



Gaseous Pollutant Monitoring Program Quality Management Plan (QMP)

Prepared for the:

**NATIONAL PARK SERVICE
AIR RESOURCES DIVISION**
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QUALITY MANAGEMENT PLAN IDENTIFICATION AND APPROVAL

The attached Quality Management Plan for the Gaseous Pollutant Monitoring Program of the National Park Service is hereby recommended for approval and commits the resources and personnel to follow the elements described within.

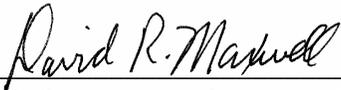
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FOREWORD

The following document is a Quality Management Plan (QMP) for the environmental data operations of the Gaseous Pollutant Monitoring Program (GPMP) of the National Park Service Air Resources Division (NPS ARD). This QMP outlines the roles of organizations involved in the program.

This QMP was generated using the EPA Quality Assurance (QA) regulations and guidance as described in EPA QA/R-2, *EPA Requirements for Quality Management Plans* (EPA, 2001). All pertinent elements of the QMP regulations and guidance are addressed in this document.

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	National Performance Audit Program (EPA)
NPS ARD	National Park Service Air Resources Division
OAQPS	Office of Air Quality Planning and Standards (EPA)
PAMS	Photochemical Assessment Monitoring Stations
PM _{2.5}	Particulate Matter less than 2.5 Microns
PM ₁₀	Particulate Matter less than 10 Microns
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

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1.0 PROGRAM MANAGEMENT AND ORGANIZATION

The purpose of this section is to document the overall quality assurance policy, scope, applicability, and management responsibilities of the Gaseous Pollutant Monitoring Program of the National Park Service Air Resources Division (NPS ARD). The section describes the program, organization, and management as it relates to quality assurance.

1.1 INTRODUCTION

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 (O₃) and meteorological conditions in a large number of parks, with additional monitoring of other gaseous pollutants including sulfur dioxide (SO₂), carbon monoxide (CO), oxides of nitrogen (NO_x), and particulates (PM₁₀, PM_{2.5}, and PM_{coarse}) in selected parks. This QMP 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 mid-1990s to provide broader coverage of rural air quality, particularly in the western United States. Note that the NPS ARD also conducts shorter-term air quality monitoring including portable ozone and special studies monitoring in selected parks. In addition, ARD cooperates with other national and state programs that monitor ambient gases, meteorology, deposition chemistry, particulate matter, and visibility. The operational protocols for these unique sites are not included in this QMP. 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;
- Provide data to primary national EPA data repositories and presentation media, including AIRNow and the Air Quality System (AQS);
- Cooperating with other national, regional, and state air monitoring analysis programs related to park resource issues; and
- Identify those air pollutants with the potential to injure or damage park biological resources, monitor these pollutants, and correlate measurable effects to these resources to existing ambient levels of these pollutants.

These objectives are the foundation of a network design in accordance with the Environmental Protection Agency (EPA) regulations of 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. A summary of the specific GPMP tasks are presented in Figure 1-1. Further information on the GPMP can be found at <http://www.nature.nps.gov/air/monitoring/network.cfm>.

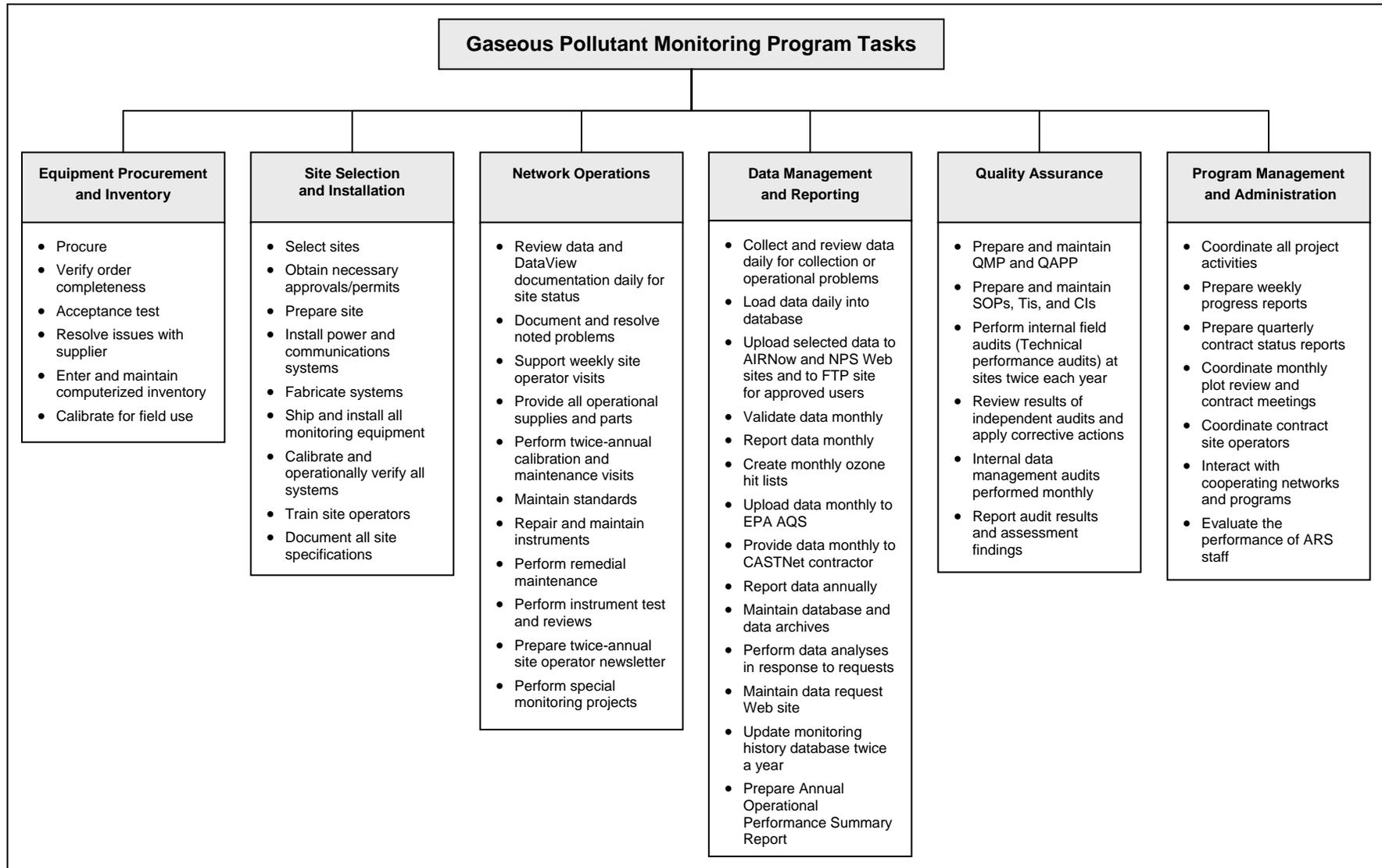


Figure 1-1. Summary of Gaseous Pollutant Monitoring Program Tasks.

1.2 GASEOUS, PARTICULATE, AND METEOROLOGY MONITORING

The gaseous, particulate, 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. 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. The QAPP supports the certification of the ozone measurements conducted using EPA reference or equivalent methods. Note that the GPMP also collects ozone data using non-equivalent instrumentation at selected portable ozone monitoring (POMs) sites for air pollution screening purposes. In addition, sulfur dioxide, carbon monoxide, and oxides of nitrogen are monitored in selected park units primarily for research purposes, but may or may not meet EPA reference or equivalent methods. Selected data sets for these parameters may be submitted to the EPA by the NPS for certification.

Particulates - At selected park units, both EPA equivalent method and non-equivalent method monitors are used to measure particulates (PM_{10} , $PM_{2.5}$, or PM_{coarse}). Data are validated and reported as 1-hour or 24-hour average data sets or as weekly integrated sample data sets.

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.

Nearly all sites collect ozone, ambient temperature, relative humidity, wind speed, wind direction, precipitation, and solar radiation. Selected sites monitor other atmospheric gases, particulates, and additional meteorological parameters. These parameters are itemized in Table 1-1.

Table 1-1. 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	Dasibi 1003-AH Dasibi 1003-PC TEI 49, 49C, and 49i 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, 49C, and 49i Dasibi 1003-PC	ppb	Scale:0 to 500 ppb MDL: 1 ppb	1 second	5-minute	Automated equivalent method	<ul style="list-style-type: none"> • 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 10 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 TEI 43iTL	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 TEI 42i 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 TEI 146i	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 1-1. Gaseous Pollutant Monitoring Program Sensor and Sampling Specifications (continued).

Parameter	Sensor	Units	Resolution or Accuracy	Sample Frequency	Averaging Period	Method Reference	Comments
Continuous Particulates	MetOne BAM-1020 MetOne E-BAM MetOne E-Sampler TEI BAM TEI TEOM Optec Size-Cut Nephelometer	µg/m ³	Scale: 1 to 1000 µg MDL: 1 µg (hourly averages)	Varies	Hourly and 24-hour	BAM-1020 – Reference method for PM ₁₀ and PM _{2.5} TEI TEOM and BAM-Reference method for PM ₁₀	Generally applied for specific research applications in the GPMP and may or may not be operated within EPA-certified ranges for equivalency
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	<ul style="list-style-type: none"> • Motor-aspirated shield • Temperatures measured at 10m
Delta Temperature	RM Young Climatronics	°C	0.1 °C 0.1 °C	1 second	Hourly	N/A	<ul style="list-style-type: none"> • Motor-aspirated shields • Delta temperature at 10m and 2m
Shelter Temperature	ARS	°C	1.5 °C	1 second	Hourly	N/A	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Climatronics: individual cup and vane sensors • R.M. Young: prop and vane sensor

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Table 1-1. Gaseous Pollutant Monitoring Program Sensor and Sampling Specifications (continued).

Parameter	Sensor	Units	Resolution or Accuracy	Sample Frequency	Averaging Period	Method Reference	Comments
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	<ul style="list-style-type: none"> • Heated tipping bucket rain gauge
Wetness	RM Young	On/Off	N/A	N/A	Hourly totals	N/A	<ul style="list-style-type: none"> • R.M. Young sensor mounted at 2 meters above ground-level
Solar Radiation	LI-COR	Watts/meter ²	90 μ A / 1000 Wm ²	1 second	Hourly averages	N/A	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • BAROCAP[®] sensor mounted at 2 meters above ground-level • Not standard at all sites; only operated at selected locations

1.3 ROLES AND RESPONSIBILITIES

1.3.1 National Park Service Air Resources Division

The NPS ARD is the operating agency of the GPMP. The agency is responsible for implementing the technical direction of the program; issuing and administering all contracts; performing final quality assurance (QA) on all data; performing data analyses; and distributing the data, analyses results, and project information.

1.3.2 Environmental Protection Agency

The NPS operates EPA CASTNet instrumentation at a number of NPS units primarily in the western U.S. This cooperative effort includes the exchange of raw and validated data, including EPA-calculated atmospheric deposition data. The EPA CASTNet quality assurance manager also acts as the quality assurance advisor to the GPMP network quality assurance manager. The NPS also uploads all collected GPMP data to the EPA Air Quality System and annually certifies the uploaded ozone data to the EPA. The EPA also reviews the GPMP QMP, QAPP, and associated QA documentation as a function of this ozone certification process.

1.3.3 National Park Service Units

Individual parks provide the location for the monitoring equipment, utilities, and most often the site operator.

1.3.4 Air Resource Specialists, Inc.

Air Resource Specialists, Inc. (ARS) is the field support and information management contractor for the monitoring effort. ARS is responsible for managing the operational aspects of all monitoring equipment, including initial testing, installation, operator training, twice-annual calibrations and maintenance, site operator telephone support, emergency repairs, and periodic auditing. ARS is also responsible for data collection, validation, reporting, and archive, and maintains a database that houses all data and other monitoring-related information. ARS prepares, updates, and maintains all field QA documents (standard operating procedures (SOPs), technical instructions (TIs), checklist instructions (CIs), and the project Quality Management Plan (QMP), Quality Assurance Project Plan (QAPP)), equipment inventory, and other program documentation.

1.3.5 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 park units. In addition, several state agencies perform independent field performance audits on GPMP monitoring sites.

A project organizational chart is provided as Figure 1-2. The quality management responsibilities of the key project participants are listed in the following section.

