Quality Assurance Project Plan for the Federal $PM_{2.5}$ Performance Evaluation Program ($PM_{2.5}$-PEP)

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Quality Assurance Project Plan for the Federal $PM_{2.5}$ Performance Evaluation Program ($PM_{2.5}$-PEP)

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, NC

Foreword

U.S. Environmental Protection Agency (EPA) policy requires that all projects involving the generation, acquisition, and use of environmental data be planned and documented and have an Agency-approved Quality Assurance Project Plan (QAPP) in place prior to the start of data collection. The primary purpose of the QAPP is to provide a project overview, describe the need for the measurements, and define quality assurance/quality control (QA/QC) activities to be applied to the project, all within a single document.

This document represents the QAPP for the environmental data operations involved in EPA's $PM_{2.5}$ Monitoring Network Performance Evaluation Program (PEP). This QAPP adheres to the following EPA regulations and guidance on monitoring and QA:

- 40 Code of Federal Regulations (CFR) Part 50, Appendix L
- 40 CFR Part 58, Appendices A and C
- *EPA QA/R-5, EPA Requirements for Quality Assurance Project Plans*
- *EPA QA/G-5, Guidance for Quality Assurance Project Plans*.

This QAPP addresses the pertinent sections of the QAPP regulations and guidance.

EPA Regional $PM_{2.5}$-PEP Leads responsible for implementing the $PM_{2.5}$-PEP in their respective EPA Regions have reviewed this QAPP and have found it acceptable (see the following approval page).

Any mention in this document of corporation names, trade names, or commercial products does not constitute EPA's endorsement or recommendation for use.

A. Project Management

A1 QA Project Plan Approval

Title: Quality Assurance Project Plan for the Federal $PM_{2.5}$ Performance Evaluation Program

The attached Quality Assurance Project Plan (QAPP) for the Federal $PM_{2.5}$ Performance Evaluation Program ($PM_{2.5}$-PEP) is hereby recommended for approval and commits the participants of the program to follow the Sections described within.

OAQPS	**Signature:** Dennis Crumpler		**Date:** 04/28/2022
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Acknowledgments

The original version of this QAPP was the product of the combined efforts of EPA's Office of Air Quality Planning and Standards (OAQPS); the Office of Radiation and Indoor Air (ORIA) support laboratories in Las Vegas, Nevada; EPA's ORIA National Exposure Research Laboratory (NERL); EPA Regional offices; and state, local, and tribal (SLT) organizations.

This version of the QAPP is the product of the combined efforts of the EPA's OAQPS and EPA Regional Offices. The following individuals are acknowledged for their contributions.

EPA Regions

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Acronyms and Abbreviations

°C	degrees Celsius
AAMG	Ambient Air Monitoring Group
AFC	Agency File Codes
AIRS	Air Innovation Research Site
AMTIC	Ambient Monitoring Technology Information Center
ANSI	American National Standards Institute
APTI	Air Pollution Training Institute
AQS	Air Quality System
ASTM	American Society for Testing and Materials
AWMA	Air and Waste Management Association
CAA	Clean Air Act
CBSA	core-based statistical area
CFR	*Code of Federal Regulations*
CMD	Contracts Management Division
CO	Contracting Officer
CO	carbon monoxide
COC	chain of custody
COR	Contracting Officer's Representative
CV	coefficient of variation
DC	direct current
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
EDO	environmental data operation
EMP	Enhanced Monitoring Plan
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
FB	field blank
FCS	failed collocated sample
FDS	field data sheet
FEM	Federal Equivalent Method
FFB	failed field blank
FIPS	Federal Information Processing Standards
FIS	failed internal standard
FLB	failed laboratory blank
FOIA	Freedom of Information Act
FRM	Federal Reference Method
FS	field scientist
FTB	failed trip blank
g	grams
GSA	General Services Administration
HEPA	high-efficiency particulate air

HVAC	heating, ventilation, and air conditioning
ID	identifier
IR	infrared
ISO	International Organization for Standardization
IUPAC	International Union of Pure and Applied Chemistry
LA	laboratory analyst
LIMS	laboratory information management system
LPM	liters per minute
LSASD	Laboratory Services and Applied Science Division (Region 4)
m^3	cubic meter(s)
µg	microgram(s)
$\mu g/m^3$	microgram(s) per cubic meter
mg	milligram(s)
µm	micrometer(s)
MoPED	field data management system for the $PM_{2.5}$-PEP
MQO	measurement quality objective
MSR	management system review
NAAQS	National Ambient Air Quality Standards
NADG	National Air Data Group
NCore	National Core multi-pollutant monitoring stations
NERL	National Environmental Research Laboratory
NIST	National Institute of Standards and Technology
NO_2	nitrogen dioxide
NPAP	National Performance Audit Program
NPD	normalized percent difference
NRMRL	National Risk Management Research Laboratory
O_3	ozone
OAQPS	Office of Air Quality Planning and Standards
OAR	Office of Air and Radiation
OEI	Office of Environmental Information
OMS	Office of Mission Support
ORD	Office of Research and Development
OSHA	Occupational Safety and Health Administration
PAMS	Photochemical Assessment Monitoring Station
Pb	lead
PC	personal computer
PD	percentage difference
PE	performance evaluation
PED	Performance Evaluation Database
PEP	Performance Evaluation Program
PM	particulate matter
$PM_{2.5}$	particulate matter less than or equal to 2.5 micrometers in diameter
PM_{10}	particulate matter less than or equal to 10 micrometers in diameter
POC	parameter occurrence code

PQAO	primary quality assurance organization
PTFE	polytetrafluoroethylene (Teflon™)
Q_a	sampler flow rate at ambient (actual) conditions of temperature and pressure
QA	quality assurance
QAM	Quality Assurance Manager
QAPP	quality assurance project plan
QC	quality control
R&P	Rupprecht & Patashnick
RH	relative humidity
RPD	relative percent difference
RPO	Regional Project Officer
RTP	Research Triangle Park
SI	self instructional
SIP	State Implementation Plan
SLAMS	State and Local Ambient Monitoring Stations
SLT	state, local, and tribal
SO_2	sulfur dioxide
SOP	standard operating procedure
SPM	special purpose monitoring
SPMS	special purpose monitoring station
SRM	standard reference material
STAG	State and Tribal Assistance Grant
T_a	temperature, ambient or actual
TB	trip blank
TDF	Technical Direction Form
TOCOR	Task Order Contract Officer Representative
TSA	technical systems audit
UPS	United Parcel Service or uninterrupted power supply
USB	Universal Serial Bus
V_a	air volume, at ambient or actual conditions
VSCC	very sharp cut cyclone
WACOR	Work Assignment Contract Officer Representative
WINS	well impactor ninety-six

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A3 Distribution and Document Control

The U.S. Environmental Protection Agency (EPA) is responsible for posting the current and fully approved version of the $PM_{2.5}$-Performance Evaluation Program (PEP) Quality Assurance Project Plan (QAPP) on EPA's Ambient Monitoring Technology Information Center (AMTIC) website[1]. This QAPP is accessible by the public via the AMTIC website. The QAPP posted on AMTIC is under version control within its quality system for ambient air monitoring networks and represents EPA's official QAPP document for the program. Downloaded or printed versions of this document and circulated versions labeled DRAFT are considered working copies that EPA does not control within its quality system.

The Office of Air Quality Planning and Standards (OAQPS) $PM_{2.5}$-PEP Lead maintains a $PM_{2.5}$-PEP Contact List of Regional Leads and primary quality assurance organization (PQAO) coordinators, consisting of Regional $PM_{2.5}$-PEP Leads and points of contact for self-implementing PQAOs of the $PM_{2.5}$-PEP. The OAQPS $PM_{2.5}$-PEP Lead (or designee) will notify individuals on this list (via e-mail or through a Monitoring List Server Notice) when EPA publishes this QAPP or any fully approved revision, attachment, or addendum to the AMTIC website. As appropriate, this e-mail notification will also direct to destroy hardcopy or electronic copies of prior versions of this QAPP which are superseded by the newly posted documents. OAQPS will retain an archived electronic copy of the previously signed version for historical reference.

As necessary, EPA will update the $PM_{2.5}$-PEP Contact List when assigned personnel to the specified $PM_{2.5}$-PEP roles change. The OAQPS $PM_{2.5}$-PEP Lead may also use the list of contacts to circulate updated versions of this QAPP that are at some level of revision and thus considered to be working drafts – such versions will clearly be labeled as working drafts. Changes other than editorial or correction of typographical errors will require a consensus of all EPA Regional $PM_{2.5}$-PEP Leads and participating self-implementing PQAO $PM_{2.5}$-PEP coordinators. Appendix D (Revision History) includes a brief summary of the major changes made between approved versions of this QAPP. The pages of the specific changes will be given a new date, on which the change becomes effective. The OAQPS $PM_{2.5}$-PEP Lead or any EPA Regional Lead can call for a full, interim review and approval (signatures from each EPA Regional Lead) of the QAPP. Otherwise, the QAPP will undergo full review beginning 4 years and 3 months after the date of the official signed version, with the objective of publishing a newly signed QAPP at least every 5 years.

Regional $PM_{2.5}$-PEP Leads and self-implementing PQAO $PM_{2.5}$-PEP coordinators, their Regional Quality Assurance Managers (QAMs), and the PQAOs within their respective EPA Regions are responsible for ensuring that all staff and contractors participating in the $PM_{2.5}$-

[1] The AMTIC's main website is accessible at https://www.epa.gov/amtic. The $PM_{2.5}$-PEP QAPP is accessible by clicking on the following three links in this order: "Understand quality assurance procedures" (on the AMTIC's main website), then "Pollutant/Network specific QA," then "$PM_{2.5}$ Performance Evaluation Program" under the National Performance Evaluation Program title.

PEP's environmental data operations are aware of how to access this approved QAPP (and any fully-approved revision, attachment, or addendum).

A3.1 Standard Operating Procedures

The Field and Laboratory SOPs for the $PM_{2.5}$-PEP are maintained with the OAQPS $PM_{2.5}$-PEP Lead and distributed to the individuals responsible for overseeing and accomplishing the described tasks. The SOPs are reviewed annually to ensure they are current and adequate and are subject to revision 5 years from the approval date. Revisions to the SOPs can be requested by individuals responsible for overseeing or accomplishing $PM_{2.5}$-PEP activities according to Sections A3.1.1 and A3.1.2.

A3.1.1 Field SOP Revisions

The field scientists (FSs) are responsible for reviewing and implementing the field activities prescribed in this QAPP and the $PM_{2.5}$-PEP field standard operating procedure (SOP) and are therefore responsible for the quality of field data collected. If a FS recommends a change or correction to this QAPP or field SOP, they will notify the Regional $PM_{2.5}$-PEP Lead in writing. The Regional $PM_{2.5}$-PEP Lead will then convey the issue to the OAQPS $PM_{2.5}$-PEP Lead and the $PM_{2.5}$-PEP Quality Assurance (QA) Workgroup, which will review the recommendation and assign it to one of the following classes according to its impact on the data quality:

- Class 1 - The change would significantly improve data quality and would lead to a new procedure that would replace the current procedure. If the $PM_{2.5}$-PEP QA Workgroup finds this change to be acceptable, the OAQPS $PM_{2.5}$-PEP Lead would issue an SOP revision. The document control information in the SOP heading would be revised to contain a new revision number and date. A Quality Bulletin (Figure A3-1) would be completed to describe the change, which OAQPS would distribute to all Regional $PM_{2.5}$-PEP Leads and FSs.
- Class 2 - The change would yield an alternate method that would not significantly improve data quality but may provide for efficiencies in some circumstances or be more cost effective. If the $PM_{2.5}$-PEP QA Workgroup finds this change to be acceptable, the original SOP would not be altered, but the OAQPS $PM_{2.5}$-PEP Lead would initiate an addendum to the procedure that describes the modification and provides an alternate method. A Quality Bulletin (Figure A3-1) would be completed to describe the change, which OAQPS would distribute to all Regional $PM_{2.5}$-PEP Leads and FSs.
- Class 3 - The change would be purely grammatical or typographical (e.g., a clarification) in nature and would not require any procedure change. The changes would be highlighted and modified in a future Class 1 change (where appropriate) or would be corrected in a future full SOP revision.

Quality Bulletin

Subject:

Number _____
Date _____
Page _____ of _____
Supersedes No. _____
Dated _____

Replace and Discard Original

Add Material to Document

Notes:

_____
PM2.5 QA Coordinator

Retain this bulletin until further notice ☐
Discard this bulletin after noting contents ☐
This bulletin will be invalid after (Date) _____ ☐
This bulletin will be incorporated into quality
Procedure No. by (Date) ☐

Figure A3-1. Example PM2.5-PEP Quality Bulletin

A3.1.2 Laboratory SOP Revisions

The laboratory analyst (LA) reviews and implements laboratory methods documented in this QAPP and the laboratory SOP. If the LA recommends any change or correction to the methods or QAPP, the LA notifies the $PM_{2.5}$-PEP weighing laboratory manager in writing. The laboratory manager will then convey the issue to the OAQPS $PM_{2.5}$-PEP Lead and the $PM_{2.5}$-PEP QA Workgroup, which will review the recommendation and attempt to classify it into one of the three class categories noted in Section B3.1.1.

A4 Project/Task Organization

This section prescribes the various roles of participants contributing to the $PM_{2.5}$-PEP. It also provides the lines of authority and reporting within the $PM_{2.5}$-PEP.

The objectives of the $PM_{2.5}$-PEP can only be achieved when all participating organizations recognize that network deployment and operation are a shared responsibility. Thus, all must do their part to ensure the program's success. The degree of complexity and the number of contributing organizations associated with the EPA's particulate matter (PM) ambient air monitoring network and the $PM_{2.5}$-PEP require that the flow of information and associated communications be structured to optimize the collective resources.

The role descriptions presented in this section aim to facilitate communications and to outline basic responsibilities. This QAPP uses the generic term[2] Field Scientist (FS) to represent an individual conducting $PM_{2.5}$-PEP sampling events and other field activities including:

- EPA contractor staff (reporting to Regional $PM_{2.5}$-PEP Leads),
- EPA Regional staff, and
- Independent field staff reporting to PQAOs self-implementing the $PM_{2.5}$-PEP.

Figure A4-1 provides the $PM_{2.5}$-PEP's basic organization structure. The subsections that follow summarize the roles and responsibilities of each component within the $PM_{2.5}$-PEP.

[2] Appendix B (Glossary) of this QAPP contains definitions of terms commonly used in the $PM_{2.5}$-PEP.

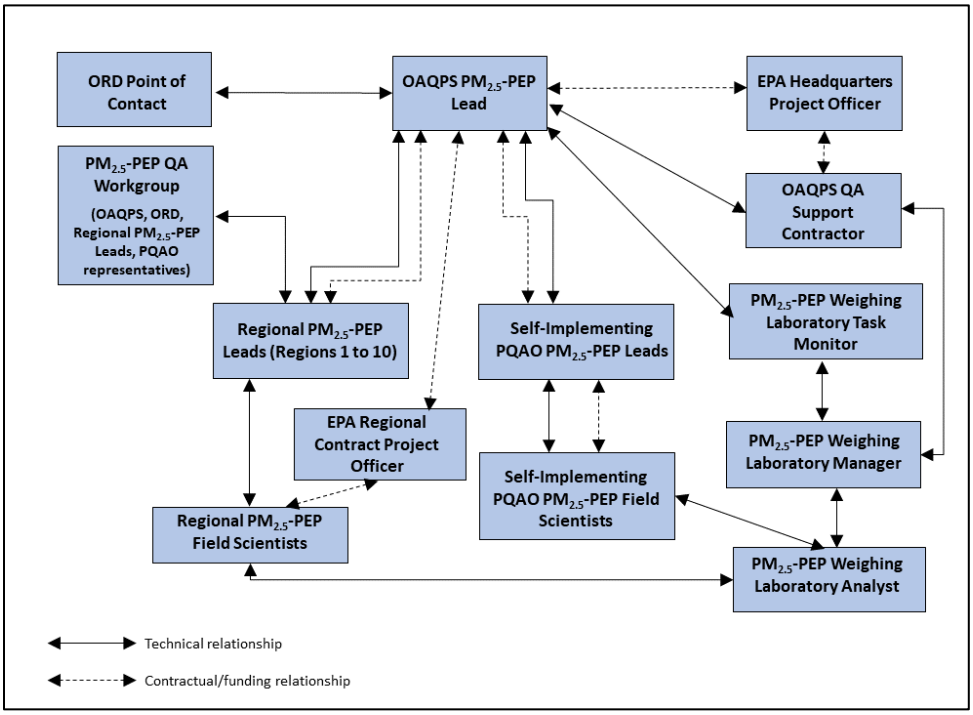


Figure A4-1. Organizational Chart Indicating Technical and Contractual Relationships of the $PM_{2.5}$-PEP

A4.1 $PM_{2.5}$-PEP Roles and Responsibilities

The following are critical roles in the planning and execution of the $PM_{2.5}$-PEP. Note that the responsibilities listed below relate to the basic functioning of the $PM_{2.5}$-PEP and there may be additional responsibilities required such as those listed in subsequent sections (A4.2 through A4.7), such as for oversight or execution of contracts, data verification and validation, and supporting $PM_{2.5}$-PEP logistical aspects.

A4.1.1 OAQPS $PM_{2.5}$-PEP Lead

The OAQPS $PM_{2.5}$-PEP Lead has the overall authority for planning and execution of the $PM_{2.5}$-PEP. In general, the OAQPS $PM_{2.5}$-PEP Lead has the following responsibilities:

- Development and maintenance of the $PM_{2.5}$-PEP quality system, comprising the implementation plan, this QAPP, and the field and laboratory SOPs;
- Oversight of the $PM_{2.5}$-PEP for coordinating and managing training events, corrective actions, process improvements, and programmatic changes;
- Coordinating and training Regional $PM_{2.5}$-PEP Leads;
- Approving with Regional PEP Leads any PQAOs that self-implement the $PM_{2.5}$-PEP;
- In concert with the EPA Headquarters Project Officer and EPA Contracts Office,

defining task order/work assignment/work order scope and details, and evaluating contractor proposals, and providing direction to the National QA Contractor;

- Evaluating $PM_{2.5}$-PEP performance annually against the data quality objectives (DQOs) and measurement quality objectives (MQOs);
- Seeking and considering input and feedback in $PM_{2.5}$-PEP performance, issues, and improvements;
- Arranging funding for the $PM_{2.5}$-PEP including allocations for the EPA Regions and self-implementing PQAOs; and
- Scheduling and facilitating annual field scientist and laboratory analyst training events and collocated sampler precision events.

A4.1.2 Regional $PM_{2.5}$-PEP Leads

A Regional $PM_{2.5}$-PEP Lead is assigned in each to oversee the $PM_{2.5}$-PEP planning and execution in each of the 10 EPA Regions. Section A4.4 lists additional responsibilities of the Regional $PM_{2.5}$-PEP Lead that pertain to management and oversight of $PM_{2.5}$-PEP contractors. The Regional $PM_{2.5}$-PEP Lead has the following responsibilities:

- Overseeing self-implementing PQAOs in their Region;
- Serving as a technical resource and assisting in the $PM_{2.5}$-PEP's technical implementation;
- Maintaining annual certification with OAQPS on the roles and responsibilities of an EPA Regional $PM_{2.5}$-PEP Lead;
- Staying up-to-date on current technical issues and changes in $PM_{2.5}$-PEP sampling equipment, procedures, and QA aspects;
- Attending conference calls and meetings on $PM_{2.5}$-PEP sampling event activities;
- Assisting in the development, review, and revision of $PM_{2.5}$-PEP quality system guidance documents (e.g., this $PM_{2.5}$ PEP QAPP and supporting SOPs);
- Participating in training activities, including national and regional conferences, web-based seminars (webinars), conference calls, and other training events;
- Assisting in refresher training and certification of $PM_{2.5}$-PEP field personnel (EPA Regional staff, contractors, and/or staff of self-implementing PQAOs) after initial training (in coordination with OAQPS);
- Providing technical oversight of the $PM_{2.5}$-PEP field activities through conducting technical systems audits (TSAs) of contractors and self-implementing PQAO partners;

- Coordinating each year with state, local, and tribal (SLT) monitoring organizations to develop the annual schedule of $PM_{2.5}$-PEP sampling events and providing this schedule to FSs;
- Annually confirming the upcoming $PM_{2.5}$-PEP sampling event schedule with each $PM_{2.5}$ monitoring organization in the Region;
- Reviewing validation data and determining whether $PM_{2.5}$-PEP sampling events provided valid data (accepting or rejecting the outcome);
- Co-approving and overseeing self-implementing PQAOs within their Region; and
- Evaluating $PM_{2.5}$-PEP results and informing monitoring organizations of:
    - Significant differences between individual $PM_{2.5}$-PEP and SLT-measured routine sample concentrations.
    - Significant trends in bias that are beyond the target DQOs.

A4.1.3 Field Scientists

FSs are the individuals executing the field sampling component of the $PM_{2.5}$-PEP and have the following responsibilities:

- Training initially and periodically on field operations and pertinent aspects of laboratory operations for the $PM_{2.5}$-PEP;
- Calibrating, verifying calibration, and operating FRM $PM_{2.5}$-PEP samplers within their Region;
- Communicating their sampling schedule and changes to the schedule as well as issues or problems with conducting $PM_{2.5}$-PEP sampling events to their Regional $PM_{2.5}$-PEP Lead and self-implementing PQAO $PM_{2.5}$-PEP Coordinator;
- Complying with the $PM_{2.5}$-PEP requirements as detailed in the quality system documents;
- Documenting actions and measurements and maintaining records required to reconstruct $PM_{2.5}$-PEP activities;
- Maintaining equipment in appropriate operational and calibration condition to successfully conduct $PM_{2.5}$-PEP sampling events; and
- Communicating with the $PM_{2.5}$-PEP gravimetric weighing laboratory when tared filters are needed and when collected $PM_{2.5}$-PEP sample deliveries are scheduled.

A4.1.4 $PM_{2.5}$-PEP Weighing Laboratory Task Monitor

The EPA Region 4 Laboratory Services and Applied Science Division (LSASD) will assign a

Task Monitor for the $PM_{2.5}$-PEP Weighing Laboratory with the following responsibilities:

- Managing the $PM_{2.5}$-PEP Weighing Laboratory Support Contractor;
- Reviewing and approving validated $PM_{2.5}$-PEP data for submission to Regional $PM_{2.5}$-PEP Leads and self-implementing PQAO $PM_{2.5}$-PEP Coordinators; and
- Seeking input from $PM_{2.5}$-PEP Leads when reviewing and validating $PM_{2.5}$-PEP data and notifying $PM_{2.5}$-PEP Leads when data are validated and suitable for reporting to AQS.

A4.1.5 $PM_{2.5}$-PEP Weighing Laboratory Manager

The $PM_{2.5}$-PEP Weighing Laboratory Manager has the following responsibilities:

- Oversight of the $PM_{2.5}$-PEP weighing laboratory and weighing laboratory analysts;
- Assigning a primary and back-up weighing laboratory analyst;
- Communication of issues or problems with the $PM_{2.5}$-PEP Weighing Laboratory Task Monitor, EPA Region 4 $PM_{2.5}$-PEP Regional Lead, and OAQPS $PM_{2.5}$-PEP Lead; and
- Conducting first level review and validation of $PM_{2.5}$-PEP data and contacting Regional $PM_{2.5}$-PEP Leads and FSs to clarify discrepancies and correct documentation errors to troubleshoot data results that are subject to invalidation.

A4.1.6 $PM_{2.5}$-PEP Weighing Laboratory Analysts

The weighing laboratory analyst plays a critical role in the $PM_{2.5}$-PEP and has the following responsibilities:

- Completing initial and ongoing laboratory analyst training;
- Compliance with the $PM_{2.5}$-PEP requirements as detailed in the quality system documents;
- Receiving, inventorying, and inspecting new filters;
- Conditioning new filters for measuring tare weights;
- Coordinating tare filter shipments to FSs;
- Receiving completed $PM_{2.5}$-PEP sampling event shipments, storing sampled filters, conditioning the sampled filters, and measuring post-sampling filter weights;
- Verifying calibration and proper operation of the laboratory analytical balance(s);
- Recording dispatched tared filter shipments and received sampled filter shipments;

- Ensuring the environmental conditions of the weighing laboratory remain in the required ranges and taking corrective actions when excursions occur; and
- Scheduling maintenance of the weighing laboratory heating, ventilation, and air conditioning (HVAC) systems.

Note: $PM_{2.5}$-PEP weighing activities occur at the EPA Region 4 LSASD weighing laboratory. Self-implementing PQAOs have the option to utilize a third-party weighing laboratory; however, such requires approval of the OAQPS $PM_{2.5}$-PEP Lead. Should third-party laboratories be approved, this QAPP will be amended to include the responsibilities of the respective laboratory manager and laboratory analysts.

A4.2 $PM_{2.5}$-PEP Workgroups

Staff in OAQPS' Ambient Air Monitoring Group (AAMG) chair and facilitate a series of workgroups that provide technical advice to OAQPS and otherwise support the successful implementation of QA monitoring and assessment procedures within the nation's ambient air monitoring networks. The $PM_{2.5}$-PEP QA Workgroup and Interagency Air Monitoring QA Workgroup are specific to supporting implementation of the $PM_{2.5}$-PEP.

A4.2.1 $PM_{2.5}$-PEP QA Workgroup

The $PM_{2.5}$-PEP QA Workgroup consists of the following members:

- OAQPS $PM_{2.5}$-PEP Lead (Workgroup Chair);
- EPA Regional $PM_{2.5}$-PEP Leads;
- Representatives of PQAOs which self-implement the $PM_{2.5}$-PEP; and
- Other Federal or SLT staff who oversee and execute the field or laboratory operations of the $PM_{2.5}$-PEP either at the national level or within their respective jurisdictions.

The QA Workgroup aims to meet at least twice per year, or otherwise at the discretion of the Workgroup Chair (typically via conference call). Participants serve as advisors to OAQPS and the Regional Leads.

The QA Workgroup assists in the review and revision of $PM_{2.5}$-PEP guidance and procedure documents, including this $PM_{2.5}$-PEP QAPP and the $PM_{2.5}$-PEP field and laboratory SOPs. OAQPS staff will arrange to make draft documents available to the QA Workgroup for peer review and will announce each document's availability for review. The QA Workgroup focuses reviews on issues that are national in scope or on $PM_{2.5}$-PEP document revisions that may have national implications.

The EPA $PM_{2.5}$-PEP and self-implementing PQAO $PM_{2.5}$-PEP field personnel are invited to attend one or two meetings each year to provide operational feedback on the technical implementation of field and laboratory procedures.

As noted in Section B2, $PM_{2.5}$-PEP FSs must comply with quality control (QC) and QA practices and measurements prescribed in this QAPP as they prepare for and conduct $PM_{2.5}$-PEP sampling events. EPA Regional contractors are encouraged to notify OAQPS and Regional Leads of any proposed changes or corrections that would benefit the program.

A4.2.2 Interagency Air Monitoring QA Workgroup

A broader workgroup convenes on occasion, as directed by the OAQPS AAMG QA Team, to review and revise QA documents that are of national scope or importance. This QAPP will be circulated to that group for comment; however, it will not affect the approval schedule of the revision initiated by OAQPS. Subsequent QAPP reviews requested by any Region(s) may involve a review by this workgroup if such participation is included in the initiating Region's request. The list of individuals for this workgroup is maintained within EPA OAQPS.

A4.3 EPA's Office of Air Quality Planning and Standards (OAQPS)

Organized within the EPA's Office of Air and Radiation (OAR), OAQPS has the overall responsibility for ensuring that data collected in the nation's ambient air monitoring networks meet all established quality standards. EPA has documented specific regulations for the development of a quality system for its ambient air monitoring networks within 40 Code of Federal Regulations (CFR) Part 58, Appendix A.

While SLT monitoring agencies are responsible for implementing monitoring for the $PM_{2.5}$ network, EPA has developed and implemented a federal $PM_{2.5}$-PEP to conduct sampling events independent from activities performed within the $PM_{2.5}$ ambient air monitoring network. OAQPS oversees activities of the Federal Independent $PM_{2.5}$-PEP.

OAQPS is ultimately responsible for this QAPP, technical components (with support from the EPA Regional Offices and monitoring organizations), and the resource estimates underlying $PM_{2.5}$-PEP implementation. OAQPS has the following responsibilities for $PM_{2.5}$-PEP and staff within OAQPS' AAMG are tasked with these responsibilities, unless directed otherwise.

- Developing the national level $PM_{2.5}$-PEP budget for allocating the appropriate State and Tribal Assistance Grant (STAG) funds to implement the federal $PM_{2.5}$-PEP program in each Region and self-implementing PQAO;
- Allocating the funding for the purchase and distribution of $PM_{2.5}$-PEP portable Federal Reference Method (FRM) samplers;
- Working with the Regions to determine which monitoring organizations will utilize the federally implemented $PM_{2.5}$-PEP and to determine how many $PM_{2.5}$-PEP sampling events are required per PQAO;
- Transferring the necessary funds to the EPA Regional Contracts Management Divisions (CMDs) to support the $PM_{2.5}$-PEP and to EPA Region 4 LSASD in Athens, Georgia for gravimetric analyses, laboratory equipment, and consumables;

- Providing filters to the $PM_{2.5}$-PEP weighing laboratory to tare (pre-sample weighing) and distribute to the Regional field offices;
- Preparing and updating documents such as the $PM_{2.5}$-PEP Implementation Plan, the $PM_{2.5}$-PEP QAPP, scope statements for $PM_{2.5}$-PEP contractors, and the $PM_{2.5}$-PEP Field SOP, and collaborating on the laboratory SOP;
- Developing or revising field and laboratory personnel requirements;
- Developing field training activities, participating in training, and providing technical support and guidance to Regional $PM_{2.5}$-PEP contacts;
- Maintaining a list of all PQAOs operating $PM_{2.5}$ monitoring sites used for determining National Ambient Air Quality Standards (NAAQS) attainment;
- Developing field information management systems;
- Maintaining the EPA's Air Quality System (AQS) data management system through the OAQPS National Air Data Group (NADG);
- Assessing the $PM_{2.5}$-PEP concentration information and completeness data in AQS and taking action to address shortcomings or problems identified during the data review;
- Initiating and implementing a communications network (typically via the $PM_{2.5}$-PEP QA Workgroup) and acting as a liaison to EPA Regional Offices and PQAOs who implement the $PM_{2.5}$-PEP;
- Interacting with monitoring organizations concerning the implementation and data results of $PM_{2.5}$-PEP sampling events;
- Ensuring the success of the program by performing various oversight activities such as management system reviews (MSRs) and/or TSAs of EPA Regional and participating PQAO field operations and the supporting $PM_{2.5}$-PEP gravimetric analysis (weighing) laboratory;
- Arranging to document comments and responses pertaining to $PM_{2.5}$-PEP reports, scientific publications, and presentations as part of the peer review process of the Air Monitoring QA Workgroup; and
- *(Future responsibility)* Maintaining the laboratory information management system (LIMS), $PM_{2.5}$-PEP field data storage application (jointly with the $PM_{2.5}$-PEP weighing laboratory), and the MoPED field data system software. [*These capabilities were under development at the time of this document's release.*]

A4.4 EPA Regional Offices

The EPA Regional Offices serve as the major communication link between the $PM_{2.5}$ network monitoring organizations and OAQPS within the $PM_{2.5}$-PEP. This role is critical to the implementation of the program. Each Regional office assigns a $PM_{2.5}$-PEP Lead from its air monitoring branch/division to oversee the technical aspects of its $PM_{2.5}$-PEP field activities. The responsibilities of the Regional $PM_{2.5}$-PEP Lead are described in Sections A4.1.2 and A.4.5.4.

A4.4.1 Region 4 LSASD – $PM_{2.5}$-PEP Gravimetric Weighing Laboratory

The Region 4 LSASD hosts and maintains the $PM_{2.5}$-PEP weighing laboratory and has the following responsibilities within the $PM_{2.5}$-PEP:

- Assigning a task monitor to oversee the technical aspects of the laboratory and the Federal contractor responsible for managing the $PM_{2.5}$-PEP weighing laboratory;
- Assigning a Laboratory Manager to oversee the technical aspects of activities performed by LAs;
- Developing and maintaining (with OAQPS) an approved laboratory SOP and periodically reviewing and updating the SOP as needed;
- Selecting (with OAQPS) the parameters subject to QC check and internal audits; establishing the procedures for assessing the parameters and establishing acceptance limits of QA/QC checks and audit results;
- Serving as the primary analysis laboratory for the $PM_{2.5}$-PEP with respect to logistical, technical, and analytical support personnel, which includes the necessary facilities to store, condition, weigh, distribute, and archive filters;
- Distributing tared filters, which are packaged in coolers with freezer bricks (ice substitutes), and other supplies, to Regional field offices;
- Training and certifying LAs;
- Providing technical oversight of laboratory activities by performing ongoing assessment of the laboratory's QA/QC data;
- Reviewing, correcting, and validating gravimetric laboratory data and field sampling data prior to upload to AQS; and
- Coordinating capital costs, labor, direct costs, and overhead with the National $PM_{2.5}$-PEP Lead to secure appropriate funding.

A4.5 EPA Contracts Supporting the PM2.5-PEP

The contracts supporting the implementation and execution of the PM2.5-PEP are awarded at the Regional level[3]. Therefore, EPA Contracting Officers (COs), Regional PM2.5-PEP Leads, and Regional Project Officers (RPOs) manage the contractors who support the PM2.5-PEP. The EPA COs may be assigned to more than one Region. As the PM2.5-PEP continues to mature, EPA may also utilize alternative contract vehicles such as General Services Administration (GSA) contracts.

Some important aspects of EPA contracts used to support the PM2.5-PEP include the following:

- Only the Regional PM2.5-PEP Lead and the RPOs and COs of the contracts are authorized to provide a PM2.5-PEP contractor with technical direction or clarification on work to be performed. Direction or clarification must be provided in writing.

- The Regional PM2.5-PEP Leads and RPOs work together to prepare PM2.5-PEP work assignments, task orders, and/or delivery orders to be placed on a contract. These instruments are effective only upon CO approval.

The EPA document *An Acquisition Guide for Executives*[4] describes the roles and responsibilities of COs, RPOs, and other key individuals involved in Government acquisition of goods and services; these need not be explained here. The important roles and responsibilities of individuals involved in contracting to support the PM2.5-PEP are as follows:

A4.5.1 EPA Headquarters Contracting Officers

Responsibilities of COs supporting EPA Headquarters are as follows:

- Working with OAQPS staff to define, secure, obligate, commit, and approve application of funds for work to be performed under contract;

- Ensuring that a contractor's work activities supporting the PM2.5-PEP fall within the scope of the contract supporting OAQPS or a given EPA Regional program; and

- Approving work assignments, task orders, and delivery orders placed on contract for which they are responsible.

A4.5.2 EPA Headquarters (OAQPS) Project Officers

Responsibilities of EPA Headquarters Project Officers are as follows:

[3] Historically, EPA has used its Environmental Services Assistance Team (ESAT) contract vehicles to provide the PM2.5-PEP with necessary services and resources. However, EPA no longer utilizes centralized ESAT contracts and individual contracts are now fully administered within each Region.
[4] Available at https://19january2017snapshot.epa.gov/contracts/acquisition-guide-executives_.html. A PDF version is on the AirQA website at https://ha.battelle.org/airqa/LinkClick.aspx?fileticket=zu1OASG4adc%3d&portalid=0.

- Serving as a liaison between the OAQPS QA Support Contractor, the OAQPS Program Leads (who are qualified Work Assignment Contract Officer Representatives [WACOR] or Task Order Contract Officer Representatives [TOCOR]), and the EPA CO;
- Serving as liaison between the contractor and CO;
- Providing contract-wide administration: Reviewing work assignments, task orders and funding documents, and associated forms and forwarding them to the CO; and
- Working with the OAQPS Program Lead to submit specific forms and documentation for unique tasks and activities under the contract, task order, or work assignment (e.g., paperwork for EPA-owned equipment transferred to the contractor-managed government property list).

A4.5.3 EPA Regional Project Officers

Responsibilities for EPA Regional Project Officers are as follows:

- Preparing (with Regional $PM_{2.5}$-PEP Leads) work assignments, task orders, and delivery orders on the contract used for $PM_{2.5}$-PEP support in their respective Region;
- Reviewing and approving work plans and/or proposals which $PM_{2.5}$-PEP contractors prepare and submit;
- Providing contract administration support to these contracts;
- Providing overall management and coordinating performance oversight of their $PM_{2.5}$-PEP contractors with the Regional $PM_{2.5}$-PEP Leads;
- Reviewing the invoices of these contractors with input from Regional $PM_{2.5}$-PEP Leads;
- Ensuring that their supporting contractors are qualified to perform their assigned duties on the $PM_{2.5}$-PEP; and
- Regularly communicating with program participants (OAQPS, other Regions, etc.).

A4.5.4 EPA Regional $PM_{2.5}$-PEP Leads Contractor Oversight

The following are EPA Regional $PM_{2.5}$-PEP Lead responsibilities related to oversight of contractors (note these are in addition to technical responsibilities):

- Reviewing Regional $PM_{2.5}$-PEP contractor proposals and/or work plans and preparing findings on proposed tasks, labor hours, skill mix, and materials and quantities;
- Working with the RPO to prepare work assignments, task orders, and/or delivery orders for their $PM_{2.5}$-PEP contractors;
- Communicating with the OAQPS $PM_{2.5}$-PEP Lead to determine $PM_{2.5}$-PEP funding;

- Monitoring contractor compliance with requirements stated in work assignments, task orders, and/or delivery orders;
- Reviewing and verifying contractor deliverables received and accepted, and/or progress made;
- Tracking costs and labor hours, providing technical direction (in accordance with the terms of the contract), and reviewing and approving monthly technical and financial reports/invoices;
- Communicating with the RPO and the OAQPS $PM_{2.5}$-PEP Lead on contractor performance, budgetary, and administrative/logistical issues (at least annually);
- Establishing a file system containing all relevant documentation, including notes of conversations with contractors and other items that provide an audit trail of the contractor's actions and $PM_{2.5}$-PEP technical information; and
- Conducting performance assessments of (1) supporting contractors on $PM_{2.5}$-PEP field activities and (2) any self-implementing PQAOs within the Region's jurisdiction at least annually and ensuring necessary corrective action is taken.

A4.5.5 $PM_{2.5}$-PEP Contractors

- Understanding government regulations as they pertain to contracts and inherent government functions;
- Developing a work plan and cost estimates for each work assignment, task order, or delivery order;
- Providing qualified staff to meet all contract requirements;
- Implementing the activities described in the EPA-approved work assignment, task order, or work plan;
- Receiving training and certification(s) necessary to perform field and laboratory $PM_{2.5}$-PEP activities; and
- Communicating with the WACOR, TOCOR, RPO, and/or Regional $PM_{2.5}$-PEP Lead (as applicable per the contract) on progress, problems, remedies, and plans, along with spending reports, on $PM_{2.5}$-PEP activities at a frequency and within a content format dictated by the contract.

A4.6 State, Local, and Tribal Monitoring Organizations

The SLT organizations and their associated PQAO are responsible for entering the site locational information, including the AQS site identifier (ID), into the AQS database. The AQS site ID takes the form *xx-yyy-zzzz*, where *xx* is the state's two-digit Federal Information Processing

Standards (FIPS) code, *yyy* is the three-digit FIPS county code, and *zzzz* is a four-digit site identifier that uniquely identifies the site within the state and county. The AQS site ID has a two-digit parameter occurrence code (POC) appended to it when denoting a specific sampler (monitor) at the site. The SLT organization must confirm that the AQS site ID is entered into AQS before it will be able to upload monitoring data from the site into the AQS database. For the bias to be properly associated with the SLT's network, a $PM_{2.5}$ sampler must be designated as the primary monitor at each monitoring site. This assignment must be performed by designated personnel in the SLT or cognizant PQAO.

Note that except for PQAOs that intend to self-implement the $PM_{2.5}$-PEP, SLTs and PQAOs will not receive nor be required to comply with this QAPP. Responsibilities listed below are those for which the SLTs and PQAOs are expected under routine $PM_{2.5}$ monitoring programs.

A4.6.1 SLT $PM_{2.5}$ Monitoring Site Managers

EPA could not effectively plan and execute the $PM_{2.5}$-PEP without the participation and cooperation of SLT monitoring organizations around the country. The $PM_{2.5}$-PEP provides an invaluable QA/QC function on the overall performance of the national monitoring network and often indicates potentially serious sampler performance, site, and/or laboratory issues. EPA Regional offices rely on the SLT organizations to effectively operate their $PM_{2.5}$-PEP networks, and cooperation of SLT organizations is required to make each $PM_{2.5}$-PEP sampling event successful. SLT organizations may identify problems that will impede the $PM_{2.5}$-PEP's mission as early as possible and help find solutions.

Managers of SLT monitoring organizations responsible for operating and maintaining $PM_{2.5}$ routine monitoring sites have the following responsibilities prior to and during $PM_{2.5}$-PEP sampling events:

- Maintaining an accurate list of all State and Local Ambient Monitoring Stations (SLAMS), special purpose monitoring stations (SPMS), and/or tribal sites for the PQAO in which the SLT participates. The list includes addresses, AQS site identifiers, manufacturers and models of routine sampling equipment, and sampling schedules.

- Ensuring sufficient space for a $PM_{2.5}$-PEP sampler to be collocated with the site's routine $PM_{2.5}$ sampler, while meeting siting requirements in 40 CFR Part 58, Appendix E and the $PM_{2.5}$-PEP Field SOP. The SLT site manager will contact the Regional $PM_{2.5}$-PEP Lead prior to the $PM_{2.5}$-PEP sampling event if it is not possible for a site to meet the siting requirements for a $PM_{2.5}$-PEP sampler.

- Ensuring that adequate electrical power and connections are available to run $PM_{2.5}$-PEP samplers during a $PM_{2.5}$-PEP sampling event.

- Ensuring that each site is safely accessible for a $PM_{2.5}$-PEP sampling event.

- Ensuring that each site meets the applicable state Occupational Safety and Health Administration (OSHA) safety requirements (e.g., providing secured ladders and

appropriate safety rails and/or cages). While states generally have OSHA jurisdiction at their facilities, EPA contractors must comply with Federal OSHA regulations. Therefore, EPA may request compliance with Federal OSHA requirements if EPA's contractors or FSs assert a violation renders a site unsafe to conduct a $PM_{2.5}$-PEP sampling event.

- Ensuring that the $PM_{2.5}$-PEP FS has necessary access to the site as many as two or more days prior to and following the day of the $PM_{2.5}$-PEP sampling event for setup and equipment retrieval, as well as necessary information on site operation.

A4.6.2 $PM_{2.5}$-PEP Self-Implementing PQAOs

PQAOs (consisting of one or more SLT monitoring organizations) have the option to self-implement the $PM_{2.5}$-PEP within their jurisdiction. Self-implementation requires the PQAO to maintain a minimum level of independence and adequacy from the routine monitoring network when fulfilling its $PM_{2.5}$-PEP responsibilities. Information on adequacy and independence is found in 40 CFR Part 58 Appendix A and the adequacy document, *National Performance Audit Program, $PM_{2.5}$. $PM_{10\text{-}2.5}$, and Lead Performance Evaluation Program Implementation Decision Memorandum*[5]. Because this information may change over time, OAQPS posts the adequacy document on the AMTIC website and performs an annual review to make necessary updates.

For the purposes of self-implementation of the $PM_{2.5}$-PEP, the PEP activities comprise an independent assessment performed by an independent organization compliant with the following definition:

> **Independent assessment**: An assessment that is performed by a qualified individual, group, or organization that is not part of the organization directly performing and accountable for the work being assessed (i.e., must not be involved with conducting or overseeing generation of routine ambient air monitoring data). An independent organization could be another unit of the same agency sufficiently separated in terms of organizational reporting and able to provide for independent sampling and filter weighing for $PM_{2.5}$-PEP sampling events.

In practical terms, the self-implementing PQAO must have independent staff and equipment for field and weighing laboratory activities from routine $PM_{2.5}$ monitoring to ensure the $PM_{2.5}$-PEP activities comprise independent assessment.

When self-implementing the $PM_{2.5}$-PEP, PQAOs have the following responsibilities:

- Adhering to the definition of independent assessment given above, which requires assigning staff to the roles of PQAO $PM_{2.5}$-PEP Coordinator (First Level Supervision in Figure A4-2) and PQAO $PM_{2.5}$-PEP FS (QA Field Sampling in Figure A4-2) who are separated from routine field monitoring activities by minimally one additional level of management (i.e., the PQAO $PM_{2.5}$-PEP Coordinator must have one level of management

[5] The memorandum for each calendar year is available at https://www.epa.gov/amtic/ambient-air-monitoring-quality-assurance#npep. It is entitled *National Performance Audit Program, PM2.5, PM10-2.5, and Lead Performance Evaluation Program Implementation Decision Memorandum for Calendar Year XXXX*, where "XXXX" is the applicable year. A PDF of the 2021 version is available on the AirQA website at https://ha.battelle.org/airqa/LinkClick.aspx?fileticket=mG9dsYIVPUs%3d&portalid=0.

above them before management is common for the $PM_{2.5}$-PEP and routine $PM_{2.5}$ field monitoring activities – as shown in Figure A4-2).

- Ensuring FSs attend and complete the required field training (Section A8).
- Implementing a comparable or equivalent $PM_{2.5}$-PEP at the frequency prescribed by Federal regulations specified in 40 CFR Part 58, Appendix A.
- Maintaining independent FRM $PM_{2.5}$ samplers dedicated exclusively to $PM_{2.5}$-PEP sampling events. These samplers are subject to the verification procedures outlined in the $PM_{2.5}$-PEP field SOP and their calibration must be checked with transfer standards that are independent of those used for routine $PM_{2.5}$ sampling.
- Ensuring staff are properly trained and certified by participating in $PM_{2.5}$-PEP training and certification activities held by OAQPS or the self-implementing PQAO's respective EPA Region.
- Procuring necessary equipment and consumables for the $PM_{2.5}$-PEP.
- Developing required SOPs and QA procedures for administering the $PM_{2.5}$-PEP and incorporating them into their respective QAPPs.
- Including their $PM_{2.5}$-PEP samplers in Regional collocation studies (i.e., parking lot studies) for generating data to estimate precision in the measurement of $PM_{2.5}$ concentrations using $PM_{2.5}$-PEP samplers as described in Section B5.4.1.
- Coordinating with the Regional $PM_{2.5}$-PEP Lead to identify $PM_{2.5}$ monitoring sites within their jurisdiction for conducting $PM_{2.5}$-PEP sampling events and preparing the associated sampling schedules.
- Cooperating in TSAs of its $PM_{2.5}$-PEP activities as performed by the EPA Region.
- If the self-implementing PQAO employs a third-party laboratory for weighing their $PM_{2.5}$-PEP filters (note that utilizing a third-party weighing laboratory requires approval of the OAQPS $PM_{2.5}$-PEP Lead and is generally discouraged due to the additional inherent variability this imparts to PEP measurements), ensuring the following:
  - Ensuring third-party weighing laboratories participate in an annual gravimetric round-robin performance evaluation administered by OAQPS.
  - Ensuring third-party laboratories are subject to an annual TSA by EPA or an independent assessor approved by the respective EPA Regional Lead.
  - Preparing and submitting to EPA a weighing laboratory annual report in an EPA-specified format.

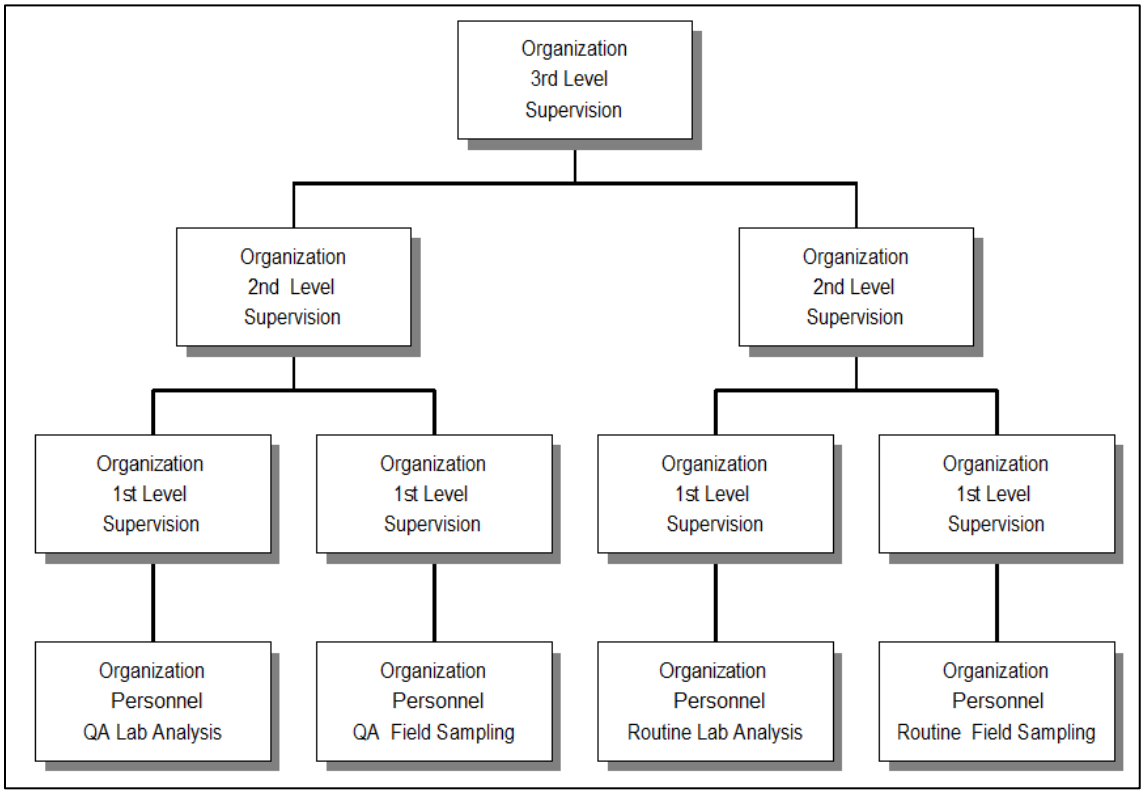


Figure A4-2. Required Management Structure for Self-Implementing PQAOs

An organization can self-implement the $PM_{2.5}$-PEP if their assessment is independent as defined above and:

- Has a management structure that, at a minimum, will allow for the separation of its routine sampling personnel from its auditing personnel by two levels of management, as illustrated in Figure A4-2.
- Employs a separate laboratory facility and equipment for pre- and post-sample weighing of $PM_{2.5}$-PEP sample filters than the laboratory and equipment used to weigh sample filters for routine monitoring (this is presumed to be the $PM_{2.5}$-PEP weighing laboratory unless the self-implementing PQAO employs a third-party weighing laboratory).
- The $PM_{2.5}$-PEP laboratory personnel meet the $PM_{2.5}$-PEP field and laboratory training and certification requirements (Section A8).
- Participate in the $PM_{2.5}$-PEP centralized field standards metrology certification process.
- Submit a plan for approval which demonstrates independence to the OAQPS $PM_{2.5}$-PEP Lead and to the EPA Regional office responsible for overseeing QA-related activities for the ambient air monitoring network.

