Montana Ambient Air Monitoring Program Quality Assurance Project Plan

Volume I: Continuous Monitor, Filter-Based Sampler, and Meteorological Sensor Requirements for Monitoring Ambient Air

September 1, 2017

State of Montana Ambient Air Monitoring Program
Montana Department of Environmental Quality Air Quality Bureau
1520 E. Sixth Avenue
Helena, Montana 59620-0901

Foreword

The Montana Department of Environmental Quality Air Quality Bureau ambient air monitoring program (monitoring program) collects ambient air pollution measurements to assess Montana's outdoor air quality in order to protect public health; determine regional compliance with National Ambient Air Quality Standards (NAAQS) and Montana Ambient Air Quality Standards (MAAQS); and support emissions strategy development and air pollution research studies.

The 2017 Montana Ambient Air Monitoring Quality Assurance Project Plan (QAPP) developed by the monitoring program is in two parts:

- Volume I: Continuous Monitor, Filter based Sampler, and Meteorological Sensor Requirements for Monitoring Ambient Air; and
- Volume II: $PM_{2.5}$ Chemical Speciation Sampling at Trends, NCore, Supplemental and Tribal Sites.

Volume I focus is primarily on collecting criteria pollutant ambient air measurements using regulatory and non-regulatory monitors to provide air pollution data to the public in a timely manner, to support compliance with ambient air quality standards, and for air pollution research studies.

Volume II emphasis is collecting the fine fraction of PM (i.e., particles with aerodynamic diameters less than or equal to 2.5 micrometers (µm), referred to as $PM_{2.5}$) and determining the chemical composition of these particles. The $PM_{2.5}$ precursor measurements are made within the chemical speciation network (CSN) which is a complementary network to the national $PM_{2.5}$ mass monitoring network. CSN stations are non-regulatory monitors and the chemical species data are not used for attainment or nonattainment decisions related to $PM_{2.5}$ mass. The programmatic objectives of the CSN network are to provide: annual and seasonal spatial characterization of aerosols; air quality trends information for analysis and tracking the progress of state implementation programs; data to assist in development of emission control strategies; and a chemical speciation data set for comparison to the data collected from the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring network.

NOTE: Throughout this QAPP Volume I are numerous references to the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program (QA Handbook, Vol. II) and Volume IV: Meteorological Measurements (QA Handbook, Vol. IV). To aid QAPP users, the QA Handbook titles are abbreviated as QA Handbook, Vol. II and QA Handbook, Vol. IV.

For reader convenience, footnotes are hyperlinked to the online versions of the documents they reference.

Purpose of the Quality Assurance Project Plan

This Quality Assurance Project Plan (QAPP) establishes an effective system for acquiring ambient air monitoring data, including:

- Setting standards for collecting data,
- Managing accountability,
- Establishing processes for acquiring data,
- Listing requirements and guidelines for DEQ's air monitoring program, and
- Establishing detailed procedures for measuring air quality.

Use this QAPP as the reference for defining and implementing all activities necessary to ensure that the monitoring program acquires and provides the most representative data of the highest quality. By implementing this quality system, the state of Montana ensures that collected ambient air data is of "known quality" and of acceptable value; therefore, data can be used with confidence to manage Montana's air resource.

The QAPP meets the requirements in Title 40 Protection of Environment, Code of Federal Regulations Part 58 (40 CFR Part 58), Appendix A, Section 2.[1] Moreover, this QAPP fulfills the requirements in the Administrative Rules of Montana (ARM) 17.8.204 – Ambient Air Monitoring.

[1] - Title 40 Code of Federal Regulations Part 58, Appendix A, Section 2 – Quality System Requirements.

Title and Approval Sheet

Title: Montana Ambient Air Monitoring Program Quality Assurance Project Plan: Volume I: Continuous Monitor, Filter-Based Sampler, and Meteorological Sensor Requirements for Monitoring Ambient Air.

The attached Montana Ambient Air Monitoring Program Quality Assurance Project Plan, Volume I, is approved and commits the state of Montana Department of Environmental Quality to follow the elements described within.

Signature:_____ Date: _____

David L. Klemp,
Bureau Chief
Air Quality Bureau
Air, Energy, and Mining Division
Montana Department of Environmental Quality

Signature:_____ Date: _____

Cynthia Meier-Dingman,
QA Council Chair,
Contracts & QA Coordinator
Office of Information Technology
Montana Department of Environmental Quality

Revision Approval

Title: Montana Ambient Air Monitoring Program Quality Assurance Project Plan: Volume I: Continuous Monitor, Filter-Based Sampler, and Meteorological Sensor Requirements for Monitoring Ambient Air.

The September 2017 revision to the Montana Ambient Air Monitoring Program Quality Assurance Project Plan, Volume I, noted as Revision I (see **Section 4.4 – Project Approval Process and Revision Information**), is approved and commits the state of Montana Department of Environmental Quality to follow the elements described within.

Signature:_____ Date: _____
Doug Kuenzli, Research and Monitoring Services Section Supervisor
Air Quality Bureau
Air, Energy, and Mining Division
Montana Department of Environmental Quality

Signature:_____ Date:_____
Annette Williams, Technical Support Services Program Manager
Air Quality Bureau
Air, Energy, and Mining Division
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Signature:_____ Date: _____
Liz Ulrich, Analysis and Planning Services Section Supervisor
Air Quality Bureau
Air, Energy, and Mining Division
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Signature:_____ Date:_____
Joseph Ugorowski, Air Monitoring Quality Assurance Manager
Analysis and Planning Services Section
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Revision History

Revision Number	Date	Author	Section Modified	Description of Changes
0	04/15/2013	J. Ugorowski		Initial version.
1.	01/15/2017	J. Ugorowski	All References 4.4 19, 19.2 Appendix 1	Monitoring program administrative changes: • Air Quality Bureau *(formerly Air Resources Management Bureau)* • Technical Support Services (TSS) Program *(formerly Air Monitoring and Analysis Program)* • Research and Monitoring Services (RMS) Section *(formerly Air Monitoring Section (AMS))* • Analysis and Planning Services (APS) Section *(formerly Air Quality Policy and Planning (AQPP) Section)* • Data management staff residing directly in Technical Support Services Program *(Formerly Data Management Section)* • Removed monitoring program supervisors and replaced with monitoring program management (i.e., TSS Program Manager, RMS Section Supervisor, and APS Section Supervisor) • QA Staff other than QA Manager not in APS Section but residing in RMS Section • Organization chart (Figure Appendix 1)
			Purpose 4.4 7 8.1 8.2, 19.3, 20.0, 21.5 8.3 9.1.3 9.1.10 9.1.12	Monitoring program technical updates: • Updated QAPP to include ARM 17.8.204 – Ambient Air Monitoring (BER Approved March 15, 2015) reference that all ambient monitoring performed within the state of Montana is to be conducted using an approved QAPP. • Included monitoring program's authority to review and approve the QAPP. • Linked QAPP approval process with SOP approval process in Section 8.1. • Removed Training Plan; referenced Quality Management Plan for training. • Revised SOP approval to include RMS Section delegated staff. • Removed references to annual QA report and replaced with systems audits and audits of data quality • Updated QAPP to include the monitoring program's 2016 Records Management Plan (SOP-309) • Updated Montana Metropolitan and Micropolitan Statistical Areas with 2015 U.S. Census Bureau population estimates • Removed reference to Monitoring Station SOP; referenced QA Handbooks Vol. II and IV for establishing a monitoring station.

			• Renamed STN QAPP as Volume II: $PM_{2.5}$ Chemical Speciation Sampling at Trends, NCore, Supplemental and Tribal Sites of the Montana Ambient Air Monitoring QAPP.
		15.2	• Removed DEQ ozone "primary standard" in text and Figure 1. • Changed the laboratory primary volumetric-flow standard to primary flow standard.
		18.4	• Updated processing precision and accuracy information from Agilaire AirVision precision and accuracy reporting system (PARS) module to monitor assessment module. Also, included processing accuracy information from manual instruments using monitor assessment module
		19.1.4	• Updated PM2.5-PEP, Pb-PEP, & AAPGVP QA Website from RTI to Batelle.
		21.2.5	• Removed reference that we do not send the PM flow rate verifications to AQS.
			Updated QAPP to conform with the "40 CFR Parts 50, 51, 52 et al. 58, National Ambient Air Quality Standards for Particulate Matter; Final Rule (78 FR 3086, January 15, 2013) including:
		9.7	• Accessing data from $PM_{2.5}$ FEM monitors and evaluating comparability to collocated $PM_{2.5}$ FRM monitors for requests that the FEM data should or should not be used in to comparison to the NAAQS. These assessments are required in annual network plans. (40 CFR Part 58.11 (e))
		9.4	• Identifying in the annual network plan continuously operating FEM PM monitors with design values within ±5% of the 24-hour $PM_{2.5}$ NAAQS that are or are not appropriate for comparison to the NAAQS. (40 CFR Part 58.12(d)(1)(iii))
		5.5, 21.2.5	• Added "weight of evidence" approach when determining the suitability of data for regulatory decisions. (40 CFR Part 58, Appendix A, 1.2.3)
		9.4, 9.7	Referenced EPA's April 20, 2013 memorandum, "Update on Use of $PM_{2.5}$ Continuous FEMS."
			Updated QAPP to conform to the 40 CFR Part 50 "Method for the determination of Lead in Total Suspended Particulate Matter" (78 FR 40000, July 3, 2013) including:
		10.1, 12	• Replaced Flame Atomic Absorption Spectroscopy with Inductively Coupled Plasma Mass Spectrometry (ICP–MS) reference method. (40 CFR Part 50, Appendix G)
			Updated QAPP to conform to the "40 CFR Parts 50, 51, 52, 53, 58. National Ambient Air Quality Standards for Ozone; Final Rule" (80 FR 65292, October 26, 2015) including:
		Annual Network Plan	• Included 2015 O3 8-hour NAAQS. (40 CFR Part 50.19)
		18.5.5	• Updated AQS reporting units and decimal places reference. (40 CFR Part 50, Appendix U, Section 3(1))
		9.5	• Changed O3 8-hour rolling to 8-hour moving average. (40 CFR Part 50, Appendix U, Section 2(b))
		9.4	• Changed O3 monitoring season to April – September. (40 CFR Part 58, Appendix D, Section 4.1(a))

				Updated QAPP to conform to the "40 CFR Part 58, Revisions to Ambient Monitoring Quality Assurance and Other Requirements; Final Rule" (81 FR 17248, March 28, 2016) including:
			All References	• Renamed Appendix A to Part 58 "Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards."
			9.1.13	• Included AQS "NAAQS exclusion" description for regulatory monitor. (40 CFR Part 58, Appendix A, 1.1)
			4.4	• Providing EPA with copies of revised QAPPs prior to in-house approval. (40 CFR Part 58, Appendix A, 2.1.1)
				• Referenced SOPs as required elements of the QAPP. (40 CFR Part 58, Appendix A, 2.1.2)
			9	• Referencing list of existing sites and monitors. (40 CFR Part 58, Appendix A, 2.1.2)
			5.3.2	• Removed PM_{10}-$PM_{2.5}$ DQO (40 CFR Part 58, Appendix A, 2.3.1)
			18, 18.5.7	• Removed reporting to AQS of $PM_{2.5}$ and Pb manual sampler average daily temperature and barometric pressure. (40 CFR Part 58.16)
			9.4	• Updated operating schedule : o Manual $PM_{2.5}$ sampler 1-in-3 day schedule waiver requests regarding alternative schedules. (40 CFR Part 58.12 (d)(1)(i)) o Maintaining 1-in-3 day or daily schedule until the referenced design value no longer meets ± 10% or ± 5% criteria for 3 consecutive years. (40 CFR Part 58.12 (d)(1)(ii)) o Identifying in the annual network plan continuously operating FEM PM monitors with design values within ±10% of the 24-hour $PM_{2.5}$ NAAQS that are or are not appropriate for comparison to the NAAQS. (40 CFR Part 58.12 (d)(1)(ii))
			4.3, 18.5.9	• Revised annual air monitoring data certification: o Focus on criteria pollutants. o included monitoring data from SLAMS and SPM sites provided the data measurements used FRM/FEM monitors and the sites met the criteria in 40 CFR Part 58, Appendix A. (40 CFR Part 58.15)
			9.7	• Revised annual network plan requirements: o Must be made available for public inspection and comment for at least 30 days prior to submission to the EPA and the submitted plan shall include and address, as appropriate, any received comments. (40 CFR Part 58.10 (a)(1)) o Network modification plan that addresses findings of network assessment due year after network assessment is produced. (40 CFR Part 58.14 (a))
			19.1.1	• Referenced NPEP independent assessment and adequacy for self-implementing NPAP-TTP and PEP $PM_{2.5}$ audits.

			(40 CFR Part 58, Appendix A, Section 2.4)
		19.1.4	• Participating in AAPGVP once every five years. (40 CFR Part 58, Appendix A, Section 2.6.1)
		5.2, Gas calibration/ZSP spreadsheets SOP-401: Gas Audits	• Updating operation of the QA program: o Gas analyzer 1-Point QC checks at lower prescribed range related to its monitoring objective. (40 CFR Part 58, Appendix A, Section 3.1.1) o Gas analyzer three non-consecutive audit points over 10 audit levels. (40 CFR Part 58, Appendix A, Section 3.1.2)
		13.1	• Submitting PM flow rate verifications to AQS by removing statement and reference to internal decision in Appendix 6. (40 CFR Part 58, Appendix A, Section 3.2.1, 3.3.1)
		18.5.9 9.1.12 9.1.12 9.1.6, 18.5.7	• Revising and including new definitions: o Added "Certifying Agency" o Added "Chemical Speciation Network" o Added "Supplemental Speciation Station" o Revised "Meteorological Measurements" to include NCore (40 CFR Part 58.1)
		9.1.11 9.1.12	Updated QAPP to include "monitor type" definition changes in AQS: • Alignment of AQS monitor type to 40 CFR Part 58 definition: can only be populated with one selection (e.g., SLAMS, SPM). • Monitor Network Affiliation: name of network or program of monitor (e.g., NCore, Chemical Speciation Network (CSN), Speciation Trends Network (STN) stations) (August 2016 National Ambient Air Quality Conference, AQS presentations)
		18.6 18.5.10	Updated QAPP to conform to the "40 CFR Part 50 and 51, Treatment of Data Influenced by Exceptional Events" Final Rule (81 FR 68216, October 3, 2016) including: • Notifying pubic of exceptional event (40 CFR Part 50.14 (c)(1)) • Updating initial AQS data flagging date requirement (40 CFR Part 50.14 (c)(2)) • Changing demonstration submittal timeline (40 CFR Part 50.14 (c)(2)(i)(B))
		All References 21.1.1 18.4	Updated QAPP to include information from the January 2017 QA Handbook Vol. II (EPA-454/B-17-001): • Changed MetOne BAM reference membrane span foil verification from critical to operational criteria (Appendix D) • Referenced the Rounding Policy for Evaluating NAAQS QA/QC Acceptance Criteria (Appendix L)
		Appendix 4	NCore trace level MQOs: • Removed conducting NOy 1-PT QC (Precision) check using IPN and NPN Gas; we can use NO_2 GPT to complete NOy precision check. (QA Eye, Issue 20, page 4, October 2016)
		Appendix 5	Measurement Check Summary Table: • Removed $PM_{10-2.5}$

			Appendix 6	Internal Decisions and Guidance: • Updated to include the PM QA/QC activity Rounding Internal Decision • Removed Not to AQS PM Flow Rate Verification Internal Decision
	05/15/2017	J. Ugorowski	Appendix 2	Standard Operating Procedure List: • Removed SOP-021: Monitoring Station: Site Evaluation, Selection, Deployment • Removed SOP-308: Reports • Updated SOP list for SOPs revised or completed by May 15, 2017

Table of Contents

Table of Contents – Figures

Table of Contents – Tables

Acronyms and Abbreviations

AAGVP	-	Ambient Air Gas Verification Program
ADQ	-	audit of data quality
ADVP	-	Automatic Data Validation Processor
AMTIC	-	Ambient Monitoring Technology Information Center
APS	-	(DEQ) Analysis and Planning Services (Section)
AQB	-	(DEQ) Air Quality Bureau
AQI	-	Air Quality Index
AQS	-	Air Quality System (EPA ambient air database)
ARM	-	Administrative Rules of Montana
ASQ	-	American Society for Quality
ASTM	-	American Society for Testing and Materials
BAM	-	beta attention monitor
CAA	-	Clean Air Act
CARF	-	(monitoring program) Corrective Action Request Form
CASTNET	-	Clean Air Status and Trends Network
CBSA	-	core-based statistical area
CFR	-	Code of Federal Regulations
CO	-	carbon monoxide
CSN	-	chemical speciation network (40 CFR Part 58)
DASC	-	Data Assessment Statistical Calculator
DEQ	-	Montana Department of Environmental Quality
DQA	-	data quality assessment
DQI	-	data quality indicator
DQO	-	data quality objective
EDXRF	-	energy-dispersive X-ray fluorescence spectrometry
EPA	-	U.S. Environmental Protection Agency
FEM	-	federal equivalent method
FRM	-	federal reference method
GPT	-	gas phase titration
H_2S	-	hydrogen sulfide
Hi-Vol	-	high-volume
ICP-MS	-	inductively coupled plasma–mass spectrometry
IDL	-	instrument detection limit
IML	-	Inter-Mountain Labs, Inc.
IMPROVE	-	Interagency Monitoring of Protected Visual Environments
Inform	-	Informational only (qualifier code)
LC	-	local *actual* conditions
LDL	-	lower detection limit
Lo-Vol	-	low-volume
m^3	-	cubic meter

MAAQS	-	Montana Ambient Air Quality Standards
MCA	-	Montana Code Annotated
MDL	-	method detection limit
MFC	-	mass flow controller
MQO	-	measurement quality objective
MS	-	Microsoft
MSA	-	metropolitan statistical area
MST	-	Mountain Standard Time
NAAQS	-	National Ambient Air Quality Standards
NATTS	-	national air toxics trends stations
NCore	-	National Core (multipollutant monitoring stations)
NIST	-	National Institute of Standards and Technology
NO	-	nitrogen oxide
NO_2	-	nitrogen dioxide
NOx	-	oxides of nitrogen; the sum of the concentrations of NO and NO_2
NOy	-	sum of all total reactive nitrogen oxides
NPAP	-	National Performance Audit Program
O_3	-	Ozone
OAQPS	-	EPA Office of Air Quality Planning and Standards
OEI	-	EPA Office of Environmental Information
ORD	-	EPA Office of Research and Development
PAMS	-	photochemical assessment monitoring stations
PARS	-	precision and accuracy reporting system
Pb	-	lead
Pb-PM_{10}	-	lead PM_{10}; Pb is sampled using the FRM method based on Appendix O of 40 CFR Part 50 (PM_{10C} sampler) and analyzed based on Appendix Q of 40 CFR Part 50 FRM
Pb-TSP	-	lead total suspended particulate; Pb is sampled using the FRM method based on Appendix B of 40 CFR Part 50 and analyzed based on Appendix G of 40 CFR Part 50
PEP	-	Performance Evaluation Program
PM	-	particulate matter
PM_{10}	-	particles with an average aerodynamic diameter of 10 µm or less as measured by a reference method based on Appendix J of 40 CFR Part 50
$PM_{10-2.5}$	-	particles with an average aerodynamic diameter ≤ a nominal 10 µm and > 2.5 µm as measured by a reference method based on Appendix O of 40 CFR Part 50
PM_{10C}	-	particles with an average aerodynamic diameter of 10 µm or less as measured by a reference method based on Appendix O of 40 CFR Part 50
$PM_{2.5}$	-	particles with an average aerodynamic diameter of 2.5 µm or less as measured by a reference method based on Appendix L of 40 CFR Part 50
PQAO	-	primary quality assurance organization
PSD	-	prevention of significant deterioration
psig	-	pounds-per-square-inch gage
QA	-	quality assurance

QA Handbook, Vol. II	-	Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program
QA Handbook, Vol. IV	-	Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements
QAPP	-	quality assurance project plan
QC	-	quality control
QMP	-	quality management plan
RadNet	-	EPA's nationwide radiation monitoring system
ReqExc	-	request exclusion (qualifier code)
RMS	-	(DEQ) Research and Monitoring Services (Section)
SC	-	standard *reference* conditions (25 °C and 760 mm Hg)
SIP	-	State Implementation Plan
SLAMS	-	state or local air monitoring stations
SO_2	-	sulfur dioxide
SOP	-	standard operating procedure
SPM	-	special purpose monitor
SRDS	-	sample run data sheet
SRP	-	standard reference photometer
STN	-	speciation trends network (40 CFR Part 58)
TS	-	transfer standard
TSA	-	technical systems audit
TSP	-	total suspended particulates as measured by a reference method based on Appendix B of 40 CFR Part 50
TSS	-	(DEQ) Technical Support Services (Program)
WESTAR	-	Western States Air Resources Council
Z/S/P	-	zero, span, and precision check
µm	-	micrometer

QAPP Distribution List

Electronic copies of the Montana Ambient Air Monitoring Program Quality Assurance Project Plan (QAPP) have been distributed to the individuals listed in **Table 1**. Listed officials are responsible for ensuring that all staff associated with the project are using the most current version of this QAPP.

Table 1. Monitoring Program Distribution List

Position	Branch/Office: Location
Department of Environmental Quality	
Quality Assurance Council Chair	State Office (Metcalf Building): Helena
Air Quality Bureau Chief	State Office (Metcalf Building): Helena
Technical Support Services Program Manager	State Office (Metcalf Building): Helena
Research and Monitoring Services Section Supervisor	State Office (Airport Road Building): Helena
Analysis and Planning Services Section Supervisor	State Office (Metcalf Building): Helena
Air Monitoring Quality Assurance Manager	State Office (Airport Road Building): Helena
Monitoring Program Staff	State Office (Airport Road Building): Helena
Local Air Pollution Control Programs	
Cascade County	Cascade City-County Health Department: Great Falls
Flathead County	Flathead City-County Health Department: Kalispell
Lewis & Clark County	Lewis & Clark County Health Department: Helena
Lincoln County	Lincoln County Health Department: Libby
Missoula County	Missoula City-County Health Department: Missoula
Silver Bow	Butte-Silver Bow Health Department: Butte
Yellowstone County	River Stone Health: Billings
U.S. Environmental Protection Agency, Region 8	
State of Montana Air Quality Monitoring Representative	Denver, CO

This document is available online at the Montana Department of Environmental Quality (DEQ) – Air Quality Links and DEQ Publications website [(AQB I), see References].

1. Clean Air Regulations & Monitored Pollutants

The state of Montana ambient air monitoring program (monitoring program) measures concentrations of ambient air quality pollutants per the federal Clean Air Act (CAA)[1] and the Clean Air Act of Montana.[2] By approving Montana's State Implementation Plan (SIP) [(AQB II), see References], the U.S. Environmental Protection Agency (EPA) delegates authority to the state to enforce the CAA. Further, the state must comply with and implement the CAA. The Montana SIP is the legal document for state implementation of and state and federal enforcement of the CAA in Montana and provides the framework for protecting air quality and establishing the monitoring program.

Amended in 1990, the CAA requires EPA to set air quality standards for the most common air pollutants with known harmful health and environment effects. EPA calls these "criteria" air pollutants. There are two different types of criteria pollutants:

1. Primary pollutants enter the atmosphere directly and include sulfur dioxide, hydrogen sulfide, oxides of nitrogen [with nitrogen dioxide (NO_2) as the indicator], carbon monoxide, and particulate matter.
2. Secondary pollutants are formed from the primary pollutants by atmospheric chemical reactions. The secondary criteria pollutants include NO_2, principally formed from nitrogen oxide (NO) and ozone, formed via photochemical reactions involving oxides of nitrogen and non-methane carbon-containing species.

EPA develops human health-based and/or environmentally-based (science-based) limits to regulate criteria pollutants by setting permissible levels. These limits are referred to as National Ambient Air Quality Standards (NAAQS).[3] The CAA establishes two types of NAAQS:

1. Primary standards: A set of air pollutant limits to protect human health, including the health of sensitive populations such as asthmatics, children, and the elderly.
2. Secondary standards: A set of air pollutant limits to protect public welfare, including protection against decreased visibility and damage to animals and crops, vegetation, and buildings.

Montana has adopted similar air quality standards, known as the Montana Ambient Air Quality Standards (MAAQS), for air pollutants.[4]

NAAQS and MAAQS air pollutants include:

- Particulate matter (PM) [particles with an average aerodynamic diameter of 10 micrometers (µm) or less (PM_{10}) and 2.5 µm or less ($PM_{2.5}$)] NAAQS and MAAQS.

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[1] - U.S. Clean Air Act (CAA).
[2] - Clean Air Act of Montana, Title 75 Environmental Protection, Chapter 2. Air Quality.
[3] - National Ambient Air Quality Standards (NAAQS).
[4] - Administrative Rules of Montana (ARM), Title 17, Chapter 8, Subchapter 2 - Ambient Air Quality.

- Sulfur dioxide (SO_2) NAAQS and MAAQS.
- Carbon monoxide (CO) NAAQS and MAAQS.
- Oxides of nitrogen (NO_x) [with NO_2 as the indicator] NAAQS and MAAQS.
- Ozone (O_3) NAAQS and MAAQS.
- Lead (Pb) NAAQS and MAAQS.
- Hydrogen sulfide (H_2S) MAAQS.
- Settable PM MAAQS.
- Fluoride in forage MAAQS.
- Visibility MAAQS.

Additional air pollutants and NAAQS summary information is available on EPA's Air and Radiation website [(Air and Radiation I), see References]. Furthermore, a NAAQS/MAAQS summary table is available in monitoring program's annual Montana Air Quality Monitoring Network Plan (Monitoring Network Plan) [(AQB III), see References].

Non-criteria monitored pollutants include $PM_{10-2.5}$ [particles with an average aerodynamic diameter ≤ to a nominal 10 µm and > a nominal and 2.5 µm] and total reactive nitrogen oxides (NOy). NOy is a secondary pollutant, which is the sum of all the reactive nitrogen species, including nitrogen acids, organic nitrates, particulate nitrates, and other organic nitrogen oxides. NOy species data helps us understand ozone (O_3) photochemistry.

2. Objectives of DEQ's Air Monitoring Program

DEQ's monitoring program collects ambient air pollution measurements to assess Montana's outdoor air quality in order to protect public health and determine regional compliance with National Ambient Air Quality Standards (NAAQS)[1] and Montana Ambient Air Quality Standards (MAAQS).[2] Decisions that are made based on the collected data may have far-reaching implications regarding an area's planning and development. In addition, areas that experience persistent air quality problems are designated by EPA as nonattainment areas. Consequently, the Clean Air Act (CAA)[3] requires monitoring and additional air pollution controls in these areas.

Air pollution measurements come from a network of ambient air monitoring established in areas of concern throughout the state. Primarily, the network is designed to meet three basic monitoring objectives, as described in the Code of Federal Regulations (CFR): [4]

1. Provide air pollution data to the general public in a timely manner.
2. Support compliance with ambient air quality standards and emissions strategy development.
3. Support air pollution research studies.

The monitoring program may also measure air quality when activating emergency controls to prevent or alleviate air pollution episodes.

2.1 Ensuring User Needs and Quality Data

Collected data supports the Montana State Implementation Plan (SIP) [(AQB II), see References], national air quality assessments, and policy decisions. Data users include DEQ and EPA planners, permit regulators, and compliance personnel; meteorologists; the media; environmental groups; local governments; industry; public health professionals; academia; and the public. For an illustration of the data user relationships, refer to the Montana Ambient Air Monitoring Program Quality Management Plan (Monitoring Program QMP) [(AQB IV), see References].

Judging by the diversity of groups and untold numbers of data users, potentially an infinite number of decisions are made using the collected data. The monitoring program's goal, therefore, is to provide ambient air monitoring data of known quality according to established quality indicators. In other words, all data collection must fall within prescribed requirements so that users are confident in the data and the decisions they make based on that data. We accomplish this goal by implementing the elements and activities contained in this QAPP.

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[1] - National Ambient Air Quality Standards (NAAQS).
[2] - Administrative Rules of Montana (ARM), Title 17, Chapter 8, Subchapter 2 - Ambient Air Quality.
[3] - U.S. Clean Air Act (CAA).
[4] - 40 CFR Part 58, Appendix D – Network Design Criteria for Ambient Air Quality Monitoring.