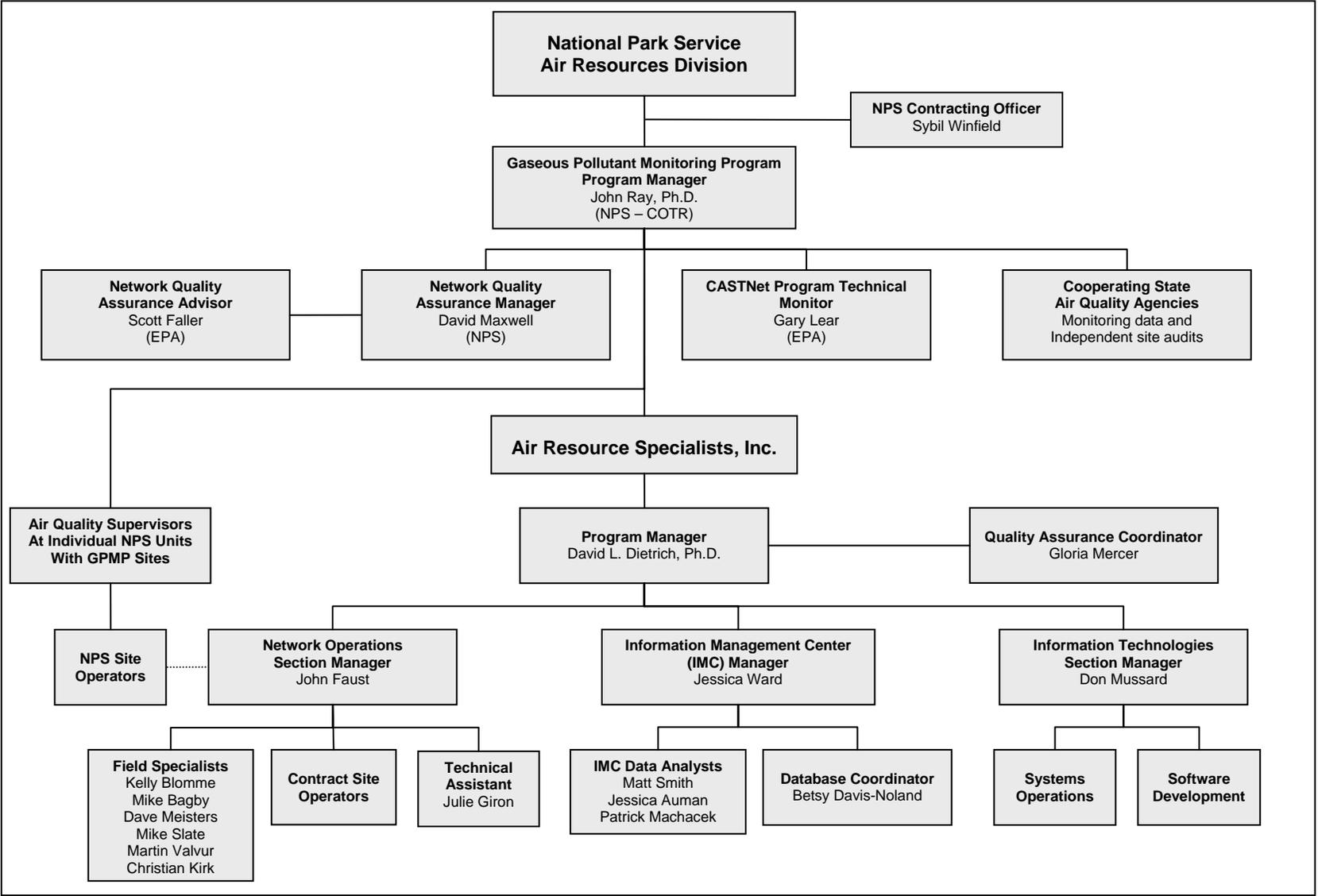


Figure 1-2. National Park Service Gaseous Pollutant Monitoring Program Quality Assurance Organizational Chart.

1.4 KEY QUALITY ASSURANCE PERSONNEL

1.4.1 Gaseous Pollutant Monitoring Program (GPMP) Program Manager – Dr. John Ray

Under the guidance and direction of NPS ARD management (Associate Director of Natural Resource Stewardship and Science, Herbert C. Frost, Ph.D.; Division Chief of the Air Resources Division Natural Resource Program Center, Christine Shaver; and Branch Chief of Resource and Monitoring, John Vimont; and NPS contracting office oversight), Dr. Ray directs the technical aspects of the Gaseous Pollutant Monitoring Program, including program planning and administration, budgeting, data analysis and reporting, field monitoring operations, contractor performance reviews, analyzing and approving data, reporting data and analysis results, and reviewing and approving quality assurance procedures. He coordinates with all project participants to ensure that the program develops and maintains an adequate quality system. He also serves as the Contracting Officer's Technical Representative (COTR) for the program.

1.4.2 Network Quality Assurance Manager – David Maxwell

Mr. Maxwell of the NPS ARD 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 Contracting Officer's Representative (COR) for the program.

1.4.3 Network Quality Assurance Advisor – Scott Faller

Mr. Faller of the 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.

1.4.4 ARS Program Manager – Dr. David Dietrich

Dr. Dietrich (ARS) is the primary point of contact between the 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.

1.4.5 ARS Quality Assurance Coordinator – Ms. Gloria Mercer

Ms. Mercer (ARS) is responsible for preparation and internal control of all quality control and quality assurance documentation for the program.

1.4.6 ARS Network Operations Section Manager – Mr. John Faust

Mr. 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.

1.4.7 ARS Information Management Center (IMC) Manager

Jessica Ward is responsible for coordinating and performing data collection, reduction, validation, archiving, and reporting of GPMP data including uploads to AIRNow and AQS, and for implementing data management-related QC and QA procedures.

1.4.8 ARS Field Specialists

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

1.4.9 ARS 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.

1.4.10 NPS Site Operators

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.

1.4.11 Cooperating State Air Quality Agencies

A number of state agencies cooperate with the GPMP to provide monitoring assistance and air quality data in selected NPS units. In addition, several state agencies perform independent field performance audits on GPMP monitoring sites.

2.0 QUALITY SYSTEM COMPONENTS

A quality system is defined as a structured and documented management system describing the policies, objectives, principals, organizational authority, responsibilities, accountability, and implementation of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance (QA) and quality control (QC). This section describes the principle components comprising the quality system for the GPMP and how they are used to implement the quality system. In addition, the latter part of this section briefly discusses the monitoring system and how data flow through the system.

2.1 DESCRIPTION OF THE GASEOUS POLLUTANT MONITORING PROGRAM

The NPS air quality monitoring strategy has focused primarily on Class I areas as defined by the Clean Air Act and its amendments, but also includes Class II areas with significant natural resources. The GPMP network consists of individual stations located in NPS units throughout the United States.

As of July 1, 2009, the NPS is principally operating 48 sites in 37 parks. EPA-certified ozone analyzers operated at 28 sites and non-certified portable ozone analyzers (POMS) operated at 16 sites. Monitoring at 4 additional sites did not include ozone analyzers. In addition, data from sites principally operated by cooperating agencies are often used by the NPS to represent the air quality in some national park units. This QAPP specifically addresses the procedures used by the NPS to operate and certify ozone measurements at NPS-operated sites with EPA-certified analyzers.

A map showing the GPMP monitoring station locations is provided as Figure 2-1. Table 2-1 lists the specific parameters monitored at three categories of sites: EPA-certified GPMP sites principally operated by NPS, sites with non-EPA certified ozone analyzers (POMS), and sites principally operated by state or other agencies that were reported in 2008 by the NPS to represent the air quality in selected park units.

Note that the number and location of sites in all categories may change slightly from year to year.

Continuous data and site documentation are compiled on site by a data acquisition system (DAS). The GPMP DAS consists of a datalogger and a DataView (site documentation) computer. The datalogger collects and averages instantaneous data from the monitoring instrumentation into one-minute and hourly averaged parameters (in engineering units). The datalogger also documents instrument status flags. The DataView computer maintains a record of both 1-minute and hourly average values which can be reviewed locally and remotely as a digital stripchart or data tables. DataView also tracks the station's operational status including flags and alarms and serves as the digital station log where the results of the site operator's manual system checks and programmed automatic checks are recorded. At sites with telephone access, the datalogger is interrogated and contents are downloaded to ARS on an automated daily basis. The DataView computer is interrogated and operator-entered lognotes are retrieved on an

automated basis twice per week. At sites without a working telephone, data and lognotes are retrieved locally by the site operator and e-mailed to ARS on a weekly basis.

Hourly raw data from selected sites are uploaded to the NPS ARD Web site and to the EPA AIRNow program to support near real-time data presentations. The hourly data are automatically screened and manually reviewed daily by ARS to identify any operational inconsistencies. Any noted problem initiates corrective actions. All raw data and site documentation are appended to the IMC database. Network data are fully validated and reported monthly. Validated data are also posted monthly to the EPA Air Quality System (AQS) and to the NPS Data Retrieval Web site. Data are backed up daily and archived off-site monthly to ensure that no raw or validated data are lost. An annual report is also prepared and distributed. All procedures are summarized in the GPMP QAPP (ARS, 2009) and fully documented in a series of standard operating procedures, technical instructions, and checklist instructions (ARS 1990-2009).

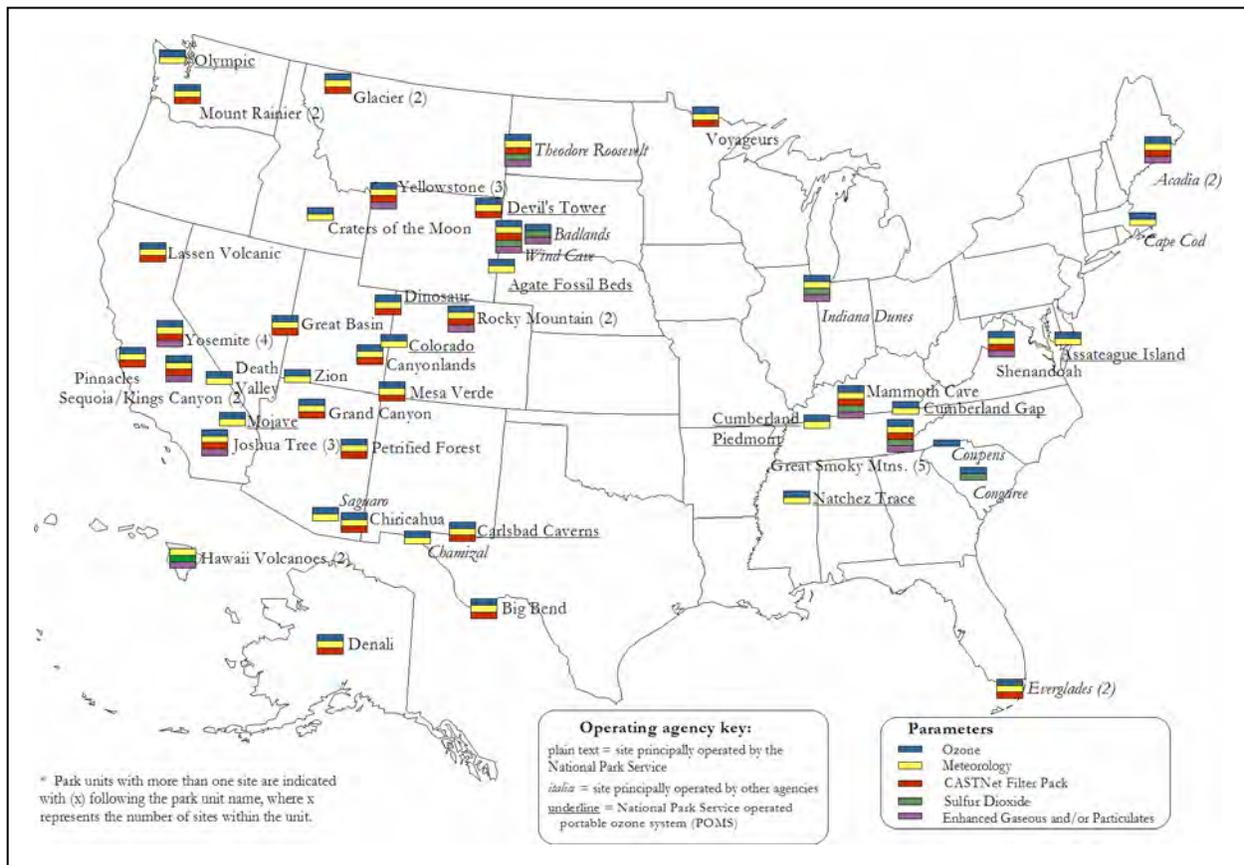


Figure 2-1. National Park Service Gaseous Pollutant Monitoring Program Monitoring Locations.

Table 2-1. National Park Service Gaseous Pollutant Monitoring Program Monitoring Sites and Parameters Measured.

