.	
• Verify site operator is performing all duties. Retrain as required.	
• Document all calibrations and actions on ARS computer-based maintenance and calibration spreadsheets.	
• Prepare written trip report within 30 days of visit.	

Table B6-3. Gaseous Pollutant Monitoring Program Replacement Parts Inventory.

Category	System / Part	Number Generally Available			
		TECO	Monitor Labs	Dasibi	API
Gas Analyzers	Ozone analyzer	2	9	1	3
	Ozone calibrator	3	-	11	-
	SO_2 analyzer	2	-	-	-
	NO_x analyzer	0	-	-	-
	CO analyzer	1	-	-	-
	Gas dilution system	3	-	-	-
	Zero air supply	2	-	-	-
	Charcoal canister	6	-	-	-
	Desiccant canister	6	-	-	-
	Analyzer pumps	4	2	2	0
	Solenoid valves	8	0	5	1
	UV lamps	10	6	8	5
	Scrubbers	12	10	15	1
		Climatronics	**R.M. Young**	**Rotronics**	**Vaisala**
Meteorology	Wind speed sensors	10	9	-	-
	Wind direction sensors	10	9	-	10
	Relative humidity sensors	-	-	6	10
	Temperature sensors	1	-	3	-
	Delta temperature systems	2	3	-	-
	Solar radiation systems	5	-	-	-
	Precipitation gauges	5	2	-	-
	Wetness sensors	-	4	-	-
	Wind speed cup sets	8	8	-	-
	Wind direction vanes	6	9	-	-
	Wind speed bearings	25	10	-	-
	Wind direction bearings	25	10	-	-
		ESC	**Gateway**		
Data Acquisition	Datalogger	6	-		
	DataView computer	-	5		
		General			
Support Systems	Shelters	0			
	Towers	1			
	Air conditioners	1			
	Instrument racks	0			

Table B7-1. Calibration Methods for the Monitored Parameters in the Gaseous Pollutant Monitoring Program.

Measurement Variable	Calibration Method
Ozone (O_3)	Multipoint by UV photometer transfer standard (traceable to a NIST-certified primary standard)
Sulfur Dioxide (SO_2)	Multipoint mass flow dilution of EPA Protocol gas
Carbon Monoxide (CO)	Multipoint mass flow dilution of EPA Protocol gas
Nitrogen Dioxide (NO_2)	Multipoint mass flow dilution of EPA Protocol gas and gas phase titration of ozone and NO for NO_2 converter check
DAS Time	Compare with NIST time
DAS Voltage	Compare with known voltage inputs from certified voltage source
Temperature	Water bath comparisons to a certified transfer standard or collocated comparisons to a certified transfer standard
Temperature Difference (ΔT)	Water bath comparisons to a certified transfer standard
Shelter Temperature	Collocated comparisons to a certified transfer standard
Relative Humidity	Collocated comparisons to a certified transfer standard
Wind Direction	Alignment using two landmarks, orientation to true north, and linearity with a directional protractor
Wind Speed	Rotational rate at zero and three upscale speed levels using a selectable speed anemometer drive
Precipitation	Simulated known precipitation rate using water from a calibrated cylinder
Wetness	Simulated using water placed on sensor
Solar Radiation	Collocated comparisons to a certified transfer standard
Barometric Pressure	Comparison to a hand-held certified transfer standard

Note: See Table B5-1 for the acceptance criteria and certification/verification frequencies of all NIST-traceable calibration standards.

Table B7-2. Calibration Acceptance Criteria in the Gaseous Pollutant Monitoring Program.