3. Structure of DEQ's Air Monitoring Program

The state monitoring program comprises DEQ personnel and city-county health officials. Additionally, the federal government provides monitoring program funding and oversight. The EPA Office of Air Quality Planning and Standards [(OAQPS I), see References] within the Office of Air and Radiation develops regulations to limit and reduce air pollution and to establish the quality systems structure of the national ambient air quality monitoring network.

EPA Region 8, located in Denver, Colorado, coordinates and distributes information and requirements from the national level to DEQ's monitoring program. Furthermore, air monitoring staff from EPA Region 8 evaluate and approve the program's required annual Montana Air Quality Monitoring Network Plan (Monitoring Network Plan) [(AQB III), see References]. In addition, they evaluate the monitoring program every 3 years through a technical systems audit (TSA).

The DEQ portion of the monitoring program resides within the Air, Energy, and Mining Division's Air Quality Bureau (AQB). DEQ's organizational structure for implementing the monitoring program is shown in **Appendix 1**. Monitoring program activities occur primarily within two sections of the AQB Technical Support Services (TSS) Program:

1. Research and Monitoring Services (RMS) Section: Collects and validates ambient air monitoring data within Montana.
2. Analysis and Planning Services (APS) Section: Develops, maintains, and oversees the quality system for the monitoring program.

Additionally, monitoring program data management functions are performed by staff within the AQB-TSS Program. Refer to the Montana Ambient Air Monitoring Program Quality Management Plan (Monitoring Program QMP) [(AQB IV), see References] for the specific roles and responsibilities of each significant position within the monitoring program. In addition, the monitoring program relies on remote-site operators for many day-to-day activities at some of the monitoring stations. Remote-site operators may be DEQ part-time staff or local city-county health officials.

3.1 A Primary Quality Assurance Organization

EPA recognizes the monitoring program as a primary quality assurance organization (PQAO). As such, the monitoring program's goal is to create a reasonably homogeneous network to reduce measurement uncertainty among all stations in the network. The goal is achieved by:

- Maintaining a reliable team of field operators working with a common set of procedures.
- Following a common QAPP.
- Having common calibration instruments and standards.
- Having common makes and models of field instruments.
- Maintaining oversight by a common quality assurance (QA) organization.
- Providing support by a common management, laboratory, or headquarters.

4. What We Collect and How

This section outlines how the monitoring program collects ambient air monitoring data. It also describes the type of data needed, work schedule, work products, and reporting requirements. For information regarding the geographic areas of the monitoring network, refer to the annual Montana Air Quality Monitoring Network Plan (Monitoring Network Plan) [(AQB III), see References].

At the federal level, EPA's Office of Air Quality Planning and Standards [(OAQPS I), see References] supports planning and implementation of state or local air monitoring stations (SLAMS) operating within the state of Montana. Additionally, OAQPS oversees the Technical Air Pollution Resources which includes links to the National Ambient Air Quality Standards (NAAQS), Air Quality System (AQS) repository of ambient air quality data, and Ambient Monitoring Technology Information Center (AMTIC) websites [(Air and Radiation II), see References]. The AMTIC website contains information on monitoring methods, QA procedures, and federal regulations related to ambient air quality monitoring.

All of the gaseous and PM pollutant ambient measurements are designed to meet as many of the requirements as possible for federal network design, monitor inlet and probes, and quality assurance (QA). Additionally, sampling and analysis methods used to make regulatory NAAQS compliance determinations are reference, or equivalent, methods as defined in the Code of Federal Regulations (CFR).[1]

The goal is to collect data of "known quality" during all monitoring collection activities, with respect to siting and QA activities, independent of regulatory or non-regulatory monitor classification. At the same time, we must control resources and labor while managing accountability.

4.1 Required Documentation

The monitoring program's work of collecting, documenting, editing, and reporting data includes, but is not limited to,

1. Establishing a monitoring network that has:
   - appropriate density, location, and sampling frequency,
   - associated meteorological monitoring, and
   - accurate and reliable data recording equipment, procedures, and software.
2. Developing encompassing documentation for:
   - data and report format, content, and schedules,
   - quality objectives and criteria,
   - procedures for equipment installation, operation, and preventative maintenance as well as for QA activities, and
   - establishing assessment criteria and schedules.

[1] - 40 CFR Part 50 - National Primary and Secondary Ambient Air Quality Standards.

3. Operating the network equipment and implementing the established quality program.

The data, reports, and documentation we produce meet or exceed our program goals and EPA's quality assurance requirements. Some of what we produce includes:

- ambient air monitoring data of known quality,
- annual ambient air monitoring data and precision/accuracy certification per 40 CFR Part 58.15[2],
- monitoring network plan and periodic monitoring network assessment per 40 CFR Part 58.10[3],
- air quality summary reports,
- standard operating procedures, and
- policy and guidance documentation.

4.2 Various Tasks Associated with Monitoring Air Data

The monitoring program has a number of ongoing monitoring activities. In the field we have scheduled sampling events and day-to-day instrument checks, calibrations, scheduled preventative and corrective maintenance, and performance evaluations, including monitoring program field audits and the national performance evaluation programs. Additional work schedule commitments and resource constraints include establishing and terminating stations and monitors when required. Analytical laboratory activities include pre- and post-sample filter weighing, along with associated environmental and analytical quality control (QC) checks. Data generation, verification, and validation follow an established timetable, while data and precision/accuracy submittals to EPA's AQS [(OAQPS II), see References] database have established deadlines. For additional information about the monitoring program's work schedule, see **Section 9 - Network Sampling Design**.

The monitoring program performs all activities to support continued successful operation and changes to the existing statewide ambient air quality monitoring network. As such, standard operating procedures (SOPs) document the approved procedures and criteria for all aspects of collection activities. SOPs cover the specific field activities of installing, operating, calibrating, and providing periodic preventative maintenance and service for equipment located at ambient air monitoring stations. Additional SOPs cover collecting, processing, and managing data, as well as assessing and oversight, verifying and validating data, and validating standards and laboratory procedures. A list of the monitoring program SOPs is included in **Appendix 2**.

4.3 AQS Data Reporting

The monitoring program does not contract with independent providers for data collection activities or the reporting of ambient air measurements. Once the data is collected, the Research and Monitoring Services (RMS) Section verifies and validates it, then the Technical Support Services (TSS) Program Database Analyst uploads the data to EPA's AQS database. Furthermore, the monitoring program certifies the previous year's monitoring data from SLAMS and SPM sites provided the data

[2] - 40 CFR Part 58.15 - Annual air monitoring data certification.
[3] - 40 CFR Part 58.10 - Annual monitoring network plan and periodic network assessment.

measurements obtained used FRM/FEM monitors and the sites met the criteria in appendix A of 40 CFR Part 58. For more information on AQS data reporting and certification refer to **Section 18 - Data Acquisition and Information Management**.

Data generation, verification, and validation follow an established timetable, while data and precision/accuracy submittals to the AQS database have established deadlines. For additional AQS data submittal requirements, see 40 CFR Part 58.16.[4]

4.4 Project Approval Process and Revision Information

The air monitoring QA Manager (QA Manager) reviews the QAPP annually to determine how current and relevant it is. Following review, the QAPP is revised as needed with the approval of the monitoring program management (i.e., TSS Program Manager, RMS Section Supervisor, and APS Section Supervisor) and the Bureau Chief of the Air Quality Bureau (AQB). Additionally, the monitoring program has the delegated authority to approve the QAPP per the monitoring program's and Department's Quality Management Plan (QMP). Refer to the Montana Ambient Air Monitoring Program QMP (Monitoring Program QMP) [(AQB IV), see References] for more information on the monitoring program's QAPP approval authority. Finally, prior to in-house approval of the revised QAPP, a copy is submitted to the EPA Region 8 for review to ensure there are no regulatory issues with the revision.

The 2013 QAPP Volume I was the first revision since the issuance of the Montana QAPP in 1996. Development of the 1996 Montana QAPP used EPA's Requirements for Quality Assurance Project Plans framework and document control structure (QA/R-5) [(OEI I), see References]. Because several significant changes have occurred since 1996, the 2013 Montana QAPP Volume I was established again as revision 0. The 2017 QAPP Volume I is revision 1. **Appendix 3** has a crosswalk table noting EPA's required QAPP elements of QA/R-5 and corresponding sections of this QAPP, Volume II. Summaries of subsequent QAPP revisions are noted in the Revision History.

Meanwhile, the 2017 QAPP Volume II was submitted to the EPA Region 8 for approval in 2006. In 2008, the monitoring program received verbal approval by phone from EPA Region 8. Because several significant changes have occurred since 2008, the 2017 Montana QAPP Volume II was established again as revision 0.

Additionally, SOPs are considered required elements of the QAPP and are included by reference in Volume I, Appendix 2 and Volume II, Foreword. For more information on the monitoring program's SOP approval process refer to **Section 8.1 - Quality System and Quality Assessment Documents**.

[4] - 40 CFR Part 58.16 - Data submittal and archiving requirements.

5. Quality Objectives and Criteria for Managing Quality

The following section describes the monitoring program's quality specifications at two levels:

1. What data needs will the monitoring fulfill? (i.e., What question is the data intended to answer?)
2. What measurement will be used to support the study question?

The first level addresses data quality objectives, while the second level addresses measurement quality objectives (MQOs).

Data quality objectives clarify the purpose of the study and define the type, quality, and quantity of ambient air monitoring data needed to meet the requisite monitoring program objective(s). Furthermore, data quality objectives establish the acceptable tolerance for errors, or uncertainty, in the data collected. In practical terms, these objectives (1) provide the overview of the purpose for establishing the monitoring program, (2) define the data to be collected, and (3) determine the expectations for the resulting data collected.

Measurement quality objectives help evaluate and control the data as it is collected. They set the acceptance thresholds for quality assurance and instrument operating specifications to ensure that total measurement uncertainty is within the range prescribed by the objectives. Primarily, *measurement* quality objectives that have a direct effect on attaining data quality objectives are defined by precision, bias, completeness, representativeness, and detectability.

5.1 Managing Uncertainty Associated with Air Monitoring Measurements

The basis for the monitoring program quality system and this QAPP is the need to identify, understand, and control uncertainty associated with the collected air data and provide acceptable data quality uncertainty estimates to data users. Two types of uncertainty occur during collection of ambient air data:

1. uncertainty associated with the natural (spatial and temporal) variability of the sample population studied, and
2. uncertainty associated with the data collection measurement process (field, preparation, and laboratory).

The monitoring program's task is to control for both types of uncertainty when ambient air data is collected.

Population uncertainty is controlled for during network design, network reviews, and site evaluations. Measurement uncertainty is controlled for by applying the results of the monitoring program QA activities in the data validation and editing process.

Collected data is valid only when related QC activities and measurements meet the evaluation criteria for measurement quality objectives. Measurement uncertainty is evaluated during the data review, verification, and validation activities that occur throughout the year; during annual data certifications; and during periodic data quality assessments.

5.2 Quantifying Ambient Air Data Quality Indicators

Measures of data quality indicators are used to show the quality and reliability of the data. Data quality is defined by quantifying representativeness, precision, bias, detectability, accuracy, comparability, and completeness. Each is addressed below.

Representativeness
Representativeness is the measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variation at a sampling point, a process condition, or an environmental condition. Central to representativeness is assurance that both the sampling and measurement processes are free from known biases. Associated indicators are usually qualitative, such as comparability. Quantitative elements of representativeness include precision and bias estimates.

Representativeness is the most important indicator because it is the basis upon which the ambient air monitoring network operates in order to meet monitoring objectives. It includes consideration of siting criteria, spatial scales, monitoring objectives, source configuration, and duration of study. Spatial scale of representativeness is developed further in **Section 9 - Network Sampling Design**.

Precision
Precision is the measurement of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions, expressed generally in terms of the standard deviation. Precision defines the ability of personnel and equipment to obtain repeatable results for identical samples or under specified conditions. This is the random component of error. Precision is estimated from periodic checks made by the operator or from results of collocated samplers.

Precision estimates for automated gaseous measurement are determined from the biweekly one-point quality control checks (precision checks); gaseous precision checks are measurements of the analyzer response to a test gas concentration at a level in the prescribed range that is related to the monitoring objectives for the monitor. Precision estimates for automated and manual PM methods are calculated using the results of collocated samplers.

Bias
Bias is the systematic or persistent distortion of a measurement process, which causes errors in one direction. Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.

Bias estimates of automated gaseous measurement are also determined from the biweekly one-point quality control checks (precision checks). Bias estimates for automated and manual $PM_{2.5}$, $PM_{10-2.5}$, and Pb measurements are calculated using the results of collocated Performance Evaluation Program audits.

Detectability

Detectability is the determination of the low-range critical value of a characteristic that a method-specific procedure can reliably discern. Specific detection limits are determined as part of the reference and equivalent determinations for most instrumentation. Instrument sensitivity indicators include:

- Noise: Spontaneous, short-duration deviations in output, about the mean output, that are not caused by changes in input concentration. Noise is determined as the standard deviation about the mean and is expressed in concentration units.
- Lower detection limit (LDL): The minimum concentration that produces a signal of twice the noise level.
- Instrument detection limit (IDL): The minimum concentration that produces a signal of three times the noise level.
- Method detection limit (MDL): The minimum concentration of a substance that can be reported to 99% confidence that the analyte concentration is greater than zero.

In addition to EPA's general reference and equivalent method determinations, site-specific gaseous analyzer MDL determinations are made at the National Core (NCore) multipollutant monitoring station. The NCore instrument-specific MDL estimates are based on routine operation of the instrument.

Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy is a nebulous term and is a combination of the random (imprecision) and systematic (bias) error from sampling and analytical procedures. Accuracy is used when the random and systematic errors cannot be resolved.

Comparability

Comparability is a qualitative term that expresses the confidence that two data sets can contribute to common interpretation and analysis. Comparability tests the consistency of units and collection and analysis methods used by the various monitoring organizations throughout the nation. Data comparability is achieved via uniform procedures and designated reference or equivalent methods. Quantitative measures of comparability involve statistical tests that measure the similarity or difference between two or more data sets. Data quality indicators that measure bias are also valuable tools for ensuring comparability of data.

By generating known quality ambient air monitoring data for precision, bias, and accuracy estimates, the monitoring program can compare its data to similar ambient air monitoring data throughout the country.

Completeness
Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected under correct, normal conditions. It is related to the sampling frequency and the percent of data that passes acceptability criteria (valid samples) and validates the statistics generated from the measurement process. Completeness is achieved by selecting the proper sampling frequency (providing adequate training of the site operator) and adhering to instrument calibration, monitoring, and maintenance protocols.

Data collection is considered complete if it produces representative data during the required hours of the day and during the required months or seasons over the time period of interest. In general, most National Ambient Air Quality Standards (NAAQS)[1] comparisons require a minimum 75% data capture. For a discussion of this topic, see **Section 9.5 – Data Completeness**.

5.3 Establishing Data Quality Objectives

Data quality objectives are qualitative and quantitative statements that:

- Describe the environmental problem to be investigated (see **Section 1 – Clean Air Regulations & Monitored Pollutants**).
- Identify the decision (see **Section 2 – Objectives of DEQ's Air Monitoring Program**).
- Identify the inputs to the decision (see **Section 4 – What We Collect and How**).
- Define the study boundaries (see **Section 9 – Network Sampling Design**).
- Develop a decision rule (see **Section 5.3.1 – Decision Rules for NAAQS Compliance**).
- Specify the tolerable limits on the probability of making a decision error because of uncertainty in the data (see **Section 5.3.3 – Acceptable Limits on Decision Errors**).
- Optimize the design for obtaining data (see **Section 9 – Network Sampling Design**).

Some data quality objectives of ambient air monitoring are based on NAAQS that predate the development of the data quality objectives systematic process [(OEI II), see References]. The first guidance reference for data quality objectives appeared in the 1998 40 Code of Federal Regulations (CFR) Part 58, Appendix A.[2] Further, EPA has developed objectives, expressed as measurement uncertainty goals, for criteria pollutants that have undergone a NAAQS revision after 2006. Current data quality objectives are based on assessing and controlling the measurement uncertainty for the monitoring objective with the most stringent data quality requirements (i.e., determining compliance with and/or progress toward meeting the NAAQS). Primarily, the objectives are based on the precision and bias estimates for a NAAQS attainment period. If the collected data exceeds the objective measurement uncertainty goals and performance criteria established by the MQOs, the data may be ineligible for making NAAQS compliance determinations.

[1] - National Ambient Air Quality Standards (NAAQS).
[2] - 1998 40 CFR Part 58, Appendix A – Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).

Not all ambient air monitoring data collected by the monitoring program is intended for NAAQS compliance determinations. Evaluations of conformity with the data quality objectives are made after the data is collected to assess the adequacy of the data in relation to their intended use.

5.3.1 Decision Rules for NAAQS Compliance

Decision rules are developed using "If….then" statements. Decision rules specific to the monitoring program are used primarily to make NAAQS compliance determinations using calculated design values (see **Section 9.6 – NAAQS Comparisons and Design Values**). "Design value" refers to the calculated concentration according to the applicable Appendix of 40 CFR Part 50 for the highest site in an attainment or non-attainment area (40 CFR Part 58.1). Furthermore, NAAQS compliance determinations are made using estimates (based on the sampled data) to the true (actual) value of the parameter. For example, sampled data for the $PM_{2.5}$ criteria pollutant is used to estimate the true daily $PM_{2.5}$ concentrations to answer the key SLAMS primary monitoring question whether the 24-hour or annual $PM_{2.5}$ NAAQS were met. Consequently, the resulting 24-hour $PM_{2.5}$ NAAQS compliance decision rules are:

- If the true proportion of daily concentrations is ≤ to 35 µg/m^3 using the 3-year average $PM_{2.5}$ design value, then the monitored area or region is considered in attainment for $PM_{2.5}$, and the decision to continue or discontinue monitoring is determined during the network review process (see **Section 9.1.16 – Continuing/Discontinuing a Monitor Station**).
- If the true proportion of daily concentrations is > than 35 µg/m^3 using the 3-year average $PM_{2.5}$ design value, then the monitored area is considered in nonattainment for $PM_{2.5}$, and monitoring is continued. $PM_{2.5}$ control strategies outlined in the State Implementation Plan (SIP) [(AQB II, 2016), see References] are implemented.

Both of the decision rule statements above are founded on the assertion that the data completeness and associated precision and bias measurement uncertainty goals are met.

5.3.2 Uncertainty Goals for Ambient Air Measurements

Measurement uncertainty goals for ozone, $PM_{2.5}$, Pb, NO_2, and SO_2 are found in the CFR.[3] The remaining pollutant measurement uncertainty goals are included as MQOs in Appendix D of the QA Handbook, Vol. II [(OAQPS III), see References]. Additionally, the measurement uncertainty goals for NCore station trace-level gas instruments are listed in **Appendix 4.** Remember, the data quality objectives in the CFR are goals. If the goals are not achieved, the decisions are made with less certainty.

5.3.3 Acceptable Limits on Decision Errors

Data users must realize that the ambient air data collected by the monitoring program contains a certain amount of error, or uncertainty. If data users must take action based on the collected data, they must

[3] - 40 CFR Part 58, Appendix A – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards, Section 2.3 – Data Quality Performance Requirements.

be confident that the data is of acceptable quality. Therefore, the purpose of the monitoring program QA is to identify the sources of error and provide an acceptable estimate of the difference between the measured and the true ambient air values. The calculated uncertainty estimates ensure that the monitoring data are of such quality that users are willing to risk making a wrong decision (e.g., designating an area as non-attainment when in fact it meets attainment).

Limits on decision errors are defined during the data quality objective process. EPA has established the tolerable levels of potential errors for the criteria pollutants during NAAQS compliance determinations. Continuing with the 24-hour $PM_{2.5}$ NAAQS example presented above, the tolerable levels of potential errors include:

- incorrectly concluding that an area is in nonattainment when it truly meets attainment no more than 5% of the time, and
- incorrectly concluding that an area meets attainment when it truly is in non-attainment no more than 5% of the time.

Note that both of the allowed error statements are founded on the assertion that the data completeness and associated precision and bias measurement uncertainty goals are met.

5.3.4 Assessments of Data Quality

Data quality assessments are evaluations of the data quality indicators in order to determine whether the quality of data is adequate (i.e., total error in the data is tolerable) to support the study question or decision. Evaluations typically include: (1) reviewing the monitor's sampling design; (2) conducting a preliminary data and QA review; (3) developing data completeness summaries; (4) estimating precision and bias confidence intervals over the time period of interest; and (5) verifying the assumptions of the statistical tests. Data quality assessments are discussed further in **Section 21.4 – Reconciling Data Quality Objectives**.

5.4 Characterizing Ambient Air Measurement Quality Objectives

Performance criteria for measurement quality objectives are established to:

- control data quality,
- ensure that total measurement uncertainty is within the range prescribed by the data quality objectives, and
- develop validation templates.

Measurement quality objectives provide an estimate of the quality of the overall data collection effort meeting the data quality objectives (e.g., precision estimate using 3 years of collocated PM data). MQOs also provide an estimate of the quality of the data for an individual phase of the measurement process (e.g., PM flow rate verifications). Additionally, uncertainty estimates for overall measurement and individual phases of the measurement process have different acceptance thresholds, or allowed errors.

The different allowed errors result from the ability to discern the sources of error and their direct effect on the measurement obtained.

For example, collocated $PM_{2.5}$ precision estimates assess the overall field and laboratory processes. You cannot pinpoint a specific phase of the measurement when a precision estimate is higher than the established goal. Individual precision values greater than the established goal are tolerated provided the overall 3-year data quality objective of 10% precision is achieved. In contrast, $PM_{2.5}$ sampler flow rates, which are specific to the functioning of the sampler, have allowed errors in the individual measurement phase. The MQOs associated with flow rate verifications of the PM sampler must be met each time or the sampler is recalibrated.

In summary, since uncertainty is usually cumulative, there is much less tolerance for uncertainty for individual phases of a measurement system because each phase contributes to overall measurement uncertainty.

5.5 Specifying Ambient Air Validation Templates

Through time the established MQOs have been documented as validation templates. EPA's validation templates in the QA Handbook for ambient air pollutant and meteorological parameters allow for consistent validation of the criteria pollutants throughout the nation. Furthermore, the monitoring program has opted to use the validation templates to retain this consistency of reporting and allow for data to be compared among the different monitoring organizations. Access the validation templates from the following references and links:

- Pollutant parameter validation templates: Appendix D of the QA Handbook, Vol. II. For the NCore station trace level gas instruments refer to **Appendix 4**.
- Meteorological parameter validation templates: Section 0 of the QA Handbook, Vol. IV [(OAQPS IV), see References].

Appendix 5 has a pollutant Measurement Quality Sample Summary Table. The table includes the type of check, coverage, and frequency for the automated and manual methods, as well as summary criteria for acceptable performance associated with each type of check.

The pollutant-specific validation templates have three sets of criteria: critical, operational, and systematic. Each is described below.

Critical Criteria
These are deemed vital to maintaining sample integrity (i.e., ambient air concentration value) and include the QC check activity results, such as the following:

- gaseous zero, span, and precision (Z/S/P) checks,
- PM flow rate verifications,
- NO_2 converter efficiencies,
- PM continuous and filter-based sampler average flow rates, variability in flow rates, and sampling periods,

- PM low-volume and Pb sampler filter holding and recovery times,
- reference membrane span foil verification [beta attenuation monitor (BAM)], and
- laboratory filter acceptance testing and conditioning environment.

Observations that do not meet each criterion should be invalidated unless there is a compelling reason for doing otherwise.

The sample, or group of samples, for which one or more of these criteria are not met is invalid until proved otherwise. The monitoring program investigates the cause of not operating in the acceptable range for each of the violated criteria. Additionally, the investigation focuses on reducing the likelihood that additional samples will be invalidated. If there is a compelling reason for not invalidating data, the investigation and justification for not doing so is documented as part of the corrective action request process.

Operational criteria
These criteria are important for maintaining and evaluating the quality of the data collection system and include:

- federal gas analyzer performance evaluations,
- monitoring program gas analyzer and PM sampler performance evaluations
- calibrations,
- gaseous standard certifications and dilution systems,
- ozone transfer standard certifications,
- PM sampler leak checks and temperature and pressure verifications,
- internal shelter temperatures, and
- laboratory filter and balance checks.

Violation of a criterion, or a number of criteria, may invalidate the data. The sample, or group of samples, for which one or more of these criteria are not met is suspect unless other QA information demonstrates otherwise. If there is a reason for not invalidating data, the reason for not meeting the criteria and justification for not doing so is documented as part of the corrective action request process.

Systematic criteria
These criteria are important for correctly interpreting the data but do not usually affect the validity of a sample or a group of samples. They include:

- siting,
- sample probe material and residence times,
- PM calibration transfer standard certifications,
- annual and 3-year precision and bias estimates, and
- performance evaluation probability intervals.

For example, the data quality objectives of completeness, precision, and bias are included in systematic criteria. If the objectives are not met, this does not invalidate any of the samples, but it may affect the error rate or uncertainty associated with the attainment/non-attainment decision.

Data users (e.g., EPA) make systematic criteria evaluations when faced with attainment/nonattainment decisions. If data quality objectives are nonconforming, the monitoring program makes additional evaluations to determine why they were not met (e.g., because of equipment, procedural, or operational issues).

According to the QA Handbook, Vol. II, Section 17.3.3 – Validation Templates, "Strict adherence to the validation templates is not required. They are meant to be a guide based upon the knowledge of the Workgroup who developed them and may be a starting point for monitoring organization specific validation requirement."

Applying the validation template criteria during data verification and validation is discussed further in **Section 21 – Data Validation and Usability**. Finally, the corrective action request and resolution process, as mentioned above, is described in **Section 19.4 – Corrective Action**.

5.6 Determining Data Suitability Using the "Weight of Evidence" Approach

The monitoring program uses a "weight of evidence" approach when determining the suitability of data for regulatory decisions per 40 CFR Part 58, Appendix A.[4] As stated in the regulations, "Failure to conduct or pass a required check or procedure, or a series of required checks or procedures, does not by itself invalidate data for regulatory decision making." In addition, the critical, operational, and systematic criteria discussed in **Section 5.5 - Specifying Ambient Air Validation Templates** form the basis for the weight of evidence approach. The "weight of evidence" approach is developed further in **Section 21.2.5 - Resolving and Communicating Data Validation**.

[4] - 40 CFR Part 58, Appendix A – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards, Section 1 – General Information.

6. Quality Assurance Defined

Quality assurance and quality control have been defined and interpreted in many ways. Quality assurance is concerned with the activities that have an effect on the quality of the ambient air monitoring measurements. Quality assurance also establishes methods and techniques to evaluate this quality. With that in mind, QA of the monitoring program's collection of ambient air monitoring data includes two distinct but interrelated functions: internal control and external assessment. Each is described below.

Internal Control (Quality Control)
Internal control of the measurement process is done by implementing operational techniques, procedures, and corrective actions to ensure that measurement uncertainty is maintained within established acceptance criteria of the measurement quality objectives. Quality control activities are performed by monitoring program staff directly involved with the monitoring station operation and ambient air data collection, verification, and validation activities.

External Assessment (Quality Assessment)
Periodic independent evaluations of the quality of the monitoring data include monitoring program performance evaluations (field audits), data quality assessments, and national performance evaluations. Assessment is necessary to provide adequate confidence that the data collected will satisfy the users' needs at the decision level, or data quality objective. Assessment activities are performed by independent EPA contractors or monitoring program staff who are not typically directly involved with the monitoring station operation and ambient air data collection, verification, and validation activities.

In this QAPP, the term "quality assurance" (QA) includes both internal control and external assessment. To avoid confusion about the meaning of quality assurance, "assessment" refers to external assessment activities and "quality control" (QC) refers to internal control activities.

7. Staff Training

Adequate personnel training and education are integral to the monitoring program's success at producing reliable and credible ambient air monitoring data. Training is aimed at increasing the effectiveness of employees and the monitoring program.

In general, monitoring program training for new hires combines required reading, on-the-job mentoring, self-guided study, and formal training. Continuing education for existing staff consists of self-guided lessons, formal training, and workshops and conferences.

For specifics on the training provided, such as how the training is assured and documented, refer to the Montana Ambient Air Monitoring Program Quality Management Plan (Monitoring Program QMP) [(AQB IV), see References].