Site Name and Abbreviation	Air Quality Parameters						Meteorology
	O ₃	PM	SO ₂	CO	NO _x	Filter Pack	
NPS-Operated Gaseous Pollutant Monitoring Program (GPMP) Sites							
Big Bend National Park	BIBE-KB	N					N
Canyonlands National Park	CANY-IS	N					N
Chiricahua National Monument	CHIR-ES	N					N
Craters of the Moon National Monument and Preserve	CRMO-VC	N					N
Death Valley National Park	DEVA-PV	N					N
Denali National Park and Preserve	DENA-HQ	N				N	N
Everglades National Park - Beard Center	EVER-BC					N	N
Glacier National Park	GLAC-WG	N				N	N
Grand Canyon National Park	GRCA-AS	N				N	N
Great Basin National Park	GRBA-MY	N				N	N
Great Smoky Mtns. NP - Clingmans Dome (seasonal)	GRSM-CD	N					N
Great Smoky Mtns. NP - Cove Mountain	GRSM-CM	N		N			N
Great Smoky Mtns. NP - Look Rock	GRSM-LR	N	S	S	S	S	N
Hawaii Volcanoes National Park - Observatory	HAVO-OB		N	N			N
Hawaii Volcanoes National Park - Visitors Center	HAVO-VC			N			N
Joshua Tree NP - Black Rock	JOTR-BR	N				N	N
Joshua Tree NP - Cottonwood Canyon	JOTR-CC	N	N				N
Lassen Volcanic National Park	LAVO-ML	N				N	N
Mammoth Cave National Park	MACA-HM	N	S	N	N	N	N
Mesa Verde National Park	MEVE-MY	N				N	N
Mount Rainier National Park - Tahoma Woods	MORA-TW	N				N	N
Petrified Forest National Park	PEFO-SE	N				N	N
Pinnacles National Monument	PINN-SE	N				N	N
Rocky Mountain National Park - Longs Peak	ROMO-LP	N				S	N
Sequoia/Kings Canyon National Parks - Ash Mountain	SEKI-AS	N	N			N	N
Sequoia/Kings Canyon National Parks - Lower Kaweah	SEKI-LK	N					N
Shenandoah National Park	SHEN-BM	N	S			N	N
Voyageurs National Park	VOYA-SB	N				N	N
Yellowstone National Park - Old Faithful	YELL-OF		N		N		N
Yellowstone National Park - Water Tank	YELL-WT	N				N	N
Yosemite National Park	YOSE-TD	N				N	N
Zion National Park	ZION-DW	N					N

Air Quality Parameters

O₃ - Ozone
 PM - Particulates
 SO₂ - Sulfur Dioxide
 CO - Carbon Monoxide
 NO₂ - Oxides of Nitrogen
 Filter Pack - Dry Deposition Filter Pack

N - Operated by NPS
 S - Operated by state or other agency

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**Table 2-1. National Park Service Gaseous Pollutant Monitoring Program
 Monitoring Sites and Parameters Measured (continued).**

Site Name and Abbreviation	Air Quality Parameters						Meteorology
	O ₃	PM	SO ₂	CO	NO _x	Filter Pack	
NPS-POMS Network (Portable Ozone Monitoring Systems)							
Agate Fossil Beds National Monument	AGFO-RA	N					N
Assateague Island National Seashore	ASIS-MA	N					N
Carlsbad Caverns National Park	CAVE-MA	N				N	N
Colorado National Monument	COLM-MY	N					N
Cumberland Gap National Historic Park	CUGA-HS	N					N
Cumberland-Piedmont I&M Network	CUPI	N					N
Devil's Tower National Monument	DETO-JR	N				N	N
Dinosaur National Monument	DINO-WE	N				N	N
Glacier National Park - Saint Mary's Ranger District	GLAC-SM	N					N
Joshua Tree National Park - Pinto Wells	JOTR-PW	N				N	N
Mojave National Preserve	MOJA-KM	N					N
Natchez Trace National Historical Park	NATR-BR	N					N
Olympic National Park	OLYM-DP	N					N
Rocky Mountain National Park - Trail Ridge	ROMO-TR	N					N
Yosemite National Park - Mobile	YOSE-MO	N					N
Yosemite National Park - School Yard	YOSE-SY	N					N
Monitoring Stations in Parks, Supported by NPS but Operated Principally by Other Agencies							
Acadia National Park - Cadillac Mountain	ACAD-CM	S					S
Acadia National Park - McFarland Hill	ACAD-MH	S	S			N	S
Badlands National Park	BADL-VC	S	S	S		S	
Cape Cod National Seashore	CACO-XX	S					S
Chamizal National Memorial	CHAM-XX	S					S
Acadia National Park - Cadillac Mountain	ACAD-CM	S					S
Congaree National Park	COSW-BL	S		S			
Cowpens National Battlefield	COWP-SM	S					
Everglades National Park - Cutler Road	EVER-CR	S					
Great Smoky Mtns. NP - Cades Cove	GRSM-CC	S					N
Great Smoky Mtns. NP - Purchase Knob	GRSM-PK	S					
Indiana Dunes National Lakeshore	INDU-AB	S	S	S			S
Mount Rainier National Park - Jackson Visitors Center	MORA-JV	S					
Saguaro National Park	SAGU-PC	S					S
Theodore Roosevelt National Park	THRO-VC	S	S	S		N	N
Wind Cave National Park	WICA-VC	S	S	S		S	N
Yellowstone National Park - West Entrance	YELL-ST		S		S		S
Yosemite National Park - Yosemite Village	YOSE-VI		S				

Air Quality Parameters

- O₃ - Ozone
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 - CO - Carbon Monoxide
 - NO₂ - Oxides of Nitrogen
 - Filter Pack - Dry Deposition Filter Pack
- N - Operated by NPS
 S - Operated by state or other agency

2.2 QUALITY ASSURANCE SYSTEM

2.2.1 National Park Service Air Resources Division

The NPS ARD provides oversight to the entire program and meets regularly to review the program and discuss any and all issues that concern the program. In addition, the NPS GPMP program manager and network quality assurance manager meet with ARS managers and staff to discuss field and data management activities at least monthly. The NPS ARD also receives weekly project status reports and semiannual contract status reports prepared by ARS. The network quality assurance manager maintains the official, approved QMP and QAPP and is responsible for overall network and program quality assurance.

2.2.2 NPS Units

NPS site operators visit the monitoring sites once each week to assess the operational status of the instrumentation. The operators can also perform troubleshooting and maintenance, as directed by ARS, to resolve a problem. The site operators are fully trained in site maintenance and are supported by fully documented operational procedures (SOPs, TIs, CIs). All operator actions and observations are documented on the DataView computer and are used in the data validation process. The site operators are directed to contact ARS by telephone or e-mail anytime they observe an inconsistency or have a question.

2.2.3 Air Resource Specialists, Inc.

ARS program and section managers (network operations section manager and IMC manager) and quality assurance coordinator oversee the work performed by its network operations staff, IMC staff, and NPS site operators. They meet periodically to discuss QA issues as they arise throughout the program. Instrument assessment/audit reports are reviewed as they are completed. ARS' responsibility is to ensure that field operations and data management activities are performed with QA in mind and that the monitoring activity schedule is maintained.

The ARS quality assurance coordinator, in concert with the network quality assurance manager, maintains the Quality Management Plan (QMP), Quality Assurance Project Plan (QAPP), standard operating procedures (SOPs), technical instructions (TIs), and checklist instructions (CIs) for the program. The appropriate documents are maintained on-site by site operators, in both hardcopy and in electronic form. The documents detail operational and maintenance procedures for each instrument at the monitoring location. ARS field specialists also provide site operator training upon initial start-up of the monitoring site, and every six months during twice-annual site visits. This is an on-hands training and questions are encouraged at this time. The site operators can also contact ARS by telephone (toll-free 800 number) or by e-mail to discuss issues and resolve problems.

Additional standard operating procedures and technical instructions are also maintained in the ARS air quality laboratory for equipment calibration and maintenance, and in the Information Management Center for data collection, validation, reporting, and archive activities. All personnel working on the project are fully trained in and are familiar with the content of these documents. The network quality assurance manager, ARS quality assurance coordinator, program manager, and section managers review all documents annually and update them as necessary.

Instrument assessments are performed by ARS during twice-annual site calibration and maintenance visits. Field specialists document the internal assessment/audit results in a written site visit trip report, which is forwarded to the NPS ARD. ARS also prepares weekly status reports and semiannual contract status reports for the GPMP. Independent field performance audits are performed on a number of sites by cooperating state agencies (see Section 1.3.5).

In addition, the NPS ARD and ARS personnel participate in a monthly plot review meeting. Topics discussed include quality review of each monitoring site, and review of all collected data for the prior month. Corrective actions are taken as necessary.

2.3 QUALITY DOCUMENTS

The following documents, plans, and guidelines have been implemented in the GPMP.

2.3.1 Quality Management Plan (QMP)

This QMP (described herein) outlines the management structure and how the QA system is implemented. All entities listed in this QMP adhere to these guidelines. The QMP is developed by the ARS quality assurance coordinator with the cooperation and approval of the GPMP program manager and the GPMP network quality assurance manager, who maintains the official, approved document. It is reviewed and approved by the network operations section manager, the IMC manager, and ARS program manager. It is also reviewed and commented on by the EPA, who has the final approval. The document is not officially approved until the EPA signs off on the document.

2.3.2 Quality Assurance Project Plan (QAPP)

As directed by the GPMP program manager, a QAPP was developed for the field and data operations related to NPS-operated sites. All monitoring at NPS-operated sites adhere to the QAPP and SOPs, TIs, and CIs applicable to the program. Cooperating agencies that operate monitoring sites in NPS units generally adhere to independent, agency-specific quality systems. The QAPP and supporting QA documentation are reviewed and updated no less than annually as approved by the GPMP program manager, GPMP network quality assurance manager, and ARS managers. The GPMP network quality assurance manager maintains the official, approved QAPP. The QAPP is also reviewed and commented on by the EPA, who has the final approval. The document is not officially approved until the EPA signs off and approves of it.

2.3.3 Assessment Reports

Program progress reports are prepared weekly to relate current monitoring status to the NPS ARD. Data reports are prepared monthly and annually. A semiannual contract status report is prepared by ARS to track contract task orders and task order modifications. Site assessment, or internal field performance audit reports, are prepared by field specialists after their twice-annual site visits. The reports reflect internal performance audit results, summary of parameter maintenance, notes and observations taken at the monitoring site, and completed calibration forms. The reports are forwarded to the NPS ARD. Cooperating state agencies periodically perform independent field performance audits of a number of network sites and generally forward the audit reports to the NPS ARD. All network QA documentation is reviewed annually. Network operations and data management issues, and quality plans are discussed monthly at GPMP plot reviews.

3.0 PERSONNEL QUALIFICATION AND TRAINING

This section outlines the process involved and training available for air monitoring professionals in the Gaseous Pollutant Monitoring Program.

3.1 PERSONNEL QUALIFICATIONS

ARS is responsible for providing training to site operators, field staff, and data collection/validation staff. Personnel assigned to the GPMP meet the educational, work experience, responsibility, personal attributes, and training requirements for their positions.

3.2 TRAINING AND CERTIFICATION

Appropriate training is made available to persons supporting the GPMP, commensurate with their duties:

Site operators (provided by the NPS) are given training on routine operations, data collection, log recording, preventive maintenance, troubleshooting, and remedial repairs by ARS field specialists. A training session is conducted during new site installations and repeated during the twice-annual maintenance visits. This training session consists of all steps needed to service and maintain the monitoring instrumentation, the datalogger, and the DataView system. ARS also provides ongoing telephone support to site operators. Site operators can call for assistance to resolve operational issues. Written SOPs, TIs, and CIs provide detailed guidance for all procedures. These SOPs, TIs, and CIs are also available digitally on DataView and are linked for ready reference from the digital log sheets. In addition, a training CD is available on-site and is accessible through DataView. The CD describes and illustrates the basic duties required by the site operator. Semiannual newsletters that include the description of a network operational procedure are mailed to the site operators twice each year to supplement their training and encourage their continued interest in data quality.

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). This certification will be 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 IMC manager and 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.

NPS ARD staff managing the project or working on the project are trained in their prospective duties by senior NPS ARD staff and scientists. Most NPS ARD staff have professional experience in their individual disciplines.

4.0 PROCUREMENT OF EQUIPMENT AND SERVICES

This section summarizes the procedures in place to ensure that all acquired equipment and services are procured within federal regulations, are delivered in a timely fashion, and are within the required specifications.

4.1 PROCUREMENT

GPMP network services are procured by the NPS ARD through direct purchase, contracts, or cooperative agreements. All procurement procedures strictly follow federal procurement regulations as administered by the NPS ARD.

As authorized under the NPS contract, ARS procures required equipment and services to operate the network. All capital and subcontract purchases are itemized and reported monthly to the Contracting Officer's Technical Representative (COTR) and Contracting Officer's Representative (COR). All ARS purchases are fully documented through ARS purchase order procedures. Newly purchased gaseous analyzers and particulate samplers are calibrated at the manufacturer and are calibrated after receipt at ARS. Sensors are accepted if documentation of the calibration is received with the analyzer and after successful calibration at ARS. Newly purchased meteorological sensors are calibrated at the manufacturer. Sensors are accepted if documentation of the calibration and calibration results are received with the sensor. All other purchased systems are acceptance tested by ARS and accepted if they meet manufacturer and industry standard specifications. All procured capital equipment is tracked in ARS' equipment inventory database.

4.1.1 Direct Purchase

The NPS ARD has the responsibility to procure all equipment and services for the GPMP network. The NPS procures equipment in two ways. Depending upon the scope of work in a particular contract, the NPS ARD may direct the contractor to purchase the equipment. The other option is for the NPS ARD to prepare a purchase order and procure equipment directly from the vendor.

4.1.2 Contracts

The NPS ARD utilizes contractors to coordinate, operate, and maintain the GPMP. All contracts are competitively awarded. Bidder's proposals are evaluated for both technical merit and cost.

The National Business Center (<http://ideasec.nbc.gov/j2ee/login.jsp>) provides NPS procurement opportunities. Commercial vendors seeking federal markets for their products and services can search, monitor, and retrieve opportunities by the federal contracting community.

NPS ARD normally awards contracts for one year with the option to extend the contract on an annual basis for up to an additional four years. When additional tasks are required during the term of a contract, the NPS ARD issues a task order amendment and provides the necessary funding based upon an agreed scope of work and cost with the contractor. Contractors are reimbursed for

their labor and equipment purchased on behalf of the NPS (fixed price/cost plus fixed fee contract).

4.1.3 Cooperative Agreements

The NPS ARD may enter into cooperative agreements with other federal, state, or tribal agencies to perform mutually beneficial services. For example, the NPS ARD has agreements with several states to cooperatively operate monitoring stations in selected parks and with the EPA CASTNet program to support deposition monitoring in selected parks. Agreements are negotiated between the contracting officers of the cooperating agencies.

Special monitoring is often done in cooperation with other federal agencies or university researchers under interagency or cooperative agreements. These programs typically have their own technical plans and quality assurance plans, but may use the monitoring sites, shelters, infrastructure resources, and data from the GPMP network.