A4.6.3 PQAOs

In the $PM_{2.5}$-PEP, a PQAO is an SLT organization or a coordinated aggregation of SLT organizations that is responsible for a set of routine $PM_{2.5}$ monitoring sites from which data quality assessments can logically be pooled. Each routine $PM_{2.5}$ sampler within the national monitoring network must be associated with one, and only one, PQAO. Within the $PM_{2.5}$-PEP, PQAOs have the following responsibilities:

- Operating within the $PM_{2.5}$ national monitoring network according to the established regulations and guidelines pertaining to proper siting, operations, and QA procedures; or having a waiver for operating outside of requirements in 40 CFR Part 58 and its appendices which has been approved by the respective EPA Regional Administrator.
- Participating in the Air Monitoring QA Workgroup chaired by OAQPS for development and review of pertinent $PM_{2.5}$-PEP guidance documents.
- Determining whether to continue using the federal $PM_{2.5}$-PEP or to self-implement the program on an annual basis.
- Ensuring that an SLT organization representative is aware of scheduling and is present (if required by the EPA Region) when the $PM_{2.5}$-PEP FS arrives and conducts the $PM_{2.5}$-PEP sampling event.
- Communicating with the SLT's site operator to ensure the routine sampler is in the normal operating mode during $PM_{2.5}$-PEP events.
- Notifying the EPA $PM_{2.5}$-PEP FS if the monitoring site's routine primary sampler did not perform adequately during a conducted $PM_{2.5}$-PEP sampling event or performed in such a way that would result in invalidation of the routine sampling. Such may allow the possibility of substituting a result from a collocated sampler at the site.
- Ensuring that the monitoring site's routine sampling results are posted to the AQS and notifying the EPA $PM_{2.5}$-PEP FS if a substitute value from a collocated sampler was submitted.
- Ensuring the program's success by coordinating and/or performing various internal oversight activities of the $PM_{2.5}$ monitoring network including performance checks, audits of samplers, and internal TSAs of routine field and laboratory activities.
- Participating in training activities including multi-state conferences, EPA teleconferences, and other training vehicles.
- Reviewing routine and $PM_{2.5}$-PEP sample data and working with the Regions on corrective actions.

A4.7 Other Participating Entities in the $PM_{2.5}$-PEP

A4.7.1 EPA Office of Research and Development

For the $PM_{2.5}$-PEP, the EPA Office of Research and Development (ORD) has the following responsibilities:

- Serving as a technical consultant, advisor, and arbiter of technical issues regarding the sampling and analysis of $PM_{2.5}$-PEP samples collected with the FRM BGI PQ200 sampler. This is primarily done through ORD's Center for Environmental Measurement and Modeling (CEMM) which provides many of the applied research elements for the $PM_{2.5}$-PEP.

- Providing guidance to $PM_{2.5}$-PEP for field and analytical activities.

- Designating ambient air samplers as a FRM or Federal equivalent method (FEM). ORD designates the FRM/FEM portable sampler through the Federal Reference and Equivalency Program (40 CFR Part 53).

- Providing access to its National Risk Management Research Laboratory (NRMRL) Metrology Laboratory at Research Triangle Park (RTP), North Carolina, for annual calibration/verification of the $PM_{2.5}$-PEP's flow rate/pressure/temperature transfer standards.

- Providing technical consultation support for the national monitoring procurement contracts.

A4.7.2 Acquisition Management in EPA's Office of Mission Support

The Office of Mission Support (OMS) is responsible for issuing contracts and various national procurements for EPA. These contracts are developed in concert with OAQPS Air Quality Assessment Division technical staff. The OMS is responsible for communications with vendors and extramural contract organizations.

For the $PM_{2.5}$-PEP, the OMS's responsibilities include the following:

- Developing national contracts for the $PM_{2.5}$-PEP sampler and filter purchases and working with ORD and OAR contracts and technical staff to secure purchase and receipt of these products.

- Providing support to COs and contract support staff for national procurements for federal implementation of the $PM_{2.5}$-PEP, major equipment repairs, and equipment upgrades.

A5 Problem Definition/Background

This section places the $PM_{2.5}$-PEP in historical perspective, identifying the program's purpose and position relative to the Ambient Air Quality Monitoring Program.

A5.1 Background

In 1970, the Clean Air Act (CAA) was signed into law. The CAA regulates the ambient concentrations of six criteria pollutants: particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb). The CAA requires SLT organizations to monitor these criteria pollutants through the Ambient Air Quality Surveillance Program as defined in 40 CFR Part 58.

PM as a criteria pollutant is generally used to describe a broad class of substances that exist as liquid or solid particles over a wide range of sizes. Two particle size fractions are measured in the Ambient Air Monitoring Program: those less than or equal to 10 micrometers (PM_{10}) and those less than or equal to 2.5 micrometers ($PM_{2.5}$). This QAPP focuses only on $PM_{2.5}$.

The background and rationale for the implementation of the $PM_{2.5}$ national monitoring network can be found in EPA's 2004 *Air Quality Criteria for Particulate Matter*, which is available at https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=87903. Some of the report's key findings include:

- The characteristics, sources, and potential health effects of larger or "coarse" particles (those between 2.5 to 10 micrometers [µm] in diameter) are very different from those associated with smaller, or fine, particles (smaller than 2.5 µm in diameter).
- Coarse particles typically originate from sources such as windblown dust from the desert or agricultural fields and dust that is circulated on unpaved roads from vehicle traffic.
- Fine particles are generally emitted from activities such as industrial and residential combustion and from vehicle exhaust. Fine particles are also formed in the atmosphere from gases, such as SO_2, nitrogen oxides, and volatile organic compounds, which are emitted from combustion activities and then become particles because of chemical transformations or agglomeration in the air.
- Coarse particles can deposit in the respiratory system and contribute to adverse health effects, such as aggravating asthma. Fine particles, which deposit deeply in the lungs and can be transferred into the blood stream in some form, are more likely than coarse particles to contribute to the adverse health effects (e.g., premature mortality and hospital admissions) found in many published community epidemiological studies.
- Community studies found that adverse public health effects are associated with exposure to particles at levels well below the current PM standards for both short-term (e.g., less than 1 day to up to 5 days) and long-term (generally 1 year to several years) periods.
- Adverse health effects associated with fine PM included premature death and increased hospital admissions and emergency room visits (primarily among the elderly and individuals with cardiopulmonary disease); increased respiratory disease and disease symptoms (among children and individuals with respiratory disease, such as asthma); decreased lung function (particularly in children and individuals with asthma); and alterations in lung tissue and structure and in respiratory tract defense mechanisms.

A5.2 $PM_{2.5}$ Monitoring Networks

Pursuant to 40 CFR Part 58, EPA has assigned the responsibility for measuring ambient $PM_{2.5}$ concentrations using FRM or FEM and posting results in the AQS to SLT monitoring organizations. Each of the individual SLT monitoring networks is designed to meet at least one of the following six basic air quality monitoring objectives:

- Determining the highest concentrations to occur in the area covered by the network;
- Determining representative concentrations in areas of high population density;
- Determining the impact on ambient pollution levels of significant source or source categories;
- Determining background (i.e., non-source impacted) concentration levels;
- Determining the extent of regional pollutant transport among populated areas and in support of secondary pollutants; and
- Determining the welfare-related impacts in more rural and remote areas.

The EPA's Ambient Air Quality Monitoring Network consists of four component monitoring networks that measure the criteria pollutants:

- **SLAMS and Tribal Monitoring Network**[6] consists of approximately 4,000 monitoring stations whose size and distribution are largely determined by the needs of SLT organizations to meet their respective State Implementation Plan (SIP) and Tribal Implementation Plan requirements. These monitoring stations are typically fixed and operate for multiple years to measure pollutants for compliance with criteria pollutant NAAQS.
- **National Core (NCore) Network**[7] is a multi-pollutant network that integrates several advanced measurement systems for PM, gaseous pollutants, and meteorology. The NCore network contains approximately 80 sites, most of which have been operating since January 2011.
- **Photochemical Assessment Monitoring Station (PAMS) network**[8]: Measures O_3 precursors, meteorology, and O_3 in each core-based statistical area (CBSA) with population ≥ 1 million. The current PAMS network has approximately 45 sites and will be expanded to include Enhanced Monitoring Plan (EMP) sites for areas in non-attainment.
- **Special Purpose Monitoring (SPM)**: Program that provides for special studies that SLT organizations perform to support their SIPs and other air program activities. SPM sampling is not permanently established and, thus, can be easily adjusted to accommodate

[6] https://www.epa.gov/amtic/amtic-pm25-monitoring-network
[7] https://www.epa.gov/amtic/ncore-monitoring-network
[8] https://www.epa.gov/amtic/photochemical-assessment-monitoring-stations-pams

changing needs and priorities. SLT organizations use SPM to supplement their routine monitoring as circumstances require and resources permit. If data from SPM are used for SIP purposes, they must meet QA and methodology requirements for the SLAMS.

This QAPP prescribes the $PM_{2.5}$-PEP, which is a QA program limited to the SLAMS and NCore networks. The $PM_{2.5}$-PEP supports network objectives and includes all $PM_{2.5}$ FRM and FEM samplers used to measure $PM_{2.5}$ concentrations in ambient air for comparison to the $PM_{2.5}$ NAAQS.

A5.3 Quality Considerations

$PM_{2.5}$ measurements from $PM_{2.5}$ FRM/FEM samplers within the SLAMS and NCore networks are compared against the $PM_{2.5}$ NAAQS. To draw conclusions from these comparisons with an acceptable level of confidence, EPA has developed a quality system to optimize and quantify the quality of data used to make $PM_{2.5}$ NAAQS determinations. When developing the $PM_{2.5}$ NAAQS, EPA used the DQO process to determine the allowable measurement system imprecision and bias that would not significantly affect a decision maker's ability to compare pollutant concentrations to the NAAQS. The precision (10% coefficient of variation [CV]) and bias (±10%) requirements are based on total measurement uncertainty, which incorporates errors from all phases of the measurement process (e.g., field sampling, sample handling, and laboratory analysis). The SLT organizations operating monitoring sites within the $PM_{2.5}$ national monitoring network collect measurements from collocated samplers that can be used to generate estimates of precision.

The $PM_{2.5}$-PEP is a QA program that is used to independently evaluate the measurement system bias of the national $PM_{2.5}$ monitoring network and incorporates measurement uncertainties from field and laboratory activities. The pertinent regulations for the $PM_{2.5}$-PEP are outlined in 40 CFR Part 58, Appendix A, Section 3.2.4. The strategy is for the $PM_{2.5}$-PEP to collocate a portable $PM_{2.5}$-PEP sampler within 1 to 4 meters of a statistically meaningful number of routine $PM_{2.5}$ samplers in each PQAO. During each sampling event, both the routine and $PM_{2.5}$-PEP samplers operate simultaneously. The SLT/PQAO's measurement is made routinely following the normal procedure and the $PM_{2.5}$-PEP measurement follows an independent collection and analysis convention. The resulting routine PQAO measurement and $PM_{2.5}$-PEP measurement are then compared to calculate a percent difference of the $PM_{2.5}$ concentrations which is used to evaluate bias.

A5.4 $PM_{2.5}$-PEP Implementation

In the originally proposed monitoring regulations for $PM_{2.5}$, SLT organizations were responsible for implementing the $PM_{2.5}$-PEP. However, due to many comments received during the review period for the December 13, 1996 $PM_{2.5}$ NAAQS proposal, EPA made the following revisions:

- Made allowances to shift the implementation burden from the SLT organizations to the federal government.
- Modified the system to include an independent $PM_{2.5}$-PEP.

- Reduced the burden of implementing the $PM_{2.5}$-PEP by changing the frequency of the $PM_{2.5}$-PEP sampling events across all sites to 25% of the $PM_{2.5}$ monitoring sites.

Between August and October 1997, EPA discussed the possibility of federal implementation with EPA Regions and various SLT organizations. Most responses received from these organizations favored federal implementation of the $PM_{2.5}$-PEP.

EPA evaluated potential contracting mechanisms to assist in the implementation of this activity and decided to use the ESAT contract within each EPA Region to provide the necessary field and laboratory activities to the $PM_{2.5}$-PEP. EPA no longer utilizes ESAT at the centralized contract, therefore contracts supporting the implementation and execution of the $PM_{2.5}$-PEP are awarded at the Regional level and per the Regional office's preferred contract mechanism. Each Region is responsible for implementing the field component of the $PM_{2.5}$-PEP. The LSASD is responsible for hosting and operating the $PM_{2.5}$-PEP weighing laboratory.

Prior to 2007, only the State of Illinois chose to fully implement its own $PM_{2.5}$-PEP, which included field and gravimetric laboratory support. In response to the 2006 regulatory revisions, a few more states and some Tribal organizations opted to partially self-implement the program in 2007. Those PQAOs that have chosen to partially self-implement the $PM_{2.5}$-PEP are essentially providing the same service that contractors provide at the Regional level, i.e., they conduct and perform all of the necessary field activities. All SLT organizations that have chosen to partially self-implement the $PM_{2.5}$-PEP have agreed that a central service laboratory is the better alternative to individual SLT organizations running their own independent service laboratory or contracting with an independent laboratory. An important consideration is that the fully self-implementing organization must ensure that its resulting $PM_{2.5}$-PEP data are entered into the AQS as prescribed in 40 CFR Part 58.16, which states, "The data and information reported for each reporting period must contain all data and information gathered during the reporting period and be received in the AQS within 90 days after the end of the quarterly reporting period."

Historically, the $PM_{2.5}$-PEP has experienced delays in data availability for national assessments. In March 2015, EPA conducted a Lean-based event to analyze and improve the business processes associated with managing $PM_{2.5}$-PEP data, as well as data from EPA's National Performance Audit Program (NPAP). This Lean event resulted in the development of a new business process for the $PM_{2.5}$-PEP that is expected to reduce delays in submission of $PM_{2.5}$-PEP data to AQS by 68 percent and at a cost savings of $50,000 per year in contract costs. This process will result in a new automated data collection and transfer software system called MoPED. MoPED will replace the manual transfer of information on field data sheets (FDSs) that FSs previously used to capture field data for eventual input to the $PM_{2.5}$-PEP's Performance Evaluation Database (PED) and into AQS. EPA is designing the MoPED to retrieve key information that is stored in AQS and is necessary for performing the setup of each $PM_{2.5}$-PEP sampling event. MoPED also stores the pre-event performance checks and the sampler's logged run data for the sampling event which are downloaded to a laptop or tablet personal computer (PC). The MoPED will be used to upload sampling event data to AQS to combine with the filter gravimetric result and calculate the 24-hour average ambient concentration for that sampling period. As of the approval of this QAPP, the MoPED was not operational, therefore aspects of its implementation are on hold. Aspects of the MoPED are described in sections as they are

intended to be implemented when EPA is able to move forward with its implementation. Aspects of the $PM_{2.5}$-PEP that will be handled differently with the implementation of MoPED are detailed in *italics* in subsequent sections of this QAPP. Concurrently with the development of the MoPED, EPA is developing an updated sample handling database (new PED) or LIMS for the $PM_{2.5}$-PEP weighing laboratory to replace the existing PED, which is becoming obsolete.

A6 Project/Task Description

The purpose of this section is to provide an understanding of the various activities within the $PM_{2.5}$-PEP including types of measurements and their associated QA/QC goals, procedures, and timetables.

A6.1 Description of Work to Be Performed

EPA designed the $PM_{2.5}$-PEP to generate data to estimate total measurement system bias present in the $PM_{2.5}$ ambient air monitoring network. The $PM_{2.5}$-PEP conducts a sampling event using the EPA's FRM which employs a precise and consistently performing approved FRM air sampler to collect 24-hour ambient air samples that are analyzed gravimetrically for calculating the average concentration over the sampling period. These data are then compared with coincident $PM_{2.5}$ ambient concentration generated by the SLT routine sampler. SLT monitoring agencies may use a variety of approved $PM_{2.5}$ FRM samplers or FEM continuous or semi-continuous monitors. Since the $PM_{2.5}$-PEP serves as a monitoring network on its own merit, it must collect and analyze ambient air $PM_{2.5}$ samples using sampling and laboratory procedures that adhere to the requirements of the $PM_{2.5}$ FRMs in 40 CFR Part 50 Appendix L. In fact, the $PM_{2.5}$-PEP imposes the most stringent interpretation of the Appendix L FRM requirements to optimize the consistency in the bias assessment of the SLT network across the US.

The $PM_{2.5}$ FRM methodology involves collecting particulates less than or equal to 2.5 µm on 46.2-mm polytetrafluoroethylene (PTFE) Teflon™ filters independent from the national network and gravimetrically determining the mass of $PM_{2.5}$ collected on the filter. The mass collected on the filter is then used to determine the 24-hour average concentration in $\mu g/m^3$ by dividing the collected mass by the total volume of ambient air pulled through the sampler. Applicable regulations for this activity can be found in 40 CFR Part 58, Appendix A, Section 3.2.3.

The following information briefly describes the $PM_{2.5}$-PEP field and laboratory activities. Detailed SOPs for field and laboratory activities are available to $PM_{2.5}$-PEP participants (or interested parties) via the AMTIC website and the AirQA website which supports the $PM_{2.5}$-PEP: http://www.airqa.org. The process is represented by the following steps:

- The OAQPS $PM_{2.5}$-PEP Lead acquires and ships new PTFE filters to the $PM_{2.5}$-PEP weighing laboratory where they are inventoried, inspected, equilibrated, weighed, and prepared for the field.
- The $PM_{2.5}$-PEP weighing laboratory initiates a chain-of-custody (COC) form to accompany each filter and ships or delivers to each Region specified numbers of filters in protective sampling cassettes sealed in anti-static bags.

- The FSs in each Region generate a FDS for each filter and transport the filter cassettes and other necessary equipment with accompanying COC and FDS forms to the field and conducts a $PM_{2.5}$-PEP sampling event, sampling for 24 hours concurrent and collocated with an SLT monitoring organization routine sampler.

- Upon conclusion of the $PM_{2.5}$-PEP sampling event, the FS retrieves the collected $PM_{2.5}$-PEP filter(s), downloads the sampler logged data to a laptop or tablet PC, and sends the filter cassettes, completed COC and FDS forms, and data (e.g., flash drive) to the $PM_{2.5}$-PEP weighing laboratory. Copies of COCs, FDSs, run data, and other pertinent records including logbook entries are retained by the FSs' field office (which may or may not be at an EPA facility). Hard copies of these records must be retained (refer to Section B10).

- The $PM_{2.5}$-PEP weighing laboratory receives, inspects, equilibrates, and weighs the exposed sampling event filters in addition to designated field blanks (FBs) and trip blanks (TBs). The difference between the post-collection weight and the tare weight is calculated. The gained mass for exposed samples is normalized to the collected sample volume to determine the concentration and the gained mass for FB and TB filters is assessed to determine presence of incidental contamination. Sampling and weighing data are validated within the PM PED, converted to 24-hour average concentrations, and uploaded to the AQS database. (*In the MoPED-served process, the validation will be an automated, logic-driven algorithm that is completed by AQS. The validation parameters will not change.*)

A6.2 Field Activities

In a $PM_{2.5}$-PEP sampling event, a portable $PM_{2.5}$-PEP sampler is collocated with a routine SLT-operated $PM_{2.5}$ sampler. The FS assembles the PEP sampler, performs calibration and operational checks, installs the filter sample, and programs the sampler to collect over the 24-period assigned for the monitoring site's routine sampler. Upon completion of the 24-hour sampling event, the FS retrieves the collected filter(s), disassembles the portable PEP sampler, and ships the collected filter(s) and associated sample collection and FDS/COC documentation to the $PM_{2.5}$-PEP weighing laboratory.

A6.2.1 $PM_{2.5}$-PEP Field Equipment

The $PM_{2.5}$-PEP's FRM samplers are designed to be durable, rugged, and capable of frequent transport. These samplers are constructed in groups of components for transport, with each group weighing no more than 40 pounds and a total weight not exceeding 120 pounds.

To optimize consistency of nationwide $PM_{2.5}$-PEP measurements, EPA has designated BGI PQ200 portable samplers (Mesa Laboratories, Inc.; Lakewood, Colorado), with either controller board Revision T or Revision U, as the preferred FRM sampler for conducting $PM_{2.5}$-PEP sampling events. The $PM_{2.5}$-PEP Field SOP contains detailed sampler operating instructions, based on the latest operating manual published by Mesa Laboratories. The SOP instructions must be strictly followed to ensure data quality.

OAQPS purchases samplers for the $PM_{2.5}$-PEP and distributes them among the Regional offices. Self-implementing $PM_{2.5}$-PEP PQAOs must acquire independent FRM samplers which are to be

dedicated for $PM_{2.5}$-PEP sampling events. If for any reason a self-implementing PQAO requests use of a different FRM manufacturer and model they must conduct an extensive collocation study with their EPA Region to demonstrate that the bias between the PQAO and EPA samplers meets the Regional fleet collocation precision criteria (refer to Section B5.4.1).

A second practice critical to achieving nationally consistent results is the use of consistent calibration and performance testing standards for flow rate, temperature, and barometric pressure. For consistency, the $PM_{2.5}$-PEP has evolved over time to using BGI (Mesa Labs) standards as field (travel) transfer standards; however, other properly NIST-traceable transfer standards are acceptable for use. The accuracy of the transfer standards is certified by comparing their measurements to those of higher level standards certified by, or meeting tolerances specified by, the National Institute of Standards and Testing (NIST). These certifications are conducted within the EPA ORD metrology laboratory located in the RTP, North Carolina campus.

A6.2.2 $PM_{2.5}$-PEP Sampling Events

The following are required for each $PM_{2.5}$-PEP sampling to ensure acceptable data quality:

- The $PM_{2.5}$-PEP sampler will be properly transported, assembled, calibrated, operated, and maintained according to procedures and specifications given in the $PM_{2.5}$-PEP field SOP which are based on the guidance outlined in *QA Guidance Document 2.12 Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods.* [9]
- FSs will verify the performance of the $PM_{2.5}$-PEP sampler (as specified in 40 CFR Part 50, Appendix L) prior to conducting a sampling event.
- FSs will adhere to filter retrieval/recovery times and shipping schedule requirements (as specified in Section A6.4).
- FSs will properly complete and submit the COC and FDS form for each sampling event filter, field blank, and trip blank to the weighing laboratory.
    - *When EPA successfully launches MoPED, the FS performing a $PM_{2.5}$-PEP sampling event will utilize MoPED to collect and upload the sampling event's field data to AQS. EPA is designing MoPED to streamline the verification and validation of $PM_{2.5}$-PEP field data to AQS. The $PM_{2.5}$-PEP Field SOP will include instructions for using MoPED during $PM_{2.5}$-PEP sampling events.*

In addition to adhering to the standards, principles, and practices outlined in this QAPP and the supporting Field SOP, $PM_{2.5}$-PEP activities and procedures may need to adjust to the relevant site-specific conditions and operations. For example, the $PM_{2.5}$-PEP sampler may not be able to meet siting criteria specified in 40 CFR Part 58 Appendices C, D, and E if the PQAO has an approved waiver from the EPA Regional Ambient Air Monitoring Program for varying from siting requirements.

[9] https://www.epa.gov/sites/default/files/2021-03/documents/p100oi8x.pdf

A6.2.3 Critical Field Measurements and Metadata

Field measurements used to calculate $PM_{2.5}$ concentrations from $PM_{2.5}$-PEP samples are a critical component of the $PM_{2.5}$-PEP. The sampler's average flow rate and the elapsed sampling time are critical field measurements necessary to calculate total air volume sampled:

$$total\ air\ volume\ sampled\ =\ average\ flow\ rate\ \times\ elapsed\ time$$

The mass of $PM_{2.5}$ on the filter sample reported by the $PM_{2.5}$-PEP weighing laboratory is divided by the total air volume sampled to calculate the in-air $PM_{2.5}$-PEP concentration.

The PM_{10} separator inlet head and very sharp cut cyclone (VSCC) or well impactor ninety-six (WINS) impactor $PM_{2.5}$ separator are designed to operate at the design flow rate of 16.67 liters per minute (LPM). Any deviation in flow rate from the design value will affect how precisely the PM_{10} and $PM_{2.5}$ separators eliminate particles larger than 10 µm and 2.5 µm, respectively, from the ingested air. Recalibration action levels have been established (Section B7.2.2) to better ensure the BGI PQ200 samplers perform within the flow rate range and with the flow rate precision (CV) specified in the FRM.

The AQS Site ID code and the sampler start and end times and dates are critical metadata necessary for AQS to pair $PM_{2.5}$-PEP concentrations with their collocated routine $PM_{2.5}$ monitoring network concentrations.

A6.3 Laboratory Activities

The $PM_{2.5}$-PEP laboratory activities include filter handling, inspection, equilibration, weighing, data entry/management, and archiving.

A6.3.1 Weighing Laboratory Activities

The $PM_{2.5}$-PEP weighing laboratory activities will comply with the standards, principles and practices described in this QAPP and in the laboratory SOP. The SOP includes details to ensure microbalance operation and calibration occurs in accordance with: the vendor's instruction manual, the requirements for gravimetric analyses provided in 40 CFR 50, Appendix L, and the *QA Guidance Document 2.12 Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods.* [10] The laboratory has defined filter shipping/receiving requirements within the SOP which apply to shipping containers (i.e., insulated coolers), cold packs, and COC requirements/documentation.

The following information summarizes the $PM_{2.5}$-PEP weighing laboratory activities in a typical chronological order.

A6.3.1.1 Filter Acquisition, Inspection, Conditioning, and Pre-sampling Weighing

The $PM_{2.5}$-PEP weighing laboratory is responsible for the following filter activities:

[10] https://www.epa.gov/sites/default/files/2021-03/documents/p100oi8x.pdf

- Receiving new PTFE filters from the OAQPS $PM_{2.5}$-PEP Lead. Filters from the most recent year's production run are utilized unless there is an insufficient quantity. In such cases, the previous two years' excess filters are brought back into service.
- Performing integrity inspections (e.g., lack of pinholes, tears, discoloration, ring separation) on the filters to be used.
- Inventorying each filter for subsequent data entry into the PED.
- Equilibrating the filters and measuring tare (pre-sampling) weights.
- Storing or preparing filters for field activities.
- Initiating a three-part carbonless COC form that accompanies each filter at each step of its journey and life cycle until it returns to the laboratory

A6.3.1.2 Post-Sampling Laboratory Activities

Once the FS completes filter sample retrieval and shipment, the $PM_{2.5}$-PEP weighing LA is responsible for the following activities:

- Receiving filters shipped from the field, measuring the shipment temperature upon receipt, inspecting filters for integrity (e.g., damage), and logging them into the PED.
- Storing received sampled filters in cold storage (0-4 °C) until equilibrated for weighing.
- Removing filters from cold storage and equilibrating them in the climate controlled weighing room.
- Weighing equilibrated filters and recording gravimetric data into the PED (a Microsoft® Access database application).
- Archiving the weighed filters in cold storage

The laboratory SOP provides more details regarding these laboratory activities.

A6.4 Timing for $PM_{2.5}$-PEP Activities

Laboratory and field activities in the $PM_{2.5}$-PEP include those annual events that are completed for preparing for approximately one year's worth of PM-PEP sampling events as well as continual events that occur as PEP sampling events are conducted. These events are briefly described below and additional detail on these activities is provided in the $PM_{2.5}$-PEP field and laboratory SOPs.

A6.4.1 $PM_{2.5}$-PEP Annual Activities

The following $PM_{2.5}$-PEP activities are conducted annually to prepare for approximately the next year of PEP sampling events:

1. Calibration verification/certification of the field transfer standard for temperature, barometric pressure, and flow rate by the EPA RTP metrology laboratory or transfer standard manufacturer metrology service.

2. Creating a list of network monitoring sites eligible for $PM_{2.5}$-PEP sampling events.

3. Selecting sites from this list at which $PM_{2.5}$-PEP sampling events will be performed in the given calendar year.

4. Developing a schedule for $PM_{2.5}$-PEP sampling events.

5. Calibration verification/certification and maintenance of the weighing laboratory analytical balance(s) and environmental monitoring equipment.

6. Receiving and inspecting filter media and determining lot equilibration duration.

7. Annual maintenance of vehicles and trailers (as equipped), etc.

A6.4.1.1 Annual Selection of $PM_{2.5}$-PEP Audits

Within 40 CFR Part 58, Appendix A, Section 3.2.4, the $PM_{2.5}$-PEP sampling design was codified and then amended in October 2006 to require the following:

- PQAOs with five or fewer monitoring sites within the network must conduct and report a minimum of five (5) valid $PM_{2.5}$-PEP sampling events per year.

- PQAOs with more than five monitoring sites within the network must conduct and report a minimum of eight (8) valid $PM_{2.5}$-PEP sampling events per year.

Additionally, among the primary routine samplers in the national monitoring network within a PQAO:

- Each method designation represented among the primary monitors must be subjected to a $PM_{2.5}$-PEP sampling event each year.

- Each individual primary monitor must be subjected to a $PM_{2.5}$-PEP sampling event at least once every six (6) years.

Together, these two requirements result in conducting a $PM_{2.5}$-PEP sampling event at approximately 15% of all $PM_{2.5}$ network monitoring sites each year.

A $PM_{2.5}$-PEP sampling event is valid for completeness purposes (i.e., satisfies the CFR requirement for the number of $PM_{2.5}$-PEP events per PQAO) when the $PM_{2.5}$-PEP sampler collects a 24±1 hour filter sample concomitantly with the SLT monitoring site $PM_{2.5}$ sampler and both the $PM_{2.5}$-PEP and routine SLT monitoring site sampler concentration data for the 24-hour period are validated (i.e., not voided or invalidated) and are successfully reported to AQS. Additionally, to be considered valid for the $PM_{2.5}$-PEP bias assessment, both the $PM_{2.5}$-PEP and SLT monitoring site measured $PM_{2.5}$ concentrations must be ≥ 3 $\mu g/m^3$.

EPA recognizes that ambient $PM_{2.5}$ concentrations across the US have trended downward for the last 15 years; consequently, the incidence of invalid data pairs for assessing bias due to one or both SLT and the $PM_{2.5}$-PEP concentrations being < 3 $\mu g/m^3$ during a $PM_{2.5}$-PEP sampling event at a given site has increased significantly. At the same time EPA has firmly established that the practical detection limit is substantially lower than the detection limit of 2 $\mu g/m^3$ stated in the original promulgated FRM (40 CFR Part 50 Appendix L). Therefore, for purposes of completeness in the $PM_{2.5}$-PEP, sampling events are not invalidated when concentrations are ≤ 3 $\mu g/m^3$, and therefore count toward the PQAO's completeness. However, data from these sampling events are excluded from the bias assessment by AQS, and the affected PQAO will be informed when the $PM_{2.5}$-PEP concentration is confirmed to be < 3 $\mu g/m^3$. One extra $PM_{2.5}$-PEP sampling event should be scheduled and performed in each PQAO in those geographic areas where historical data show $PM_{2.5}$ concentrations (either as queried from AQS or from previous PEP events) are < 3 $\mu g/m^3$. Self-implementing PQAOs may conduct up to three extra $PM_{2.5}$-PEP events to increase the probability of achieving the prescribed number of data pairs of which both concentrations exceed 3 $\mu g/m^3$. $PM_{2.5}$-PEP Regional Leads should designate additional $PM_{2.5}$-PEP sampling events to accommodate make-up sampling events when cancellations or invalid sampling events occur.

A6.4.1.2 Scheduling $PM_{2.5}$-PEP Sampling Events

During the autumn of each calendar year, personnel from the SLT organizations work with the Regional $PM_{2.5}$-PEP Leads to prepare a list of $PM_{2.5}$ network monitoring sites at which $PM_{2.5}$-PEP sampling events can be conducted and a schedule for conducting the PEP events in the next calendar year. This list of monitoring sites and proposed schedule should be completed by December 1 of the preceding year during which the PEP events are to occur. Self-implementing PQAO $PM_{2.5}$-PEP Coordinators should prepare their prospective PEP event lists and schedules and seek Regional $PM_{2.5}$-PEP Lead approval by January 1 of the year during which the PEP events are to occur. The schedule of PEP events should be prepared to maximize efficiency in consideration of the following:

- The required number of $PM_{2.5}$-PEP sampling events noted in Section A6.4.1.1.
- Coordinating each $PM_{2.5}$-PEP sampling event with the monitoring schedule of the selected site's primary routine sampler.
- Inter-site proximity ($PM_{2.5}$-PEP sampling events can be scheduled for the same day or week among sites close in proximity to each other).
- Coordination with other QA programs (e.g., Pb-PEP and NPAP) if possible.

$PM_{2.5}$-PEP sampling events at SLT monitoring sites conducting routine collocated sampling should be scheduled preferentially to occur on dates for which the collocated monitor is also sampling. This provides insurance that a valid result for the $PM_{2.5}$-PEP event can be recorded in the event the primary sampler fails to produce valid measurement data during the event.

A6.4.1.2.1 Make-Up $PM_{2.5}$-PEP Events

In the event a $PM_{2.5}$-PEP sample or associated SLT $PM_{2.5}$ routine sample measurement is invalid

for the PEP event, a make-up PEP event may be scheduled to ensure the required number of valid annual audits is completed. $PM_{2.5}$-PEP FSs are discouraged from scheduling make-up events on days not on the national monitoring schedule unless there are special circumstances (e.g., offshore travel or the event is near the end of the calendar year). When a sampling event is known to be invalid at the time of sample retrieval and it is otherwise difficult to travel to the location, the FS (with $PM_{2.5}$-PEP Regional Lead approval) may schedule a make-up PEP sampling event. If the SLT organization is amenable to hosting a $PM_{2.5}$-PEP sampling event on a day other than a routine sampling day and is willing to post the result of its collected sample to AQS, then the sampling event can be scheduled for that day. Note that primary routine $PM_{2.5}$ samplers operating continuously (e.g., FEMs) simplify the scheduling of make-up $PM_{2.5}$ sampling events.

A6.4.2 Ongoing $PM_{2.5}$-PEP Activities

Once the $PM_{2.5}$-PEP sampling event schedule is completed and approved, numerous field and laboratory activities occur periodically and on an ongoing event-by-event basis. The following is a general timeline of events:

1. FSs notify (approximately one month in advance of the events) the $PM_{2.5}$-PEP Weighing Laboratory of the upcoming events and request the number of filters needed to accomplish sampling and QC (i.e., FBs and TBs).

2. FSs verify field transfer standards are within certification dates and suitable for field deployment.

3. FSs inspect transportation vehicles and equipment transport cases.

4. FSs inspect and replace shipping containers (i.e., insulated coolers), refrigeration bricks, and other consumables.

5. LAs inspect and equilibrate new filters.

6. LAs measure and record tare weights on new filters, install filters in sampling cassettes, generate COC forms, and package filters for shipment to FSs.

7. FSs set up the FRM $PM_{2.5}$-PEP sampler at the SLT monitoring site, conduct pre-sampling checks and calibration verifications, document activities on the FDS/COC form, and program the sampler to sample during the SLT sampling event.

8. FSs retrieve the $PM_{2.5}$-PEP filter sample, package it for shipping, and ship the filter and accompanying FDS/COC form to the $PM_{2.5}$-PEP weighing laboratory.

9. LAs receive filter shipments, measure shipment temperatures, log filter collection information into the PED, and store filters refrigerated until conditioned for post-sampling weight measurements.

10. LAs condition sampled filters, verify analytical balance calibration and operation, measure post-sampling weights, and input measurement data into the PED.

11. The $PM_{2.5}$-PEP laboratory manager and EPA $PM_{2.5}$-PEP Weighing Laboratory Task Monitor review and verify the sample collection and mass measurement data in the PED. Data that show as invalid or compromised are more closely reviewed and the $PM_{2.5}$-PEP laboratory manager and EPA $PM_{2.5}$-PEP Weighing Laboratory Task Monitor communicate with $PM_{2.5}$-PEP Regional Leads and FSs to correct data as possible.

12. The $PM_{2.5}$-PEP laboratory manager and EPA $PM_{2.5}$-PEP Weighing Laboratory Task Monitor approve data for upload to AQS.

A7 Data Quality Objectives and Criteria for Measurement

This section describes the DQOs established by EPA for the $PM_{2.5}$ monitoring program and how the $PM_{2.5}$-PEP assesses conformance with the DQOs and the performance criteria for the environmental data operation (EDO) used to generate $PM_{2.5}$-PEP data.

A7.1 Data Quality Objectives for the $PM_{2.5}$ Ambient Air Monitoring Program

DQOs are qualitative and quantitative statements derived from the DQO process that clarify the objectives for capturing data, define the appropriate type of data to collect, and specify the tolerable levels of decision errors or estimation uncertainty from the collected data. By applying the DQO process to the development of a quality system for $PM_{2.5}$ monitoring, EPA ensures that committed resources are collecting data that can be used to meet their intended use (e.g., NAAQS comparison).

In 1997, EPA implemented the DQO process to the $PM_{2.5}$ ambient air monitoring program. The DQOs were based on the ability to measure ambient concentrations that can be compared to the $PM_{2.5}$ NAAQS, so that an attainment decision could be made for the given monitoring site to within a given level of confidence (or equivalently, decision error percentage). EPA deemed ±5% to be an acceptable decision error limit. Practically, this means that 95% of the time a site's designation as in attainment or non-attainment will be correct.

The DQO for acceptable precision (10% CV) and bias (± 10%) in the national $PM_{2.5}$ monitoring network are identified in 40 CFR Part 58 Appendix A Section 2.3.1.1. Bias is calculated according to 40 CFR Part 58 Appendix A Section 4.2.5 (Section 4.2.5 references PEP audits as conducted under Section 4.1.3; however, this is incorrect and should be a reference Section 3.2.4). EPA uses these precision and bias limits as goals against which to evaluate measurement uncertainty. **The $PM_{2.5}$-PEP provides the measurements upon which the bias component of the DQO for the $PM_{2.5}$ ambient air monitoring program is evaluated**.

Bias is conventionally measured and evaluated by introducing a standard reference material (SRM) to the measurement process and evaluating the results. Because there is no convenient, practical, or accurate way of introducing a known concentration of particles into a $PM_{2.5}$ FRM/FEM sampler, EPA chose to standardize the $PM_{2.5}$-PEP on the sampler that was deemed to be the most precise of the FRM samplers under 40 CFR Part 50 Appendix L. Equally critically important, the selected $PM_{2.5}$-PEP's gravimetric laboratory is to comprise a climate control system, gravimetric analysis equipment, and associated procedures that rigorously adhere to the technical design, operational parameters, and QC requirements prescribed in the FRM. The $PM_{2.5}$-PEP serves, as closely as possible, as a reference standard by which a relative network

bias and the relative accuracy of an SLT monitoring organization's $PM_{2.5}$ measurement during a given $PM_{2.5}$-PEP sampling event can be determined.

The $PM_{2.5}$-PEP bias assessment is national in scope and incorporates several QA concepts and practices. It is important to ensure that the $PM_{2.5}$-PEP collects a statistically sufficient number of data points to assess bias. The more samples and data collected, the larger the confidence in the bias assessment; however, the amount of data must be balanced against the finite and limited annual $PM_{2.5}$-PEP funding.

The minimum number of $PM_{2.5}$-PEP samples needed to detect a bias of ±10% depends on the precision (i.e., the CV) of $PM_{2.5}$ measurements and the (unknown) amount of bias actually present. Neither of these statistics were well characterized at the onset of the $PM_{2.5}$-PEP. Initially based on a statistical review, the frequency of $PM_{2.5}$-PEP sampling events was set at 25% of the $PM_{2.5}$ national monitoring network each year (i.e., each primary routine sampler in the network was audited once every four years). This frequency was shown to be adequate to evaluate bias for a typical reporting organization assuming initial estimates of sampler CV of less than 10% and allowing for a 10% decision error.

In 2005, the minimum sampling frequency required to detect a 10% bias over three (3) years was re-evaluated using acquired network data to get an improved estimate of CV and bias. A background paper from 2005 on this re-evaluation is available here: https://www.epa.gov/sites/production/files/2020-09/documents/pepreduction.pdf.

Using the updated estimates, EPA determined that approximately 24 $PM_{2.5}$-PEP sampling events in large networks over a 3-year period and 15 sampling events in relatively smaller networks (i.e., 8 per year and 5 per year, respectively) would be adequate to evaluate a ±10% bias for a reporting organization. This resulted in the current regulations (40 CFR Part 58, Appendix A, Section 3.2.4) on minimum numbers of $PM_{2.5}$-PEP sampling events for a PQAO to conduct annually (see Section A6.4.2). Per 40 CFR Part 58 Appendix A Section 4(b), EPA assesses bias in concentrations generated by the $PM_{2.5}$ ambient air monitoring network annually at the PQAO level.

A7.2 Data Quality Indicators and Associated Measurement Quality Objectives

Once DQOs are established, the quality of the data must be controlled and evaluated to ensure that it is properly maintained at the required level. EPA establishes MQOs to evaluate and control various phases (e.g., sampling, preparation, analysis) of the measurement process to ensure that total measurement uncertainty is within the range recommended by the DQOs. Within the $PM_{2.5}$ national monitoring program, EPA has defined MQOs in terms of the following data quality indicators (DQIs):

- **Precision.** A measure of mutual agreement in $PM_{2.5}$ measurements possessing identical properties, usually under prescribed similar conditions. Precision is typically expressed as a standard deviation.

- For the $PM_{2.5}$-PEP, the impact of field activities on precision is assessed by collocating samplers from each Region's or self-implementing PQAO's $PM_{2.5}$-PEP sampler fleet and comparing filter samples collected from each for a given sampling day (see Section B5.4.1). These are colloquially known as parking lot studies as they are often conducted in a parking lot.

- The impact of laboratory handling and analysis on precision is estimated through duplicate filter weighing (e.g., batch duplicates – Section B5.1.2.2).

- **Bias.** The systematic or persistent distortion of a measurement process which leads to error in $PM_{2.5}$ measurements in one direction. Bias is determined by comparing these measurements against a true or reference value, expressed as a percentage difference (PD) from the true or reference value, and noting whether the difference is consistently positive or negative.

  - For the $PM_{2.5}$-PEP, the impact of field activities on bias is assessed based on sampler flow rate. The impact of flow rate on the collected mass is complex due to relationship between the particle size separator and flow rate. Independent of the particle size separator, a flow rate that is biased low (i.e., the indicated flow rate is higher than the actual flow rate) will result in overestimation of the collected volume and will bias the in-air concentration low, and conversely will underestimate in-air concentrations when the flow rate is biased high. The particle size cut point of the $PM_{2.5}$-PEP separators (i.e., the size of the PM collected or excluded) is dependent on the flow rate. The separators (VSCC or WINS) are manufactured to operate at the design flow rate of 16.67 LPM, in which any deviation from the design value will affect how precisely the particulate separators eliminate particles larger or smaller than $PM_{2.5}$ from the filtrate. When a sampler's flow rate is biased low (less than 16.67 LPM), particulates larger than 2.5 µm are collected on the filter leading to an overestimate of the $PM_{2.5}$ concentration. Conversely, when the flow rate is biased high (greater than 16.67 LPM), the largest particulate collected is smaller than 2.5 µm, excluding desired particulates and leading to an underestimate of the $PM_{2.5}$ concentration. Therefore, EPA requires one-point sampler flow rate checks prior to each $PM_{2.5}$-PEP sampling event and quarterly flow rate audits on each $PM_{2.5}$-PEP sampler.

  - Field activity bias for the $PM_{2.5}$-PEP is also assessed by periodic collection of FB and TB filter samples. Evidence of contamination on FB and TB filters indicates the positive bias that may be due to filter handling, sampling, and/or transport). Note that such field QC filter samples only indicate the potential for positive bias and do not imply when negative bias may be present due to field activities.

- The $PM_{2.5}$-PEP weighing laboratory controls its filter conditioning environment to minimize temperature and humidity variation and to eliminate airborne dust to keep filters pristine, minimizing bias impacts. Temperature and relative humidity (RH) must be maintained within specified ranges and within variability tolerances during filter conditioning prior to filter weighing to eliminate the bias imparted by moisture variation on the filter mass. The laboratory also incorporates laboratory filter blanks into analytical batches to verify that contamination is not introduced to filters during the conditioning, handling, and analysis processes. Acceptance criteria established for laboratory blanks, FBs, and TBs evaluate the potential for negative and positive bias. Routine periodic balance checks are employed to ensure the microbalance measurements are not unacceptably biased.

- **Accuracy –** Represents closeness of a measurement to "truth" (typically represented by an accepted reference value). Accuracy combines random error (precision) and systematic error (bias) components that result from sampling and analytical operations. This term is used throughout the CFR and in some of the sections of this document.

  - Because it is extremely difficult to make accurate real-time measurements of airborne $PM_{2.5}$, the accuracy of filter-based $PM_{2.5}$ measurements are apportioned into separate assessments of precision and bias.

- **Representativeness.** A measure of the degree in which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

  - To adequately characterize bias within the $PM_{2.5}$ national monitoring network, each PQAO must perform a specified number of annual $PM_{2.5}$-PEP sampling events (refer to Section A6.4.1.1). The $PM_{2.5}$-PEP sample duration must coincide with the same 24-hour duration (± 1 hour) of the routine SLT monitoring organization sampler and must meet the $PM_{2.5}$ sampler collocation siting and inlet height requirements specified in 40 CFR Part 58 Appendices A, C, and E.

  - The number of $PM_{2.5}$-PEP sampling events required per PQAO described in Section A6.4.1.1 was determined to be adequately representative of the routine $PM_{2.5}$ monitoring network to properly characterize the network bias.

- **Detectability.** The determination of the low-range critical value of a characteristic that a method-specific procedure can reliably discern.

  - The laboratory analysis method is the primary driver of detectability for the FRM as it requires a minimum $PM_{2.5}$ mass collected on the filter to detect the $PM_{2.5}$ mass reproducibly. This minimum mass also impacts the volume of air flow during a field sampling event, which is a function of sampling duration (24 ± 1 hour) and the sampler flow rate (16.67 LPM). The laboratory method must be capable of detecting a $PM_{2.5}$ concentration of 2 $\mu g/m^3$ (equivalent to a deposited filter mass of ~48 µg) as specified in 40 CFR Part 50 Appendix L Section 3.1. EPA OAQPS has determined

that based on the laboratory method capability to detect, with certainty, a 20-µg difference between pre-sampling tare weight and post-sampling weight, a concentration of 0.8 µg/m^3 can be detected on sampled filters.

- **Sensitivity.** The capability of a method/instrument to discriminate between small differences in concentration. More generally, sensitivity measures a method's response to a change in input.
  - Instrument specification requirements drive the level of sensitivity obtained in the $PM_{2.5}$-PEP. The ability to attain measurements resolved by 0.1 µg/m^3 requires balance measurement differences of approximately 2.4 µg.
- **Resolution.** The smallest unit of measurement indicated by an instrument.
  - CFR Part 50 Appendix L defines many of the $PM_{2.5}$-PEP instrument resolution requirements. For example, a $PM_{2.5}$-PEP sampler's barometric pressure sensor must have a resolution of at least 5 mmHg.
- **Completeness.** A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions. Data completeness requirements for the $PM_{2.5}$-PEP are included in 40 CFR Part 58 Appendix A.
  - The $PM_{2.5}$-PEP requires completion of 100% of the required minimum number of valid $PM_{2.5}$-PEP sampling events each year for each PQAO. Note that there are two metrics for completeness – that there are valid samples collected that meet all technical acceptance criteria and are not invalidated and, samples considered valid for the purposes of inclusion in the bias assessment. The $PM_{2.5}$-PEP does not require 100% completeness for valid samples for bias assessment. While EPA attempts to ensure that collected PEP samples are those with $PM_{2.5}$ concentrations ≥ 3 µg/m^3, this is outside of the program's control.
- **Comparability.** A measure of confidence with which data in one dataset are comparable to data in another.
  - Because $PM_{2.5}$-PEP samples are collected and analyzed using the same or equivalent procedures and with equal or more stringent acceptance criteria as in the national monitoring network, the routine and PEP data are suitably comparable.

EPA has defined an MQO and associated acceptance criteria for each DQI which is applicable for specific phases of the EDO. Parts of *Guidance Document 2.12* [11] have identified some of these acceptance criteria. In theory, if these acceptance criteria are met, then measurement uncertainty should be controlled to the levels required by the DQOs.

[11] https://www.epa.gov/sites/default/files/2021-03/documents/p100oi8x.pdf

The $PM_{2.5}$-PEP is essentially an independent national monitoring program. However, because it has the added importance of producing data that can be used to estimate bias at the PQAO level, its data quality requirements are more stringent than those in the national $PM_{2.5}$ monitoring program. Table A7-1 and Table A7-2 list the QC activities related to the MQOs and acceptance criteria for field and laboratory activities, respectively, in the $PM_{2.5}$-PEP.