Parameter	Calibration Method	Criteria	Calibration Acceptance Criteria	SOP Reference
Gas Max difference	Gas primary or transfer standard (0 and 5 upscale points)	Max error	≤ ±5.0% at any designated point	SOP 3100
Gas Average difference	Gas primary or transfer standard (0 and 5 upscale points)	Average error	≤ ±5.0% average of all points	SOP 3100
Gas Slope (m)	Gas primary or transfer standard (0 and 5 upscale points)	Actual	0.950 ≤ m ≤ 1.050	SOP 3100
Gas Intercept (b)	Gas primary or transfer standard (0 and 5 upscale points)	Actual	≤ ± 3.0 ppb for O_3, NO_X and SO_2 ≤ ± 0.3 ppm for CO	SOP 3100
Gas Correlation (r)	Gas primary or transfer standard (0 and 5 upscale points)	Actual	r > 0.9950	SOP 3100
Data Acquisition System Time	Compare with NIST time	Max error	≤ ± 2 minutes	SOP 3160
Data Acquisition System Voltage	Known voltage inputs	Max error	≤ ± 0.01% VDC	SOP 3160
Meteorological Translator Cards	Compare with calibrated voltmeter	Max error	≤ ± 0.1% of designated value	TI 3150-2100 TI 3150-2105
Temperature	Three water baths and certified thermometer (0°C, approximately 20°C, 40°C to 50°C)	Max error	≤ ±0.5°C (RM Young) ≤ ±0.2°C (Climatronics)	TI 3150-2113 TI 3150-2105
	Or collocated transfer standard (non-immersible sensors)	Max error	≤ ±1.0°C (Rotronics/Vaisala)	TI 3150-2115 TI 3150-2116
Temperature Difference	Three water baths (0°C, approximately 20°C, 40°C to 50°C)	Max error	≤ ±0.2°C (RM Young) ≤ ±0.1°C (Climatronics)	TI 3150-2113 TI 3150-2105
Shelter Temperature	Temperature transfer standard	Max error	±1.5°C	SOP 3450
Relative Humidity	RH sensor transfer standard	Max error	≤ ±5.0% RH error	TI 3150-2115 TI 3150-2116
Wind Speed	Compare to calibrated motor at 4 speeds	Max error	≤ ±0.2 m/s at <5 m/s ≤ ±5.0% at ≥ 5 m/s	TI 3150-2100
Wind Speed Starting Threshold	Weighted torque disk	Max error	≤ 0.3 g-cm (RM Young) ≤ 0.2 g-cm (Climatronics)	TI 3150-2103 TI 3150-2100
Wind Direction Alignment	Solar azimuth, Precision compass, USGS map	Max error	≤ ±5° from true degrees at any designated point	SOP 3150
Wind Direction Linearity	45° increment inputs	Max error	≤ ±3° at any designated point	SOP 3150
Wind Direction Starting Threshold	Weighted torque disk	Max error	≤ 9 g-cm (RM Young) ≤ 6 g-cm (Climatronics)	SOP 3150
Precipitation (Tipping Bucket)	Addition of known water volume	Max error	≤ ±5.0% of input volume	SOP 3150
Wetness	Add simulated water on sensor	Response	-5 to 5 DAS value dry 95 to 105 DAS value wet	
Solar Radiation	Collocated transfer standard	Average error	≤ ±5%	SOP 3150
Barometric Pressure	Compare to calibrated unit	Max error	≤ ±1.5 mmHg	SOP 3150

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 operation, data quality, and data completeness are assessed each business day by reviewing the data downloaded by telephone from the datalogger. Any inconsistencies noted in the data are reported to the network operations section manager, who initiates appropriate corrective action. Corrective action begins with review of the inconsistency by a field specialist. If warranted, the field specialist enters a description of the problem and begins a tracking timeline of the problem in the Site Status Log. The field specialist then initiates troubleshooting activities with the site operator. If troubleshooting results indicate an analyzer, sensor, or system has failed, a replacement unit is shipped to the site and the malfunctioning unit returned for repair. If the problem is determined to be too complex for the site operator to fix alone, a field specialist is sent to the site to evaluate and correct the problem. All actions related to each individual problem and the final problem resolution are entered on the Site Status Log. An electronic version of the Site Status Log is maintained in the IMC database and is available on the GPMP project Web site. Hard copies of the site status log sheets for each identified problem are kept in a notebook until the problem is resolved. Once resolved, the individual status log sheets are filed by site for ready reference. New and resolved problems are also summarized in the weekly reports.

Assessments of the program include semiannual internal performance audits of the instrumentation by trained ARS field staff (see SOP 3000, *Procedures for Semiannual Maintenance Visits to a National Park Service Ambient Air Monitoring Station*). The internal audits are based upon accuracy goals, which are described below.

Gaseous internal performance audits are conducted using an ozone transfer standard (traceable to a NIST-certified primary standard) or a gas dilution/gas phase titration system and introducing a reference zero at three test atmospheres (using EPA protocol gases) to the analyzer through its normal sampling system, including the sample intake manifold, filters, and scrubbers.

The percent difference between the actual concentration of the audit test gas and the concentration indicated by the analyzer is used to determine if the analyzer is operating within specified limits. Analyzers whose reading for any single point differs from the test atmosphere by more than ± 10% are considered to be out of tolerance. Audit challenge ranges and acceptance criteria for the gaseous analyzers are presented in Table C1-1.

Meteorological measurement systems are audited in accordance with the EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV – Meteorological Measurements* (1995). Accuracy goals for the meteorological parameters are obtained from the EPA's *Meteorological Program Guidance for Regulatory Modeling Applications*. The auditor uses NIST-traceable test equipment for all meteorological performance audits. Meteorological audit procedures are described below.

Temperature and Temperature Difference - The entire temperature system is physically challenged by actual measurement of known temperatures. Each temperature sensor is immersed in three (3) temperature baths with NIST-traceable thermometers. The temperature tests are performed at 0°C, ambient (approximately 20°C), and as near to full-scale as possible. Readings of the bath temperatures obtained with the NIST-traceable thermometer are compared to the on-site datalogger output. Temperature differences (ΔT) systems are assessed by simultaneously immersing both sensors in each of the three baths and noting the measured temperature difference between sensors. The data are used to assess the accuracy and linearity of each sensor.