4.2 PROGRAM PERFORMANCE AND QUALITY ASSURANCE REQUIREMENTS

The NPS ARD administers the GPMP to ensure that all procured equipment and services are delivered in a timely fashion and are within required performance specifications. ARS performs acceptance testing of monitoring system components to ensure their compliance with design specifications and EPA criteria if applicable. ARS works directly with the manufacturer to resolve any delivery or performance inconsistencies.

5.0 DOCUMENTS AND RECORDS

The primary responsibility of recordkeeping falls upon the NPS ARD and their contractors. For this program, a number of documents and records need to be retained. A document, from a record management perspective, is a volume that contains information which describes, defines, specifies, reports, certifies, or provides data or results pertaining to environmental programs. As defined in the Federal Records Act of 1950 and the paperwork Reduction Act of 1995 (now 44 U.S.C. 3101-3107), records are: “books, papers, maps, photographs, machine readable materials, or other documentary materials, regardless of physical form or characteristics, made or received by an agency of the U.S. Government under Federal Law or in connection with the transaction of public business and preserved or appropriate for preservation by that agency or its legitimate successor as evidence of the organization, functions, policies, decisions, procedures, operations, or other activities of the Government or because of the informational value of data in them...” All agencies will adhere to this guideline. Section 5.2 discusses the processes that are implemented for storing documents and records. For more information see the Gaseous Pollutant Monitoring Program QAPP (ARS, 2009).

5.1 DOCUMENT HIERARCHY AND PROCESS

This QMP encompasses the entire program and is the highest document covering this program. The QAPP also governs the program. All project participants must adhere to the statements made in the QMP and QAPP. SOPs, TIs, and CIs are created and maintained for specific components of monitoring; individuals must adhere to the procedures in the documents related to their components (e.g., site maintenance, calibrations, data validation, etc.).

These documents are prepared by the ARS quality assurance coordinator and reviewed, approved, and revised by the key quality assurance personnel listed in Section 1.4.

5.2 DISPOSITION AND STORAGE OF DOCUMENTS AND RECORDS

Project-related standard operating procedures, technical instructions, and checklist instructions are controlled documents that are maintained in the ARS Quality Assurance Documentation Library. A copy of the documents are maintained on-site (in both hardcopy and digitally on DataView). Documents can also be viewed on <http://ard-request.air-resource.com/project>. The QAPP and QMP are also controlled documents. The network quality assurance manager is responsible for keeping the documents current and maintain a distribution list. Parties on the distribution list will receive updated versions of the plans as they are made.

All hardcopy records, field documentation, digital data, DataView documentation, and other documents for the current and previous monitoring years reside in the IMC database and archive files. The preceding five years of hardcopy records are housed by ARS in an off-site storage facility. Field documentation includes log sheets, daily summaries, audit results, calibration results, quality control checks, and procedures and maintenance performed.

Project data (raw and validated) reside in the IMC database and are available for use during the life of the project. All raw data are archived onto CD monthly and delivered to the NPS ARD. Validated data are also uploaded monthly to the NPS Data Retrieval Web site (<http://12.45.109.6>) and EPA AQS database for public access and archive.

The electronic data system utilized by ARS is detailed in Section A7.3.2 of the QAPP (ARS, 2009) and described in Section 6.0 of this QMP. The raw electronic data are stored for a minimum of 5 years, and as long as program participants deem necessary. ARS performs daily archives of all information in the database, which represent the primary source of GPMP data. A disaster recovery and data backup plan for all GPMP data files is in place. All raw data are archived onto CD monthly and delivered to the NPS ARD. Validated data are also uploaded to the NPS Data Retrieval Web site and EPA AQS database for access and archive.

5.3 DISPOSITION OF REPORTS

All the information, electronic and written, are retained for a minimum of 5 years and as long as program participants deem necessary.

6.0 COMPUTER HARDWARE AND SOFTWARE

There is an increasing dependence upon computers and computer-related hardware in the collection of environmental data. Indeed, all environmental programs within and outside of the NPS use computers extensively to collect, store, validate, and analyze environmental data. This section outlines briefly what computer systems are employed throughout the GPMP. This section also describes the roles and responsibilities for system hardware and software.

ARS owns all computer systems and peripherals used on this project except those residing at the individual monitoring sites. On-site computers and peripherals including the DataView laptop, printers, and modems are owned by the NPS ARD.

The ARS computer systems, including workstations, file servers, Web servers, database servers, and peripherals, have 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, each IMC workstation is configured for stand-alone data collection. Daily automated data polls and auxiliary data acquisition can be made from any workstation. ARS owns several laptop computers with similar software on-board and network sties 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 and is never overwritten

This 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 the long-standing relationships with reliable vendors for fast response in parts replacement. ARS' Information Technology (IT) staff is experienced in on-site hardware maintenance.

DataView records – At sites with DataView computers, all logged data and lognotes are stored on the on-site computer for 90 days. In the case of a prolonged site communications problem or catastrophic failure of the IMC data collection system, the independent data record from each site could be retrieved by telephone or by generating site-specific CDs.

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, but digital data files and hardcopy reports are stored at off-site locations and NPS ARD.

Personnel – Although the GPMP contract represents a very important part of the ARS workload, at 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 clients.

Security of the contents of the NPS on-site DataView computers is maintained by:

- Requiring a username and password to login to DataView.
- Providing no Internet access from the site.
- Requiring remote access authentication by username and password.

DataView logs are downloaded by ARS twice each week and appended to the IMC database.

The software and content of the on-site DataView computers are periodically reviewed and updated remotely by ARS.

7.0 PLANNING

7.1 PROJECT GOALS AND OBJECTIVES

This section outlines planning and implementation procedures that are employed in the GPMP. To ensure that the work is being performed and that the quality of the data is acceptable, clear communication is required throughout all phases of this program.

The NPS ARD operates a network of air quality monitoring stations (referred to as the Gaseous Pollutant Monitoring Program; GPMP) to assess the status and trends of air pollution in NPS units. Monitoring has been ongoing in a number of parks since the early 1980s. The fundamental monitoring plan was documented in the *Air Quality Monitoring Strategy for the National Park Service 2007* natural resource report. A primary objective of the GPMP is to measure existing levels of air pollution in National Park Service units, and to establish the status and trends of park unit air quality. 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 Air Resources Division and to assist parks in evaluating their resource management needs. Accordingly, the Air Resources Division has established a network of stations to monitor ozone (O₃), sulfur dioxide (SO₂), carbon monoxide (CO), oxides of nitrogen (NO_x), particulates (PM₁₀, PM_{2.5}, and PM_{coarse}) and meteorological conditions in the parks. This QMP specifically addresses these longer-term trend GPMP monitoring sites. Note that the NPS ARD also conducts shorter-term air quality monitoring including portable ozone and special studies monitoring in selected parks. In addition, ARD cooperates with other national and state programs that monitor ambient gases, meteorology, deposition chemistry, particulate matter, ultraviolet radiation, and visibility. The operational protocols for these unique sites are not included in this QMP. The GPMP monitoring sites in individual NPS units 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;
- Provide data to primary natural EPA data repositories and presentation media including AIRNow and the Air Quality System (AQS);
- Cooperating with other national, regional, and state air monitoring and analysis programs related to park resource issues; and
- Identify those air pollutants with the potential to injure or damage park biological resources, monitor these pollutants, and correlate measurable effects to these resources to existing ambient levels of these pollutants.

These objectives are the foundation of a network design in accordance with the EPA regulations of 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.

7.2 PLANNING AND CONCEPTUALIZATION

GPMP network planning is a continual process led by the NPS ARD. The planning process responds to the needs of individual NPS units, results of recent research, needs of cooperating state and national programs, and annual budgets. Further planning occurs during the monthly program review meetings. This is the opportunity for all members to discuss the previous results and look forward to the challenges of the upcoming months and year.

The NPS ARD makes all executive decisions regarding the program, which includes selection and funding of contractors, expansion or reduction of the network, initiation or termination of agreements with other agencies, and other technical and non-technical issues.

7.3 KEY PLANNING PERSONNEL

7.3.1 National Park Service Air Resources Division

The NPS ARD has the responsibility to assess all options and make the final decision on the implementation of the program. The agency is responsible for implementing the technical direction of the program, issuing and administering all contracts, obtaining site operators, operating the program sites, performing final QA on the data, certifying data annually for the EPA, performing data analyses, and distributing data, analyses, and all project information.

7.3.2 ARS Program and Section Managers

ARS' managers must verify that they have enough manpower to perform the duties required of the GPMP. They must communicate with the NPS ARD to ensure that project schedules are defined and are being met.

7.4 PLANNING OF DATA AND PERFORMANCE CRITERIA

Data quality is a network priority. The NPS ARD has adopted the following EPA guidance documents for instrument performance and data quality:

- 40 CFR 50, *National Primary and Secondary Ambient Air Quality Standards* (July 2008)
- 40 CFR 50, Appendix D. *Measurement Principle and Calibration Procedure for the Measurement of Ozone in the Atmosphere* (July 2008)
- 40 CFR 53, *Ambient Air Monitoring Reference and Equivalent Methods* (October 2006)

- 40 CFR 58, Appendix A. *Quality Assurance Requirements for SLAMS, SPMs and PSD Air Monitoring* (October 2006)
- 40 CFR 58, Appendix D, *Network Design Criteria for Ambient Air Quality Monitoring* (November 2008)
- 40 CFR 58, Appendix E, *Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring* (October 2006)
- *EPA Quality Assurance Handbook for Air Pollution Measurement Systems:*
 - Volume I, *A Field Guide to Environmental Quality Assurance* (April 1994)
 - Volume II, *Ambient Air Quality Monitoring Program* (December 2008)
 - Part 2.12 *Monitoring PM_{2.5} in Ambient Air Using Designated Reference or Class I Equivalent Methods* (November 1998)
 - Volume IV, *Meteorological Measurements* (December 2008)
- *EPA Compendium Method IO-1.2. Determination of PM₁₀ in Ambient Air Using the Thermo Environmental Instruments (formerly Wedding and Associates) Continuous Beta Attenuation Monitor.* (June 1999)
- *EPA Compendium Method IO-1.3. Determination of PM₁₀ in Ambient Air Using a Continuous Rupperecht & Patashnick (R&P) TEOM[®] Particle Monitor* (June 1999)
- *EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications* (February 2000)

The GPMP QAPP and referenced SOPs, TIs, and CIs define all aspects of the program. Data quality is assured through documented, consistent procedures that include internal and external audits; periodic instrument maintenance and calibration; continuing data review; comprehensive, thorough validation; monthly program data reviews; systematic data archives; and frequent, timely data reports. All program functions are fully documented and consistently applied. The quantity, quality, and timeliness of the data meet the program goals and objectives of the NPS and the needs of cooperating and dependent state and federal agencies and programs. The GPMP is structured to respond quickly, as needs, requirements, technology, or advancing scientific understanding changes.

7.5 INTERNET PLANNING ACTIVITIES

The Internet is used by the NPS ARD to provide program information and access to GPMP data through the NPS ARD Web site: <http://www.nature.nps.gov/air/monitoring/index.cfm>. This site includes:

- Monitoring program descriptions.
- Program and research results.
- Access to validated data and data reports.
- Monitoring history.

- Real-time display of data from selected sites.
- Links to cooperating sites (including EPA AIRNow).
- Links to related sites.

Expanding the use of the Internet to publicly provide information and distribute data is an NPS ARD priority.

In addition, the GPMP uses the Internet to communicate program plans, status, and useful information to all internal project participants, including site operators, through a project Web site.

The NPS ARD is responsible for planning and directing the implementation of project-related Internet applications.

8.0 IMPLEMENTATION OF WORK

The GPMP organization has developed a QAPP (ARS, 2009) that describes the process and work performed for the program. This section outlines each agency that is required to implement the work. The NPS, through its contractors, is ultimately responsible for the preparation of documented GPMP field operations and data management procedures.

8.1 IMPLEMENTATION OF ROLES

8.1.1 National Park Service Air Resources Division

The NPS ARD is the primary operational agency for the GPMP. The NPS ARD awards and administers all operational contracts for the GPMP. Funding for all contracted work flows through the NPS ARD. The agency ensures program schedules and quality data collection are maintained through weekly status reports and monthly project meetings.

8.1.2 Site Operators

Site operators are generally employed by the NPS and are responsible for routine weekly duties performed at the monitoring sites. This includes:

- All routine on-site servicing operations, on a weekly basis.
- Equipment operation.
- Equipment troubleshooting and maintenance as directed by ARS.
- Data collection/documentation.
- Site maintenance and security.

On rare occasions, an NPS unit may not have available staff to assign as a site operator. Upon direction from the GPMP program manager, ARS will hire, train, and compensate a local site operator to perform all routine weekly duties as listed above.

8.1.3 ARS Staff

ARS field personnel review the operational status of the network daily, including data quality assurance indicators, provide site operator technical support, initiate corrective actions to address any identified inconsistency, and perform any required remedial maintenance on all program monitoring instrumentation and support equipment. ARS field specialists are also responsible for semiannual on-site internal performance audits, maintenance, and calibrations of all monitoring equipment systems and training of site operators. Field staff are responsible for acquiring all necessary monitoring equipment and maintain site-specific equipment inventories. ARS works in conjunction with NPS staff to select appropriate monitoring sites and coordinate the installation of necessary utilities.