Table A7-1. MQOs and Acceptance Criteria for $PM_{2.5}$-PEP Field Activities

DQI Category	Frequency	Acceptance Criteria	Reference
Sampling Representativeness - Sampling Period (duration)	Each $PM_{2.5}$-PEP filter	1,440 minutes ± 60 minutes (24 hours ± 1 hour) Midnight to midnight local standard time concurrently with the routine sampler	Part 50 App. L, Sect. 3.3
Data Representativeness (total sampling events performed each year)	Annually within a PQAO	Completion of - 5 valid $PM_{2.5}$-PEP sampling events for PQAOs operating ≤ 5 sites or - 8 valid $PM_{2.5}$-PEP sampling events for PQAOs operating > 5 sites	Part 58 App. A, Sect. 3.2.4
Data Representativeness (sampling events performed per method designation, i.e., sampler type)	Annually within a PQAO	Completion of 1 valid $PM_{2.5}$-PEP sampling event per primary method designation	Part 58, App. A, Sect. 3.2.4.1
Data Representativeness (sampling events performed per site)	At least once every 6 years within a PQAO	Completion of 1 valid $PM_{2.5}$-PEP sampling event of each primary monitor	Part 58, App. A, Sect. 3.2.4.2
Data Completeness (percentage of required number of $PM_{2.5}$-PEP sampling events performed)	Annually within a PQAO	100% (concentrations < 3 µg/m^3 do not invalidate a sampling event for purposes of completeness)	Part 58 App. A, Sect. 3.2.4
Sampling Instrument Specifications			
Detectability - Lower Detection Limit	All data	Approximately 2 µg/m^3	Part 50, App. L, Sect. 3.1
Bias - Sampler Flow Rate	For the 24-hour sampling period	± 4% of 16.67 LPM	Part 50, App. L, Sect. 7.4.3.1
Bias - External Leak Check	Each $PM_{2.5}$-PEP audit	< 80 mL/min[c]	Part 50, App. L, Sect. 7.4.6.1
Bias - Internal Leak Check	If external leak check fails	< 80 mL/min[c]	Part 50, App. L, Sect. 7.4.6.2
Collocated Sampler Siting Criteria			
Sampler Representativeness - Inlet spacing	Each $PM_{2.5}$-PEP audit	Inlet to inlet must be within 4 meters of each other and at least 1 meter apart	Part 58, App. A, Sect. 3.2.3.4(b)
Sampler Representativeness - Horizontal distance from supporting structures	Each $PM_{2.5}$-PEP audit	> 2 meters	Part 58, App. E, Sect. 11

Table A7-1. MQOs and Acceptance Criteria for PM2.5-PEP Field Activities (continued)

DQI Category	Frequency	Acceptance Criteria	Reference
Sampler Representativeness - Distance from trees to inlet probe	Each PM2.5-PEP audit	> 10 meters from dripline of nearest tree	Part 58, App. E, Sect. 11
Sampler Representativeness - Distance from high volume (≥ 200 L/minute) sampler	Each PM2.5-PEP audit	> 2 meters from inlet of high volume sampler	Part 58, App. E, Sect. 11
PM2.5-PEP Precision (Using Collocated Samplers)[a]			
Precision - Regional PM2.5-PEP Collocation Events	2/year (semi-annual)	Individual samplers with CV >10% are flagged and filters are reweighed to confirm. If CV >20%, all sampler data are flagged from the last precision check, corrective action initiated, and impact on data assessed.	PM2.5-PEP Requirement
Precision - Regional PM2.5-PEP Collocation Events	2/year (semi-annual)	Any sampler with at least 2 and more than 50% of all relative notable differences over the collocation event (which may consist of several days) is flagged and require further evaluation.	PM2.5-PEP Requirement
PM2.5-PEP Sampler Internal Audits[b]			
Bias – Sampler Flow Rate Audit	4/year (quarterly)	Percent difference within ± 4% of transfer standard Percent difference within ± 4% of design flow (16.67 LPM)	Part 50, App. L, Sect. 9.2.5; PM2.5-PEP Requirement
Bias - Barometric Pressure Audit	4/year (quarterly)	Within ± 10 mm Hg of transfer standard	Part 50, App. L, Sect. 7.4.9 and 9.3
Bias - Temperature Audit	4/year (quarterly)	Within ± 2°C of transfer standard	Part 50, App. L, Sect. 7.4.8 and 9.3
PM2.5-PEP Blanks			
Bias - Field Blank	1 per PM2.5-PEP sampling event (PEPs < 2 years old) or 1 per trip (all other programs)	± 30 µg difference between pre-sampling & post-sampling	Part 50, App. L, Sect. 8.3.7
Bias - Trip Blank	1 per PM2.5-PEP sampling trip	± 15 µg difference between pre-sampling & post-sampling	PM2.5-PEP Requirement

[a] Twice per year, all PM2.5-PEP samplers used by the Region or self-implementing PQAO must be collocated (parking lot study) and 24-hour concentrations analyzed as described in Section B5.4.1.

[b] Quarterly audits are performed similarly to the verification checks conducted prior to every PM2.5-PEP sampling event. However, the audits should (preferably) be conducted by a certified and experienced technician other than the PM2.5-PEP FS that typically uses the specific sampler. Also, the working standard used during the audit must be a different standard than that used during verifications or calibrations.

[c] PQ200 sampler leak check criteria is to check for 5 cm H_2O of vacuum pressure loss over 2 minutes. The listed leak check criteria are stated per CFR requirements. The internal leak check procedure is not needed if the external leak check passes criteria, as the external leak check incorporates the portion of the flow path assessed with the internal leak check procedure.

Table A7-2. MQOs and Acceptance Criteria for PM2.5-PEP Laboratory Activities

Activity	Frequency	Acceptance Criteria	Reference
Filter Conditioning Environment			
Bias - Pre-sampling filter equilibration	All filters	24 hrs minimum[a] in weighing room; ≤ 5 μg change between sequential weighing of each filter	Part 50, App. L, Sect. 8.2
Bias - Post-sampling filter equilibration	All filters	24 hr minimum[b] with 7-day maximum[c] from start of equilibration to post-weighing	PM2.5-PEP Requirement Part 50, App. L, Sect. 8.2
Bias - Filter Equilibration Temperature Range	All filters	24-hr mean 20 to 23°C; individual 5-min averages between 18 and 25°C; no more than ten 5-min averages missing from a 24-hour period	Part 50, App. L, Sect. 8.2.1
Bias - Filter Equilibration Temperature Control	All filters	Standard deviation of 5-minute averages ≤ 2°C over 24 hr	Part 50, App. L, Sect. 8.2.2
Bias - Relative Humidity Range	All filters	24-hr mean 30 to 40%; Individual 5-minute averages must be between 25% and 45%	Part 50, App. L, Sect. 8.2.3
Bias - Relative Humidity Control	All filters	Standard deviations of 5-minute averages ≤ 5% over 24 hr; and 24-hour mean within ± 5% RH between pre- & post-weighing	Part 50, App. L, Sect. 8.2.4
Laboratory Quality Control Checks			
Bias - Laboratory Filter Blank	1 per every 10 filters in a weighing session	± 15 μg/filter change between weighings	Part 50, App. L, Sect. 8.3.7
Bias - Lot Stability Test	20 filters weighed approximately every 24 hours over successive days for each new lot of filter media	Establishes conditioning period required for each lot of filters for filter tare weights: mass difference of ±15 µg/filter between successive weighings following 24-hour conditioning periods for 19 of 20 filters	PM2.5-PEP Requirement
Precision – Intra-batch duplicates	One exposed filter weighed earlier in the weighing session, one required per post-sampling weighing session	± 15 µg/filter change between weighings	PM2.5-PEP Requirement
Precision – Inter-batch duplicates	One exposed filter weighed in a previous weighing session, one per post-sampling weighing session	± 15 µg/filter change between weighings	PM2.5-PEP Requirement
Bias - Low mass (less than expected weight of an un-exposed filter) standard microbalance check	Beginning/end every weigh session and after every 10 filter mass measurements	± 3 µg from certified assigned mass	PM2.5-PEP Requirement
Bias - High mass (greater than expected weight of an un-exposed filter) standard microbalance check	Beginning/end every weigh session and one after every 10 filter mass measurements	± 3 µg from certified assigned mass	PM2.5-PEP Requirement

Table A7-2. MQOs and Acceptance Criteria for PM2.5-PEP Laboratory Activities (continued)

Activity	Frequency	Acceptance Criteria	Reference
Bias - Balance performance evaluation (PE) audit [d]	2/yr	All masses must be within ± 3 μg of the assigned certified mass	PM2.5-PEP Requirement
Bias - Interlaboratory comparison [e]	2/yr	Advisory limits set by OAQPS	PM2.5-PEP Recommendation

[a] The minimum pre-sampling equilibration time is determined per filter lot and is either 24-hrs or the equilibration time determined during the lot stability test, whichever is larger.

[b] The minimum post-sampling equilibration time is minimally 96 hours except in extenuating circumstances in which case the minimum equilibration time will be 24 hours.

[c] Review of inter-batch duplicate data suggests significant weight loss due to semi-volatile evaporation occurs after 7 days of equilibration in the weigh lab.

[d] Standard weights for performing balance PE audits should be independent of standard weights used for other verification activities performed by the PM2.5-PEP Laboratory. PE audit conducted at discretion of OAQPS PM2.5-PEP Lead.

[e] Round-robin performance evaluation administered by OAQPS.

A8 Training Requirements and Certifications

This section prescribes the training required for implementing the PM2.5-PEP to ensure that specific operational skills for staff performing activities can be verified, documented, and updated, as necessary. Staff responsible for providing training will incorporate up-to-date knowledge regarding field and laboratory operations in training exercises.

While there is some overlap in the field and laboratory activities, this section is organized such that field activities and laboratory activities are discussed separately.

OAQPS has developed a training program to ensure PM2.5-PEP personnel have a baseline level of knowledge about the PM2.5 national monitoring network, the principles and operation of the PM2.5-PEP, and their QA procedures, which includes the following:

- National-level conferences and training workshops
- In-person training at EPA facilities for hands-on experience and operational reviews
- National- and Regional-level conference calls
- Individual training sessions upon request.
- Use of the AMTIC and AirQA websites to post documentation including this QAPP, field and laboratory SOPs, and other current materials used in PM2.5-PEP training.

EPA, through its Regional offices and headquarters, has access to multiple training facilities, which provide the capacity to:

- Develop internal expertise in fine PM monitoring and gravimetric analysis.

- Have monitoring equipment readily accessible to EPA staff for questions and concerns.
- Perform field and laboratory training for personnel at EPA, Regional offices, monitoring organizations, and contractors.
- Perform special studies (study sampler performance, evaluate measurement uncertainty).
- Perform research studies for future monitoring activities.

A8.1 Field Scientist Training

Focused training for the $PM_{2.5}$-PEP includes is required initially and annually thereafter for FSs who conduct $PM_{2.5}$-PEP sampling events. This training and successful demonstration includes the following:

- Specific, extensive hands-on field activity training sessions sponsored and developed by OAQPS and which involve FSs and/or LAs (supporting EPA Regions and self-implementing PQAOs), Regional $PM_{2.5}$-PEP Leads, and Regional staff (if they perform $PM_{2.5}$-PEP sampling events).
- A program to certify the participants of the training sessions that involves satisfactory performance on a written test and an operational proficiency test. Unsatisfactory completion of either of these tests results in additional training until the individual achieves successful certification.

Note that the training requirements as prescribed in this section are applicable to both the Regional $PM_{2.5}$-PEP Leads and FSs as well as the $PM_{2.5}$-PEP coordinators and FSs at each self-implementing PQAO.

A8.1.1 Field Scientist Trainers

Trainers are certified by OAQPS as qualified field operations trainers and include OAQPS personnel from the AAMG QA Team, Regional $PM_{2.5}$-PEP QA staff, and EPA Regional contractors who are certified FSs for the $PM_{2.5}$-PEP. Trainers are required to complete the same training as FS complete and therefore attend the initial, comprehensive field training course, complete the exams, and attend ongoing training courses and demonstrate continued proficiency. The $PM_{2.5}$-PEP OAQPS Lead or Regional Lead approves and certifies trainers.

A8.1.2 Initial Training for New Field Scientists

Before performing a $PM_{2.5}$-PEP sampling event unsupervised, a new FS trainee will complete training coursework as well as shadow a certified $PM_{2.5}$-PEP FS on two $PM_{2.5}$-PEP sampling events.

The FS trainee will attend the initial comprehensive $PM_{2.5}$-PEP Field Operations training course. Typically, the course is conducted annually at OAQPS headquarters; however, if there is a need for a new trainee to perform $PM_{2.5}$-PEP sampling events unsupervised before the next available

national initial training course, at the discretion of the OAQPS $PM_{2.5}$-PEP Lead, the training course may be administered by an EPA Regional $PM_{2.5}$-PEP Lead certified trainer (with assistance from a Regional $PM_{2.5}$-PEP contractor certified trainer, if available).

The FS will also attend two $PM_{2.5}$-PEP sampling event trips with a certified FS and/or their Regional $PM_{2.5}$-PEP Lead as part of the initial training and certification. On the first sampling event, the trainee observes the relevant field activities performed by the trainer: sampler transport, sampler setup, verification of the sampler calibration and operation (temperature, pressure, and flow rate, etc.). On the second sampling event, the trainee performs the relevant field activities under the supervision of the trainer. Based on assessment by the trainer, the trainee may need to attend additional sampling events to gain familiarity with the equipment and procedures prior to successful training completion.

A8.1.2.1 Initial Comprehensive $PM_{2.5}$-PEP Field Operations Proficiency Training Course

The Initial Comprehensive $PM_{2.5}$-PEP Field Operations Proficiency Training Course typically occurs over three full days where trainees attend lecture, observe trainers, and practice conducting procedures to gain and strengthen familiarity with the equipment and procedures.

The training course covers the following topics:

- Introduction to $PM_{2.5}$ monitoring for compliance with NAAQS
- QA requirements for monitoring $PM_{2.5}$ for compliance with the NAAQS
- Introduction to the $PM_{2.5}$-PEP
- Planning and preparation
- Filter receipt, storage, and handling
- Communications with the $PM_{2.5}$-PEP weighing laboratory
- Sampler transport, placement, and assembly
- Equipment calibration verifications and checks
- Programming a sampling event
- Filter exposure and retrieval and concluding the sampling event
- Use of COC and FDS forms
- Use of the AirQA website to review the sampling event data for verification and validation
- $PM_{2.5}$-PEP QA/QC procedures and documentation retention

- Troubleshooting in the field.

The training course consists of:

(a) classroom instruction,

(b) hands-on practice of field operational procedures,

(c) a proficiency exam to perform field procedures detailed in the Field Performance Examination Checklist, and

(d) a written, open-book exam.

Trainees must score ≥ 90% on both the field proficiency and written exams to achieve certification. Trainees can revisit exam questions or repeat demonstration of procedures until satisfactory performance is demonstrated to the examiner.

A8.1.3 Annual $PM_{2.5}$-PEP Field Operations Proficiency Recertification Training

Each year the OAQPS $PM_{2.5}$-PEP Lead, in consultation with the Regional $PM_{2.5}$-PEP Leads, determine the need, schedule, and agenda topics for a recertification training workshop. The preferred format for the training is an in-person classroom instruction; however, a webinar format may be necessary if travel ability is limited. The main objective of the training workshop is to supplement and refresh FS skills and to verify FS recertification by proficiency testing. Additional training objectives include: providing instruction on new operating procedures in the laboratory and field, communicating developments in data management (such as the implementation of MoPED), and communicating programmatic changes due to regulatory changes or revisions in national QA policy and guidance. Attendance is mandatory for EPA contractor FSs and it is encouraged for participating self-implementing PQAO agencies. In cases where PQAO agencies cannot attend in person, they will be given an opportunity to participate through web-based audio/video technology, as available. If there are individuals that cannot attend, a separate follow-up session may be scheduled by the OAQPS $PM_{2.5}$-PEP Lead and respective Regional counterpart. Regional $PM_{2.5}$-PEP Leads are encouraged to attend at least every other year (refer to Section A8).

A8.1.3.1 Field Scientist Training Recertification

For the FS to successful demonstrate proficiency for recertification, the FS will score ≥ 90% on both the practical and written exams, which are typically conducted at the conclusion of the Field Operations Proficiency Recertification Training workshop. Upon evaluating the exam scores, if more than 5% of those tested (FS and Regional Leads) cannot achieve ≥ 90% on the exams, then the exam materials or training presentation materials and hands-on instruction activities may be adjusted. The OAQPS $PM_{2.5}$-PEP Lead and Regional Leads will confer and determine whether to revise the exam questions and/or presented materials and instruction to improve communication of concepts and requirements.

If the certification activities identify individuals who appear to be incapable of properly performing the field activities, the Regional $PM_{2.5}$-PEP Lead and RPOs are notified so remedial action can be taken.

A8.2 $PM_{2.5}$-PEP Weighing Laboratory Analyst Training

$PM_{2.5}$-PEP weighing LAs will undergo initial training before performing $PM_{2.5}$-PEP filter preparation activities unsupervised and, once certified, will undergo annual training to demonstrate continued proficiency. Training consists of a practical demonstration of proficiency and attendance at a training session workshop. The $PM_{2.5}$-PEP Weighing Laboratory Manager or properly trained designee will serve as the trainer.

A8.2.1 Initial Training for New $PM_{2.5}$-PEP Weighing Laboratory Analysts

New $PM_{2.5}$-PEP weighing LAs are required to undergo initial training before performing $PM_{2.5}$-PEP filter preparation activities unsupervised. Initial training consists of attending a practical training session and two filter life cycle sessions with a certified trainer (e.g., another LA or the $PM_{2.5}$-PEP Weighing Laboratory Manager) where the trainee observes for the first filter life cycle session and then performs the procedures for the second life cycle session under the supervision of a trainer. Initial training is complete if the trainer determines the trainee satisfactorily demonstrated proficiency of procedures on the second filter life cycle training session. The Weighing Laboratory Performance Examination Checklist (maintained by the OAPQS $PM_{2.5}$-PEP Lead) provides guidance for the initial training.

The trainee is required to attend the next available Initial Comprehensive $PM_{2.5}$-PEP Field Operations Proficiency Training Course held at an EPA-operated facility (e.g., OAQPS headquarters at RTP, North Carolina, or a Regional facility).

A8.2.2 Laboratory Analyst Practical Training

Laboratory analyst certification training for routine $PM_{2.5}$-PEP filter preparation and weighing activities consists of two full days of training at an OAQPS-designated $PM_{2.5}$-PEP weighing laboratory. Laboratory analyst training includes the life cycle training described above as well as the following topics:

- General laboratory activities including facilities and filter handling
- Communications with FSs and laboratory management
- Filter conditioning, including overview of the weighing laboratory climate control system and the requirements before performing a filter weighing session
- Filter weighing (static elimination, filter handling, balance operation)
- COC and FDS forms and their features
- $PM_{2.5}$-PEP PED and data handling software (such may include LIMS or MoPED upon release)

- AirQA website
- QA/QC of filter weighing activities including parameters and action levels for the balance as well as the standard masses and their treatment in the laboratory
- Equipment inventory and maintenance
- Equipment calibrations (balance, standard weights, environmental monitoring)
- Filter shipping
- Data entry into the $PM_{2.5}$-PEP PED and other software systems (e.g., LIMS or MoPED upon release) and data transfer
- Information retention schedules storage and archiving
- Filter archiving
- Troubleshooting of equipment and software.

A8.2.2.1 Laboratory Analyst Filter Life Cycle Training

Filter life cycles encompass the steps involved from inspection of new filters through final post-sampling filter weight measurements and include the data entry and associated QA/QC practices. Specifically, these include: filter inspection, filter equilibration, pre-sampling filter weighing, loading the filter into a cassette, generating a COC form, filter packaging and shipping, post-sampling filter weighing, and input of gravimetric measurements and associated QA/QC data into the PED and other software (e.g., LIMS or MoPED once released).

Filter life cycle training involves demonstration of the procedures for the purposes of instruction (i.e., to a new LA trainee) or evaluation of the individual performing the procedures (as performed for certification of a certified LA).

A8.2.3 Laboratory Analyst Attendance at Annual $PM_{2.5}$-PEP Field Scientist Training Session

The LA is expected to provide a formal or informal report in each annual field operations recertification workshop (this report may be made in person or via digital communications). This report will include procedures that are operating satisfactorily and those that require improvement (e.g., issues internal to the weighing laboratory, issues associated with the FS-lab interface such as issues with filter ordering or shipping/receipt).

A8.2.4 Laboratory Analyst Training Demonstration of Proficiency

LAs will take a practical exam to demonstrate proficiency for certification and must achieve a score of ≥ 90%. If the certification activities identify individuals who appear to be incapable of properly performing the laboratory activities, the Regional $PM_{2.5}$-PEP Lead Laboratory Manager are notified to initiate remedial action.

A8.3 Certification of Regional PM2.5-PEP Leads and Field Scientist Trainers

Regional PM2.5-PEP Leads have critical responsibilities in the implementation of the PM2.5-PEP among which is the potential need to train their contractors and participating PQAO field personnel. They are required to concur on the certification of their Region's PM2.5-PEP FSs as trainers for FS personnel such as new FS or FS that could not attend the annual certification workshop (such as newly hired contractor FS or self-implementing PQAO PM2.5-PEP FSs). The Regional Leads should also maintain their knowledge of current issues and changes in equipment and/or PM2.5-PEP procedures, and changes in regulations or policies that affect the implementation of the PM2.5-PEP or the validation and use of the resulting data for network bias assessments. Table A8-1 presents the training events that Regional PM2.5-PEP Leads will attend to obtain and maintain their status as qualified PM2.5-PEP Lead and PM2.5-PEP trainer. The OAQPS PM2.5-PEP Lead or designee will approve the certification of each trainer.

Table A8-1. Training Events for Maintaining Qualification as a PM2.5-PEP Lead and Trainer

Course and Level of Proficiency
Initial Comprehensive PM2.5-PEP Field Operations Proficiency Training Course Score of ≥ 90% on written and performance exams
Annual PM2.5-PEP and NPAP Regional Leads, co-leads, and self-implementing PQAO PM2.5-PEP coordinators Score of ≥ 90% on written exam [a]
Annual PM2.5-PEP Field Operations Proficiency Recertification Training
Annual Regional PM2.5-PEP Lead and PQAO PM2.5-PEP Coordinators Recertification Webinar [b]

[a] 1-day training course that pertains to the unique responsibilities of the Regional PM2.5-PEP Leads. This course can be held annually based on installation of new PM2.5-PEP Leads or back-ups. It may be taught in advance of an annual training for FSs or it may be held as a separate webinar.

[b] The annual EPA Regional PM2.5-PEP Lead and PQAO PM2.5-PEP Coordinator Recertification Webinar, hosted by OAQPS, is generally an abbreviated version of the PM2.5-PEP FS recertification training, and topic updates generally specific to this group's responsibilities.

A8.4 Additional Ambient Air Monitoring Training

Additional supplemental training for PM2.5 air monitoring and QA/QC training is offered through the following organizations:

- OAQPS staff within AAMG
- Air and Waste Management Association (AWMA) (http://www.awma.org)
- EPA Air Pollution Training Institute (APTI) (http://www.epa.gov/apti)
- EPA Office of Environmental Information (OEI) (http://www.epa.gov/quality/trcourse.html)
- EPA Regional offices.

Such training may consist of classroom lectures, workshops, teleconferences, and on-the-job training. Table A8-2 presents a sequence of core ambient air monitoring and QA courses for FSs and Regional QAMs (the latter marked with a single asterisk). The suggested course sequences assume little or no experience in QA/QC or air monitoring.

Table A8-2. Supplemental Training Courses in Ambient Air Monitoring and QA

Sequence	Course Title (Self Instructional [SI])	Course ID Number	Source
1*	Air Pollution Control Orientation Course, SI-422	422	APTI
2*	Principles and Practices of Air Pollution Control, 452	452	APTI
3*	Introduction to EPA Quality System Requirements	—	OEI
4*	Introduction to Ambient Air Monitoring, SI-434	434	APTI
5*	General Quality Assurance Considerations for Ambient Air Monitoring (under revision), SI-471	471	APTI
6*	Quality Assurance for Air Pollution Measurement Systems, 470	470	APTI
7*	Introduction to Data Quality Objectives	—	OEI
8*	Introduction to Quality Assurance Project Plans	—	OEI
9	Atmospheric Sampling, 435	435	APTI
10	Analytical Methods for Air Quality Standards, 464	464	APTI
11	Chain-of-Custody Procedures for Samples and Data, SI-443	443	APTI
*	Introduction to Data Quality Assessment	—	OEI
*	Introduction to Data Quality Indicators	—	OEI
*	Assessing Quality Systems	—	OEI
*	Detecting Improper Laboratory Practices	—	OEI
*	Beginning Environmental Statistical Techniques, SI-473A	473	APTI
*	Introduction to Environmental Statistics, SI-473B	473B	APTI
*	Interpreting Monitoring Data	—	OEI
*	Interpreting Multivariate Analysis	—	OEI
*	Quality Audits for Improved Performance	QA6	AWMA
	Air Quality System (AQS) Training	—**	OAQPS
*	Federal Reference Method Performance Evaluation Program Training (field/laboratory)	QA7	OAQPS
*	$PM_{2.5}$ Monitoring Implementation (video)	PM1	OAQPS

* Courses recommended for Regional QAMs
** Information on AQS training is available at https://www.epa.gov/aqs/aqs-training
APTI courses are available at: https://www.apti-learn.net/LMS/EPAHomePage.aspx?m=1&n=0

A8.5 Training Requirements for Self-Implementing PQAO Staff

PQAO staff performing $PM_{2.5}$-PEP sampling events must undergo the training described for their EPA counterparts in Sections A8.1 and A8.3. Completion of these training certifications is one

of the program adequacy requirements for acquiring self-implementation status. The Regional $PM_{2.5}$-PEP Lead can work with the OAQPS $PM_{2.5}$-PEP Lead to provide the Initial Comprehensive $PM_{2.5}$ Field Operations Proficiency Training Course for the PQAO personnel. Self-implementing PQAO partners are encouraged to attend annual $PM_{2.5}$-PEP recertification workshops and webinars. In particular the PQAO $PM_{2.5}$-PEP coordinators are expected to provide briefings to their PQAO QA field personnel that are unable to attend. Similarly, contract vendors that support self-implementing PQAO organizations are subject to the same training requirements. Self-implementing PQAO staff and their support staff are encouraged to attend the annual training sessions described in the sections above.

A9 Documentation and Records

The purpose of this section is to define the records that are critical to the $PM_{2.5}$-PEP, the information to be included in data reporting packages, data reporting formats, and document control procedures to be used.

From a records management perspective, the following terms are defined:

- *Document*: A volume containing information that describes, defines, specifies, reports, certifies, or provides data or results pertaining to environmental programs.

- *Records:* As defined in the Federal Records Act of 1950 and the Paperwork Reduction Act of 1995 (now 44 U.S.C. 3101-3107), this term refers to "...books, papers, maps, photographs, machine readable materials, or other documentary materials, regardless of physical form or characteristics, made or received by an agency of the U.S. Government under Federal Law or in connection with the transaction of public business and preserved or appropriate for preservation by that agency or its legitimate successor as evidence of the organization, functions, policies, decisions, procedures, operations, or other activities of the Government or because of the informational value of data in them..."

- *Reporting package:* All information required to support the $PM_{2.5}$-PEP concentration data reported to EPA. This information includes all data required to be collected, as well as other data which the $PM_{2.5}$-PEP deems important.

EPA's Records Management Policy (https://www.epa.gov/sites/production/files/2015-03/documents/cio-2155.3.pdf) clarifies requirements under the Federal Records Act. Regional $PM_{2.5}$-PEP Leads, FSs, and self-implementing PQAO staff are encouraged to refer to EPA's Records Management Policy for any questions related to the creation, management, and destruction of EPA records that are not addressed in this section. Table A9-1 lists the categories and types of $PM_{2.5}$-PEP records and documents that are applicable to document control within EPA's quality system. They are filed according to the statute of limitations discussed in Section A9.4 below.

A9.1 Information Included in the Reporting Package

A9.1.1 Data Reporting Package Format and Document Control

The $PM_{2.5}$-PEP records management system is structured to satisfy requirements in EPA's National Records Management Program (https://www.epa.gov/records). A file plan lists office

records and describes how they are organized and maintained. A good file plan is a key component of a recordkeeping system and leads to a successful records management program through:

- Effective documentation of activities
- Consistent record identification
- Quick retrieval of records
- Ability to determine the disposition of records no longer needed
- Ability to meet statutory and regulatory requirements.

The $PM_{2.5}$-PEP records management system uses Agency File Codes (AFCs) to facilitate easy retrieval of information during TSAs and reviews. Individual EPA Regions and/or self-implementing PQAOs may use a filing system other than AFC (e.g., Technical Direction Form [TDF]) so long as it is equivalent in functionality and allows for appropriate responses to interrogatories, TSAs, and/or other reviews. All filing system language and codes herein refer specifically to the AFC system.

The $PM_{2.5}$-PEP records management system follows official EPA records schedules, which constitute EPA policy on how long to retain Agency records and appropriate disposition. For more information on EPA records schedules, refer to https://www.epa.gov/records/epa-records-schedules-detailed-information.

To archive the information as a cohesive unit, the $PM_{2.5}$-PEP records management system files each item from Table A9-1 under the major code "$PM_{2.5}$-PEP," followed by the AFC function code and the schedule numbers listed in Table A9-2.

Table A9-1. Critical Documents and Records in the $PM_{2.5}$-PEP

Category	Record/Document Types
Management and organization	State Implementation Plan Reporting agency information Organizational structure Personnel qualifications and training Training certification Quality Management Plan Document Control Plan EPA directives Grant allocations Support contract
Site information	Network description Site characterization file Site maps Site pictures

Table A9-1. Critical Documents and Records in the $PM_{2.5}$-PEP (continued)

Category	Record/Document Types
Environmental data operations	Quality Assurance Project Plans Standard operating procedures Field and laboratory notebooks Sample handling/custody records Inspection/maintenance records
Raw data	Any original data (routine and QC data), including data entry forms
Data reporting	Air Quality Index Report Annual state and local monitoring stations' air quality information Data/summary reports Journal articles/papers/presentations
Data management	Data algorithms Data management plans/flowcharts $PM_{2.5}$ data Data management systems
QA	Network reviews Control charts Data Quality Assessments QA reports System audits Response/corrective action reports Site audits

Table A9-2. $PM_{2.5}$-PEP Reporting Package Information

Agency File Code [a]		Category	Record/Document Types
Function Code	**Schedule #**		
301-093	**006**	**Program Management Files**	
	006.1	Management and organization	• Organizational structure for EPA and how the Regions and contractors fit into running the $PM_{2.5}$-PEP • Organizational structure for the support contractors • PEP project plans and subsequent revisions • Quality Management Plan
	006.2	Monitoring site information	• Site characterization file (Site Data Sheets) • Site maps and pictures • SLT site contact information
	006.3	Field operations and data acquisition (by EPA Regional staff or contractors on behalf of EPA)	• QAPPs and SOPs • Field logbooks and communications • Sample handling/COC forms • Documentation of instrument inspection and maintenance • Field testing of $PM_{2.5}$-PEP equipment
	006.4	Communications (contractor technical project activity)	• Telephone record and e-mail between contractors and SLT organizations, and between contractors and the Contracting Officer's Representative (COR)

Table A9-2. PM2.5-PEP Reporting Package Information (continued)

Agency File Code [a]			
Function Code	**Schedule #**	**Category**	**Record/Document Types**
301-093	006.5	Communications (EPA project activity)	• Telephone record and e-mail between EPA Regional or Headquarters staff and SLT organizations, vice versa • Telephone record and e-mail between EPA Regional and other EPA personnel (Headquarters to Regions, vice versa)
	006.6	Equipment/instruments used by contractors in the PM2.5-PEP (time records would reference AFC 405-202)	• Procurement logs • Inventories of capital equipment, supplies, consumables • Repair and maintenance (e.g., vendor service records, calibration records) • Retirement or scrapping
Agency File Code [a]			
Function Code	**Function Code**	**Agency File Code [a]**	**Record/Document Types**
405	**202**	**Contract Management Records**	
	202.1	Contract administration	• Work assignments, task orders, delivery orders, work plans • Contractor monthly reports • Technical directives from the COR to the contractor • Invoices for consumables • Requisite qualifications of FSs and LAs for PM2.5-PEP, contractor-implemented activities • Training records and certificates of contractors conducted and issued by the EPA Regional COR
404-142-01	**179**	**Special Purpose Programs**	
	179.1	Data administration and integration	• Data management plans/flowcharts • Raw data: any original data (routine and QC data), including data entry forms • Data algorithms • Documentation of PM2.5-PEP database (PED) (national/Regional level) • PM2.5 PED data • COC forms
404-142-01	**173**	**Data Files Consisting of Summarized Information**	
	173.1	Data summaries, special reports, and progress reports	• Data/summary/monthly field activity reports • Journal articles/papers/presentations • Data validation summaries
108-025-01-01	**237**	**State and Local Agency Air Monitoring Files**	
	237.1	QA/QC Reports	• Annual and 3-year PM2.5-PEP QA reports • PEP Data Quality Assessments • Other QA reports • Response/corrective action reports • Reports of site audits

Table A9-2. PM2.5-PEP Reporting Package Information (continued)

Agency File Code [a]		Agency File Code [a]	Record/Document Types
Function Code	**Function Code**		
405	**036**	**Routine Procurement**	
	036.1	Acquisition of capital equipment and supplies by EPA (either Headquarters or Regional office)	• Needs assessments and reports • Program copies of purchase requests • Requests for bids or proposals • Proposals, bids, or quotations • Bills of lading • Warranties and certificates of performance • Evaluations of proposals, bids, quotations, or trial installations
403-256	**122**	**Supervisors' Personnel Files and Duplicate Official Personnel Folder Documentation**	
	122.1	Personnel qualifications, training, and certifications	• Regional PM2.5-PEP Lead training certifications • Certification as a PM2.5-PEP FS and/or LA • Certification as a PM2.5-PEP FS trainer and/or LA trainer

[a] Regions and self-implementing PQAOs are not required to use the AFC system and may choose to use filing system equivalent in functionality.

For example, according to Table A9-2,

- PM2.5-PEP project plans would be filed under the heading "PM2.5-PEP/301-093-006.1"
- COC forms would be filed under "PM2.5-PEP/301-093-006.3."

A9.1.2 Field and Laboratory Record Notebooks

The PM2.5-PEP requires each FS and LA to keep and maintain a record notebook (logbook) to record field and laboratory activities. Each notebook will be uniquely numbered and associated with the individual for the PM2.5-PEP. Although dedicated data entry forms are associated with all routine environmental data operations, these record notebooks can be used to record additional information about operations. In the laboratory, notebooks may also be associated with the temperature and humidity recording instruments, cold storage (refrigerator) units, calibration equipment and standards, and the analytical microbalances used for this program. Notebooks should be used to record service dates and notes, records of certification, internal audits, repairs or adjustments, replacements, cleaning, calibrations, etc.

A9.1.3 Electronic Data Collection and Archiving

Data collected electronically include data captured without the use of an individual employing pen and paper, i.e., by an electronic system. Such electronically collected data include: data logged by samplers during sample collection (recording flow rates, temperatures, etc.), balance readings electronically recorded into the PED, measurements logged by environmental temperature and relative humidity monitoring systems, and hand-entered data such as sample observations entered into a computer into the PED or other electronic data software system (e.g., LIMS or MoPED).

For the $PM_{2.5}$-PEP weighing laboratory, these primary electronic data sources are required to determine the $PM_{2.5}$-PEP concentration, therefore must be acquired and maintained according to the processes in Sections B9 and B10. If electronic data need to be revised or edited based on additional information, the $PM_{2.5}$-PEP laboratory will follow Section B9 to determine whether the captured field data are fit for use or should be invalidated.

The electronic data files captured from the $PM_{2.5}$-PEP samplers during each $PM_{2.5}$-PEP sampling event (or other activities that characterize a sampler's reported data quality) serve as an official, permanent record (e.g., data that lead to significant findings or conclusions). Therefore, they are to be submitted to EPA and filed as a data reporting package within the $PM_{2.5}$-PEP records management system. This ensures that all $PM_{2.5}$-PEP data are properly archived. They are also archived at their respective Regional offices. Section A9.4, and Section B10 contain more information on this process.

A9.1.3.1 Electronic Performance Data Tracking

Calibration verifications, performance audits, and calibrations of the $PM_{2.5}$-PEP sampler (BGI PQ200) are tracked on the AirQA website. AirQA also tracks the annual accuracy certification, quarterly maintenance checks, and annual audits of the NIST traceable primary and transfer standards used in $PM_{2.5}$-PEP sampler verifications, audits, and calibrations. *AQS and MoPED, once implemented, will also maintain up-to-date information on samplers and field calibration standards.* Each Region and self-implementing PQAO is expected to maintain a workbook of calibration verification results of every $PM_{2.5}$-PEP sampler as well as quarterly maintenance checks and annual calibrations.

A9.1.4 Hand-Recorded Data

The $PM_{2.5}$-PEP has implemented data processes that minimize the need for manual entry of data as well as the chance of transcription and other clerical errors; however, FS are still required to record some information by hand, such as to complete the sample COC/FDS. Information recorded by hand must be legibly recorded using indelible ink. Necessary corrections are made by inserting one line through the incorrect entry, placing the correct entry alongside the incorrect entry by providing the information nearby or associated by annotation, and initialing and dating the correction. If the rationale for the correction is not obvious, the individual making the correction will notate the rationale to the correction.

$PM_{2.5}$-PEP QA/QC data are generally stored in a digital format within the PED; however, paper forms and logbooks are currently used for activities such as cleaning, quarterly performance testing, calibration, and annual certification of samplers. Additionally, due to the design of the PED user interface, the LA must select filter IDs by dropdown menu, which increases the likelihood of incorrect filter ID selection. For this reason, the $PM_{2.5}$-PEP LA hand records all balance measurements on a dedicated form. These hand-recorded weight measurements are maintained in the event there are data subject to invalidation, in such cases the Laboratory Manager or Laboratory Task Monitor will consult the hand-recorded data to verify an electronic record. The hand-recorded data are considered to be the primary data source and a representative amount (approximately 10%) of the hand-recorded data are verified during data reviews.

A9.1.5 E-mail and Text Messages

EPA's Records Management Policy (available at: https://semspub.epa.gov/work/HQ/190129.pdf) provides the following guidance on the proper use and management of e-mail and text messages:

> "Official Agency business should first and foremost be done on official EPA information systems. The FRA now prohibits the creation or sending of a federal record using a non-EPA electronic messaging account unless the individual creating or sending the record either: (1) copies their EPA email account at the time of initial creation or transmission of the record, or (2) forwards a complete copy of the record to their EPA email account within 20 days of the original creation or transmission of the record. These FRA requirements are designed to ensure that any use of a non-EPA information system does not affect the preservation of federal records for FRA purposes, or the ability to identify and process those records if requested under the Freedom of Information Act (FOIA), Privacy Act or for other official business (e.g., litigation, congressional oversight requests, etc.). EPA strongly discourages the use of personal email or other personal electronic messaging systems, including text messaging on a personal mobile device, for sending or receiving Agency records, but to the extent such use occurs, the individual creating or sending the record from a non-EPA electronic messaging system must copy their EPA email account at the time of transmission or forward that record to their EPA email account within 20 days of creation or sending.
>
> Additionally, EPA discourages the use of text messaging on a mobile device for sending or receiving substantive (or non-transitory) Agency records. However, EPA recognizes that some Agency staff perform time-sensitive work that may, at times, require the creation of substantive (or non-transitory) records in the form of text messages for emergency or environmental notification purposes. In those limited instances, staff must continue to save and manage any text message records related to their work…"

A9.2 Laboratory Data Format for Uploading to AQS

Under the PED paradigm, the OAQPS QA Support Contractor extracts validated ambient concentration results from the PED, converts the derived concentration data to a format accepted by AQS, and uploads the data to AQS.

> *Once MoPED is in place, the $PM_{2.5}$-PEP weighing laboratory LIMS software application will extract and submit validated data to AQS via a browser-based upload tool found here: https://aqs.epa.gov/auditor_upload. The analytical results must be a .csv file type, and the formatting must match that described in Table A9-3.*

Table A9-3. PM2.5-PEP Weighing Laboratory Data Description for AQS Upload via Browser-based Tool

Column Header	Example Entry	Description
Pre-Sampling Tare Mass		
Filter_ID	T1111111	Sample filter ID; an eight (8) character string starting with 'T' and followed by 7 numerical digits
Pre_Weight_Date	20191007 09:44	Date and time of pre-sampling weighing, formatted YYYYMMDD HH:MM (in 24-hour clock time)
Units_Code	131 [a]	AQS unit code For tare filter mass under the MoPED Regime the unit code = 131 (milligrams)
Pre_Weight	378.417	Mass (in milligrams) of tared filter
Expiration_Date	20191106 08:44	Filters must be exposed in a sampling event by this date/time (formatted YYYYMMDD HH:MM [in 24-hour clock time]) or they must be reconditioned and pre-weighed again or discarded
Post-Sampling Filtrate Mass		
Filter_ID	T1111111	Sample filter ID; an eight (8) character string starting with 'T' and followed by 7 numerical digits
Analysis_Date	20191017 00:04	Date and time of post-sampling weighing, formatted YYYYMMDD HH:MM (in 24-hour clock time)
Units_Code	131 [a]	AQS unit code. For exposed filter mass under the MoPED Regime the unit code = 131 (milligrams)
Post_Weight	459.725	Mass (in milligrams) of the filter post-sampling

[a] Currently, the filter pre-sampling (tare) weight and post-sampling weight are not input to AQS. The data submitted to AQS consists of the concentration value, for which the Units Code is 001, µg/m^3, calculated from the mass difference between the pre-sampling and post-sampling weights normalized to the collected sample volume during the 24-hour PEP sample event.

A9.3 Data Archiving and Retrieval

FSs supporting PM2.5-PEP field activities retain the data reporting package according to the archival policies for filters, data, and records listed in Table A9-4, for a four (4) year period ending on the last day of the calendar year in which the fourth-year ends. For example, all data collected in calendar year 2019 are archived until December 31, 2023. Upon reaching the end of the four (4)-year data retention period, the FS (and/or supervisor if a contractor) informs the OAQPS PM2.5-PEP Lead and the Regional PM2.5-PEP Lead that the material has met the archive limit and asks for a decision on whether further archiving is necessary, or disposal should occur. Some FS support contracts may require a retention time longer than four (4) years, in which case the data/materials must be archived for this extended period before disposal.

The PED data will be archived indefinitely, and PED audit trail records will be maintained minimally for 4 years.

Table A9-4. Archive Policies for Filters, Data, and Records within the $PM_{2.5}$-PEP

Data Type	Medium	Location	Retention Time [a]	Final Disposition [b]
Weighing records; COC forms	Hard copy	Laboratory	≥ 2 full calendar years (January through December) in laboratory facility, after which archived in offsite archive facility for 30 years	Discarded, with permission from OAQPS
Laboratory notebooks	Hard copy	Laboratory	≥ 2 full calendar years (January through December) in laboratory facility, after which archived in offsite archive facility for 30 years	Discarded, with permission from OAQPS
Field notebooks	Hard copy	Air Quality Division	≥ 4 years	Discarded
PED or LIMS Database (excluding audit trail records) [c]	Electronic (network drive)	Air Quality Division	Indefinite	Back-up media retained indefinitely
PED or LIMS audit trail records [c]	Electronic (back-up tapes)	Air Quality Division	≥ 4 years	Discarded
Weighing laboratory and filter storage environmental records	Electronic and hard copy	Air Quality Division	Indefinite	Back-up media retained indefinitely
Field transfer standard calibration records	Electronic and hard copy	Air Quality Division	Indefinite	Back-up media retained indefinitely
Filters following post-sampling weighing	Filters	Laboratory	≥ 4 years; 1 full calendar year at 4°C, and then 3 additional calendar years at ambient temperature	Discarded

[a] Some individual contracts may require a retention time longer than four (4) years, in which case the data/materials must be archived for this extended period before disposition.

[b] OAQPS may request data retention times greater than four (4) years in unique situations, e.g., response to the New Horizon oil spill during cleanups.

[c] A commercial LIMS is not in place at the $PM_{2.5}$-PEP weighing laboratory at the time this document was distributed. The compiled Microsoft Access data base and reporting program called the PED has served the $PM_{2.5}$ PEP as a LIMS for the life of the program beginning in 1999.

B Data Generation and Acquisition

B1 Sampling Design

The section describes components of the $PM_{2.5}$-PEP sampling design, the key parameters to be evaluated, the number and types of samples to be expected, and how the samples are to be collected.

B1.1 Scheduled Project Activities, Including Measurement Activities

If the $PM_{2.5}$-PEP event adheres to the prescribed timeline with no interferences or internal delays, the $PM_{2.5}$-PEP sampling event data can be made available in AQS approximately 40 days after a $PM_{2.5}$-PEP sampling event. Historical timelines indicate $PM_{2.5}$-PEP data are typically available in AQS after approximately 60 days.

The successful implementation of the MoPED should enable more consistent achievement of the 40-day objective.

Table B1-1 contains the general elapsed timeline from the end of the $PM_{2.5}$-PEP sample collection period to availability of the $PM_{2.5}$-PEP data in AQS.

Table B1-1. Milestones from $PM_{2.5}$-PEP Sample Retrieval to Availability in AQS

Milestone	Timeframe
Retrieval of $PM_{2.5}$-PEP filter sample and sampler logged data	Within 24 hours of the end of sample collection is best practice. Make-up events near year end or calamities may dictate up to 48 hours on holidays or weekends, longer must be justified by Regional PEP Lead; e.g., a medical emergency. Retrieval may never exceed 96 hours.
Shipment of filter samples to the $PM_{2.5}$-PEP weighing laboratory	On the same day as retrieval from the sampler (shipped by overnight courier) and received the following day at the laboratory
Filter equilibration and final weighing	Within 30 days of the end of sample collection if the laboratory receives the shipment at temperature ≤ 4 °C or if received at temperature > 4 °C and ≤ 25 °C and the received temperature is < the average 24-hr sampling period temperature. Within 10 days of the end of sample collection if the laboratory receives the shipment at temperature > 4 °C and ≤ 25 °C. [a]
Approval of validated $PM_{2.5}$-PEP filter sample concentration and input to AQS	Goal is within 60 days of the conclusion of the sampling event

[a] Filters received > 25 °C are automatically invalidated but still are weighed within 10 days.

B1.1.1 Filter Holding Times

Filter holding times are critical aspects of the $PM_{2.5}$-PEP. As illustrated in Figure B1-1 and stipulated in the CFR, filters must be used (exposed) within 30 days of their pre-sampling tare weight measurement or they must be reconditioned and go through the pre-weighing process (tare weighed) again. Therefore, the $PM_{2.5}$-PEP weighing laboratory and FSs should stay in close communication to ensure that sufficient filters are available for field deployment (conditioned and tare-weighed) to ensure tare-weighed filters have sufficient time remaining of this 30-day period for field sampling. The maximum duration from filter tare weight to post-sampling weight measurements may not exceed 60 days as detailed in Figure B1-1.

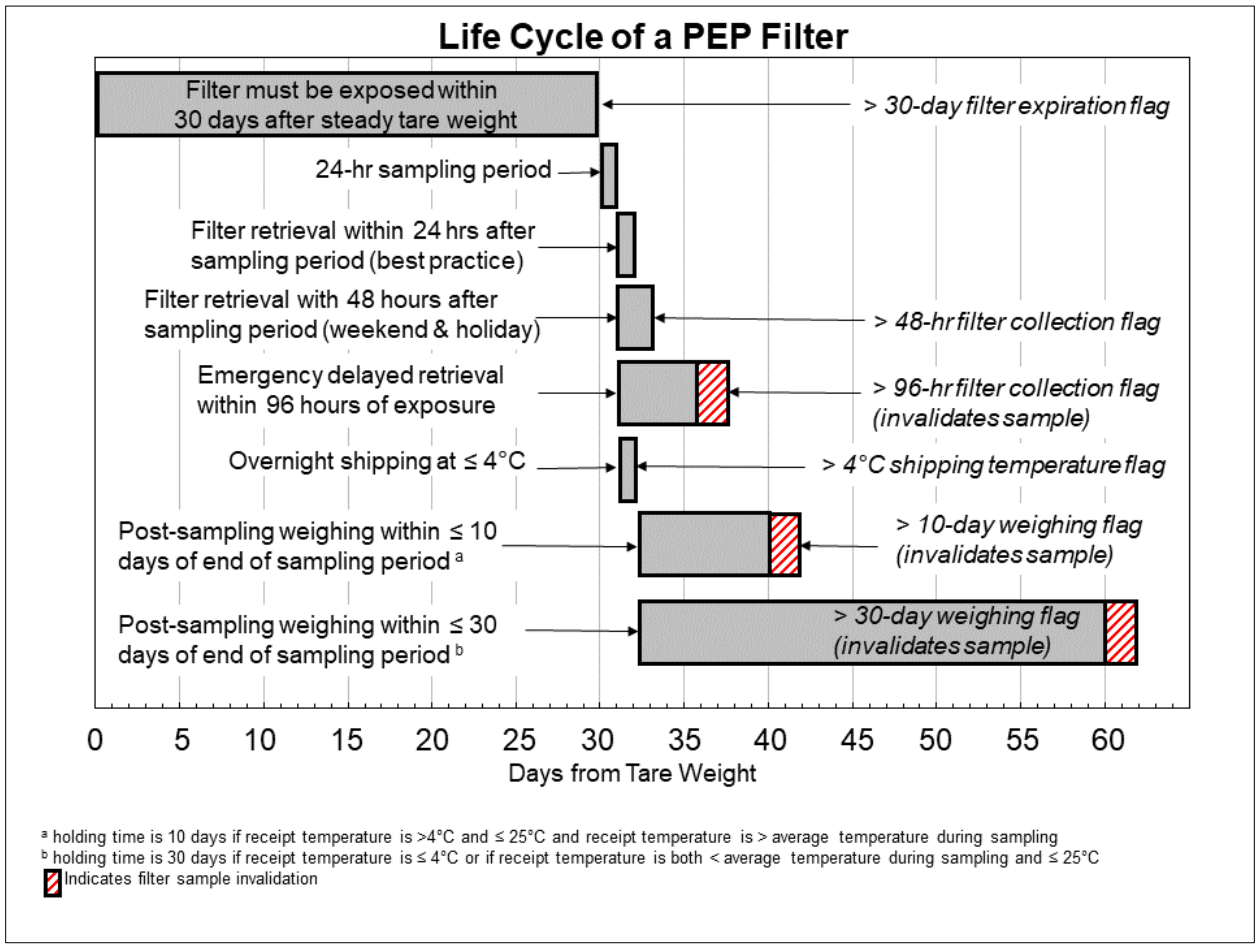


Figure B1-1. Filter Holding Times

B1.2 Rationale for the Sampling Design

This QAPP documents the EDOs for a QA activity, not a routine monitoring activity. The $PM_{2.5}$-PEP sampling design has been codified in 40 CFR Part 58, Appendix A, Section 3.2.4. The frequency of $PM_{2.5}$-PEP sampling events is described in Section A7.

B1.3 Sampling Design Assumptions

The intent of the $PM_{2.5}$-PEP sampling design is to collect data of sufficient quality and quantity to characterize whether overall measurement bias achieves the DQOs described in Section A7. To accomplish this, the DQO development process has been carefully followed to ensure that the DQIs and associated MQOs are well-defined and bounded to optimize data collection. While the initial DQO and related MQO process accomplished this, two recent developments in the routine $PM_{2.5}$ monitoring network have called into doubt that the defined MQOs can satisfy the initial sampling design. Therefore, EPA is currently undertaking efforts to determine whether the decision error of 5% holds with these new developments and whether MQO adjustments are needed to the $PM_{2.5}$-PEP. These two main developments are that the routine $PM_{2.5}$ monitoring network has increasingly adopted continuous FEM monitors and that the ambient concentrations of $PM_{2.5}$ are decreasing. Practically, these respectively have shown that bias, as determined by the $PM_{2.5}$-PEP has increased and that the $PM_{2.5}$-PEP is increasingly likely to collect a sample

with a concentration < 3 $\mu g/m^3$, which is not valid for bias assessment. The differences in measurement principles and a decrease in data suitable for comparison combine to challenge the ability of the $PM_{2.5}$-PEP to adequately assess routine $PM_{2.5}$ measurement bias at more typical ambient concentrations at more locations across the US.

Two assumptions made for the $PM_{2.5}$-PEP sampling design impact the representativeness:

- The $PM_{2.5}$ FRM is the true $PM_{2.5}$ measurement for the 24-hour period and that FEMs and FRMs are suitably comparable for the measurement of $PM_{2.5}$. EPA ORD has determined the equivalency of FEMs to FRMs.