Relative Humidity - The relative humidity monitoring system performance assessment is conducted using a reference relative humidity monitoring system. The humidity observation is taken as near as possible to the sensor. Relative humidity data observed on the on-site datalogger are compared to the reference readings.

Wind Speed – The wind speed audit consists of a dynamic test of the horizontal wind speed sensors using an R.M. Young model selectable anemometer drive. The sensor is tested at zero plus three (3) shaft revolution speeds. The equivalent wind speed is calculated corresponding to the manufacturer's specified values for shaft RPM versus wind velocity and compared to readings obtained from the on-site datalogger. A bearing integrity check is also performed using an R.M. Young torque disk.

Wind Direction - Wind direction sensor audits includes the verification of sensor orientation, linearity, and bearing integrity. The wind sensor crossarm alignment relative to true north is checked, the wind direction vane is pointed toward and from at least two landmarks, and the datalogger's response is noted. In addition to the sensor orientation and linearity checks, the sensor bearings are tested using an R.M. Young vane bearing torque gauge.

Precipitation - The precipitation audit consists of introducing three (3) known amounts of water to the bucket. The known amounts of water are compared with the readings from the on-site datalogger to establish sensor accuracy.

Wetness – The wetness sensor audit consists of introducing water to the sensor and comparing the readings from the on-site datalogger to establish sensor performance.

Solar Radiation – The solar radiation audit consists of collocating a certified LiCor pyranometer next to the station sensor. Five (5) simultaneous readings are collected. Readings from the audit standard and on-site dataloggers are compared to establish sensor accuracy.

Barometric Pressure - The barometric pressure audit consists of comparing the on-site sensor with a recently calibrated hand-held sensor.

Audit challenge ranges and acceptable criteria for the meteorological sensors are identical to the calibration acceptance criteria listed in Table B7-2. Internal performance audit results are provided as follows:

- The results of all internal performance audits are documented on ARS computer-based calibration worksheets. If the auditor determines that the sampler is operating outside of project accuracy goals (at the warning or fail levels), they take immediate action to correct the noted problem during site maintenance and calibration.

- Fully documented written site visit maintenance reports (including internal performance audits) are normally completed within 30 days of an audit.

Any problems noted during the internal audit component of the semiannual site visit are addressed immediately during the maintenance and calibration phases of the semiannual site visits. Problems noted and resolved during the semiannual visit are documented on the site visit documentation. Problems that cannot be immediately resolved are tracked to their resolution in the Site Status Log.

The network goal is to have independent field performance audits performed annually on at least 20% of the network sites. Independent network performance assessments are performed by cooperating air quality agencies, (including state agencies or local air quality districts, who perform periodic independent field performance audits), the CASTNet auditor, or the EPA NPAP auditor. The NPS generally encourages these audits through a memorandum of understanding with individual cooperating agencies. States such as Maine, Tennessee, Colorado, and California conduct periodic independent audits of NPS-operated sites and forward their results to the individual site operators and/or the GPMP program manager who forwards the results to ARS. All GPMP sites that participate in the CASTNet program receive an independent audit once every two years. Beginning in 2007, the EPA NPAP program will schedule audits periodically to NPS sites. CASTNet and EPA audit results are forwarded to the GPMP program manager or quality assurance coordinator. Any noted inconsistencies are immediately addressed. Audit schedules are determined by the cooperating agencies and range from quarterly to multiple years.

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 generally performed during the last week of each month. These plot reviews, attended by the GPMP program manager, network quality assurance 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.

C2 REPORTS TO MANAGEMENT

Reports to management include weekly and quarterly progress reports, as well as monthly and annual data reports. The schedule of distribution of these reports is presented in Section A6.3. 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 45 days of month end and include a monthly summary of gaseous and meteorological data by site, and the monthly data collection statistics for all collected parameters for each site.

Quarterly 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 within 15 days of the end of each calendar quarter.

Annual Data Reports - Annual data reports are delivered once per year and include site specification information, data collection statistics, summary of gaseous and meteorological data, comparison of collected gas concentrations to the National Ambient Air Quality Standards, data analyses (such as trend analyses), and data accuracy and precision summaries.

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 - Validated data are uploaded to the publicly accessible Data Request Web Site in conjunction with the Monthly Data Reports. Data may be retrieved in spreadsheet-ready ASCII files, or in graphical format (such as stacked time series plots and wind roses).

Table C1-1. Gaseous Analyzers Audit Ranges and Acceptance Criteria.