ARS data analysts retrieve data and system documentation by telephone modem each day. The data analysts and the field specialist independently review the incoming data to verify proper operation of the monitoring systems. Hourly raw data, primarily during the ozone season,

are also posted to FTP sites for use by EPA AIRNow, posting on the NPS ARD Web site, and used by other selected agencies. ARS validates the data monthly and reviews all data with the GPMP program manager and network quality assurance manager. Validated data are reported, archived, and posted monthly to the Data Retrieval Web site and the EPA AQS. An annual data report is compiled to summarize each year's monitoring results. This annual data report is a cooperative effort among ARS and NPS ARD.

8.1.4 Cooperating State Agencies

External independent audits of a number of NPS-operated network sites are performed by cooperating state agencies as their schedules permit. Audit results are forwarded to the NPS ARD. A number of agencies operate air quality monitoring sites within NPS units as part of their state networks and in cooperation with the NPS unit and NPS ARD. Agencies that collect data in NPS units in accordance with EPA QA protocols submit their validated data to EPA AQS. These data are downloaded annually, reviewed, and included in the GPMP annual data report by ARS.

8.2 IMPLEMENTATION OF QA DOCUMENTATION

Quality assurance documentation for the program (SOPs, TIs, and CIs) are created and revised according to SOP 2001, *Guide to Writing of Quality Management Plans, Quality Assurance Project Plans, Standard Operating Procedures, Technical Instructions, and Checklist Instructions* (ARS, 1990; see Appendix A). Documents are created by personnel familiar with the proper procedures, including the program manager, section managers, technical staff, and ARS quality assurance coordinator. The GPMP program manager, network quality assurance manager, ARS quality assurance coordinator, section managers, and program manager review and approve the documents.

The documents are reviewed and approved on an annual basis, or sooner if changes are necessitated. Control and distribution of all QA/QC documents is performed by the ARS quality assurance coordinator to ensure that all recipients possess the most current versions. All requests for QA/QC documents shall be made through the ARS quality assurance coordinator. A database containing all documents and recipients is maintained to assure recipients are delivered the most current versions.

9.0 ASSESSMENT AND RESPONSE

This section describes the quality-related activities necessary to support the GPMP for assessment and reporting.

9.1 PROGRAM ASSESSMENT TECHNIQUES

System 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 initiates troubleshooting activities with the site operator. If troubleshooting results indicate an analyzer or sensor 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.

Assessments of the program include periodic (approximately every 6 weeks) internal performance audits of the instrumentation by trained ARS field staff. The audits are based upon network accuracy goals.

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 National Performance Audit Program (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 2009, 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 Office of Air Quality Planning and Standards (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.

9.2 REPORTS TO MANAGEMENT

Reports to management include weekly and semiannual status reports, as well as monthly and annual data reports.

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

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

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

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

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

Annual AQS Data Certification Packet - Prepared annually in conjunction with the delivery of the annual report and forwarded to the EPA. The packet includes data and QA/QC summaries and statistics presented in EPA-specified formats.

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

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

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

9.3 PLANNING, TRAINING, AND AUTHORITY

9.3.1 Planning

The QMP is an essential component of an effective planning process. This QMP outlines how assessors, QA managers, and field and data collection staff plan, schedule, implement, and participate in assessments. The GPMP contractor prepares an annual work plan, as approved by the GPMP program manager, to outline each year's activities. Assessment of the network contractor technical and fiscal performance is continuously tracked by the NPS GPMP program manager (COTR) and network quality assurance manager (COR). Monthly meetings or more frequent e-mail and telephone contact are used to refine the broader plan, respond to issues, and resolve conflict. At the beginning of the year, those who have been assigned to perform site assessments set out their tentative schedule for assessments. This schedule is first submitted to the NPS ARD and the field operators who are scheduled to be assessed. Usually, one month before the assessment, the sites to be assessed are notified by telephone of the exact dates and times.

9.3.2 Training

Training is essential to assessors in two ways: the assessor needs to understand the process by which data are generated, without this knowledge the assessment may be inadequate, and in order to communicate clearly with the operational function that is being assessed, the assessor must be competent. Training fills these needs. A part of training that is not seen or documented is the fact that those chosen for assessment should have experience in the field in which they are assessing. Although most QA criteria and theory are universal, understanding the process by being experienced in working in that field is essential.

9.3.3 Authority

All personnel that are chosen to conduct assessments have the authority to do so through the NPS ARD. The ARD has the overall responsibility and authority over this QA portion of this program. It delegates this authority to perform assessments to its agents that perform such duties. All personnel in this capacity have the right and responsibility to:

- Identify problems.
- Identify and cite noteworthy practices that may be shared with others to improve the quality of their operations.
- Propose recommendations for resolving quality problems.
- Independently confirm implementation and effectiveness of solutions.
- Report these findings to the GPMP program manager and site operator.

9.3.4 Disputes

Occasionally, findings in an independent assessment report may be disputed by network operations staff. Any disputes that are announced should first be handled as it is described in Section 10 of this document. If this fails to satisfy the situation, then the NPS ARD has the final authority to make a decision concerning a dispute.

10.0 QUALITY IMPROVEMENT

This section outlines planning and implementation procedures that are employed for improving the quality of the program. All project participants involved have the responsibility to improve the quality of the program over an unspecified period of time. There can be no set dates on when this improvement can or will occur, however, all of the project participants will make every effort to improve the system during the life of the GPMP.

10.1 QUALITY IMPROVEMENT PROCESS

The GPMP program manager is responsible for reviewing and directing the implementation of a corrective action. At the direction of the GPMP program manager, ARS evaluates, tests, and recommends any needed procedural changes including field, data management, or reporting functions along with a proposed schedule to implement any changes. With the approval of the GPMP program manager, the change is implemented and documented through changes in SOPs, TIs, and CIs, and referenced in a revised QAPP as appropriate. Change history is documented by the numbered and dated revision records of the associated SOPs, TIs, CIs, and QAPP. All parties subject to the change are fully trained in the revised procedures. This includes parties responsible for independent performance audits if the changes affect the audit procedures. Oversight tracking of the change is generally assigned to the network quality assurance manager. Throughout the change process, ARS will regularly report technical progress on the procedural changes to the network quality assurance manager and immediately notify the network quality assurance manager of any variations to the schedule adopted for a specific change. The network quality assurance manager and GPMP program manager have the ultimate responsibility to review and verify that the changes are appropriately implemented and documented by ARS.

10.2 QUALITY IMPROVEMENT ASSURANCE

Open and direct communication is encouraged at all levels of this project. ARS staff and site operators are encouraged to openly communicate through management channels or directly with the GPMP program manager or network quality assurance manager. There are no restrictions to direct communication among all project participants, although the GPMP program manager is to be copied or kept informed of significant communication. ARS has the primary responsibility to communicate with and resolve issues with equipment or subcontract vendors and suppliers. The NPS has the primary responsibility to resolve performance issues with the site operators.

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GLOSSARY OF QUALITY ASSURANCE AND RELATED TERMS

Activity – An all-inclusive term describing a specific set of operations of related tasks to be performed, either serially or in parallel (e.g., research and development, field sampling, analytical operations, equipment fabrication) that, in total, result in a product or service.

Assessment – The evaluation process used to measure the performance or effectiveness of a system and its elements. As used here, assessment is an all-inclusive term used to denote any of the following: audit, performance evaluation, management system review, peer review, inspection, or surveillance.

Audit (quality) – A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

Certification – The process of testing and evaluation against specifications designed to document, verify, and recognize the competence of a person, organization, or other entity to perform a function or service, usually for a specified time.

Checklist instruction (CI) – A document containing step-by-step procedures applicable to a specific instrument, system, method, etc. The procedures are in the form of a checklist.

Corrective action – Any measures taken to rectify conditions adverse to quality and, where possible, to preclude their recurrence.

Data reduction – The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collating them into a more useful form. Data reduction is irreversible and generally results in a reduced data set and an associated loss of detail.

Document – Any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures, or results.

Environmental data – Any parameters or pieces of information collected or produced from measurements, analyses, or models of environmental processes, conditions, and effects of pollutants on human health and the ecology, including results from laboratory analyses or from experimental systems representing such processes and conditions.

Finding – An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive or negative, and is normally accompanied by specific examples of the observed condition.

Independent assessment – An assessment performed by a qualified individual, group, or organization that is not a part of the organization directly performing and accountable for the work being assessed.

Inspection – The examination or measurement of an item or activity to verify conformance to specific requirements.

Management – Those individuals directly responsible and accountable for planning, implementing, and assessing work.

Management system – A structured, non-technical system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for conducting work and producing items and services.

Organization – A company, corporation, firm, enterprise, or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration.

Organization structure – The responsibilities, authorities, and relationships, arranged in a pattern, through which an organization performs its functions.

Procedure – A specified way to perform an activity.

Process – A set of interrelated resources and activities that transforms inputs into outputs. Examples of processes include analysis, design, data collection, operation, fabrication, and calculation.

Project – An organized set of activities within a program.

Quality – The totality of features and characteristics of a product or service that bears on its ability to meet the stated or implied needs and expectations of the user.

Quality assurance (QA) – An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality Assurance Project Plan (QAPP) – A formal document describing in comprehensive detail the necessary quality assurance (QA), quality control (QC), and other technical activities that must be implemented to ensure that the results of the work performed satisfy the stated performance criteria. The QAPP components are divided into four classes: 1) Project Management, 2) Measurement/Data Acquisition, 3) Assessment/Oversight, and 4) Data Validation and Usability. Guidance and requirements on preparation of QAPPs can be found in EPA QA/R-5 and QA/G-5.

Quality control (QC) – The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality. The system of activities and checks used to ensure that measurement systems are maintained within prescribed limits providing protection against “out of control” conditions and ensuring the results are of acceptable quality.

Quality improvement – A management program for improving the quality of operations. Such management programs generally entail a formal mechanism for encouraging worker recommendations with timely management evaluation and feedback or implementation.

Quality Management Plan (QMP) – A formal document that describes the quality system in terms of the organization's structure, the functional responsibilities of management and staff, the lines of authority, and the required interfaces for those planning, implementing, and assessing all activities conducted.

Quality system – A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance (QA) and quality control (QC).

Requirement - A formal statement of a need and the expected manner in which it is to be met.

Specification – A document stating requirements and referring to or including drawings or other relevant documents. Specifications should indicate the means and criteria for determining conformance.

Standard operating procedure (SOP) – A controlled document containing general procedures, protocols, methods, schedules, responsibilities, etc., for a given class or group of related tasks. SOPs should reference TIs for further detail.

Technical instruction (TI) – A controlled document containing step-by-step procedures applicable to a specific instrument, system, method, etc.

Technical Systems Audits (TSAs) – An on-site review and inspection of a state or local agency's ambient air monitoring program to assess its compliance with established regulations governing the following six areas: network management, field operations, laboratory operations, data management, quality assurance, and reporting.

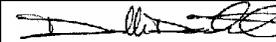
Vendor – Any individual or organization furnishing items or services or performing work according to a procurement document or a financial assistance agreement. An all-inclusive term used in place of any of the following: seller, contractor, subcontractor, fabricator, or consultant.

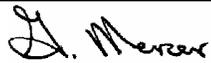
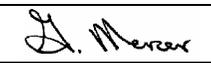
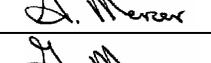
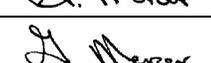
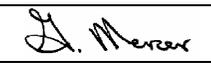
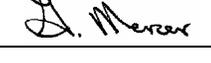
APPENDIX A

STANDARD OPERATING PROCEDURE 2001

GUIDE TO WRITING OF QUALITY MANAGEMENT PLANS, QUALITY ASSURANCE PROJECT PLANS, STANDARD OPERATING PROCEDURES, TECHNICAL INSTRUCTIONS, AND CHECKLIST INSTRUCTIONS

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	GUIDE TO WRITING OF QUALITY MANAGEMENT PLANS, QUALITY ASSURANCE PROJECT PLANS, STANDARD OPERATING PROCEDURES, TECHNICAL INSTRUCTIONS, AND CHECKLIST INSTRUCTIONS
TYPE	STANDARD OPERATING PROCEDURE
NUMBER	2001
DATE	JANUARY 1990

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	David L. Dietrich	
PROJECT MANAGER	James H. Wagner	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Changes to revision procedures, equipment, responsibilities, and document tracking.	March 1996	
	Reviewed; no changes necessary.	March 1997	
	Reviewed; no changes necessary.	March 1998	
	Reviewed; no changes necessary.	March 1999	
	Reviewed; no changes necessary.	March 2000	
	Reviewed; no changes necessary.	March 2001	
	Reviewed; no changes necessary.	March 2002	
	Reviewed; no changes necessary.	March 2003	
	-- continued --		

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	GUIDE TO WRITING OF QUALITY MANAGEMENT PLANS, QUALITY ASSURANCE PROJECT PLANS, STANDARD OPERATING PROCEDURES, TECHNICAL INSTRUCTIONS, AND CHECKLIST INSTRUCTIONS
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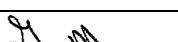
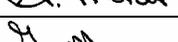
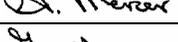
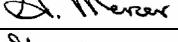
REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	March 2004	
2.0	Added CIs, changed QMP and QAPP discussions.	March 2005	
	Reviewed; no changes necessary.	March 2006	
	Reviewed; no changes necessary.	March 2007	
	Reviewed; no changes necessary.	March 2008	
	Reviewed; no changes necessary.	March 2009	

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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) details the guidelines that should be followed when preparing quality management plans (QMPs), quality assurance project plans (QAPPs), standard operating procedures (SOPs), technical instructions (TIs), and checklist instructions (CIs).