8. Documents and Records Management

The monitoring program has the additional responsibility of maintaining documentation that establishes the validity of air monitoring data, so data users can have confidence when using those data. The vast majority of documentation and records produced by the monitoring program consists of data and supporting information. Sound record keeping ultimately validates or voids an instrument's data. When considering the value and potential effect of maintaining accurate documentation, remember: if you did not document it, you did not do it.

8.1 Quality System and Quality Assessment Documents

The Montana Ambient Air Monitoring Program Quality Management Plan (Monitoring Program QMP) [(AQB IV), see References) details the distribution of and access to the quality system and quality assessment documents. Also, the QMP identifies the parties responsible for maintaining and distributing these records. Documents identified in the QMP include:

- quality system documents (Monitoring Program QMP, QAPPs, and SOPs), and
- quality assessment documents (TSA reports, network reviews, and periodic network assessments).

For quality system documents, the monitoring program uses a formal document control procedure. Quality system documents are published with the date and revision information clearly noted on the title page and top right corner of each individual page. When quality system documentation is superseded by a newer document, the replacement document clearly states it is a revision by adding a new origination date and version number both on the cover page and top of the page.

Official current versions of any quality system document are available to the public on DEQ's Air Quality Links and DEQ Publications website [(AQB V), see References]. The QA Manager removes older versions of quality system documents.

Standard Operating Procedures
Standard operating procedures are a required element of the QAPP. Monitoring program SOPs are developed, reviewed, and approved after a new process is developed or after new equipment or software is purchased. Developing SOPs is a two-phase process:

1. The new equipment is first operated according to the specifications recommended by the manufacturer and EPA requirements.
2. Equipment operation is then tailored to meet the monitoring program's specifications.

Once the equipment operation is fully understood, we develop an SOP, allowing for sufficient time before an SOP is due. Under normal circumstances, new equipment SOPs are due at the end of 1 year.

Standard operating procedures are developed by the monitoring program staff directly involved with the equipment operation or procedure.

Standard operating procedures are reviewed annually to ensure the document and criteria are current. If the SOP requires revision, the monitoring program staff directly involved with the equipment operation or procedure must revise it. During initial development and annual maintenance, the QA Manager reviews each SOP, which is then approved by the Technical Support Services (TSS) Program Manager, Research and Monitoring Services (RMS) Section Supervisor, or delegated staff who oversees that specific monitoring data collection activity. Specific responsibilities and procedures are documented in the appropriate SOP. A list of the monitoring program SOPs is included in **Appendix 2**.

8.2 Data Records and Supporting Information

Most data collected by the monitoring program is done so electronically and stored electronically on DEQ's network drive. Monitoring program data records and supporting information include:

- Monitoring program guidance and policies:
  - internal decisions
- Site information:
  - site correspondence
  - site maps
  - site photos
- Sample collection and handling records:
  - instrument logs
  - station logs
  - gas analyzer monthly site check logs
  - PM low-volume sampler run data sheets
  - PM low-volume sampler run information (electronic)
  - laboratory filter acceptance testing, weighing, and conditioning environment information
  - laboratory sample and instrument logs
  - archived low-volume sampler PM filters
- Quality control records:
  - PM sampler flow rate verifications and calibrations
  - gas analyzer zero/span/one-point QC ("precision") checks and calibrations
  - compressed gas cylinder certifications
  - field standard certification reports
- Quality assessment records:
  - control charts
  - strip charts
  - field audit reports
  - system audit reports
  - laboratory audit reports
  - data analysis records (audits of data quality, data quality assessments)

  - compressed gas cylinder certifications
  - laboratory and field audit standard certification reports
- Data:
  - original and edited validated ambient air monitoring data
  - gas one-point QC ("precision") and PM flow rate verification information for Air Quality System (AQS) [(OAQPS II), see References] uploads
  - PM sampler and gas analyzer accuracy information for AQS upload
- Corrective action requests:
- Data certification records:
  - certification letter
  - annual air quality data summary report
  - annual precision and accuracy data summary
- Equipment and information technology records:
  - equipment manuals
  - computer software and database manuals

8.3 Documents and Records Storage, Backup, Retention, and Disposal

At a minimum, all hard copy and electronic documents and records are securely stored on-site for life + 4 years except instrument logs which are discarded once the equipment is no longer used. All records are disposed using the Records Disposal Request Procedure. For more information on the monitoring program's documents and records, including type, location, backup, retention, archiving, and disposition requirements, refer to the monitoring program's Records Management Plan (SOP-309).

9. Network Sampling Design

The state of Montana ambient air monitoring network meets the monitoring objectives and network design requirements in the Code of Federal Regulations (CFR).[1] The network is established and operated in areas of concern throughout the state and includes the following monitors:

- Air quality public reporting monitors: The continuous $PM_{2.5}$ monitoring network, including regulatory and non-regulatory monitors, produces near real-time $PM_{2.5}$ concentration data that is available to the public online [(AQB VI), see References]. In addition, the $PM_{2.5}$ concentration data is used to develop air quality forecasts during summer wildfires and wintertime stagnation events.
- Compliance monitors: The gaseous and PM monitors support compliance with the National Ambient Air Quality Standards/Montana Ambient Air Quality Standards (NAAQS/MAAQS) [(AQB III), see References] and aid in developing emissions strategies. These regulatory monitors measure the effects on air quality from source emissions, track trends over time, and produce data with which to compare area air pollution levels against the NAAQS.[2] Note the NAAQS compliance monitors may be required by the State Implementation Plan (SIP) to be operated in nonattainment, maintenance, and limited maintenance areas [(AQB II), see References].
- Air pollution research monitors: These regulatory and non-regulatory monitors support the monitoring program's research efforts. Investigations provide ambient air monitoring data to support national, regional, and local air quality evaluations; network reviews; and other monitoring program activities. The monitors include:

    - Special study: Monitors collecting information on gaseous saturation and PM concentration, as well as other investigations to determine the extent of a pollutant of concern.
    - Comparison: Monitors located adjacent to other instruments measuring the same pollutant to compare different sampling/monitoring methodologies.
    - Background: Monitors typically located in rural areas in anticipation of additional oil and gas resource development and as part of the National Core monitoring network.
    - Conditional: Criteria pollutant monitors established at the request of data users during high concentration ambient air pollution events and operated according to the DEQ Air Quality Bureau's (AQB) Conditional Air Quality Monitoring Guidance [(AQB VII), see References].

Depending on the research monitoring effort, the monitoring program may use the information obtained for internal purposes only, and the data collected will not be submitted to EPA's Air Quality System (AQS) [(OAQPS II), see References]. Data users may request data for the results of the air pollution investigations.

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[1] - 40 CFR Part 58, Appendix D– Network Design Criteria for Ambient Air Quality Monitoring.
[2] - National Ambient Air Quality Standards (NAAQS).

During an emergency, the existing monitoring network and/or additional monitors will be used as necessary to provide the public with air pollution monitoring data, as outlined in the Montana Code Annotated.[3]

Montana has other monitoring networks. The Montana industrial ambient air monitoring network includes pre-construction and permit-mandated operated sites, with background and compliance monitoring conducted currently, or in the past, for $PM_{2.5}$, PM_{10}, SO_2, O_3, NO_2, and H_2S. AQB's permitting program administers the industrial monitoring efforts and network conformance to 40 CFR Part 58 network design. The monitoring program oversees the industrial monitoring network and evaluates quality assurance plans for industrial air monitoring.

Montana's monitoring program and this QAPP have no role in, nor oversight of, the following monitoring networks:

- Ten federal Class 1 area background monitors, which provide $PM_{2.5}$ chemical species data as part of the Interagency Monitoring of Protected Environments Network [(IMPROVE), see References]. Some are located on tribal lands.
- A single air quality trends and atmospheric deposition monitor, which provides background air pollution data as part of the Clean Air Status and Trends Network [(CASTNET), see References]).
- A single radiation monitor, which provides near real-time gamma-count rate data as part of the EPA nationwide radiation monitoring system, [(RadNet), see References].
- Two tribal lands monitors, which collect PM and gaseous pollutant data.

When designing a sampling network and selecting monitoring sites, we must comply with federal requirements. The following sections discuss the requirements for designing a monitoring network as they pertain to the state of Montana ambient air monitoring network. However, because of the complexities of design, the information is by no means complete. Designing the network and establishing stations and monitors involves a comprehensive review of network design and siting regulations.

Additional references are included throughout the section for readers who require a more in-depth understanding of network design. A thorough review of the annual Montana Air Quality Monitoring Network Plan (Monitoring Network Plan) [(AQB III),see References] is *essential* for understanding the development, design, and implementation of Montana's ambient air monitoring network and the network's conformance to 40 CFR Part 58 monitoring requirements. Finally, the Monitoring Network Plan includes a listing of the current existing sites and monitors in operation by the monitoring program.

9.1 The Life Cycle of an Ambient Air Monitoring Station

Implementing and maintaining an ambient air pollutant monitoring station based on the network design requirements is a complex process. "Station" refers to a monitor or group of monitors that have a

[3] - Montana Code Annotated (MCA), Title 75, Chapter 2, Part 4, Subpart 402 – Emergency Procedure.

shared objective located at a particular site (40 CFR Part 58.1). The life cycle of an ambient air monitoring station encompasses several phases. A description of each phase is included in the sections that follow.

9.1.1 Determining Pollutant Monitoring Objectives

The first step in developing an ambient air pollutant monitoring station is deciding on the pollutant to be measured and the reason for establishing the monitor. The reason for establishing the monitor falls under one of three 40 CFR Part 58, Appendix D monitoring objectives:

1. Provide air pollution data to the general public in a timely manner.
2. Determine compliance with and/or progress made toward meeting the NAAQS/MAAQS, evaluate regional air quality models, track trends in air pollution abatement control measures, and develop an emission-control strategy.
3. Support air pollution research studies.

9.1.2 Defining Site Type

Once the design element of the monitoring objective network is decided, site types are designated. "Site" refers to geographic location; one or more stations may be at the same site (40 CFR, Part 58.1). "Site type" designations refer to why the site was established to meet the desired monitoring objective. There are six general site types:

1. Sites that determine the highest concentration of pollutants expected to occur in an area covered by the network.
2. Sites that measure typical concentrations in areas of high population density.
3. Sites that determine the effect of significant sources on ambient pollution levels or source categories on air quality.
4. Sites that determine general background concentration levels.
5. Sites that determine the extent of regional transport among populated areas and in support of secondary standards.
6. Sites that measure air pollution effects on visibility, vegetation damage, or other welfare-based effects.

A monitor operating in the network may have multiple site types. For example, a monitor established to meet the NAAQS compliance monitoring objective may be located to determine both the highest concentration and typical concentration in an area of high population density. Refer to the annual Monitoring Network Plan for the monitoring program's site-type designations in use.

NOTE: "Site type" as referenced in 40 CFR Part 58 is referred to as "monitor objective type" in the EPA Air Quality System (AQS) [(OAQPS II), see References]. To avoid confusion, this QAPP also uses "site type" per 40 CFR Part 58, Appendix D.

9.1.3 Monitoring Requirements and Number of Sites

Ambient air monitoring stations intended to demonstrate compliance with NAAQS must meet certain minimum requirements in 40 CFR Part 58, Appendix D. The minimum number of sites to establish for specific pollutants within required NAAQS compliance monitoring areas are based on the following:

- populations in core-based statistical areas and metropolitan statistical areas,
- source and non-source pollutant emissions,
- calculations of population-weighted pollutant emissions, and
- measured pollutant concentrations compared with the applicable NAAQS.

Core-based statistical areas (CBSAs) are "defined by the U.S. Office of Management and Budget as statistical geographic entities consisting of the county or counties associated with at least one urbanized area or urban cluster of at least 10,000 people, plus adjacent counties having a high degree of social and economic integration."[4] Additionally, CBSAs are further divided as metropolitan statistical areas and micropolitan statistical areas. Metropolitan statistical areas (MSAs) have populations greater than 50,000, while micropolitan statistical areas have populations between 10,000 and 50,000. However, for areas that experience persistent air quality issues, EPA recognizes that typical CBSA boundaries may not apply. In these instances, different defined limits and areas based on additional political boundaries or geographic characteristics are applied.

Table 2 summarizes Montana's three MSAs and five micropolitan statistical areas. In Montana, the metropolitan and micropolitan statistical areas use the city name and the sum of the county component populations. For example, the Helena, Montana, micropolitan statistical area (population 78,603) comprises Jefferson County and Lewis and Clark County.

[4] - 40 CFR, Part 58.1 - Definitions.

Table 2. Montana Metropolitan and Micropolitan Statistical Areas (U.S. Census[1])

CBSA	CBSA Population	City Population[2]	County Components	County Population[3]	Central or Outlying County
Metropolitan[4]					
1. Billings	169,728	110,323	Carbon	10,460	Outlying
			Golden Valley	831	Outlying
			Yellowstone	158,437	Central
2. Great Falls	81,755	59,178	Cascade	81,755	Central
3. Missoula	116,130	72,364	Missoula	116,130	Central
Micropolitan[5]					
1. Bozeman	104,502	45,250	Gallatin	104,502	Central
2. Butte-Silver Bow	34,553	33,989	Silver Bow	34,553	Central
3. Helena	79,135	31,169	Jefferson	11,853	Outlying
			Lewis and Clark	67,282	Central
4. Kalispell	98,082	22,716	Flathead	98,082	Central

[1] - U.S. Census Bureau, American Fact Finder website. July 01, 2016 U.S. Census Population Estimate. Accessed August 31, 2017. <http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml>

[2] - U.S. Census Bureau, Guided Search - Step-by-step access to Census Information (Montana, All estimates of places within Montana): "Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2016." Accessed August 31, 2017. <https://factfinder.census.gov/faces/nav/jsf/pages/guided_search.xhtml>

[3] – U.S. Census Bureau, Guided Search - Step-by-step access to Census Information (Montana, County): "Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2016." Accessed August 31, 2017 .<https://factfinder.census.gov/faces/nav/jsf/pages/guided_search.xhtml>

[4] – U.S. Census Bureau, Our Surveys and Programs, Metropolitan and Micropolitan webpage: "Cumulative Estimates of Resident Population Change and Rankings: April 1, 2010 to July 1, 2016 -United States -- Metropolitan Statistical Area; and for Puerto Rico." Accessed August 31, 2017. <https://www.census.gov/programs-surveys/metro-micro.html>

[5] – U.S. Census Bureau, Our Surveys and Programs, Metropolitan and Micropolitan webpage: "Cumulative Estimates of Resident Population Change and Rankings: April 1, 2010 to July 1, 2016 - United States -- Micropolitan Statistical Area; and for Puerto Rico" Accessed August 31, 2017. <https://www.census.gov/programs-surveys/metro-micro.html>

In addition, the monitoring network requirements are subject to additional monitoring requests made at the discretion of the EPA Regional Administrator. Such required monitoring may include (1) monitors where the minimum monitoring requirements are insufficient to meet the monitoring objectives, (2) monitors where the likelihood of air quality violations is significant, and (3) SO_2 and NO_2 monitors located to protect sensitive and vulnerable populations. The EPA Regional Administrator must approve modifications and deviations from required monitoring. The monitoring program's waiver requests for required monitoring are included in the annual Monitoring Network Plan and periodic monitoring network assessment.

The total number of sites needed to serve the requests of various data users are typically higher than the prescribed minimum requirements. With that in mind, the optimum network size is a balance between the data needs and available resources. For current pollutant-specific monitoring requirements, which are complex and changing, refer to the most recent 40 CFR Part 58, Appendix D and the annual Monitoring Network Plan.

9.1.4 Defining Spatial Scales

Data collected at the monitoring station must represent the spatial area under study. The spatial scale of representativeness clarifies the link between general monitoring objectives, site types, and the physical location of a monitor. The goal in siting a monitor is to match the spatial scale represented by the samples obtained with the spatial scale most appropriate for the monitoring site type, air pollutant to be measured, and the monitoring objective. Spatial scales include:

- Microscale: Defines the concentrations in air volume associated with area dimensions from several meters up to about 100 meters in radius (up to about 328 feet or 0.06 mile).
- Middle scale: Defines the concentration typical of areas up to several city blocks in size, with dimensions ranging from about 100 meters to 0.5 kilometer in radius (328 to about 1,400 feet or 0.31 mile).
- Neighborhood scale: Defines concentrations within some extended area of the city that has relatively uniform land use, with dimensions in the 0.5- to 4.0-kilometer radius range (about 0.31 mile to 2.5 miles).
- Urban scale: Defines the overall citywide conditions, with dimensions in the 4- to 50-kilometer radius range (2.5 to 31 miles). This scale would usually require more than one site for definition.
- Regional scale: Defines a rural area of reasonable homogeneous geography, extending from tens to hundreds of kilometers (10 km = 6 miles, 100 km = 62 miles).
- National and global scales: Represent concentrations characterizing the nation and the globe as a whole.

In Montana, the ambient air monitoring station scales of representativeness include microscale, neighborhood scale, and regional scale. Most of the ambient air pollutant monitoring stations are sited at the neighborhood scale. In Montana's cities and towns, the neighborhood scale allows the monitoring program to locate a site where people live and work for extended periods. For stations located outside of Montana's cities and towns, the neighborhood scale allows for background site types in a rural environment. Refer to the annual Monitoring Network Plan for the spatial scales represented at the monitors in Montana.

9.1.5 Solving Proper Siting

According to 40 CFR Part 58, Appendix D, "proper siting of a monitor requires specification of the monitoring objective, the types of sites necessary to meet the monitoring objective, and then the desired spatial scale of representativeness." Identifying both the site type(s) and spatial scale helps data users to interpret the monitoring data for a particular objective. As **Table 3** illustrates, some spatial scales are better matched for the established site type. For additional general and pollutant-specific guidance and monitoring requirements related to site types and spatial scales, refer to 40 CFR Part 58, Appendix D.

Table 3. Relationship Between Site Types and Spatial Scales of Representativeness[1]

Site Type	Appropriate Spatial Scale
Highest concentration	Micro, middle, neighborhood, (sometimes urban or regional for secondary formed pollutants)
Population oriented	Neighborhood, urban
Source oriented	Micro, middle, neighborhood,
General background and transport	Urban, regional
Welfare-related impacts	Urban, regional

[1] From Table D–1 of Appendix D to 40 CFR Part 58

9.1.6 Establishing Meteorological Measurements

To support modeling and forecasting efforts, meteorological sensors are frequently collocated with the pollutant monitors at air monitoring stations. Typical meteorological measurements include wind speed, wind direction, and ambient temperature. At the NCore station we monitor for the typical meteorological measurements along with relative humidity. Additionally, the currently used meteorological sensors may be traditional sensors that meet the siting and equipment requirements of QA Handbook, Vol. IV [(OAQPS IV), see References] or non-traditional sensors. Currently used non-traditional meteorological sensors meet industry-accepted, tested methodology.

9.1.7 Resolving Physical Location

Once the site type(s) and spatial scale determinations are final, the next step is finding a suitable physical location. The *general* physical location selected is the geographic area represented by the intersection of the site type and desired spatial scale. In order to select the general physical location you must know the following:

- location of sources of emissions,
- geographical variability of ambient pollutant concentrations,
- meteorological conditions, and
- population density.

The most important and difficult factors to determine are the temporal and spatial variability of ambient pollutant concentrations in conjunction with the meteorological conditions present at a prospective location. The distribution of wind speed frequency and wind direction “wind roses” can provide seasonal and annual summaries of meteorological data to help select a station. For a wind rose tutorial, visit the Gallatin National Forest Avalanche Center website [(GNFAC), see References].

You can also conduct gaseous saturation and special PM studies to help select a site. Given so many factors, site selection is based upon the best available evidence and experience of the monitoring program.

Determining the *specific* physical location is discussed in **Section 9.1.9 – Defining Monitor Inlet and Probe Siting**. For additional siting considerations and discussions, refer to the monitoring network design section of QA Handbook, Vol. II [(OAQPS III), see References].

9.1.8 Determining the Monitoring Method

Monitoring methods used at a monitoring station depend on the objective and intended use of collected data. Federal reference method/federal equivalent method (FRM/FEM) monitors are required for any ambient air monitoring measurements used to compare with the applicable NAAQS, as described in CFR.[5] During research monitoring (such as conditional "smoke" monitoring), the monitoring program may use a non-FRM/FEM monitor to collect ambient air data. In these instances industry-accepted, tested methodology is used.

Reference and equivalent monitoring methods include manual samplers and automated analyzers. Reference methods are *specified* in an Appendix to 40 CFR Part 50[6] and *designated* as a reference method per 40 CFR Part 53.[7] Equivalent methods are *designated* as such per the performance testing procedures in 40 CFR Part 53. Approved FRM/FEM methods refer to individual monitoring instruments that either provide a pollutant concentration or provide a sample for further laboratory analysis and must be operated minimally as required. Reference methods in 40 CFR Part 50 include:

- PM and Pb: Distinctive manual methods that are fully specified, including the applicability, principle, range, sampling specifications, and analysis required.
- Gaseous criteria pollutants: Measurement principles, sources of interferences, calibration procedures, and calibration frequencies.

An invaluable reference is the list of current designated FRM/FEM, downloadable from the Technical Air Pollution Resources - Ambient Monitoring Technology Information Center (AMTIC), Air Monitoring Methods - Criteria Pollutants website [(OAQPS V), see References]. Although the list is established for the criteria pollutant monitoring methods, it also includes $PM_{10-2.5}$ samplers and analyzers. Furthermore, the List of Designated Reference and Equivalent Methods is updated each time a new reference or equivalent method is designated or modified. For additional information, refer to **Section 18.5.4 - AQS Parameter and Method Codes**.

9.1.9 Defining Monitor Inlet and Probe Siting

After the general physical location is determined and the monitoring method is identified, the next step is to find a suitable *specific* site location with an appropriate monitor inlet and probe siting. Probes and

[5] - 40 CFR Part 58, Appendix C – Ambient Air Quality Methodology.
[6] - 40 CFR Part 50 – National Primary and Secondary Ambient Air Quality Standards .
[7] - 40 CFR Part 53 – Ambient Air Monitoring Reference and Equivalent Methods.

manifolds must be positioned to avoid introducing bias to the sample. Important considerations are (1) probe height above ground, (2) probe length, and (3) physical influences near the probe. Per CFR,[8] requirements include:

- horizontal and vertical placement,
- spacing from minor sources,
- spacing from obstructions,
- spacing from roadways, and
- spacing for pollutant-specific probes and inlets.

Table 4 summarizes EPA's criteria for specific monitor inlet and probe siting. Regulatory monitors must meet the required elements of 40 CFR Part 58, Appendix E, or be granted an EPA monitor inlet and probe siting waiver. The EPA considers written requests to waive one or more siting criteria for some monitoring sites, provided the monitoring program adequately demonstrates the need (purpose) for monitoring or establishing a monitoring site at that location. Monitor inlet and probe siting waiver requests are included in the annual Monitoring Network Plan.

[8] - 40 CFR Part 58, Appendix E – Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring.

Table 4. Summary of Monitor Inlet and Probe Siting Criteria[1]

Pollutant	Height from ground to probe or inlet	Horizontal and vertical distance from supporting structures[2] to probe or inlet (meters)	Distance from trees to probe or inlet (meters)	Distance from roadways to probe or inlet (meters)
SO_2 [3,4,5,6]	2-15	> 1	> 10	N/A
CO [4,5,7]	2-15	> 1	> 10	2-10 for downtown areas or street canyons microscale; see 40 CFR PART 58, Appendix E, Table E-2 for middle and neighborhood scales.
O_3 [3,4,5]	2-15	> 1	> 10	See 40 CFR Part 58, Appendix E, Table E-1 for all scales
NO_2 [3,4,5]	2-7 (micro non-near-road); 2-15	> 1	> 10	See 40 CFR Part 58, Appendix E, Table E-1 for all scales
PM, Pb [3,4,5,8]	2-7 (micro); 2-7 (middle $PM_{10-2.5}$); 2-15 (all other scales).	> 2	> 10 (all scales)	2-10 (micro); see 40 CFR Part 58, Appendix E, Figure E-1 for all other scales.

N/A—Not applicable.

[1] From 40 CFR Part 58, Appendix E, Table E-4 – Summary of Probe and Monitoring Path Siting Criteria. Note: Removed non applicable open path analyzer and near-road NO_2 and $PM_{2.5}$ monitoring requirements from Table E-4.

[2] When the probe is located on a rooftop, this separation distance is from walls, parapets, or penthouses located on roof.

[3] Should be > 20 meters from the drip-line of tree(s) and must be 10 meters from the drip-line when the tree(s) form an obstruction.

[4] Distance from sampler, probe, or 90% of monitoring path to obstacle, such as a building, must be at least twice the height the obstacle protrudes above the sampler, probe, or monitoring path. Sites not meeting this criterion may be classified as middle scale (see text).

[5] Must have unrestricted airflow 270 degrees around the probe or sampler; 180 degrees if the probe is on the side of a building or a wall.

[6] The probe, sampler, or monitoring path should be away from minor sources, such as furnace or incineration flues. The separation distance depends on the height of the minor source's emission point (such as a flue), the type of fuel or waste burned, and the quality of the fuel (sulfur, ash, or lead content). This criterion is designed to avoid undue influences from minor sources.

[7] For microscale CO monitoring sites in downtown areas or street canyons (not at near-road NO_2 monitoring sites), the probe must be > 10 meters from a street intersection and preferably at a midblock location.

[8] To preclude airflow interference, collocated monitors must be within 4 meters of each other and at least 2 meters apart for flow rates greater than 200 liters/min or at least 1 meter apart for samplers with flow rates less than 200 liters/min.

9.1.10 Establishing the Monitoring Station

Once the specific site location is decided, the next step is to establish the monitoring station. The monitoring station must be safely accessible year-round. Factors to consider when establishing an air monitoring station include (1) site accessibility, (2) site security, and (3) the availability of utilities. For more information on establishing a monitoring station, refer to the monitoring network design section of QA Handbook, Vol. II and the QA Handbook, Vol. IV .

9.1.11 Determining Monitor Type Designations

When an air monitoring station is established, the monitor employed is typically designated according to its intended use. "Monitor" refers to an "instrument, sampler, analyzer, or other device that measures or assists in measuring atmospheric air pollutants, which is acceptable for use in ambient air surveillance under the applicable provisions of 40 CFR Part 58, Appendix C" (40 CFR Part 58.1). The monitoring program incorporates the following AQS/CFR[9] monitor type designations in the network:

- State or Local Air Monitoring Stations (SLAMS): Comprise the ambient air quality monitoring sites that are primarily needed for NAAQS comparisons; they may also serve other purposes. All SLAMs monitors are designated as regulatory (NAAQS-compliance) monitors. EPA approval is required to establish, modify, or terminate SLAMS monitors.
- Special Purpose Monitor (SPMs): Monitors designated for a special purpose in the annual network plan and in AQS; may be regulatory (NAAQS-compliance) or non-regulatory monitors. These monitors are not established to monitor long-term trends; instead, they are intended to be moved to accommodate changing needs and priorities. The monitoring program does not count SPMs when showing compliance with the minimum monitoring requirements for the number and location of monitors of various types. Prior EPA approval is not required to establish, modify, or terminate an SPM.

Table 5 summarizes design requirements and options for SLAMS and SPM CFR networks. Not all monitors deployed by the monitoring program allow a monitor-type designation because of the nature of monitoring data collection activity. These monitors may include, but are not limited to, special study, comparison, and conditional monitors used during research investigations. Additional monitor-type designations not currently used in the Montana monitoring network include (1) tribal, (2) industrial, and (3) other federal monitors.

9.1.12 Assigning Monitor Network Affiliation

The AQS monitor network affiliation is the network or program the monitor is associated with. Note that monitor network affiliation designations may have more than one value at the time or no value. For example, SLAMS criteria monitors often have no network affiliation. The monitoring program incorporates the following monitor network affiliation designations in the network:

[9] - 40 CFR Part 58, Appendix A – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards, Section 1 – General Information.