Parameters	Audit Concentration Ranges (ppm)			Acceptance Criteria (difference between audit test gas concentration and analyzer response)
	Level 1	Level 2	Level 3	
O_3	0.03 – 0.08	0.15 – 0.20	0.35 – 0.45	±5% for any point
Values noted below for SO_2, CO, and NO_2 are general guidelines that may vary depending on the specific GPMP research application				
SO_2	0.03 – 0.08	0.15 – 0.20	0.35 – 0.45	±5% for any point
CO	3.0 – 8.0	15.0 – 20.0	35.0 – 45.0	±5% for any point
NO_2	0.03 – 0.08	0.15 – 0.20	0.35 – 0.45	±5% for any point

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

Gaseous and meteorological data undergo specific validation procedures detailed in Sections A7, B4, and D2, and SOP 3450, *Ambient Air Quality and Meteorological Monitoring Data Validation.* Specific data validation acceptance criteria that are used for all monitored parameters are listed in Table D1-1.

D2 VALIDATION AND VERIFICATION METHODS

Analytical methods for gaseous 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*. Validation of O_3, SO_2, CO, NO_x and all meteorological parameters include three validation levels: Level 0, Preliminary, and Final. A flowchart detailing these procedures is presented as Figure D2-1. ARS personnel validate all data.

Level 0 data validation:

The data validation process begins with a visual review and screen. Data analysts:

- Collect data via modem.
- Initially screen the daily data for anomalies.
- Visually review graphed raw data on stackplots on a daily basis.
- Check daily calibration data (zero and span values) for the expected range.

After data for the site/day are verified, they are screened for anomalies by a computer program. This program applies anomaly flags (Level 0 validation codes). These flags 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 ARS IMC 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. Data analysts:

- Review DataView site documentation.
- Review the ARS Site Status Log.
- Record and review comments on the raw data stackplots.
- Review daily summaries.
- Review trip reports (semiannual internal audit and calibration results).
- Review calibration plots.
- Enter and review any internal performance audit data received for the site/month into the IMC database.
- Enter and review any external, independent performance audit data received for the site/month into the IMC database.
- Enter validation codes into and adjust values in the IMC database as required.
- Update the ARS Data Validation Log.
- Review validated data stackplots.
- Review electronic stripcharts remotely via DataView laptop at site.

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 out 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 (see Table A7-3).

After placing comments on stackplots, data analysts enter validation codes for each hourly average value for each parameter into the IMC database. A complete list of validation codes can be found in Table 4-2 of Technical Instruction 3450-5010, *Ambient Air Quality and Meteorological Monitoring Data - Preliminary Validation*. The codes entered come directly from the commented stackplots and are also guided by the datalogger and anomaly screening and datalogger flags, although sometimes an anomaly screening flag is also a validation code. All flags are tracked by date and source.

Final data validation:
Data analysts complete validation:

- Participate in a group plot review that includes input from the NPS program manager, NPS air quality specialist, ARS program manager, the section managers, field specialists, and site operators. 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 final validation date in the Data Validation Log for the site/month is deleted.
- 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.
- A new Final validation date is entered in 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 and meteorological monitoring systems were installed to provide scientifically defensible air quality data.

The monitoring program was designed to collect gaseous and meteorological data to characterize the extent, frequency of occurrence, and magnitude of air quality. 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 entered into 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 internal performance audits, calibrations, automated and manual precision accuracy tests, independent performance audits,

technical systems audits, and all other methods used to ensure data quality. All valid data 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. A copy of the letter certifying 2005 data is provided as Figure D3-1.