1.1 COMPONENTS OF QUALITY ASSURANCE

Quality assurance (QA) and quality control (QC) documentation and terms are defined as follows:

- Quality Assurance - All planned or systematic actions necessary to provide adequate confidence that collected data satisfy the defined need.
- Quality Management Plan (QMP) - A controlled document describing a quality system in terms of the organizational structure, policy and procedures, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, documenting, and assessing all activities conducted.
- Quality Assurance Project Plan (QAPP) - A controlled document containing an orderly assembly of specific objectives, principles, procedures, guidelines, SOPs, and TIs for a specific project (e.g., IMPROVE Optical Monitoring Project Plan). A project plan should reference SOPs and TIs for further detail.
- Quality Control - Operational techniques and activities that sustain the quality of the data:
 - Internal - Routine checks included in normal internal operating procedures (e.g., periodic calibrations)
 - External - Activities performed on an occasional basis usually by a person outside of the normal operational routine (e.g., independent performance audits, laboratory intercomparisons)
- Standard Operating Procedure (SOP) - A controlled document containing general procedures, protocols, methods, schedules, responsibilities, etc., for a given class or group of related tasks (e.g., calibration of ambient gas analyzers). SOPs should reference TIs for further detail.
- Technical Instruction (TI) - A controlled document containing step-by-step procedures applicable to a specific instrument, system, method, etc. (e.g., calibration of a Monitor Labs 8810 ozone analyzer).
- Checklist Instruction (CI) - A document providing step-by-step information designed to aid in completing an instrument checklist.

- Accuracy - The amount of agreement of a measurement (X), with an accepted reference or true value (T), usually expressed as the difference between the two values ($X - T$) or the difference as a percentage of the referenced or true value ($100 (X-T)/T$), and sometimes expressed as a ratio (X/T).
- Accuracy Bias - A systematic (consistent) error in test results. Bias can exist between test results and the true value (absolute bias, or lack of accuracy), or between results from the different sources (relative bias).
- Precision - A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is most desirably expressed in terms of the coefficient of variation (relative standard deviation). The coefficient of variation (CV) equals standard deviation/mean times 100.
- Completeness - The amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal operations, usually expressed as a percentage.
- Representativeness - The accuracy and precision with which a measurement represents a sample characteristic or a sample represents a population.
- Comparability - A measure of the confidence with which one data set can be compared to another, based upon an assessment of the similarities and differences in experimental design, objectives, methods, and analyses.

2.0 RESPONSIBILITIES

2.1 QUALITY MANAGEMENT PLANS

The program manager shall:

- Prepare and write the plans in coordination with the COTR (contracting officer's technical representative) and program steering committee, and with the assistance of project managers, the quality assurance manager, and others qualified by their expertise and authority.
- Review the plans to assure compliance with all appropriate laws, regulations, agency policies, all other appropriate guidance documents, and good QA practices.

The contracting officer's technical representative (COTR) shall:

- Coordinate with the program manager and program steering committee to prepare and write the plans, and with the assistance of project managers, the quality assurance manager, and others qualified by their expertise and authority.
- Review the plans to assure compliance with all appropriate laws, regulations, agency policies, all other appropriate guidance documents, and good QA practices.

The program steering committee shall:

- Coordinate with the program manager and COTR to prepare and write the plans, and with the assistance of project managers, the quality assurance manager, and others qualified by their expertise and authority.
- Review the plans to assure compliance with all appropriate laws, regulations, agency policies, all other appropriate guidance documents, and good QA practices.

The project manager shall:

- Assist the program manager, COTR, and program steering committee in preparing and writing the plans.
- Review the plans to assure compliance with all appropriate laws, regulations, agency policies, all other appropriate guidance documents, and good QA practices.

The quality assurance manager shall:

- Assist the program manager, COTR, and program steering committee in preparing and writing the plans.
- Review the plans to assure compliance with all appropriate laws, regulations, agency policies, all other appropriate guidance documents, and good QA practices.
- Maintain control and distribution of the documents.

2.2 QUALITY ASSURANCE PROJECT PLANS

The project manager shall:

- Prepare and write the plans with assistance from the program manager, quality assurance manager, and technical staff.
- Review the plans to assure compliance with all appropriate laws, regulations, agency policies, company policies, all other appropriate guidance documents, and good QA practices.

The program manager shall:

- Assist the project manager in preparing and writing the plans.
- Review the plans to assure compliance with all appropriate laws, regulations, agency policies, company policies, all other appropriate guidance documents, and good QA practices.

The quality assurance manager shall:

- Assist the project manager in preparing and writing the plans.
- Review the plans to assure compliance with all appropriate laws, regulations, agency policies, company policies, all other appropriate guidance documents, and good QA practices.
- Maintain control and distribution of the documents.

Technical staff shall assist the project manager in preparing and writing the plans.

The contracting officer's technical representative shall:

- Review the plans to assure compliance with all appropriate laws, regulations, agency policies, company policies, all other appropriate guidance documents, and good QA practices.

2.3 STANDARD OPERATING PROCEDURES (SOPs)

The project manager shall:

- Assign appropriate technical staff to prepare and write SOPs with assistance from the quality assurance manager.
- Review the SOPs to assure compliance with all appropriate laws, regulations, agency policies, company policies, manufacturer specifications, all other appropriate guidance documents, and good QA practices.

Technical staff shall prepare and write SOPs with assistance from the project manager and quality assurance manager.

The quality assurance manager shall:

- Assign document numbers to the standard operating procedures.
- Assist technical staff in preparing and writing SOPs.
- Review the SOPs to assure compliance with all appropriate laws, regulations, agency policies, company policies, manufacturer specifications, all other appropriate guidance documents, and good QA practices.
- Maintain control and distribution of all documents.

The program manager shall review the SOPs to assure compliance with all appropriate laws, regulations, agency policies, company policies, manufacturer specifications, all other appropriate guidance documents, and good QA practices.

2.4 TECHNICAL INSTRUCTIONS (TIs)

The project manager shall:

- Assign appropriate technical staff, experienced in and responsible for the work, to prepare and write the TIs, with assistance from the quality assurance manager.
- Review the TIs to assure compliance with appropriate regulations, guidelines, manufacturer specifications, and good QA practices.

Technical staff shall prepare and write the TIs with assistance from the project manager and quality assurance manager.

The quality assurance manager shall:

- Assign document numbers to the technical instructions.
- Assist technical staff in preparing and writing TIs.
- Review the TIs to assure compliance with appropriate regulations, guidelines, manufacturer specifications, and good QA practices.
- Maintain control and distribution of all documents.

The program manager shall review the TIs to assure compliance with appropriate regulations, guidelines, manufacturer specifications, and good QA practices.

2.5 CHECKLIST INSTRUCTIONS (CIs)

The project manager shall:

- Assign appropriate technical staff, experienced in and responsible for the work, to prepare and write the CIs, with assistance from the quality assurance manager.
- Review the CIs to assure compliance with appropriate regulations, guidelines, manufacturer specifications, and good QA practices.

Technical staff shall prepare and write the CIs with assistance from the project manager and quality assurance manager.

The quality assurance manager shall:

- Assign document numbers to the checklist instructions.
- Assist technical staff in preparing and writing CIs.
- Review the CIs and checklists for appropriate and consistent content.
- Maintain and distribute document files.

The program manager shall review the CIs to assure compliance with appropriate regulations, guidelines, manufacturer specifications, and good QA practices.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Equipment and materials required for developing quality assurance plans and documents include, but are not limited to the following:

- Project management documents specific to the program
- Technical instrumentation manuals
- Manufacturer's instruction manuals
- Reference documents (such as current SOPs, TIs, and CIs)
- IBM-PC compatible systems
- Word processing software (such as Microsoft Word)
- Document tracking software (such as Microsoft Access)
- Letter-quality laserjet printer
- Photocopy machine

4.0 METHODS

This section describes preparation and creation of documents, and includes five (5) major subsections:

- 4.1 Numbering
- 4.2 Format and Style
- 4.3 Revision Procedures
- 4.4 Sign-off Procedures
- 4.5 Distribution

4.1 NUMBERING

Quality management plans and quality assurance project plans are no longer numbered, but are instead identified by document title.

4.1.1 Standard Operating Procedures

Each standard operating procedure will be identified by an exclusive four-digit number (NNNN). Allowable four-digit numbers are in the following categories:

<u>Number</u>	<u>Category</u>
0000-0999	Management QA plan (obsolete)
1000-1999	Project QA plan (obsolete)
2000-2999	SOP - general (proposals, training, SOP writing)
3000-3999	SOP - ambient air quality and meteorology
4000-4999	SOP - visibility

5000-5999	SOP - air pollution modeling
6000-6999	SOP - general computer hardware software and operations
7000-7999	SOP - (unassigned)
8000-8999	SOP - (unassigned)

Each SOP number must be specifically assigned by the quality assurance manager. An example SOP number is SOP 3100, *Calibration of Ambient Air Quality Analyzers*.

4.1.2 Technical Instructions and Checklist Instructions

Technical instructions and checklist instructions will be identified by an eight-digit number (NNNN-NNNN). The first four digits refer to the SOP number where the TI or CI is referenced, and the second four digits identify the TI or CI. Allowable four-digit numbers are in the following categories:

<u>Number</u>	<u>Category</u>
0000-0999	General planning, training, and policies
1000-1999	Procurement, inspection, shipping, receiving, and inventory
2000-2999	Calibration and testing
3000-3999	Installation, maintenance, operating, corrective actions, and configuration control
4000-4999	Data or sample collection and handling
5000-5999	Data or sample processing, validation, analysis, reporting, and archive
6000-6999	Audit procedures and reports
7000-7999	(unassigned)
8000-8999	(unassigned)
9000-9999	(unassigned)

Each TI or CI number must be specifically assigned by the quality assurance manager. An example TI number is TI 3100-2000, *Calibration and Routine Maintenance of a Lear Siegler ML 8810 Ozone Analyzer* (referenced from SOP 3100). An example CI is CI 3176-3100, *Weekly Station Visit - Wind Speed/Wind Direction Sensor (Climatronics)*.

4.2 FORMAT AND STYLE

All QA/QC documents will be published as controlled documents. Each page will be numbered, dated, identified with a numerical code or title, and have a revision number. The title page will clearly define the document, and will have provisions for approval signatures and revision history documentation. (Checklist instructions will have a title identifying the document and space for revision history, but will not require signatures). All documents will be written in clean, concise English. All technical terms will be defined and all acronyms will be spelled out at least once. Names of individuals will not appear in the text. Fully completed example forms, diagrams, photographs, and illustrations are invaluable and shall be used whenever possible.

Complete format and style requirements are detailed in TI 2005-0310, *Style Guide for Producing Quality Assurance Documents*.

4.3 REVISION PROCEDURES

Revision numbering begins with "0" for originals. Subsequent revisions may be either major or minor. Major revisions constitute long or complicated changes and will be numbered as "1.0", "2.0", "3.0", etc., and will be distributed to all individuals possessing prior revisions of the documents. Minor revisions constitute only simple changes and will be numbered as "0.1", "0.2", "0.3", etc., and will not require distribution of the documents. All revisions shall be documented in full or in summary on the title page and must abide by the sign-off procedures applicable to the document.

4.4 SIGN-OFF PROCEDURES

The following minimum sign-off procedures apply:

Quality Management Plan:

- Originator
- COTR
- Program manager
- QA manager

Quality Assurance Project Plan:

- Originator
- Project manager
- Program manager
- QA manager

Standard Operating Procedure:

- Originator
- Project manager
- Program manager
- QA manager

Technical Instruction:

- Originator
- Project manager
- Program manager
- QA manager

Checklist instructions do not require sign-off procedures.

Any document or revision (except checklist instructions) that does not contain a fully signed-off title page shall be considered a draft, and must be labeled as such if used or referenced in any way. Any procedure that is more than three years old will be considered out-dated (with the same status as a draft) until the document is reviewed (as appropriate) and a new signed-off title page is obtained.

4.5 DISTRIBUTION

Control and distribution of all QA/QC documents is performed by the quality assurance manager to ensure that all recipients possess the most current revisions. All requests for QA/QC documents shall be made through the quality assurance manager.

A document tracking database shall be maintained to aid in tracking document revisions and recipients.

5.0 ELEMENTS OF A QUALITY MANAGEMENT PLAN

A quality management plan (QMP) documents management practices, including QA and QC activities, used to ensure that the results of technical work are of the type and quality needed for their intended use. The elements to be addressed in a QMP include:

- Management and organization
- Quality system description
- Personnel qualifications and training
- Procurement of items and services
- Documentation and records
- Computer hardware and software
- Planning
- Implementation of work processes
- Assessment and response
- Quality improvement

Specific requirements for each of these elements are discussed in the following subsections and detailed in *EPA Requirements for Quality Management Plans*, EPA/240/B-01/002. A QMP is valid for no longer than five years.

5.1 MANAGEMENT AND ORGANIZATION

The management and organization section addresses overall policy, scope, applicability, and management responsibilities of the organization's quality system. The section includes:

- An approval page for signatures of the organization's management and QA manager.
- A statement of the organization's policy on quality assurance, why it's important, and the general goals and objectives of the quality system.
- An organization chart that identifies all of the components of the organization and the position and lines of reporting.
- A discussion of the authorities of the QA manager and any other QA staff.
- A discussion of the technical activities that are supported by the quality system.
- A discussion of how management will assure that applicable elements of the quality system are understood and implemented in all programs.