- National Core Multi-pollutant Monitoring Stations (NCore): Monitors that are part of the national strategy to integrate multiple monitoring networks and measurements. NCore stations are a subset of the SLAMs network. Most NCore stations are designated at the neighborhood and urban scale; however, the Montana NCore station is designated as a rural background site type and provides concentration measurements at the regional scale. The federal reference method (FRM) and federal equivalent method (FEM) monitors in use at the station are designated as regulatory monitors, and the data collected are eligible for comparison with the applicable NAAQS.
- Chemical Speciation Network (CSN): Designed to provide a basic, long-term record of the characterization of the metals, ions, and carbon constituents of $PM_{2.5}$. CSN stations are a subset of the SLAMS network and consist of 40 CFR Part 58, Appendix D required Speciation Trends Network (STN) samplers and supplemental speciation stations that are not part of the STN. CSN stations are non-regulatory monitors and are normally operated by state and local air pollution agencies. An overview of all samplers operating within the nationwide STN is available through the EPA Technical Air Pollution Resources - AMTIC, Chemical Speciation Network website [(OAQPS VI), see References]. The monitoring program's implementation methods for $PM_{2.5}$ CSN samplers and related QA activities are detailed in Volume II: $PM_{2.5}$ Chemical Speciation Sampling at Trends, NCore, Supplemental and Tribal Sites of the Montana Ambient Air Monitoring Quality Assurance Project Plan. The $PM_{2.5}$ speciation data are located in the AQS database.

Additional monitor network affiliation designations not currently used in the Montana monitoring network include (1) photochemical assessment monitoring stations (PAMS), (2) national air toxics trends stations (NATTS), (4) IMPROVE, (5) CASTNET, and (6) Radnet monitoring networks.

Table 5. SLAMS and SPM CFR Network Design Requirements Summary.

Item	SLAMS[1]	SPM[2,3,4]	CFR Reference
Network Design	Must follow	Optional[5]	Network Design Criteria for Ambient Air Quality Monitoring (40 CFR Part 58, Appendix D)
Sampler/ Instrument Method	Must use FRM/FEM	FRM/FEM Optional[1,6]	Ambient Air Quality Methodology (40 CFR Part 58, Appendix C)
Monitor Inlet and Probe Siting	Must follow	Optional[1]	Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring (40 CFR Part 58, Appendix E)[7]
QA Activities	Must follow	If uses FRM/FEM and meets the monitor inlet and probe siting requirements of 40 CFR Part 58, Appendix E, shall follow the QA criteria in 40 CFR Part 58, Appendix A, unless the administrator approves an alternative to the requirements of Appendix A with respect to such SPM sites because meeting those requirements would be physically and/or financially impractical due to the physical conditions at the at the monitoring site and the requirements are not essential to achieving the intended DQO.[1,8]	Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards (40 CFR Part 58, Appendix A)[7]

[1] - 40 CFR Part 58.11, Network technical requirements.
[2] - 40 CFR Part 58, Subpart C, Special Purpose Monitors.
[3] - Each SPM monitor is identified in the periodic network assessment and annual network plan, with a statement of purpose and evidence that Appendix A requirements were met or with an approved alternative, per 40 CFR Part 58.11 (a)(2) [40 CFR Part 58.20(a)].
[4] – SPM ambient air data collected may be used for SIP or NAAQS compliance determinations depending on the duration of operation (i.e., greater than 24 months) subject to the conditions of the $PM_{2.5}$ FEM sampler comparability evaluations of 40 CFR 58.11(e) and $PM_{2.5}$ data determinations of 40 CFR 58.30 unless 40 CFR Part 58, Appendix A, Appendix C, or Appendix E were not met in practice [40 CFR Part 58.20 (c)].
[5] - 40 CFR Part 58, Appendix D, network design criteria applicable to SLAMS only [40 CFR Part 58.11(c)].
[6] - If SPM ambient air data is collected using an FRM or FEM, the monitor must meet (1) Network technical requirements (40 CFR Part 58.11), (2) Operating schedule (40 CFR Part 58.12) and, (3) Quality Assurance Requirements for SLAMS, SPMS, and PSD Air Monitoring (40 CFR Part 58, Appendix A) or an approved alternative as provided by 40 CFR Part 58.11(a)(2) [40 CFR Part 58.20(b)].
[7] - Per 40 CFR Part 58.20(b), the monitoring program indicates whether each monitor reporting to AQS meets the requirements of 40 CFR Part 58, Appendices A and E by the use of the NAAQS exclusion (regulatory or non-regulatory) monitor designation in AQS.
[8] - If SPM ambient air data collection is conducted using an FRM or FEM, and the monitoring program QA activities meet the requirements of 40 CFR Part 58, Appendix A: (1) the data is reported to AQS (data collected from other monitoring program SPMs may be submitted to AQS) [40 CFR Part 58.20 (b)]; (2) the data is certified during the annual air monitoring data certification [40 CFR Part 58.15].

9.1.13 Explaining Regulatory and Non-Regulatory Monitors

For monitors reporting to AQS, the next step after determining the monitor type is deciding regulatory or non-regulatory monitor status. If it is a non-regulatory monitor, it is designated as "NAAQS exclusion" in AQS. Some monitor types must be designated as regulatory, such as SLAMS, while other monitor types may be regulatory or non-regulatory, such as SPMs. For SPMs obtaining criteria pollutant air measurements the -regulatory/non-regulatory monitor type designation is based on (1) the monitor method in use (FRM/FEM or non-FRM/FEM monitor), (2) the monitor inlet and probe siting, and (3) the implemented QA activities. In order for ambient air pollutant concentration data to be considered regulatory (NAAQS-compliance) quality must:

- Use an FRM/FEM instrument per 40 CFR Part 58, Appendix C.
- Meet monitor inlet and probe siting criteria requirements or a waiver per 40 CFR Part 58, Appendix E.
- Meet QA requirements per 40 CFR Part 58, Appendix A.

The NAAQS exclusion designation process consists of the monitoring program first identifying the monitor in AQS as "NAAQS exclusion," and second, EPA providing "Yes/No" concurrence. Refer to the annual Monitoring Network Plan for the monitor designations.

9.1.14 Completing the Network Modification Documentation

The final planning stage in establishing an air monitoring station is completing the network documentation based on the intended use of the data. For SLAMS and SPM monitors, EPA network documentation is required. However, not all monitors deployed by the monitoring program require EPA notification. These monitors include, but are not limited to, special study, comparison, and conditional monitors used during monitoring program research investigations. Also, any meteorological parameters monitored at a site, except the NCore multipollutant monitoring site, do not require EPA notification.

The EPA network documentation notifies data users of the reasons for establishing the site or monitor and includes the geographic coordinates, site type, and monitor type(s). Planned changes to remove, move, or establish monitors are detailed in the annual Monitoring Network Plan. Including the monitor in the annual network plan notifies EPA and allows them to comment on the change.

If establishment of SLAMs and SPM monitors occurs outside of planned changes, EPA Region 8 requires a written request for network modification. The Research and Monitoring Services (RMS) Section Supervisor and respective monitoring coordinators must complete the requests, which are archived in the monitoring program Site Correspondence folder, per the Records Management Plan (SOP-309).

You must complete additional AQS site and monitor forms when reporting collected ambient air data to AQS. RMS Section monitoring coordinators complete the forms and the TSS Program Database Analyst uses them to establish or terminate a site or monitor in AQS. Additionally, when a monitor status is modified, you must complete an AQS monitor amendment form. AQS site and monitor forms are located in the Air Quality Monitoring and Data Management Section Site and Monitor Form Instruction

Manual [(AQB VIII), see References]. The manual identifies every data field, except monitor NAAQS exclusions, for creating a new site or monitor in AQS.

9.1.15 Conducting Site Evaluations

Site evaluations ensure that the monitoring station maintains correct siting requirements. The following checklist is a guide for evaluating sites during performance evaluations (field audits). The performance evaluation process is discussed in greater detail in **Section 19.2.1 - Performance Evaluations (Field Audits)**. In the audit report, note any deviations from required siting and design requirements as well as any observed safety issues. Note the following during station audits:

- Verifying that obstructions (tree growth, new buildings, etc.) do not now compromise the original siting.
- Verifying that the current location agrees with the original coordinates.
- Confirming that the manifold and probe inlet are clean.
- Inspecting the site for weathered electrical cords and sample lines.
- Verifying that the sample exhausts are unlikely to be re-entrained by the sample inlet.

9.1.16 Completing Network Reviews

The monitoring program conducts annual network reviews of the ambient air monitoring stations to verify conformance with applicable 40 CFR Part 58 monitoring requirements and monitoring program objectives. The network review process determines the continued relevancy of the existing air monitor stations and identifies the need for any additional stations. The network review process includes examination of the:

- conformance to network design requirements,
- number of monitors,
- location of monitors, and
- conformance to monitor inlet and probe siting requirements.

Once the network review is completed, document all planned modifications to the air monitoring network in the annual Monitoring Network Plan. For more information on annual network plan requirements, refer to **Section 9.7 – Adaptive Network, Looking Forward**.

9.1.17 Continuing/Discontinuing Monitor Station Operation

Decisions to continue or discontinue an air monitoring station are based on the outcomes of the network reviews. Modifications to SLAMS sites require EPA approval.

9.2 Classification of Monitor Measurements as Critical/Non-Critical

The monitoring program considers "critical" all of the gaseous and PM pollutant ambient measurements, independent of the monitor regulatory status (regulatory or non-regulatory) and designation (SLAMS, SPM, research). Further, these measurements are designed to meet as many of the federal network design, monitor inlet and probe, and QA requirements as possible.

Most of the meteorological measurements obtained from the sensors located at the monitoring stations do not meet EPA siting and equipment requirements; therefore, the data are considered "non-critical" or for informational purposes only. Most of the data is not uploaded to AQS. Additionally, the recorded internal shelter temperatures are used during QA review but are considered for informational purposes only and are not uploaded to AQS.

9.3 Collocated Monitoring

Collocated monitors provide estimates of measurement system precision. A percentage of PM_{10}, $PM_{2.5}$, and Pb samplers operating in the network are required to be collocated with other monitors. For example, $PM_{2.5}$ continuous and manual collocated monitoring requirements include 15% of each FRM/FEM collocated (if fewer than three monitors have at least one collocated monitor). For FRM monitors, the monitor is collocated with the same FRM monitor. For FEM monitors, the first one is collocated with an FRM monitor, and subsequent collocated monitors alternate between FEM and FRM monitors. If there are an odd number of collocated monitors, the additional monitor is an FRM.

The collocated monitor coverage and state or federal responsibility depends on the pollutant and monitoring method. **Appendix 5** includes a Measurement Quality Sample Summary Table with specific collocated requirements.

9.4 The Operating Schedule

The monitoring program collects ambient air pollutant measurements on the operating schedules identified in **Table 6**. Continuous instruments are operated year-round to obtain hourly averages, except during periods of maintenance and instrument calibration. Manual methods operate on the nationally established annual monitoring schedule at 1-in-3-, 1-in-6-, or 1-in-12-day sampling frequencies. For the current annual national monitoring schedule, visit the EPA AMTIC website [(OAQPS VII), see References].

The EPA Regional Administrator can exempt automated and manual methods from operation during certain periods or seasons. In the past, the monitoring program has requested seasonal monitoring exemptions for CO monitors and manual PM_{10} samplers. However, at this time, there are no manual PM_{10} samplers in use. Should any exemption requests for operating schedules be made in the future, they will be included in the annual Monitoring Network Plan.

Table 6. Automated and Manual Method Operating Schedules

Automated Methods	Sample Frequency			Manual Methods	Design Value / Ratio to Standard	Sample Frequency[2]			
	5-Min Block[1] Average	Hourly Average	Seasonal (April Sept)			Daily	1-in-3	1-in-6	1-in-12
CO		✓		$PM_{2.5}$			✓[3]		
NO_2		✓		$PM_{2.5}$	± 5%[4]	✓[5,7,8]			
NO/NOy		✓		$PM_{2.5}$	± 10%[4]		✓[6,7,8]		
SO_2	✓	✓		$PM_{2.5}$ –Col					✓[9]
O_3		✓	✓[10]	PM_{10}	0.9-1.2[11]	✓[12]			
$PM_{2.5}$		✓		PM_{10}	0.80-1.4[11]		✓[12]		
PM_{10}		✓		PM_{10}	0.70-1.45[11]			✓	
$PM_{10-2.5}$		✓		PM_{10} –Col					✓[9]
				$PM_{10-2.5}$ – NCore			✓		
				Pb-TSP[13]/Pb-PM_{10}[14]				✓	

[1] - Maximum 5-minute block of the twelve 5-minute-block averages in each hour.
[2] - To provide nationwide comparability, PM filters are collected from midnight to midnight Mountain **Standard** Time (MST) throughout the year on the national monitoring schedule.
[3] - Manual $PM_{2.5}$ samplers at required SLAMS stations without a collocated continuously operating $PM_{2.5}$ monitor must operate on at least a 1-in-3 day schedule unless a waiver for an alternative schedule has been approved. (See 40 CFR Part 58.12 (d)(1)(i) and (ii)).)
[4] – D*esign value* is the site-level metric (*i.e.*, statistic) that is compared to the NAAQS (24-hour and/or annual) level to determine compliance. (See 40 CFR Part 50).
[5] – Required SLAMS stations whose measurements determine the 24-hour design value for their area and whose data are within ±5 percent of the level of the 24-hour PM2.5 NAAQS must have an FRM or FEM operate on a daily schedule if that area's design value for the annual NAAQS is less than the level of the annual PM2.5 standard. (See 40 CFR Part 58.12 (d)(1)(iii)).
[6] – Required SLAMS stations whose measurements determine the design value for their area and that are within ±10 percent of the annual NAAQS, and all required sites where one or more 24-hour values have exceeded the 24-hour NAAQS each year for a consecutive period of at least 3 years are required to maintain at least a 1-in-3 day sampling frequency. (See 40 CFR Part 58.12 (d)(1)(ii)).
[7] – The 1-in-3 day or daily schedule must be maintained until the referenced design value no longer meets these criteria for 3 consecutive years.
[8] – A continuously operating FEM PM monitor satisfies this requirement unless it is identified in the monitoring agency's annual monitoring network plan as not appropriate for comparison to the NAAQS and the EPA Regional Administrator has approved that the data from that monitor may be excluded from comparison to the NAAQS. For more information refer to 40 CFR Part 58.11(e); EPA's April 20, 2013 memorandum, "Update on Use of PM2.5 Continuous FEMS"; and Monitoring Network Plan.
[9] - 1-in-12 is the minimum PM collocated scheduled sampling frequency. PM collocated sampling frequencies are adjusted to ensure the number of valid samples is ≥ 30 each year.
[10] - The required O_3 monitoring season for NCore stations is January through December.
[11] – Ratio to Standard is the calculated concentration to compare to the applicable NAAQS. (See 40 CFR Part 50).
[12] –A continuously operating FEM PM_{10} monitor satisfies this requirement.
[13] – Lead total suspended particulate (Pb-TSP) sampler.
[14] – Lead PM_{10} (Pb-PM_{10}) sampler.

Completing Replacement Sampling Days for Scheduled PM Sampling
The RMS Section PM and NCore monitoring coordinators identify and track "replacement sampling days" that substitute for the scheduled manual PM monitoring days. A number of considerations arise when using replacement sampling days as substitutes for the scheduled sampling days. Perhaps the most important consideration is that the replacement day must be completed within 1 week of the scheduled day.

EPA Region 8 requests notification when replacement days are used and that the "scheduled but not collected" days are reported with an appropriate null code. Within the monitoring program, the RMS Section monitoring coordinators track replacement days in use at the SLAMS sites. The RMS Section Supervisor or QA Manager is responsible for notifying EPA when replacement days are in use at SLAMS.

9.5 Data Completeness

Data required for comparing with the NAAQS have specific completeness requirements. These requirements generally start from completeness at hourly and daily (24-hour) concentration values. For automated (continuous) measurements, 75% of the hour is needed to consider the hour valid (i.e., 45, 1-minute values are considered a valid hour average). Daily average estimates for the manual PM and Pb sampling methods are based on a 24-hour sampling period. **Table 7** provides the completeness goals for the criteria and non-criteria pollutants.

The blue highlighted cells in **Table 7** refer to the standards that apply to the specific pollutant. Completeness goals that are not highlighted play an important role in achieving the CFR completeness goals. For example, even though there is only an 8-hour ozone standard, it's important to have complete 1-hour values to compare with the 8-hour standard.

Table 7. Completeness Goals for Ambient Air Monitoring Data

	Completeness Goals and Associated NAAQS (Highlighted)								
Pollutant	5 min Block Average	1-Hour Average	3-Hour Block Average	8-Hour Block Average	8-Hour Moving[1] Average	Daily Average	Season (days)	3-Month Average[2]	Annual
Automated Methods		75% (≥ 45 1 min averages)	75% (All 3 hours)	75% (≥ 6 hours)	75% (≥ 6 hours)	75% (≥ 18 hours)	90%		75%
CO		✓		✓					
NO_2		✓							✓ 1 hour: hourly values per quarter. Annual: hourly values per year
NO, NOy		✓							
SO_2	✓	✓	✓			✓			✓ hourly values per quarter
O_3		✓			✓		✓		
PM_{10}		✓				✓[3]			
$PM_{2.5}$		✓				✓			✓ daily values per quarter
$PM_{10-2.5}$		✓				✓[3]			
Manual Methods						1440 min ± 60 min (23-25 hrs)			
PM_{10}						✓			
$PM_{2.5}$						✓			✓ scheduled days per quarter
Pb						✓		✓	✓ 1978 NAAQS: NA 2008 NAAQS: 3-month averages

NA – Not available.

[1] –2015 NAAQS: 8-hour average refers to the moving average of eight consecutive hourly O_3 concentrations measured at a site. Moving 8-hour averages are computed from the hourly O_3 concentration data for each hour of the year and shall be stored in the first, or start, hour of the 8-hour period. 8-hour averages from 7:00 AM – 11:00 PM local standard time. Additionally, the daily maximum 8-hour average O3 concentration for a given day is the highest of the 17 consecutive 8-hour averages beginning with the 8-hour period from 7:00 a.m. to 3:00 p.m. and ending with the 8-hour period from 11:00 p.m. to 7:00 a.m. the following day (i.e., the 8-hour averages for 7:00 a.m. to 11:00 p.m.). (40 CFR 50, Appendix U, Section 2(b)).

[2] – 1978 NAAQS: calendar quarterly average. 2008 NAAQS: arithmetic averages of 3 consecutive monthly means.

[3] – Automated samplers not defined in 40 CFR Part 50; ≥ 18 hours relationship developed by inference to 40 CFR Part 50, Appendix N – Interpretation of the NAAQS for $PM_{2.5}$.

9.6 NAAQS Comparisons and Design Values

Design value statistics describe the air quality status of a given area relative to the NAAQS level. NAAQS comparisons are typically made based on 3 consecutive, complete calendar years of data. Generally, depending on the calculation of the design value, EPA requires data to be 75% complete. In some cases, however, a design value might be calculated with less than 75% data completeness. In addition to the 1-hour and daily (24-hour) concentration values typically collected and reported, the data used for design value calculations include 3-hour, 8-hour, quarterly, annual, and multiple-year levels of data aggregation. For more information on estimates of pollutant-specific design value, refer to 40 CFR Part 50.

9.7 Adaptive Network, Looking Forward

New ambient air quality standards and technologies, revised national monitoring strategies, and observed network trends provide the impetus for an adaptive monitoring network. Often the annual network reviews, annual network plans, and periodic network assessments facilitate changes to the monitoring network. Within that framework, the annual Monitoring Network Plan includes planned current monitoring network changes made within 18 months from the plan date. Meanwhile, the periodic network assessment accommodates the future monitoring network design. Primarily, 5-year network assessment activities include (1) evaluating the network's effectiveness and efficiency relative to its monitoring objectives and costs, (2) determining whether new technologies are appropriate for incorporation into the monitoring network, and (3) developing recommendations for network reconfigurations and improvements. In addition, the annual monitoring network plan includes a network modification plan that addresses the findings of network assessment in the year after the network assessment is produced per 40 CFR Part 58.14.

Finally, the monitoring program includes our position on the use of data from continuous $PM_{2.5}$ FEM monitors as eligible for NAAQS comparison in its annual Monitoring Network Plan per CFR[10] requirements. Each year the monitoring program accesses data from $PM_{2.5}$ FEM monitors and evaluates the comparability to collocated $PM_{2.5}$ FRM monitors. The EPA's approval of an annual Monitoring Network Plan constitutes concurrence with the monitoring program's recommendation to use or not use data from continuous $PM_{2.5}$ FEMs as eligible for comparison to the NAAQS. For more information refer to 40 CFR Part 58.11 and the EPA's April 20, 2013 memorandum, "Update on Use of PM2.5 Continuous FEMS."

SLAMS monitoring network changes that occur outside of the annual network plan and periodic network assessment require written communication to the EPA and approval. Additionally, any monitoring program requests to discontinue a SLAMS monitor is subject to the approval of the EPA Regional Administrator. Furthermore, all planned monitoring network changes conform to 40 CFR Part 58.14.[11]

[10] - 40 CFR Part 58.11 - Network technical requirements.
[11] - 40 CFR Part 58.14 - System modification.

Annual Monitoring Network Plans are submitted to the EPA Regional Administer on July 1. The first monitoring network assessment, following promulgation of the 2006 monitoring rule, was sent to EPA in July 2010; subsequent network assessments are completed once every 5 years. The annual network plan is available for public inspection and comment for at least 30 days before being submitted to EPA. Finally, the monitoring program documents the process for obtaining public comment and addresses as appropriate, all public comments received through the process in the annual Monitoring Network Plan.

10. Sampling Methods

All of the monitors used to obtain data for concentrations of ambient air pollution in order to determine National Ambient Air Quality Standards (NAAQS)[1] compliance must be designated as EPA-reference or equivalent methods. Equipment with approved modifications can also be used. For Montana Ambient Air Quality Standards (MAAQS) [2] compliance determinations of visibility, settled particulate matter, fluoride in forage, and H_2S air pollutants, the methods must adhere to the Administrative Rules of Montana (ARM) 17.8.2 or be a department-approved equivalent method.

When non-regulatory data is collected, the monitoring program may use a non-federal reference method/federal equivalent method (FRM/FEM) monitor. The meteorological sensors may be non-traditional sensors or traditional sensors that meet EPA's siting and equipment requirements per the QA Handbook, Vol. IV [(OAQPS IV), see References]. The monitoring program's FRM/FEM monitors and non-traditional meteorological sensors meet industry-accepted, tested methodology.

For descriptions of the monitoring program's monitors and equipment, refer to Section 2 - Summary of Method, in each instrument-specific SOP. Each monitor is installed, operated, and maintained per the procedures, guidance, and requirements detailed in the following: (a) 40 Code of Federal Regulations (CFR) Parts 50, 53, and 58; (b) the QA Handbook, Vol. II, Appendix D [(OAQPS III), see References]; and (c) each instrument-specific SOP. Additionally, the specific EPA-designated method code associated with SLAMS or SPM monitors at any particular site are included in the annual Montana Air Quality Monitoring Network Plan (Monitoring Network Plan) [(AQB III), see References].

10.1 Equivalent Method Requests

To request new equivalent methods, refer to CFR and follow the instructions.[3] Current EPA-approved equivalent methods in the monitoring program include:

- Inductively Coupled Argon Plasma-Optical Emission Spectrometry (Montana). Manual Equivalent Method: EQL-0483-057. "Determination of Lead Concentration in Ambient Particulate Matter by Inductively Coupled Argon Plasma-Optical Emission Spectrometry (State of Montana)." State of Montana, Department of Health and Environmental Sciences, Cogswell Building, Helena, MT 59620. (Federal Register: Vol. 48, page 14748, 04/05/83).

The approved Montana Pb-TSP equivalent method is no longer applicable because the 2008 Pb NAAQS superseded the 1978 Pb NAAQS. Consequently, the lower detection limit for the analytical reference method decreased from 0.07 µg Pb/m^3 to 5% of the NAAQS, or 0.0075 µg Pb/m^3 method detection limit

[1] - National Ambient Air Quality Standards (NAAQS).
[2] - ARM, Title 17, Chapter 8, Subchapter 2 - Ambient Air Quality.
[3] - 40 CFR Part 53.4 - Applications for reference or equivalent method determinations.

(MDL). To continue to use the approved Montana Pb-TSP equivalent method, we must demonstrate that the MDL meets the 0.0075 µg Pb/m^3 per CFR.[4]

10.2 Reference and Equivalent Equipment Modification Requests

To request to modify reference or equivalent method equipment (e.g., altering equipment or operating on ranges other than approved), refer to CFR.[5] The QA Manager requests equipment modifications, and the Research and Monitoring Services (RMS) Section archives them in the EPA Equipment Modification Request folder.

Current EPA-approved modification of methods include:

- Gaseous analyzer request approved for Advanced Pollution Instrumentation, Inc. (API) 300 CO analyzers operating with the dynamic zero adjustment feature set to **ON**. (EPA; December 17, 1996).
- Gaseous analyzer request approved for externally mounted pumps installed on the API 300/300E CO analyzers (EPA; May 14, 2004).

10.3 Pb-PM_{10} Sampler in Lieu of Pb-TSP Sampler Requests

In certain cases, the monitoring program's Pb-PM_{10} reference method samplers may be used in lieu of Pb total suspended particulate matter (Pb-TSP) samplers at non-source- and source-oriented SLAMS stations. The EPA allows the use of Pb-PM_{10} monitors instead of Pb-TSP monitors under certain limited circumstances: (1) where lead is not expected to occur as large (ultra-coarse) particles and (2) where 3-month average lead concentrations are not expected to be greater than or equal to 0.10 µg/m^3. Lead-PM_{10} sampler requests are included as part of the monitoring program's annual network plan. For more information on the Pb-PM_{10} sampler, refer to CFR.[6]

10.4 Approved MAAQS Monitoring Methods

In addition to MAAQS-permitted monitoring methods in the Administrative Rules of Montana (ARM),[7] the monitoring program has approved methods for settled particulate matter and H_2S air pollutants.

10.4.1 Settled Particulate Matter

The measurement method identified in ARM 17.8 is a 1977 publication, "Methods of Air Sampling and Analysis" [(Katz, 1977), see References], and closely resembles an American Society for Testing and Materials (ASTM) International method (D 1739-62). The latter has been updated several times, most recently in 1998 [(ASTM), see References]. The essence of the method is to determine the weight of

[4] - 40 CFR Part 53.33 – Test procedures for methods for lead (Pb).
[5] - 40 CFR Part 58, Appendix C, Section 2.8 – Modifications of Methods by Users.
[6] - 40 CFR Part 58, Appendix C, Section 2.10 - Use of Pb-PM_{10} at SLAMS.
[7] - Administrative Rules of Montana (ARM) Title 17, Chapter 8, Subchapter 2 - Ambient Air Quality.

material that collects in an open bucket left outside for 30 days. Considerations for the collection site conform to the normal concerns for monitoring objectives and scale of representativeness. To prevent wind from removing any collected material, water or a preservative is put in the collection container. Analysis can be limited to total mass collected, expanded to soluble and insoluble mass, or even involve chemical analysis of the collected material. The lower limit of measurement is approximately 0.2 g/m^2/month.

10.4.2 Hydrogen Sulfide

H_2S Reference Method: The analytical method referenced by the Montana Ambient Air Quality Standard for hydrogen sulfide is the methylene blue spectrophotometric method, published in the 1977 "Methods of Air Sampling and Analysis." This old "wet chemistry" method is essentially a laboratory method and does not readily lend itself to field use for long periods of continuous monitoring. To deal with these problems, the monitoring program is designating the following method as equivalent.

H_2S Equivalent Method: Hydrogen sulfide is most commonly measured continuously today by passing the sampled air stream through a sulfur-oxides scrubber, followed by a catalytic oxidizer, which converts the hydrogen sulfide in the sample to sulfur dioxide (SO_2). The SO_2 is then measured using an EPA-designated equivalent method. Manufacturers of ambient air monitoring equipment build H_2S analyzers around their EPA-designated equivalent SO_2 analyzers.

To be acceptable as equivalent to the ARM 17.8 reference measurement method, an H_2S analyzer must use an EPA-designated equivalent SO_2 analyzer, and the system must meet the following requirements:

Sulfur oxides scrubbing efficiency	> 95%
$H_2S \longrightarrow SO_2$ converter efficiency	> 95%
Lower detection limit	< 1ppb
90% full-scale response time	< 120 seconds

Quality objectives for measuring H_2S are the same as for SO_2.