- Collocation of sampler inlets within 1 to 4 m results in the two samplers ingesting an equivalent portion of the same air parcel. Historical information on PM_{10} collocation data and preliminary $PM_{2.5}$ data indicates that ambient air within 1 to 4 meters of the primary routine sampler is homogenous. Therefore, EPA assumes that a $PM_{2.5}$-PEP sampler correctly positioned within this space will sample from the same $PM_{2.5}$ air parcel as the primary routine sampler.

B1.4 Validation of Non-Standard Measurements

The $PM_{2.5}$-PEP collects no samples and analytical measurements considered to be non-standard; therefore, this section is not relevant to the $PM_{2.5}$-PEP.

B2 Sampling Methods and Requirements

The $PM_{2.5}$-PEP has developed an SOP for the field operations (*Field Standard Operating Procedures for the Federal $PM_{2.5}$ Performance Evaluation Program*) that describes in detail the activities and procedures that are to be followed. The following sub-sections summarize these activities.

B2.1 $PM_{2.5}$-PEP Sampler

Limiting the $PM_{2.5}$-PEP FRM sampler employed to a single make and model reduces bias and precision differences inherent between different sampler models. The BGI PQ200 was the portable sampler model of three designated as FRMs in 1999 and 2000 deemed the most convenient, serviceable, and durable. The performance specifications for the FRM employed in the $PM_{2.5}$-PEP are detailed in Table B2-1. The older generation BGI PQ200s could not maintain acceptable flow rates at elevations of 7000 feet and higher, therefore, EPA used the other portable samplers (Andersen RAAS 200 or the Rupprecht & Patashnick 2000) at those sites. Currently, the RAAS 200 and the R&P 2000 (later updated the Thermo-Fisher 2000 when Thermo-Fisher purchased R&P) are no longer in production or supported. A new generation direct current (DC) pump motor which overcomes problems derived from sampling at high altitudes has been developed and approved for use in the BGI PQ200. The FS should confirm that the newest generation Maxon DC motor is used to operate the sampler at elevations of 7,000 feet or higher.

Table B2-1. PM2.5-PEP FRM Sampler Performance Specifications

Performance Parameter	Specification	Reference
Sample flow rate	1.000 m^3/hr	40 CFR Part 50, Appendix L, Section 7.4
Flow regulation	1.000 m^3/hr ± 5% [a]	40 CFR Part 50, Appendix L, Section 7.4
Flow rate precision	2% CV [b]	40 CFR Part 50, Appendix L, Section 7.4
Flow rate accuracy	± 2%	40 CFR Part 50, Appendix L, Section 7.4
External leakage	< 80 mL/min [c]	40 CFR Part 50, Appendix L, Section 7.4
Internal leakage	< 80 mL/min [c]	40 CFR Part 50, Appendix L, Section 7.4
Ambient temperature sensor	−30°C to 45°C 0.1°C resolution; ± 2.0°C accuracy	Volume II–MS. 2.12 40 CFR Part 50, Appendix L, Section 7.4
Filter temperature sensor	−30°C to 45°C 0.1°C resolution; ± 1.0°C accuracy	Volume II–MS. 2.12 40 CFR Part 50, Appendix L, Section 7.4
Barometric pressure	600 to 800 mm Hg 5 mm resolution; ± 10 mm accuracy	Volume II–MS. 2.12 40 CFR Part 50, Appendix L, Section 7.4
Clock/timer	Date/time 1 min resolution; ± 1 min/month accuracy	Volume II–MS. 2.12 40 CFR Part 50, Appendix L, Section 7.4

[a] The PQ200 flowrate pre-event flowrate check acceptance level is ±4% to provide more assurance that the event flow rate is within the FRM specifications.

[b] The 24-hour average CV achieved by the new Rev-U version of the BGI PQ200 controller board is routinely < 0.1%, therefore, troubleshooting should occur at an action level of 1% to maintain acceptable performance of the PM2.5-PEP fleet.

[c] PQ200 sampler leak check criteria is to check for 5 cm H_2O of vacuum pressure loss over 2 minutes. This criterion was shown to be equivalent to the listed leak check criteria stated in CFR requirements for the FRM.

As with all electronic components, the PQ200 electronic control boards have evolved over time. The PQ200 used in the PM2.5-PEP must be updated to the Revision T (Rev-T) main controller board or newer. Mesa Laboratories was given approval for a new generation Revision U (Rev-U) control board in 2018. Rev-T boards went out of production in 2019 and are being replaced by Rev-U as they reach the end of their lifecycle or require replacement due to failure. If it is ever necessary to utilize other FRM sampler models in PM2.5-PEP sampling events, they must be approved by OAQPS, confirmed to be serviceable, and participate in semi-annual collocation events (Section B5.4.1) to demonstrate comparability.

B2.2 Sample Event Preparation, Sample Collection, Sample Retrieval, and Sample Shipment

B2.2.1 Pre-Sampling Event Preparation

In planning a PM2.5-PEP sampling event for a given monitoring site, the FS records (or verifies) the following information on a Site Data Sheet (Form SD-01; available in the PM2.5-PEP Field SOP):

- AQS Site ID
- Method designation (e.g., EQPM-0308-170)

- Sampler make and model (e.g., Met One BAM-1020)
- Site latitude and longitude coordinates
- $PM_{2.5}$ network type (e.g., SLAMS)
- Reporting organization
- Reporting organization contact
- Street address
- Directions to and from a major thoroughfare
- Safety concerns (Report safety concerns to the EPA Regional $PM_{2.5}$-PEP Lead immediately)
- Location and directions to the nearest medical treatment facility
- Additional equipment needed (e.g., ropes, ladders)
- Closest EPA contracted courier package drop-off location for shipping $PM_{2.5}$-PEP filter samples (at the time of this document's release the United Parcel Service [UPS] is EPA's contracted courier)
- Important free-form notes.

The FS may not have all this information when visiting a site for the first time (e.g., the site may be newly established, the FS records may be out of date, or AQS may contain errant information) and thus may need to complete parts of the Site Data Sheet during the visit. The information within AQS must be verified during the site visit.

The FS will coordinate approximately one month in advance of the PEP event with the $PM_{2.5}$-PEP laboratory to ensure that the correct number of tared filters has been/will be supplied to cover the needed samples and QC samples (e.g., FB and TB). The FS will verify the information and use-by dates on the filter COC/FDS forms to ensure the information is correct and there is sufficient time remaining for the filters to be used within their 30-day period. Filters will be properly secured (refer to filter handling in Section B3) in the insulated cooler with frozen freezer packs. The FS will also confirm that the filter COC forms, field notebook, Site Data Sheets, and other required paperwork are present and secured for travel. *Once MoPED is implemented, a tablet or laptop PC with MoPED software will also be required.*

Before embarking on a $PM_{2.5}$-PEP sampling event trip, the FS will confirm that sampling equipment (including a backup sampler and a backup set of calibration equipment) is operational and securely stowed in the transport vehicle. The FS will also check that adequate supplies are on hand to perform the scheduled sampling events and will contact the appropriate SLT site operators to confirm sampling schedule and the monitoring site's accessibility on the proposed setup and sampling dates.

The FS will contact the SLT site operator (or designee) in advance of the sampling event as described in Section C2.1.1.4.

B2.2.2 Sampling Event Setup

Upon arriving at the site, the FS meets the SLT site operator or other appropriate personnel who will grant site access and the FS then performs an initial safety inspection prior to setting up equipment. The FS is not obligated to visit a monitoring site or proceed with setting up equipment for the $PM_{2.5}$-PEP sampling event if it is determined that site conditions (e.g., weather or dangerous monitoring platforms) may jeopardize personal safety. The FS will notify the Regional $PM_{2.5}$-PEP Lead immediately upon identifying unsafe conditions and will document them on the Site Data Sheet. The Regional Lead will then take steps to communicate with the SLT monitoring agency to ensure the site is safely accessible for a $PM_{2.5}$-PEP sampling event.

If FS deems the site is safe, the $PM_{2.5}$-PEP sampler is assembled and positioned such that the inlet is within 1 to 4 meters horizontally of the site's routine primary $PM_{2.5}$ sampler inlet (if a collocated monitor is operating at the site and to be operating the date of the PEP event, the PEP sampler inlet should optimally be positioned to within 1 to 4 meters of both the primary and collocated routine sampler inlets), the $PM_{2.5}$ separator inspected (e.g., VSCC grit pot emptied or WINS impactor cleaned and oiled, as appropriate), the sampler checked for leaks, the sampler clock time is verified per Section B2.2.2.1 below, and the sampler temperature (Section B7.2.2.2), barometric pressure (Section B7.2.2.1), and flow rate (Section B7.2.2.3) calibration verifications are performed per the $PM_{2.5}$-PEP Field SOP.

If while on site the FS has no available $PM_{2.5}$-PEP sampler that can pass calibration verification checks, the FS contacts the Regional $PM_{2.5}$-PEP Lead for instructions on how to proceed. The Regional $PM_{2.5}$-PEP Lead considers the specific failed verification checks when deciding. If no recommendation to continue can be made, the FS should postpone and work with the SLT site coordinator and the Regional $PM_{2.5}$-PEP Lead to reschedule the $PM_{2.5}$-PEP sampling event.

Once all pre-sampling operational and calibration verifications are completed, the filter cassette is installed, and the sampler is programmed to run for 24 hours from midnight to midnight local standard time. An exception to the midnight-to-midnight schedule should only be made when the SLT primary routine sampler operates on a different schedule. If delays occur in the intended PEP sampling schedule, the FS will notify the SLT site operator and the Regional $PM_{2.5}$-PEP Lead.

B2.2.2.1 Sampler Clock

Prior to each $PM_{2.5}$-event at the monitoring site as described in the Field SOP. The FS checks the sampler clock time and date by referring to the time linked to an atomic clock, such as that found at http://www.time.gov, or to a known time standard (e.g., cellular/smart phone). If the FS uses a personal device as a time standard, that device must be able to synchronize to local time, as the FS can cross one or more time zones to travel to a $PM_{2.5}$-PEP sampling event. Time synchronization can occur prior to heading to the monitoring site, particularly if the site has no reliable cellular/wi-fi service.

B2.2.3 Sampling Event Filter Retrieval, Storage, and Shipping

Following completion of the $PM_{2.5}$-PEP sampling event, the FS returns to the site(s) and follows the procedures in the $PM_{2.5}$-PEP Field SOP to retrieve (recover) the sampling filter cassette, visually inspect the filter, appropriately store it (in a cooler with cold freezer packs) for transport to the laboratory, and download the data from the sampler, typically to a removable storage medium (e.g., USB flash drive) via the sampler's universal serial bus (USB) port.[12] This flash drive is to be included in the shipment to the PEP weighing laboratory. If there are safety concerns or severe weather at the site during filter retrieval and sampler teardown, the sampler data may be downloaded later when conditions are safe.

> *With the implementation of MoPED, the sampler's logged data will be directly uploaded to the AQS database through the tablet or laptop PC which will eliminate the need to ship a flash drive of the data to the weighing laboratory.*

The FS completes the COC/FDS form(s) and the sampled $PM_{2.5}$-PEP filters and their corresponding COC/FDS forms are properly packaged and transported to the $PM_{2.5}$-PEP weighing laboratory as soon as possible following completion of the sampling event following the procedures in the $PM_{2.5}$-PEP Field SOP. Ideally, the filter is shipped the day of retrieval with EPA's contracted courier for next-day delivery. The FS will retain a copy of the COC form and file the form under $PM_{2.5}$-PEP/301-093-006.3 (or other acceptable filing system), and will record the number of containers shipped and the corresponding air bill number (tracking information) in the field notebook. The FS then notifies (typically by email) the $PM_{2.5}$-PEP weighing laboratory (preferably at the time the shipment(s) is relinquished to the courier) of the anticipated delivery, the quantity of containers included in the shipment, and the associated air bill number.

B2.2.4 Return to the Field Office

Upon completing a $PM_{2.5}$-PEP sampling event trip, the FS returns to the Regional (field) office. At the field office the FS ensures that necessary vehicle servicing is completed, and that equipment and supplies are properly returned and stored. This is also an opportunity for the FS to order needed supplies and perform necessary equipment maintenance, such as quarterly inspection and cleaning. The FS will also prepare a backup, to be stored at the field office, of the logged data from the sampler(s) for performed $PM_{2.5}$-PEP events. The FS debriefs the Regional $PM_{2.5}$-PEP Lead on the trip and whether future $PM_{2.5}$-PEP sampling events remain on schedule.

B2.3 Sample Collection and Preservation

This section details the requirements for maintaining sample integrity including sample contamination prevention, sampling volume and duration requirements, temperature preservation requirements, and permissible filter holding times. Information on sampler maintenance to reduce contamination sources and ensure the collection of representative samples is discussed in Section B6.

[12] Data are typically transferred to a flash drive or to another external storage device through the USB connection. In 2006, BGI discontinued support for its DataTrans® data loggers. DataTrans® can still be used in the $PM_{2.5}$-PEP program (and recommended during inclement weather), but future support from MESA Labs will be unavailable

B2.3.1 Sample Contamination Prevention

The $PM_{2.5}$-PEP has established rigid protocols for preventing sample contamination. Once filters have been pre-weighed, they are installed into cassettes, the metal cassette caps installed, and the assembled filter cassette stored individually in static-resistant zipperlock plastic bags. Once a filter cassette is shipped to the field, it must not be removed from the plastic bag and the cassette caps must not be opened until installed in the sampler (or appropriately used for a blank) as the filter could become exposed to dust, pollen, or other contaminants or could become damaged. Filter cassettes must be stored in protective containers and in the transport container when not in the sampler. Prior to handling a sample cassette, the FS must thoroughly clean their hands with an alcohol wipe and allow them to air dry or (preferably) must wear clean powder-free examination gloves (e.g., nitrile). The FS must reclean hands or replace gloves if they become dirty or encounter any potentially contaminated surface.

B2.3.2 Sample Collection Volume and Duration

The total volume of sampled air to be collected, flow rate requirements, and sample duration are specified in 40 CFR Part 50, Appendix L. The sampled air volume and the filtrate mass are the two most critical measurements of the ambient monitoring FRM procedures. To determine the sampled air volume the average flow rate and sampling duration must be known. The sampling unit flow controller will control the flow to 16.67 LPM (1.00 m^3/hour) and will log the flow rate at least every 5 minutes over the 24-hour sampling duration for a total target sampling volume of 24 m^3. A sampling period shorter or longer than 24 hours may be necessary in some cases, but the sampling duration may not be less than 23 hours or greater than 25 hours or the sample is invalidated (voided). In such cases, the FS must notify the Regional $PM_{2.5}$-PEP Lead to schedule a makeup $PM_{2.5}$-PEP sampling event. Inaccurate measurement of flow rate and/or sampling duration may introduce error or bias in the determination of the concentration through inaccurate determination of the total sampling volume collected over the 24-hour sampling period.

B2.3.3 Filter Temperature Preservation Requirements

The filter temperature requirements for $PM_{2.5}$ sample collection are specified in 40 CFR Part 50, Appendix L. While no temperature requirements are specified for filters after completing tare weights and during transport to the monitoring site, excessive heat is to be avoided (e.g., do not leave in direct sunlight or in a closed vehicle during summer). During the 24-hour sampling event, the filters are to be maintained near ambient temperature and shall not exceed the ambient temperature by more than 5°C for more than 30 minutes.[13] Upon retrieval of the sample, the filter cassette is capped and placed in cold storage (e.g., a cooler with cold freezer packs) as soon as possible to achieve ≤ 4°C, which should be maintained through shipment to the weighing laboratory. Upon receipt at the laboratory the filter is maintained at ≤ 4°C until conditioning for measuring post-collection weight.

[13] In the event the filter temperature differential exceeds 5ºC for a 30-minute interval, as indicated by the logged sampler data, the FS will indicate this condition on the COC/FDS by the FS. The sampler places an "F" flag in the data log.

B2.3.4 Permissible Time Schedule and Holding Times for Field-Related Activities

Once the filter pre-weight is measured, the filter must be used for sampling (i.e., installed in a sampler for a PEP event) or as a QC sample (e.g., FB or TB) within 30 days. If the 30-day period is exceeded the filter tare weight must be re-established.

Following the 24-hour sampling duration, the collected sample holding time begins, which permits not more than 30 days to weigh the sample filter(s) and may only permit 10 days if the sample shipment temperature is not ≤ 4°C or ≤ the average temperature during the collection. FSs should retrieve (recover) the filter and immediately place it in cold storage (≤ 4°C) within 24 hours of the end of collection (best practice) and this time period should not exceed 48 hours such as may be required during holidays when the site may be inaccessible. Under no circumstances may the retrieval exceed 96 hours from the end of collection (such samples are invalidated), and this extended duration is only permissible during emergencies (such as if the FS is ill or other extenuating circumstance). If the retrieval time exceeds 48 hours from the end of collection, the FS must indicate on the FDS an explanation for the retrieval delay and the maximum temperature during the post-sampling to retrieval period.

Once the filter(s) has been retrieved from the sampler(s) and is in cold storage awaiting transport, the FS should ship the filter(s) to the weighing laboratory as soon as possible, preferably the same day of retrieval (best practice) for arrival at the weighing laboratory the following day. However, if the filter is retrieved from the sampler on a Friday, the FS should maintain the filter in cold storage (≤ 4°C) until the next shipping day when overnight (next-day) shipping ensures the filter arrives at the weighing laboratory on a weekday (e.g., a Sunday or Monday) and will notify the laboratory of the delayed shipment and expected arrival date. Filter shipments received at the laboratory should be ≤ 4°C upon arrival to ensure the maximum holding time of 30 days from the end of the 24-hour sample collection period (note that this is not the retrieval date) for measuring post-collection weights. For filters arriving at the weighing laboratory > 25°C, the sample(s) is invalidated. Table B2-2 lists permissible time intervals for field-related activities.

Table B2-2. Permissible Field-Related Holding Times

Field Activity	Permissible Holding Time
Start of 24-hr sample collection	≤ 30 days from date of filter pre-weight [a]
Retrieval of filter from sampler and placement in storage ≤ 4°C	Within 24 hours (best practice), and may not exceed 96 hours
Shipment of retrieved filter to $PM_{2.5}$-PEP weighing laboratory at ≤ 4°C	Ship filter on day of retrieval via next-day delivery (best practice) with frozen freezer bricks. Filter must be shipped with sufficient time to be received at weighing laboratory for conditioning and weighing within 10 or 30 days of the end of sample collection [b]

[a] Refer to the "use by" date on the $PM_{2.5}$-PEP COC form.

[b] 30-day holding time applies for samples received ≤ 4°C or ≤ average ambient temperature during 24-hour sample collection period, otherwise 10-day holding time applies.

B2.4 Corrective Action for Field Activities

Corrective actions associated with field activities are imposed as necessary to ensure $PM_{2.5}$-PEP sampling events are acceptable. Common corrective actions for routine expected issues are listed in the Field SOP. The PQ200 Troubleshooting Guide, available on the AirQA website, provides additional guidance on troubleshooting $PM_{2.5}$-PEP sampler issues.

B3 Sample Handling and Custody

Because only a small amount of PM is typically collected on a sample filter, contamination and improper handling are major sources of error in reportable $PM_{2.5}$ concentration measurement. Filter cassettes must be handled carefully to minimize contamination and to avoid dislodging collected PM from exposed sample filters. Additionally, a portion of the deposited PM will consist of semi-volatile material that evaporates and for which increased temperatures hastens this evaporation. Additionally, the longer the duration after the completion of sampling until performing the post-collection measurements, the greater extent of such material can evaporate. To limit mass loss due to evaporation to the extent possible, sampled filters should be retrieved as soon as possible and stored refrigerated until conditioned for post-collection weight determination. For this reason, FS should avoid excessive delays between the end of sample collection and sample retrieval. As much as possible, only the LA should handle bare filters and FS should minimize any contact with the filter medium, only handling the cassette.

To maintain evidence of proper filter handling, the COC procedure must be properly followed and documented. The COC procedures ensure that:

- Filters are processed, transferred, stored, and analyzed by authorized personnel.
- Sample integrity is maintained during all phases of sample handling and analysis.
- An accurate, written record is maintained for sample handling and treatment of filters from the time filters are packaged for distribution to FSs through sampling, laboratory analysis, and disposal.

Proper custody involves assigning responsibility for all stages of sample handling and ensuring that any custody transfers are documented. An individual has custody of a sample filter if the authorized individual is in physical possession of the filter, or the filter is stored in a secured area that is restricted to authorized personnel. The COC form (an example is shown below in Figure B3-1) originates at the $PM_{2.5}$-PEP weighing laboratory, proceeds through field activities, and then is returned to the laboratory. The $PM_{2.5}$-PEP weighing laboratory transcribes the information recorded on the COC form into its sample tracking system where the records are available electronically.

PEP Chain-of-Custody Form for BGI PQ200A

☐ PM 2.5 event ☐ PM 10 Event

PART I – WEIGHING LABORATORY

Filter Weighing and Shipping Information from Weighing Lab or Shipping Log				
Filter ID		Filter Cassette ID		☐ TB - Trip Blank
Weighing Lab		Cassette Type		
Analyst/Custodian		Tare Weight Date		
Shipment Date		Tracking No.		
Sent to (PE Org)		Shipping Company		
Date This Filter Must be Used by:		Return to:		

Normally, the weighing laboratory completes Part I, keeps 1 copy and sends 2 copies to the field office with the unexposed filter cassette.

PART II – FIELD OFFICE

Date Received:	Received by:	Location:
Package Condition: ☐ Good ☐ Reject (Why?)		

If rejected, the filter cassette should be returned to the weighing laboratory with the next outgoing shipment.

PART III – FIELD SITE

Sampling Event Information		
Arrival Date at Site		PEP Field Scientist:
Site Name & Description		
Primary SLT PM-2.5 Sampler	Make/Model:	Serial No.:
Primary SLT PM-10 Sampler	Make/Model:	Serial No.:
AQS Site ID		POC:
Other Operators or Observers		

Sampling Event Filter Data		
Sampling Date:	Retrieval Date:	Time:
Event Filter Integrity: ☐ OK ☐ Reject (describe)		
Sample Type		
☐ RO – Routine PEP ☐ FB - Field Blank (Associated RO Cassette ID: _____) ☐ Other (describe) ☐ CO - Collocated PEP ☐ Expired Filter (not used) ☐ TB - Trip Blank (Record last RO Cassette ID used in this audit trip: _____)		
☐ Void (why?)		
PEP Cut Point: ☐ PM-2.5 ☐ PM-10	PEP PM-2.5 Separator Type: ☐ WINS ☐ VSCC	

PART IV – FIELD FILTER SHIPPING TO WEIGHING LAB

Shipment Date		Affiliation:
Shipped by		Shipping Destination:
Tracking No.		Shipping Company:

On completion of Part II-IV, the field scientist keeps one copy and sends the top (original) copy to the laboratory with the filter.

PART V – WEIGHING LABORATORY

Date Received		Received by:		Integrity Flag:
Shipment Integrity OK?	☐ Yes ☐ No	Max Temperature: °C	Cold Pack Condition: ☐ Frozen ☐ Cold ☐ Ambient	

The weighing laboratory will DATE-STAMP and attach the COC form to the receiving log-book, in which same info is recorded.

Notes:

05-15-2017 version

Figure B3-1. Example PM2.5-PEP Chain of Custody Form

B4 Analytical Methods Requirements

This section describes how the $PM_{2.5}$-PEP uses gravimetric analysis to determine the $PM_{2.5}$ mass collected on sample filters. The net mass increase on a sample filter is calculated by subtracting the initial tare filter weight (pre-sampling) from the final filter weight (post-sampling). This difference is assumed to be the $PM_{2.5}$ mass deposited on the filter, given the filter handling procedures noted in Section B3. This mass difference is divided by the total volume of sampled air passed through the filter (as reported by the sampler logged data) to calculate the $PM_{2.5}$ sample concentration in $\mu g/m^3$. This $PM_{2.5}$-PEP-derived concentration is compared to the $PM_{2.5}$ concentration measured by the SLT monitoring agency's primary monitor for the same 24-hour period.

The $PM_{2.5}$-PEP Laboratory SOP details the analytical methods used in the $PM_{2.5}$-PEP. The $PM_{2.5}$-PEP weighing laboratory is responsible for implementing these analytical and associated QA procedures and requirements.

The following sections prescribe the QA and QC requirements for the $PM_{2.5}$-PEP laboratory analytical procedures.

B4.1 Analytical Facilities

The $PM_{2.5}$-PEP weighing laboratory has procedures in place to ensure that the MQOs described in Table A7-2 are achieved. The laboratory's weighing room is used for filter conditioning, weighing the filters, and staging the weighed filters before being moved to more permanent storage facility. In case of emergency, EPA has arranged for laboratory facilities at EPA's campus in RTP, North Carolina, to serve as a backup weighing laboratory for the $PM_{2.5}$-PEP.

Table B4-1 lists performance specifications of the analytical laboratory environment and equipment.

Table B4-1. Performance Specifications for the $PM_{2.5}$-PEP Weighing Laboratory

Equipment	Performance Specifications
Microbalance	Readability ≤ 1 µg, repeatability of 1 µg
Microbalance and Filter Conditioning Environment	Climate-controlled [a] draft-free room, chamber, or equivalent Mean relative humidity between 30% and 40%, with a target of 35% and variability (1 standard deviation) not more than ±5% over 24 hours; no individual RH readings (5-minute averages) falling below 25% or above 45%. The 24-hr average RH must be within ±5% for pre- and post-weighing. [b] Mean temperature between 20°C and 23°C over 24 hours, with variability of the 5-minute averages (1 standard deviation) not exceeding ±2°C over 24 hours; no individual 5-minute average can be below 18°C or above 25°C. [b] No more than ten 5-minute average values are permitted to be missing from a 24-hour period.
Mass Reference Standards	Mass standards will bracket the expected nominal weight of filter plus typical loads by approximately ± 200 mg Individual (Class 1) standard weight tolerance within ± 10 µg

[a] If mean temperature reading or relative humidity is outside of specified range, the laboratory manager should use discretion o determine if the 24-hour conditioning period should be reset.

[b] 40 CFR Part 50, Appendix L, Section 8.3.3.

B4.1.1 Laboratory Sample Contamination Prevention

The weighing room is equipped with a high-efficiency particulate air (HEPA) filtered air handling system and adhesive sticky mats are installed on the floor to minimize contamination of the filters from airborne dust and other contaminants. Weighing room access is restricted to trained LAs and each must wear an anti-static (static dissipative) labcoat.

Filters are conditioned, equilibrated, and stored in protective petri dishes in the weighing room. To reduce the risk of contamination, powder-free and antistatic gloves are worn while handling filters, and filters are only contacted with smooth-tipped, non-serrated forceps.

B4.1.2 Laboratory Environment Requirements

The filter equilibration chamber (i.e., weighing room) is to be maintained within a tightly controlled range of temperature and relative humidity to minimize filter weight mass fluctuation contributed by filter humidity changes. The following weighing laboratory room temperature requirements for the $PM_{2.5}$-PEP are more stringent than those for the national $PM_{2.5}$ monitoring network (40 CFR Part 50, Appendix L, Section 8.2):

- Mean 24-hour temperature must be held to between 20°C and 23°C, with a variability (calculated as standard deviation from 5-minute averages) of not more than ± 2°C over 24 hours.
- Individual temperature readings (5-minute average readings) must remain within the range of 18°C to 25°C.

The weighing laboratory room must meet the following RH requirements (40 CFR Part 50, Appendix L, Section 8.2):

- Mean 24-hour RH must be controlled to between 30% and 40%, with a target of 35% and with variability (calculated as standard deviation from 5-minute averages) of not more than ± 5% over 24 hours.
- Individual RH readings (5-minute average readings) must remain within the range of 25% to 45%.

The temperature and RH of the weighing laboratory are to be continually measured and logged (measurements recorded with a frequency of not less than every 5 minutes).

B4.1.3 Filter Storage Environmental Requirements

Filters are to be stored in protective packaging until inspected and equilibrated for measuring tare weights. During equilibration (for tare weighing or post-sampling weighing), filters are stored in the weighing room subject to the environmental conditions in Section B4.1.2. Following tare weights, filters do not require specific environmental conditions (temperature extremes should be avoided) and are packaged for use in sampling events or maintained in the laboratory for use as laboratory QC samples. Once received from the field, filters are stored immediately in refrigerated storage until equilibrated for post-sampling weights. This refrigerated storage is to be maintained at 0 to 4°C and the temperature of the storage unit monitored continually (i.e.,

temperature recorded by a logger every 5 minutes). Excursions from this temperature range are not to exceed 30 minutes over a 24-hour period. The weighing laboratory manager and primary analyst are notified when temperature excursions occur.

B4.2 Analytical Equipment

The $PM_{2.5}$-PEP laboratory SOP contains a complete listing of analytical equipment used in the $PM_{2.5}$-PEP. Briefly, this includes an electronic microbalance with sufficient sensitivity and stability, certified standard mass weights for verifying balance calibration, and static elimination devices. Additional support equipment includes forceps for handling filters, racks and associated trays for holding filters for conditioning, and a heavy vibration-free table (e.g., marble or similar) on which the balance is installed.

The microbalance is the primary analytical instrument used for gravimetric analysis in the FRM and must have a readability of ≤ 1 µg and a readability of 1 µg. The $PM_{2.5}$-PEP weighing laboratory currently uses a Sartorius® MC-5 microbalance, which meets these specifications for readability and repeatability. A technician services the microbalance twice annually, verifies the balance calibration, and adjusts the calibration as necessary during these maintenance visits.

Within the weighing room, the microbalance is installed on a vibration-free table and is protected from significant drafts (i.e., with baffles or located out of the path of significant drafts).

Static elimination devices consist of an anti-static brush and specially designed polonium-210 (^{210}Po) strips that are replaced at the manufacturer recommended duration (i.e., every six months).

B4.3 Analytical Process

The analytical determination of $PM_{2.5}$ mass on filters requires two distinct weighing sessions: a pre-sampling weighing session to determine the initial tared mass of the unexposed filter, and a post-sampling weighing session to determine the final mass of the exposed filter. The difference of these two mass measurements provides the mass of $PM_{2.5}$ deposited on the filter during sampling. Additional filter weighing sessions are also needed to determine the duration of conditioning needed for new filter material and may be performed occasionally to confirm the duration of conditioning needed for sampled filters. These additional weighing sessions involve collection of successive filter weight measurements until a stable filter mass is achieved (i.e., mass difference ≤ 15 µg) in consecutive sessions conducted approximately 24 hours apart.

The standard $PM_{2.5}$-PEP weighing laboratory practice is to dedicate one entire week for pre-sampling tare weighing sessions and the next entire week for post-sampling weighing sessions and alternating these weeks. Sampled filters are maintained refrigerated at ≤ 4°C until set out for equilibration on the Friday of the week of the pre-sampling weighing session and then weighed the following Tuesday during the post-sampling weighing session week. The only deviations to this arrangement occur when sampled filters have a limited holding time until expiration, such as occurs for filters received > 4°C, and require more immediate weighing to ensure the sample is not invalidated (this situation is rare and occurs only every few months).

B4.3.1 New Filter Receipt and Inventorying

Filter media are to meet the specifications listed below in Table B4-2. EPA purchases filters from a reputable vendor for the $PM_{2.5}$ monitoring program. A portion of the purchased filters are earmarked for the $PM_{2.5}$-PEP.

Table B4-2. $PM_{2.5}$-PEP Filter Media Specifications

Equipment	Specifications	Reference
Filter Design Specifications (Certified by Vendor)		
Size	46.2-mm diameter ± 0.25 mm	40 CFR Part 50, Appendix L, Section 6.1
Medium	Polytetrafluoroethylene	40 CFR Part 50, Appendix L, Section 6.2
Support ring	Polymethyl pentene or equivalent[a] 0.38 ± 0.04 mm thick 46.2 ± 0.25 mm outer diameter 3.68 (+ 0.00 mm, -0.51 mm) width	40 CFR Part 50, Appendix L, Section 6.3
Pore size	2 µm	40 CFR Part 50, Appendix L, Section 6.4
Filter thickness	30–50 µm	40 CFR Part 50, Appendix L, Section 6.5
Maximum pressure drop	30 cm H_2O at 16.67 LPM	40 CFR Part 50, Appendix L, Section 6.6
Maximum moisture pickup	10-µg increase in 24 hr	40 CFR Part 50, Appendix L, Section 6.7
Collection efficiency	99.7%	40 CFR Part 50, Appendix L, Section 6.8
Filter weight stability	< 20 µg	40 CFR Part 50, Appendix L, Sections 6.9.1 and 6.9.2
Alkalinity	< 25.0 micro-equivalents/g	40 CFR Part 50, Appendix L, Section 6.10

[a] The current suppler of PTFE filters uses a proprietary PTFE modified with a co-monomer for the support ring.

Upon receipt of new unexposed 46.2-mm PTFE filters at the $PM_{2.5}$-PEP Laboratory, the Laboratory Manager, primary LA will examine and inventory the filters. Filters are packaged by the manufacturer in plastic clamshell boxes containing two stacks of 25 filters, with each stack contained within a plastic holder and a thick paper sleeve, for a total of 50 filters per box. The filters received in a shipment (which may consist of more than one individual shipment) for the year are considered to be a lot of material, unless the manufacturer has otherwise defined the lot by range of filter serial number. The examination and inventorying include the following activities:

- Documenting (logging in) filter receipt in the laboratory's PED (or LIMS) by range of filter ID. Filter IDs are the alphanumeric (e.g., T4664850) filter serial number assigned by the manufacturer and are unique to each filter and are sequential in number.
- Labeling each box with the date of receipt and, if not already indicated by the manufacturer, the filter ID range.
- Generally inspecting each box of filters and its contents to verify integrity, noting any problems, and reserving filter boxes exhibiting obvious quality issues.
- Storing the filters securely until moved to the laboratory's conditioning and weighing room.

B4.3.2 New Filter Inspection

Once inventoried, new filters are to be inspected to ensure they are free from defects that would compromise collection of field samples. Filters will be selected for inspection in a first-in first-used convention such that older filters are inspected and placed into service first. Filters in lots received more 2 years prior are discarded.

A laboratory analyst visually inspects filters according to the FRM criteria (with the aid of a diffuse backlight) for defects such as pinholes, tears, ring separation, discoloration, and loose material that would make them unsuitable for use. Defective filters may still be used for laboratory QC procedures, such as for laboratory blanks.

B4.3.3 Filter Weighing Considerations

PTFE filters are especially susceptible to static electricity which both attracts dust and causes interferences with the analytical balance stability of the filter weight measurement. To mitigate the impact of static on the filter weighing, each filter is treated for static by exposing it to an arrangement of anti-static polonium-210 strips that ionizes the atmosphere around the filter and eliminates static on the filter.

QC activities associated with weighing sessions is described in Section B5.1.

B4.3.4 Filter Lot Stability Testing

With each new lot of filter material, the minimum equilibration period must be experimentally determined by completing a lot stability test. The minimum equilibration time is 24 hours; however, in practice this period is not sufficient to ensure mass stability of the filter media. Filters are considered to be properly mass equilibrated when their mass change is $\leq \pm$ 15 µg between weights measured approximately 24 hours apart. Historical data show that this period is between 48 and 72 hours. EPA Method 2.12 discusses performing this procedure on 9 total filters where 3 filters each are selected from 3 different boxes (where each box contains 50 filters). The lot stability test for the $PM_{2.5}$-PEP involves selecting 20 filters from minimally 5 different boxes (where not more than 4 filters are from the same box) and comprises the following steps:

1. Select 20 inspected filters total from minimally five different boxes.

2. Equilibrate these 20 filters in petri dishes in the weighing laboratory/conditioning environment for minimally and approximately 24 hours (i.e., not less than 24 hours but not to exceed 2 days from equilibration start, ~30 hours is acceptable). Filters are conditioned within petri dishes with the lids attached loosely to allow air circulation.

3. Perform the typical balance calibration verifications and measure and record the mass of each filter for the 24-hour equilibration weight.

4. Approximately 24 hours after the first weight, weigh each filter for a 48-hour equilibration weight. If the masses of 19 of 20 of the filters at 48 hours of equilibration are within ±15 µg of the 24-hour equilibration mass, the equilibration period for the lot is

determined to be minimally 24 hours. If fewer than 19 filters meet this criterion, continue the equilibration and proceed to the next step.

5. Approximately 48 hours after the first weight, weigh each filter for a 72-hour equilibration weight. If the masses of 19 of 20 of the filters at 72 hours of equilibration are within ±15 µg of the 48-hour equilibration mass, the equilibration period for the lot is determined to be minimally 48 hours. If fewer than 19 filters meet this criterion, proceed to the next step.

6. Approximately 72 hours after the first weight, weigh each filter for a 96-hour equilibration weight. If the masses of 19 of 20 of the filters at 96 hours of equilibration are within ±15 µg of the 72-hour equilibration mass, the equilibration period for the lot is determined to be minimally 72 hours. While significant mass changes exceeding 15 µg/filter are not anticipated after 72 hours of equilibration, if fewer than 19 filters meet the criterion, the minimum equilibration period is 96 hours for the lot and will require to equilibration over weekends. In such cases, laboratory analysts should ensure that the data indicating such a long equilibration time is warranted by closely examining the filter weighing data to ensure that filters were not misidentified or subject to other weighing error which would explain the extended equilibration period. Charting the weights over time per filter will inform whether masses of the selected filters continue to change in the same direction (e.g., gaining or losing mass together) during equilibration. If more than 3 filters are not stabilizing, recheck the static control devices (^{210}Po) for malfunction or exceedance of expiration period.

7. If an equilibration period of 96 hours or more is deemed necessary, continue to collect weights approximately every 24 hours until the equilibration period is established (i.e., 19 of 20 filters show ≤ 15 µg of mass change between 24-hour weighings).

The tested filters may be cycled back into the general filter supply and used for field samples or laboratory blanks.

B4.3.5 Filter Conditioning and Measuring Pre-weights (Tare Weights)

Inspected filters are individually placed into petri dishes to begin conditioning at the environmental conditions in the weighing room. The petri dishes are kept unsealed (lids loosely fitted) during conditioning/equilibration to allow air circulation. Filters are to be equilibrated minimally for the equilibration period determined in the lot stability test conducted in Section B4.3.4. Note that this equilibration period must be no less than 24 hours prior to collecting a pre-sampling tare weight.

For measuring pre-sampling tare weights, each filter in the weighing session is weighed and then reweighed for a replicate weight again later in the same weighing session. The difference between these replicate weights must be ≤ 5 µg for each filter. For filters meeting this criterion, the tare mass is considered stable and is assigned as the most recent (second) weighing, and the filter is ready for field deployment. Filters with replicate weight differences that exceed 5 µg will need to be conditioned longer and weighed again in replicate until the criterion is met.

Data generated by the weighing process (e.g., filter mass, filter ID, analysis date) are entered into the laboratory's PED (or LIMS application when released) which notifies the LA when filter masses do not meet prescribed acceptance criteria for equilibration time and replicate tare weights. Following successful measurement of the tare weight, the LA installs filters for field deployment into a cassette, installs the protective caps to the cassette, seals the assembled cassette into a zipperlock anti-static bag, and generates a COC/FDS for each filter for field deployment. Filters are then ready for field deployment based on need indicated by each Region and self-implementing PQAO. Once the filter is installed in the cassette and leaves the weighing room, it remains in the cassette until it returns to the weighing room for post-sampling equilibration. The LA typically also assigns filters to be laboratory blanks at this time, which will be weighed with the returned field collected filters. Filters which are not used for a field sample or as a laboratory QC sample within 30 days will need to have tare weights re-established before they can be returned to the pool of filters available for use.

Once MoPED is released, a file transfer application will upload the tare weight datafiles to AQS.

B4.3.6 Filter Post-Sampling Conditioning and Weighing

Following return of the sampled filter shipments to the laboratory, the laboratory sample receipt custodian (typically the LA) measures the sample shipment temperature, unpacks each shipment to inspect the received filter(s), and logs them into the PED (or LIMS when/if applicable). Received filters are stored in a refrigerator at ≤ 4 °C until ready for conditioning/equilibration. Filters are removed from cold storage and brought into the weighing laboratory where they are equilibrated for a minimum of 24 hours; however, the $PM_{2.5}$-PEP laboratory standard practice is to equilibrate sampled filters for 96 hours. This is accomplished by beginning equilibration on the Friday before the week dedicated to post-sampling filter weighing. Equilibrated filters are then weighed on the following Tuesday, accomplishing equilibration of approximately 96 hours. Concurrently, evidence has shown that extended equilibration periods encourage excessive volatilization of collected PM on sampled filters, therefore equilibration should not exceed 7 days (168 hours) except in extenuating circumstances. Filter holding times are discussed in Section B2.3.4.

B4.3.7 Filter Archiving

Once filters have finished with post-sampling weights and the data are validated/invalidated and approved for reporting, the LA will archive the processed filters. Filters are archived through the end of the next full calendar year, and then at room temperature for four additional years. For example, a filter sample collected on March 1, 2021, will be archived in cold storage until December 31, 2022, then at room temperature until December 31, 2026.

B4.4 Laboratory Corrective Actions

The $PM_{2.5}$-PEP weighing laboratory will identify operational issues and take corrective action when necessary to ensure the data meet quality criteria. The $PM_{2.5}$-PEP Laboratory SOP provides additional information on routine corrective actions.

B5 Quality Control Requirements

The PM2.5-PEP prescribes QC procedures and associated acceptance criteria for the field and laboratory activities to ensure that measurement systems are within appropriate control and identifies when out of control conditions exist. These QC activities are routinely performed to control bias and imprecision of measurements, and include: verifying calibrations (control bias), demonstrating lack of positive bias from contamination (control bias), and conducting replicate or duplicate measurements to evaluate precision (assess imprecision). These QC procedures include: calibrations, calibration verifications, precision measurements (replicates), negative control (blanks) measurements, and functional checks (leak checks). These practices generally follow those in Method 2.12; however, some acceptance criteria are more stringent for the PM2.5-PEP.

In the PM2.5-PEP, QC activities ensure that measurement uncertainty, as discussed in Section A7, is maintained within acceptance criteria for DQO attainment. QC checks are performed on sampling and measurement equipment prior to use and on an ongoing basis to ensure proper performance. QC checks that do not meet acceptance criteria require corrective action to be taken to correct out of tolerance conditions. Following correction of out of tolerance conditions, the QC checks are to be repeated and meet criteria before data can be reported. Correction may require sourcing a replacement instrument or adjusting procedures to address the root cause of the out of tolerance condition.

Figure B5-1 illustrates some of the QC samples and activities that help evaluate and control data quality within the PM2.5-PEP. They are aligned according to their purpose (as noted at the bottom of the figure).

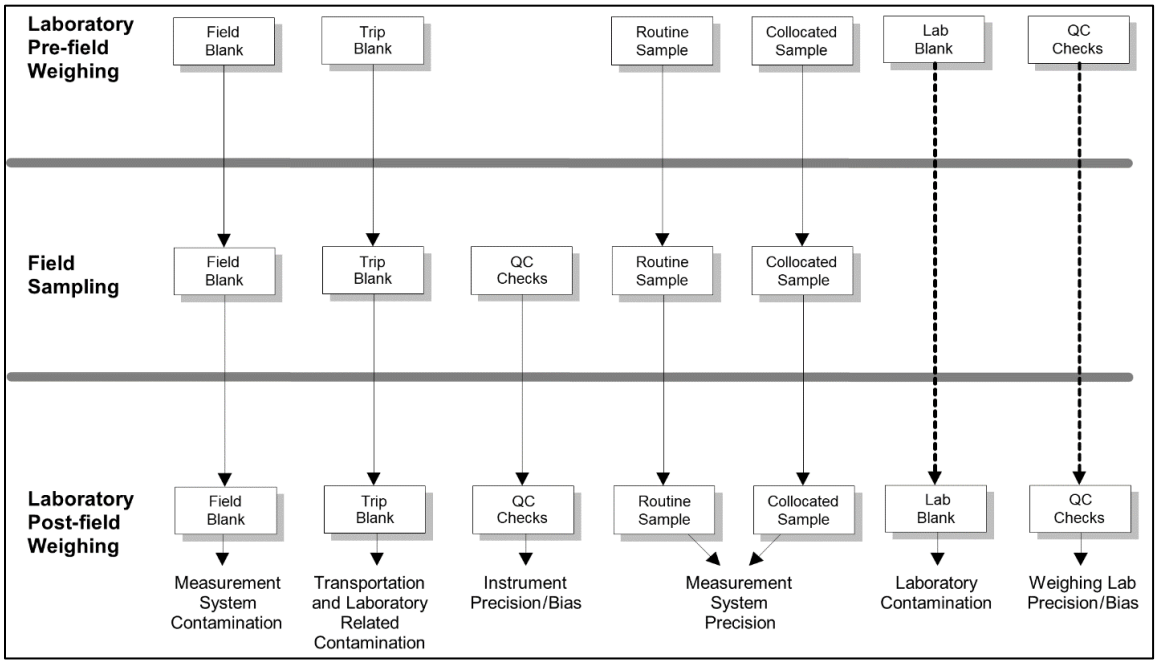


Figure B5-1. PM2.5-PEP Noteworthy Quality Control Samples and Activities

B5.1 Laboratory QC Procedures

Laboratory QC procedures are designed to ensure that instruments and conditions critical to ensuring that bias and precision for filter preparation and weighing are tightly controlled within defined parameters. These QC procedures include calibrations and calibration verifications of the microbalance, standard weights, and environmental monitoring instruments as well as analysis of blank filter samples and replicate filter weights.

B5.1.1 Laboratory Instrument Calibrations

Refer to Section B7 for requirements for laboratory instrument and standards calibration and calibration verifications.

B5.1.2 Laboratory Quality Control Filter Samples

Weighing sessions are dedicated for measuring pre-sampling tare weights or for measuring post-sampling weight. Associated QC samples are tailored to the weighing session type.

Filter samples are assigned to a batch and all filters in the batch are weighed together in a weighing session bracketed by working standard weights as described in Section B7.1. Filters to be weighed for pre-sampling (tare) weights are typically assigned to batches that only contain new filter samples and do not contain field-sampled filters. To determine post-sampling weights, filter samples collected in the field are assigned to a batch with their associated field QC samples. The filters and assigned batch QC samples are weighed together in each weighing session for the batch. Note that due to the varying holding times and the impracticality of tracking individual filters deployed to the field, filters exposed during $PM_{2.5}$-PEP events are assigned to a new batch after receipt and are not maintained within the same batch as assigned during pre-sampling weights.

B5.1.2.1 QC for Pre-Sampling Tare Filter Weights

For pre-sampling tare weight weighing sessions, the filters to be weighed will have been inspected and conditioned/equilibrated in the weighing room and the environmental conditions controlled to within the specified tolerances for the equilibration period determined in Section B7.1. For the start of the weighing session, the LA calibrates the analytical balance by performing the balance's internal calibration procedure. Once calibrated, the LA will verify the calibration with standard weights bracketing the expected balance load (this is approximately 400 mg based on the current filter media). After calibrating and verifying calibration of the balance, the LA will eliminate static on each filter to be weighed (with the ^{210}Po anti-static strips) and measure a tare weight of each filter, recording the mass in the PED. After every 10 filters, the LA will weigh a standard weight as described in Section B7.1.1.1. Once a mass is measured and recorded in the PED for each filter in the weighing session, the weighing session sequence is repeated and each filter is weighed again (in replicate) with standard weight measurements interspersed every 10 filters and concluding the weighing session. The replicate weights are to be within ±5 µg of each other or further conditioning is required to ensure filter tare mass is stable.

No dedicated filter QC samples are weighed during tare weight sessions; however, the LA will select filters from those weighed to serve as laboratory filter blanks for the weighing session associated with filters when returned from the field post-sampling. Laboratory blank filters are negative controls intended to detect contamination or other mass changes in the filter conditioning, filter handling, and filter weighing procedures. Laboratory blanks do not leave the laboratory weighing room.

B5.1.2.2 QC for Post-Sampling Filter Weights

Batch QC for post-sampling weighing sessions includes laboratory filter blanks, intra-batch duplicates, and inter-batch duplicates.

Once post-sampled filters are properly equilibrated (e.g., for approximately 96 hours), the LA conducts a weighing session dedicated to post-sampled filters. As with the pre-sampling tare weight sessions, the LA calibrates the analytical balance and verifies the calibration with two bracketing standard weights. After calibrating and verifying calibration of the balance, the LA will eliminate static on each filter to be weighed (with the ^{210}Po anti-static strips) and measure the mass of each filter, recording the mass in the PED. After every 10 filters, the LA will weigh a laboratory filter blank selected from those assigned in an associated pre-sampling tare weighing session, which must show the mass is within ± 15 µg of the mass from the initial tare weight. A new filter is weighed for each of these laboratory filter blanks. Following the laboratory filter blank, the LA will verify balance calibration with a standard mass weight as described in Section B7.1.1.1. At the conclusion of the post-sampling weighing session, the LA will measure a replicate weight of another filter (typically the first sampled filter) weighed in the session as an intra-batch duplicate, as well as a field-collected filter sample from a previous post-sampling weighing batch (this is typically from the most recent post-sampling weighing session from approximately 11 days previous) as an inter-batch duplicate. Both the intra-batch duplicate and inter-batch duplicate which must be within ±15 µg of the initial weight.

If after taking corrective action for batch QC failure the QC sample results remain unacceptable, the weighing session measurement data are not accepted and the weighing session is to be repeated after remediating the out of tolerance condition. An exceedance of acceptance criteria may be due to transcription error, microbalance malfunction, or insufficient conditioning of filters such that they have not reached mass equilibrium before weighing. Corrective steps should involve examining weighing session batch QC checks (e.g., working standard calibration verifications and laboratory filter blanks) to eliminate microbalance malfunction.

B5.2 Field QC Procedures

Field QC procedures are designed to ensure the sampling unit is operating properly, the sampling flow rate control is within the defined tolerance, and that the sampled air is representative of the ambient air to be characterized. These activities include calibration verifications, operational checks, and collection of field QC filter samples.

Calibrations and calibration verifications of field equipment are covered in Section B7.2.2 and are to precede the operational QC check, which is the sampler leak check. Field QC filter samples consist of FBs and TBs.

Once the sampler is assembled and powered on, the FS will perform calibration checks on the sampling flow rate, barometric pressure probe, and temperature probes (ambient and filter probes), and will perform a leak check to ensure the sampler does not ingest air that was not routed through the particle size separator.

B5.2.1 Field QC Samples

Field blanks are collected at about 55% of $PM_{2.5}$-PEP events; trip blanks at about 10-15%. These field QC blank filter samples are designed to demonstrate potential contamination that may occur to sampled (exposed) field filter samples during field activities.

- **Field blanks** provide an estimate of total measurement system contamination encompassing all procedures following the pre-sampling (tare) weight measurement through the post-sampling weight measurement. To collect a field blank, the FS installs the filter cassette in the sampling unit as is done for a typical sampling event; however, does not activate the sampling flow, and retrieves the FB filter after a brief waiting period of approximately 5 minutes. Apparent contamination on FBs prompts inspection of the associated TB and laboratory filter blank samples to ascertain at which point(s) in the process the contamination occurred. FBs are required to be collected at the following frequency:

  - For a self-implementing PQAO program that is less than 2 years old, a FB is required to be collected with each $PM_{2.5}$-PEP sampling event (i.e., at each site a $PM_{2.5}$-PEP sample is collected).