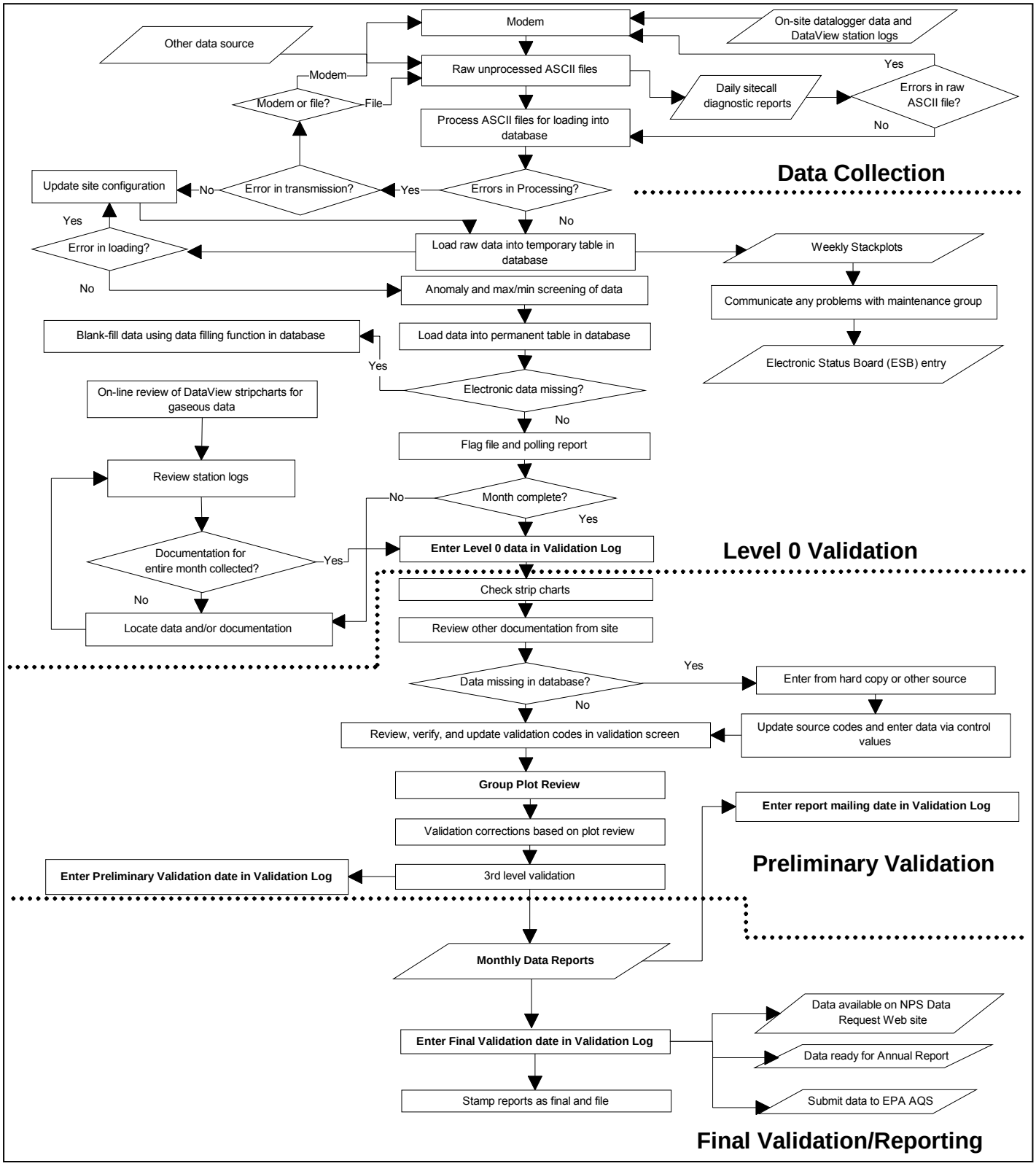

Figure D2-1. Gaseous Pollutant Monitoring Program Data Validation Flowchart.

United States Department of the Interior
NATIONAL PARK SERVICE
Air Resources Division
P.O. Box 25287
Denver, Colorado 80225

IN REPLY REFER TO:

December 13, 2006

Mr. David Lutz
MQAG (C339-02)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Re: Certification of National Park Service, Gaseous Pollutant Monitoring Program Data for 2005

Dear Mr. Lutz:

The National Park Service, Air Resources Division, hereby certifies the NPS Gaseous Pollutant Monitoring Program (GPMP) pollutant data (ozone, sulfur dioxide, carbon monoxide, nitric oxide, oxides of nitrogen, and $PM_{2.5}$) for the year 2005 that currently reside on the EPA AQS. These data have undergone stringent validation procedures and are believed to be a consistent and accurate representation of ambient air quality conditions within the monitored NPS units.

Attached are:

- A summary table of NPS units where monitoring occurred during 2005.
- AMP450 report (Quick Look Criteria Parameters) for CY 2005.
- AMP240 report (Precision and Accuracy Reporting Organization Summary) for CY 2005.

Please contact me (john_d_ray@nps.gov; 303-9969-2820) if you have any questions.

Sincerely,

John D. Ray, Ph.D.
Program Manager

JR:jw

Cc: Dave Maxwell
John Vimont
Brian Mitchell
Chris Shaver

Figure D3-1. Letter to EPA Certifying 2005 GPMP Data.

Table D1-1. Validation Acceptance Criteria for the Gaseous Pollutant Monitoring Program.