10.5 Probe Material and Pollutant Sample Residence Time

For reactive-gas monitors (SO_2, H_2S, NO_2, and O_3) the probe manifold material (sample lines and fittings) must be Teflon® or borosilicate (Pyrex®) glass per 40 CFR Part 58, Appendix E. These materials lessen the oxidation of gases as they enter the sampling train. Furthermore, Teflon® or borosilicate (Pyrex®) glass must be used as the probe material for delivering calibration test gas concentrations. For non-reactive gas monitors (CO), probe manifold materials can have brass fittings. For volatile organic compound (VOC) sampling, Teflon® is unacceptable for the probe material because of VOC adsorption and desorption reactions on the Teflon®.

Additionally, all reactive-gas monitors must have a sample residence time of less than 20 seconds. Residence time is the amount of time it takes for the sample to travel from the probe inlet to the sample intake. Equations are found in the QA Handbook, Vol. II [(OAQPS III), see References].

11. Sample Handling and Custody

Most ambient air monitoring data is collected via real-time or near real-time (in-situ) monitoring equipment. However, the manual filter-based PM_{10}, $PM_{2.5}$, $PM_{10-2.5}$, and Pb samplers, fluoride in forage samples, and settled particulate matter samples must be collected physically by a laboratory. The PM filter sample recovery, transport, and processing times follow the prescribed filter handling procedures in 40 CFR Part 50. Handling and custody information for particulate matter filters are documented using sample run data sheets, laboratory sample chain-of-custody forms, and electronic gravimetric laboratory reports.

The appropriate Research and Monitoring Services (RMS) Section monitoring coordinator must complete filter handling evaluations during data review and validation (see **Section 21 – Data Validation and Usability**). Filter handling procedures of the PM samples are detailed in the instrument-specific SOP (see **Appendix 2**). The monitoring program does not currently run Pb samplers or collect fluoride in forage and samples of settled particulate matter.

11.1 Chain of Custody

Chain-of-Custody (COC) forms accompany the PM filters from the field to the gravimetric laboratory. Procedures for maintaining custody of samples and completing COC forms are described in the filter shipment section of the appropriate SOP (see **Appendix 2**).

11.2 Sample Retention and Disposal Requirements

After the analytical laboratory does post-sample weighing, the PM filters are returned to the RMS Section for retention and archival. Dispose of the filters at the end of the 5-year retention period.

12. Analytical Methods

For analyzing ambient air samples, laboratory analytical methods must meet the applicable regulations. Primarily, particulate matter (PM) and lead (Pb) manual methods involve sampling, which requires laboratory analysis. Analytical methods and procedures include:

- PM: The analytical instruments used for the PM gravimetric analysis is an analytical balance (high-volume PM_{10}/total suspended particulates (TSP) samples) and a microbalance (low-volume PM samples). The sample analysis requirements are detailed in the Montana Department of Public Health and Human Services Environmental Laboratory's "Standard Operating Procedure HIVOL Filters for Hi-Vol Samples" publication for high-volume PM_{10}/TSP samples and in the Inter-Mountain Labs, Inc.'s (IML) $PM_{2.5}$ QAPP for the low-volume PM samples.
- Pb-TSP: For Pb-TSP sample analysis, the reference analytical method is inductively coupled plasma – mass spectrometry (ICP-MS) performed per 40 CFR Part 50 Appendix G.[1]
- Pb-PM_{10}: The Pb content of the PM_{10} sample is analyzed by energy-dispersive X-ray fluorescence spectrometry (EDXRF), per 40 CFR 50 Appendix Q,[2] or by an approved equivalent method, such as the Eastern Research Group, Inc.'s, ICP-MS manual equivalent method.
- Fluoride in Forage: The fluoride content of forage is analyzed chemically using the semi-automated method described in "Methods of Air Sampling and Analysis" [(Lodge, 1989), see References] and incorporated by reference in ARM Chapter 17.8.202 (except that the surfaces of the plant must not be washed). It can also be analyzed by an approved equivalent method.
- Settled Particulate Matter: The "dust-fall" method is used to determine compliance, as described in "Methods of Air Sampling and Analysis" [(Katz, 1977), see References] and the 1998 ASTM International method (D 1739-62).

The monitoring program does not currently collect and analyze high-volume PM_{10}/TSP, Pb-TSP, Pb-PM_{10}, fluoride in forage, or settled particulate matter samples.

[1] - 40 CFR Part 50, Appendix G – Reference Method for the Determination of Lead in Total Suspended Particulate Matter Collected from Ambient Air.
[2] - 40 CFR Part 50, Appendix Q - Reference Method for the Determination of Lead in Particulate Matter as PM_{10} Collected from Ambient Air.

13. Quality Control

Quality Control (QC) is the act of standardizing the measurement process by following specific procedures. QC provides a reasonable level of documented checking at various stages of data collection to ensure data quality. In practical terms, QC results provide for analysis of instrument operation and drift. QC is not conducted so much to eliminate or reduce errors. Instead, the monitoring program does QC in order to measure the effects of their activities. Although the QC check itself does not eliminate errors, the QC data is used to take appropriate corrective action and isolate or eliminate the observed source of error that exceeds established tolerable levels. The frequency of the QC checks ensures minimal data loss.

Quality control procedures, such as instrument verifications, are considered "checks without correction" and are used to ensure that the instruments are operating within the prescribed calibration tolerances. During verification, the analyzer/sampler is operated in its normal sampling mode and samples the test atmosphere through all filters, scrubbers, conditioners, and other components used during normal ambient sampling. As much of the ambient air inlet system as possible is used.

Each of the monitoring program's QC checks evaluate phases of measurement uncertainty. QC procedures include, but are not limited to:

- Station visits: Weekly (at a minimum), done by the Research and Monitoring Services (RMS) Section monitoring coordinator; remote monitor access or on-site station visits by the site operator verify satisfactory instrument operation.
- Precision and bias checks: Performed according to CFR[1] provide an overall assessment of uncertainty and include the results of:
    - bi-weekly (one every 14 days) gaseous analyzer one-point QC "precision" checks relative to routine concentrations recorded at the station, and
    - collocated PM samplers operating on the established national sampling schedule (see **Section 9.4 – The Operating Schedule**).
- Gas analyzer zero/span checks: Bi-weekly zero/span checks verify proper instrument operation.
- PM sampler flow-rate verifications: Monthly continuous and manual method flow-rate checks, along with additional sampler temperature, pressure, and leak checks, verify proper instrument operation.
- Meteorological sensor verifications: 6-month verifications establish continued proper operation of the meteorological equipment.
- Gravimetric laboratory activities: PM filter, microbalance, environmental conditioning, temperature, and pressure sensor checks; frequency is based on CFR requirements.[2]
- Standards certifications: QC field standards are the same as the calibration standards. For the QC standard type and certification schedule, see **Section 15.2 – Calibration Standards**.

[1] - 40 CFR Part 58, Appendix A – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards.
[2] - 40 CFR Part 50 – National Primary and Secondary Ambient Air Quality Standards.

For additional QC activities, frequencies, and acceptance criteria for pollutant monitors, see the QA Handbook, Vol. II, Appendix D [(OAQPS III), see References]; for meteorological sensors, see the QA Handbook, Vol. IV, Section 0 [(OAQPS IV), see References]. Additionally, **Appendix 4** lists the frequency and acceptance criteria for QC checks of the NCore station trace-level gas instruments. The monitoring program strives to perform all required QC checks independent of the critical, operational, or systematic criteria priority level. For more information on the validation of the ambient air measurements based on the QC check results, see **Section 21 – Data Validation and Usability**.

Applicable various QC procedures, frequency, acceptance criteria, and troubleshooting are documented in the instrument-specific SOPs. A list of the monitoring program SOPs is included in **Appendix 2**. Quality control documentation includes (1) monitoring site and analyzer checklists, (2) electronic strip charts, (3) control charts, and (4) QC check results.

Quality control documentation is archived on the network drive or in hard copy in the respective RMS Section monitoring coordinators' work area, per Records Management Plan (SOP-309) requirements.

13.1 Quality Control Reporting Requirements

Quarterly, the monitoring program reports the results of the SLAMs and SPM monitor one-point gaseous QC checks and PM flow rate verifications to the Air Quality System (AQS) [(OAQPS II), see References], per the precision sections of the Data Review, Verification, and Validation SOPs (SOP-501, SOP-502).

Additionally, if the routine data is submitted as valid, then the QC check results are submitted. If the routine data is not submitted, then the corresponding QC check results are not submitted. The rationale is that when pooling QC check information, the resulting data quality estimate represents valid data that is in the AQS database. For more information on reporting QC checks, refer to **Section 21.3 – Reporting QA Data**.

13.2 Quality Control Corrective Actions

If QC activities uncover a need for corrective action (e.g., when instruments are exceeding the established performance criteria), corrective action must be immediate, or on the spot. A corrective action is designed to bring the non-conforming analyzer, instrument, or sensor back on-line through calibration and/or maintenance. A decision matrix for troubleshooting corrective action is included in the instrument-specific SOPs. All corrective actions resulting from QC are documented on the appropriate verification and calibration forms, located in the instrument SOPs.

If long-term issues exist, use corrective action investigations to determine the cause of nonconformance. The investigations are typically conducted to confirm proper equipment operation or to ensure the validity of data previously collected. An additional QC investigation includes troubleshooting when collocated sampler precision estimates are outside of established goals. The corrective action request and resolution process is discussed in **Section 19.4 – Corrective Action**.

14. Instrument & Equipment Procurement, Testing, Inspection, and Maintenance

The Research and Monitoring Services (RMS) Section Supervisor and Lead Worker are responsible for identifying air monitoring equipment needs and approving equipment purchases. Use the following protocol to procure air monitoring equipment:

- Equipment evaluation and selection: Before purchase, the equipment's necessary performance specifications are established. Subsequently, individual equipment models are evaluated, and other users are queried about the equipment's performance, dependability, and ease of use. As possible and appropriate, buy new equipment that is compatible with existing equipment.
- Purchase specifications: The purchase contract includes the performance specifications that ensure we obtain only equipment of desired quality. In addition, equipment must come with a 1-year warranty, and payment is not made until the equipment has passed an acceptance test.
- Acceptance testing: The new equipment is tested to ensure it meets the requirements listed in the purchase specifications within the warranty period. For analyzers, the minimum test consists of checking zero drift, span drift, voltage stability, temperature stability, and linearity. Acceptance testing procedures are in the SOPs for each specific analyzer. The RMS Section Lead Worker prepares and archives acceptance-test reports.

RMS Section staff maintain preventive and remedial maintenance tasks, schedules, and parts and supplies. The instrument-specific SOP specifies maintenance frequency requirements and procedures. Develop maintenance procedures using the instrument operating manuals and according to personal experience. A list of the monitoring program SOPs is included in **Appendix 2**.

15. Instrument & Equipment Calibration and Calibration Frequency

Calibration is defined as "the comparison of a measurement standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustment" [(ASQ), see References].

Calibration of an analyzer instrument establishes the quantitative relationship between an actual value of a standard, be it a pollutant concentration, a temperature, or a mass value (in ppm, °C or µg, etc.) and the analyzer's response (chart recorder reading, output volts, digital output, etc.). This relationship is used to convert subsequent analyzer response values to corresponding concentrations. Once an instrument's calibration relationship is established, it is checked, or verified, at reasonable frequencies to verify that it remains in calibration. Under normal operating conditions, an instrument is verified immediately before calibration.

Calibration frequency and acceptance criteria for pollutant and meteorological instruments are included in the QA Handbook, Vol. II, Appendix D [(OAQPS III), see References] and QA Handbook, Vol. IV, Section 0 [(OAQPS IV), see References] validation templates. Additionally, calibration frequency and acceptance criteria for NCore trace-level gas instruments are listed in **Appendix 4**. Furthermore, validation of the ambient air measurements based on calibration information is discussed in **Section 21 – Data Validation and Usability**.

The various calibration procedures, frequencies, and acceptance criteria are documented in the instrument-specific procedure sections of the SOPs. A list of the monitoring program SOPs is included in **Appendix 2**. Additionally, calibration documentation is stored and archived per the Records Management Plan (SOP-309) requirements.

15.1 Calibration-Verifications

Calibration-verifications (i.e., "checks without correction") for particulate matter and gaseous multi-points can substitute for required calibrations, provided that the verification results are within prescribed tolerances (e.g., below the warning limits or within the established calibration criteria). The warning and calibration criteria have been developed so that as long as the instrument is within these tolerances, adjustments are unnecessary.

15.2 Calibration Standards

Begin the calibration process by certifying a calibration or transfer standard against an authoritative standard, or by obtaining a standard that has been duly certified. All monitoring program standards are verified using the process known as traceability. Traceability provides an unbroken chain of comparisons (with stated uncertainties) from the authoritative reference standards to the monitoring program's standards. "Traceable" is defined in 40 Code of Federal Regulations (CFR) Part 50 and 58 to mean that a local standard has been compared and certified either directly with a primary standard or compared indirectly but by not more than one intermediate standard.

Although a number of regulations, guidance, and technical assistance documents are available to help in completing certifications for monitoring program calibration standards, the information is conflicting and vague in places. Therefore, the monitoring program's standards certification processes were developed using the best understanding of standard certification information to ensure the standards used incorporate "traceable" as defined in 40 CFR Part 50 and 58. All ambient air monitoring instruments in the monitoring program are calibrated and verified using calibration standards. Currently calibration standards include:

- Ozone: Because of the inherent instability and reactivity of ozone (O_3), test-gas concentrations are produced on-site using a transportable standard that is capable of accurately producing O_3 concentrations and providing accurate assays of O_3 concentrations. Ozone concentrations produced by each monitoring program instrument are traceable to the National Institute of Standards and Technology (NIST) laboratory's national standard reference photometer (SRP) via the EPA Region 8 SRP (see **Section 19.1.3 – Ozone Transfer Standard Verifications**). The monitoring program's traceability process is illustrated in **Figure 1**.

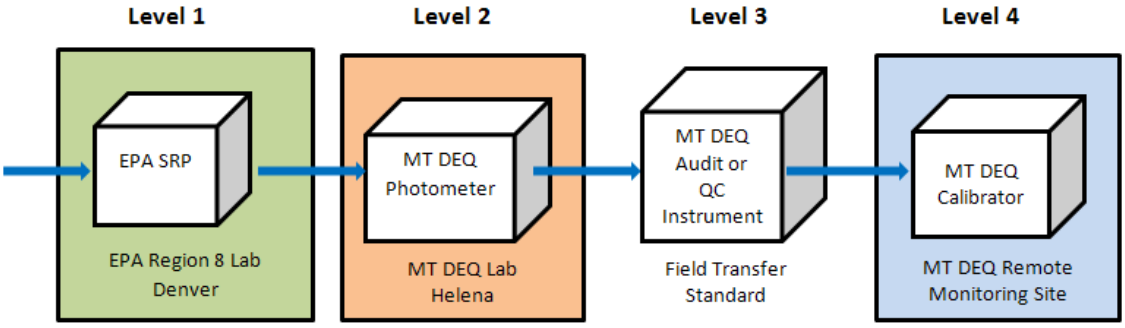

Figure 1. Monitoring program ozone transfer standard relationships and traceability.

Test-gas concentrations of O_3 are traceable using a primary standard ultraviolet photometer, as described in 40 CFR Part 50, Appendix D[1] and in the Transfer Standards for Calibration of Air Monitoring of Air Monitoring Analyzers for Ozone Technical Assistance Document [(OAQPS VIII), see References]. Initial transfer standard verifications for O_3 consist of a 6-day, six-point (6x6) comparison with the DEQ reference standard. Additionally, field and monitoring site O_3 transfer standards are re-verified a minimum of once every 6 months. If an unsatisfactory field re-verification arises, the field O_3 transfer standard is verified in the laboratory to the DEQ reference standard.

- Zero Air: Zero-air generators provide clean air below the analyzer lower-detection limits operating at a maximum required flow rate of 20 liters per minute. Zero air must be free of contaminants that could cause a detectable response and species, which react with the

[1] - 40 CFR Part 50, Appendix D - Measurement Principle and Calibration Procedure for the Measurement of Ozone in the Atmosphere.

measured pollutant, per the applicable Appendix of 40 CFR Part 50[2] and QA Handbook, Vol. II [(OAQPS III), see References].

- Compressed Gas Cylinders: Gaseous standards used to generate test-gas concentrations are purchased, certified, and maintained to EPA protocol [(ORD), see References]. In general, a compressed-gas calibration standard may be recertified if the gas pressure in the cylinder is greater than 500 psig. In addition, a compressed gas calibration standard should not be used when its gas pressure is below 100 psig.
- Calibrators: Mass-flow controlled dilution-calibrators, accurate to ± 2%, are used to calibrate gaseous analyzers. Further, mass-flow controlled dilution-calibrators capable of gas-phase titration (GPT) are used for NOx and NOy monitoring. Mass-flow controller (MFC) verifications to the primary laboratory equipment occur as needed and are dictated by equipment use and experience. Typically, MFCs are verified quarterly during the first year of operation, and depending on the MFC's stability, the verification frequency decreases after 1 year.
- Flow Measuring Devices: Annually PM orifice flow standard certifications are completed by referencing the standards to the laboratory primary flow standard. An independent third party verifies the laboratory primary flow standards annually.
- Auxiliary Standards: Auxiliary standards include field barometers and thermometers. Each month, field barometers are verified with the wall barometers in the laboratory. Once yearly, field temperature standards are compared to the laboratory's primary thermometer.

Staff in the Research and Monitoring Services (RMS) Section and Analysis and Planning Services Section certify the field standards. Calibration requirements for the critical field and laboratory may be found in the applicable Validation of Standards series SOPs. A list of the monitoring program's SOPs are included in **Appendix 2**. Documents of calibration standard certifications are stored and archived according to the Records Management Plan (SOP-309) requirements.

15.3 Calibration Corrective Actions

If equipment operates outside of acceptance criteria following a calibration, you must initiate a corrective action investigation to determine the cause of observed nonconformance. For gaseous analyzers, the station calibrator dilution flow rates and corresponding concentrations are re-verified, and the calibration is repeated. For PM instruments, the calibration procedures are repeated, and troubleshooting of the equipment and standards are completed. Depending on the outcome of the repeated calibration and troubleshooting efforts, the station instrument or calibration equipment may require maintenance. The corrective action request and resolution process is discussed in **Section 19.4 – Corrective Action**.

[2] - 40 CFR Part 50 – National Primary and Secondary Ambient Air Quality Standards.

16. Inspection/Acceptance of Supplies and Consumables

Critical air monitoring program supplies, standards, sources, and acceptance criteria are identified in **Table 8**. Acceptance is typically not completed when the Research and Monitoring Services (RMS) Section receives the supplies and consumables because the manufacturer is responsible for supplying the items and materials to required specifications. However, acceptance of the item is confirmed during use. If a problem is noted, initiate the corrective action request process.

Table 8. Air Monitoring Supplies and Consumables

Item	Supply Source	Acceptance Criteria
Low-volume particulate matter sampler filters (PTFE Teflon®)	EPA	Must meet requirements of 40 CFR Part 50, Appendix L, Section 6.0
Pb-TSP Filters (Glass fiber or other relatively inert, non-hygroscopic material)	EPA	Must meet requirements of 40 CFR Part 50, Appendix B, Section 7.1, and Appendix G, Section 6.1
Beta attenuation monitor (BAM) filter tapes (glass fiber)	Monitor manufacture	Must meet monitor equivalency designation requirements
Gaseous instrument compressed gas and permeation devices	Reputable vendor	Must meet EPA Protocol requirements
Zero-air scrubbers & desiccants (charcoal, purafil, silica gel, platinum/palladium)	Reputable vendor	Must be free of interferences and meet zero-air system requirements
Gaseous instrument sample lines	Reputable vendor	Must meet pollutant-specific inlet and probe requirements
Continuous instrument inline filters	Reputable vendor	Must meet pollutant-specific inline filter requirements of reference and equivalency designation

17. Non-direct Measurements

Non-direct measurements are also called “existing” or “secondary data.” Some non-direct measurements support the monitoring program. This includes data from outside sources, such as:

- chemical and physical properties data,
- geographic location data,
- past monitoring data and summary information derived from previous collected data, and
- National Weather Service data.

Using outside data calls for quality control to the extent possible and should follow QA procedures outlined in this document and in applicable EPA guidance documents.

18. Data Acquisition and Information Management

The monitoring program's primary output is ambient air monitoring data of reliable and known quality. To that end, we have developed formal procedures for acquiring data and managing information:

- data recording,
- data transmittal,
- automated and manual data verification (see **Section 21 – Data Validation and Usability**),
- data storage and retrieval,
- data transfer (public reporting),
- data validation (see **Section 21 – Data Validation and Usability**),
- data transfer (AQS database reporting),and
- data management.

For automated (continuous) instrument samples, the data management system used to collect, process, and report air quality data to the Air Quality System (AQS) [(OAQPS II), see References] database uses Agilaire AirVision software. Additionally, the AirVision database is the final local storage for all ambient air monitoring data that is collected. To ensure the integrity of the data collection system, all data acquisition and management components are implemented in a client-server environment operating under Microsoft (MS) windows. Furthermore, only authorized users can access the database. Editing privileges are approved as needed. Finally, the database is backed up nightly by the Montana Department of Administration, thereby allowing for recovery of ambient monitoring data if disaster strikes.

Figure 2 illustrates the automated (continuous instrument) data acquisition and transfer process. For more information regarding data acquisition processes, refer to the Monitor and Samplers SOPs and Data Collection Series SOPs. The data transfer process is discussed in greater detail in **Section 18.5 – Reporting and Certifying Data**.

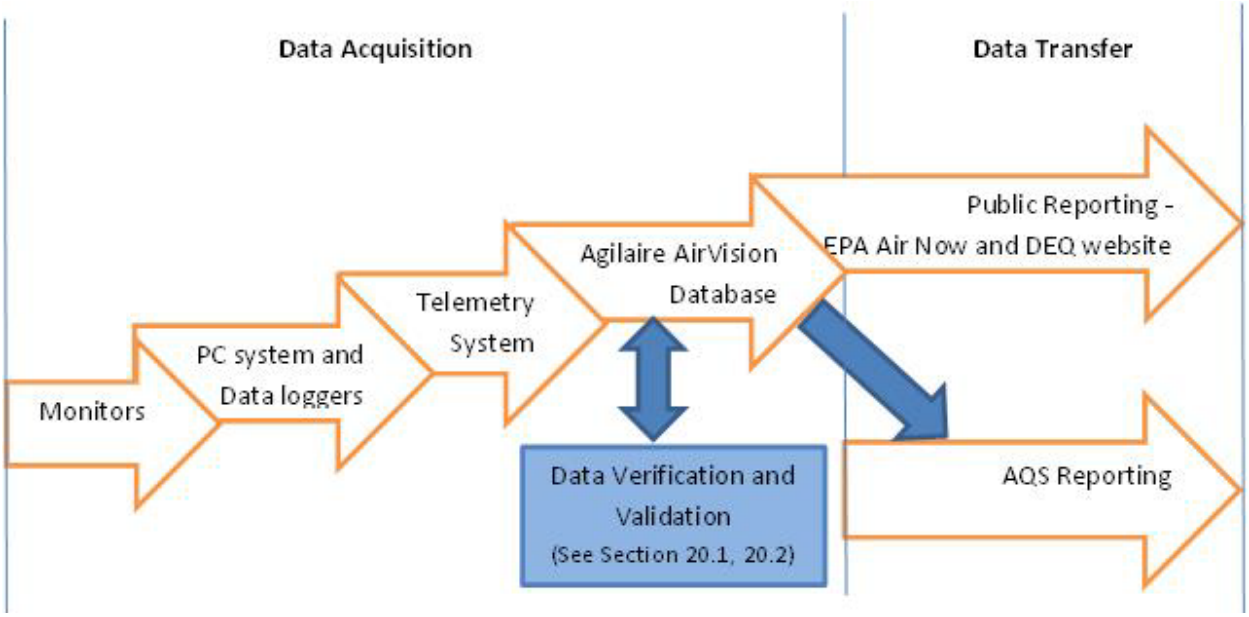

Figure 2. Continuous instrument data acquisition and transfer process.

For manual method (filter-based) samples, the gravimetric laboratory provides PM concentration data in AQS format for direct editing during data verification and validation. After data verification and validation, the PM filter-based data is uploaded to AQS and imported into the Agilaire AirVision database. For more information, refer to the Continuous Instrument and Integrated Sampling (SOP-301).

18.1 Acquiring Data from Backup Instruments

If the primary data recording instruments fail, or the data files become corrupted, it is possible to recover the measurement information collected on the gaseous chart recorders and PM sampler internal data loggers. Getting data from the instruments to the Agilaire AirVision database is accomplished via direct download or by using the file import tool. Document all data acquisition resulting from backup instruments using the annotation log in the Agilaire AirVision database.

18.2 Altering Data during Processing

Typically, alterations and transformations of gaseous and PM SLAMS concentrations are not performed during data processing. If extenuating circumstances apply, and scaling factors are required to bring an instrument's collected data into compliance during data processing, all alterations are documented using the annotation log in the Agilaire AirVision database. Additionally, alterations of previously posted AQS data must conform to the corrective action process and documentation requirements (see **Section 18.5.8 – AQS Corrective Actions**).

18.3 Correcting Data Using QA Information

The monitoring program does not adjust gaseous ambient air measurements using the calibration and QC check zero/span results. However, the monitoring program completes CO analyzer auto zero corrections daily, as allowed in the federal reference method/federal equivalent method (FRM/FEM) monitor designation, or as an approved equipment modification (see **Section 10.2 – Reference and Equivalent Equipment Modification Requests**).

18.4 Processing Precision and Accuracy Information

The monitoring program adheres to the EPA QA Handbook, Vol. II [(OAQPS III), see References] rounding policy when evaluating QA/QC results. The standard rounding convention is that the resolution of the measurement device or instrument display determines the significant figures used for rounding, not the established criteria defined in the regulations or guidance documents. The monitoring program's rounding policy decision for the PM samplers is based on the resolution of our measurement devices (transfer standards) used during QA/QC activities. The decision and the calculations used to evaluate and determine the rounding conventions for our transfer standards in use during PM QA/QC activities is documented in **Appendix 6 – Monitoring Program Internal Decisions and Guidance**.

Before uploading to AQS, enter continuous and manual instrument precision and accuracy information into the Agilaire AirVision monitor assessment module. For precision and accuracy coding processes and protocols, follow the procedures outlined in the precision sections of the data review SOPs and accuracy SOPs.

For more information, refer to the Data Review, Verification, and Validation SOPs (SOP-501, SOP-502) and the AQS Accuracy Transaction SOP (SOP-306). For further information on the AQS precision and accuracy reporting requirements, refer to **Section 18.5.7 - AQS Data Reporting Requirements**.

18.5 Reporting and Certifying Data

Use the following information to report and certify data.

18.5.1 Reporting the Air Quality Index

EPA's air quality index (AQI) is a tool that simplifies reporting of ambient air monitoring data to the public via the EPA AIRNow website [(OAQPS VIIII), see References], or to any publicly accessible format (newspaper, website, etc.) that uses the AQI categories. The AQI incorporates into a single index the concentrations of five criteria pollutants: O_3, PM, CO, SO_2, and NO_2. The AQI transforms the ambient concentration to a scale of zero to 500. The scale of the index is divided into general categories that are associated with health messages. Ambient air monitoring data collected by the monitoring program is exempt from CFR requirements[1] because no Montana metropolitan statistical area has a population of more than 350,000.

[1] - 40 CFR Part 58, Appendix G – Uniform Air Quality Index (AQI) and Daily Reporting.

18.5.2 Reporting Public Data

The continuous PM network produces near real-time $PM_{2.5}$ data that is available on DEQ's website online [(AQB VI), see References] and on EPA's AIRNow websites. The publicly available data is considered "provisional" and subject to change following data review, verification, and validation.

18.5.3 AQS Standard Reporting Format

Most monitoring data collected is reported to AQS. The AQS format for registering new sites and monitors is defined in the AQS data Coding Manual. Additional AQS coding manual and reporting information are available on the Technical Air Pollution Resources AQS, Manuals and Guides website [(OAQPS X), see References].