  - For the federal $PM_{2.5}$-PEP and self-implementing PQAO programs older than 2 years, a FB is required to be collected with each $PM_{2.5}$-PEP trip, where a trip may include more than one $PM_{2.5}$-PEP sampling event at more than one monitoring site. The FS determines the site at which the FB will be collected, unless otherwise directed by the Regional $PM_{2.5}$-PEP Lead (such as when a problem is identified at a particular site).

- **Trip blanks** provide an estimate of measurement system contamination encompassing filter handling, transport, and conditioning activities following the pre-sampling tare weight measurement through the post-sampling weight measurement. To collect a TB, the FS leaves the assembled TB filter cassette sealed in the plastic zipperlock anti-static bag and the TB accompanies the associated exposed filter sample(s) and FB(s) throughout the entire $PM_{2.5}$-PEP trip. TBs provide a frame of reference when FB results exhibit a mass gain that exceeds tolerance levels, indicative of potential contamination. One trip blank is to be collected per $PM_{2.5}$-PEP trip and each TB is to be associated with at least one FB.

B5.3 Evaluation of Blank Results

Results from blank samples, including laboratory blanks, TBs, and FBs, are evaluated for contamination individually and then results can be aggregated to investigate contamination or trends in mass changes for a given blank type.

B5.3.1 Individual Blank Results Evaluation

Results from a single individual filter blank that exceed the criteria prescribed in this section initiate a review of the activities and environmental conditions associated with the event at which the blank was generated. To evaluate the mass gain or loss of a filter blank, the absolute mass difference is determined:

Absolute mass difference for a single filter *(d_i).* For a given blank filter, the absolute difference in its mass measurements, d_i, is calculated as follows, where X_i represents the mass of the yet-unexposed filter (i.e., pre-sampling tare weight), and Y_i represents the mass of the filter in subsequent weighings, such as when returned to the laboratory following a sampling event (i.e., post-sampling for TBs and FBs) or weighed with a post-sampling weighing batch as a laboratory filter blank.

$$d_i = |Y_i - X_i|$$

Note: *Due to taking absolute value, the value of d_i is always non-negative and can be converted from a mass to an equivalent in-air concentration ($\mu g/m^3$) by dividing by 24 m^3.*

Laboratory filter blanks do not leave the weighing laboratory and are expected to maintain a stable mass within ± 15 µg of the established tare weight for subsequent weighings. When this criterion is exceeded, the LA should investigate the potential cause of the mass gain or loss of the blank, which may include filter mix-up, balance calibration drift, incomplete static elimination, omission of complete balance tare (re-zero) between filters, contamination, or damage to the filter, for example. Other corrective actions may include verifying the correct data transcription, cleaning the analytical balance weighing pan with the anti-static brush, extending the duration of filter sample static elimination (^{210}Po strip), examining environmental conditions for unstable temperature and/or RH, cycling the balance draft shield door to ensure proper operation, and reweighing the filter sample. If there is not an obvious error and the acceptance criterion remains exceeded after these corrective steps (which has not occurred to the analyst's awareness), the filter weighing session data are not accepted and the filter samples are equilibrated for minimally an additional 12 hours and the weighing session repeated.

TBs and FBs experience increased handling during transport and field activities when compared to laboratory blanks. TBs and FBs also require conditioning within the weighing laboratory to achieve mass stability prior to measuring post-sampling weights. Generally, the level of contamination (mass increase) on TBs is expected to be greater than that of associated laboratory filter blanks, and FBs are generally expected to exhibit greater mass gain than both laboratory filter blanks and TBs.

- If the absolute mass difference (d_i) for an individual FB is > 30 µg, then the associated TB data should be examined for a mass gain indicating contamination, which could have been introduced during procedures to load filters into cassettes, install metal cassette caps, and seal the assembled cassettes into antistatic bags.

- If the absolute mass difference (d_i) for an individual TB is > 15 µg, then further investigation is necessary to determine the source of the contamination. This would be particularly true if an associated FB exhibits a normal value, e.g., within one (1) standard deviation of the program mean for that year. For example, a problem may exist with sample handling during loading or possibly ineffective cleaning of the cassette and subsequent transfer of contamination from the cassette to the tared filter.

Depending on the outcome of the investigation of the mass difference exceedance, the TB and/or FB may be flagged as failed trip blank (FTB) or failed field blank (FFB), respectively.

The mass measurement differences for laboratory filter blanks, TBs, and FBs are control charted (see Section B5.6) and can be used to determine whether equilibrium status is less certain.

B5.3.2 Aggregated Blank Results Evaluation

Results from groups of blanks can illustrate norms and annual or seasonal trends at specified levels of aggregation, e.g., by the National Program, Region, or individual FS. To evaluate the blank data in aggregate, the mean of the individual absolute mass differences for a given blank filter type is calculated:

Mean absolute difference (d_z). For a group of n filters of a given blank type, the mean absolute difference, d_z, is calculated as follows, where d_1 through d_n represent the absolute value of the mass difference for individual blanks within the group:

$$d_z = \frac{d_1 + d_2 + d_3 \ldots . d_n}{n}$$

Note: *Blank filter types can be aggregated in numerous ways to investigate potential contamination or bias, such as for an individual weighing batch, date range, Region(s), FS(s), and/or Nationally.*

Filter weighing will be suspended until the cause(s) of the laboratory blank mass instability is identified and corrected when any individual laboratory filter blank exceeds ± 15 µg from its tare weight. Minimally, the LA will evaluate the mean difference for laboratory filter blanks within the weighing batch for instability of the laboratory filter blank masses. Instability may be due to fluctuating or drifting environmental conditions, microbalance operational or calibration instability, or deteriorating static elimination.

When such instances occur, the filter sample weight data cannot be reported and the LA will immediately notify the Laboratory Manager. If more than two (2) weeks are needed to resolve the cause of the instability, then the $PM_{2.5}$-PEP Laboratory Manager will notify the manager of the backup weighing laboratory, and weighing operations will be temporarily shifted to the backup laboratory until the issue is resolved. The problem and its eventual solution are to be

reported and appropriately filed using the AFC system (or other acceptable filing system) under response and corrective action reports (PEP/108-025-01-01-237.1, see Section A9).

Evaluation of mean differences may illustrate or suggest contamination or bias unique to that level of aggregation (e.g., by Region, date range, etc.). The OAQPS $PM_{2.5}$-PEP Lead (or designee) will minimally evaluate the national aggregation of laboratory blanks, trip blanks, and field blanks for each calendar year to investigate potential trends. The OAQPS $PM_{2.5}$-PEP Lead or designee will take corrective action when mean absolute differences aggregated nationally exceed the following:

- Field blanks: $d_z > 20$ µg, or
- Trip blanks: $d_z > 10$ µg, or
- Laboratory blanks: $d_z > 10$ µg.

If further inspection of blank data indicates a potential issue at a smaller level of aggregation (e.g., in a specific Region), the OAQPS $PM_{2.5}$-PEP Lead (or designee) will initiate a review of the activities and environmental conditions associated with the group of blank filters.

B5.4 $PM_{2.5}$-PEP Precision

To satisfy the precision DQO for samples collected from $PM_{2.5}$-PEP samplers, the $PM_{2.5}$-PEP must ensure the entire measurement process is within statistical control. The $PM_{2.5}$-PEP incorporates the following types of precision measurements:

- Measurements from filter samples collected from three or more collocated $PM_{2.5}$-PEP samplers during a Regional collocation event (Section B5.4.1), and

- Measurements from laboratory batch duplicates (Section B5.1.2.2).

B5.4.1 $PM_{2.5}$-PEP Regional Collocation Studies

The precision (repeatability) of a single sampler cannot be characterized without the ability to introduce an identical atmosphere for repeated sampling. Since this condition cannot be practically accommodated, the $PM_{2.5}$-PEP cannot practically evaluate the precision of a single sampler. However, the ability to characterize the precision among discrete samplers (e.g., a fleet of samplers) can be accomplished by collocating samplers and comparing the resulting measured $PM_{2.5}$ concentrations. To do this, $PM_{2.5}$-PEP executes special collocation studies at the Regional level to characterize total measurement precision associated with each Region's $PM_{2.5}$-PEP sampler fleet. These "parking lot" studies (because they are typically conducted in a parking lot) also assess relative bias of a single $PM_{2.5}$-PEP sampler compared to the other samplers involved in the studies.

Twice per year (semi-annually), all of a Region's $PM_{2.5}$-PEP samplers are to participate in a collocation study. During a collocation study, the $PM_{2.5}$-PEP samplers are collocated (and thus are subject to the same atmospheric conditions) with all inlets within 1 to 4 meters of one another and 24-hour $PM_{2.5}$ samples are collected from each sampler over at least three days (not necessarily consecutive). The concentration data obtained from a collocation study are used to characterize precision in the samplers' $PM_{2.5}$ measurements. These data also help identify

individual $PM_{2.5}$-PEP samplers that demonstrate a concentration bias trend when compared with the remainder of the Regional sampler fleet.

Self-implementing PQAOs must participate in at least one semi-annual collocation study hosted by their respective Region. If a self-implementing PQAO chooses to participate in only one Regional collocation study in a year, then it must conduct one other collocation study on its own, as long as the study involves at least three (3) $PM_{2.5}$-PEP samplers and meets all other collocation criteria such as the number of sampling days (3), sample duration (24 ± 1 hour), sampler spacing, and general siting criteria. Regions and self-implementing PQAOs are each responsible for the setup and operation of their own equipment in these studies.

The $PM_{2.5}$-PEP weighing laboratory is responsible for shipping pre-weighed filters to the Regions for use in collocation studies, performing the gravimetric analyses on the returned exposed filters, and uploading the study results to the PED. The OAQPS QA Support Contractor will analyze the acquired measurement data to evaluate the sampler precision and any noteworthy findings such as identification of samplers demonstrating relative bias and/or poor precision. Results of these evaluations are typically included in $PM_{2.5}$-PEP QA reports.

B5.4.1.1 Single Sampler Precision Evaluation via CV Analysis

EPA uses the Regional collocation study data to **assess single sampler precision in the $PM_{2.5}$-PEP** according to the following six-step decision framework:

1. **Screen the $PM_{2.5}$ concentration measurements**. Exclude any individual daily measurement from this assessment when < 3 μg/m^3.

2. **Create pairings of all $PM_{2.5}$-PEP samples.** Among all samplers in the collocation study whose measurements are ≥ 3 μg/m^3, pair them together so that a given sampler is paired with every other sampler exactly once for each sampling date. If n such samplers participate in a given study, there will be $n \times (n-1)/2$ total sampler pairs provided no measurements are excluded. As the samplers are paired, so are their measured $PM_{2.5}$ concentrations on a given sampling day within the collocation study.

3. **Calculate the relative percent difference ($RPD_{i,j,q}$) in $PM_{2.5}$ concentration measurements for each sampler pair (i, j) on each sampling day (q) within the study.** If $X_{i,j,q}$ and $Y_{i,j.q}$ represent the $PM_{2.5}$ concentrations for the two paired samplers i and j ($i \neq j$) on sampling day q, then $RPD_{i,j,q}$ is calculated as follows (40 CFR Part 58 Appendix A, Equation 6):

$$RPD_{i,j,q} = \frac{Y_{i,j,q} - X_{i,j,q}}{(Y_{i,j,q} + X_{i,j,q})/2} \times 100$$

   (Note that $RPD_{i,j,q} = RPD_{j,i,q.}$)

4. **Calculate the estimator of precision ($CV_{j,q}$) for a single sampler (j) on a single sampling day (q) within the study**. A 90% upper confidence limit on the coefficient of

variation ($CV_{j,q}$) is used as the precision estimator for a single sampler (j) on a single study day (q). Each sampler is represented within exactly $k = n$-1 distinct sampler pairs (where n is defined in Step 2). If $RPD_{i,j,q}$ is as defined in Step 3 and $X^2_{0.1,k-1}$ is the 10th percentile of a chi-squared distribution with k-1 degrees of freedom, then the precision estimator ($CV_{j,q}$) is calculated as follows (40 CFR Part 58 Appendix A, Equation 7):

$$CV_{j,q} = \sqrt{\frac{k \times \sum_{i \neq j} RPD_{i,j,q}^2 - (\sum_{i \neq j} RPD_{i,j,q})^2}{2k(k-1)}} \times \sqrt{\frac{k-1}{X^2_{0.1,k-1}}}$$

The factor of two in the denominator adjusts for the fact that each value of $RPD_{j,q}$ is calculated from two measurements containing error.

5. **Calculate the precision of a single sampler (j) across the entire collocation study (CV_j).** For a specific PM2.5-PEP sampler j, the day-specific values $CV_{j,q}$ from Step 4 are aggregated over all days of the collocation study by calculating the square root of a weighted sum of squares as follows, where m is the number of day-specific values $CV_{j,q}$ for sampler j made during the collocation study. The value of m generally equals the number of days in the collocation study for which the PM2.5 concentration measurements from sampler j on each day was ≥ 3 µg/m^3:

$$CV_j = \sqrt{\frac{\sum_{q=1}^{m} CV_{j,q}^2}{m}}$$

6. **Apply corrective action on specific samplers when warranted.** If the value of CV_j from Step 5 exceeds 10% for a specific PM2.5-PEP sampler (j), that sampler is flagged for further evaluation and its filter samples from the collocation study may be reweighed to confirm the finding.

    a. If the value of CV_j is between 10% and 20%, then the OAQPS QA Support Contractor informs the OAQPS PM2.5-PEP Lead, who alerts the corresponding Regional PM2.5-PEP Lead of the problem.

    b. If the value of CV_j exceeds 20%, then the OAQPS QA Support Contractor provides a list of the PM2.5-PEP sampling events using that sampler since the sampler's last precision check to the OAQPS PM2.5-PEP Lead. The OAQPS PM2.5-PEP Lead alerts the corresponding Regional PM2.5-PEP Lead to initiate corrective action. Control charts of CVs and relative percent differences (RPDs) will be prepared to determine trends (Section B5.6).

    c. Historical data have shown that if ambient concentrations are near or below 5 µg/m^3, every sampler pair (i, j) will have a very high probability of exceeding an $RPD_{i,j,q}$ of 10%, even if the absolute difference between the two measurements is ≤ 1 µg/m^3. Several of the locations at which routine collocation studies were previously performed have high probabilities of concentrations in this range and it

is probable in many sampling locations. Therefore, the ambient concentration on a given day is considered when determining whether corrective actions are warranted when CV_j values exceed acceptance limits. EPA is currently developing an updated decision framework for the evaluation of collocation data when ambient concentrations are < 5 µg/m^3. In the interim, differences between sampler measurements in this concentration range are considered acceptable if the difference is ≤ 1.7 µg/m^3.

B5.4.1.2 Single Sampler Precision-based Performance Test

EPA also uses the Regional collocation study data to assess $PM_{2.5}$-PEP sampler performance and to identify individual samplers that yield aberrant results[14] according to the following seven-step decision framework:

1. **Screen the measured $PM_{2.5}$ concentrations for reasonableness.** Only concentrations below 200 µg/m^3 are considered "reasonable" under typical conditions (A wildfire or dust storm might generate these levels of $PM_{2.5}$) for a collocation study. $PM_{2.5}$ measurements obtained from the collocation study > 200 µg/m^3 are removed from the dataset prior to proceeding to the next step.

2. **Create all pairs of $PM_{2.5}$-PEP samplers (as described previously).** Among all samplers in the collocation study whose data are ≤ 200 µg/m^3, pair them up so that each sampler is paired with each other sampler exactly once. If n such samplers exist, there will be n*(n-1)/2 total pairs provided no data are excluded. As the samplers are paired, so are their $PM_{2.5}$ concentrations measured in the study on a given sampling day.

3. **Calculate the normalized percent difference ($NPD_{i,j,q}$) in $PM_{2.5}$ concentration measurements for each sampler pair (i, j) on each sampling day (q).** On a given study day, $NPD_{i,j,q}$ is calculated as follows, where $X_{i,q}$ and $Y_{j,q}$ represents the $PM_{2.5}$ concentrations for the paired samplers (i, j) on sampling day q, and *mean* equals the mean $PM_{2.5}$ concentration of all collocated samplers on the given study day:

$$NPD_{i,j,q} = \frac{|Y_{i,q} - X_{j,q}|}{mean} \times 100\%$$

4. **Identify those sampler pairs with notable differences in $PM_{2.5}$ concentration measurements**. On a given study day, those sampler pairs (i, j) with values of $NPD_{i,j,q}$ > 15% are flagged as "notable differences." Those pairs with values of $NPD_{i,j,q}$ ≤ 15% are accepted as being within the range of within-sampler precision historically observed within the $PM_{2.5}$-PEP.

5. **Identify those sampler pairs with relevant notable differences in $PM_{2.5}$ concentration measurements**. EPA has determined that 3 µg/m^3 is the lowest ambient $PM_{2.5}$ concentration that can be used to reliably characterize within-sampler precision.

[14] Assessment results are reported on the AirQA website (http://www.airqa.org). For more information on the development of the decision framework, see Appendix C (Documents to Support Data Quality Objectives).

Therefore, among sampler pairs having notable differences on a given study day, a pair is flagged as having relevant notable differences if either $PM_{2.5}$ concentration in the pair is ≥ 3 $\mu g/m^3$.

6. **Flag those samplers requiring further evaluation.** A $PM_{2.5}$-PEP sampler is flagged for further evaluation if both of the following hold:

   - It is associated with more than one sample pair having a relevant notable difference on a given study day, and

   - It is associated with at least 50% of the sampler pairs having relevant notable differences across the entire collocation study (i.e., across all study days).

   While $PM_{2.5}$ concentration measurements are expected to differ slightly among the collocated $PM_{2.5}$-PEP samplers on a given day due to various sources (e.g., sampler variability, analytical variability), those samplers whose measurements are highly inconsistent with the other collocated $PM_{2.5}$-PEP samplers require further investigation. For such samplers, the OAQPS $PM_{2.5}$-PEP Lead alerts the corresponding Regional $PM_{2.5}$-PEP Lead of the problem. The respective Regional $PM_{2.5}$-PEP Lead quarantines the suspect sampler(s) from use in the $PM_{2.5}$-PEP until corrective action can be taken and the issue(s) resolved.

7. **Further investigate collocation studies which produce a high number of relevant notable differences.** If the overall collocation study results show a high number of notable differences, the OAQPS $PM_{2.5}$-PEP Lead alerts the corresponding Regional $PM_{2.5}$-PEP Lead of the problem. The respective Regional $PM_{2.5}$-PEP Lead will investigate the samplers and the filter handling process for all personnel involved in the collocation study.

B5.4.1.3 Review of Regional Collocation Study Results

Upon receiving data from the collocation studies for all Regions (and thus across the entire national $PM_{2.5}$-PEP sampler fleet) for a given calendar year, OAQPS, or a designee, performs a review of the data to determine if repeatability of the samplers varies greatly among the Regions (or weighing laboratories if filters in collocation studies are analyzed by laboratories other than the $PM_{2.5}$-PEP weighing laboratory). In this review, OAQPS (or its QA Support Contractor) performs statistical tests for equal variances in $PM_{2.5}$ concentration measurements among Regions (or laboratories), using established tests such as Bartlett's test (an all-purpose statistical test that can be used for equal and unequal numbers of samplers among the Regions), Hartley's test (a statistical test that requires equal numbers of samplers per Region but is designed to find differences between the largest and smallest variances), or Levene's test (an alternative to Bartlett's test for testing for differences among the dispersions of several groups with greater power than Bartlett's for non-normal distributions of data). OAQPS may apply additional methods to evaluate data across collocation studies, as deemed appropriate. The $PM_{2.5}$-PEP QA Workgroup reviews new methods that may be proposed for these data analyses.

Conclusions from these statistical tests for equal variance allow OAQPS to determine whether corrective action must be taken to reduce the variability for any Region (or laboratory). Corrective action may include a formal review of field and/or laboratory staff training and operations to investigate the root cause. With these data, OAQPS is also able to evaluate the certainty with which bias of the routine $PM_{2.5}$ monitoring network can be estimated.

B5.4.2 National Collocation Studies

A national collocation event is the most comprehensive way to assess the precision of $PM_{2.5}$-PEP samplers for the nation. Such national collocation events can be scheduled to occur during $PM_{2.5}$-PEP annual refresher training as typically occurs at the Air Innovation Research Site (AIRS) at the EPA's campus in RTP, North Carolina. Collected measurement data will be assessed as in Section B5.4.1. EPA will make reasonable efforts to conduct a national collocation study every two years; however, the national collocation study may not be conducted as intended, such as if national training sessions are held virtually (and therefore field scientists do not travel), or other scheduling conflicts exist.

B5.5 $PM_{2.5}$-PEP Sampler Bias

Bias for the $PM_{2.5}$-PEP samplers is determined for the entire PM2.5-PEP and for a single sampler as follows:

National Review of Flow Rate Verifications—semi-annual and annual basis (|Bias|). Per 40 CFR Part 58, Appendix A, Section 4.2.2, absolute bias of the national $PM_{2.5}$-PEP sampler fleet over a specified time period is calculated as follows (40 CFR Part 58 Appendix A, Equation 3):

$$|Bias| = AB + t_{0.95,n-1} \times \frac{AS}{\sqrt{n}}$$

where *AB* and *AS* denote the mean and standard deviation, respectively, of the absolute values of the percent differences (d_i) associated within a specified time period (refer to Section 7.2.2.3), *n* is the number of measurement pairs within this period, and $t_{0.95,n-1}$ is the 95th percentile of the two-sided Student-t distribution.

Per 40 CFR Part 58 Appendix A, Section 4.1.3.1 and 4.1.3.2, the 25th and 75th percentiles of the percent differences (d_i) are determined for the given time period. The absolute bias estimate (|*Bias*|) is flagged as positive if both percentiles are positive and as negative if both percentiles are negative.

The flow rate verification results should be aggregated at the Regional and national level on a six-month and 12-month basis.

Bias of a single sampler—quarterly basis (D_j). For an individual $PM_{2.5}$-PEP sampler *j*, the average (D_j) of the individual percent differences (d_i) from the past two and the past four quarters for both flow rate verifications and flow rate audits is calculated as follows, where n_j is the number of individual percent differences produced for sampler *j* during the selected period (40 CFR Part 58, Appendix A, Equation 4):

$$Dj = \frac{1}{n_j} \times \sum_{i=1}^{n_j} |d_i|$$

The mean bias (D_j) can also be used to identify a systematic drift in a sampler's performance. If a systematic drift is noted, then the sampler may need to be recalibrated more frequently.

B5.6 Control Charts

The $PM_{2.5}$-PEP employs control charts of QC data to visualize that the measurement processes are within control limits and to observe trends in performance that may indicate an out of tolerance condition is approaching. Control charts represent an early warning system to evaluate trends in the collected QC data that may impact measurement precision and bias. Control charts will include time (date and time, as appropriate) along the x-axis and the parameter value on the y-axis and acceptance criteria will be shown on the chart. Table B5-1 indicates which QC data are to be control charted.

Table B5-1. Control Charts of QC Data for the $PM_{2.5}$-PEP

Measurement Data	Plotted Parameter and Associated Statistics
Laboratory conditioning environment (temperature and relative humidity)	Daily mean and standard deviation
Lot stability test, laboratory blanks, field blanks, and trip blanks	Difference of pre- and post-sampling weighed values
Intra-batch and inter-batch duplicate filter weights	Mass difference for each filter replicate measurement pair
Microbalance standard weight checks	For each standard weight (e.g., 300-mg), plot the weighed mass and the difference between the measurement and the certified mass
Sampler leak check	Difference between ending pressure and beginning pressure
Barometric pressure sampler check	Difference between transfer standard and sampler reading
Ambient temperature sampler check	Difference between transfer standard and sampler reading
Filter temperature sampler check	Difference between transfer standard and sampler reading
Flow rate sampler check	Percent difference between transfer standard and sampler reading
Collocation studies	Precision: Mass concentration CV of all samplers per semi-annual basis (aggregated at the Regional and national levels). See *CV* equation in step 4-5 of Section B5.4.1.1.

B5.6.1 Control Chart Use and Maintenance

With the implementation of MoPED and an updated PED or LIMS at the weighing laboratory, the $PM_{2.5}$-PEP will be transitioning to near real-time tracking of verifications, calibrations, and standardizations of samplers and field and laboratory instruments with these software systems and their capability for preparing control charts as listed in Section B5.6. FSs and LAs will be responsible for reviewing control charts which apply to their activities on a weekly basis when field and laboratory activities occur, respectively, and for taking corrective actions whenever conditions are trending toward an out-of-control

condition. Control charts are to be reviewed at least quarterly by the $PM_{2.5}$-PEP Laboratory Manager and the Regional $PM_{2.5}$-PEP Leads, for laboratory and field data, respectively.

B6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

This section describes the procedures for testing, inspecting, and maintaining instruments and equipment to ensure they are in sound operating condition and performing acceptably. Instrument inspection and maintenance activities are documented and filed using the AFC (under $PM_{2.5}$-PEP/301-093-006.3) or equivalent filing system. Individual Regions and/or self-implementing PQAOs may use a filing system other than AFC (e.g., TDF) so long as it is equivalent in functionality and allows for appropriate responses to interrogatories, TSAs, and/or other reviews. Refer to Section A9 for details on document filing and records.

B6.1 Instrument and Equipment Testing

B6.1.1 Field Instrumentation/Equipment Testing

$PM_{2.5}$-PEP samplers are FRM monitors (refer to Section B2.1) and EPA tests such equipment using procedures described in 40 CFR Part 53 and summarized in Section B5.2.

New samplers acquired for use in the $PM_{2.5}$-PEP are tested for proper operation as follows before being deployed:

- A series of single-point calibration verifications (see Section B7.2.2), and recalibration if verification results warrant such.

- A shakedown period in which the Regions perform a series of controlled tests and pilot runs on new samplers to identify the presence of problems or specific sampler components which attribute to deviations from normal operating ranges. Any problems should be reported to the OAQPS $PM_{2.5}$-PEP Lead, who will engage the manufacturer as necessary to help resolve them.

- A collocation with at least two other samplers that are believed to be performing satisfactorily. The collocation results will comply with acceptance criteria for a routine collocation study (see Section B5.4.1).

This same inspection/testing is performed if new or upgraded FRM sampler hardware is introduced for service (e.g., mass flow controller and/or control board).

Transfer standards for flow rate, temperature, and barometric pressure are calibrated as described in Section B7.2.1 and will undergo a brief testing period prior to field deployment or redeployment to ensure that readings and measurements are reasonable. No further scheduled testing or inspections are needed for the transfer standards unless the FS suspects the transfer standard is not performing properly.

B6.1.2 Laboratory Instrumentation/Equipment Testing

The $PM_{2.5}$-PEP weighing laboratory microbalance is verified with each weighing session for proper operation by performing internal calibration routines and ongoing calibration verification checks with standard mass weights as described in Section B7.1.1.1. Additional functional checks are conducted as part of normal operation, and include proper taring between filters or standard weights, proper draft door operation, and electronic transfer of measurement data to the PED. Minimally annually, an accredited vendor will perform maintenance on the analytical balance and test its performance. This testing will verify the proper balance operation at the balance weighing pan edges by performing an eccentricity test which involves 4 replicate weights of a mass minimally 30% of the balance capacity in each corner of the balance pan (or an equivalent 90° apart on a circular balance pan). The replicate weights must be within ± 0.007 mg of the certified mass for each replicate weight, unless an alternative tolerance is specified by the balance technician. The balance calibration is verified with no loading and at several masses across the balance's measurement range (e.g., 50, 100, 500, and 1000 mg), which must be within ± 0.003 mg of the certified mass value at each tested mass. If the balance is new or repaired, these functional tests will be completed prior to use of the balance for $PM_{2.5}$-PEP measurements. The balance technician should provide a certification report for the balance calibration and functional tests (which includes indication of whether adjustment was required or performed) and such reports are to be maintained in the laboratory records.

Certified weights employed for balance calibration checks and performing quarterly certified weight verifications will be certified minimally annually by a metrology laboratory as described in Section B7.1; however, will not undergo other testing.

Sensors for measuring and recording environmental conditions in the laboratory will be calibrated and the calibration verified periodically as described in Section B7.1.2.1. The weighing laboratory maintains a primary set of weighing laboratory/equilibration chamber environmental sensors as well as a backup set in the event the primary set is malfunctioning (this redundancy is to insure against data loss). The laboratory analyst will periodically compare the measurements from the primary and backup sensors to verify proper operation; however, no other formal functional checks or testing are performed.

LAs verify the operation of the HVAC system and the refrigeration storage units by examining the recorded data in addition to employing alarms on the systems that notify the primary LA and the laboratory manager when conditions fall outside of the required ranges.

B6.2 Instrument and Equipment Inspection

Routine inspection of equipment and components can be subdivided into laboratory and field areas.

B6.2.1 Inspection of Field Items

Several $PM_{2.5}$-PEP sampler components and filter cassette parts are subject to routine inspection, both in the quarterly maintenance events and in the field before and after the $PM_{2.5}$-PEP

sampling event. These are covered in detail in Section 7.5 of the $PM_{2.5}$-PEP Field SOP. Table B6-1 lists these inspections and their required frequency.

Table B6-1. Routine QC Inspections of $PM_{2.5}$-PEP Field Items

Field Item to Inspect	Inspection Frequency	Inspection Focus	Inspection Action	Documentation Requirement
Sampler downtube	Every sampling event	Presence of visible particulate on interior	Clean interior with a clean dry cloth	Document in logbook
WINS impactor well	Every sampling event (for samplers so equipped)	Presence of cone shape of particulate on impactor well	Replace impactor well filter and properly oil	Document in logbook [a]
Very sharp-cut cyclone (VSCC)	Every 10 sampling events or after a dust storm or heavy air pollution episode (for samplers so equipped)	Collection reservoir (grit pot) laden with particulate matter	Clean reservoir	Document in logbook [a]
Sampler rain collector	Every sampling event	Sufficient volume of condensation to pour	Empty rain collector	Document in logbook
Sampler flow path O-rings	Every sampling event	Damage or deformation	Replace o-rings	Document in logbook
Filter cassettes	After each sampling event	Presence of visible particulate matter	Check downtube and WINS impactor/ VSCC	Document in logbook
Cassette seals	Each sample	Seals are clean and smooth	Clean with a clean dry cloth or replace as needed	Document in logbook when replaced
Sampler backup battery	Every six months	Decrease in voltage and/or battery life	Replace battery	Document in logbook
Transfer standard battery	Every sampling event	Low battery condition	Replace battery as needed	Document in logbook

[a] Performance also to be documented in MoPED once deployed.

B6.2.2 Inspection of Laboratory Items

Table B6-2 details the parameters requiring inspection in the laboratory weighing room.

Table B6-2. Routine $PM_{2.5}$-PEP Weighing Laboratory Equipment Inspections

Item	Inspection Frequency	Inspection Focus	Inspection Action	Documentation Requirement
Weighing room temperature	Daily [a]	Temperature within 20°C to 23°C	1. Check HVAC system 2. Call service provider that holds maintenance agreement 3. Notify the $PM_{2.5}$-PEP Laboratory Manager	Document in logbook
Weighing room relative humidity	Daily [a]	Relative humidity within 30% to 40%	1. Check HVAC system 2. Call service provider that holds maintenance agreement 3. Notify the $PM_{2.5}$-PEP Laboratory Manager	Document in logbook
Dust in weighing room	Monthly	Dust must not be present (white glove test)	Clean weigh room	Document in logbook

[a] The currently employed sensors report continuously to a cloud storage site provided by Dickson Instruments. This cloud site user interface provides plots and tables of temperature and RH measurements and provides warnings when measurements fall outside user-assigned action levels.

B6.3 Equipment and Instrument Maintenance

This section describes the required maintenance activities for field and laboratory equipment including preventive maintenance.

B6.3.1 Field Equipment Maintenance

Table B6-3 details the appropriate maintenance checks of $PM_{2.5}$ samplers and their frequency. Section 7.5 of the $PM_{2.5}$-PEP Field SOP provides procedures for cleaning the field equipment.

Table B6-3. Field Maintenance for the $PM_{2.5}$-PEP

Frequency	Maintenance Item
Every 10 sampling events or as needed	1. Clean VSCC (for samplers so equipped)
Quarterly (every 3 months)	1. Clean sampler inlet surfaces 2. Clean first stage size-selective inlet (PM_{10} head) and condensate line 3. Clean impactor housing (if applicable) and impactor jet surfaces 4. Clean VSCC (for samplers so equipped) 5. Clean interior of sampler unit 6. Check condition of sampler transport containers 7. Clean sampler downtube 8. Inspect cooling air intake fan(s) and filter; replace if necessary 9. Inspect all o-rings, visible and hidden, and reapply vacuum grease as needed 10. Inspect vacuum tubing, tube fittings, and other connections to pump and electrical components; service if necessary

B6.3.2 Laboratory Equipment Maintenance

Maintenance of the environmental control system for the weighing room is handled through service agreements with an external vendor for the weighing laboratory's HVAC system. The HVAC service technician performs a functional check on the HVAC system quarterly, which involves checking system component voltages as well as refrigerant and/or compressor operational pressures. Note that the quarterly functional checks do not involve maintenance or checking of the thermostat or humidistat measurements. The weighing laboratory relies on the environmental monitoring probe measurements to signal out-of-tolerance conditions. Additionally, the weighing laboratory manager or designee will inspect the humidity canister on the HVAC system to ensure there is sufficient salt and water every six months and changes the HVAC HEPA filter minimally annually.

Similarly, maintenance for the microbalances is performed by an accredited vendor and is scheduled to occur at initial setup and minimally annually thereafter (this occurs currently every six (6) months). The service vendor can be called for a service visit if there is a problem with the microbalance that cannot be resolved within the laboratory. The laboratory maintains a spare microbalance for use if the primary microbalance is not meeting operational specifications.

The $PM_{2.5}$-PEP laboratory manager annually renews the service agreements for both the HVAC system and the microbalance. In the event either company's service agreement is not renewed, a new service provider is selected, and a contract put in place.

Table B6-4 details the weighing laboratory maintenance items and the required frequency.

EPA contractor(s) provide maintenance (e.g., backup) of network file shares used to store the weighing laboratory's PED or LIMS database, according to policies established by EPA's Office of Administration and Resource Management.

Table B6-4. $PM_{2.5}$-PEP Weighing Laboratory Maintenance Activities

Laboratory Maintenance Activity	Required Frequency
Perform functional check on HVAC system	Quarterly
Inspect HVAC system coolant levels and water and salt levels in humidity canister	Every 6 months
Clean balance table	Each day of use
Clean overall laboratory (dusting and organizing)	Monthly
Replace adhesive-coated floor mats	Weekly, or when soiled to a point of non-performance
HEPA filter change	Annually
Polonium-210 strip change	Every 6 months

Table B6-4. $PM_{2.5}$-PEP Weighing Laboratory Maintenance Activities (continued)

Laboratory Maintenance Activity	Required Frequency
Polonium-210 strip cleaning	Monthly, or more frequently if indicated by blank data
Clean microbalance	Every 6 months, staggered from vendor and service calibration
Service and calibrate microbalance	Annual (performed by vendor)
Backup PC connected to microbalance	Minimally weekly; automated daily backup preferred
Computer virus check	Weekly, with automated on-access scans and on-delivery e-mail scans
Filter weighing software database compaction	Checked monthly; compaction as needed to ensure sufficient hard drive storage space
Computer system preventive maintenance (e.g., archive files, compress hard drive, and ensure sufficient storage space	Annually

B7 Instrument Calibration and Frequency

This section describes the calibration and calibration verification procedures used for instruments generating field and laboratory measurements in the $PM_{2.5}$-PEP and certification of standards employed to calibrate and verify calibration of the instruments. Instruments that cannot be successfully calibrated will be repaired or replaced as practical. Following calibration (adjustment of instrument), calibration verifications are performed.

The $PM_{2.5}$-PEP FSs or LAs are to document calibration events in field/laboratory records and/or notebooks as indicated in the $PM_{2.5}$-PEP Field and Laboratory SOPs. Calibration records are appropriately filed using the AFC (under $PM_{2.5}$-PEP/301-093-006.6) or equivalent filing system (refer to Section A9).

B7.1 Laboratory Calibrations and Calibration Verifications

Standards for calibration and calibration verification of the laboratory balance, standard weights, temperature, and RH are required to undergo a NIST-traceable calibration certification every year.

B7.1.1 Microbalance Calibration

The microbalance employed in the $PM_{2.5}$-PEP weighing laboratory is calibrated minimally annually by a contracted service technician accredited to perform balance maintenance, adjustment, and calibration. The technician will verify the balance operation (as in Section B6.1) and calibration using NIST-traceably certified weights and will service the balance and adjust the calibration if function or calibration are shown to be out of tolerance. The microbalance is calibrated each day of use prior to use employing the internal calibration function of the microbalance (which employs weights installed internally to the balance by the manufacturer). Following a successful internal microbalance calibration (as indicated by the balance), the LA

verifies the balance calibration as described below in Section B7.1.1.1. Balance calibration and calibration verification requirements are summarized in Table B7-1.

Table B7-1. Microbalance Calibration Requirements for the $PM_{2.5}$-PEP

Activity	Frequency	Criteria	Procedure Summary
Calibration and Servicing	At least 2/year	Calibration check weights from approximately 0.050 to 1 g must be within ±0.003 mg	The authorized service provider performs servicing and calibration of the microbalance. The microbalance is tared and then a series of NIST-traceable calibration masses from approximately 0.05 to 1.0 g are weighed to verify calibration. If any weight is outside of ±0.003 mg, the technician adjusts the microbalance calibration.
Internal Calibration	Prior to each weighing session	Successful completion of internal self-calibration	LA activates the microbalance internal self-calibration procedure, which employs a standard 5-g weight. If procedure cannot be completed successfully, the LA will verify the microbalance is level and that the balance is stable before repeating internal calibration. If internal calibration cannot be successfully completed, perform an external calibration (reference laboratory SOP and microbalance user manual) and schedule servicing by a certified microbalance technician.
Calibration Verification	Following internal calibration at the beginning of each weighing session, after every 10 filter mass measurement, and concluding the weighing session	Within ±3 µg of the certified weight corrected for the apparent mass correction (C_w)	1. Check that the microbalance grounding cable is properly and securely connected. 2. Clean microbalance pan and draft shield with antistatic brush. If the calibration verification continues to fail, halt the weighing session, and perform maintenance/troubleshooting. Any filters weighed during the weigh session since the last passing calibration verification weight are to be re-weighed once the microbalance is operating within specification.

B7.1.1.1 Microbalance Calibration Verification and Standard Weights

Following successful internal self-calibration of the microbalance and at the beginning of each weighing session, the LA weighs two certified working standard weights to verify the balance calibration at the balance load mass range of use. One of these weights is then weighed periodically throughout the weighing session and concluding the weighing session.

The $PM_{2.5}$-PEP uses American Society for Testing and Materials (ASTM) Class 1 or Class 0 NIST-traceable standard weight sets (standard weights must bracket the expected weight of an un-exposed filter[15]) for its primary and secondary (working) standards. The weights weighed include a low and high mass, typically 300 mg and 500 mg, respectively, which covers the

[15] If the expected weight of an un-exposed filter is 375 mg, one standard weight must be less than 375 mg (e.g., 300 mg) and another greater than 375 mg (e.g., 500 mg).

anticipated filter weight of approximately 375 to 425 mg (additional or alternative weights will be weighed if filter masses are outside this typical range). The laboratory employs three weight sets for calibration verifications and assessments of balance operation, a primary weight set, a working weight set, and an independent assessment weight set.

Both working and primary standard weights are recertified annually against ASTM Level 00 or Level 0 mass standards at an International Organization for Standardization (ISO)-17025 accredited laboratory. Standard mass weights must be within ±10 µg of their certified value upon recertification.

- **Working standard weights** – The working standard weights are to be used for performing routine daily balance calibration verifications. On a quarterly basis, the certified mass of the low and high mass working standard weights is to be assigned by comparison with the primary standard weights following an apparent mass correction process (Section B7.1.1.2). To check for mass changes in the working standard weights, a double-substitution procedure is followed and an apparent mass correction of the working standard weight (Section B7.1.1.2), C_w, is calculated. This procedure involves repeated weighing of the working standard weight and corresponding primary standard weight.

- **Primary standard weights** – The primary weight set is the authoritative weight set employed to verify the tolerance of the working standard weights. The primary weights are reserved for this purpose and should only be used to verify the working standard weights or to verify balance calibration if the working standard weights are unavailable or suspected of being out of tolerance.

- **Independent assessment weights –** The independent assessment weights are reserved to periodically independently verify balance calibration. This weight set is certified by a metrology laboratory independent from that employed to certify the working and primary standard weights. Their use for independent assessment is detailed in Section C1.1.6.

As the weighing session progresses, the LA weighs one of the certified working standard weights after each 10 filter weights and at the conclusion of the weighing session. Each measurement of a working standard weight must show the balance reading is within ±3 µg of the assigned C_w, otherwise corrective action is necessary. Bracketing the beginning and end of the weighing session as well as interspersing the calibration verification checks throughout the weighing session demonstrates the balance was operating within tolerance throughout the weighing session.

If the working standard weight check fails the acceptance criterion at the beginning of a weighing session, corrective action may be as simple as allowing additional time for the microbalance to sufficiently warm up followed by repeating the microbalance internal calibration procedure. If the acceptance criterion is still not met when weighing the working standards, the LA will verify the working standards against the primary standards as in Section B7.1.1.2. If it is established that the microbalance does not meet acceptance criteria for both the working and primary standards and other troubleshooting techniques fail, then the service technician should be called to service the balance and the backup balance should be employed for weighing

sessions.

Filter weight measurements for which the temporally bracketing (prior to and following) working standard weight checks do not meet the acceptance criterion will not be accepted and will need to be reweighed with passing bracketing balance calibration verifications. The affected filters will remain in the conditioning environment to be reweighed once the microbalance meets the acceptance criteria.

B7.1.1.2 Apparent Mass Correction for Working Standard Weights

Prior to use and on a quarterly basis, the working standard weights will be compared to the primary standard weights to determine the apparent mass correction. Calculate the apparent mass correction, C_w, for each individual working standard weight by weighing both the working standard weight and the corresponding primary standard weight (e.g., both are nominally 250-mg weights). The procedure is described in detail in the Laboratory SOP and is summarized below for calculation purposes. Subsequent determinations of C_w are compared to the initial C_w and must be within ±2 µg of the initially determined C_w.

Perform and record stable mass measurements for the working standard and primary standard weight according to the following sequence:

1. working standard weight 1 (w_1)
2. primary standard weight 1 (p_1)
3. primary standard weight 2 (p_2)
4. working standard weight 2 (w_2)

Use the certified standard weight masses for the primary standard weight (C_p) and the nominal mass of the working standard weight (N_w) and primary standard weight (N_p) and determine C_w per the following formula:

$$C_w = C_p + \frac{(w_1 - p_1 + w_2 - p_2)}{2} + N_p - N_w$$

For example:

The LA weighs a 250-mg nominal working standard weight and primary standard weight. The primary standard weight certified mass is 250.0008 mg. The LA weighs records the following measured masses for the working standard weight and primary standard weight:

w_1 = 249.9994 mg
p_1 = 250.0001 mg
p_2 = 250.0006 mg
w_1 = 249.9995 mg

C_w is calculated as (all values in mg):

$$C_w = 250.0008 + \frac{(249.9994 - 250.0001 + 249.9995 - 250.0003)}{2} + 250 - 250 = \underline{\mathbf{249.9999\ mg}}$$

B7.1.2 Environmental Monitoring Instrument Calibrations

The PM2.5-PEP weighing laboratory utilizes temperature and RH probes connected to a data logger to continuously monitor and record environmental conditions within the weighing lab. The environmental monitoring probes are calibrated annually by an accredited metrology laboratory. The metrology laboratory will verify that the temperature and RH probe responses are within ±2°C and ±2% RH, respectively, at minimally two values bracketing the expected measurement range in the weighing laboratory room, approximately 20 to 30°C and 20 to 60% RH, respectively. If the tolerances are not met, the metrology laboratory will adjust the probe response to within these specifications. The laboratory will provide a certificate of calibration to the weighing laboratory for their records.

The weighing laboratory maintains five sets of environmental monitoring probes. Four of these sets are the same make and model that serve as the working probes and one is a different make and model and is maintained as the primary probe set to serve as a QC reference. The laboratory ensures two of the working probe sets are installed and functioning properly at all times where one of the two operating sets is assigned as the active working set and the other as the backup set. This redundancy ensures constant environmental conditions data collection and permits substitution from the backup in the event the active probe fails. The two sets of working probes that are not installed are maintained within calibration so they can be rotated into service when the active or backup probe sets are removed from service, typically toward the end of their valid calibration period.

B7.1.2.1 Environmental Monitoring Instrument Calibration Verification

The active and backup temperature and RH probe calibrations are verified quarterly by comparison to the primary probe set and must be within ± 2°C and ±2% RH, respectively, for the temperature and RH probes. Corrective action must be taken if these criteria are not met, which may include rotating in one of the reserved calibrated working probe sets. The LA and laboratory manager will evaluate the impact of the out of tolerance condition on filter equilibration and measured masses of filters since the most recent environmental probe acceptable calibration verification. Such corrective actions and data impact will be discussed with the weighing laboratory task monitor and may require elevation to the PM2.5-PEP OAQPS Lead depending on the scope of the data impacted.

B7.1.2.2 Refrigeration Unit Probe Monitor Calibration/Calibration Verification

The temperature probe employed for monitoring refrigerated storage units for sampled filters is to be within calibration when initially placed into service and the calibration verified quarterly by comparison to a temperature transfer standard at two temperatures bracketing 0 and 4°C (this may be performed by an accredited metrology laboratory). The measured temperature must be within ± 2°C at both of the tested temperatures. If this tolerance is exceeded, the temperature probe response is adjusted such that the probe response is within the defined tolerance. For tolerance exceedances, the LA and laboratory manager will assess the impact on the data for sampled filters stored in the refrigerated storage units since the most recent acceptable calibration verification. The data impact will be discussed with the weighing laboratory task monitor and may require elevation to the PM2.5-PEP OAQPS Lead depending on the scope of the

data impacted.

B7.1.2.3 Sample Shipment Thermometer Calibration/Calibration Verification

The infrared (IR) thermometer employed to measure temperatures of received sample shipments is calibrated when new and is sent to an accredited metrology laboratory annually for calibration/calibration verification. The thermometer must be within ±2°C of the temperature standard and the metrology laboratory will provide a certificate of calibration for the IR thermometer calibration for the laboratory records. Note that the calibration/calibration verification must cover the range of temperature use, which is approximately -10 to 30°C.

Table B7-2. Environmental Temperature and Relative Humidity Probe Calibration Requirements

Activity	Frequency	Criteria	Procedure Summary
Working active and backup environmental temperature probe calibration verification	Quarterly	± 2°C of NIST-traceable standard	Comparison of the working standard probes to the primary standard probes to verify calibration. If out of tolerance, assess impact on collected measurement data and on actively conditioning filters. Replace with properly functioning probe.
Working active and backup relative humidity probe calibration verification	Quarterly	± 2% RH of NIST-traceable standard	Comparison of the working standard probes to the primary standard probes to verify calibration. If out of tolerance, assess impact on collected measurement data and on actively conditioning filters. Replace with properly functioning probe.
Primary temperature probe calibration/calibration verification	Annually	± 2°C of NIST-traceable standard across measurement range	Calibration performed by metrology laboratory covering range of use, which must cover 10 to 35°C
Primary relative humidity probe calibration/calibration verification	Annually	± 2% RH of NIST-traceable standard across measurement range	Calibration performed by metrology laboratory covering range of use, which must cover 15 to 80% RH
Infrared thermo-meter calibration/calibration verification	Annually	± 2°C of NIST-traceable standard	Calibration performed by metrology laboratory covering range of use, which must cover -10 to 35°C
Refrigerated storage unit temperature probe calibration/calibration verification	Quarterly	± 2°C of NIST-traceable standard across measurement range	Calibration/calibration verification at minimally two temperatures covering range of use, which must cover -5 to 10°C. Alternatively may be performed by an accredited metrology laboratory.

B7.2 Field Sampler Calibration and Calibration Verification

The $PM_{2.5}$-PEP Field SOP provides details for corrective action for calibrations and calibration verifications. Field equipment calibrations and calibration verifications use NIST-traceable standards. In general, sampler calibration verifications must meet acceptance criteria before the sampler can be used for $PM_{2.5}$-PEP sampling events. Calibration verifications test the sampler in the as-is condition before changes to the instrument calibrations are made. In the event of a failed calibration verification, troubleshooting and corrective action occur, and the process is repeated or adjustments to the calibration are made. If an instrument cannot be calibrated, a replacement instrument is substituted, and the sampler is to be repaired.

The $PM_{2.5}$-PEP sampler is calibrated initially, annually thereafter, and upon failure to pass calibration verification checks listed in Section B7.2.2. The following sampler measurements are subject to calibration:

- Ambient and filter temperature measurements against the temperature transfer standard
- Barometric pressure measurement against the barometric pressure transfer standard
- Flow rate measurement against the flow transfer standard (after a successful leak test)
- Sampler clock against a known time standard.

The FS records the calibration in the field log or other appropriate record, detailing the transfer standards employed and their calibration dates.

When EPA successfully releases the MoPED system, all clock, pressure, temperature, leak check, and flow verification information will be recorded in MoPED. Calibration will also be documented in the MoPED system in the event of a failed verification check. MoPED will post an outcome record in AQS including the status of NIST-traceable calibration standards for flow, temperature, barometric pressure, and calibration certification records of all samplers. If a standard fails in the field or during its annual NIST certification test, it is removed from the list of available and properly functioning instruments contained in AQS. MoPED will not permit its use in the field, for quarterly audits, or for annual certification of samplers until it is repaired and shown to be within proper calibration and operation by a qualified metrology laboratory. Sampler performance and certification will be similarly tracked. Samplers must be certified as having passed a NIST traceable certification annually within 360 days of each event to which it is deployed.

B7.2.1 Field Instrument Calibration

The sampling unit comprises a flow controller, barometric pressure probe, ambient temperature probe, and filter position temperature probe that must be calibrated and these calibrations verified before each use (Section B7.2.2) by comparison to a certified transfer standard (typically a MesaLabs DeltaCal). FSs are to maintain two separate, independent, transfer standards and employ one for calibration establishment (the primary standard) and the other for calibration verifications (the working standard).

In general, sampler temperature, barometric pressure, and flow rate calibrations follow the general outline steps below:

1. Calibration evaluation in as-is condition:

    a. Verify using a primary or independent NIST-traceable standard reference instrument and evaluate against the calibration acceptance criteria in Table B7-3 (note these are more stringent than the calibration verification criteria). If criteria are exceeded recalibration per SOP is required.

    b. If the sampler meets the calibration acceptance criteria without adjustment, repeat the evaluation with the routine working transfer standard and evaluate against the calibration acceptance criteria. If criteria are exceeded recalibration per SOP is required.

    c. If the sampler meets the calibration acceptance criteria with both the primary transfer standard and working transfer standard, no adjustment is required. If the calibration acceptance criteria are exceeded, the sampler calibration must be adjusted (calibrated) with the primary calibration standard per the SOP.