5.2 QUALITY SYSTEM DESCRIPTION

The quality system description section addresses how an organization manages its quality system and defines the primary responsibilities for managing and implementing each component of the system. The section includes:

- A description of the organization's quality system that includes the principal components of the system and the roles and responsibilities of management and staff with regards to these components.
- A list of the tools for implementing each component of the quality system (e.g., QAPP, training plans, systems audits).
- A list of components of the organization that develop QMPs in support of the organization's quality system and the review and approval procedures for such documentation.

5.3 PERSONNEL QUALIFICATIONS AND TRAINING

The personnel qualifications and training section addresses procedures for assuring that all personnel performing work have the necessary skills to effectively accomplish their work. The section includes:

- A statement of the policy regarding training for management and staff.
- A description of the process(es) for identifying, ensuring, and documenting that personnel have the appropriate knowledge and skill necessary.

5.4 PROCUREMENT OF ITEMS AND SERVICES

The procurement of items and services section addresses the procedures for purchased items and services that directly affect the quality of the program. The section describes:

- The review and approval of procurement documents to ensure they are accurate and complete.
- The review and approval of all applicable responses to solicitations.
- Processes to ensure that procured items and services are of acceptable quality.

5.5 DOCUMENTATION AND RECORDS

The documentation and records section addresses appropriate controls for quality-related documents and records determined to be important to the mission of the organization. The section describes procedures for:

- Identifying quality-related documents and records requiring control.
- Preparing, reviewing for conformance to technical and quality system requirements, approving, issuing, using, authenticating, and revising documents and records.
- Ensuring that records and documents accurately reflect completed work.
- Maintaining documents and records including transmittal, distribution, retention, access, preservation, traceability, retrieval, removal of obsolete documentation, and disposition.

5.6 COMPUTER HARDWARE AND SOFTWARE

The computer hardware and software section addresses how the organization satisfies the project's requirements with computer hardware and software. The section describes:

- Developing, installing, testing, using, maintaining, controlling, and documenting computer hardware and software used to ensure it meets technical and quality requirements and directives from management.
- Assessing and documenting the impact of changes to user requirements and/or the hardware and software on performance.
- Evaluating purchased hardware and software to ensure it meets user requirements and complies with applicable contractual requirements and standards.
- Ensuring that data and information produced from, or collected by, computers meet applicable information resource management requirements and standards.

5.7 PLANNING

The planning section addresses how individual data operations will be planned within the organization to ensure that data or information collected are of the needed and expected quality for their desired use. The section describes:

- Planning environmental data operations using a systematic planning process.
- Developing, reviewing, approving, implementing, and revising a quality assurance project plan (QAPP).
- Evaluating data collected for other purposes or from other sources, including the application of any statistical methods, for a new use.

5.8 IMPLEMENTATION OF WORK PROCESSES

The implementation of work processes section addresses how work processes will be implemented within the organization to ensure that data or information collected are of the needed and expected quality for their desired use. The section describes:

- Ensuring that work is performed according to approved planning and technical documents.
- Identifying operations that need procedures, preparation, review, approval, revision, and withdrawal of these procedures, and policy for their use.
- Controlling and documenting the release, change, and use of planned procedures, removal of obsolete documentation from work areas, and verification that the changes are made as prescribed.

5.9 ASSESSMENT AND RESPONSE

The assessment and response section addresses how the organization will determine the suitability and effectiveness of the implemented quality system and the quality performance of the environmental programs to which the quality system applies. The section describes:

- Assessing the adequacy of the quality system at least annually.
- Planning, implementing, and documenting assessments and reporting assessment results to management.
- Determining the level of completeness, experience, and training necessary to ensure that personnel conducting assessments are technically knowledgeable, have no real or perceived conflict of interest, and have no direct involvement or responsibility for the work being assessed.
- Ensuring that personnel conducting assessments have sufficient authority, access to programs, managers, documents, and records.

- Management's review and response to findings.
- Identifying how and when corrective actions are to be taken in response to the assessment.
- Addressing any disputes encountered as a result of assessments.

5.10 QUALITY IMPROVEMENT

The quality improvement section addresses how the organization will improve the organization's quality system. The section describes:

- Individuals responsible for identifying, planning, implementing, and evaluating the effectiveness of quality-important activities and describe the process to ensure continuous quality improvement.
- The encouragement of staff at all levels to establish communications between customers and suppliers, identify process improvement opportunities, and identify and offer solutions to problems.

6.0 ELEMENTS OF A QUALITY ASSURANCE PROJECT PLAN

A quality assurance project plan (QAPP) is an orderly assembly of detailed, specific procedures that delineate how quality data for a specific project are produced. A given program would have only one QMP, but would have a project plan for each project (e.g., the IMPROVE Program could have individual QAPPs for optical monitoring, particle monitoring, and modeling). Every project that involves environmentally-related measurements should have a written, approved QAPP. The plan shall be composed of standardized, recognizable elements covering the entire project from planning, through implementation, to assessment. The elements to be addressed in a QAPP include:

- Project Management
- Data Generation and Acquisition
- Assessment and Oversight
- Data Validation and Usability

Specific requirements for each of these elements are discussed in the following subsections and detailed in *EPA Requirements for Quality Assurance Project Plans*, EPA/240/B-01/003. A QAPP is valid for no longer than five years. After five years, it shall either be reissued without change, revised, or withdrawn from the EPA quality system.

6.1 PROJECT MANAGEMENT

The project management section addresses project management, including project history and objectives, roles and responsibilities of the participants, etc. It documents that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs have been documented. The section includes:

- A title and approval sheet with signatures of the appropriate approving officials.
- A table of contents including sections, figures, tables, references, and appendices.
- A distribution list, listing the individuals and their organizations who need copies of the approved QAPP and any subsequent revisions.
- A description of the project/task organization, identifying the individuals or organizations participating in the project and their specific roles and responsibilities. Include a organization chart showing the relationships and lines of communication among all project participants.
- A description of the specific problem to be solved, decision to be made, or outcome to be achieved.
- A project/task description summary of all work to be performed, products to be produced, and the schedule for implementation.
- A description of the quality objectives and the performance criteria to achieve those objectives.
- A description of any specialized training or certifications needed by personnel to complete the project or task, how training will be provided and how the necessary skills will be assured and documented.
- A description of the process and responsibilities for ensuring the appropriate project personnel have the most current approved version of the QAPP, information and records that must be included in the data report package, identify any other records and document that will be produced, and specify all applicable requirements for the final disposition of records and documents.

6.2 DATA GENERATION AND ACQUISITION

The data generation and acquisition section addresses all aspects of data generation and acquisition to ensure that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and documented. The section includes:

- A sampling process design including the types and numbers of samples required, the sampling network, locations, frequencies, measurement parameters, and rationale for the design.
- Sampling methods and procedures for collecting samples and identifying the sampling methods and equipment, performance requirements, and procedures in the event a sampling or measurement system failure occurs.
- Sample handling and custody requirements in the field, laboratory, and transport.

- Analytical methods and equipment required, what to do when a failure in the analytical system occurs, and a list of any method performance standards.
- Quality control activities needed for each sampling, analysis, or measurement technique, including the associated method or procedure, acceptance criteria, and corrective action.
- A description of instrument/equipment testing, inspection and maintenance, and how their components affecting quality will be performed and documented. Also include a discussion of the procedures by which final acceptance will be performed.
- A description of instrument/equipment calibration and frequency tools, gauges, instruments, and test equipment used for data generation or collection activities. Describe how calibrations will be conducted.
- A description of inspection/acceptance of supplies and consumables to be used.
- A description of measurements and data types that are obtained from non-measurement or non-direct sources.
- A description of the data management process, tracing the path of data from their generation to their final use or storage.

6.3 ASSESSMENT AND OVERSIGHT

The assessment and oversight section addresses the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The section includes:

- Assessments and response actions used, including the frequency and type.
- Reports to management; identify the frequency and distribution of reports to inform management of the project status.

6.4 DATA VALIDATION AND USABILITY

The data validation and usability section addresses all activities that occur after the data collection phase is completed. The section includes:

- Criteria used to review, verify, and validate data.
- A description of the process used for verifying and validating data and how the results are conveyed to data users.
- A description of how the results will be reconciled with the requirements defined by the data user or decision-maker.

7.0 ELEMENTS OF QUALITY ASSURANCE AND QUALITY CONTROL DOCUMENTS

Standard operating procedures, technical instructions, and checklist instructions should be written for specific elements of a project to ensure the validity and traceability of data and all other components critical to project QA and QC. Figure 7-1 presents these elements grouped according to their organizational level. The following subsections further describe each element; definitions are compiled and abridged from EPA-600/9-76-005, *EPA Quality Assurance Handbook for Air Pollution Measurement Systems*.

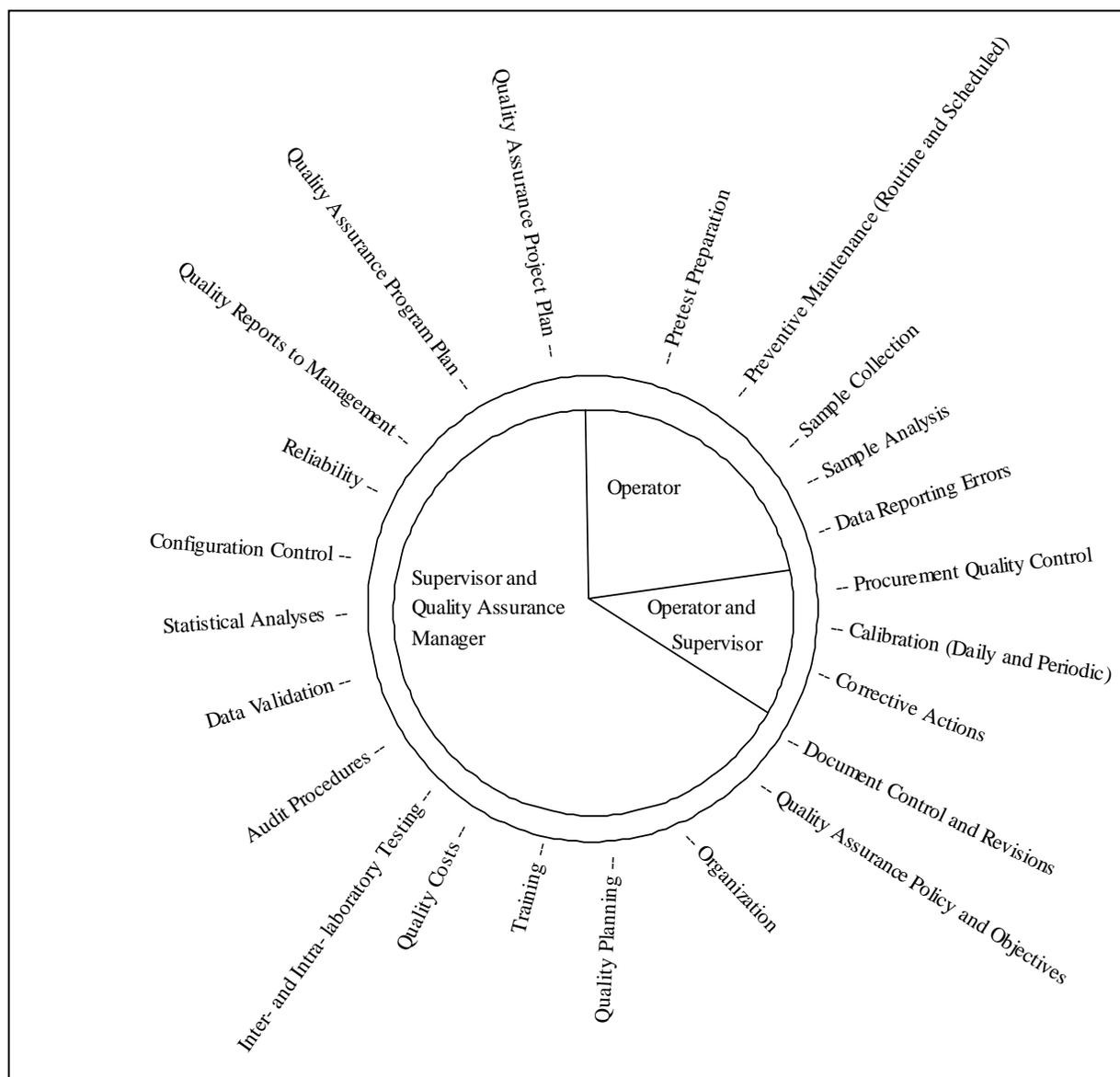


Figure 7-1. Quality Assurance Elements and Responsibilities.

7.1 DOCUMENT CONTROL AND REVISIONS

A structured system for documenting SOPs, TIs, CIs, and revisions should be implemented and followed. Each page of an SOP or TI shall be numbered, dated, identified with a numerical code, and have a revision number. Each page of a CI shall be numbered, dated, and identified with a numerical code.

The most important elements of a QA program to which document control should be applied are:

- Sampling procedures
- Calibration procedures
- Preventative maintenance and operations procedures
- Data collection, processing, analysis, validation, reporting, and archiving procedures
- Performance and system audit procedures
- Quality management plans
- Quality assurance project plans

7.2 QUALITY ASSURANCE POLICY AND OBJECTIVES

A written policy should be adopted that defined the amount of precision, accuracy, completeness, representativeness, and comparability that is necessary or possible for meeting monitoring program objectives. A summary table of these objectives is an important result of this effort. The policy and objectives must consider what is an acceptable operational and QA cost to ensure the specified objectives.