18.5.4 AQS Parameter and Method Codes

In AQS, the pollutant measured is called a "parameter," and the specific FRM/FEM method used is designated as the "method code" (**see Section 9.1.8 – Determining the Monitoring Method**). AQS provides the Technical Air Pollution Resources-AQS Codes and Descriptions website, which can help identify the correct parameter, method, unit, and duration code for data reporting [(OAQPS XI), see References]. Any approved reference or equivalent method listed on the AMTIC website has a reference or equivalent method number. An example from the List of Designated Reference and Equivalent Methods of an approved reference sampler is the BGI $PM_{2.5}$ sampler (**Figure 3**). This sampler typically uses the Parameter Code "88101" ($PM_{2.5}$ local conditions) and is associated with the method code "116." The method code is usually the last three digits of the designated reference (listed as RFPS) or equivalent (listed as EQPM) method.

***BGI Inc. Models PQ200 or PQ200A $PM_{2.5}$ Ambient Fine Particle Sampler* Manual Reference Method: RFPS-0498-116**

"BGI Incorporated Models PQ200 and PQ200A $PM_{2.5}$ Ambient Fine Particle Sampler," operated with firmware version 3.88 or 3.89R, for 24-hour continuous sample periods, in accordance with the Model PQ200/PQ200A Instruction Manual and with the requirements and sample collection filters specified in 40 CFR Part 50, Appendix L, and with or without the optional Solar Power Supply or the optional dual-filter cassette (P/N F-21/6) and associated lower impactor housing (P/N B2027), where the upper filter is used for $PM_{2.5}$. The Model PQ200A is described as a portable audit sampler and includes a set of three carrying cases.
Federal Register: Vol. 63, page 18911, 04/16/98

Figure 3. Example of reference method description from "List of Designated Reference and Equivalent Methods."

18.5.5 Standard Reporting Format for the AQS Pollutant Units and Decimal Place

The monitoring program reports pollutant data and QA information to the AQS database using the unit and decimal place information presented in **Table 9**. These decimal places are used for data comparisons with the National Ambient Air Quality Standards (NAAQS)[2] and are the values displayed in AQS "standard" summary reports.

[2] - National Ambient Air Quality Standards (NAAQS).

Table 9. AQS Pollutant Reporting Units and Decimal Places

Parameter	Units	Decimal[1]	Reference/Additional Information
CO	Ppm	1	40 CFR Part 50.8 (a), (d)
CO Trace (NCore)	Ppb	0[2]	
SO_2	Ppb	0	40 CFR Part 50, Appendix T, Section 4
SO_2 (NCore)	Ppb	1[3]	
O_3	Ppm	3	40 CFR Part 50, Appendix U, Section 3
NO, NO_2, NOx	Ppb	0	40 CFR Part 50, Appendix S, Section 4
NO, NOy (NCore)	Ppb	1[3,4]	
Pb (2008 NAAQS)	$\mu g/m^3$@ LC	3	40 CFR Part 50, Appendix R, Section 3 (b)
$PM_{2.5}$ (filter-based and automated)	$\mu g/m^3$@ LC	1	40 CFR Part 50, Appendix N, Section 3
PM_{10} (filter-based and automated)	$\mu g/m^3$@ SC	0	40 CFR Part 50, Appendix K, Section 1[5]
$PM_{10-2.5}$ (filter-based and automated)	$\mu g/m^3$@ LC	1	40 CFR Part 50, Appendix O, Section 1[5]

[1] – Truncate additional digits past reporting unit/decimal.
[2] – EPA NCore Training Workshop; 2009 National Air Monitoring Conference.
[3] – NCore SO_2, NO, NOy performance evaluation (field audit) recorded zeros reported to 3 decimals.
[4] – NO, NOy are not criteria pollutants, inferences developed using 40 CFR Part 50, Appendix S, Section 4 as reference.
[5] – Automated PM_{10} and $PM_{10-2.5}$ sampler inference developed using $PM_{2.5}$ automated (continuous) 1-hour samplers from 40 CFR Part 50, Appendix N – Interpretation of the NAAQS for $PM_{2.5}$.
LC – Local conditions [temperature and pressure].
SC – Standard 'reference' conditions [temperature (25 ˚Celsius (C)) and pressure (760 mm mercury (Hg))].

18.5.6 AQS Qualifiers

When reporting data to AQS, use qualifiers to clarify data that is missing, data technically valid but an exception is noted, or data collected during an exceptional event [(OAQPS II), see References]. Available qualifier types include:

- "Null" data qualifiers – Required: The null code explains why no sample value was reported.
- "QA" qualifiers – Optional: QA qualifiers are used when data is valid but document a QA exception (e.g., measurement was "below lowest calibration level"). The monitoring program does not use QA qualifiers unless an unusual or extreme valid concentration is recorded and reported. In this case the "V – validated value" is used.
- Informational ("Inform") qualifiers – Optional: Used when submitting data that is affected by an exceptional event and for which exclusion of the data will not be requested. Primarily, information-only flags are used for non-criteria pollutant parameters. The monitoring program does not use informational-only qualifiers.
- Request Exclusion ("ReqExc") qualifiers – Required: Required when submitting criteria pollutant data that is affected by an exceptional event and for which exclusion will be requested.

For more information on the AQS qualifier descriptions and available character codes, refer to the AQS Codes and Descriptions website mentioned in **Section 18.5.4 - AQS Parameter and Method Codes**. For more information on using qualifiers during data validation, refer to **Section 21.2.4 – Qualifier Codes/Flags and Annotations**.

18.5.7 AQS Data Reporting Requirements

Within 90 days following the end of the sample quarter, upload quarterly SLAMS monitor/SPM data and required QA (precision and accuracy) information to the AQS database. Additional information reported includes the filter-based $PM_{2.5}$ FRM/FEM sampler field blank mass.

Meteorological measurement reporting except at NCore, is left to the monitoring program's discretion. Additionally, the TSS Program Database Analyst updates the Update Review Tracker Template Spreadsheet after uploading the AQS data. For more information on the reporting of typical AQS data reporting, refer to the respective automated and manual Data Processing and Management series SOP.

18.5.8 AQS Corrective Actions

Invalidations and alterations of data posted previously to AQS must conform to the corrective action process and documentation requirements of **Section 19.4 – Corrective Action**.

18.5.9 Certifying Data

The monitoring program's SLAMS and SPM data and required QA information must be certified annually. Although the focus is on certifying criteria pollutant monitoring data, the current requirement is to certify monitoring data from SLAMS and SPM sites provided FRM/FEM monitors were used to obtain the air measurements and the sites met the criteria in appendix A of 40 CFR Part 58. Additionally, the monitoring program, i.e., the "certifying agency," certifies SPM data and required QA information unless the EPA Regional Administrator has approved an alternative method to the QA requirements of 40 CFR Part 58, Appendix A. On or before May 1 each year, submit a data certification letter and required monitoring data and QA report information to the EPA Regional Administrator. See 40 CFR Part 58.15[3] for details, since the data reporting requirements and time period certification dates can change.

EPA reviews the certification information submitted. If the results are consistent with the certification criteria, a certification flag is set on the data posted in the AQS database. In 2013, the data certification process changed when the EPA created a new certification report and an updated certification form that allowed EPA Region 8 staff to set a certification flag based on the report findings. Currently, the AQS report used during the annual data certification is the AMP 600 – Certification Evaluation and Concurrence report, which includes certification recommendations based on data completeness, completed QA/QC activities, and the status of a monitoring program's quality system documents.

After the monitoring program's certification reports date, the monitoring data must remain unaltered because after certification is complete, any updates to the data will cause the certification flag to be dropped. For more information on the annual monitoring data certification process, refer to the Data Certification SOP (SOP-304).

[3] - 40 CFR Part 58.15 - Annual air monitoring data certification.

18.5.10 Processing and Reporting Exceptional Event Data

Exceptional-event affected data are flagged according to CFR.[4] Within that requirement, the monitoring program notifies EPA of its intent to exclude one or more measured exceedances of an applicable ambient air quality standard as resulting from an exceptional event. This is done by creating an initial event description and placing a flag in the appropriate field for the data record of concern, which has been submitted to the AQS database. Qualifier code flags for exceptional events are explained in **Section 18.5.6 - AQS Qualifiers**. Typically, flagging the exceptional event data happens during the initial submittal of AQS data.

For more information on how the monitoring program addresses qualification, verification, and validation of data collected during exceptional events, see **Section 21.2.3 – Exceptional Event Data**.

Once the data is flagged in AQS and after the Air Quality Bureau Analysis and Planning Services (APS) Section consults with EPA; the APS Section develops an exceptional event demonstration package to document and justify that the reported data resulted from an exceptional event. After the APS Section demonstrates that an exceedance or violation of the ambient air quality monitoring data was caused by an exceptional event, EPA has the authority to remove air quality data from regulatory determinations. Finally, exceptional event requests and demonstrations are due to EPA on the date established by the EPA following the APS Section initial consult and notification.

18.6 Notifying the Public of an Exceptional Event

DEQ notifies the public whenever an exceptional event occurs or is reasonably anticipated to occur which may result in the exceedance of an applicable air quality standard per CFR[5] requirements. DEQ notifications to the public include issuing “Air Quality Alerts” on the DEQ’s website online. Additionally, the U.S. National Weather Service (NWS) [(NOAA), see References] attaches the DEQ issued alerts to the NWS current conditions website, which is available to:

- Local/regional media (TV/radio/newspaper),
- Social media websites (Facebook, Twitter),
- Public health and education departments, and
- The general public.

Furthermore, the continuous PM network that produces near real-time $PM_{2.5}$ data includes air quality discussions and forecasts during summer wildfires and wintertime stagnation events.

Finally, DEQ in a collaborative effort with the MT Department of Public Health and Human Services produced the “Public Health Wildfire Communication Toolkit” [(DPHHS), see References]. The toolkit

[4] - 40 CFR Part 50.14 - Treatment of air quality monitoring data influenced by exceptional events.
[5] - 40 CFR Part 50.14(c)(1) – Public notification.

provides a communication strategy for public health departments to engage the public in smoke information during wildland fires and includes steps to reduce exposure during a wildfire.

For more information on the types of exceptional events, refer to **Section 21.2.3 - Exceptional Event Data**.

19. Assessment and Response Actions

Assessments evaluate the performance, or effectiveness, of collecting ambient air data and quality assurance (QA) activities and ensure that this QAPP is implemented as prescribed. One significant evaluation is the annual network review, which verifies the existing network's conformance with federal requirements (see **Section 9.1.15 – Completing Network Reviews**). Additional assessments include, but are not limited to: (1) performance evaluations, (2) systems audits, (3) laboratory audits, (4) corrective action review and follow-up, and (5) data quality assessments. Each are described in this section.

Assessments are conducted on a routine basis by EPA Region 8 staff, independent contractors coordinated through EPA, and the monitoring program's QA staff.

19.1 Independent Assessments

Independent assessments are conducted by parties outside the monitoring program. The monitoring program provides for independent assessments using EPA national performance evaluation, technical systems audit, and pollutant standard verification programs. The results determine data comparability of the monitoring program's to others throughout the nation.

19.1.1 National Performance Evaluations

National performance evaluation programs consist of the National Performance Audit Program (NPAP) for gaseous pollutants and Performance Evaluation Program (PEP) for lead (Pb) and particulate matter (PM) samplers. The objectives are to assess the monitoring program's proficiency in operating the monitoring network. The audit results are the basis for statistical evaluations and comparisons of all the monitoring organizations operating throughout the country.

EPA Region 8 coordinates and oversees the federal performance evaluations; however, the monitoring program may opt to perform the audits on its own, as provided in CFR[1]; and in program implementation decision memorandum [(OAQPS XII), see References]. Currently, the monitoring program does not have enough resources to carry out the national performance evaluations and consents to EPA to apply an appropriate portion of its grant funds for EPA to complete the NPAP and PEP audits.

NPAP audits of gaseous pollutants through-the-probe are prioritized and completed according to the EPA schedule. PEP audit coverage and frequencies are described in the measurement quality summary table in **Appendix 5**. The national performance evaluation results are posted to the Air Quality System (AQS) website [(OAQPS II), see References] and are available during the annual data certification.

[1] - 40 CFR Part 58, Appendix A, Section 2.4 – National Performance Evaluation Programs.

19.1.2 Technical Systems Audits

A member of the EPA Region 8 Air Program conducts a technical systems audit of the monitoring program once every 3 years. The systems audit is an on-site review and inspection of the monitoring program to assess compliance with established regulations governing the collection, analysis, validation, and reporting of ambient air quality data. Consequently, the audit gives the monitoring program the opportunity to keep improving its monitoring efforts. All issues in the systems audit report require immediate consideration and follow-up. Additionally, reports are stored and archived according to the Records Management Plan (SOP-309).

19.1.3 Ozone Transfer Standard Verifications

The National Institute of Standards and Technology's (NIST) standard reference photometer (SRP) establishes traceability among ozone standards used throughout the nation (see **Figure 4**). Each year, the EPA's Region 8 SRP is compared indirectly with NIST's SRP, as a level 1 SRP. Level 1 SRPs refer to the family of Level 1 standard reference photometers that are traceable to the world's ozone reference standard. Each year, the monitoring program delivers to the EPA's Region 8 laboratory its Level 2 ozone transfer standard for comparison and verification with EPA's Region 8 SRP. This Level 2 standard is the monitoring program's ozone reference standard and is maintained in the air monitoring laboratory. All additional standards are then verified to the monitoring program reference standard as Level 3 or 4 ozone transfer standards (see **Figure 1** in **Section 15.2 – Calibration Standards**).

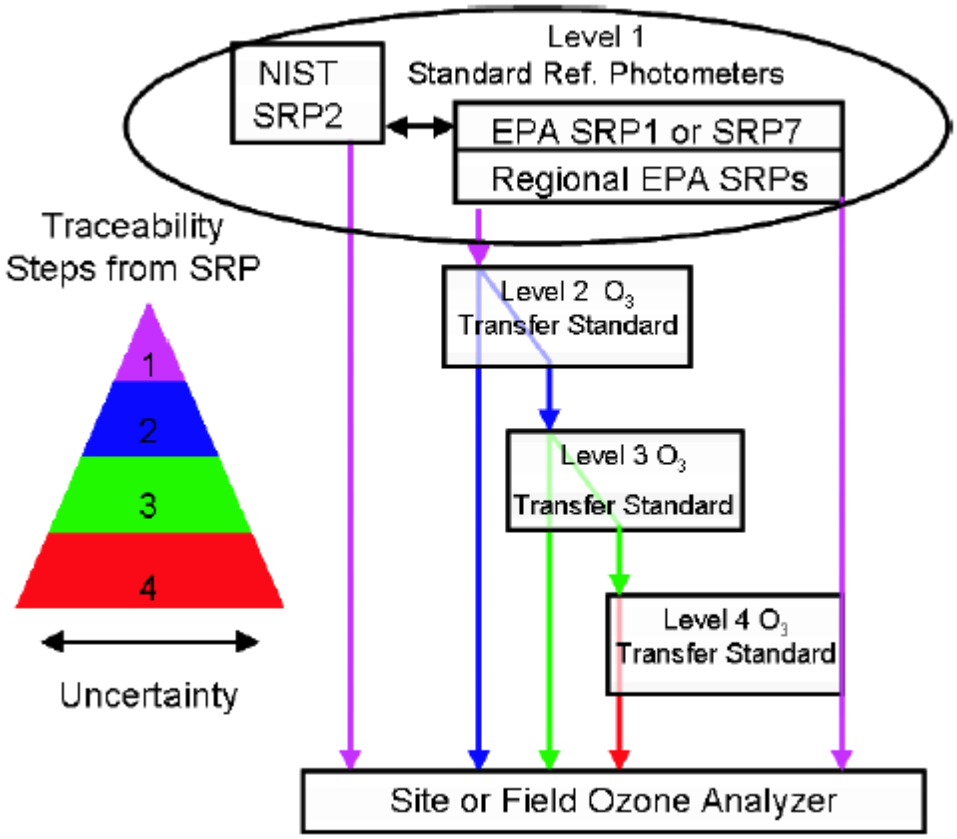

Figure 4. U.S. ambient air ozone standard traceability scheme (Reprinted from 2010 O_3 TS TAD).

19.1.4 Ambient-Air Protocol Gas Verification Program

Currently, the monitoring program participates in the EPA Ambient-Air Protocol Gas Verification Program according to CFR[2] requirements. The program verifies the accuracy of vendor-certified protocol gas standards and provides a blind comparison of the manufacturer's gas certificate of analysis. The monitoring program submits to EPA the gas producers in use annually and sends in a new unused gas cylinder to the designated laboratory for verification once every five years. Gas vendor surveys are completed and protocol compressed gas cylinders are registered for participation in the program using the Battelle AirQA Website [(Battelle), see references].

19.2 Monitoring Program Assessments

Typically, monitoring program staff and the QA Manager conduct in-house assessments. Additionally, the QA Manager oversees assessments, assisting with monitoring program assessments, performance

[2] - 40 CFR Part 58, Appendix A, 2 - Quality System Requirements, 2.6.1.

evaluations, laboratory audits, and systems audits. The QA Manager typically (1) reviews audit schedules, (2) conducts audit verifications, (3) ensures the audit results are uploaded to the AQS database [(OAQPS II), see References], and (4) evaluates the QC and assessment results according to the requisite monitoring program objectives. In-house assessments are described below.

19.2.1 Performance Evaluations (Field Audits)

Performance evaluations audit field instruments by using a separate ("independent") set of calibrated standards (see **Section 15.2 – Calibration Standards**) to check the sample collection process. In general, they involve side-by-side comparisons of concentrations or flow rates. The purpose of the performance audits are to:

- objectively assess the accuracy of the data collected by a monitor,
- identify monitors that may be out of control,
- identify systematic bias of a monitor or of the monitoring network, and
- measure improvement in data quality based on data from previous and current audits.

Pollutant performance evaluations are conducted in accordance with 40 CFR Part 58, Appendix A, QA requirements.[3] Meteorological sensor performance evaluations are performed annually and adhere to the established conventions described in the QA Handbook, Vol. IV. The goal is to audit 25% of the pollutant network each quarter such that the minimum annual gaseous analyzer and semi-annual PM and Pb sampler audit requirements are met. Completed pollutant performance evaluations verify the results of QC checks and provide data users with the confidence that collected data are representative and reliable for their intended use.

Procedures and acceptance criteria for the applicable performance evaluation are documented in the gaseous, PM, and meteorological sensor audit SOPs. A list of the monitoring program SOPs is included in **Appendix 2**. Typically, documenting performance evaluation consists of field worksheets and audit reports. Results of pollutant field audits are reported to the AQS database according to the data submittal and reporting requirements in CFR.[4]

Validation of the ambient air measurements based on the performance evaluation results is discussed in **Section 21 – Data Validation and Usability**. After a performance evaluation is completed, audit results and a summary of any observed equipment and siting issues are emailed to the Research and Monitoring Services (RMS) Section monitoring coordinators. Performance evaluation documentation is stored and archived according to the Records Management Plan (SOP-309) requirements.

Gaseous Annual Performance Evaluations (Field Audits)
Gaseous annual performance evaluations (field audits) are conducted per the CFR[3] audit level requirements and QA Handbook, Vol. II [(OAQPS III), see References] acceptance criteria.

[3] - 40 CFR Part 58, Appendix A – Quality Assurance for SLAMS, SPMs, and PSD Air Monitoring.
[4] - 40 CFR Part 58.16 -Data submittal and archiving requirements.

Performance Evaluation (Field Audit) Corrective Actions
If the field audit is unsatisfactory, the auditor must first verify the operation of the audit equipment before requesting the operator or RMS Section staff to check the instrument using the station calibration standards. In some circumstances, verifying the audit standard may be completed on-site immediately following the audit; however, occasionally the audit equipment is damaged in transport or malfunctions while in use, and verification in the laboratory may be required. If the audit equipment's operation is verified, the auditor sends an email noting the observed equipment issues to the appropriate RMS Section monitoring coordinator.

19.2.2 Systems Audits

Systems audits of the monitoring stations determine whether the monitoring program, remote site operators, and local city-county health officials' collection of ambient air data comply with this QAPP and related SOPs. Completed systems audits provide important information to help ensure that collected data are legally defensible. On-site inspection and review of the QA practices of all SLAMS networks are completed at 5-year intervals (if resources permit) by an Analysis and Planning Services Section staff member. System audit protocols and procedures are detailed in the Technical Systems Audit SOP-405.

19.2.3 Analytical Laboratory Audits

Audits of analytical gravimetric and Pb analysis laboratories are conducted according to the Analytical Laboratory Audit SOP-406. Audits are performed every 3 years (if resources permit). Currently, the monitoring program does not run Pb samplers or conduct Pb analysis laboratory audits.

19.2.4 Lead Analysis Audits

Laboratories that analyze Pb are required to audit quarterly the Pb Reference Method analytical procedure using filters containing a known quantity of Pb. These audit filters are prepared, analyzed, and reported as required in CFR.[5] Currently, the Pb analytical analysis is not taking place.

19.2.5 Data Quality Audits

An audit of data quality (ADQ) examines data after they have been collected and verified by the monitoring program. ADQs determine how well the measurement system performed with respect to performance goals and criteria in the QAPP and whether the data were accumulated, transferred, reduced, calculated, summarized, and reported without the introduction of bias or errors. Data quality audits trace data through all their processing steps, from origin to final reporting and storage, and duplicate intermediate calculations.

[5] - 40 CFR Part 58, Appendix A, 3.4.6 – Pb Analysis Audits.

Typically, an ADQ begins by selecting a pollutant parameter and reviewing the pollutant data set then devising a plan for the assessment. An ADQ usually includes:

- reviewing data identification by site, parameter, and date,
- reviewing pollutant relationships monitored at the station (e.g., normal observed pollutant behavior of NO/NO_2, and O_3 or $NO \leq NOx$),
- reviewing data for possible data collection and processing errors (i.e., transcription and reduction errors),
- evaluating any observed outliers,
- reviewing QA data,
- verifying proper use of null codes,
- completing analytical inter-laboratory comparisons, and
- verifying internal consistency of units and standard reporting conventions.

An ADQ identifies areas for continued quality improvement within the monitoring program and incorporates findings into the monitoring program's quality system. If resources are available, data quality audits are performed during a systems audit such that each network is audited every 5 years for one or more of the sampled pollutants. The QA Manager must complete and track the data quality audits.

19.3 Data Quality Assessments

Quality assurance information can be statistically assessed at various levels of aggregation to determine whether the data quality objectives have been attained. Additionally, the estimates can be aggregated at the following three levels: monitor, primary quality assurance organization (PQAO), and national. EPA provides annual estimates of data quality using the monitoring program's reported data and QA results and include data completeness, precision, and bias reports available from AQS.

Monitoring program evaluations conducted from the assessment reports ensure that the quality of the data is within prescribed requirements. Typically, these evaluations occur during the annual data certification. Additionally, AQS reports used during these evaluations include the AMP 600 – Certification Evaluation and Concurrence report; AMP 430 – Data Completeness Report; and AMP 256 – QA Data Quality Indicator report, which includes the precision and bias summary statistics for all of the monitors operating in the network.

For additional information on the equations, calculations, and procedures used to complete assessments of data quality, refer to 40 CFR Part 58, Appendix A, Section 4[6]; the Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR part 58 Appendix A [(OAQPS XIII), see References]; and the Data Assessment Statistical Calculator (DASC) MS Excel software [(OAQPS XIIII), see References]. For SLAMS 3-year interval data quality assessments, refer to **Section 21.4 – Reconciling Data Quality Objectives**.

[6] - 40 CFR Part 58, Appendix A, Section 4 – Calculations for Data Quality Assessment.

19.4 Corrective Action

Long-term corrective actions necessary to eliminate non-conformance with monitoring program objectives involves invalidating previously collected and submitted ambient air monitoring data. Primarily, this action is required following the review of QA activities (such as calibration or audit results) that show an analyzer/sampler operated outside the established acceptance criteria. Invalidation of data may also be required following equipment repair. Long-term corrective action also includes, but is not limited to, issues resulting from monitor siting, gaseous pollutant sample residence times, and the use of defective standards to complete a check or calibrate an instrument.

Additionally, corrective action taken during the data validation process (see **Section 21.2.5 – Resolving and Communicating Data Validation**) normally indicates an investigation is needed to validate the ambient air monitoring data for a certain time period. If monitoring program personnel suspect erroneous data, equipment failure, or another undesired effect, they can initiate corrective action requests, which may be issued to any monitoring program staff involved in ambient air monitoring data collection.

19.4.1 Corrective Action Process

The monitoring program has developed a method for implementing and tracking long-term corrective action. The process is documented using the Monitoring Program Corrective Action Request Form (CARF), included in **Appendix 7**. This type of corrective action is tracked in the AQB air monitoring network drive corrective action folder both when issued and when the corrective action is completed. The additional steps to the long-term corrective action process are:

Issuer:
1. Complete the CARF.
2. Place original CARF form in the AQB air monitoring network drive corrective action folder; this identifies the start of the corrective action.
3. Notify by email the monitoring program staff responsible for completing the corrective action investigation; send copy to the QA Manager and RMS Section Supervisor.
4. Forward the email to administrative support staff and ask him/her to update the corrective action tracking spreadsheet.

Recipient:
5. Investigate to identify the cause of non-conformance.
6. Determine the resolution to eliminate the source of non-conformance (e.g., maintenance, repair, calibration, etc.).
7. Include other recipients as applicable to address other required actions to correct any affected data as a result of non-conformance (e.g., data alterations, invalidations, etc.).
8. Identify a solution to avoid future related non-conforming events.
9. Implement the corrective action.
10. Notify issuer of the completed CARF.

Issuer:
11. Review completed CARF to ensure it was implemented as requested.

12. If CARF not completed as requested, notify recipient(s) of issue.
13. If CARF completed as requested, notify admin, QA Manager, and RMS Section Supervisor by email of the completed CARF.

19.4.2 Corrective Action Follow-up

The appropriate monitoring program supervisors and QA Manager must review the corrective action to ensure it was implemented as designed. The QA Manager must follow up on long-term corrective action. Corrective action follow-up includes:

1. Establishing the effectiveness of the corrective action.
2. Verifying that the corrective action has eliminated the problem.
3. Archiving the corrective action review documentation in the RMS Section network drive corrective action tracking spreadsheet.
4. Incorporating the lessons learned into applicable quality system documents, internal decisions and guidance, procedures, and appropriate communication.

20. Required Reporting

Periodic assessments and documentation of data quality are submitted to EPA as required and include:

- Quarterly ambient air monitoring data and associated QA information to the Air Quality System [(OAQPS II), see References] database, per 40 CFR Part 58.16[1]
- Annual ambient air monitoring data and precision/accuracy certification, per 40 CFR Part 58.15[2]
- Annual network plans and 5-year periodic network assessments, per 40 CFR Part 58.10[3]

[1] - 40 CFR Part 58.16 -Data submittal and archiving requirements.
[2] - 40 CFR Part 58.15 -Annual air monitoring data certification.
[3] - 40 CFR Part 58.10 -Annual monitoring network plan and periodic network assessment.

21. Data Validation and Usability

This section addresses the quality assurance (QA) activities that occur after air monitoring data is collected. By implementing the procedures in this section, the monitoring program can determine whether the collected data conform to specified criteria of the measurement quality objectives, thus satisfying the established data quality objectives. This section closes with the monitoring program's quality improvement efforts as part of the ambient air monitoring data collection life cycle.

21.1 Data Review, Verification, and Validation

Data review, verification, and validation are used in an objective and consistent way to accept, reject, or qualify the ambient air monitoring data collected.

Via objective evidence, **verification** is confirmation that *specified requirements* have been fulfilled [(ASQ), see References]. Via objective evidence, **validation** is confirmation that the particular requirements for a specific *intended use* are fulfilled [(ASQ), see References]. For example, we could verify that for a monitor, all 1-point QC checks were performed every 2 weeks (*specified requirement*) as described in standard operating procedures (*specified requirement*). However, for regulatory monitors, if the checks were outside the specified requirements, the validation process might determine that the data could not be used for National Ambient Air Quality Standards (NAAQS)[1] determinations (*intended use*).

For the monitoring program, data review definitions have further meaning:

- Data verification: The process of inspection, analysis, and review of QA activity and instrument/station information to determine the collected data's compliance and conformance to the stated measurement quality objectives (MQOs). During data verification:
    1. Deviations from stated MQOs are noted and documented.
    2. Any missing or rejected data is *replaced* with an appropriate Air Quality System (AQS) "null" qualifier code [(OAQPS II), see References].