Parameter	Calibration Method	Criteria	NPS Validation Criteria (Data Reasonableness)	SOP Reference
Temperature (Climatronics or RM Young)	Three water baths and certified thermometer (0°C, approximately 20°C, and 40°C to 50°C)	Max error	≤ ±0.5°C from actual	TI 3450-5010
Temperature (Rotronics)	Temperature transfer standard	Max error	≤ ±1.5°C	TI 3450-5010
Temperature and Temperature Difference (Climatronics or RM Young)	Three water baths (0°C, approximately 20°C, and 40°C to 50°C)	Max error	≤ ±0.5°C	TI 3450-5010
Shelter Temperature	Temperature transfer standard	Max error	±1.5°C	TI 3450-5010
Relative Humidity	RH sensor transfer standard	Max error	≤ ±10.0%	TI 3450-5010
Wind Speed	Selectable speed rpm motor	Max error	≤ ±0.5 m/s for values <5.0 m/s ≤ ±5.0% for values >5.0 m/s	TI 3450-5010
Wind Speed Starting Threshold	Weighted torque disk	Max error	≤ 0.4 g-cm (Climatronics) ≤ 0.5 g-cm (RM Young)	TI 3450-5010
Wind Direction Alignment	Solar Azimuth, Precision compass, USGS map	Max error	≤ ±5° from true degrees	TI 3450-5010
Wind Direction Linearity	45° increment inputs	Max error	≤ ±5°	TI 3450-5010
Wind Direction Starting Threshold	Weighted torque disk	Max error	≤ 8 g-cm (Climatronics) ≤ 11 (RM Young)	TI 3450-5010
Precipitation (Tipping Bucket)	Addition of known water volume	Max error	≤ ±10.0%	TI 3450-5010
Precipitation (Weighting Gauge)	Addition of certified weights, or known water volume	Max error	≤ ±10% or ≤ ±0.10 inches	TI 3450-5010
Wetness Sensor	Mist with distilled water; and apply test resistance (230-240 Ohms)	Response	Confirmed sensor response as necessary to correct readings to full scale of 100 (equivalent to 1.0VDC)	TI 3450-5010
Solar Radiation	Collocated transfer standard	Average error	≤ ±10%	TI 3450-5010
Barometric Pressure	Collocated transfer standard	Max error	≤ ±3.0 mmHg or ±4.0 mb	TI 3450-5010
Gas Max difference	Gas primary or transfer standard (0 and 5 upscale points)	Max error	≤ ±10.0% of actual	TI 3450-5010
Gas Average difference	Gas primary or transfer standard (0 and 5 upscale points)	Average error	≤ ±10.0%	TI 3450-5010
Gas Slope (m)	Gas primary or transfer standard (0 and 5 upscale points)	Actual	0.900 ≤ slope ≤ 1.100	TI 3450-5010
Gas Intercept (b)	Gas primary or transfer standard (0 and 5 upscale points)	Actual	≤ ±5.0 ppb from actual for O_3 and SO_2 ≤ ±5.0 ppm for CO	TI 3450-5010
Gas Correlation (r)	Gas primary or transfer standard (0 and 5 upscale points)	Actual	>0.9900	TI 3450-5010
Data Acquisition System Time	Compare with NIST time	Max error	≤ ±2 minutes	TI 3450-5010
Data Acquisition System Voltage	Known voltage inputs	Max error	≤ ±0.003 VDC	TI 3450-5010
Meteorological Translator Cards	Compare with calibrated voltmeter	Max error	≤ ±0.005 VDC of designated zero value; and ≤ ±0.1% of span	TI 3450-5010

REFERENCES

40 CFR 50, *National Primary and Secondary Ambient Air Quality Standards* http://ecfr.gpoaccess.gov/

40 CFR 50 Appendix D, *Measurement Principle and Calibration Procedure for the Measurement of Ozone in the Atmosphere* http://ecfr.gpoaccess.gov/

40 CFR 53, *Ambient Air Monitoring Reference and Equivalent Methods* http://ecfr.gpoaccess.gov/

40 CFR 58, Appendix A, *Quality Assurance Requirements for State and Local Air Monitoring Stations, (SLAMS)* http://ecfr.gpoaccess.gov/

40 CFR 58 Appendix B, *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring* http://ecfr.gpoaccess.gov/

40 CFR 58 Appendix D, *Network Design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS)* http://ecfr.gpoaccess.gov/

40 CFR 58 Appendix E, *Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring* http://ecfr.gpoaccess.gov/

Air Resource Specialists, Inc. *Introduction to DataView*, June 2000.

Clean Air Act 1963 (amendments 1970, 1977, 1990) http://www.epa.gov/oar/caa/contents.html

EPA Quality Assurance Handbook for Air Pollution Measurement Systems:
Volume I, *A Field Guide to Environmental Quality Assurance*.
(EPA/600/R-94/038a)
http://www.epa.gov/ttn/amtic/files/ambient/qaqc/r94-038a.pdf
Volume II, *Ambient Air Quality Monitoring Program Quality System Development*
(EPA-454/R-98-004)
http://www.epa.gov/ttn/amtic/files/ambient/qaqc/redbook.pdf
Volume IV, *Meteorological Measurements*
(EPA/600/R-94/038d)
http://www.epa.gov/scram001/guidance/met/vol4metmeas1.pdf

EPA *Guidance for Quality Assurance Project Plans (QAPPs)*
(EPA/240/R-02/009)
http://www.epa.gov/quality1/qs-docs/g5-final.pdf

EPA *Requirements for Quality Assurance Project Plans (QAPPs)*
(EPA/240/B-01/003)
http://www.epa.gov/quality1/qs-docs/r5-final.pdf

EPA *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005) http://www.epa.gov/scram001/guidance/met/mmgrma.pdf

National Park Service, *1991 NPS Monitoring Strategy* http://www2.nature.nps.gov/air/Monitoring/docs/trenddoc.htm

National Park Service, *Ozone Pollutant Monitoring in the National Parks* http://www2.nature.nps.gov/air/Monitoring/docs/mnetview.pdf

Organic Act of 1916 http://www.nps.gov/legacy/organic-act.htm

NPS ARD Web site (http://www2.nature.nps.gov/air)