7.3 ORGANIZATION

Elements of a QA plan should be assigned to specific staff. Such elements include: establishing objectives, determining the amount of emphasis to place on each QA element, identifying QA problems to be resolved, preparing a QA project and program plan, and implementing plans.

7.4 QUALITY PLANNING

The sequence of actions required to accomplish program objectives should be determined in advance. This sequence needs to be communicated and scheduled to those responsible for executing the program.

7.5 TRAINING

All persons involved in any function affecting data quality should have sufficient training to ensure quality data. Training can include:

- On-the-job training
- Short-term training (e.g., seminars, short courses, video courses)
- Long-term training
- Testing
- Proficiency tests
- Interviews

7.6 PRETEST PREPARATION

The most important pretest activities include determining:

- Monitoring network size
- Sampling station location
- Probe siting
- Method and equipment selection

7.7 PREVENTIVE MAINTENANCE

An effective preventive maintenance program increases data completeness and quality. Poor preventive maintenance may result in increased downtime, increased unscheduled maintenance costs, and yield invalid data.

The preventive maintenance schedule will be based on:

- Defining the equipment or parts most likely to fail or those that need periodic replacement.
- Ensuring that an adequate spare parts or unit inventory is available so that downtime will be minimized.

7.8 SAMPLE COLLECTION

Pre- and post-sample collection checks should be performed by the operator and be thoroughly documented.

7.9 SAMPLE ANALYSIS

Functional checks should be performed by the data analyst to check the stability and validity of the data and performance of the system.

Control checks should be performed during analysis. Some checks are performed during routine analysis while others are performed periodically to estimate analysis variability in terms of precision and accuracy (e.g., pre- and post-calibration, audits, or interlaboratory checks).

7.10 DATA REPORTING ERRORS

Tracking of human and system errors is essential. Strict data validation and review procedures must be established to review the critical characteristics in the measurement and analysis system. Validity checks should include a review of potential errors in:

- Measurement
- Calibration
- Timing
- Computation
- File management
- Output

7.11 PROCUREMENT QUALITY CONTROL

The quality of equipment and supplies used in a measurement process significantly affects the quality and the amount of data generated from the process. Quality control procedures for procurement should be used to ensure objectives of the measurement process.

Quality control procedures for the procurement of air quality instrumentation could include:

- Making pre-purchase evaluation and selection
- Contacting users of the analyzers being evaluated
- Preparing contract specifications
- Conducting acceptance tests
- Comparing to performance of equipment with known response
- Maintaining records of equipment - performance specifications, acceptance test data, maintenance data, and vendor performance

7.12 CALIBRATION

Calibration may be the single most important operation in the measurement process.

A calibration plan should be developed and implemented for all data measurement and test equipment. Calibration standards should include:

- Statement of maximum allowable time between pre-, post-, and mid-point calibration checks
- Statement and listing of minimum quality of calibration standards
- Provisions for standards traceability if possible
- Written calibration procedures, including a statement of intended range of validity
- Documentation of qualifications of the person performing the calibration

7.13 CORRECTIVE ACTIONS

Corrective actions are of two types: 1) immediate (to correct non-conforming data or repair equipment) and 2) long-term (to eliminate causes of non-conformity).

- Steps comprising a closed-loop corrective action system are:
- Define the problem
- Assign responsibility for investigating the problem
- Determine the cause of the problem
- Determine a corrective action to eliminate the problem
- Assign responsibility to implement corrective action
- Determine effectiveness of corrective action and implement the action
- Verify that the corrective action has eliminated the problem

7.14 QUALITY COSTS

There is a cost to assuring quality data. These costs should be accounted for so that overall program costs and cost effectiveness can be appraised.

Cost categorization suggestions include:

- Preventive costs
- Appraisal costs
- Correction - failure costs

Allocation of costs can help to identify QA/QC activities that may be disproportionate relative to total program costs.

7.15 INTER- AND INTRA-LABORATORY TESTING

Laboratory tests are of two major types:

- Collaborative Tests - involve several laboratories to define the limits of a method.
- Performance Tests - may involve a number of laboratories as a means for participants to compare their results with other labs. This test allows the participants to take corrective action when their results are outside of stated audit limits.

Inter- and intra-laboratory tests identify sources of measurement error and estimate bias and variability (repeatability and replicability) in measurements resulting from these sources.

7.16 AUDIT PROCEDURES

Two types of audits are customary in air quality monitoring applications:

- Performance Audits - to quantitatively evaluate the quality of data produced by the total measurement system (sample collection, sample analysis, and data processing). Individuals performing the audit have generally different standards and equipment from the regular team (operating the measurement system) to obtain an independent assessment. The performance audit is commonly limited to a portion of the total measurement system (e.g., flow rate measurement, sample analysis), but may include the entire measurement system.

A performance audit may include:

- Objective assessment of the accuracy of data collected by a given measurement system
 - Identification of out-of-control sensors
 - Identification of systematic bias of a sensor or of the monitoring network
 - Measurement of improvement in data quality based on data from previous and current audits
- System Audits - qualitative on-site inspection and review of the total measurement system. The auditor should have extensive background experience with the measurement system being audited.

The role of audits in the overall management program is verification. While audits do not improve data quality if all work is correctly performed, they do provide assurance that the work prescribed for the measurement program has been conducted properly. Audits conducted by individuals not responsible for the day-to-day operations provide a control and assessment mechanism to program managers.

7.17 DATA VALIDATION

Data validation can be accomplished by a variety of manual and computerized methods. Selection of specific validation methods must include a thorough review of data types, frequencies, representativeness, and other considerations as outlined below:

- Data validation is the process whereby data are filtered and either accepted or flagged for further investigation based on a set of criteria.
- Validation is performed to isolate spurious values since values are not automatically rejected. Records of invalid data should be maintained.
- Validation methods can include review by supervisory personnel as well as application of validation criteria by computer. Criteria depend on the types of data and on the purpose of the measurement.
- Data validation will refer to those activities performed after the fact, that is, after the data have been collected. The difference between data validation and quality control techniques is that the quality control techniques attempt to minimize the amount of bad data being collected, while data validation seeks to prevent any bad data from getting through the data collection and storage systems. Thus data validation serves as a final screen before the data are used in decision making.
- It is preferable that data validation be performed as soon as possible after data collection, so that questionable data can be checked by recalling information on unusual events and on meteorological conditions which can aid in the validation. Also, timely corrective actions may be taken when indicated to minimize further generation of questionable data.
- Data validation procedures should include the following:
 - Routine Validation Procedures - Routine checks and review procedures should include:
 - Data identification checks
 - Unusual event review
 - Deterministic relationship checks
 - Data processing practices
 - Tests for Internal Consistency - Comparisons of values in the data set which appear atypical when compared to the whole data set. Visual review of data plots and a variety of statistical methods exist to identify and evaluate outliers.
 - Tests for Historical Consistency - Checks of a data set to data recorded in the past (historical or temporal consistency).
 - Tests for Consistency with Parallel Data Sets - Data compared to other data sets collected at the same time or under similar conditions.

7.17.1 Validation Levels

Collected data routinely undergo processing and analysis in discrete stages or levels. At each progressive level, data are more closely scrutinized, and the validity of the data becomes better understood. The validation process is often described in a multi-level sequence:

- Level A - Data are appended to files with consistent, defined formats.

Raw values (such as voltages) are converted to engineering units and initial calibration values may be applied; however, raw values are maintained in the file.

Time and date are checked, and missing records are blank-filled to ensure time consistency.

- Level 0 - Data listings and plots are manually reviewed in conjunction with log sheets, calibration reports, audit reports, and other documentation. Preliminary validation codes are assigned to the primary data set.

Known offsets and corrections are applied to the primary data set. All data are in engineering units; raw values are no longer carried in the file.

Validity codes are not assigned to secondary data (e.g., temperature and relative humidity data in a transmissometer file).

- Level 1 - Manual and statistical methods are applied to reduced and plotted data to identify and evaluate outliers. Identified inconsistencies are further evaluated by reviewing all available documentation.

Validity codes of the primary data set are refined. Initial validity codes are assigned to secondary data carried in the file.

Secondary calculations or unit conversions are made to the primary data set and are carried in the file (e.g., extinction data are also converted to standard visual range and both data representations are carried in the file).

Data are averaged into selected reporting increments.

Uncertainties of the primary data are statistically calculated and carried in the file.

- Level 2 - Tests for consistency with parallel and/or historical data sets are applied; identified inconsistencies are investigated.

Validity codes for primary and secondary data sets are refined.

Data are analyzed, summarized, and presented for other averaging times.

- Level 3 - Modeling and other detailed analytical techniques are applied to understand cause-and-effect relationships.

Primary and secondary data as well as other collocated measurements are combined to calculate related parameters, physical budgets, and other physical descriptions of the monitored regime.

Not all data will require all levels of validation. For example, Level 1 validation may be all that is required for well-documented instrumentation and measurement techniques such as conventional meteorological data collection. Level 2 or 3 validation will likely be required for most field monitoring, especially when individual samples are taken or when the collected data support research programs or special studies.

7.18 STATISTICAL ANALYSES

Statistical analyses are critical in determining calibration curves and in understanding and representing collected data. Statistical analyses methods could include:

- Summary statistics - such as the geometric mean and standard deviation can be used to simplify the presentation of the data
- Cumulative frequency distributions - to summarize and present large data sets such as seasonal summaries
- Estimation procedures - to make statements about a population from a small sample of data
- Outlier identification - identifying unusually large or small values
- Audit data - representation of precision, accuracy, and bias
- Control charts - to graphically display data and evaluate the variability of small groups of data to the overall data set
- Sampling - selecting and verifying sampling rates
- Calibration - calculating calibration curves and frequency of calibrations
- Replication, repeatability, and reproducibility - determining error
- Reliability and maintainability - reliably maintaining accurate data

7.19 CONFIGURATION CONTROL

Configuration control is used to record changes in air pollution measurement method equipment and the physical arrangement of this equipment in the monitoring system.

Configuration control may be grouped into two types depending on the purpose:

- Provides history (record) of changes during the life of the monitoring purpose
- Provides design and operation data on the first monitoring instrument or system when multiple instruments or system are planned

Configuration control record procedures are the same as those used for document control (Section 7.1).

Document control, described in Section 7.1, is used to make sure all personnel on a monitoring project are using the same and most current written procedures for sampling, analysis, calibration, data collection, reporting, auditing, etc. When revisions are made in these procedures, they should be documented as described in Section 7.1. Similarly, a system is needed to record changes made in the equipment and/or physical arrangement of this equipment in the monitoring system that are not included as part of document control. This system is called configuration control.

7.20 RELIABILITY

Reliability of an air pollution measurement system (or any system) is defined as the probability that the system will perform its intended function for a prescribed period of time under the operating conditions specified, or conversely, unreliability is the probability that a device will fail to perform as specified. Generally, as the measurement system becomes more complicated, its probability of failure increases. In order to ensure high equipment reliability, the following should be considered:

- Specify equipment reliability in manufacturing - select high reliability components.
- Inspect and test incoming equipment for adherence to reliability specifications (e.g., conduct performance acceptance tests) or have the equipment supplier conduct these tests.
- Control the operating environment that influences the reliability of the equipment and hence the measurements.
- Provide for adequate training.
- Provide preventive maintenance to reduce or minimize wear-out failures.
- Provide records of failures, analyze and use these data to initiate corrective actions, and predict failure rates.

7.21 QUALITY REPORTS TO MANAGEMENT

Several reports are recommended in the performance of quality assurance tasks. Concise, accurate presentation of data and derived results is necessary. QA reports for management can include:

- Quarterly data quality assessment reports
- Performance and system audit reports

Interlaboratory comparison summaries

- Data validation reports
- Quality cost reports
- Instrument or equipment downtime
- Quality assurance program and project plans
- Control charts

Reports should be prepared with the following guidelines as appropriate:

- Objective of the measurement program, in terms of data required and an uncertainty statement concerning the results.
- Methods of data analysis should be described unless they are well-documented in the open literature.
- A statement on any limitation and on applicability of the results should be included.
- All raw data should be included in or with the report when practical.

8.0 SUGGESTED DOCUMENT OUTLINE

8.1 SUGGESTED OUTLINE FOR A STANDARD OPERATING PROCEDURE

A standard operating procedure should include:

- Title page, with provision for approval signatures and revision documentation
- Table of contents with a list of figures and tables
- Section 1.0 - Introduction, statement of purpose, and applicability
- Section 2.0 - Responsibilities (by agency, department, or job category)
- Section 3.0 - Required Equipment and Materials (tools, documents, manuals, log sheets, hardware)
- Section 4.0 - Methods
- Section 5.0 - Forms, Examples, and Illustrations (if necessary due to numerous illustrations)
- Section 6.0 - Definitions (if necessary)
- Section 7.0 - References (if necessary)

8.2 SUGGESTED OUTLINE FOR A TECHNICAL INSTRUCTION

A technical instruction should include:

- Title page, with provision for approval signatures and revision documentation
- Table of contents with a list of figures and tables
- Section 1.0 - Introduction, statement of applicability, reference to appropriate SOP
- Section 2.0 - Responsibilities (by agency, department, or job category)
- Section 3.0 - Required Equipment and Materials (tools, documents, manuals, log sheets, hardware)
- Section 4.0 - Methods
- Section 5.0 - Forms, Examples, and Illustrations (if necessary due to numerous illustrations)
- Section 6.0 - Definitions (if necessary)
- Section 7.0 - References (if necessary)

9.0 REFERENCES

- U.S. Environmental Protection Agency, 2002. Guidance for Quality Assurance Project Plans, EPA/240/R-02/009.
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