2. Calibration adjustment

    a. Following calibration adjustment per SOP, repeat the process above in Step 1a through 1c to evaluate the calibration.

    b. If the instrument cannot be properly calibrated or evaluation acceptance criteria are not met, troubleshoot the cause and provide remedial solution (corrective actions are included in Table B7-3), which may involve consulting the manufacturer for technical assistance or repair.

Certified transfer standards are evaluated annually by an accredited NIST-traceable metrology laboratory to ensure the tolerances listed in Table B7-4 are met. The certifications are valid for 12 months from the date of certification. The metrology laboratory tests the transfer standard in as-received condition and will make adjustments to the calibration if the evaluation shows the standard to be out of tolerance.

The MoPED is designed to ensure that FSs do not use a transfer standard or sampler with an expired calibration or verification. It will issue reminders to users when equipment is nearing expiration of its calibration or verification. The MoPED system will not allow users to complete sampler setup if the certification period for the flowrate, temperature, and barometric pressure transfer standards has expired. The system will also not allow sampling event entries using a $PM_{2.5}$-PEP sampler that has not been calibrated within the previous 12 months with an independent transfer standard.

Table B7-3. Sampler Temperature, Barometric Pressure, and Flow Rate Calibration Evaluation Requirements

Activity Parameter	Frequency	Acceptance Criteria	Corrective Action Upon Criteria Failure
Single-point Temperature Probe (ambient and filter) Calibration Evaluation	Annually and after a failed calibration verification	± 1°C of transfer standard reading	Re-calibrate temperature probe per SOP. If re-calibration fails, troubleshoot the probe and its connection to the motherboard. Replace probe if necessary. Do not use sampler for $PM_{2.5}$-PEP sampling events until probes are calibrated and pass a single-point verification.
Single-point Barometric Pressure Calibration	Annually and after a failed single-point verification	± 5 mm Hg of transfer standard	Re-calibrate pressure sensor. If re-calibration fails, troubleshoot the sensor. Replace sensor if necessary. Do not use sampler for $PM_{2.5}$-PEP sampling events until the sensor is calibrated and passes a single-point verification.
Single-point Flow Rate Calibration	Annually and after a failed single-point verification	± 2% from transfer standard at the design flow rate (16.67 LPM)	Re-verify temperature and pressure calibration and re-verify system is leak free. Re-calibrate sampler flow rate. Do not use sampler for $PM_{2.5}$-PEP sampling events until the flow rate is calibrated and passes a single-point verification.

Table B7-4. Certification Requirements and Acceptance Criteria for Field Transfer Standards

Standard Parameter	Frequency of Recertification or Verification	Acceptance Criteria
Flow Rate	annually	± 2% of NIST-traceable standard
Thermometer	annually	± 1°C of NIST-traceable standard
Barometer	annually	± 5 mm Hg of NIST-traceable standard

Prior to calibration or calibration verification of the sampler temperature and/or barometric pressure sensor, the sampler is powered on for 30 to 60 minutes to allow the electronics to equilibrate to ambient conditions. The working standard is powered on for approximately one hour to allow for equilibration to local temperature and barometric pressure. More or less time may be required to reach this equilibrium and the FS should follow guidelines of the manufacturer in deviating from 1 hour.

B7.2.2 Field Instrument Calibration Verification

Upon assembly of the $PM_{2.5}$-PEP sampler, the FS powers on the sampler and allows it to warm up and acclimate to the ambient conditions at the site. Once sufficiently equilibrated, the FS will verify the calibration of the flow controller, barometric pressure probe, ambient temperature probe, and filter position temperature probe by comparison to a certified transfer standard. To ensure the flow controller references accurate temperature and barometric pressure readings, the

temperature and barometric pressure calibration verifications must be performed before the flow rate calibration verification.

Failure to meet the specified acceptance tolerances requires recalibration of the sampler slope and intercept for the failing parameter to match the certified transfer standard reading(s). Once the sampler calibration has been adjusted, the calibration verification checks must be repeated and meet the criteria listed above. If any of the three calibration verification checks cannot meet the specified criteria, the sampler may not be used for a $PM_{2.5}$-PEP event.

B7.2.2.1 Barometric Pressure Calibration Verification

Prior to each $PM_{2.5}$-PEP sampling event, the FS will perform a routine one-point calibration verification of the barometric pressure sensor by comparing the sampler's barometric pressure reading of the ambient barometric pressure to that measured by the certified working transfer standard. The sampler barometric pressure reading must be within ± 10 mmHg of the certified transfer standard or the sampler barometric pressure measurement system must be recalibrated.

If a re-calibration is necessary for a PQ200 sampler, a new one-point calibration curve is generated at ambient barometric pressure per the Field SOP.

B7.2.2.2 Temperature Sensors Calibration Verification

Prior to each $PM_{2.5}$-PEP sampling event, the FS will perform a routine one-point calibration verification of the ambient temperature sensor and the filter temperature sensor by comparing the sampler's temperature readings for these two probes to the certified working transfer standard. The sampler temperature readings must be within ± 2°C of the certified transfer standard or the sampler temperature sensor exceeding this criterion must be recalibrated.

If a re-calibration of either temperature probe is necessary for a PQ200 sampler, a new three-point calibration curve is generated at the home facility per the instructions in the Field SOP.

B7.2.2.3 Flow Rate Calibration Verification

As part of each $PM_{2.5}$-PEP sampling event, the FS implements a flow rate calibration verification with each setup. The flow rate check measures a sampler's normal operating flow rate using a certified flow rate transfer standard. The transfer standard flow rate and the corresponding flow rate indicated by the sampler are reported.

Accuracy of a single sampler—single check basis (d_i). The percent difference, d_i, for a single flow rate audit or verification, *i,* is calculated as follows (40 CFR Part 58, Appendix A, Equation 1):

$$d_i = \frac{Y_i - X_i}{X_i} \times 100\%$$

where X_i represents the transfer standard's flow rate (known) and Y_i represents the sampler's indicated flow rate (measured).

The single sampler flow rate verification is performed prior to each $PM_{2.5}$-PEP sampling event to ensure the sampler flow rate control is within calibration. The percent difference and the measured flow rate must meet the following acceptance criteria before completing the $PM_{2.5}$-PEP sampling event:

- Percent difference from the transfer standard's flow rate (d_i): ≤ ± 4%
- Measured flow rate: ≤ ± 4% from the design flow rate of 16.67 L/minute

The flow rate verification results are also used to calculate bias for the $PM_{2.5}$-PEP (discussed in Section B5.5), while the quarterly flow rate audits are used to evaluate sampler performance. Table A7-1 provides the audit acceptance criteria for the $PM_{2.5}$-PEP samplers.

During each $PM_{2.5}$-PEP sampling event setup, and after the leak check, or temperature and barometric pressure calibration verifications are performed on the $PM_{2.5}$-PEP sampler, the FS performs a one-point flow rate calibration verification using a NIST-traceable calibration standard. A successful leak check must precede a flow rate calibration verification, as a leak in the system will cause disagreement between the flow standard and the sampler-reported flow rate. A limited two-point or three-point temperature calibration can be performed in the field per the field SOP assuming the FS has a primary transfer standard.

B8 Inspection/Acceptance for Supplies and Consumables

The $PM_{2.5}$-PEP relies on various supplies and consumables that are critical to its operation and may directly or indirectly affect $PM_{2.5}$-PEP data quality. This section presents the system for inspecting, accepting, documenting, and tracking these supplies and consumables. By having documented inspection and acceptance criteria, consistency of the supplies can be ensured.

Forms relevant to this section are found in the $PM_{2.5}$-PEP Field and Laboratory SOPs, with examples placed at the end of this section. They include:

- Field/Laboratory Inventory Form (INV-01; Figure B8-1)
- Field/Laboratory Procurement Log Form (PRO-01; Figure B8-2)
- Field/Laboratory Equipment/Consumable Receiving Report Form (REC-01; Figure B8-3).

EPA is moving most forms and periodic reports to electronic/digital formats for storage. Electronic versions of the forms can be acquired from the National $PM_{2.5}$-PEP Lead at OAQPS.

B8.1 Critical Supplies and Consumables

This section describes the needed supplies for the $PM_{2.5}$-PEP and includes items for the weighing laboratory and the field. Generally, critical field and laboratory equipment has been selected by the $PM_{2.5}$-PEP organizers based on the required performance specifications of resolution, accuracy, and ease of use.

B8.1.1 Laboratory Supplies and Equipment

Table B8-1 lists the critical laboratory equipment in the $PM_{2.5}$-PEP. Equipment not deemed critical (affecting data quality) can be selected at the discretion of the $PM_{2.5}$-PEP Laboratory Manager. To maintain consistency in the $PM_{2.5}$-PEP, all consumables/equipment with a model number in Table B8-1 are purchased using the same model number, if available, as supplies are needed. The LA is required to keep an inventory of all equipment using the Field/Laboratory Inventory Form (INV-01; Figure B8-1).

Table B8-1. Weighing Laboratory Equipment and Supplies

Quantity	Units	Item	Preferred Vendor [a]	Model # [a]
2	Each	Microbalance	Sartorius	MC-5
2	Sets	ASTM Class 1 weights	Rice Lake Weighing Systems	11909
2	Each	Balance table	Thermo Fisher Scientific	HM019945
2	Each	Computer	Dell	
2	Each	Barcode reader		
1	Each	Relative humidity/temperature Weigh room probe	Vaisala	E-37510-02
1	Each	Relative humidity/temperature Weigh room probe	Dickson	15302225
2	Each	NIST-traceable thermometer sensor Primary	Dickson	15-041A
1	Each	Tacky mat plastic frame	Thermo Fisher Scientific	06-528A
1	Each	Uninterruptible power supply	Cole-Parmer	E-05158-60
1	Each	Refrigerator		
1	Each	Freezer		
1	Each	Sonicator bath		
2	Each	Antifatigue floor mat	Richmond	19-61-763
2	Each	Equilibration rack		
1	Each	Laser printer		
1	Each	Dehumidifier		
1	Each	Light table		
1	Each	Microsoft Access 2000 or later		077-00370
2	Each	SartoWedge software for microbalances	Sartorius	YSW01
1	Each	Barcode-printing software	Cole-Parmer	E-21190-10
24	Each	HVAC filters		
1	Case of 1,000	Powder-free antistatic gloves	Thermo Fisher Scientific	11-393-85A
12	Each	Polonium-210 strips	NRD	2U500
7	Pack of 100	Petri slides	Gelman	7231
1	Case of 12 bottles	Staticide	Cole-Parmer	E-33672-00
1	Case of 15 packs	Low-lint wipes (Kimwipes)	Kimberly-Clark	34155
1	Each	HVAC service contract		
1	Each	Microbalance service contract (two scheduled visits per year)	Sartorius	
1		Cleaning supplies		
2	Each	Worklon antistatic laboratory coats	Thermo Fisher Scientific	01-352-69B
2	Each	Forceps (stainless steel with plastic tips)	VWR	25672-100

Table B8-1. Weighing Laboratory Equipment and Supplies (continued)

Quantity	Units	Item	Preferred Vendor [a]	Model # [a]
1	Case	Antistatic 3" x 5" reclosable bags (for cassettes)	Consolidated Plastics	90202KH
1	Case of 1,000	Alcohol swipes	Thermo Fisher Scientific	14-819-2
20	Each	Coolers (6-pack size)		
4	Case of 24	Reusable U-Tek refrigerant packs (−1ºC)	Thermo Fisher Scientific	03-528B
1	Case	Antistatic 9" x 12" reclosable bags	Consolidated Plastics	90210KH
4	Each	Logbooks		
3	120 sheets	Hard surface tacky mat (moderate tack)	Thermo Fisher Scientific	06-527-2

[a] When a preferred vendor or model number is not specified, the purchaser can determine an acceptable unit.

As consumables run low or when new purchases are necessary, the LA is responsible for assisting in the procurement of these items following the policy and requirements described in the scope of work of the contract with the $PM_{2.5}$-PEP weighing laboratory. The LA should continue purchasing consumable equipment with the same model numbers as the equipment initially procured unless the $PM_{2.5}$-PEP Laboratory Manager suggests a different item due to improved quality, reduction in contamination, improved ease of use, unavailability, or lower cost (without sacrificing quality). Such changes should be approved by the $PM_{2.5}$-PEP Laboratory Task Monitor. Any unavoidable equipment changes that could affect the results of collected data will be reported to the OAQPS National $PM_{2.5}$-PEP Lead.

The LA performs the following procedures:

- Develop procurement requests as per EPA requirements.
- Upon order, add items to the Field/Laboratory Procurement Log Form (PRO-01).
- Once a month (or as needed), provide a copy of the PRO-01 to the $PM_{2.5}$-PEP Laboratory Manager and the Regional $PM_{2.5}$-PEP Lead.
- File PRO-01 under AFC “PEP/301-093-006.6.” or another acceptable/equivalent filing system.

B8.1.2 Field Equipment and Supplies

To ensure consistency and to meet the DQOs, OAQPS either directly purchases or facilitates purchases of all major capital equipment such as samplers and calibrator transfer standards. OAQPS consults with Regions on consumables for $PM_{2.5}$-PEP field activities. Table B8-2 lists these items; quantities are not given as they vary with the size of the field operation (i.e., number of $PM_{2.5}$-PEP samplers and sites). Initial quantities to procure are arranged with each Regional $PM_{2.5}$-PEP Lead. The FS is required to keep and inventory all equipment, including any warranty information.

Table B8-2. Field Equipment and Supplies

Qty.	$PM_{2.5}$-PEP Field Equipment and Supplies	Vendor/Catalog Number*	Make/Model Number*
	Monitoring Equipment and Supplies		
	Transport cases for loose equipment/consumables	Forestry Suppliers/31113	Collapsible crate
	Backpack frame for carrying samplers	Forestry Suppliers/35913	
	Portable FRM $PM_{2.5}$ sampler(s) with carrying case	Mesa Labs	BGI PQ200 (preferred)
	Very sharp cut cyclone (VSCC)	Mesa Labs	VSCCB
	WINS (if not using a VSCC)	Mesa Labs	Discontinued
	Pre-weighed 46.2-mm diameter filters in the proper cassette	Supplied by weighing lab	
	COC form for each filter cassette		
	Anti-static ziplock bags for shipping COCs and data storage media		
	Impactor oil and dropper (NOTE: Dow 704 has been found to solidify when sustained at 4°C for long periods.)	SPI Supplies	Octoil®-S (SPI Number 00031)
	Impactor filters (37-mm diameter glass fiber)	Mesa Labs (preferred)	
	Teflon-coated tweezers (for handling impactor filters)		
	Sample shipping containers (coolers)		
	Custody seals (tape or stickers)		
	Foam brick (ice substitutes), 36/box	Daigger	
	12-volt electric transport cooler with AC transformer (if used)	Globe Mart/5615-807	Coleman 16 quart
	Filter transport coolers (6 quart)		
	Bubble wrap		
	$PM_{2.5}$-PEP FRM Sampler Operations Manual		
	Field notebook(s)		
	Clipboard (8 inch' x 14 inch)		
	Grip binders		
	Data storage media (e.g., diskette, CD, or USB card)		
	Silicone grease for O-rings (e.g., vacuum grease)	Daigger/AX23061A	EF23061A
	FRM $PM_{2.5}$-PEP Field SOP (this document)		
	Laptop computer with PQ200 job-control software and MoPED software		
	Datatrans™ to download data (ideal for use in inclement weather)	Discontinued	Discontinued
	Cables for connecting the data-download device to the FRM sampler		
	Magnetic compass or other means of determining site orientation		
	Tape measure (metric)		
	Smart/cell phone		
	Global positioning system (GPS) device		
	Mechanical pencils and markers (indelible)		
	Mounting Equipment and Tools		
	Ladder and a rope for hoisting equipment		
	Hand truck/cart with wheels and straps for transporting equipment		
	Bubble level for checking the portable FRM sampler		
	Wooden shims or other means for leveling the FRM sampler		
	Toolbox with basic tools, including the following:		

Table B8-2. Field Equipment and Supplies (continued)

Qty.	$PM_{2.5}$-PEP Field Equipment and Supplies	Vendor/Catalog Number*	Make/Model Number*
	Allen wrenches (metric and standard)		
	Micro screwdriver set		
	Pliers (multiple sizes and types)		
	Screwdrivers (standard straight and Philips head)		
	Wire cutters		
	Small cinch ties		
	Electrical tape		
	Soldering gun/solder		
	Hemostat (for flow rate troubleshooting)		
	Flashlight with spare batteries		
	Heavy-duty, grounded, weatherproof electrical extension cord with multiple outlets (one 12 ft and one 25 ft length)		
	Tie-down cables, anchors, plywood sheet, and bungee cords to anchor and stabilize the portable FRM sampler and to dampen vibration (optional)		
	Masking tape Packaging tape Strapping tape		
	Calibration/Verification Standards and Related Equipment		
	Downtube flow rate adapter		
	Temperature, pressure, and flow verification device with external temperature probe	BGI deltaCal BGI Tri-Cal Alicat	DC-1 TC-12 FP-25
	Temperature verification/calibration standard (NIST-traceable) with probe (optional)	VWR	61220-601
	Styrofoam cup and deionized ice water for temperature calibrations		
	Flow-check filter in transport cassette		
	Impermeable “filter” disk for internal leak checks		
	Accurately set timepiece (cell phone)		
	Spare Parts and Optional Equipment		
	Spare O-rings for the portable FRM sampler		
	Spare batteries (for all battery-powered equipment)		
	Fuses, as required by all equipment used		
	Spare in-line filters (if required by the portable FRM sampler)		
	Voltmeter/ammeter/ohmmeter for troubleshooting		
	Spare impactor(s)		
	Ground fault circuit interrupter (GFCI) tester		
	Portable GFCI device		
	Camera (digital) for site pictures		
	Cleaning Supplies and Equipment		
	Lint-free laboratory wipes for cleaning WINS and other sampling equipment (e.g., Kimwipes)		
	Disposable paper towels		
	Large locking plastic bag for cleanup of debris, wipes		

Table B8-2. Field Equipment and Supplies (continued)

Qty.	$PM_{2.5}$-PEP Field Equipment and Supplies	Vendor/Catalog Number*	Make/Model Number*
	Soft brush		
	Supply of deionized water for cleaning and rinsing equipment		
	Isopropyl alcohol to aid in removal of grease and dirt		
	Alcohol wipes for preloading hand wipe		
	Penetrating oil (silicone oil or 3-in-1™)		
	Lint-free pipe cleaners		
	Safety pin/dental pick		
	Lint-free cotton-tipped swabs		
	Wooden dowel and cloth wads to clean downtube		
	Spray bottle		
	Disposable powder-free examination gloves (e.g., nitrile)		

* When no vendor/catalog number or make/model is specified in the above table, any vendor or make/model is acceptable. Unless specifically stated, other equivalent equipment and supplies from different vendor makes/models are acceptable

As consumables run low or when new equipment purchases are necessary, the FS is responsible for assisting in the procurement of these items following the policy and requirements described in the contractor scope of work. The FS should continue purchasing consumable equipment with the same model numbers as the equipment that was initially procured unless the Regional $PM_{2.5}$-PEP Lead suggests a different item because of its improved quality, reduction in contamination, increased ease of use, unavailability, or lower cost (without sacrificing quality). The Regional $PM_{2.5}$-PEP Lead will report any equipment changes that could affect the results of sampling events to the OAQPS $PM_{2.5}$-PEP Lead. The FS performs the following required procedures:

- Develop procurement requests as per EPA requirements.
- Upon order, add items to the Field/Laboratory Procurement Log Form (PRO-01).
- Once a month (or as needed), provide a copy of the PRO-01 to the Regional $PM_{2.5}$-PEP Lead.
- File PRO-01 under AFC "PEP/301-093-006.6" or other acceptable filing system.

B8.2 Acceptance Criteria on Equipment and Consumables

The $PM_{2.5}$-PEP's major pieces of capital equipment include the following:

Laboratory
- Microbalances
- Calibration equipment
- NIST-traceable mass standards
- Temperature recorder
- Relative humidity recorder

Field
- Portable samplers
- Calibration equipment

EPA has selected equipment and consumables for the $PM_{2.5}$-PEP based upon their advertised specifications on accuracy and resolution, but the program has over 20 years of operating experience, which also informs the selections. For example, the current fleet of $PM_{2.5}$-PEP portable samplers is built to FRM performance specifications and have a good track record of dependability and serviceability.

Upon receipt, new $PM_{2.5}$-PEP equipment is inspected and tested using calibration standards (see Section B7) to ensure they operate within their required performance parameters. All samplers undergo a break-in and shakedown (Section B6.1.1) to test major performance features, expectations, and any new attributes introduced by the manufacturer in model updates. All equipment is purchased under warranty and undergoes yearly calibration and certification as described in Section B7.

$PM_{2.5}$-PEP field and laboratory personnel use the Field/Laboratory Procurement Log Form (PRO-01) (Figure B8-1) to record the purchase and receipt of new equipment and consumables and to indicate whether these items were accepted or rejected upon receipt. In addition, the laboratory and field personnel use the Field/Laboratory Inventory Form (INV-01) (Figure B8-2) to list each equipment item and its warranty dates. These or equivalent forms can be produced and stored electronically.

B8.3 Tracking and Quality Verification of Supplies and Consumables

Tracking and quality verification of supplies and consumables meet two needs:

1) the need of the end user of the supply or consumable to have an item of the required quality, and
2) the need for the purchasing department to accurately track goods received so that payment or credit of invoices can be approved.

Upon receiving packages containing new supplies and consumables, the receiving personnel perform the following activities to address these needs:

- Perform a rudimentary inspection of the packages and note any obvious problems with a shipment, such as crushed or open/damaged box or wet cardboard.
- Obtain the appropriate purchase order(s) for the incoming items from office files.
- Complete a Field/Laboratory Equipment/Consumable Receiving Report Form (REC-01) (Figure B8-3), reconciling the received items and quantity against the purchase order and inspecting the condition of each received item.
- If the received items match the purchase order and the condition of the equipment or consumables is acceptable, record this finding on the form and file the form under AFC “PEP/301-093-006.6” or other acceptable filing system.
- If the quantity of received items does not match the purchase order or if the condition of the received items is not acceptable, complete REC-01 with remarks of these findings added and send a copy of the form to the Regional and National $PM_{2.5}$-PEP Leads. This information will be vetted among all the $PM_{2.5}$-PEP Leads and FSs. If the problem presents an imminent risk to program-wide data quality, a conference call will be

convened with the Regional $PM_{2.5}$-PEP QA Workgroup to present the problem and arrive at a program-wide solution.

Item	Model Number	Quantity	PO#	Vendor	Date		Cost	Initials	Accept/ Reject
					Ordered	Received			

Figure B8-1. Field/Laboratory Procurement Log Form (PRO-01)

Item	Vendor	Model Number	Quantity	Purchase Date	Warranty

Figure B8-2. Field/Laboratory Inventory Form (INV-01)

- Contact the vendor to report any problem with the package and/or contents.
- Add receipt information to the Field/Laboratory Procurement Log Form (PRO-01) and to the Field/Laboratory Inventory Form (INV-01).

In addition, any voice communication with vendors is transcribed onto a phone communication form and this record maintained.

Field/Laboratory Equipment/Consumable Receiving Report Form (REC-01) Date: _____				
Received From:				
Shipped From:				
Shipped Via:				
Shipping Charge	Prepaid	Collect	Freight Bill Number	
Purchase Order Number				
Quantity	Description of Item			Condition
Remarks:..... ..... Accept Shipment _____ .... Problem _____				
Notes:				

Figure B8-3. Field/Laboratory Equipment/Consumable Receiving Report Form (REC-01)

B9 Acquisition of Non-Direct Measurement Data

Most of the data used in the $PM_{2.5}$-PEP are direct measurements acquired by the FSs and LAs working for the $PM_{2.5}$-PEP as described in Sections B1 through B8. However, some data are obtained from sources outside the $PM_{2.5}$-PEP or data acquired within the PEP are to be judged as fit for use by the $PM_{2.5}$-PEP laboratory. An example of chemical data might be the composition of refrigerant foam in new generation cold temperature sealed refrigerant bricks. An example of monitoring data might be field blank data from the SLTs that own and operate the samplers and monitoring sites in the National $PM_{2.5}$ network. This section addresses data that are not obtained by direct measurement from $PM_{2.5}$-PEP maintained equipment or analysis methods. It also addresses quality issues related to the use of these non-direct data sources within the $PM_{2.5}$-PEP.

B9.1 Chemical and Physical Properties Data

Physical and chemical property data and conversion constants are often required when processing raw data into reporting units. This type of information, which was not specified in the monitoring regulations, is obtained for the $PM_{2.5}$-PEP from nationally and internationally recognized sources. Other data sources may be used with approval from the OAQPS $PM_{2.5}$-PEP Lead. The following information sources may be used in the $PM_{2.5}$-PEP without prior approval:

- NIST
- ASTM for certification of gravimetric balance verification and audit weights
- ISO, International Union of Pure and Applied Chemistry (IUPAC), American National Standards Institute (ANSI), and other widely recognized national and international standards organizations
- EPA published references, including:
    - *QA Handbook for Air Pollution Measurement Systems: "Volume II: Ambient Air Quality Monitoring Program" EPA-454/B-13-003, May 2013* - Full Document and subsequent revisions
- Standard handbooks including CRC Press' *Handbook of Chemistry and Physics* and *Lange's Handbook of Chemistry*.

B9.1.1 Equipment Manufacturers' Literature

Manufacturers' literature, which includes operations manuals and user manuals on specific equipment, provides important numerical information and equations to the $PM_{2.5}$-PEP. However, these information sources should be used with caution as certain information may contain some degree of error or may be of lower quality which could impact the quality of certain $PM_{2.5}$-PEP data. Examples include:

- Data containing insufficient precision
- Outdated values for physical constants

- Typographical errors
- Incorrectly specified units
- Inconsistent values within a manual
- Use of different reference conditions than those specified in EPA regulations.

Thus, appropriate cross-checks are needed to verify the reasonableness of information in these manuals. Whenever possible and during acceptance testing, the FSs compare physical and chemical constants in the operator's manuals to those given in the above information sources. If discrepancies are found, then the FS may raise these issues with the Regional $PM_{2.5}$-PEP Lead during $PM_{2.5}$-PEP QA Workgroup conference calls and recertification training sessions.

B9.1.2 Monitoring Site Information

When preparing for a $PM_{2.5}$-PEP sampling event at a monitoring site, the FS must rely on site-specific information provided by the Regional $PM_{2.5}$-PEP Lead or the SLT organization that operates the site and its permanent $PM_{2.5}$ samplers. This information includes the following:

- The name and AQS identifier of the PQAO responsible for the given site.
- The AQS site ID
- Type(s) of SLT-operated $PM_{2.5}$ sampler(s) at the site, their status, and sampler method designation(s)
- Information that distinguishes the primary monitor if multiple SLT site samplers exist
- Presence of any nearby contributors of airborne $PM_{2.5}$ and the proximity of these sources to the site
- General site information on $PM_{2.5}$ levels and trends, and meteorological information.

This information should be included in the site file which is stored in the Regional field office. Information on site location and presence of SLT-operated $PM_{2.5}$ samplers should be available in the AQS database for accuracy before proceeding to a site.

B9.1.3 Monitoring Measurement Databases

$PM_{2.5}$-PEP policy dictates that no data obtained from outside organizations shall be used in creating reportable data or published reports without prior approval from the OAQPS $PM_{2.5}$-PEP Lead. Requests to use such information may be made during the $PM_{2.5}$-PEP QA Workgroup conference calls or on an individual basis. This policy is intended to ensure the use of high-quality data in $PM_{2.5}$-PEP reporting.

Data from the EPA's AQS database may be included in published $PM_{2.5}$-PEP reports but with appropriate caution. Care must be taken in reviewing or using any data whose contents are flagged or otherwise qualified due to questionable quality or validity. If data are flagged within AQS, such data shall not be used unless it is clear that the data still meet critical QA/QC

requirements. Because it is impossible to assure that a database such as AQS is completely free from errors, including outliers and biases, caution and skepticism must be taken when comparing routine data from other reporting agencies as reported in the AQS. Thus, $PM_{2.5}$-PEP contributors must review available QA/QC information to assure that the external data are comparable with $PM_{2.5}$-PEP measurements and that the original data generator had an acceptable QA program in place. EPA presumes data reported by PQAOs to AQS are correct as the PQAO certifies that the data are correct when reported to the database.

B10 Data Management

B10.1 Background and Overview

This section describes the data management operations, including data recording, transformation, transmittal, reduction, validation, analysis, management, storage, and retrieval that pertain to $PM_{2.5}$ measurements for the $PM_{2.5}$-PEP. This includes an overview of the mathematical operations and analyses performed on raw ("as-collected") $PM_{2.5}$ data.

Each $PM_{2.5}$-PEP contributor (Section A4) is responsible for collecting quality compliant data from his/her area of influence and distributing the data to the appropriate participants, including OAQPS. Table B10-1 represents the data management structure for the $PM_{2.5}$-PEP.

EPA is in the process of completing a major change to the $PM_{2.5}$-PEP information management system. This system, illustrated in Figure B10-1, features the total separation of field and laboratory data until both are integrated (by $PM_{2.5}$-PEP sampling event) upon their independent upload to AQS (these data are stored within the QA module of AQS). FSs will record and upload field data to AQS via MoPED software installed on a tablet PC in the field while LAs in the $PM_{2.5}$-PEP weighing laboratory utilize the PED (or other implemented database) to upload laboratory gravimetric results to AQS.

Table B10-1. $PM_{2.5}$-PEP Data Collection Sources

Contributor	Type(s) of Data	Distribution
Regional $PM_{2.5}$-PEP Lead or PQAO $PM_{2.5}$-PEP coordinator	List of sites to participate in the performance evaluation for the target year AQS Site ID, POC (or other unique identifier to the primary sampler) and method code of the primary $PM_{2.5}$ sampler (Method code can be determined once sampler make and model are known.)	-To SLT monitoring organizations -To $PM_{2.5}$-PEP Regional Office Monitoring Program Contact(s) -To AQS. AQS is set up to provide each PQAO's $PM_{2.5}$-PEP history and target sites available each year

Table B10-1. $PM_{2.5}$-PEP Data Collection Sources (continued)

Contributor	Type(s) of Data	Distribution
$PM_{2.5}$-PEP Field Scientist	Data from operation of the $PM_{2.5}$-PEP sampler, including COC The sampling event download data Data from quarterly maintenance equipment performance checks, annual performance calibrations and certifications, and non-routine maintenance checks based on field performance	-Sampling event data to AQS -Sampling event download data currently goes to the $PM_{2.5}$-PEP weighing laboratory for storage in the PED. It will continue to be transferred to the new LIMS system when deployed and retrieved by a utility in AirQA for rapid identification and troubleshooting potential sampler issues -Historical data associated with performance checks and annual calibration/certifications has been stored at the FS offices or EPA Region; An AirQA utility will be constructed to host this data for identification and troubleshooting of sampler and calibrator issues
$PM_{2.5}$-PEP Laboratory	Mass concentrations for $PM_{2.5}$-PEP sampling events QA/AC data for laboratory weighing sessions	-To OAQPS QA Support Contractor
PQAOs	Routine $PM_{2.5}$ FRM and FEM monitoring data Monitoring site meta-data including latitude, longitude, and PM2.5 monitors operating at sites	-To AQS
OAQPS QA Support Contractor	Comprehensive Performance Evaluation Reports and $PM_{2.5}$-PEP QA/QC reports from data extracted from Lab's database and AQS Pre- and post-sampling filter mass, filter ID, analysis date	-To OAQPS $PM_{2.5}$-PEP Lead, EPA Regional Leads, and partnering SLT $PM_{2.5}$-PEP coordinators -Final Reports posted on AirQA and AMTIC -To AQS

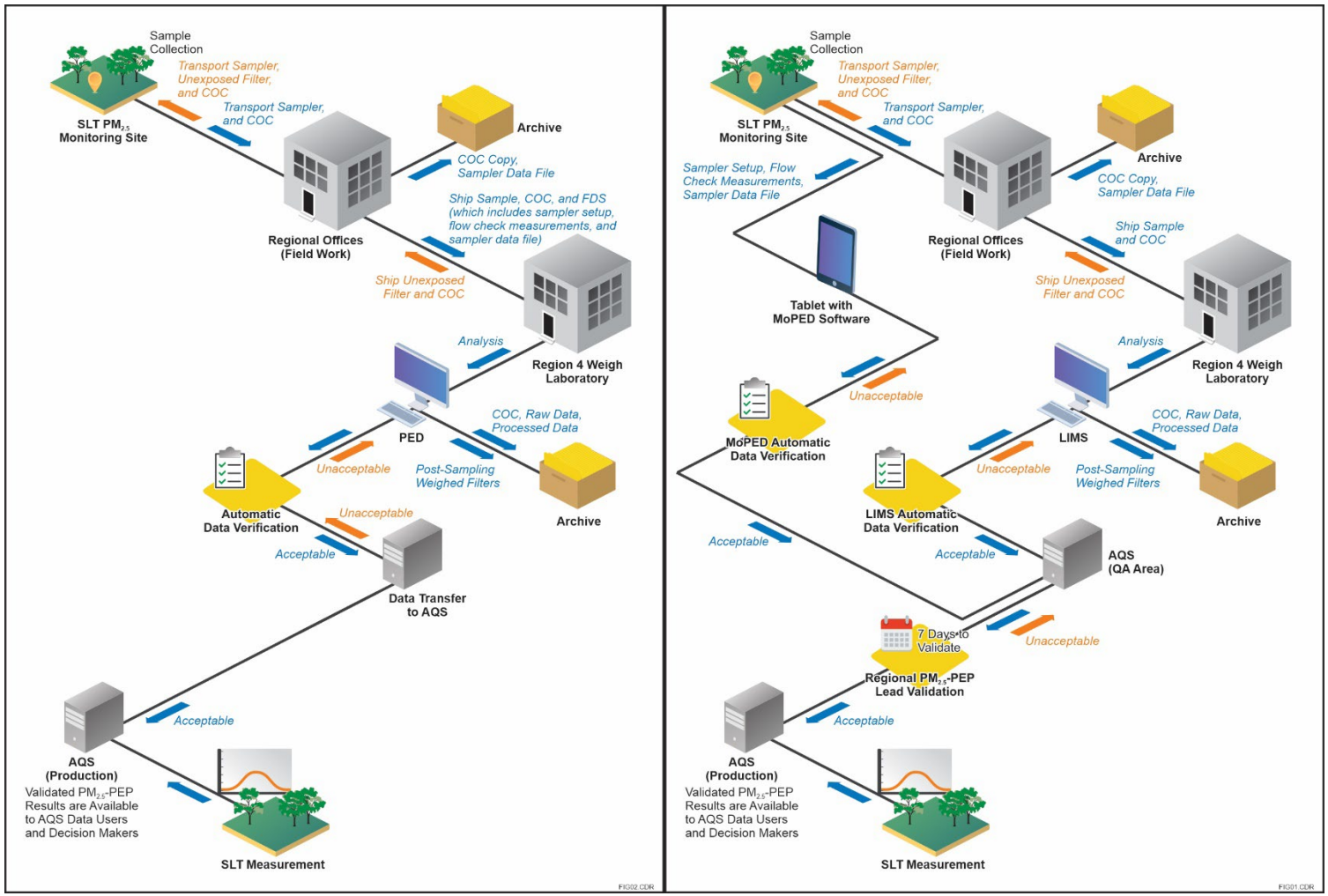


Figure B10-1. Overview of the $PM_{2.5}$-PEP information management system under the PED (left) and MoPED/LIMS paradigms (right; when available)

Under the PM2.5-PEP's new information management system, PM2.5-PEP sampling event data will be available to AQS users only when PM2.5 concentrations for both samples in a pair (PM2.5-PEP sampler and its collocated primary SLT routine sampler) are uploaded to AQS and matched/linked by AQS.

The OAQPS PM2.5-PEP Lead, Regional PM2.5-PEP Leads, and FSs (if granted access[16]) are encouraged to check the AirQA website (https://www.airqa.org) to track the status of PM2.5-PEP sampling event completion, calibrator certification status, sampler verification status, and other PM2.5-PEP metrics.

B10.1.1 Information Management Security

Access to data, applications, and reports on the AirQA website (https://www.airqa.org) is restricted to pre-registered personnel supporting the PEPs and requires a unique username and password for access. The PM2.5-PEP weighing laboratory maintains the PED (and its successor) on an EPA file share, and access is restricted to authorized laboratory personnel. PM2.5-PEP data can only be released from these two sources with written permission by the OAQPS PM2.5-PEP Lead. Data available on AQS are publicly available through AQS data access applications (e.g., the AQS Datamart) and are not otherwise controlled from access.

PM2.5-PEP measurements that have not been loaded into AQS should not be released. Only validated, approved data are loaded into AQS for public access. In addition, the PM2.5-PEP weighing laboratory archives all hard copies of weighing logs and routine back-up copies of the PED (or its LIMS successor) database. A comparison of the archived PED copies with the current version of the PED allows unauthorized or altered entries to be detected in the current PED/LIMS database.

B10.1.2 Field Data

At a given monitoring site, field data from a PM2.5-PEP sampling event originate from two sources: data generated by the PM2.5-PEP sampler and recorded by the FS and the coincident sampling event results from the SLT organization's primary PM2.5 sampler, which are only available upon that organization loading the data into AQS.

B10.1.2.1 PM2.5-PEP Sampler Data

Before departing for a PM2.5-PEP sampling event, the FS updates the COC by completing the appropriate filter information (routine PM2.5-PEP sample, field blank, or trip blank). The PM2.5-PEP sampler, once appropriately programmed, and field transfer standard provide all other required data. Data are downloaded to a portable PC upon recovery of the PM2.5-PEP sample filter. Currently, these data are transmitted to the laboratory via a USB flash drive along with a hard copy FDS.

[16] Membership to the AirQA website is private. Once an account registration has been submitted, the website administrator is notified, and the registration is subject to verification through the OAQPS PM2.5-PEP Lead and/or the Regional PM2.5-PEP Lead.

Before returning to the Regional field office (if possible), the FS updates the COC and FDS forms and ships the original hardcopy COC form and sample(s) to the $PM_{2.5}$-PEP weighing laboratory. On a monthly basis, FSs receive (via email) copies of the FDS data as it has been transferred into the PED for final verification. They are required to attest that the data correctly matches the FS's copies of the COC and FDS. Disparities must be reconciled and proper corrections to the FS's FDS or PED-generated FDS must be made.

When MoPED is activated the downloaded data files will be processed by the MoPED software, which will automatically extract the necessary information needed for upload to AQS. Additional information will be documented in a FDS stored in MoPED to supplement the information collected automatically. This electronic FDS will be also transmitted to the lab for storage in the successor to the PED, or possibly to a different database such as one maintained on the AIRQA website.

The $PM_{2.5}$ FRM samplers employed in the $PM_{2.5}$-PEP must comply with the data generation and format requirements in 40 CFR Part 50 Appendix L as listed below in Table B10-2.

Table B10-2. $PM_{2.5}$-PEP Field Sampler Measurement Recording Requirements

Information to be Provided	Appendix L Section Reference	Availability				Format	
		Anytime[a]	End of Period[b]	Visual Display[c]	Data Output[d]	Digital Reading[e]	Units
Flow rate polling, 30-second maximum interval	7.4.5.1	✓	—	✓	*	XX.X	L/min
Flow rate, average for the sample period	7.4.5.2	*	✓	*	✓	XX.X	L/min
Flow rate, coefficient of variation (CV) for the sample period	7.4.5.2	*	✓	*	✓ ●	XX.X	%
Flow rate, 5-minute average out of specification[f]	7.4.5.2	✓	✓	✓	✓ ●	On/off	-
Sample volume, total	7.4.5.2	*	✓	✓	✓ ●	XX.X	m^3
Temperature, ambient, 30-second interval	7.4.8	✓	—	✓	—	XX.X	°C
Temperature, ambient, minimum, maximum, average for the sample period	7.4.8	*	✓	✓	✓ ●	XX.X	°C
Barometric pressure, ambient, 30-second interval	7.4.9	✓	—	✓	—	XXX	mm Hg
Barometric pressure, ambient, minimum, maximum, average for the sample period	7.4.9	*	✓	✓	✓ ●	XXX	mm Hg
Filter temperature, 30-second interval	7.4.11	✓	—	✓	—	XX.X	°C

Table B10-2. PM2.5-PEP Field Sampler Measurement Recording Requirements (continued)

Information to be Provided	Appendix L Section Reference	Availability				Format	
		Anytime[a]	End of Period[b]	Visual Display[c]	Data Output[d]	Digital Reading[e]	Units
Filter temperature, differential, 30-minute interval, out of specification[f]	7.4.11	✱	✓	✓	✓ ●	On/off	-
Filter temperature, maximum differential from ambient, date, time of occurrence	7.4.11	✱	✱	✱	✱	X.X, YY/MM/DD HH:mm	°C, Yr/mo/day hr min
Date and time	7.4.12	✓	—	✓	—	YY/MM/DD HH:mm	Yr/mo/day hr min
Sample start and stop time settings	7.4.12	✓	✓	✓	✓	YY/MM/DD HH:mm	Yr/mo/day hr min
Sample period start time	7.4.12	—	✓	✓	✓ ●	YYYY/MM/ DD HH:mm	Yr/mo/day hr min
Elapsed sample time	7.4.13	✱	✓	✓	✓ ●	HH:mm	Hr min
Elapsed sample time out of specification[f]	7.4.13	—	✓	✓	✓ ●	On/off	
Power interruptions >1 min, start time of first 10 power interruptions	7.4.15.5	✱	✓	✱	✓	1HH:mm, 2HH:mm, etc.	Hr min
User-entered information, such as sampler and site identification	7.4.16	✓	✓	✓	✓ ●	As entered	-

✓ Provision of this information is required.
— Not applicable.
✱ Provision of this information is optional. If information related to the entire sample period is optionally provided before the end of the sample period, then the value provided should be the value calculated for the portion of the sampler period completed up to the time the information is provided.
● Indicates that this information is also required to be provided to the AQS database.
[a] Information must be available at any time the sampler is operating, whether it is sampling or not.
[b] Information relates to the entire sample collection period and must be provided following the end of the sample period until the operator manually resets the sampler or the sampler automatically resets itself upon the start of a new sample period.
[c] Information accessible from the instrument digital display.
[d] Information will be available as digital data at the sampler's data output port following the end of the sample period until the operator manually resets the sampler or the sampler automatically resets itself upon the start of a new sample period.
[e] Digital readings, both visual and data output, shall have no less than the number of significant digits and resolution specified in this table.
[f] Flag warnings may be displayed to the operator by a single-flag indicator or each flag may be displayed individually. Only a set (on) flag warning must be indicated; an unset (off) flag may be indicated by the absence of a flag warning. Sampler users should refer to Section 10.12 of Appendix L about the validity of samples for which the sampler provided an associated flag warning.

B10.1.2.2 SLT Organization's Primary PM2.5 Sampler Data

The SLT organization's primary $PM_{2.5}$ sampler at the monitoring site, whose data are used for determining $PM_{2.5}$ NAAQS attainment, is operated in accordance with its normal operational schedule. The organization's field operator acquires the data which are validated and reported to

AQS as detailed in the organization's QAPP and SOPs and available for matching with the $PM_{2.5}$-PEP measurement.

B10.1.3 Laboratory Data

Laboratory data used by the $PM_{2.5}$-PEP originate from the $PM_{2.5}$-PEP weighing laboratory (for $PM_{2.5}$-PEP sample data).

B10.1.3.1 $PM_{2.5}$-PEP Weighing Laboratory Data

The $PM_{2.5}$-PEP weighing laboratory weighs filters pre- and post-sampling according to the $PM_{2.5}$-PEP Laboratory SOP. The data acquired by the weighing laboratory are collected and validated as detailed in Section D1. Currently the $PM_{2.5}$-PEP event's validated ambient concentration data are extracted from the PED and uploaded to AQS by the OAQPS QA Support Contractor.

Upon activation of MoPED, the PED's successor will record the acquired sample mass data and validate the result based on:

- *Critical lab climate data*
- *Balance performance checks*
- *Laboratory blank and field blank data*
- *Any notification from the field that the sample is invalid based on field observations*

Data from the laboratory weighing sessions are extracted and electronically delivered to AQS via a browser-based upload tool.

B10.1.3.2 SLT Organization Laboratory Data

The SLT support $PM_{2.5}$ filter weighing laboratory operates in accordance with its own SOPs. The data acquired by the laboratory follows the normal path as detailed in the SLT governing QAPP and SOPs.

B10.2 Data Recording

Forms are available for those methods that generate information for use in the $PM_{2.5}$-PEP in which the data must be hand recorded. Table B10-3 lists these forms and their reference sources. Other data forms could be used for taking interim notes or for backup purposes, but any critical data must be captured through approved automated data capture processes.

Data are also captured electronically as recorded by the sampler while operating and within the laboratory through the PED as samples are logged in, temperatures of shipments are recorded, filter and standard weights are measured, and environmental conditions of the laboratory and refrigerated storage units are logged. These electronic data sources are recorded into or by computer and maintained electronically.

To minimize the chances of transcription and other clerical errors, OAQPS will be replacing the $PM_{2.5}$-PEP hard copy field data capture forms with the MoPED software. This software also verifies the field data and transmits the field data to AQS.

Table B10-3. List of $PM_{2.5}$-PEP data forms for critical data capture

Reference	Form Title
Laboratory SOP, Section 8	BAT-01 – $PM_{2.5}$-PEP Filter Weighing Data Entry Form
Laboratory SOP, Section 9	COC-01 – $PM_{2.5}$-PEP Chain-of-Custody Form†

† This COC form has undergone several formatting changes over the years. The current form is maintained by the OAQPS National $PM_{2.5}$-PEP Lead.

B10.3 Data Validation

Data validation represents a combination of confirming that data processing operations have been correctly performed and of monitoring the quality of the field and laboratory operations. Data validation can identify problems in either of these areas. Once problems are identified, the data can be corrected or invalidated, and corrective actions can be taken for field or laboratory operations. Numerical data stored in the $PM_{2.5}$-PEP weighing laboratory's PED (and its successor) are never internally overwritten by condition flags. Flags that denote error conditions or QA status are saved as separate fields in the database, so that the original data can be recovered. Appendix C (Validation Template used by the PED in the first level Validation Algorithm) presents a data validation template from the PED, which is currently used by the $PM_{2.5}$-PEP Laboratory Manager and EPA Laboratory Task Monitor to assist in validating data.

The PED application (named "PEDuser") provides the EPA $PM_{2.5}$-PEP Laboratory Lead with the validation checks necessary to enable a first level review and approval of the data for upload to AQS. The $PM_{2.5}$-PEP will continue to utilize the PED for data validation until MoPED is implemented.

> *The successful launch of the MoPED is dependent in part on the success of a new LIMS database application which can host the necessary data and generate a delimited data file with the necessary information that can be directly uploaded to AQS. Under the new paradigm, the laboratory will transfer gravimetric data from a LIMS-generated .csv file to AQS to be paired with the sampler run data (entered by the FS via MoPED) for calculating a $PM_{2.5}$ concentration within AQS. Regional $PM_{2.5}$-PEP Leads will have an opportunity to approve or invalidate results in AQS for 14 days. After 14 days, approval is assumed and AQS will post the data in tables for the respective PQAO's QA data (e.g., available in report AMP251).*

The following validation functions are performed with the data in the PED to ensure the quality of $PM_{2.5}$-PEP data:

- **100% data review.** Filter weight reports and COC forms are currently subjected to a 100% data review by the $PM_{2.5}$-PEP Laboratory Manager and the EPA $PM_{2.5}$-PEP Laboratory Task Monitor or designee reviews a representative amount of the filter concentration data each month. The EPA $PM_{2.5}$-PEP Laboratory Task Monitor has final approval authority on validated laboratory and FDS data.

- **Range checks.** The FS is responsible for identifying pre-event verification data and any logged sampler run-time data outside of specified ranges. For example, valid sample start

and stop times must be between 00:00 and 23:59. The FS also verifies the temperature range for the sample collection, which are typically between 10°C and 50°C in the summer.

- **Comprehensive data checks.** As data are processed, the data record must be comprehensive and complete. For example, each $PM_{2.5}$-PEP sampling event record must indicate a start time, an end time, an average flow rate, filter weigh dates, and operator and technician names.

- **Internal consistency and other reasonableness checks.** The data undergo internal consistency checks. For example, the end collection time of a filter sample event must be later than the collection start time. Computed filter volume (integrated flow) must be approximately equal to the exposure time multiplied by the average flow rate.

- **Data and sample filter retention.** The $PM_{2.5}$-PEP weighing laboratory will retain raw data records for a minimum of four (4) calendar years. These records must be readily available for audits and data verification activities. After four (4) years, the FS or LA may request instructions from the OAQPS $PM_{2.5}$-PEP Lead on the disposition of hard copy records and computer back-up media. The laboratory archives sample filters in cold storage through the end of the next full calendar year, and then at room temperature for three additional years. For example, the laboratory archives a filter sample collected on March 1, 2019, in cold storage until December 31, 2020, and then at room temperature until December 31, 2023.

  NOTE: The time frame for retention and disposition of Agency records is determined by EPA records schedules (see Section A9 Documentation and Records); however, records may need to be retained for longer periods. For example, some individual contracts may require a retention time longer than four (4) years, in which case the data/materials must be archived for this extended period before disposal.

- **Statistical data checks.** Errors found during statistical screening are traced back to original data entry files and to the raw data records, if necessary. These checks shall be conducted on a monthly schedule and before any data are submitted to AQS. Data verification is the process in which raw data are screened and assessed before acceptance by AQS.

- **Sample batch data validation.** Data collected in batches (e.g., a weighing session) are reviewed together due to their common QC practices. As such, data may be compromised within a batch and may therefore have flags applied to all samples in the batch.

- **Comparison of field blank and associated event result.** Historically, FB filter data occasionally (but rarely) have been incidentally transposed with the associated 24-hour $PM_{2.5}$-PEP sampling event data. A test can be devised to determine if the concentration results of two filters associated with the same sampling event fall into the historical ranges of 24-hour ambient samples for that particular site or the historical norms for field blanks. Such allows the laboratory manager to reasonably adjust the sample data in such cases where an exposed collected filter sample shows little or no mass accumulation, but

the associated FB shows mass accumulation commensurate with the typical ambient filter collection.

Table B10-4 summarizes the validation checks applicable to the $PM_{2.5}$-PEP data.

Table B10-4. Validation Check Summaries Used in the $PM_{2.5}$-PEP

Type of Data Check	Electronic Transmission & Storage	Manual Checks	Automated Checks
Data parity and transmission protocol checks	✓		
Data review		✓	✓
Date and time consistency		✓	✓
Completeness of required fields		✓	✓
Range checking			✓
Statistical outlier checking			✓
Manual inspection of charts and reports		✓	
Sample batch data validation		✓	✓

B10.4 Data Conversions

Calculations for transforming raw data from measured units to final concentrations are relatively straightforward. Formulas given in Table B10-5 pertain to $PM_{2.5}$ sampling and analysis.