- Data validation: Evaluation and determination that collected data is as representative as possible of actual air quality conditions present in the area of the instrument at the time of monitoring. Determinations designate that collected data meets their intended use. During data validation:
    1. Any data that is influenced by an air quality episode or exceptional event is *modified* with an appropriate qualifier code.
    2. Nonconformities with the established acceptance criteria are investigated and resolved.

[1] - National Ambient Air Quality Standards (NAAQS).

Acceptance criteria for verification and validation are based on the results of the QA activities and instrument operation, outlined in the EPA QA Handbook validation templates and criteria described in **Section 5.5 – Specifying Ambient Air Validation Templates**. The validation templates have three tables of criteria; each table has a hierarchy, or level of priority, according to its influence on the quality and acceptability of the data collected. The designation of operational or systematic criteria in the validation templates does not imply that these checks need *not* be performed. If a required operational or systematic quality control check is not performed, it can be a basis for invalidation of all associated data.

Table 10 includes a summary description of the validation templates' criteria tables for ambient air data and the implications for the data verification/validation process. As stated previously, strict adherence to the validation templates is not required [(OAQPS III), see References]. They are meant to be a guide based upon the knowledge of the workgroup and a starting point for the monitoring program's specific validation requirement. Measurement quality objectives (based upon requirements in the Code of Federal Regulations (CFR)) as well as this QAPP and SOPs—in combination with the monitoring program's technical expertise—may be used to invalidate a sample or measurement. Data validation investigations and resolutions stemming from deviations of established criteria are discussed in **Section 21.2.5 - Resolving and Communicating Data Validation**.

Annual data reviews are performed before the annual data certification. For more information on the annual monitoring data review and certification process, refer to the Data Certification SOP (SOP-304) and **Section 18.5.9 – Certifying Data**.

Table 10. Summary of Validation Template Criteria & Priorities for Data Verification/Validation

	Critical Criteria	Operational Criteria	Systematic Criteria
Description	Critical to maintain the integrity of a sample or group of samples.	Important for maintaining and evaluating the data collection system.	Important for the correct interpretation of data.
Examples	- Gaseous Z/S/P checks - PM flow rate verifications - NO_2 converter efficiencies - PM continuous and filter-based sampler average flow rates, variability in flow rates and sampling periods - PM low-volume and Pb sampler filter holding and recovery times - Laboratory filter acceptance testing and conditioning environment	- Federal gas analyzer performance evaluations - Monitoring program gas analyzer and PM sampler performance evaluations[1] - Calibrations; - Gaseous standards certifications and dilution systems - Ozone transfer standards certifications - Reference membrane span foil verification (MetOne BAM) - Internal shelter temperatures - PM sampler leak checks and temperature and pressure verifications - Laboratory filter and balance checks	- Siting - Completeness - Sample probe material and residence times - PM calibration standards certifications - Annual and 3-year (as appropriate) precision and bias estimates
Implications on data for deviations	Must be met to ensure the quality of the data collected. **If any criteria are violated, sample is invalid until proved otherwise**.	Indicates there might be a problem with quality of the data collected. **Violation of criteria may be cause for data invalidation**.	Indicates a potentially systematic problem with the data collection activity. **Typically, not a cause for invalidation of samples, but may affect error rate.**[2]
Monitoring program investigation	Conducted to determine cause of not operating in the acceptable range. Reason to not invalidate collected data is documented.	Considers other QC information that may or may not indicate the data are acceptable. The reason for the data not meeting the criteria must be justified and documented.	See **Section 21.4– Reconciling Data Quality Objectives**

[1] - Under most circumstances, field audit (accuracy) results are not intended to provide the basis for invalidating data. However, unsatisfactory results signal the auditor and operator to initiate a documented check of the instrument using the station's calibration standards. If, during the investigation, the instrument operated outside established control limits, the critical criteria table discussion of using QC checks to validate data applies.

[2] - Non-representative siting, dirty or fouled sample lines, etc., may in the end be cause for data invalidation.

21.2 Methods for Verifying and Validating Data

Data is *verified* after it is collected in the field or analyzed in the lab. Automated and manual data verification methods compare applicable QC activity results to the acceptance criteria established in the ambient air validation templates (see **Section 5.5 – Specifying Ambient Air Validation Templates**). Additionally, the appropriate null codes replace missing data or data collected during periods when QC criteria were not being met.

Data is *validated* after it is verified; usually, someone other than the data collector validates the data. Data validation reviews *all* available QA activities and documentation to ensure the ambient air data measurement is representative of actual ambient conditions. In addition, qualifier flags are placed on criteria pollutant data that are influenced by an exceptional event.

A summary of the methods for verifying and validating data is presented below. Also described are data collected during exceptional events, qualifier codes and annotations, and the process for resolving and communicating data validation.

21.2.1 Automated (Continuous) Instrument Data

The monitoring program currently uses software that provides a degree of data analysis and flagging based upon a set of user-defined values. This software module, called the Automatic Data Validation Processor (ADVP), highlights questionable data values so they can be analyzed in more detail by program staff. In this way, the ADVP adds a level of data verification not previously available. Additionally, a flagged daily summary report is generated automatically and emailed to data users each morning.

During data verification, the results of the QC checks are evaluated to the established MQO acceptance criteria. Within the monitoring program, some continuous PM monitors are operated by county health officials who conduct QC checks on the instruments and report the results to the Research and Monitoring Services (RMS) Section PM coordinator for use during data verification. In addition, gaseous data verifications are performed directly by the RMS Section Gaseous and Meteorological Monitoring coordinator or NCore coordinator.

Each monitoring coordinator completes the first step of the data validation process. For continuous instruments, data is validated by thoroughly reviewing (1) performance evaluations, (2) analyzer monthly site-check logs, (3) control charts, (4) electronic strip charts, (5) instrument stability records, (6) ADVP-produced flags, and (7) auxiliary supporting information, such as internal shelter temperatures. Once the initial data validation is complete, the RMS Section Supervisor assesses the validation process and resulting data before reporting. If data validation issues arise, the resolution process is followed (see **Section 21.2.5 – Resolving and Communicating Data Validation**).

Following data review, the monitoring coordinators and supervisor sign off on the data in the Update Review Tracker Template Spreadsheet (see **Section 18.5.7 – AQS Data Reporting Requirements**). For more information on the data review process, refer to the SOPs for continuous gaseous, particulate matter, and meteorological data review, verification, and validation.

21.2.2 Manual (Filter-Based) Sampler Data

The process for verifying and validating manual (filter-based) sampler data is slightly different than the method for automated instrument data because the sample-run information is obtained manually. However, once the data is uploaded to the Agilaire AirVision database, the monitoring coordinator's review responsibilities are similar.

The data verification process begins when site operators manually complete PM sample-run data sheets (SRDSs) that accompany the exposed filters from the field to the laboratory, along with the sample chain-of-custody forms. The SRDSs retain valuable site and date-specific sample setup and run information used during the data verification and validation process. Post-gravimetric laboratory filter weighing, the filter weight, and QA information is delivered to the monitoring program via post or email.

Pertinent filter run information is received electronically is uploaded directly into the Agilaire AirVision database. Verifying and validating data includes a review and evaluation of all sampler-run, QA activity, and laboratory information. If a data validation issue arises, the resolution process is followed (see **Section 21.2.5 – Resolving and Communicating Data Validation**).

Following review, the monitoring coordinator and supervisor sign off on the data in the Update Review Tracker Template Spreadsheet (see **Section 18.5.7 – AQS Data Reporting Requirements**). For more information on the data review process, refer to the Integrated Low Volume Particulate Data Review, Verification, and Validation SOP (SOP-504).

21.2.3 Exceptional Event Data

Sometimes monitoring activities occur during unusual air quality episodes or exceptional events that do not represent normal ambient air. The data collected under these circumstances need to be identified or qualified as an exceptional event in AQS so that these data are excluded when making compliance determinations. Exceptional events include:

- chemical spills and industrial accidents,
- structural fires,
- exceedances from transported pollution,
- exceedances from a terrorist attack,
- natural events:
    - natural disasters and associated clean-up activities,
    - volcanic and seismic activities,
    - high wind,
    - wildland fires,

  - stratospheric ozone intrusions, and
- prescribed fire.

Exceptional events data are flagged according to CFR.[2] Qualification determinations of this data are made according to the DEQ Air Quality Bureau's (AQB) Exceptional Event Guidance. Once the collected data qualifies as an exceptional event, qualifier flags are placed on the data before uploading to AQS. Currently, the AQB Exceptional Event Guidance is under development. In the interim, determinations are completed under the direction of AQB's exceptional event workgroup. For more information about reporting requirements for exceptional events, see **Section 18.5.10 – Processing and Reporting Exceptional Event Data**.

21.2.4 Qualifier Codes/Flags and Annotations

AQS qualifiers include codes and flags. Before being submitted to AQS, qualifiers are inserted as null codes to replace ambient air monitoring data for hours or periods when the instrument is not collecting valid data. In addition, qualifiers are inserted as flags to document an exception to the collected data. Qualifier flags include QA exceptions and exceptional event qualifiers. Null codes explain why a sample value was not reported, while qualifier flags accompany the data to AQS, and the data remains technically valid.

For the most part, the null codes are descriptive and include:

- power failure,
- calibration,
- PM flow-rate verification (precision) check, and
- gaseous Z/S/P check null codes.

A number of non-descriptive null codes include:

- lab error,
- poor QA results,
- maintenance/routine repairs,
- voided by operator,
- miscellaneous void ,
- machine malfunction, and
- corrupt data file.

Descriptive null codes require no further explanation. However, additional annotations are necessary when using non-descriptive null codes because these codes are vague and do not accurately describe why the sample value was not reported. The Agilaire AirVision database includes an annotation log that allows for data explanations when using non-descriptive null codes. When using non-descriptive null codes, the monitoring coordinator performing the data review must place additional explanations in the annotations log. For more information on the types of qualifiers available during data verification and validation, refer to **Section 18.5.6 – AQS Qualifiers**.

[2] - 40 CFR Part 50.14 - Treatment of air quality monitoring data influenced by exceptional events.

21.2.5 Resolving and Communicating Data Validation

The monitoring program uses great care in universally applying the invalidation criteria. Note that the validation templates are evolving, and the acceptance criteria in the MQO validation template were based on the current state of knowledge at the time they were developed. Therefore, the validation templates are the starting point but are reviewed during the data validation resolution process to ensure the criteria are within reason, based on the professional and technical expertise of the monitoring program and the physical limitations of monitoring equipment.

Sometimes data is outside of the established acceptance criteria, but we believe the data still meets its intended use. In these instances, the monitoring program uses the "weight of evidence" approach when determining the suitability of data for regulatory decisions per 40 CFR Part 58, Appendix A.[3] As stated in the regulations, "Failure to conduct or pass a required check or procedure, or a series of required checks or procedures, does not by itself invalidate data for regulatory decision making." The monitoring program considers other information to document that the monitors were working correctly or when the monitors stopped working correctly independent of the completion of acceptable QC check. Other information used in the past includes pressure board failures on PM monitors; faulty mother boards on gaseous SO_2 analyzers that caused the instrument to shut down, but upon reboot the instrument the instrument remained operational; and O_3 analyzers with internal temperature logging of the photometer lamp that indicated the instrument remained operational when the shelter temperature was outside of the established temperature range.

If collected data exceeds the established acceptance criteria, the monitoring coordinator investigates the validity of the data to determine whether it is of adequate quality for its intended purpose. To begin the investigation, the monitoring coordinator notifies the RMS Section Supervisor about the issue and the level of validation criteria priority: critical, operational, or systematic. At that time, the RMS Section Supervisor determines the best way to resolve the validation issue. Depending on the level of deviation, the investigation may expand into a group consultation among relevant monitoring program parties, including, but not limited to, the RMS Lead Worker and Analysis and Planning Services QA Manager. Additionally, investigations are typically documented as part of the corrective-action process.

In some instances, the resolution process results in developing an internal decision and issuing subsequent documentation or guidance. Additionally, data validation resolutions are available for incorporation into the monitoring program quality system (see **Section 21.5 – Improving the Quality System**).

21.3 Reporting QA Data

Should QC checks fail, leading to invalidation of the data, any completed QC checks are not reported to AQS during the same time period that the routine data were invalidated [(OAQPS XV), see References].

[3] - 40 CFR Part 58, Appendix A – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards, Section 1 – General Information.

Because the routine data are unavailable in AQS, it is inappropriate to provide a QC value used in overall estimates of the precision and bias of those data. The intention is for the site, monitor, or primary quality assurance organization (PQAO) estimates of precision and bias to represent valid monitoring data that is routinely reported.

21.3.1 NPAP and PEP Data

Performance evaluation results of the National Performance Audit Program (NPAP) and Performance Evaluation Program (PEP) represent the monitoring program's PM and Pb bias estimates and gaseous precision and bias verifications at the PQAO level. These results are not used to invalidate the ambient monitoring data collected. Note that Pb-PEP collocated audits do not occur at this time because the monitoring program does not collect Pb samples. Additionally, NPAP and PEP audit results are submitted to AQS independent of the monitoring program and completed by an EPA contractor. If the NPAP/PEP performance evaluation is unsatisfactory, an investigation will determine the cause of the non-conformance (see **Section 21.2.5 – Resolving and Communicating Data Validation**).

21.3.2 Collocated PM Data

Similar to the NPAP/PEP data, results of collocated PM data represent the monitoring program's precision estimates at the PQAO level. If the precision estimate of a collocated PM monitor exceeds the established measurement uncertainty goal, the collocated sampler data is typically submitted to AQS as valid. The resulting precision estimate reflects the actual monitor operating conditions, and the results are used to identify issues with the monitors. Retaining these measurements as valid allows us to track trends and gain a better understanding of the monitors' operating capabilities. In these instances, the monitoring program makes every effort to determine the cause of the non-conformance (see **Section 21.2.5 – Resolving and Communicating Data Validation**).

21.3.3 Monitoring Program Performance Evaluation (Field Audit) Data

Performance audit results are invalidated if the routine monitoring data are invalidated during the time period encompassing the audit. If the performance evaluation results are outside the audit acceptance criteria, but the data is reported as valid, the audit results are submitted to AQS.

21.4 Reconciling Data Quality Objectives

Reconciling the data quality objectives (DQO) involves reviewing both routine and QA information to determine whether the DQOs have been attained and whether the data are adequate for their intended use. Evaluating the data against the DQO is referred to as a data quality assessment (DQA). During a DQA, the most important point is to verify that the collected data are consistent with the QAPP and established monitoring requirements.

The monitoring program may conduct a *formal* DQA to ensure the collected data meets the established DQOs, using the procedures detailed in the EPA document Data Quality Assessment: A Reviewer's Guide [(OEI III), see References]. Primarily, a DQA is performed on collected SLAMS or regulatory SPM

monitoring data, which is near or at the level of the NAAQS. The DQA addresses and supports the primary monitoring objective of NAAQS compliance determinations over the standard interval (3 years). The DQA is designed to answer fundamental study questions, including:

- Can the decision (or estimate) be made with the desired level of certainty, given the quality of the data set? In other words, does the estimate's region of measurement uncertainty (based on the sampled data) enclose the true (actual) value of the pollutant concentration present?
- How well did the sampling design perform?

The steps to complete a *formal* DQA include:

1. Review the DQO and sampling design: Review the monitor's DQO outputs (monitor objective, site type, monitor type, and data quality indicators) to assure they are still applicable, and note any observed discrepancies.
2. Conduct a preliminary data review: Review QA information and reports; calculate basic quarterly, annual, and 3-year statistics; and generate graphs of the summary statistics.
3. Select the statistical test: Select the most appropriate procedure for summarizing and analyzing the data, based on reviews of the acceptance criteria associated with the DQOs, the sampling design, and the preliminary data review. (See 40 CFR Part 50[4] for the exact calculations.)
4. Verify assumptions of the statistical test: Evaluate whether the underlying assumptions still hold or departures are acceptable, given the collected data and other information from the ambient air data collection. Create a summary of violations of the DQO assumptions, if any.
5. Draw conclusions from the data: Perform the calculations for the statistical test and document the inferences drawn as a result of these calculations. If any of the assumptions have been violated, the level of confidence with the test is suspect and is investigated further.

What if the DQOs are not met?

Implement the DQA process to confirm achievement of the DQOs. However, achieving the DQOs does not equate to 100% certainty that every NAAQS decision (attainment, non-attainment) will be a correct decision. Even when a DQO is achieved, the chances of making an incorrect decision increase as the data (e.g., design value) get closer to the action limit (NAAQS) (see **Section 5.3.3 – Acceptable Limits on Decision Errors**). Similarly, if the DQOs are not met, it does not mean that the pollutant data cannot be used for NAAQS decisions; it means that the decision-makers will have less confidence that they will make the correct decision, especially around the action limit (see **Section 5.3.2 –Uncertainty Goals for Ambient Air Measurements**).

[4] - 40 CFR Part 50 - National Primary and Secondary Ambient Air Quality Standards.

21.5 Improving the Quality System

Quality improvement incorporates the monitoring program observations, findings, and lessons learned from assessments (including, but not limited to, corrective actions, DQAs, and technical system audits) into the quality system documents and activities. The objective is to increase the quality of the data collected. Equipment and software evaluations also provide an opportunity for continued quality improvement of the monitoring program when purchasing and upgrading equipment, standards, and instruments. Furthermore, when AQB reviews and evaluates the systems audits and audits of data quality, they provide the necessary feedback for continual improvement of the monitoring program. Finally, quality improvement activities are completed while taking into consideration the need for material and personnel resources.

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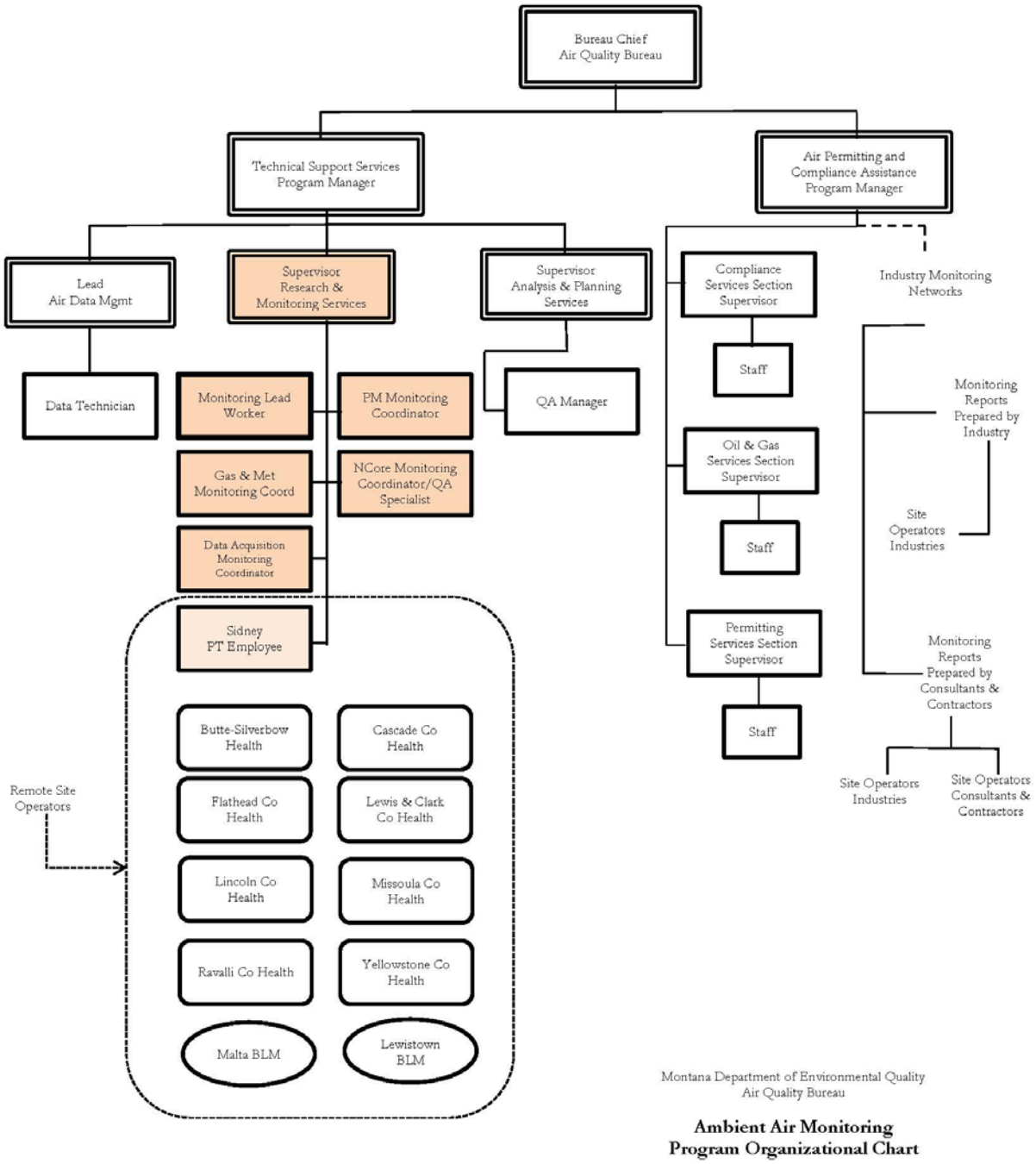
Appendix 1 – Monitoring Program Organization Chart



Monitoring program organization chart.

Appendix 2 – Monitoring Program Standard Operating Procedure List

Monitoring Program Standard Operating Procedures Series

Series Numeric Format	Standard Operating Procedures	Series Description
000	Monitors and Samplers	Acceptance Criteria, Installation/Setup, Operation, Precision Checks, Calibration, Site Checks, Troubleshooting/Corrective Action, Maintenance, Quality Control, and Data Acquisition
100	Monitor and Sampler Calibration Equipment	Calibrators and Flow Measuring Standards
200	Data Collection	Strip Chart Recorders, data loggers
300	Data Processing and Management	Processing Software, Continuous and Integrated Sampling Processing
400	Quality Assurance and Oversight	Performance Audits, Systems Audits, and Establishing Warning/Control Limits
500	Data Verification and Validation	Site Operator Review, Coordinator Review
600	Validation of Standards	Compressed Gas Cylinders; Flow measuring Standard Verifications, Certifications, and Calibrations; Ozone Photometer Certifications
700	Laboratory	Analytical Operations

Monitoring Program List of Standard Operating Procedures

SOP Number	SOP Title	Revision Number	Issue Date	Revision Date
SOP-001	API, Inc., T100U SO_2 Analyzer Standard Operating Procedure *(Formerly API, Inc., 100A SO_2 Analyzer Standard Operating Procedure:; Revision 0 - 03/31/2006; Revision 1 - 03/21/2009)*	2	3/31/2006	3/15/2016
SOP-002	API, Inc., 300 & 300E CO Analyzer Standard Operating Procedure	1	3/31/2006	3/31/2009
SOP-003	TEI, Inc., 49C UV Photometric O_3 Analyzer Standard Operating Procedure	1	3/31/2006	3/31/2009
SOP-004	Dasibi 1003-AH UV Photometric O_3 Analyzer Standard Operating Procedure	1	3/31/2006	3/31/2009
SOP-005	API, Inc., 200E Chemiluminescence NOx Analyzer Standard Operating Procedure	1	3/31/2006	3/31/2009
SOP-006	MET ONE BAM 1020 Particulate Monitor Standard Operating Procedure	3	7/15/2008	7/31/2015
~~SOP-007~~	~~Graseby Andersen/GMW Model 1200 & Model 321-B High-Volume Air Sampler Standard Operating Procedure~~		**SOP withdrawn** *(Instrument not in use)*	
~~SOP-008~~	~~Wedding and Associates High-Volume Air Sampler Standard Operating Procedure~~		**SOP withdrawn** *(Instrument not in use)*	
SOP-009	BGI PQ 200 Low Volume Particulate Sampler Standard Operating Procedure	1	7/15/2008	8/15/2015
SOP-010	Climatronics WM-III Wind Speed and Direction Sensors Standard Operating Procedure	0	9/30/2006	

SOP-011	Climatronics Sonic Anemometer Standard Operating Procedure	1	9/30/2008	11/20/2015
SOP-012	Ambient Thermometer in a Motor Aspirated Radiation Shield Standard Operating Procedure	0	9/30/2008	
SOP-013	Settled Particulate Matter (Dustfall) Collection Standard Operating Procedure	0	9/30/2008	
SOP-014	MET ONE BAM 1020 Particulate Monitor $PM_{2.5}$– FEM Configuration Standard Operating Procedure	2	8/29/2008	7/31/2015
SOP-015	Thermo 42i-Trace Level Chemiluminescence NO-NO2-NOx Analyzer Standard Operating Procedure	0	3/15/2016	
SOP-016	Thermo 48i Trace Level – Enhanced CO Analyzer Standard Operating Procedure	0	**In Development**	
SOP-017	Thermo 42i-NOy Chemiluminescence NO-DIF-NOy Analyzer Standard Operating Procedure	0	**In Development**	
SOP-018	MET ONE BAM 1020 $PM_{10\text{-}2.5}$-Coarse Standard Operating Procedure	0	**In Development**	
SOP-019	Thermo 5014i Beta Continuous Ambient Particulate Monitor Standard Operating Procedure	0	11/01/2015	
SOP-020	Gaseous Analyzer Remote QC and Status Check Standard Operating Procedure	0	12/15/2016	
SOP-101	API 700 Mass Flow Calibrator Standard Operating Procedure	0	12/30/2005	
SOP-102	ESC 7700P Dynamic Gas Calibration System Standard Operating Procedure	0	12/30/2005	
SOP-103	EESI 3000 Calibrator Standard Operating Procedure	0	12/30/2005	
SOP-104	ESC 7700RM Dynamic Gas Calibration System Standard Operating Procedure	0	7/15/2008	
~~SOP-105~~	~~Dasibi 1009-MC Calibrator Standard Operating Procedure~~		**SOP withdrawn** *(Instrument not in use)*	
SOP-106	TEI, Inc., 49C PS UV Photometric O_3 Calibrator Standard Operating Procedure	0	09/30/2008	
SOP-107	API 701 Zero Air Generator Standard Operating Procedure	0	12/30/2005	
SOP-108	ESC 770P (Perma Pure ZA-750-12) Zero Air Generator Standard Operating Procedure	0	12/30/2005	
SOP-109	MT DEQ Zero Air Generator Standard Operating Procedure	0	9/30/2008	
SOP-110	High-Volume Orifice Standard Operating Procedure	0	9/30/2008	
SOP-111	Flow Measuring Orifice (5-8 & 14-25 l/min) Standard Operating Procedure	0	7/15/2008	
SOP-112	BGI DeltaCal Standard Operating Procedure	0	3/31/2006	
SOP-113	BGI TriCal Standard Operating Procedure	0	3/31/2006	
SOP-114	BIOS DryCal Standard Operating Procedure	0	3/31/2006	
SOP-115	Hastings Mass Flow Meter Standard Operating Procedure	0	9/30/2006	
SOP-116	Gilian Gilibrator II Standard Operating Procedure	0	3/31/2006	
SOP-117	Verification of Wind Direction Instrument Orientation using the Warren-Knight Theodolite Standard Operating Procedure	0	3/31/2006	
SOP-118	Verification of Wind Direction Instrument Orientation Using NFC-6 Forester Compass Standard Operating Procedure	0	9/30/2006	