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

NPS Data Request Web site (http://12.45.109.6/)

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

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	QAPP Section(s)
SOP 3000	**Procedures for Semiannual Maintenance Visits to a National Park Service Ambient Air Monitoring Station**	**B6.2, B8, C1, Table B2-1**
SOP 3050	**Siting of Ambient Air Quality Monitoring Stations**	**Table A7-2, B1, Table B2-1, Table B5-1**
SOP 3100	**Calibration of Ambient Air Quality Analyzers**	**A7.3.1, B5, B6.1, B6.2, B7, Table B2-1, Table B5-1, Table B7-2**
TI 3100-2000	Calibration and Routine Maintenance of Monitor Labs (ML) 8810 Ozone Analyzers	
TI 3100-2001	Calibration and Routine Maintenance of Dasibi 1003-AH, 1003-RS, or 1003-PC Ozone Analyzers	
TI 3100-2002	Calibration and Routine Maintenance of Thermo Environmental Instruments Model 49 (TECO 49) Ozone 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 (TEI 49C) Ozone Analyzers	
TI 3100-2021	Calibration and Routine Maintenance of Thermo Environmental (TECO) 43C SO_2 Analyzers	
TI 3100-2030	Calibration and Routine Maintenance of Thermo Environmental Instruments (TECO) Model 42 Oxides of Nitrogen Analyzers	
TI 3100-2031	Calibration and Routine Maintenance of Thermo Environmental Instruments (TECO) Model 42C Oxides of Nitrogen Analyzers	
TI 3100-2040	Calibration and Routine Maintenance of Thermo Environmental (TEI) 48 CO Analyzers	
TI 3100-2041	Calibration and Routine Maintenance of Thermo Environmental (TEI) 48C CO Analyzers	

Number	Title	QAPP Section(s)
SOP 3150	**Calibration and Routine Maintenance of Meteorological Monitoring Systems**	**A7.3.1, B5, B6.1, B6.2, B7, Table B2-1, Table B5-1, Table B7-2**
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	Table B7-2
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	Table B7-2
TI 3150-2105	Calibration and Routine Maintenance of Climatronics or Qualimetrics Temperature/Delta Temperature Systems	Table B7-2
TI 3150-2113	Calibration and Routine Maintenance of R.M. Young Temperature/Delta Temperature Systems	Table B7-2
TI 3150-2114	Laboratory Calibration and Repair of Rotronics MP-101A AT/RH Sensors, Rotronics MP-601A Relative Humidity Sensors, or Vaisala 45AC AT/RH Sensors	
TI 3150-2115	Field Calibration and Routine Maintenance of Rotronics MP-101A AT/RH Sensors or Rotronics MP-601A Relative Humidity Sensors	Table B7-2
TI 3150-2116	Field Calibration and Routine Maintenance of Vaisala HMP 45 AC AT/RH Sensors	Table B7-2
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	
TI 3150-2150	Field Calibration and Routine Maintenance of R.M. Young Model 58101 Wetness Sensors	
SOP 3160	**Calibration of Data Acquisition Systems**	**B6.1, B7, Table B2-1, Table B5-1, Table B7-2**
SOP 3176	**Station Operator Maintenance Procedures for Meteorological Monitoring Sites Using the DataView System**	**B6.2, Table B2-1**

Number	Title	QAPP Section(s)
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 3176-3105	Weekly Station Visit Temperature (Climatronics)	
CI 3176-3107	Weekly Station Visit Relative Humidity (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 (Rotronics)	
CI 3176-3116	Weekly Station Visit Air Temperature and Relative Humidity Sensor (Vaisala)	
CI 3176-3120	Weekly Station Visit Relative Humidity Sensor (Rotronics)	
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 3176-3140	Weekly Station Visit Wetness Sensor (R.M. Young)	
CI 3176-3150	Weekly Station Visit Precipitation Sensor (Climatronics)	
CI 3176-3151	Weekly Station Visit Precipitation Sensor (Texas Electronics)	
SOP 3178	**Station Operator Maintenance Procedures for Gaseous Monitoring Sites Using the DataView System**	**B6.2, Table B2-1**
CI 3178-3101	Weekly Station Visit, Ozone Analyzer (Monitor Labs ML8810) Ozone Calibrator (Dasibi 1003-PC) CASTNet Dry Deposition	Table B5-1
CI 3178-3102	Weekly Station Visit, Ozone Analyzer (Monitor Labs ML8810) Ozone Calibrator (Dasibi 1008-PC)	Table B5-1
CI 3178-3105	Weekly Station Visit, Ozone Analyzer (Dasibi 1003-AH) Ozone Calibrator (Dasibi 1003-PC)	Table B5-1
CI 3178-3106	Weekly Station Visit, Ozone Analyzer (Dasibi 1003-AH) Ozone Calibrator (Dasibi 1003-PC) CASTNet Dry Deposition	Table B5-1