Table B10-5. Raw Data Calculations in the $PM_{2.5}$-PEP

Parameter	Units	Type of Conversion	Equation
Sampler volume (V)*	m^3	Calculated from average flow rate (Q_{ave}) in L/min and total elapsed time (t) in minutes multiplied by the unit conversion (m^3 to L)	$V = Q_{ave} \times t \times 10^{-3}$
Gravimetric $PM_{2.5}$ mass on filter ($M_{2.5}$)	µg	Calculated from filter post-weight (M_f) in mg and filter pre-weight (M_i) in mg multiplied by the unit conversion (μg to mg)	$M_{2.5} = \left(M_f - M_i\right) \times 10^3$
$PM_{2.5}$ concentration	µg/m^3	Calculated from gravimetric $PM_{2.5}$ mass on filter and sampler volume	$PM_{2.5} = \frac{M_{2.5}}{V}$

* $PM_{2.5}$-PEP samplers compute this value from the integrated flow over the collection period.

B10.5 Data Transmittal

Data transmittal occurs when data are transferred from one person or location to another or when data are copied from one form to another. Examples of data transmittal are

1) Submission of downloaded instrument data files saved on a portable storage device (typically a USB-B flash drive) for subsequent upload into a data entry system, and

2) Transcription of raw data from a laptop or notebook into an electronic data entry system.

Table B10-6 summarizes data transfer operations.

Table B10-6. Data Transfer Operations

Description of Data Transfer	Originator	Recipient	QA Measures Applied
Capture of gravimetric data into the PED	LA	LA	100% review; representative amount checks by the $PM_{2.5}$-PEP Laboratory Task Monitor or designee
Electronic data transfer	Between computers or over network	–	Parity checking; transmission protocols
Unexposed filter receiving and COC forms	LA	FS	Filter IDs are verified upon receipt; LA checks data entry with 100% review
Exposed filter receiving and COC forms	FS	LA	Filter numbers are verified upon receipt; FS checks data entry with 100% review
Verification/calibration data	FS	FS	FS checks sampler pre-event verification entry and sampler event summary data with 100% review
Sample Event Collection Data	FS	Transcribed into PED by LA	100% review; representative amount checks by the $PM_{2.5}$-PEP Laboratory Task Monitor or designee
AQS data	FS and LA	AQS (EPA)	Data transfer is checked by the OAQPS QA Support Contractor

The $PM_{2.5}$-PEP reports all $PM_{2.5}$ ambient air quality data and information specified by the AQS Data Coding Manual in the required format for acceptance into AQS. These air quality data and information are fully screened and validated prior to direct submission to AQS via electronic (AQS formatted) transmission. These data are stored in a hidden QA data table of AQS until the result acquired from the SLT site's measured (primary sampler) value is posted in AQS by the SLT. Only then are the paired data posted to the production module within AQS and available for download via the AMP256 report. SLAMS and NCore sites are required to post their site data to AQS on the schedule shown in Table D3-1. This means that $PM_{2.5}$-PEP data are often not posted to the viewable production module of AQS until after the due dates in Table D3-1. In cases where the site data have been uploaded to AQS and validated on or before the due date, the $PM_{2.5}$-PEP sampling event data are also posted and viewable.

The successful activation of MoPED will replicate this process, but force compliance with the conventions as the data are recorded in MoPED or in the Lab's LIMS (the PED successor).

B10.6 Data Reduction and Data Integrity

Data-reduction processes involve aggregating and summarizing results so that they can be understood and interpreted in different ways. The $PM_{2.5}$ monitoring regulations require certain summary data to be computed and reported regularly to EPA, such as:

- Average $PM_{2.5}$ concentration

- Accuracy, bias, and precision statistics based on accumulated FRM/FEM data
- Data completeness reports based on the numbers of valid samples collected during a specified period.

Prior to deployment and following updates or changes, the electronic databases or systems employed to capture, reduce, calculate, and report data are to be properly validated and records o of this validation maintained. Such systems include databases or software systems (e.g., LIMS or MoPED) that serve to streamline and simplify data processing and data flagging regimes. Validation is performed by inputting data into the system and independently (either with a separate validated system or by hand calculation) the expected result is returned.

The integrity of $PM_{2.5}$-PEP data reduction can be verified by independent review of the data and algorithms used. Verification of data integrity requires that $PM_{2.5}$-PEP data be stored in a manner that permits any data modification to be detected. Detection of data changes is facilitated by the record-keeping requirements of the $PM_{2.5}$-PEP Laboratory SOP, which requires archiving of hard-copy records for important data (e.g., weighing session reports and sample COC forms). These archived records enable EPA to trace raw data used in $PM_{2.5}$-PEP sampling events to original raw data records.

In addition, the $PM_{2.5}$-PEP Laboratory SOP requires that the $PM_{2.5}$-PEP weighing laboratory archive regular copies of the PED (and database into read-only media and regularly stored at an off-site location. These archival database copies may also be used to evaluate data integrity and to verify that data from a specific $PM_{2.5}$-PEP sampling event matches the data on hard-copy records.

Data hand-transcribed (i.e., manually entered) into electronic systems are to be verified 100% and this verification documented.

B10.7 Data Analysis

The $PM_{2.5}$-PEP implements the data summary and analysis requirements contained in 40 CFR Part 58 Appendix A. Additional data analysis procedures may continue to evolve to meet the internal QA/QC needs of the $PM_{2.5}$-PEP. The following specific summary statistics are tracked and reported within the $PM_{2.5}$-PEP (primarily in the annual and 3-year QA reports):

- Single sampler bias (based on flow rate performance audits)
- Single sampler precision (based on collocated data)
- Network-wide bias and precision (based on collocated data, internal flow rate performance audits)
- Data completeness.

Table B10-7 lists the equations used in generating these summary statistics.

Table B10-7. PM2.5-PEP Data Summary Equations

Data Summary	Equation	Reference
Single sampler flow rate bias - single point check calculating percent difference (d_i), where X_i is the reference flow and Y_i is the measured flow	$d_i = \frac{Y_i - X_i}{X_i} \times 100$	40 CFR 58, Appendix A, Section 4.1.1
Network-wide $PM_{2.5}$-PEP flow rate bias - bias estimate, where *AB* and *AS* denote the mean and standard deviation, respectively, of the absolute value of the d_i (equation above) over the time period, n is the number of measurement pairs over the period, and $t_{0.95,n-1}$ is the 95th percentile of the Student-t distribution	$\lvert Bias\rvert = AB + t_{0.95,n-1} \times \frac{AS}{\sqrt{n}}$	40 CFR 58, Appendix A, Section 4.1.3
Network-wide sampler flow rate bias tendency – Assigning a sign (positive/negative) to the bias estimate	Calculate the 25th and 75th percentiles of the percent differences (d_i) for a given time period. Flag the bias estimate ($\lvert Bias\rvert$) as positive if both percentiles are positive and negative if both percentiles are negative	40 CFR 58, Appendix A, Section 4.1.3.1 and 4.1.3.2
Mean (AB) – the average bias	$AB = \frac{1}{n} \times \sum_{i=1}^{n} \lvert d_i\rvert$	40 CFR Part 58, Appendix A, Section 4.1.3
Standard deviation (A*S*)—An estimate of the variability of the average bias.	$AS = \sqrt{\frac{n \times \sum_{i=1}^{n} \lvert d_i\rvert^2 - (\sum_{i=1}^{n} \lvert d_i\rvert)^2}{n(n-1)}}$	40 CFR Part 58, Appendix A, Section 4.1.3
Single sampler precision - Relative percent difference ($RPD_{i,j,q}$) of a single collocation, where X_q and Y_i are concentrations from two collocated $PM_{2.5}$-PEP samplers	$RPD_{i,j,q} = \frac{Y_{i,q} - X_{j,q}}{(Y_i + X_j)/2} \times 100$	40 CFR 58, Appendix A, Section 4.2.1
Single sampler precision – Sampler (j) precision on the q^{th} day, where k is the number of pairs of collocated measurements from collocated samplers, and $X^2_{0.1,n-1}$ is the 10th percentile of a chi-squared distribution with k-1 degrees of freedom.	$CV_{j,q} = \sqrt{\frac{k \times \sum_{i \neq j} RPD_{i,j,q}^2 - (\sum_{i \neq j} RPD_{i,j,q})^2}{2k(k-1)}} \times \sqrt{\frac{k-1}{X^2_{0.1,k-1}}}$	40 CFR 58, Appendix A, Section 4.2.1
For $PM_{2.5}$-PEP Collocation studies only: Normalized percent differences ($NPD_{i,j,q}$) in concentration for each sampler pair (i,j) on the q^{th} sampling day - where $X_{i,q}$ and $Y_{j,q}$ represents the $PM_{2.5}$ concentrations for the paired samplers, and *mean* equals the mean concentration of all collocated samplers on the given study day	$NPD_{i,j,q} = \frac{\lvert Y_{j,q} - X_{i,q}\rvert}{mean} \times 100\%$	Section A5.4.1

Table B10-7. PM2.5-PEP Data Summary Equations (continued)

Data Summary	Equation	Reference
Completeness – $PM_{2.5}$-PEP completeness is assessed where: 1. N_{valid} only includes concentrations ≥ 3 µg/m^3, or 2. N_{valid} includes all concentrations for not-invalidated sample data regardless of concentration	$Completeness = \frac{N_{valid}}{N_{scheduled}} * 100$	Section A7.2

B10.8 Data Flagging—Sample Qualifiers

When field and/or laboratory data do not meet an acceptance criterion, the data are flagged in the PED. These PED flags consist of three alphanumeric characters that indicate the condition. For overall sample concentrations results for a given filter sample for which the data are compromised, one of the following three scenarios will apply:

- The sample did not produce a numeric result (a concentration cannot be calculated).
- The sample produced a valid numeric result, but the data are compromised in some fashion.
- The sample produced a numeric result, but a critical criterion has not been met and the result is not to be reported.

Qualifiers signify captured data that do not meet all acceptance criteria as may be due to contamination, special events, or failure of associated QC limits. The sampling instrument generates flags for operational deviations (refer to the instrument manual). Appendix F (Data Qualifiers/Flags) of this QAPP contains a complete list of data qualifiers for $PM_{2.5}$-PEP field and laboratory activities. LAs and the laboratory manager should reference the quality criteria in Tables D2-1, D2-2, and D2-3 when flagging laboratory data. The PED includes automatic flagging of sample data in some instances when established criteria are not met. The data validator considers these flags when determining data validity.

B10.9 Data Tracking

Table D3-1 listed the due dates for SLT organizations to post their routine $PM_{2.5}$ sample data to AQS. AQS pairs $PM_{2.5}$-PEP measurements and SLT measurements (assuming the $PM_{2.5}$-PEP measurements were previously uploaded via MoPED software) and therefore allows for the information to enter into bias calculations. If $PM_{2.5}$-PEP sample measurements are not available in AQS on the date given in Table D3-1, the data flow in Figure B10-1 can identify possible impediments to the data reporting. The annual QA reports include analyses to determine why $PM_{2.5}$-PEP event results are not in AQS.

If a $PM_{2.5}$-PEP measurement is posted to AQS, but its paired SLT sample measurement is not, the SLT routine laboratory can check its LIMS on the status of the data record containing that measurement. If the SLT routine laboratory has no record of the sample data, the SLT

organization's data flow should be investigated, and the Regional $PM_{2.5}$-PEP Lead and OAQPS $PM_{2.5}$-PEP Lead should be notified.

If the SLT sample measurement is posted to AQS, but the $PM_{2.5}$-PEP sample measurement has not, this could be due to one of the following reasons:

1. Validation of the $PM_{2.5}$-PEP sample measurement may be pending by the Regional $PM_{2.5}$-PEP Lead (or the PQAO's $PM_{2.5}$-PEP coordinator). The Regional $PM_{2.5}$-PEP Lead should be contacted within seven (7) days (when the validation time frame expires). If this time frame does expire, the $PM_{2.5}$-PEP Laboratory Manager and OAQPS $PM_{2.5}$-PEP Lead determine if the particular result is to be validated or invalidated. If validated, the result is made available for pairing with the appropriate SLT routine $PM_{2.5}$ measurement.

2. The $PM_{2.5}$-PEP sample data may not have been uploaded to AQS. The $PM_{2.5}$-PEP database (the PED or its LIMS successor) can be checked to verify the status of the sample data. Additionally, the QA contractor responsible for uploading data may have experienced errors when uploading the data to AQS.

3. The $PM_{2.5}$-PEP weighing laboratory data may have its validation step still pending or may not have been approved. The $PM_{2.5}$-PEP Laboratory Manager should be contacted to verify status.

4. The $PM_{2.5}$-PEP weighing laboratory may not have weighed the exposed filters. The $PM_{2.5}$-PEP Laboratory Task Monitor should be contacted whenever $PM_{2.5}$-PEP data appear to be missing. The Region 4 $PM_{2.5}$-PEP Lead can consult the LA and Laboratory Manager to resolve the status of the samples associated with the missing data. The PED, or its LIMS successor, will have a record of all pre- and post-sampling weighed filters. LAs also have access to the laboratory's archive, which contains original COCs, raw data, and processed data.

5. The $PM_{2.5}$-PEP filter sample may not have been shipped to the $PM_{2.5}$-PEP weighing laboratory, or the shipment could have been lost by the shipper. The FS routinely contacts the LA via e-mail to alert them to sample shipments. The shipper can confirm the delivery or actual misplacement of the filter samples. If confirmed to have been delivered, the LA will access the received shipment log and the PED (or its LIMS successor) to locate the records. LAs with access to the PED (or its LIMS successor) can generate one of the following tracking reports:

    - List of all filters that have been received but have not been analyzed
    - List of all filters analyzed
    - List of all filters in the filter archive
    - Ad hoc reports

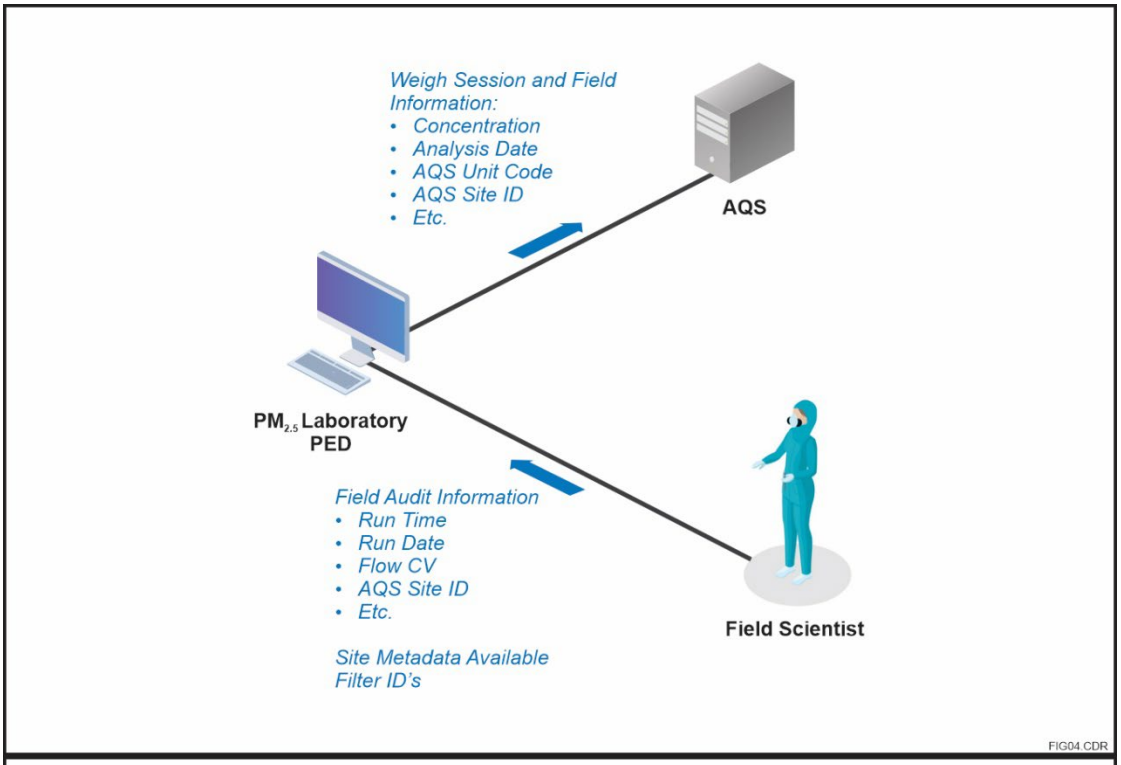
The $PM_{2.5}$-PEP Laboratory Manager or designee is responsible for tracking filter status at least twice per week and for following up on anomalies such as excessive holding time in the laboratory before reweighing.

Figure B10-2 illustrates the type of information exchange routes where data loss may occur.

B10.10 Data Storage and Retrieval

The $PM_{2.5}$ data reside on a Microsoft® Windows-compatible computer in the $PM_{2.5}$-PEP weighing laboratory that operates on the EPA's information system. The security of data in the PED (and its LIMS successor database) is ensured by using the following controls:

- Network security passwords for access to the project and database files
- Regular password changes (as specified by EPA network security)
- Storage of media, including back-up tapes in locked, restricted access areas.



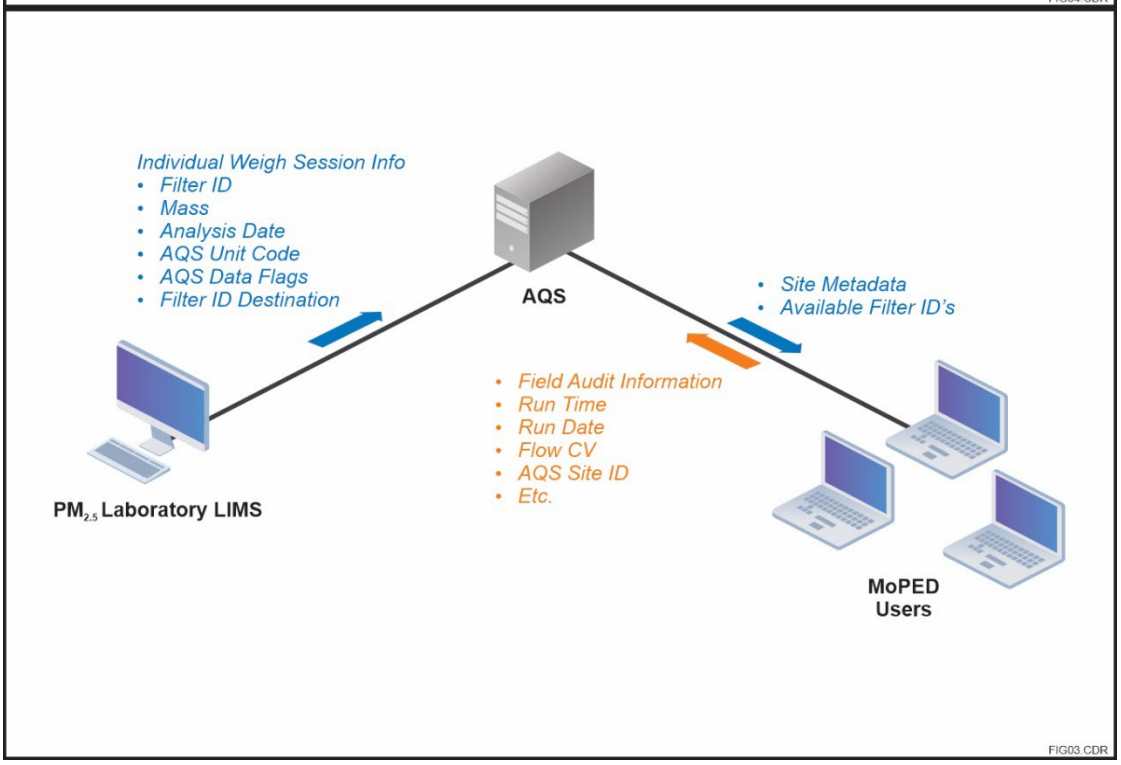


Figure B10-2. Information Exchange Routes between the PED and AQS (top) and the LIMS and MoPED (bottom; when available)

C Assessment and Oversight

C1 Assessments and Response Actions

This section is relative to the quality system implemented exclusively for the $PM_{2.5}$-PEP. For the purposes of this QAPP, an assessment is defined as an evaluation process used to measure the performance or effectiveness of the quality system and various measurement phases of the data operation.

The results of assessments indicate whether the QC efforts are adequate or need to be improved. Documentation of all QA and QC efforts implemented during the data collection, analysis, and reporting phases are important to data users and decision makers, who can then consider the impact of these control efforts on the data quality (see Section C2). Both qualitative and quantitative assessments of the effectiveness of these control efforts will identify those areas most likely to impact the data quality. Periodic assessments of $PM_{2.5}$-PEP data quality are required to be reported to OAQPS. However, the selection and extent of the QA and QC activities used by the $PM_{2.5}$-PEP depend on many local factors, such as the field and laboratory conditions, the objectives for monitoring, the level of the data quality needed, the expertise of assigned personnel, the cost of control procedures, and pollutant concentration levels.

To ensure the adequate performance of the quality system, OAQPS and the Regions implement an assessment program that utilizes the following:

- Limited MSRs
- Data quality assessments (DQAs)
- Audits of data quality (ADQs)
- TSAs
- Incidental surveillance by the National and Regional $PM_{2.5}$-PEP Leads
- Performance evaluations including laboratory round robin studies

C1.1 Assessment Activities and Project Planning

C1.1.1 Management Systems Review

An MSR is a qualitative assessment of data collection operations and/or organization(s) to establish whether the quality management structure, policies, practices, and procedures are adequate to ensure that the desired quality of data needed are met. A complete MSR would encompass more than just the implementation of the $PM_{2.5}$-PEP; consequently, OAQPS and the EPA Regional $PM_{2.5}$-PEP Leads will limit the scope of the MSRs and combine the activity with TSAs of the $PM_{2.5}$-PEP.

The following MSR elements will be incorporated into TSAs conducted at EPA Regional Offices and self-implementing SLT agencies:

- Procedures and criteria for designing and conducting audits.
- Tracking systems for assuring that the QA program is operating and that corrective actions disclosed by audits have been taken.
- The degree of management support.
- Responsibilities and roles of the QA Program Manager in the $PM_{2.5}$-PEP and authorities of the various line managers for carrying out the $PM_{2.5}$-PEP.

C1.1.2 Data Quality Assessments

The $PM_{2.5}$-PEP complies with DQOs established for the national $PM_{2.5}$ network run by SLT agencies. A DQA is a statistical analysis of environmental data used to determine whether the quality and quantity (i.e., completeness) of data is adequate to support a decision based on conformance to or compliance with the DQOs. DQAs are performed by the OAQPS $PM_{2.5}$-PEP Lead or designee (e.g., the OAQPS QA Support Contractor). Data are appropriate if the level of uncertainty is acceptable for the decision for which the data are collected. The DQA process is described in detail in *Guidance for the Data Quality Assessment Process* (EPA QA/G-9) [17]. A DQA takes the form of data summaries which are included as part of each $PM_{2.5}$-PEP Annual QA Report, discussed in Section C2. These summaries are based on data collected at the individual monitors/sites, but also aggregated at PQAO, Regional, laboratory, and national levels. Formal corrective actions are not expected from the DQA; however, Regional $PM_{2.5}$-PEP Leads may act upon information in the report where improvements are indicated.

DQAs include estimating measurement uncertainty. Measurement uncertainty includes completeness, accuracy, bias, and precision; these terms are found in 40 CFR Part 58, Appendix A and are defined in Section A7.2 of this QAPP.

C1.1.3 Audits of Data Quality

An ADQ examines not just the data used to determine monitor bias at the various levels of aggregation, but also the types of data used to reflect the efficacy of the $PM_{2.5}$-PEP's QC system. It reveals how data were handled, what judgments were made, and data handling or calculation problems or inconsistencies within examined data. ADQs can often identify the means to correct systematic data reduction errors. OAQPS performs ADQs annually as part of each laboratory and Regional TSA. Thus, sufficient time and effort is devoted to this activity so that the auditor or TSA team has a clear understanding and complete documentation of data flow. Pertinent ADQ questions appear on TSA checklists to ensure that the integrity of data collected at each stage are maintained. The ADQ serves as an effective framework for organizing the extensive amount of information gathered during the audit of laboratory, field monitoring, and support functions within the agency. The ADQ has the same reporting/corrective action requirements as the TSA**,** as described in the next subsection.

[17] Document available at: https://www.epa.gov/sites/default/files/2015-06/documents/g9-final.pdf

C1.1.4 Technical Systems Audit

A TSA is an evaluation of a data collection operation or organization to establish whether the policies, practices, and procedures are adequate for ensuring that the type and quality of data needed are obtained. TSAs are conducted on field and laboratory activities within both EPA Regions and PQAOs that self-implement $PM_{2.5}$-PEP activities and allow OAQPS to assess consistency of operation among the Regions and allow the Regions to understand the quality of the data they are producing with an overall objective to improve the quality system.

Comprehensive TSAs are performed by an individual assessor or a team of assessors. Key personnel interviewed in a TSA are those with responsibilities for planning, conducting field and/or laboratory activities, QA/QC, data management, and reporting. A TSA considers one or more of the following areas:

- **Field activities** - Filter receipt, instrument setup and calibration verifications, sampling, QA/QC, shipping, and record keeping

- **Laboratory activities** - Pre-sampling weighing, shipping, receiving, post-sampling weighing, archiving, and associated QA/QC

- **Data management activities** - Information collection, flagging, data review and validation, data security, and data reporting.

The following TSAs are to be performed within the $PM_{2.5}$-PEP:

- **Weighing Laboratory TSA**: OAQPS and/or a designee (e.g., national QA Support Contractor) performs a TSA of the $PM_{2.5}$-PEP weighing laboratory annually. Aspects of this TSA are shown on the left side of Figure C1-1.

- **Comprehensive Field TSA**: OAQPS and/or a designee (e.g., national QA Support Contractor) perform comprehensive TSAs with limited MSR elements (see Section C1.1.1) of Regional field operations on a "3-3-4" schedule (i.e., all Regional offices are audited every three years, with either three or four Regional offices audited each year such that all 10 Regions undergo audit every 3 years). This TSA supplants the need for a Regional $PM_{2.5}$-PEP Lead or designated auditor to perform a modified TSA (as described in following bullet) on their contractor and/or any self-implementing PQAO in the same year. Aspects of the field TSA are shown on the right side of Figure C1-1.

- **Modified Field TSAs**: Each Regional $PM_{2.5}$-PEP Lead performs a modified TSA in one of the two years not targeted for a 3-year comprehensive TSA (as described in previous bullet). The field operations for a self-implementing PQAO are also included in this requirement. The Regional $PM_{2.5}$-PEP Lead will focus their examination on QA performance data generated by the field operations and a review of management systems for both contractors and self-implementing PQAOs. These TSAs should include the observation of a sampling event performed by the contractors and/or self-implementing PQAO, which can be either a parking lot collocation event or a $PM_{2.5}$-PEP sampling event. Reviews of self-implementing PQAOs will include a check of their adequacy and independence criteria, which are identified in the *Adequacy and Independence Guidance*

for Agencies Who Self-implement the $PM_{2.5}$-PEP. An example of achieving adequate independence is the clear separation of the $PM_{2.5}$-PEP field operations from the PQAO monitoring network operations (as detailed in Figure A4-2).

Each of the above TSA types are guided by reports and checklists maintained by the OAQPS $PM_{2.5}$-PEP Lead. Additional resources include the oral and hands-on exam checklists used in $PM_{2.5}$-PEP training, as they provide a convenient guide for auditing field and laboratory operations performed by the Regional contractors. The OAQPS $PM_{2.5}$-PEP Lead maintain comprehensive TSA forms used for conducting TSAs of the weighing laboratory. These forms include evaluations of significant Regional EPA management/MSR elements and field assessments of their $PM_{2.5}$-PEP contractors. Modified TSAs must exclude the Regional $PM_{2.5}$-PEP management sections of the checklists since Regional $PM_{2.5}$-PEP Leads should not self-evaluate.

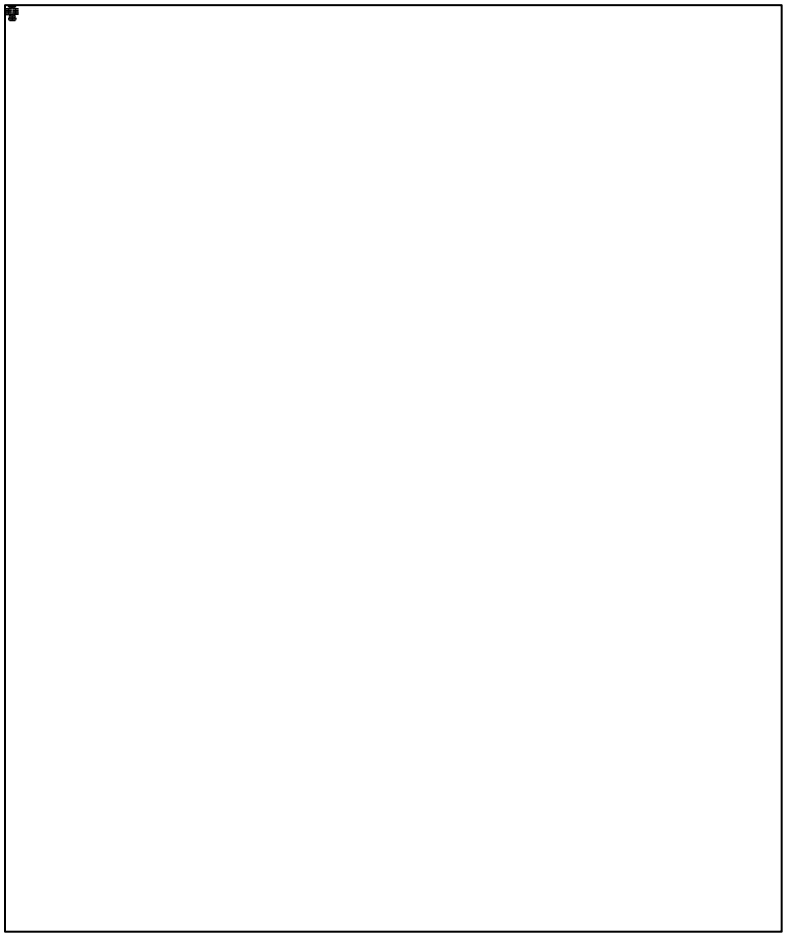


Figure C1-1. Overview of Technical Systems Audit Activities

The purpose in evaluating the FS(s) and self-implementing PQAO and management structure will be to document significant findings. If performance issues are identified prior to one of the mid-period assessments, the Regional $PM_{2.5}$-PEP Leads are encouraged to conduct a more thorough TSA.

Following a TSA, the assessor(s) prepare a comprehensive written summary of findings organized into the following areas: planning, field operations, laboratory operations, QA/QC, data management, and reporting. Problems found in specific areas are discussed, and they are ranked in order of their potential impact on data quality. Serious problems are summarized on an Assessment Finding Form (example shown in Figure C1-2).

Audit Title: _____

Audit Number: _____

Finding Number: _____

Audited Agency: _____

Finding:

Discussion:

QA Lead Signature: _____ Date: _____

Auditor Signature: _____ Date: _____

Figure C1-2. Example Assessment Finding Form

The Assessment Finding Form is completed for each major deficiency that requires formal corrective action and the assessor will include information such as the impact, estimated time period of deficiency, site(s) affected, and reason for action. The Assessment Finding Form notifies the laboratory or field office of serious problems that may compromise the quality of the data and therefore require specific corrective actions. If the assessed organization agrees with the finding, the form is signed by the $PM_{2.5}$-PEP contract organization during the TSA debriefing. If a disagreement occurs, the assessor(s) records the organization's opinions and sets a future time to address the finding. Completed Assessment Finding Forms are filed under the AFC heading "$PM_{2.5}$-PEP/108-025-01-01-237.1" or other acceptable filing system (see Section A9 *Documentation and Records*).

C1.1.4.1 Post-TSA Activities

Serving as the primary post-TSA activity, the TSA assessment report includes the following:

- Assessment title, number, and any other identifying information.
- Assessment team leaders, assessment team participants, and assessed participants.
- Background information, purpose and dates of the assessment, particular measurement phase or parameters assessed, and a brief description of the assessment process.
- Summary and conclusions of the assessment and corrective action required.
- Attachments or appendices that include all assessment evaluations and assessment finding forms.

To prepare the TSA assessment report, the TSA team meets and compares observations with collected documents and with interviews and discussions with key personnel. Expected QAPP implementation is compared with observed accomplishments and deficiencies, and the assessment findings are reviewed in detail. Within 30 calendar days of the completion of the assessment, the TSA team prepares a draft TSA assessment report and submits it to the appropriate personnel and is appropriately filed under the AFC heading "$PM_{2.5}$-PEP/108-025-01-01-237.1" or other acceptable filing system.

If the $PM_{2.5}$-PEP contract organization has written comments or questions pertaining to the TSA report, the TSA team reviews and incorporates them as appropriate and prepares and resubmits the report in final form within 30 days of receiving the written comments. The final TSA report includes an agreed-upon schedule for corrective action implementation.

C1.1.4.2 Follow-up and Corrective Action Requirements

The Regional office and FSs may work together to solve required corrective actions stated in the TSA report. As part of corrective action and follow-up, the assessed organization completes an Assessment Finding Response Form (Figure C1-3) for each Assessment Finding Form submitted by the TSA team. In addition, $PM_{2.5}$-PEP Contractors include corrective action in its monthly progress reports. The Assessment Finding Response Form is signed by the assessed organization and is sent to the Regional $PM_{2.5}$-PEP Lead, who reviews and accepts the corrective action. The

assessed organization completes the Assessment Finding Response Form within 30 days of acceptance of the TSA report. Assessment Finding Response Forms are filed under the AFC heading "$PM_{2.5}$-PEP/108-025-01-01-237.1" or other acceptable filing system.

Audit Title: _____

Audit Number: _____

Finding Number: _____

Finding:

Cause of the Problem:

Action Take of Planned for Correction:

Responsibilities and Timetable for the above actions:

Prepared by: _____ Date: _____

Signed by: _____ Date: _____

QA Division

Reviewed by: _____ Date: _____

Remarks:

Is this audit finding closed? _____ Date: _____

Figure C1-3. Assessment Finding Response Form

C1.1.5 Surveillance

Surveillance is defined as continual or frequent monitoring and verification of the status of an entity and the analysis of records to ensure that specified requirements are being fulfilled. Surveillance is similar to a TSA except that it serves as a more frequent review of certain important phases of the measurement system (i.e., calibrations and run setup) rather than a review of the entire implementation process. Because the $PM_{2.5}$-PEP has matured, surveillance is limited to specific issues that might be identified by OAQPS, the Regional $PM_{2.5}$-PEP Leads, or the $PM_{2.5}$-PEP Laboratory Manager. A Field or Lab Operations Surveillance Report Form (Figure C1-4) is used for documentation and filed under AFC heading "$PM_{2.5}$-PEP/108-025-01-01-237.1" or another acceptable filing system. $PM_{2.5}$-PEP is in a continuous process of creating host utilities on the AirQA website that record data sets that are determined to be useful in the Surveillance effort. An example would be $PM_{2.5}$-PEP annual completeness at the Regional and PQAO levels of aggregation. The AirQA website is updated monthly.

Reviewer: _____

Date of Review: _____

Personnel Reviewed: _____

Activity Monitored	Acceptable Performance	
	YES	NO

Notes:

Signature: _____ Date: _____

Figure C1-4. Field or Lab Operations Surveillance Report Form

C1.1.5.1 Overall Program Review of $PM_{2.5}$-PEP Data

The $PM_{2.5}$-PEP Laboratory Manager, Regional $PM_{2.5}$-PEP Leads, and the OAQPS $PM_{2.5}$-PEP Lead will review $PM_{2.5}$-PEP data on a periodic basis, no less frequently than annually. Such reviews will minimally involve review of routine laboratory QC data (e.g., balance calibration checks, laboratory blank data, and environmental control data), FB and TB data, and sample data that were invalidated. They will report significant issues related to $PM_{2.5}$-PEP operations to the $PM_{2.5}$-PEP Workgroup. These reviews occur after data are submitted to AQS, therefore do not impact the ongoing routine activities of the $PM_{2.5}$-PEP field and laboratory.

C1.1.6 Laboratory Performance Evaluation Audit and Round Robin Study

Per the direction of the $PM_{2.5}$-PEP OAQPS Lead, twice annually the weighing laboratory will undergo a performance evaluation (PE) audit. The PE will involve the LA and back-up LA weighing a modified standard weight(s) and/or a set of filters.

For the modified standard weights, the $PM_{2.5}$-PEP OAQPS Lead (or designee) will prepare one or more modified standard weights (i.e., remove a small portion of the standard weight) and determine the mass by comparison to primary standard weight (similar to the calculation performed for determining C_w in Section B7.1.1.2). The mass reported by the weighing laboratory must be within ±15 µg of the assigned mass.

For the set of filters, the $PM_{2.5}$-PEP OAQPS Lead (or designee) will prepare a set of two to four filters which are equilibrated in a suitable weighing laboratory and weighed for mass determination. The mass difference between each individual filter pairing will be determined (i.e., for two filters there will be one mass difference, for three filters there will be three mass differences, and for four filters there will be six mass differences) and will be the values against which the weighing laboratory is evaluated. While the overall absolute mass measurement of a given filter is expected to be potentially quite different due to moisture equilibration conditions and buoyancy effects, these effects are essentially equivalent for all filters, therefore the mass differences between filters are assumed constant regardless of moisture equilibration or buoyancy effects. The weighing laboratory reported mass differences must be within ±15 µg of the assigned mass differences for each filter pair evaluated.

OAQPS is in the process of restarting a national interlaboratory comparison of several $PM_{2.5}$ weighing laboratories, a round robin study in which a batch of filter samples and standard weights are exchanged between the laboratories for weighing and comparison.[18] The $PM_{2.5}$-PEP weighing laboratory is encouraged to participate in this study when made available on an approximate semi-annual basis, as a check on the performance of its equipment and activities of LAs. The laboratory measurements must meet the acceptance limit prescribed in the given study. If the $PM_{2.5}$-PEP filter weighing laboratory measurements display deviations in any of the weighing comparisons, the LA must inform the $PM_{2.5}$-PEP Laboratory Manager and the OAQPS $PM_{2.5}$-PEP Lead. The LA will immediately begin troubleshooting to investigate the discrepancy.

[18] OAQPS suspended the gravimetric round robin in 2018 due to a loss of personnel and funds. OAQPS is planning to restart the program in 2022. Until the round robin is reinstituted, OAQPS and its QA Support Contractor will prepare blind filter samples for a mini-performance test during the annual TSA of the $PM_{2.5}$-PEP gravimetric laboratory.

C1.1.7 Field Performance Audits

Field sampler calibrations and calibration verifications are to be assessed quarterly by performance of an audit of the sampler's temperature, barometric pressure, and flow rate readings against a transfer standard independent of those employed for calibration (the primary standard) or calibration verifications (the working standard). These performance audits are to meet the acceptance criteria for calibration verifications as described in Section B7.2.2 and summarized below in Table C1-1.

Table C1-1. Field Sampler Performance Audits

Assessment	Frequency	Acceptance Criteria	Reference
Sampler Flow Rate Audit	4/year (quarterly)	Percent difference within ±4% of transfer standard Percent difference within ± 4% of design flow (16.67 LPM)	Part 50, App. L, Sect. 9.2.5; $PM_{2.5}$-PEP Requirement
Barometric Pressure Audit	4/year (quarterly)	Within ± 10 mm Hg of transfer standard	Part 50, App. L, Sect. 7.4.9 and 9.3
Temperature Audit	4/year (quarterly)	Within ± 2°C of transfer standard	Part 50, App. L, Sect. 7.4.8 and 9.3

C1.2 Documentation of Assessments and Corrective Action

Assessments demonstrating out of tolerance or problematic conditions require corrective action and documentation of the assessment outcome and the corrective action. Corrective actions for typical field and laboratory out of tolerance conditions (e.g., calibration verification failures) are described in the respective SOPs. For systematic problems such as improper performance of an activity or unrealized error, the entity undergoing assessment will need to take corrective actions that are not readily prescribed.

The assessor will prepare a report on the outcome of the assessment and distribute the report to the appropriate parties. The party under review is generally responsible for following up on corrective actions stated in the report. The reports should clearly state the scope of the assessment, state any finding, and provide recommendations for improvement. The assessments to be conducted and the entity receiving the assessment report are summarized below in Table C1-2.

Table C1-2. Summary of Assessments

Assessment Type	Party Under Investigation	Assessment Frequency	Assessor	Report Due Date	Party Responsible for Resolution	Report Recipient [a]
DQAs	Regional $PM_{2.5}$-PEP offices	Annually	OAQPS and Regional $PM_{2.5}$-PEP Leads	120 days upon end of calendar year	Regional $PM_{2.5}$-PEP Lead	Regional $PM_{2.5}$-PEP offices
ADQs	$PM_{2.5}$-PEP weighing laboratory	Annually	OAQPS $PM_{2.5}$-PEP Lead or designee	30 days after the assessment	$PM_{2.5}$-PEP Laboratory Manager	$PM_{2.5}$-PEP weighing laboratory
	Regional $PM_{2.5}$-PEP offices	Annually	OAQPS $PM_{2.5}$-PEP Lead or designee	120 days upon end of calendar year	Regional $PM_{2.5}$-PEP Lead	Regional $PM_{2.5}$-PEP offices
TSAs	Regional $PM_{2.5}$-PEP Lead and PEP Contractor - Comprehensive	3-3-4 per yr (all Regions every 3 yr)	OAQPS $PM_{2.5}$-PEP Lead or designee	30 days after the TSA completion	Regional $PM_{2.5}$-PEP Lead and/or $PM_{2.5}$-PEP Contractor	Regional $PM_{2.5}$-PEP Lead and PEP Contractor
	$PM_{2.5}$-PEP Contractor FS - Modified	1 every 3 years; not same year as comprehensive TSA	Regional $PM_{2.5}$-PEP Lead or designee	30 days after the TSA completion	$PM_{2.5}$-PEP Contractor	$PM_{2.5}$-PEP Contractor FS and OAQPS $PM_{2.5}$-PEP Lead
	$PM_{2.5}$-PEP weighing laboratory	Annually	OAQPS $PM_{2.5}$-PEP Lead or designee	30 days after the TSA completion	$PM_{2.5}$-PEP Laboratory Manager	$PM_{2.5}$-PEP weighing laboratory
	Self-Implementing PQAO FS - Modified	1 every 3 years; not same year as comprehensive TSA	Regional $PM_{2.5}$-PEP Lead or designee	30 days after the TSA completion	SLT $PM_{2.5}$-PEP coordinator	Self-Implementing PQAO FS and OAQPS $PM_{2.5}$-PEP Lead
PE or Round Robin Study	$PM_{2.5}$-PEP weighing laboratory	Recommended Semi-Annually	OAQPS	30 days after the assessment	LA and Laboratory Manager	$PM_{2.5}$-PEP LA, Laboratory Manager, and Laboratory Task Monitor
Surveillance	Various	As needed	OAQPS and/or Regional $PM_{2.5}$-PEP Lead	30 days after the assessment	Party surveilled	Party surveilled and party responsible for

[a] OAQPS $PM_{2.5}$-PEP Lead is to be included on all reporting unless they originated the report.

C2 Communication Framework and Reports to Management

This section describes the quality-related reports and communications to management necessary to support the $PM_{2.5}$-PEP.

Effective communication among all personnel is an integral part of a quality system. Regular, planned quality reporting provides a means for tracking the following:

- Adherence to scheduled delivery of equipment, data, and reports

- Documentation of deviations from approved QA and SOPs and the impact of these deviations on data quality
- Analysis of the potential uncertainties in decisions based on the data.

C2.1 Communication

An organized communications framework facilitates the flow of information among the participating organizations and other users of the information produced by the $PM_{2.5}$-PEP. Figure C2-1 represents the principal communication pathways.

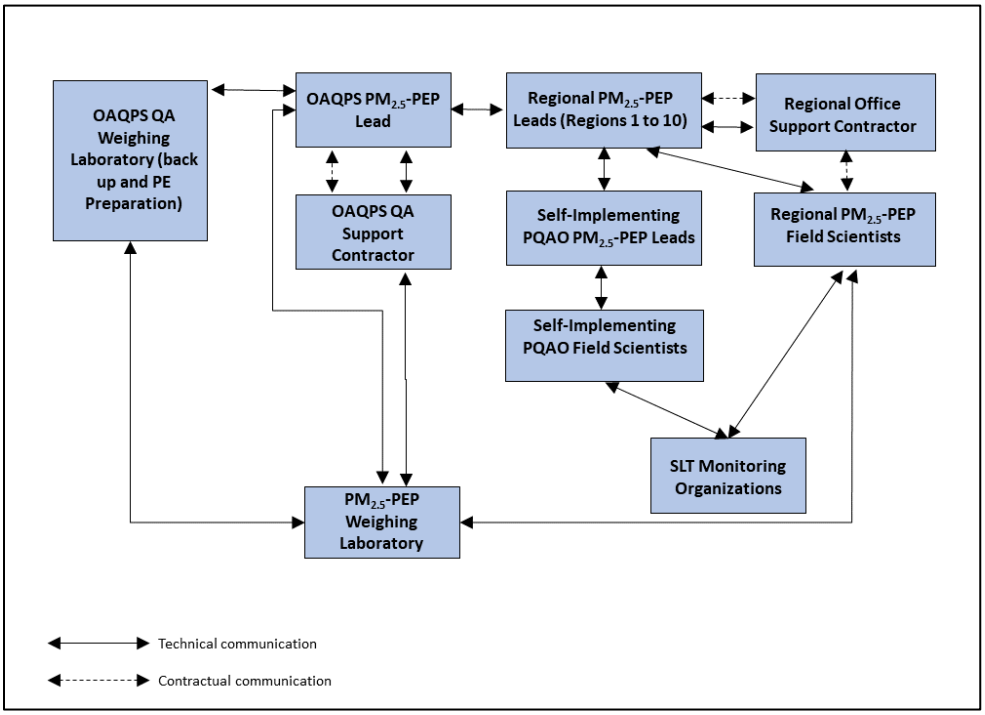


Figure C2-1. $PM_{2.5}$-PEP Lines of Communication

In general, LAs and FSs are responsible for informing the $PM_{2.5}$-PEP Laboratory Task Monitor and the Regional $PM_{2.5}$-PEP Lead, respectively, about technical progress, issues, and contractual obligations. On the technical side, the Regional $PM_{2.5}$-PEP Lead(s) are responsible for communicating with SLT organizations and for informing the OAQPS $PM_{2.5}$-PEP Lead and the $PM_{2.5}$-PEP Laboratory Manager about issues that require technical attention. Table C2-1 lists key communication networks in the $PM_{2.5}$-PEP.

The FSs communicate with the $PM_{2.5}$-PEP weighing laboratory and the Regional $PM_{2.5}$-PEP Leads on the progress of their activities and any problems and issues associated with them. Resolution of these issues should take place in the Regions unless the issue could affect the implementation of the $PM_{2.5}$-PEP at a national level. In those cases, it can be discussed and resolved through the communications between the OAQPS $PM_{2.5}$-PEP Lead, the Regional $PM_{2.5}$-PEP Leads, and, if needed, the affected contract officers.

Clear and effective communication among $PM_{2.5}$-PEP participants is critical to program success. The $PM_{2.5}$-PEP Field SOP and $PM_{2.5}$-PEP Laboratory SOP contain additional information and procedures for communication and documenting this information.

Table C2-1. Communication Pathways in the $PM_{2.5}$-PEP

Person	Communicates to	Primary Communication Topics
$PM_{2.5}$-PEP Laboratory Manager	Regional $PM_{2.5}$-PEP Lead or Self-Implementing PQAO Lead	Notification of availability of gravimetric and FDS data for verification by FS. Lab schedule changes or conditions in the lab that affect availability of tared filters Alerts when there is an apparent departure by the FS from the Field SOP that has a negative impact on Laboratory support
	OAQPS $PM_{2.5}$-PEP Lead	Request filter supply replenishments Corrective actions Technical Changes to equipment Funding and resource needs Problems and issues Program improvements
Regional $PM_{2.5}$-PEP Lead or Self-Implementing PQAO Lead [a]	$PM_{2.5}$-PEP Laboratory Manager [a]	Request tared filters [a]
	OAQPS $PM_{2.5}$-PEP Lead	Funding and resource needs Problems and issues Program improvements
	FS	$PM_{2.5}$-PEP sampling event site selection and scheduling Problems and issues Audit scheduling and follow-up Corrective action for field activities
LA [b]	$PM_{2.5}$-PEP Laboratory Manager and $PM_{2.5}$-PEP Laboratory Task Monitor	Laboratory progress Problems and issues Program improvements Scheduling
	FS	Out-going filter/equipment shipment Filter shipment receipt from field Field procedure issues
	OAQPS $PM_{2.5}$-PEP Lead or OAQPS QA Support Contractor	Database management and AQS uploads Problems and issues
FS	LA	Filter shipment from field Significant recovery schedule changes that could affect the weighing schedule Field data verification
FS	SLT organization representative (for sites hosting a $PM_{2.5}$-PEP sampling event)	Arrange scheduling, plan logistics, and obtain access for sampling event. Note any schedule delays or safety concerns, plans for rescheduling

Table C2-1. Communication Pathways in the $PM_{2.5}$-PEP (continued)

Person	Communicates to	Primary Communication Topics
OAQPS $PM_{2.5}$-PEP Lead or designee	Regional $PM_{2.5}$-PEP Leads	Requests reviews of $PM_{2.5}$-PEP COC and field data to verify accuracy or troubleshoot failed uploads to AQS Data quality and management issues Audit assistance Findings of concern in TSAs or Regional Lead's reports of data reviews and reviews of self-implementing PQAO $PM_{2.5}$-PEP
OAQPS $PM_{2.5}$-PEP Lead	Regional $PM_{2.5}$-PEP Leads or Self-Implementing PQAO Lead	Funding and resource needs Contract performance issues Program information dissemination Training information

Note: Regional $PM_{2.5}$-PEP Leads also include $PM_{2.5}$-PEP coordinators from self-implementing PQAOs.
[a] This exchange generally occurs between the FS and LA.
[b] LA refers to the Lab Analyst, but this may include participation by the Region 4 Contract Team leader who oversees the LA and $PM_{2.5}$-PEP Field Activity.

C2.1.1 Field Communication

$PM_{2.5}$-PEP-related communication is to be logged. Field communications can take place by phone or e-mail. Important phone messages or conversations are recorded on either the Phone Communication Form (COM-1; Appendix C of the $PM_{2.5}$-PEP Field SOP) or e-mail, provided it contains the same information, and stored in the field notebook. Notes include the following:

- Date
- Time
- Personnel involved
- Issue(s)
- Decision(s)
- Follow-up action(s)
- Follow-up action responsibility
- Follow-up action completed by (date).