SOP-119	Environics 6103 Dynamic Gas Calibration System Standard Operating Procedure	0	10/01/2014	
SOP-120	API T700 Dynamic Dilution Calibrator Standard Operating Procedure	0	11/01/2015	
SOP-121	Alicat Whisper MFM Standard Operating Procedure		**In Development**	
SOP-201	Soltec Strip Chart Recorder Standard Operating Procedure	0	7/15/2008	
SOP-202	ESC 8816 Data Logger Standard Operating Procedure	1	3/31/2006	6/30/2009
SOP-203	ESC 8832 Data Logger Standard Operating Procedure	1	6/30/2009	10/01/2014
SOP-204	Honeywell Minitrend Recorder		**In Development**	
SOP-301	Continuous Instrument Data Processing Standard Operating Procedure	1	7/10/2008	12/15/2015
SOP-302	Industrial Continuous and Integrated Data Processing Standard Operating Procedure	0	9/30/2008	
SOP-303	Integrated Particulate Lo-Vol Sampling Data Processing Standard Operating Procedure	1	9/30/2008	5/13/2010
SOP-304	Data Certification Standard Operating Procedure	1	9/30/2008	03/15/2017
SOP-305	~~Precision Coding and AQS Transaction Standard Operating Procedure~~		**SOP withdrawn** *(Combined SOP-305 with SOP-501)*	
SOP-306	AQS Accuracy Transaction Standard Operating Procedure	0	9/30/2008	
SOP-307	Exceptional Events / Smoke Impacted Data Standard Operating Procedure	0	5/15/2009	
SOP-308	~~Reports Standard Operating Procedure~~		**SOP withdrawn** *(staff have ability to create AQS reports)*	
SOP-309	Records Management Standard Operating Procedure	0	03/01/2016	
SOP-401	Continuous Gas Analyzer Performance Audit Standard Operating Procedure	1	6/30/2006	10/01/2014
SOP-402	Met One BAM-1020 Performance Audit Standard Operating Procedure	1	1/01/2007	8/29/2008
SOP-403	BGI PQ200 Performance Audit Standard Operating Procedure	0	1/01/2007	
SOP-404	Meteorological Sensor Performance Audit Standard Operating Procedure	0	3/31/2007	
SOP-405	Technical Systems Audit Standard Operating Procedure	0	9/30/2008	
SOP-406	Analytical Laboratory Audit Standard Operating Procedure	0	9/30/2008	
SOP-407	High-Volume Volumetric Flow Controlled Particulate Sampler Performance Audit Standard Operating Procedure	0	9/30/2008	
SOP-408	Thermo 5014i Beta Continuous Ambient Particulate Monitor Performance Audit Standard Operating Procedure		**In Development**	
SOP-501	Continuous Gaseous and Meteorological Data Review, Verification, and Validation Standard Operating Procedure *(Combined gas precision coding in SOP-305 with SOP-501: Revision)(Combined SOP-503 with SOP-501: Revision 1)*	1	9/30/2006	03/31/2017
SOP-502	Continuous Particulate Data Review, Verification, and Validation Standard Operating Procedure	0	9/30/2008	
SOP-503	~~Continuous Meteorological Data Review, Verification, and Validation Standard Operating Procedure~~		**SOP withdrawn** *(Combined SOP-503 with SOP-501: Revision 1)*	
SOP-504	Integrated Low Volume Particulate Data Review,	1	9/30/2008	8/01/2015

	Verification, and Validation Standard Operating Procedure			
SOP-505	Industrial Monitoring Data Review, Verification, and Validation Standard Operating Procedure	0	9/30/2008	
SOP-601	High-Volume Orifice Certification Standard Operating Procedure	0	12/30/2005	
SOP-602	5.0-8.8 l/min & 14.0-25.0 l/min Flow Measuring Orifice Certification Standard Operating Procedure	0	9/30/2008	
SOP-603	DeltaCal Certification Standard Operating Procedure	0	9/30/2008	
SOP-604	Mass Flow Meter Certification Standard Operating Procedure	0	9/30/2006	
SOP-605	Ozone Transfer Standard and Photometer Certification Standard Operating Procedure	2	6/30/2006	11/15/2013
SOP-606	Thermometer Certification Standard Operating Procedure	0	9/30/2008	
SOP-607	Barometer Certification Standard Operating Procedure	0	9/30/2008	
~~SOP-701~~	~~DPHHS Analytical Laboratory PM_{10} Hi-Vol Filter Weighing Standard Operating Procedure~~		**SOP withdrawn** (Method no longer in use)	
SOP-702	IML Air Science Quality Assurance Project Plan for Laboratory and Data Management Support of the Determination of Fine Particulate as $PM_{2.5}$ in the Atmosphere	1	12/31/2005 (Revision 9)	1/31/2013 (Revision 13)

Appendix 3 – Crosswalk between EPA's Requirements for QAPPs (EPA QA/R-5) and DEQ's QAPP

Crosswalk between EPA's Requirements for QAPPs (EPA QA/R-5) and DEQ's QAPP:

EPA QA/R-5	DEQ QAPP
	Purpose of the Quality Assurance Project Plan
A: Project Management	
A1 Title and Approval Sheet	Title and Approval Sheet
	Revision History
A2 Table of Contents	Table of Contents
	Table of Contents-Figures
	Table of Contents-Tables
	Acknowledgements
	Acronyms and Abbreviations
A3 Distribution List	QAPP Distribution List
A5 Problem Definition/Background	1. Clean Air Regulations & Monitored Pollutants
	2. Objectives of DEQ's Air Monitoring Program
	2.1 Ensuring User Needs and Quality Data
A4 Project Task/Organization	3. Structure of DEQ's Air Monitoring Program
	3.1 A Primary Quality Assurance Organization
A6 Project Task/Description	4. What We Collect and How
	4.1 Required Documentation
	4.2 Various Tasks Associated with Monitoring Air Data
	4.3 AQS Data Reporting
	4.4 Project Approval Process and Revision Information
A7 Quality Objectives and Criteria	5. Quality Objectives and Criteria for Managing Quality
	5.1 Managing Uncertainty Associated with Air Monitoring Measurements
	5.2 Quantifying Ambient Air Data Quality Indicators
	5.3 Establishing Data Quality Objectives
	5.3.1 Decision Rules for NAAQS Compliance
	5.3.2 Uncertainty Goals for Ambient Air Measurements
	5.3.3 Acceptable Limits on Decision Errors
	5.3.4 Assessments of Data Quality
	5.4 Characterizing Ambient Air Measurement Quality Objectives
	5.5 Specifying Ambient Air Validation Templates
	5.6 Determining Data Suitability Using the "Weight of Evidence" Approach
	6. Quality Assurance Defined
A8 Special Training/Certification	7. Staff Training
A9 Documents and Records	8. Documents and Records Management
	8.1 Quality System and Quality Assessment Documents
	8.2 Data Records and Supporting Information
	8.3 Documents and Records Storage, Backup, Retention, and Disposal
B: Data Generation and Acquisition	
B1 Sampling Process Design	9. Network Sampling Design
	9.1 The Life Cycle of an Ambient Air Monitoring Station
	9.1.1 Determining Pollutant Monitoring Objectives
	9.1.2 Defining Site Type
	9.1.3 Monitoring Requirements and Number of Sites
	9.1.4 Defining Spatial Scales
	9.1.5 Solving Proper Siting
	9.1.6 Establishing Meteorological Measurements

	9.1.7 Resolving Physical Location
	9.1.8 Determining the Monitoring Method
	9.1.9 Defining Monitor Inlet and Probe Siting
	9.1.10 Establishing the Monitoring Station
	9.1.11 Determining Monitor Type Designations
	9.1.12 Assigning Monitor Network Affiliation
	9.1.13 Explaining Regulatory and Non-Regulatory Monitors
	9.1.14 Completing the Network Modification Documentation
	9.1.15 Conducting Site Evaluations
	9.1.16 Completing Network Reviews
	9.1.17 Continuing/Discontinuing a Monitor Station
	9.2 Classification of Monitor Measurements as Critical/Non-Critical
	9.3 Collocated Monitoring
	9.4 The Operating Schedule
	9.5 Data Completeness
	9.6 NAAQS Comparisons and Design Values
	9.7 Adaptive Network, Looking Forward
B2 Sampling Methods	10. Sampling Methods
	10.1 Equivalent Method Requests
	10.2 Reference and Equivalent Equipment Modification Requests
	10.3 Pb-PM_{10} in lieu of Pb-TSP Sampler Requests
	10.4 Approved MAAQS Monitoring Methods
	10.4.1 Settled Particulate Matter
	10.4.2 Hydrogen Sulfide
	10.5 Probe Material and Pollutant Sample Residence Time
B3 Sample Handling and Custody	11. Sample Handling and Custody
	11.1 Chain of Custody
	11.2 Sample Retention and Disposal Requirements
B4 Analytical Methods	12. Analytical Methods
B5 Quality Control	13. Quality Control
	13.1 Quality Control Reporting Requirements
	13.2 Quality Control Corrective Actions
B6 Instrument/Equipment Testing, Inspection, and Maintenance	14. Instrument & Equipment Procurement, Testing, Inspection, and Maintenance
B7 Instrument/Equipment Calibration and Frequency	15. Instrument & Equipment Calibration and Calibration Frequency
	15.1 Calibration-Verifications
	15.2 Calibration Standards
	15.3 Calibration Corrective Actions
B8 Inspection/Acceptance of Supplies and Consumables	16. Inspection/Acceptance of Supplies and Consumables
B9 Non-direct Measurements	17. Non-direct Measurements
B10 Data Management	18. Data Acquisition and Information Management
	18.1 Acquiring Data from Backup Instruments
	18.2 Altering Data during Processing
	18.3 Correcting Data Using QA Information
	18.4 Processing Precision and Accuracy Information
	18.5 Reporting and Certifying Data
	18.5.1 Reporting the Air Quality Index

	18.5.2 Reporting Public Data
	18.5.3 AQS Standard Reporting Format
	18.5.4 AQS Parameter and Method Codes
	18.5.5 Standard Reporting Format for the AQS Pollutant Units and Decimal Place
	18.5.6 AQS Qualifiers
	18.5.7 AQS Data Reporting Requirements
	18.5.8 AQS Corrective Actions
	18.5.9 Certifying Data
	18.5.10 Processing and Reporting Exceptional Event Data
	18.6 Notifying the Public of an Exceptional Event
C: Assessment and Oversight	
C1 Assessments and Response Actions	19. Assessment and Response Actions
	19.1 Independent Assessments
	19.1.1 National Performance Evaluations
	19.1.2 Technical Systems Audits
	19.1.3 Ozone Transfer Standard Verifications
	19.1.4 Ambient-Air Protocol Gas Verification Program
	19.2 Monitoring Program Assessments
	19.2.1 Performance Evaluations (Field Audits)
	19.2.2 Systems Audits
	19.2.3 Analytical Laboratory Audits
	19.2.4 Lead Analysis Audits
	19.2.5 Data Quality Audits
	19.3 Data Quality Assessments
	19.4 Corrective Action
	19.4.1 Corrective Action Process
	19.4.2 Corrective Action Follow-up
C2 Reports to Management	20. Required Reporting
D: Data Validation and Usability	21. Data Validation and Usability
D1 Data Review, Verification, and Validation	21.1 Data Review, Verification, and Validation
D2 Verification and Validation Methods	21.2 Methods for Verifying and Validating Data
	21.2.1 Automated (Continuous) Instrument Data
	21.2.2 Manual (Filter-Based) Sampler Data
	21.2.3 Exceptional Event Data
	21.2.4 Qualifier Codes/Flags and Annotations
	21.2.5 Resolving and Communicating Data Validation
	21.3 Reporting QA Data
	21.3.1 NPAP and PEP Data
	21.3.2 Collocated PM Data
	21.3.3 Monitoring Program Performance Evaluation (Field Audit) Data
D3 Reconciliation with User Requirements	21.4 Reconciling Data Quality Objectives
	21.5 Improving the Quality System
	References

Appendix 4 – Measurement Quality Objectives for NCore Station Trace Level Gas Instruments

NCore Station Trace Level Gas Instruments - QC Check Measurement Quality Objectives

		CO	SO2	NO, NOy	ADDITIONAL INFORMATION
FREQUENCY		Once Every Two Weeks (every 14 days)			40 CFR Part 58, Appendix A, Sec 3.1.1
ANALYZER RANGE	EPA[1]	5000 ppb	100 ppb	200 ppb	For a typical urban NCore station
ZERO	EPA[1] ACTION LIMIT	< ±40 ppb	< ±0.100 ppb	< ±0.050 ppb	
	DEQ ACTION LIMIT	*< ±75 ppb*	*< ±0.750 ppb*	*< ±0.750 ppb*	*Proposed MT DEQ NCore Zero Action Tolerance Limit (July 08, 2011)*
PREC	CONCENTRATION	250 – 500 ppb	5 - 10 ppb	20 -40 ppb	NOy Precision (1-PT QC) Check using NO_2 GPT
	EPA[1] ACTION LIMIT	±10 %Δ	±10 %Δ	±10 %Δ	
SPAN	CONCENTRATION	4500 ppb	90 ppb	180 ppb	
	EPA[2] ACTION LIMIT	±15 %Δ	±10.0 %Δ	±15.0 %Δ	
NOy CONVERTER EFFICIENCY				≥ 96 %	Using NO/NOx Test Gas Concentration
				≥ 95 %	Using NPN Test Gas Concentration
MEASUREMENT UNCERTAINTY GOAL	EPA[1] PRECISION	15%	10%	10%	Upper 90% confidence limit (CL) for the Coefficient of Variation (CV)
	BIAS	10%	10%	10%	Upper 95% CL for the Absolute Bias CV

%Δ – Percent Difference.

[1] - EPA NCore Training Workshop National Air monitoring Conference (2009). <https://www3.epa.gov/ttn/amtic/ncoreguidance.html>

[2] - EPA TEI MODEL 48C TLE CO Analyzer SOP (Version 2.0; May 6, 2009); EPA TEI MODEL 43C TLE SO_2 Analyzer SOP (Version 2.0; May 6, 2009); EPA TELEDYNE API NOy SOP (Version 1.0; May 6, 2008). <https://www3.epa.gov/ttn/amtic/ncoreguidance.html>

NCore Station Trace Level Gas Instruments – Calibration Measurement Quality Objectives

		CO	SO_2	NO, NOy	ADDITIONAL INFORMATION
FREQUENCY	EPA[2]	Once Every 90 days and Following Maintenance, Repairs			
NUMBER OF TEST CONCENTRATIONS	EPA[2]	At Least 4 Including Zero			
AFTER ADJUSTMENT CRITERIA	EPA[2]				
	SPAN AND MID SCALE CONCENTRATIONS	< ±5.0 %Δ	< ±5.0 %Δ	< ±5.0 %Δ	
	DEQ GOAL ZERO	*< ±40 ppb*	*< ±0.100 ppb*	*< ±0.050 ppb*	
	SPAN CONCENTRATION	*±2.0 %Δ*	*±2.0 %Δ*	*±2.0 %Δ*	
	MID SCALE CONCENTRATIONS	---	----	----	
LINEARITY	EPA[2] Slope	(m): 0.98 -1.02	(m): 0.98 -1.02	(m): 0.98 -1.02	Sum of Least squares Linear Regression (SSR) of known test concentration (X) versus DAS response (Y)
	Intercept	(b): ±40 ppb	(b): ±1.0 ppb	(b): ±1.0 ppb	
	Correlation Coefficient	(r) ≥ 0.9950	(r) ≥ 0.9950	(r) ≥ 0.9950	
CONVERTER EFFICIENCY	EPA[2]			Average ≥ 96%	Slope from SSR of known NO_{DIF} test concentration (X) versus NO_{DIF} Converted (Y)

%Δ – Percent Difference.

[1] - EPA NCore Training Workshop National Air monitoring Conference (2009). <https://www3.epa.gov/ttn/amtic/ncoreguidance.html>

[2] - EPA TEI MODEL 48C TLE CO Analyzer SOP (Version 2.0; May 6, 2009); EPA TEI MODEL 43C TLE SO_2 Analyzer SOP (Version 2.0; May 6, 2009); EPA TELEDYNE API NOy SOP (Version 1.0; May 6, 2008). <https://www3.epa.gov/ttn/amtic/ncoreguidance.html>

Appendix 5 –Measurement Quality Sample Summary Table for Monitoring Ambient Air

Measurement Quality Sample Summary Table

Method	Coverage (annual)	Minimum frequency	MQOs [1] (Acceptance Criteria)	40 CFR Part 58, Appendix A [2] Reference	
				Method / Coverage / Frequency	Assessment Calculations
Gaseous Methods (CO, NO_2, SO_2, O_3)					
One-Point QC: **CO, NO2, SO2, O3,,**	Each analyzer	Once per 2 weeks (each check minimally separated by 14 days)	CO: < |± 10.1% Δ| NO_2: < |± 15.1% Δ| SO_2: < |± 10.1 % Δ| O_3: < |± 7.1% Δ|	3.1.1	4.1.2, 4.1.3
Annual performance Evaluation: **CO, NO2, SO2, O3,,**	Each analyzer	Once per year	CO: AL 1 & 2 < |±0.031 ppm| or < |± 15.1% Δ| NO_2, SO_2, O_3: AL 1 & 2 < |±1.5 ppb| or < |± 15.1% Δ| CO,NO_2, SO_2, O_3: AL 3- 10 < |± 15.1% Δ|	3.1.2	4.1.1
NPAP: **CO, NO2, SO2, O3,,**	20% of the PQAOs monitoring sites per year, 100% of the sites every 6 years	Once per year	CO: AL 1 & 2 < |±0.031 ppm| or < |± 15.1% Δ| NO_2, SO_2: AL 1 & 2 < |±1.5 ppb| or < |± 15.1% Δ| CO , NO_2, SO_2,: AL 3- 10 < |± 15.1% Δ| O_3: AL 1 & 2 < |±1.5 ppb| O_3: AL 3- 10 < |± 10.1% Δ|	3.1.3	---- [3]

AL – Audit level.

[1] - QA Handbook for Air Pollution Measurement Systems, Vol. II (QA Handbook Vol. II), Appendix D - Measurement Quality Objectives and Validation Templates. May, 2013. < https://www3.epa.gov/ttn/amtic/qalist.html> Also, June 2016 Draft QA Handbook Vol. II, Appendix D - Measurement Quality Objectives and Validation Templates.

[2] - 40 CFR Part 58, Appendix A – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards.

[3] – National Performance Evaluation Program Standard Operating Procedures. <http://www3.epa.gov/ttn/amtic/npapsop.html>

Measurement Quality Sample Summary Table (continued)

Method	Coverage (annual)	Minimum frequency	MQOs [1] (Acceptance Criteria)	40 CFR Part 58, Appendix A [2] Reference	
				Method / Coverage / Frequency	Assessment Calculations
Particulate Matter Methods					
Continuous [4] method — collocated quality control sampling: **$PM_{2.5}$**	15% of sites [5] within PQAO	1-in-12 days	$PM_{2.5}$: CV < 10.1% of samples ≥ 3 µg/m^3	$PM_{2.5}$: 3.2.3	4.2.1
Manual method—collocated quality control sampling: **$PM_{2.5}$, PM_{10}, Pb-TSP/Pb-PM_{10}**	15% of sites [5] within PQAO	1-in-12 days	$PM_{2.5}$, PM10 (Low-Vol): CV < 10.1% of samples ≥ 3 µg/m^3 PM_{10} (High-Vol): CV < 10.1% of samples ≥ 15 µg/m^3 Pb-TSP/Pb-PM_{10}: CV < 20.1% of samples ≥ 0.02 µg/m^3 [6] CV < 20.1% of samples ≥ 0.002 µg/m^3 [7]	$PM_{2.5}$: 3.2.3 PM_{10}: 3.3.4 Pb-TSP: 3.4.4 Pb-PM_{10}: 3.4.5	4.2.1
Flow rate verification: **$PM_{2.5}$, PM_{10} (Low Vol), Pb-PM_{10}**	Each sampler	Once every month (each check minimally separated by 14 days)	< |± 4.1% Δ| of transfer standard and < |± 5.1% Δ| of flow rate design value	$PM_{2.5}$: 3.2.1 PM_{10} (Low-Vol): 3.3.1 Pb-PM_{10}: 3.4.1	4.2.2
Flow rate verification: **PM_{10} (High-Vol), Pb-TSP**	Each sampler	Once every 90 days (4 in a year)	PM_{10} (High-Vol): < |± 7.1% Δ| of transfer standard and < |± 10.1% Δ| of flow rate design value Pb-TSP: < |± 7.1% Δ| of transfer standard	PM_{10} (High-Vol): 3.3.2 Pb-TSP: 3.4.2	4.2.2
Semi-annual flow rate audit: **$PM_{2.5}$, PM_{10} (low Vol), Pb-PM_{10}**	Each sampler	Once every 6 months	< |± 4.1% Δ| of transfer standard and < |± 5.1% Δ| of flow rate design value	$PM_{2.5}$: 3.2.2 PM_{10} (Low-Vol): 3.3.3 Pb-PM_{10}: 3.4.3	4.2.3
PM_{10} (High-Vol), Pb-TSP	Each sampler	Once every 6 months	PM_{10} (High-Vol): < |± 7.1% Δ| of transfer standard and < |± 10.1% Δ| of flow rate design value Pb-TSP: < |± 7.1% Δ| of transfer standard	PM_{10} (High-Vol): 3.3.3 Pb-TSP: 3.4.3	4.2.3
National Performance Evaluation Program Audits:					
PM PEP audit: **$PM_{2.5}$,**	1) 5 valid audits for PQAOs, with ≤ 5 sites 2) 8 valid audits for PQAOs, with > 5 sites 3) All samplers in 6 years	Distributed over all 4 quarters	< ± 10.1% bias of samples > 3 µg/m^3	3.2.4	4.2.5
Pb-TSP/ Pb-PM_{10}	One valid audit and 4 collocated samples to	Distributed over all 4 quarters	Pb[1]- abs 15% bias	3.4.7	4.2.4

	independent lab in each PQAO that has ≤ 5 sites and 2 audits and 6 collocated samples to independent lab at PQAOs > 5 sites (valid samples sent to an independent laboratory)				
Lead	Analytical (lead strips)	Each quarter	< 10.1%	3.4.6	4.2.6

CV= coefficient of variation.

[1] - QA Handbook for Air Pollution Measurement Systems, Vol. II (QA Handbook Vol. II), Appendix D -Measurement Quality Objectives and Validation Templates. May, 2013. < https://www3.epa.gov/ttn/amtic/qalist.html> Also, June 2016 Draft QA Handbook Vol. II, Appendix D - Measurement Quality Objectives and Validation Templates.

[2] - 40 CFR Part 58, Appendix A – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards.

[3] – National Performance Evaluation Program Standard Operating Procedures. <http://www3.epa.gov/ttn/amtic/npapsop.html>

[4] - $PM_{2.5}$ is the only particulate criteria pollutant requiring collocation of continuous and manual primary monitors.

[5] – For $PM_{2.5}$ each distinct method designation (FRM or FEM) that the monitoring program is using as a primary monitor. Additionally, the first collocated monitor must be a designated FRM monitor.

[6] - Methods approved before 3/04/2010, and manual equivalent method EQLA–0813–803.

[7] - Methods approved after 3/04/2010, with exception of manual equivalent method EQLA–0813–803).

Appendix 6 – Monitoring Program Internal Decisions and Guidance

Monitoring Program Internal Decision: Rounding Convention for Reporting PM QA/QC Results to AQS

Rounding Determinations[1]	Thermo BAM	MetOne BAM	BGI Sampler	SASS	URG
1) SF and Rounding Based on Instrument (Sampler Display)					
Flow Rate Display (lpm):	16.67	16.7	16.67	6.7	22.00
Measurement Resolution:	2 Decimal. 4 SF	1 Decimal. 3 SF	2 Decimal. 4 SF	1 Decimal. 2 SF	2 Decimal. 4 SF
Flow Rate Verification Acceptance Criteria:	< ±4%[2]	< ±4%[2]	< ±4%[2]	±10%	±10%
Flow Rate Low Range (lpm):	16.0032 ≈ 16.00	16.032 ≈ 16.0	16.0032 ≈ 16.00	6.03 ≈ 6.0	19.8 ≈ 19.80
Flow Rate Upper Range (lpm):	17.3368 ≈ 17.34	17.368 ≈ 17.4	17.3368 ≈ 17.34	7.37 ≈ 7.4	24.2 ≈ 24.20
2) SF and Rounding Based on Measurement Device (Transfer Standard Tolerance)					
Orifice – in H2O Measurement Resolution:	2 Decimal, 3 SF	2 Decimal, 3 SF	2 Decimal, 3 SF	2 Decimal, 3 SF	2 Decimal, 3 SF
Thermometer (-50.0 to 50.0°C) Measurement Resolution:	1 Decimal. 3 SF	1 Decimal. 3 SF	1 Decimal. 3 SF	1 Decimal. 3 SF	1 Decimal. 3 SF
Barometer (600-720 mmHg) Measurement Resolution:	0 Decimal. 3 SF	0 Decimal. 3 SF	0 Decimal. 3 SF	0 Decimal. 3 SF	0 Decimal. 3 SF
Least Number of SF of a Transfer Standard:	3 SF				
Flow Rate Verification Acceptance Criteria:	< ±4%[2]	< ±4%[2]	< ±4%[2]	±10%	±10%
Flow Rate Low Range (lpm):	16.0032 ≈ 16.0	16.032 ≈ 16.0	16.0032 ≈ 16.0	6.03 ≈ 6.03	19.8 ≈ 19.8
Flow Rate Upper Range (lpm):	17.3368 ≈ 17.3	17.368 ≈ 17.4	17.3368 ≈ 17.3	7.37 ≈ 7.37	24.2 ≈ 24.2
3) Acceptable Flow Rate Regime Based on 1) or 2) With The Least Number of Significant Figures					
Rounding Based on 2)	**3 SF**			**2 SF**	**3 SF**
Flow Rate Low Range (lpm):	**16.0**			**6.0**	**19.8**
Flow Rate Upper Range (lpm):	**17.3**			**7.4**	**24.2**
	NOTE: To avoid confusion the monitoring program decided that all BAMS and $PM_{10 \text{ or } 2.5}$ FRM/FEM samplers in use are held to the same acceptable flow rate regimes				

[1] - EPA's interpretation of standard rounding conventions is that the resolution of the instrument (sampler display) or measurement device (QC transfer standard) determines the significant figures used for rounding. Additionally, rounding should be based on the measurement having the least number of significant figures. (QA Handbook, Vol. II, Appendix L, January 2017).

[2] – 40 CFR Part 50, Appendix L, Section 9.2 – Flow Rate Calibration/Verification Procedure, 9.2.5.

Appendix 7 – Monitoring Program Corrective Action Request Form (CARF)

G:\ARMB\Air Monitoring\Corrective Action\Master_CARF_blank_01-29-2013.xls

Montana Department of Environmental Quality
Ambient Air Monitoring Program Corrective Action Request Form (CARF)

t 1: _____ Issue Date: _____
t 2: _____ Issued By: _____
t 3: _____ CC: Joe Ugorowski - Air Quality Policy and Planning (AQPP) Section QA Manager
(s): _____ Hoby Rash - Air Monitoring Section (AMS) Supervisor
er: 30- _____ Parameter(s): _____
nt: _____ _____
on:

	Data Invalidation			Repair		Other
l Code:						
& Hour:						
& Hour:						
Invalid:						

AR:

t 1: Date Completed: Completed By and Signature:
ts:

t 2: Date Completed: Completed By and Signature:
nts:

t 3: Date Completed: Completed By and Signature:
nts:

al): a) Complete CARF. (ACCESS CARF BLANK @ G:\ARMB\Air_Monitoring\Corrective_Action\CARF BLANK).
b) Save the original electronic CARF on G:\ARMB\Air_Monitoring\Corrective_Action\year. **File Name:** SITE_*POL*_CARF_mm-dd-yyyy.xls.
c) Send email with CARF hyperlink to the person responsible for completing the corrrective action. **CC** the QA Manager and AMS Supervisor.
d) Forward CARF issuance email to Admin; ask Admin to update CARF tracking spreadsheet.

(s): a) Complete the corrective action request. Include any comments, and fill in the Date Completed and Completed By cells.
ete) b) Update the original electronic CARF on G:\ARMB\Air_Monitoring\Corrective_Action\year and Save.
c) CARF **with** additional recipients: send a link to the CARF by email to parties responsible for completing the corrrective action. **CC** the issuer.
d) CARF **without** additional recipients: send issuer email with completed CARF hyperlink. (If issuer is a site operator forward the completed CARF to the site operator)

al): a) Review completed CARF to ensure CARF is completed as requested.
b) If CARF **not** completed as requested, notify recipient(s) of issue.
c) If CARF completed as requested, notify Admin that CARF is completed. **CC** the QA Manager and AMS Supervisor.

***POL* - CARF Pollutant ID: CO, O3, SO2, NOx, PM10, PM25, PMC, WS, WD, TMP, ETC.**

[1] **- If extuenating circumstances apply; recipient notifies issuer of > 30 day delay.**