Number	Title	QAPP Section(s)
CI 3178-3110	Weekly Station Visit, Ozone Analyzer (TEI 49) Ozone Calibrator (Dasibi 1003-PC) CASTNet Dry Deposition	Table B5-1
CI 3178-3111	Weekly Station Visit, Ozone Analyzer (TEI 49) Ozone Calibrator (Dasibi 1003-PC)	Table B5-1
CI 3178-3113	Weekly Station Visit, Ozone Analyzer (TEI 49) Ozone Calibrator (TEI 49) CASTNet Dry Deposition	Table B5-1
CI 3178-3115	Weekly Station Visit, Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C)	Table B5-1
CI 3178-3116	Weekly Station Visit, Ozone analyzer (TEI 49C) Ozone Calibrator (TEI 49C) CASTNet Dry Deposition	Table B5-1
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)	Table B5-1
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)	Table B5-1
CI 3178-3121	Weekly Station Visit, Ozone Analyzer (API 400) Ozone Calibrator (Dasibi 1003-PC) CASTNet Dry Deposition	Table B5-1
CI 3178-3122	Weekly Station Visit, Ozone Analyzer (API 400) Ozone Calibrator (Dasibi 1003-PC)	Table B5-1
CI 3178-3130	Weekly Station Visit, Carbon Monoxide Analyzer (TEI 48C) Ozone Calibrator (TEI 146C)	Table B5-1
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)	Table B5-1
CI 3178-3141	Weekly Station Visit, Ozone Analyzer (TEI 49), Oxides of Nitrogen Analyzer (TEI 42C), Gas Dilution Calibrator (TEI 146C)	Table B5-1
CI 3178-3154	Weekly Station Visit, Ozone Analyzer (TEI43C) Ozone Calibrator (TEI 146)	Table B5-1
CI 3178-3157	Weekly Station Visit, Oxides of Nitrogen Analyzer (TEI 42C) Gas Dilution Calibrator (TEI 146C)	Table B5-1
CI 3178-3300	Multipoint Calibration, Ozone Analyzer (ML 8810) Ozone Calibrator (Dasibi 1003-PC)	
CI 3178-3303	Multipoint Calibration, Ozone Analyzer (ML 8810) Ozone Calibrator (Dasibi 1008-PC)	

Number	Title	QAPP Section(s)
CI 3178-3305	Multipoint Calibration, Ozone Analyzer (Dasibi 1003-AH) Ozone Calibrator (Dasibi 1003-PC)	
CI 3178-3310	Multipoint Calibration, Ozone Analyzer (TEI 49) Ozone Calibrator (Dasibi 1003-PC)	
CI 3178-3311	Multipoint Calibration, Ozone Analyzer (TEI 149), Ozone Calibrator (TECO 146C)	
CI 3178-3312	Multipoint Calibration, Ozone Analyzer (TEI 49) Ozone Calibrator (TEI 49)	
CI 3178-3315	Multipoint Calibration, Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C)	
CI 3178-3317	Multipoint Calibration, Sulfur Dioxide Analyzer (TEI 43C TL) Sulfur Dioxide Calibrator (TEI 146)	
CI 3178-3320	Multipoint Calibration, Ozone Analyzer (API 400) Ozone Calibrator (Dasibi 1003-PC)	
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) (360ppb-440ppb) Dynamic Gas Calibrator (TEI 146)	
CI 3178-3354	Multipoint Calibration, Sulfur Dioxide Analyzer (TEI 43C) Dynamic Gas Calibrator (TEI 146)	
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**	**Table B2-1, Table B5-1**
TI 3180-2000	Calibration of a Thermal Environmental Instruments (TECO) 146C Gas Dilution Calibrator	
SOP 3300	**Certification of Ozone Transfer Standards**	**Table B2-1, Table B5-1**
SOP 3340	**Information Management Center (IMC) Concept and Configuration**	**B6.1, Table B2-1**

Number	Title	QAPP Section(s)
SOP 3345	**Day to Day Network Operations Technical Support for the National Park Service Gaseous and Meteorological Monitoring Program**	**Table B2-1**
SOP 3350	**Collection of Ambient Air Quality and Meteorological Monitoring Data**	**B10, Table B2-1**
TI 3350-4000	Collection of Ambient Air Quality and Meteorological Monitoring Data via Telephone Modem	
TI 3350-4005	Collection of DataView Files via Telephone Modem	
SOP 3450	**Ambient Air Quality and Meteorological Monitoring Data Validation**	**B10, D1, D2, Table B2-1, Table B7-2**
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 3550	**Ambient Air Quality and Meteorological Monitoring Data Reporting**	**Table B2-1**
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)**	**Table B2-1**
SOP 3750	**Meteorological Monitoring Sensor Audit Procedures**	**B7, Table B2-1**
TI 3750-6116	Rotronics MP-100F or MP-101A AT/RH Sensor Audit Procedures (IMPROVE Protocol)	