If follow-up action is required by the FS, then these actions are included in the monthly progress reports (see Section C2.2.1). At a minimum, the FS will keep the original hardcopy in the field notebook or in electronic record maintained on a PC.

Field communication between the FS and the Regional $PM_{2.5}$-PEP Lead may be required. These can occur via cellular phone. The Regional $PM_{2.5}$-PEP Lead should also identify alternates to receive field communications when they are not in the office

C2.1.1.1 Requesting and Receipt of Filter Shipments

Upon request from the FS, the LA ships filters to the field offices, provided that the request is submitted a minimum of two weeks in advance of need by the FS (no later than Thursday). Advance notice of requests is required to allow the LA to begin pre-sample equilibration on Friday and pre-weighing can begin the following week.

On the day of receipt, the FS will contact the LA indicating the filters have been received. In the event the order is incorrect, the following information is provided to the LA:

- Date of receipt
- Number of filter cassettes in shipment
- Number of filter cassettes requested
- Number of boxes in shipment
- Tracking number.

C2.1.1.2 Shipping Coolers and Freezer Bricks

On approximately a monthly basis, the $PM_{2.5}$-PEP weighing laboratory ships coolers and freezer bricks (ice substitutes) to the FSs' field offices. On the day of receipt, the FS will contact the LA indicating the equipment has been received. In the event the order is incorrect, the following information is provided to the LA:

- Date of shipment
- Tracking number
- Number of boxes with freezer bricks in shipment
- Number of additional shipping boxes requested
- Number of additional freezer bricks requested

C2.1.1.3 $PM_{2.5}$-PEP Conference Calls

There may be occasions when the FS needs to communicate with the EPA Regional $PM_{2.5}$-PEP Lead due to a unique situation that exists or has developed in conjunction with a $PM_{2.5}$-PEP sampling event. During this call, the FS uses the Phone Communication Form (COM-1) to record issues and action items that pertain to their activities. It is also permissible to take notes in a field logbook and subsequently generate an email to confirm and document the conversation. These items are included in the next monthly progress report.

C2.1.1.4 Communicating with Reporting Organizations and Site Operators

Dates for a $PM_{2.5}$-PEP sampling event should be coordinated with the site's normal operating schedule. This coordination must be completed in advance so that the FS and the SLT organization's site operator have ample advanced notice and time to prepare for the event's setup and subsequent sample recovery. The procedure for such communications includes the following:

- The Regional $PM_{2.5}$-PEP Lead (or designee) will contact each SLT organization's ambient air monitoring supervisor/manager/coordinator before the site visit. Contact must be made by phone if it is within 30 days of the site visit, but e-mail is sufficient otherwise. In preparation for initial contact with the site supervisor/manager/coordinator, The $PM_{2.5}$-PEP Lead and/or FS will confirm those SLT operated samplers that are reporting data for NAAQS attainment purposes. During initial contact with the site supervisor/manager/coordinator, the Regional $PM_{2.5}$-PEP Lead will report any site information that appears erroneous. The SLT organization may need to update site- or sampler-specific data in AQS prior to the $PM_{2.5}$-PEP sampling event.

- Approximately one (1) week before the $PM_{2.5}$-PEP sampling event, the FS contacts the SLT site operator to confirm that the sampling event remains on schedule and to confirm meeting arrangements. A confirmation should be documented either as an e-mail from the SLT operator or by the FS to the EPA Regional $PM_{2.5}$-PEP Lead.

C2.1.2 Laboratory Communications

Laboratory personnel use the Phone Communications Form (COM-1) in the same manner as the FS (Section C2.1.1). E-mail can similarly be used to create the needed documentation.

C2.1.2.1 Filter Shipment

On a biweekly schedule, the $PM_{2.5}$-PEP weighing laboratory ships tared, unexposed filters to the Regional field offices via EPA's contracted courier. On the day of shipment, the LA sends an e-mail to Regional field office representatives with the following information:

- Date of shipment
- Number of filter cassettes in shipment
- Number of boxes in shipment
- Tracking number.

C2.1.2.2 Shipping Boxes and Freezer Bricks

Monthly, or as needed, the $PM_{2.5}$-PEP weighing laboratory ships coolers and freezer bricks to the Regional offices via EPA's contracted courier. On the day of shipment, the LA communicates with the field contact and provides the following information by e-mail:

- Date of shipment

- Number of boxes and freezer bricks in shipment
- Tracking number.

C2.2 Reports

This section discusses the various types of reports that are generated in the $PM_{2.5}$-PEP. Table C2-2 provides a summary of these reports.

Table C2-2. Report Summary

Report Type	Frequency	Report Preparer	Report Distribution
Field Progress	Monthly	FS	Regional $PM_{2.5}$-PEP Lead
Laboratory Progress	Monthly	LA/Laboratory Manager	EPA $PM_{2.5}$-PEP Laboratory Task Monitor, Regional $PM_{2.5}$-PEP Leads
Data Quality Assessment Report	1/5 yr	OAQPS $PM_{2.5}$-PEP Lead and Regional $PM_{2.5}$-PEP Lead	Program distribution
Precision and Bias Report	1/yr	Regional $PM_{2.5}$-PEP Lead	Program distribution
$PM_{2.5}$-PEP QA Report	1/yr	OAQPS and Regions	FS, Regional $PM_{2.5}$-PEP Leads

C2.2.1 Progress Reports

$PM_{2.5}$-PEP field and laboratory activities will be reported to the appropriate Regional $PM_{2.5}$-PEP and $PM_{2.5}$-PEP Laboratory Task Monitor, respectively, each month. The following subsections detail the information to include in each such report.

C2.2.1.1 Laboratory Monthly Progress Report

As part of the monthly reporting as required by the $PM_{2.5}$-PEP laboratory management and operations contract, the primary LA and Laboratory Manager will compile a report to document the activities, progress, and issues (new or ongoing) since the previous monthly report. This monthly progress report will be due by the 15th of each month and will include the following details:

- **Reporting date –** Report beginning and end dates
- **Reporter –** Report author
- **Progress -** laboratory activities conducted within the reporting period, including:
  - Number of filter sample shipments received
  - Number of outgoing tare-weighed filter shipments
  - Number of filter weights including pre-sampling tare weights, post-sampling filter weights, and QC samples including laboratory blanks, duplicate samples, and balance calibration check weights

- Issues or problems occurring in the weighing laboratory
- Number and type of equipment calibrations and calibration verifications
- Number of filters inspected
- Corrective actions taken during the month and progress on ongoing corrective actions or issues

The $PM_{2.5}$-PEP Laboratory Task Monitor may request more information be included in the weekly reports if deemed necessary.

C2.2.1.2 Field Monthly Progress Report

The FS will provide the Regional $PM_{2.5}$-PEP Lead with a written Field Monthly Progress Report to document progress made in the preceding month. The deadline for delivering this report is the 15th calendar day of the following month unless otherwise specified by the Regional $PM_{2.5}$-PEP Lead. This Field Monthly Progress Report will contain the following information:

- **Reporting date –** Report beginning and end dates
- **Reporter –** Report author
- **Progress -** Progress on field activities from the preceding month, including $PM_{2.5}$-PEP sampling events scheduled and performed, required sampler maintenance, data verification, and parking lot (fleet precision) study results.
- **Issues -** Issues reported in earlier reports that have not been fully resolved, and new issues arising within the reporting period that might affect the validation of a sample result or impact completion of anticipated activities.
- **Actions -** Action necessary to resolve issues, the person(s) responsible for resolving them, and the anticipated dates when they will be resolved.

A Regional $PM_{2.5}$-PEP Lead may request more information to be included in the Field Monthly Report if deemed necessary. Also, a Regional $PM_{2.5}$-PEP Lead may require a version of this report be prepared and distributed more frequently than monthly, such as weekly or bimonthly.

C2.2.2 QA Reports

Various QA reports have been developed to document the quality of data for the $PM_{2.5}$-PEP.

- **DQA.** This assessment is a scientific and statistical evaluation performed annually to determine if data are of the right type, quality, and quantity to support their intended use. The $PM_{2.5}$-PEP QA/QC data can be statistically assessed at various levels of aggregation to determine its quality. DQAs are primarily the responsibility of the Regions (Regional assessments) and OAQPS (national assessments).

- **Precision and Bias reports.** These reports include the actual network precision and bias data produced by the $PM_{2.5}$-PEP. Precision reports can be generated on-demand as data are loaded in AQS by the PQAOs. The AQS uses the AMP256 and AMP504 reports to retrieve these values but raw data reports can also be generated through the AMP251 report. Annually the PQAOs certify that these network data are accurate and suitable (or not) for calculating attainment and non-attainment design values. The precision and bias are calculated by AQS against the acceptance criteria using the statistics documented in 40 CFR Part 58 and presented in the AMP256 and AMP600. The Regions review these certifications and concur or non-concur on the certifications and AQS tracks all results. The Air Quality Analysis Group of the Air Quality Assessment Division of OAQPS utilizes the certified data to calculate design values for all U.S. SLT air pollution agencies. These results are published annually.

- **QA summary reports.** A QA report provides an evaluation of QA/QC data for a given period to determine whether the DQOs were met. QA reports are more evaluative than the precision and accuracy reports as they combine various assessments and the QA data to report on the overall quality system. OAQPS generates QA Reports on the $PM_{2.5}$-PEP and its resultant data quality.

C2.2.2.1 Data Quality Assessment Reports

OAQPS and EPA Regions will develop a national DQA report and Regional DQA report, respectively, periodically (e.g., every five years or sooner if annual QA reports indicate a need). DQA reports evaluate and summarize the $PM_{2.5}$-PEP QA/QC data to ensure collected date are sufficient in quality and quantity and to examine whether revisions or improvements are warranted to the program.

C2.2.2.2 Precision and Bias Reports

EPA Regions will annually generate precision and bias reports following PQAO annual certification of their routine $PM_{2.5}$ measurement data. The outcomes of these examinations will inform whether improvements to the routine monitoring networks are required after evaluating the PQAO precision and bias for routine monitoring activities.

C2.2.2.3 Annual and Multiple-Year QA Reports

OAQPS will prepare an annual QA summary report of the $PM_{2.5}$-PEP to compile and summarize data collected during the prior calendar year. Such annual reports may additionally include data from prior years when their inclusion in the report is necessary to frame data outcomes or observations. The annual report will present data on completeness aggregated at the PQAO, EPA Region, and national levels for collocated site precision measurements and $PM_{2.5}$-PEP bias. Completeness is determined under the two sets of criteria previously described: (1) based solely on valid completed measurements (not invalidated and with concentration values, regardless of magnitude) and (2) based on valid measurements to be included in the bias assessment, i.e., those that yield concentrations above the DQO calculation threshold given in 40 CFR Part 58 Appendix A (both $PM_{2.5}$-PEP and routine SLT/PQAO concentration in compared data pairs must be ≥ 3 $\mu g/m^3$). Precision (percent CV) and $PM_{2.5}$ -PEP bias (average RPD) are presented at the same organizational levels of aggregation, but also as historical trends for the past 3 years and 6

years. QA sample data for FBs and TBs as well as calculations of lower detection limits are also reported at the national level for the year of interest and previous 3- and 6-year averages. In addition to concentration bias calculations as detailed in the CFR, the reports will include determination of flow rate bias of routine $PM_{2.5}$ FRM and FEM monitors based on SLT monitoring organization flow rate check and audit data reported to AQS (which began in 2017). The annual QA reports will, at the direction of the $PM_{2.5}$-PEP OAQPS Lead, incorporate summaries of the following $PM_{2.5}$-PEP QC measurement parameters:

1. $PM_{2.5}$-PEP sampler fleet precision measurements (i.e., parking lot study data)
2. Metrological certifications of flow rate, ambient temperature, and barometric pressure calibration and reference check standards
3. $PM_{2.5}$-PEP laboratory sample shipment receipt temperatures
4. Weighing laboratory internal balance checks and audits using ASTM-certified check weights and independent audit weights
5. Continuous monitoring of gravimetric weighing chamber climate controls as measured with NIST-traceable temperature and RH sensors and data loggers.
6. Weighing session batch QA/QC data for filters weighed in replicate and laboratory blank filters.
7. Measured mass data for field blank and trip blank filters.
8. Staff training completed
9. TSAs conducted and noteworthy findings
10. Recommendations for program improvement

A multi-year (e.g., 3-year or 5-year) QA Report is a composite of annual QA reports, but with a more narrative interpretation and evaluation of longer-term trends with respect to $PM_{2.5}$-PEP sampler and operational performance. A multi-year report may be prepared at the direction of the $PM_{2.5}$-PEP OAQPS Lead.

C2.2.3 Response/Corrective Action Reports

During TSAs, the response/corrective action reporting procedure is followed whenever there is an assessment finding. The reporting procedure is designed as a closed-loop system. The Response/Corrective Action Report Form identifies the originator (who reported and identified the problem), states the problem, and may suggest a solution. The form also indicates the name of the person(s) assigned to correct the problem. The appropriate supervisor fills in details on the assignment of personnel to address the problem and the schedule for completion.

The reporting procedure closes the loop by requiring that the recipient state on the form how the problem was resolved and the effectiveness of the solution. Copies of the completed Response/Corrective Action Report Form are distributed when the problem has been identified and the action has been scheduled, and then again when the correction has been completed. The originator, the Regional $PM_{2.5}$-PEP Lead, and the OAQPS $PM_{2.5}$-PEP Lead are included in both distributions.

C2.2.4 Assessment Reports

Reports for assessments are covered in Section C1.1.

D Data Validation and Usability

D1 Data Review, Verification, and Validation Requirements

This section describes how the $PM_{2.5}$-PEP will verify and validate the data collection operations associated with the program. Verification is defined for the $PM_{2.5}$-PEP as confirmation by examination and provision of objective evidence that specified MQO requirements have been fulfilled (e.g., the pre-event sampler performance checks were conducted during set-up by the FS; the number of laboratory weight checks occurred as prescribed). Validation is defined as confirmation by examination and provision of objective evidence that the requirements for a specific intended use are fulfilled (e.g., that the totality of the verified data meet the program needs as indicated by examination of field QC sample data and laboratory QC data).

The majority of the data review, verification, and validation activities are performed by the $PM_{2.5}$-PEP laboratory staff, with support from the FSs. As many of the data verification and validation activities share common procedures and aspects, they are listed together in Section D1.2 in the manner in which they occur and are not formally categorized specifically as a verification or validation activity.

To verify and validate the phases of the data collection operation, the $PM_{2.5}$-PEP uses various qualitative assessments (e.g., TSAs, network reviews) to verify that the QAPP and supporting SOPs are being followed. These assessments rely on the various QC measurements at various phases of the data collection operation and are used to validate that the $PM_{2.5}$-PEP's bias data will meet the DQOs described in Section A7. While these assessments are important to the PEP and the resulting data quality, they do not enter into the routine data verification and validation activities the $PM_{2.5}$-PEP weighing laboratory and FS staff conduct. If assessment findings result in compromising data quality and resultingly call into question the validity of collected data, these are aspects that occur after the data have been reported to AQS typically, unless intervention is implemented in advance. The OAQPS $PM_{2.5}$-PEP Lead maintains the authority to review and alter the validation status of $PM_{2.5}$-PEP data based on outcomes of assessments, including findings from annual QA reports, TSAs, ADQs, and DQAs, and other data sources.

D1.1 Sample Data Collection Activities and Associated Controls

The PEP incorporates controls to ensure to the extent possible that data are collected that meet the program requirements. Such controls include the conduct of calibration verifications prior to each sampling event to ensure that the sampler operation was within tolerance during each sampling event. The FSs employ certified transfer standards for this purpose and record measurements and observations with each sampling event and follow established practices to ensure successful sample and data collection. In the weighing laboratory, variables that impact data quality are tightly controlled and continuously monitored to again ensure data collected meet program requirements. Additionally, the PED has been developed and employed to capture the data that support evidence the recorded data meet program requirements and are flagged when data are compromised. These built-in features in the overall process maximize the likelihood that data will be valid and meet program requirements. Additionally, they eliminate and reduce the likelihood that compromised data will inadvertently slip through when they

should be invalidated.

Periodic TSAs of field and laboratory staff provide additional confidence that procedures and activities are performed according to those established and approved and that measurement data are representative of the conditions under which they were collected.

Field controls include the provision of backup samplers and backup transfer standards to ensure there is a calibrated and operable sample available in the event of malfunction. Data logged by the sampler during the sampling event can be examined to ensure conditions were within control during sampling.

Laboratory controls include the functions built into the PED and environmental conditions monitoring that notify the LA when out of tolerance conditions exist. For example, the continual environmental conditions data logger is programmed to alarm when conditions are out of tolerance which allows correction before data are impacted. This functionality will permit the LA to delay conducting filter weigh sessions if filters require further conditioning due to out of tolerance environmental controls. The PED includes functions that notify the LA if a measured mass for a standard weight is not within tolerance which prompts corrective action to prevent measurements produced by a balance with calibration out of tolerance. Additional PED functions notify the LA in real time when laboratory filter blanks or batch duplicate samples exceed acceptance criteria, which again permits corrective action to be taken before measurements are collected in out of tolerance conditions, risking invalidation.

The review of calibration verification data and QC data including FBs, TBs, laboratory filter blanks can be used to validate data collection activities. Data that indicate unacceptable levels of bias or precision or a tendency (e.g., trend on control charts) should be investigated and reconciled in the event of a transcription or other typographic error. Investigation may uncover related issues that call into question data validity or identify improper procedures.

D1.2 Workflow of Data Verification and Validation Activities

The controls in place described in Section D1.1 eliminate a significant amount of manual inspection that would otherwise be required to verify data meet acceptance criteria. Even still, there are opportunities for errors to occur that require manual inspection during the data review and verification process. The general workflow of data verification and validation activities follows. Specific details for decisions on data validation or invalidation are detailed in Section D2.

1. The LA conditions and measures tare weights on filters and ships them to the FSs. The dates and times of the filter equilibration and measurements are recorded in the PED for reference of holding times and will produce flags for filters if holding times are exceeded. After completing a weighing session (pre-sampling or post-sampling), the LA reviews the recorded measured masses and the weighing batch QC results for the blank filters, duplicate weights, and standard mass results to ensure they fall within the prescribed acceptance criteria (refer to Section B7.1). Balance measurements are electronically transferred from the balance to the PED, eliminating potential transcription errors. Filters are assigned to virtual trays and batches which allows entry of equilibration dates and

times to a number of filters simultaneously.

The updated PED or the LIMS will allow the LA to weigh samples only if the previous 24-hour climatic conditions in the weighing chamber are acceptable and all balance self-calibrations and check weight tests have been completed with satisfactory results.

2. The FS conducts the field sampling event and records all required data to document that the sampling event followed the established procedure. Prior to packaging the completed FDS/COC form and retrieved filter for shipment, FSs review the electronic logged sampler data and completed FDS/COC form to ensure all required information is recorded comprehensively, accurately, and legibly. Missing information may result in sample invalidation and the need to schedule a make-up sample.

   MoPED will incorporate features to eliminate or reduce the potential for inputting erroneous data before users can continue the field sampling event. When MoPED is in place, field data should be reported to AQS within 24 hours of sample retrieval (if possible).

3. Upon receipt of samples by the $PM_{2.5}$-PEP weighing laboratory, the LA reviews the FDS/COC form for completeness and notates any missing or discrepant information. The LA will contact the FS to resolve any incomplete or discrepant information and/or illegible information. The LA may also consult the electronically logged data (provided on the removeable data storage device shipped with the filter(s) samples) to correct missing or discrepant data. The LA measures the shipment temperatures and stores filters appropriately until beginning equilibration. The LA will document the receipt temperature and the average sample collection temperature (if needed) in addition to the date and time the filter was placed into storage (if not immediately placed into the weighing lab for equilibration) and the start date and time of filter equilibration. When inputting data into the PED, the LA inputs flags for aspects of the sample collection, transport, or receipt that do not meet acceptance criteria. The PED stores these flags and will reference the various entries in determining holding times based on the receipt temperatures and sample collection average temperatures, dates, and times. If any critical aspects do not meet the prescribed criteria, the sample is invalidated and marked as such in the PED.

   The LA files records of all invalid samples in the PED and includes a summary of why the sample was invalidated, along with the associated flags.

   Samples flagged as invalid in the field are returned to the weighing laboratory for analysis unless they are physically damaged or have been subject to a unique environmental condition (e.g., a wildfire that generates enough PM to overwhelm the flow controller) that renders them invalid. All field-collected filters will be weighed for post-sampling mass unless a filter is unweighable due to obvious physical damage or contamination. The LA should not make judgement calls as to what should or should not be weighed, if the filter integrity is intact.

4. The LA equilibrates the received filters and measures and records the equilibration start

times in the PED. When subsequently weighing filters, the PED records the date and time of mass measurement and will add flags if holding times are exceeded. The PED will also notify the LA if weighing session QC are not met. The LA will notate in the PED for any affected filters whether the environmental conditions were outside the acceptable tolerance range, for which the PED will add flags appropriately. Balance measurements are electronically transferred from the balance to the PED, eliminating potential transcription errors. As for pre-sampling tare weights, filters are assigned to trays and batches to assign QC samples and common equilibration times and dates to the filters in the batch. Once the weighing session is complete, the LA can examine the QC data in control charts to quickly ascertain that criteria were met.

The updated PED or the LIMS will allow the LA to weigh samples only if the previous 24-hour climatic conditions in the weighing chamber are acceptable and all balance self-calibrations and check weight tests have been completed with satisfactory results.

Under the MoPED regime, the LA will upload the data directly to AQS via the browser-based upload tool available at https://aqs.epa.gov/auditor_upload. The LA uploads pre- and post-sampling weigh session data immediately following the completion of each weighing session. Since all relevant validation data have been ostensibly loaded by the FS via MoPED, the validation logic algorithm of MoPED has prequalified most of the data and AQS completes the validation process along with the calculation of the resulting ambient concentration.

5. Upon completion of post-sampling weighing batch, the LA ensures batch QC criteria were complete and met the acceptance criteria. At this stage, the PED contains all of the information needed to calculate an in-air $PM_{2.5}$ concentration for the filter sample or a mass gained for FBs and TBs.

6. The LA will then prepare a filter report for each post-sampling weighed filter which includes the sample collection data from the FDS/COC and the laboratory mass data.

7. Once post-sampling weighing activities have been completed at the weighing laboratory, approximately every month, the LA and/or Laboratory Manager sends the concentration results to the respective FS to complete verification of COC/FDS data and review of the calculated $PM_{2.5}$ filtrate mass and in-air concentration. Each FS will digitally sign an accompanying form stating the data are consistent with their records; or data that appear to be incorrect are identified and a resolution process is initiated to establish the correct value or result. Once the FS verifies all data are correctly transcribed/entered, the FS attests to the veracity of the data.

8. The LA marks the data as complete in the PED which adds the data to a list of filters to be reviewed and validated by the laboratory manager.

9. Following the completion of FS review and concurrence of data veracity, the filter sample data in the PED is ready for the Laboratory Manager to review and approve for reporting. For this process, the Laboratory Manager employs the validation reports within the PED. The PED incorporates numerous data verification and validation checks the are

summarized in a data summary report for each field-collected ($PM_{2.5}$-PEP filter sample, FB, and TB) filter sample. The validation report contains the field collection data verified by the FS, the laboratory weighing data, and comments or flags applied by the LA or automatically by the PED. The report is arranged such that critical criteria and their satisfaction are together where the laboratory manager can quickly ascertain if a sample was invalidated. The Laboratory Manager generates these reports for all of the samples to be completed in the monthly batch of samples and reviews the reports. The reports reviewed include those for filter samples for which all weighing activities have been completed since the previous monthly data review. An example report is shown in Appendix C. As part of their validation activities, the Laboratory Manager will attempt to correct data where possible. When data are revised, the Laboratory Manager documents the change in form VALFORM-1 to log and trace the change. In instances where changes are not obvious errors for which the Laboratory Manager can clearly justify a change, they may contact the Regional $PM_{2.5}$-PEP Lead, self-implementing PQAO $PM_{2.5}$-PEP partner, and/or FS for clarification or correction.

The PED's successor (i.e., the LIMS) will provide validation of the gravimetric results. There will continue to be an assessment of blank results by the $PM_{2.5}$-PEP Laboratory Manager (or designee) since acceptance limits are operational criteria as defined by the FRM, EPA's QA handbook, or QA Guidance Document 2.12: Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods. Upon successful launch of MoPED, the final validation check based on field criteria will be provided through AQS, however, EPA Regional $PM_{2.5}$-PEP Leads will be able to reverse any decisions within 14 days of the AQS posting in an interim results table.

10. The laboratory manager reviews the validation report for each filter sample, paying particular attention to filter samples that include flags - particularly numerous flags - and flags indicating the sample is invalid. The laboratory manager also reviews closely the validation reports for TBs and FBs to ensure they meet acceptance criteria, and if not, assess the impact on associated field samples.

11. The laboratory manager may identify errors in data entry which result in incorrect application of flags or the omission of flags when they are warranted. The scope of the validation activities the laboratory manager performs may include reviewing weighing batch QC data, environmental conditions data, calibration data, and original FDS/COC forms to verify specific recorded data and context for inclusion or omission of flags. If changes or corrections to data are required, the laboratory manager will document these changes on VALFORM-1 and detail the rationale for the change. These completed forms are maintained in the laboratory and available for TSAs and program reviews. The laboratory manager will document the scope of the validation activities and include notes and observations in a record.

12. Following review of the data validation reports and completion of needed changes to data and flags, the data are marked as ready for approval.

13. At the time this QAPP was approved, the $PM_{2.5}$-PEP Weighing Laboratory Task Monitor

performs final review the filter sample data following completion of validation. The Laboratory Task Monitor will review the validation data and laboratory manager observations and notations, paying particular attention to field QC samples (FBs and TBs) as well as filter samples for which additional changes were made (i.e., the VALFORM-1 records), as well as to invalidated samples. The Laboratory Task Monitor may ask for additional changes or clarifications to recorded and validated data prior to approval.

14. Once the Laboratory Task Monitor approves the data, the Laboratory Manager then notifies the OAQPS QA support contractor that the data are ready for coding and submission to AQS and provides a copy of the PED with the approved data. Data are provided to the QA Contractor approximately monthly and currently consist of transmission of a complete copy of the PED updated with the current records.

    EPA intends to institute a formal notification procedure following the Laboratory Task Monitor approval which provides all valid and invalid results to the respective EPA Regional $PM_{2.5}$-PEP Lead and self-implementing PQAO $PM_{2.5}$-PEP coordinators. Once notified, the EPA Regional $PM_{2.5}$-PEP Lead or self-implementing PQAO $PM_{2.5}$-PEP coordinator will be given 14 days to approve valid data, otherwise, the data will automatically be posted to AQS. During this 14-day period, the Regional $PM_{2.5}$-PEP Leads and self-implementing PQAO $PM_{2.5}$-PEP coordinators will either affirm invalidations or work with the FS and the laboratory to correct the source of the invalidation, if feasible.

    When MoPED is implemented, MoPED will validate data which will eliminate the need for an individual to do this. In this case, the Region 4 $PM_{2.5}$-PEP Laboratory Manager will review analytical results and associated QC data that suggest the results should be invalidated (e.g., gravimetric laboratory temperature and/or relative humidity data do not meet criteria, but the gravimetric measurements were posted regardless).

    Upon successful launch of MoPED, once the field collection and laboratory data have been submitted to AQS for a given $PM_{2.5}$-PEP sample, AQS pairs the sample's field and laboratory data into a single record and this result is held in a pre-production area within AQS. Once this pairing is completed in the pre-production area within AQS, the Regional $PM_{2.5}$-PEP Lead or self-implementing PQAO $PM_{2.5}$-PEP coordinator has fourteen (14) days to approve or invalidate the sample data within the pre-production area within AQS. If no action is taken within the 14-day period, the sample result will automatically move to the production area in AQS. Once in the production area of AQS, the PEP data result will be available for pairing with the coincident routine network concentration measurement.

D2 Verification and Validation Methods

If the processes prescribed in this QAPP and supporting SOPs are followed as written, then the $PM_{2.5}$-PEP should obtain the necessary data quality to evaluate the DQO. However, exceptional field and laboratory events may occur, and field and laboratory activities may negatively affect

the integrity of samples. In addition, it is expected that QC checks will occasionally fail to meet acceptance criteria. Information about problems that affect the integrity of data is recorded in the PED as flags associated with specific filter samples. It is important to determine how these failures affect the collected data. The review of collected data and their associated QC data are verified and validated on a sample basis, on groups of samples, and on a sample batch basis based on the impact of the issue.

D2.1 Process for Validating and Verifying Data

Data are presumed to be valid unless a critical criterion has not been satisfied. In some cases, the PED may mark a critical criterion as unsatisfied, and therefore invalidate a sample result; when the critical criterion has been satisfied but there is a data transcription error. Therefore, it is critical that an individual (i.e., the Laboratory Manager or designee) review invalidated data to ensure the critical criterion is indeed unsatisfied.

A filter sample may be invalidated based on many criteria, such as known or suspected field or laboratory contamination, field or laboratory accidents, or failure of critical acceptance criteria. Table D2-1 lists the cases where single samples or groups of samples may be invalidated based on failure of any one critical acceptance criterion.

Flags may be used in combination to invalidate samples. Table D2-2 identifies the operational evaluation criteria that can be used in combination to invalidate single samples or groups of samples. Because the possible flag combinations are overwhelming and cannot be anticipated, the $PM_{2.5}$-PEP Laboratory Manager reviews the flags associated with single values or groups of samples and recommends acceptance or invalidation to the Laboratory Task Monitor.

Table D2-1. Validation Template Indicating Critical Criteria

FAILURE OF ONE OF THESE CRITICAL CRITERIA WILL RESULT IN INVALIDATION OF THE AFFECTED SAMPLE OR GROUP OF SAMPLES					
Requirement	**Type**	**Scope**	**Acceptance Criteria**	**40 CFR Reference**	**Flag Value**
Filter Holding Times					
Filter Retrieval from Sampler After Collection	**S**	All filters	≤ 96 hours from sample end date and time	Part 50, Appendix L, Section 10.10	HTE
Post-sampling weighing	**S**	All filters	≤ 30 days if $T_{received}$[a] ≤ 4°C ≤ 30 days if 4°C < $T_{received}$ ≤ 25°C and $T_{sampling}$[b] > $T_{received}$ ≤ 10 days if 4°C < $T_{received}$ ≤ 25°C and $T_{sampling}$ < $T_{received}$ Sample invalidated if $T_{received}$ > 25°C	Part 50, Appendix L refers to Quality Assurance Guidance Document 2.12	HTE
Sampling start date and time	**S**	All filters	Sampling must be ≤ 30 days from pre-sampling tare weight measurement	Part 50, Appendix L, Section 8.3	HTE
Sampling Period					
Sampling period	**S**	All sampled filters	1,380–1,500 min (23-25 hours)	Part 50, Appendix L, Section 3.3	EST
Sampling Instrument					
Flow rate audit	**S**	Each sampling event	± 4% of calibration standard at design flow (16.67 LPM)	Part 50, App L, Sec. 7.4.3	FQC
External leak check[e]	**S**	Each sampling event	<80 mL/min	Part 50, Appendix L, Section 7.4.6	FQC
Internal leak check[e]	**S**	Each sampling event	<80 mL/min	Part 50, Appendix L, Section 7.4.6	FQC

Table D2-1. Validation Template Indicating Critical Criteria (continued)

FAILURE OF ONE OF THESE CRITICAL CRITERIA WILL RESULT IN INVALIDATION OF THE AFFECTED SAMPLE OR GROUP OF SAMPLES					
Requirement	**Type**	**Scope**	**Acceptance Criteria**	**40 CFR Reference**	**Flag Value**
Filter temperature sensor	**S**	All sampled filters - average flow rate for sampling period	No excursions of >5°C lasting longer than 30 min	Part 50, Appendix L, Section 7.4	FLT
Flow rate (indicated by sampler logged data)	**S**	All sampled filters - average flow rate for sampling period	within ± 4% of design flow (16.67 LPM)	Part 50, Appendix L, Section 7.4	FLR
	S	All sampled filters – for sampling period	≤ 2% CV	Part 50, Appendix L, Section 7.4.3.2	FLR
	S	All sampled filters – for sampling period	flow rate measured over time intervals of 5 minutes within ± 5% of design flow (16.67 LPM)	Part 50, Appendix L, Section 7.4.3.1	FVL
Filter					
Filter Integrity	**S**	All filters	No contamination, damage, pinholes, particles, ring separation, or other imperfections	Part 50, Appendix L, Section 6.0	CON, DAM

Table D2-1. Validation Template Indicating Critical Criteria (continued)

FAILURE OF ONE OF THESE CRITICAL CRITERIA WILL RESULT IN INVALIDATION OF THE AFFECTED SAMPLE OR GROUP OF SAMPLES					
Requirement	**Type**	**Scope**	**Acceptance Criteria**	**40 CFR Reference**	**Flag Value**
Filter Conditioning Environment					
Equilibration prior to pre-sampling tare weight or post-sampling weight	**G**	All filters	≥ 24 hours of equilibration	Part 50, Appendix L, Section 8.2	ISP
Weighing room temperature range during equilibration	**G**	All filters	24-hr mean 20 to 23°C	Part 50, Appendix L, Section 8.2	ISP
	G	All filters	5-minute average values within 18 to 25°C	Part 50, Appendix L refers to Quality Assurance Guidance Document 2.12	ISP
Weighing room temperature control during equilibration	**G**	All filters	standard deviation of 5-minute averages ≤ 2°C over 24 hr [c]	Part 50, Appendix L, Section 8.2; Quality Assurance Guidance Document 2.12 (Table 9-1)	ISP
Weighing room relative humidity range during equilibration	**G**	All filters	24-hr mean 30 to 40% RH	Part 50, Appendix L, Section 8.2	ISP
	G	All filters	5-minute average values within 25 to 45% RH	Part 50, Appendix L refers to Quality Assurance Guidance Document 2.12	ISP
Weighing room relative humidity control during equilibration	**G**	All filters	standard deviation of 5-minute averages ≤ 5% RH over 24 hr [c]	Part 50, Appendix L, Section 8.2; Quality Assurance Guidance Document 2.12 (Table 9-1)	ISP

Table D2-1. Validation Template Indicating Critical Criteria (continued)

FAILURE OF ONE OF THESE CRITICAL CRITERIA WILL RESULT IN INVALIDATION OF THE AFFECTED SAMPLE OR GROUP OF SAMPLES					
Requirement	**Type**	**Scope**	**Acceptance Criteria**	**40 CFR Reference**	**Flag Value**
Weighing Room Pre-/post-sampling relative humidity difference	**S/G**	All filters	24-hr means within ± 5% RH	Part 50, Appendix L refers to Quality Assurance Guidance Document 2.12	ISP

NOTE: S = single filter; G = group of filters (i.e., batch)

[a] $T_{received}$ = the maximum measured temperature of the filter immediately after unpacking the cooler after arrival at the laboratory.

[b] $T_{sampling}$ = the 24-hour average ambient temperature during the sampling event.

[c] Variability estimate not defined in CFR.

[e] The PQ200 sampler leak check criterion is to check for 5 cm H_2O of vacuum pressure loss over 2 minutes. The listed leak check criterion is equivalent to the CFR requirements, as originally certified by Mesa Laboratories and approved by EPA .

Table D2-2. Validation Template Indicating Operational Criteria

OPERATIONAL EVALUATIONS					
Requirement	**Type**	**Scope**	**Acceptance Criteria**	**40 CFR Reference or Source**	**Flag Value**
Detection Limit					
Lower detection limit	**G/G1**	All field collected sample filters	2 µg/m^3 1.0 µg/m^3	Part 50, Appendix L, Section 3.1 PM$_{2.5}$-PEP established based on historical field blank data	BDL
Upper concentration limit	**G/G1**	All field collected sample filters	200 µg/m^3	Part 50, Appendix L, Section 3.2	NA
Field QC Samples					
Field blank (FB)	**G/G1**	1/audit event for programs < 2 yrs old; 1/trip for all others[c]	$d_i \leq \pm 30$ µg (single filter; refer to Section B5.3) $d_z > \pm 20$ µg (3-month average of filters; refer to Section B5.3)	Part 50, Appendix L, Section 8.3 PM$_{2.5}$-PEP Requirement	FFB
Trip Blank (TB)	**G**	1 per audit trip [d]	± 15 µg change between pre- and post-weighings	PM$_{2.5}$-PEP has set this as a corrective action level	FTB
Laboratory QC Checks					
Laboratory filter blank	**G**	After every 10 filter weights in a post-sampling weighing session	$\leq \pm 15$ µg change between weighings	Part 50, Appendix L, Section 8.3	FLB
Balance calibration verification	**G**	Beginning/end of weighing session and after every 10 filter weights	≤ 3 µg	Part 50, Appendix L, Section 8.3	FQC
Duplicate filter weighing	**G**	1/post-sampling weighing session, 1 carried over to next session	± 15 µg change between weighings	Part 50, Appendix L, Section 8.3	FLD

Table D2-2. Validation Template Indicating Operational Criteria (continued)

OPERATIONAL EVALUATIONS					
Requirement	**Type**	**Scope**	**Acceptance Criteria**	**40 CFR Reference or Source**	**Flag Value**
Accuracy performance checks and audits [e]					
Flow rate audit	**G1**	4/yr (manual)	± 4% of calibration standard at design flow (16.67 LPM)	$PM_{2.5}$-PEP Requirement	FQC
Temperature calibration verification	**S**	each sampling event	± 2°C of calibration standard	Part 50, Appendix L, Section 9.3	FQC
Barometric pressure calibration verification	**S**	each sampling event	± 10 mm Hg of calibration standard	Part 50, Appendix L, Section 7.4	FQC
Balance audit (PE)	**G**	2/yr	± 3µg of NIST-traceable (ASTM level 2) standard	$PM_{2.5}$-PEP Experience	FQC
Precision (using collocated samplers) [f]					
All samplers (mandatory)	**G**	2/year (semi-annual)	$CV_q \leq 10\%$ (see Section B5.1.5.1)	Part 50, Appendix L, Section 5.0	FCS
Calibration Verification					
Single-point flow rate verification	**G1**	Every sampling event	± 4% of working standard or 4% of design flow (16.67 LPM)	Part 50, Appendix L, Section 9.2.5	FSC
Single-point temperature verification	**G1**	Every sampling event	± 2°C of working standard	Part 50, Appendix L, Section 9.3	FSC
Single-point barometric pressure verification	**G1**	Every sampling event	± 10 mm Hg	Part 50, Appendix L, Section 7.4	FSC
Clock/timer verification	**G1**	Every sampling event	± 1 min from time standard	Not described	NA
Laboratory temperature sensor verification	**G**	1/quarter	± 2°C	Not described	FLT
Laboratory relative humidity sensor verification	**G**	1/quarter	± 2% relative humidity	Not described	FLH

NOTE: S = single filter; G = group of filters (i.e., batch); G1 = group of filters from one instrument

[a] $T_{received}$ = the maximum measured temperature of the filter immediately after unpacking the cooler after arrival at the laboratory.

[b] $T_{sampling}$ = the 24-hour average ambient temperature during the sampling event.

Table D2-2. Validation Template Indicating Operational Criteria (continued)

[c] For a new self-implementing PQAO program (i.e., <2 years old), the frequency for FBs is one per FRM/FEM audit event. For all others, one FB will be performed per FS per trip. A trip may include more than one audit event. It is up to the FS to determine which site to perform the FB, unless otherwise directed by their Regional $PM_{2.5}$-PEP Lead (such as when a problem is identified at a specific site).

[d] TBs are performed at a frequency of one per audit trip.

[e] These are independent of any sampling event and likely to occur during quarterly maintenance and the annual calibration/certification. Placing a sampler into service, even though it has failed one or more of these operational criteria in a calibration or quarterly performance check is a violation of the Field SOP.

[f] Twice per year, all of the $PM_{2.5}$-PEP samplers used by the Region (and any self-implementing PQAO) must be collocated in a "parking lot study" as described in Section B5.4.1. If the measured concentration is below 5 $\mu g/m^3$, CV_a > 10% may be accepted if the absolute differences are ≤,1.7 $\mu g/m^3$.

D2.2 Validation Considering Sample Filter Batching

Filter samples are associated with QC samples by batching samples together and are considered within these batches for validation. Invalidation is not warranted with a single exceedance of an acceptance criterion for batch QC; however, depending on the magnitude of the exceedance and whether more than one similar type of exceedance may be considered a minor or major deviation from expected performance. In such instances, flags will be added to the filter data and may rise to the level where filters assigned to the batch are invalidated. The $PM_{2.5}$-PEP has developed a validation template to consider sample validity in such instances and is shown in Table D2-3.

Table D2-3. Sample Batch Validation Template

Requirement	Number Per Batch	Acceptance Criteria	Major Deviation [a]	Minor Deviation [b]	Flag
Blanks					
Field blanks [c]	1	≤ ± 30 µg	Blank ≥ ± 40 µg	One blank > ± 30 µg	FFB
	>1	Mean ≤ ± 30 µg	Mean ≥ ± 30 µg		FFB
Laboratory blanks	1	≤ ± 15 µg	Blank ≥ ± 17 µg	Blank > ± 15 µg	FLB
	>1	Mean ≤ ± 15 µg	Mean ≥ ± 15 µg		FLB
Trip blanks [c]	1	≤ ± 15 µg	Blank ≥ ± 40 µg	One blank > ± 30 µg	FTB
	>1	Mean ≤ ± 15 µg	Mean ≥ ± 30 µg		FTB
Precision Checks					
Filter duplicates	1	≤ ± 15 µg	Duplicate > ± 17 µg	Duplicate > ± 15 µg	FLD
Accuracy					
Balance checks	4	≤ ± 3 µg	Four checks > ± 3 µg	Two checks > ± 3 µg	FIS

[a] If two major deviations occur, then the data in the batch are invalidated. See exception in footnote c. In general, when exceedances occur that prompt invalidation, corrective action will be taken to address the exceedance and the filters in the batch weighed in a successive weighing batch, the intent to successfully attain QC acceptance criteria.

[b] If four minor deviations occur, then the data in the batch are invalidated. Two minor deviations equal one major deviation. See exception in footnote c.

[c] Sample weighing batches will not be wholly invalidated when FB and/or TB samples exceed these listed criteria. Instead, these exceedances will be reviewed in context with the associated field samples to investigate potential contamination and the impact to the associated filter samples.

As noted in the footnotes to Table D2-3, data for a given batch may be invalidated based on the number of major and minor deviations assigned. The LAs evaluate the batch and generate a report based on the results described in the validation template. If the report indicates invalidating the batch of data, then the batch may be reweighed to confirm the aberrant results. Prior to re-analysis, all efforts are made to take corrective actions and, depending on the type of QC checks that were outside of acceptance criteria, to correct the problem. If the aberrant results are confirmed, the associated filter data in the batch are invalidated.

D2.3 Validation Acceptance and Reporting

To the extent possible, the $PM_{2.5}$-PEP strives to minimize data invalidation. The weighing laboratory will make reasonable efforts to salvage data that may be invalidated when transcription or data recording errors are responsible for failure of a critical criterion. The weighing laboratory may undertake additional periods of equilibration and repeat filter weighings to confirm aberrant results or eliminate a nonconformance condition such as equilibration environmental conditions excursions. Reversal of invalidation based on subjective assessment of criteria may be possible, but must be clearly identified by the Region 4 $PM_{2.5}$-PEP Laboratory Manager and approved by the EPA $PM_{2.5}$-PEP Laboratory Task Monitor.

D3 Reconciliation with User Requirements

The $PM_{2.5}$-PEP data are ultimately employed to calculate bias in the $PM_{2.5}$ routine monitoring network. To do this, the $PM_{2.5}$-PEP and routine $PM_{2.5}$ measurement data must be reported to AQS where they can be associated with coincident routine network sampling results for bias determination.

D3.1 Data Reporting

Once post-sampling weighing and data validation activities are complete and the $PM_{2.5}$-PEP Weighing Laboratory Task Monitor has approved the sample data for reporting, the OAQPS QA Support Contractor extracts the concentration data stored in the PED, performs coding regimens to translate the data into an AQS-friendly format, and uploads them to AQS. Air quality data submitted for each reporting period are edited, validated, and entered into the AQS using the procedures described in the *AQS User Guide* and the *AQS Data Coding Manual* (available at https://www.epa.gov/aqs/aqs-manuals-and-guides).

Invalidated $PM_{2.5}$-PEP sampling events cannot be posted to AQS as there is currently no provision in the AQS QA transaction data record format for adding NULL Qualifier codes.

Occasionally, validated $PM_{2.5}$-PEP results may not upload to AQS. Reasons for this include assignment of incorrect AQS site identifiers or issues with metadata associated with the site at which the $PM_{2.5}$-PEP event was conducted. These results and error reports are compiled by the national QA support contractor and then distributed to the Laboratory Manager and the Regions or self-implementing PQAOs believed to be the origin of the rejected $PM_{2.5}$-PEP event result. If the error cannot be resolved at this level, the results are submitted to the EPA National Air Data Group for further investigation on the failed upload to AQS.

D3.2 Data Pairing

The AQS pairs $PM_{2.5}$-PEP data with the coincident PQAO's routine measurement from their primary (or routine collocated) sampler. Historically, the $PM_{2.5}$-PEP sampling event results are not available for posting and pairing until approximately 40 to 50 days after the conclusion of the sampling event (to allow time for processing and data validation). This has typically preceded the posting of validated routine $PM_{2.5}$ data by at least a week or more when the routine sampler is

an FRM. However, as more routine networks utilize FEM samplers, these data are generally validated and posted to AQS sooner.

After the launch of MoPED, in cases where the $PM_{2.5}$-PEP sampling event results are available, but the coincident network routine measurements are not available, the $PM_{2.5}$-PEP sampling event results are not viewable in AQS. On a 24-hour cycle, AQS checks for matching data from the $PM_{2.5}$-PEP upload table and SLT/PQAO network.

D3.2.1 Routine $PM_{2.5}$ Monitoring Network Data Verification and AQS Reporting

To characterize $PM_{2.5}$ routine measurement bias, data for each $PM_{2.5}$-PEP sample is matched to the data for its corresponding co-collected routine $PM_{2.5}$ measurement. This QAPP does not address verification, validation, and reporting of the SLT network's routine $PM_{2.5}$ monitoring sample data. Per 40 CFR Part §58.16, PQAOs are required to upload their routine $PM_{2.5}$ monitoring data to AQS within 90 days of the end of the calendar quarter in which the measurement was collected. The $PM_{2.5}$-PEP sample data cannot be paired with their collocated routine $PM_{2.5}$ monitoring data until the latter are uploaded to AQS. Table D3-1 lists the due dates for routine $PM_{2.5}$ monitoring data submission to AQS based on when the sample was collected.

Table D3-1. Due dates for PQAOs to Report Routine $PM_{2.5}$ Data to AQS

$PM_{2.5}$ Measurement Collection Period	Date Data Due to AQS
January 1 to March 31	June 30
April 1 to June 30	September 30
July 1 to September 30	December 31
October 1 to December 31	March 31

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Appendix A

Glossary

The following glossary contains terms commonly used in the $PM_{2.5}$-PEP. All terms listed may not actually be used in this document.

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Glossary

Acceptance criteria—Specified limits that are placed on the characteristics of an item, process, or service defined in requirements documents (American Society of Quality Control definition).

Accuracy—This term refers to a measure of the closeness of an individual measurement or the average of a number of measurements to the true value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; the EPA recommends using the terms "*precision*" and "*bias,*" rather than "*accuracy*," to convey the information usually associated with accuracy.

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

Air Quality System (AQS)—The AQS, which is EPA's repository of ambient air quality data, stores data from more than 10,000 monitors, 5,000 of which are currently active. SLT agencies collect monitoring data and submit it to the AQS periodically.

American National Standards Institute (ANSI)—ANSI is the administrator and coordinator of the U.S. private-sector voluntary standardization system.

American Society for Testing and Materials (ASTM)—The ASTM is a professional organization that develops and distributes protocols for testing and provides reference standards.

ANSI/ASTM Class 1 and 2 standards—These are the standards for weighing operations with a microbalance that is certified by their manufacturer as being in conformance with ASTM's standard specification for laboratory weights and precision mass standards (E 617-9), particularly the Class 1 and 2 specifications. These standards are traceable to the National Institute of Standards and Technology (NIST).

AQS Monitor ID—This is a 10-digit combination of the AQS Site ID and POC (see each in this glossary) that together uniquely defines a specific air sampling monitor for a given pollutant.

AQS Site ID—This is a unique identifier for an AQS sampling site consisting of a 9-digit numeric code. The AQS Site ID is frequently combined with the Parameter Occurrence Code (POC) (see POC in this glossary) to provide a unique 10-digit monitor ID. The first nine digits uniquely identify each air monitoring site (two-digit state code, three-digit county code, and four-digit site code). The tenth digit (POC) identifies the monitor at that site. The state and county codes are Federal Information Processing Standard (FIPS) codes. The four-digit site codes are assigned by the local agency, which may allocate them in any way it chooses, as long as there is no duplication in the county. AQS Site IDs are associated with a specific physical location and address. Any significant change in location will typically require a new site ID.

Assessment—This term refers to the evaluation process that was used to measure the performance or effectiveness of a quality system and various measurement phases of data operation. As used here,

"*assessment*" is an all-inclusive term that is used to denote any of the following: an audit, a Performance Evaluation (PE), a management systems review (MSR), peer review, inspection, or surveillance.

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

Audit of Data Quality (ADQ)—A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality.

Authenticate—The act of establishing an item as genuine, valid, or authoritative.

Bias—The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).

Blank—A sample that is intended to contain none of the analytes of interest and is subjected to the usual analytical or measurement process to establish a zero baseline or background value. A blank is sometimes used to adjust or correct routine analytical results. A blank is used to detect contamination during sample handling preparation and/or analysis.

Calibration drift—The deviation in instrument response from a reference value over a period of time before recalibration.

Calibration—A 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 adjustments.

Cassette—A device that is supplied with $PM_{2.5}$ samplers to allow a weighed Teflon® filter to be held in place in the sampler and manipulated before and after sampling without touching the filter and to minimize damage to the filter and/or sample during such activities.

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

Chain of custody—An unbroken trail of accountability that ensures the physical security of samples, data, and records.

Characteristic—Any property or attribute of a datum, item, process, or service that is distinct, describable, and/or measurable.

Check standard—A standard that is prepared independently of the calibration standards and analyzed exactly like the samples. Check standard results are used to estimate analytical precision and to indicate the presence of bias due to the calibration of the analytical system.

Collocated samples—Two or more portions collected at the same point in time and space, so as to be considered identical.

Comparability—A measure of the confidence with which one data set or method can be compared to another.

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

Conditioning environment—A specific range of temperature and relative humidity values in which unexposed and exposed filters are to be conditioned for at least 24 hours immediately preceding their gravimetric analysis.

Confidence interval—The numerical interval constructed around a point estimate of a population parameter, combined with a probability statement (the confidence coefficient) linking it to the population's true parameter value. If the same confidence interval construction technique and assumptions are used to calculate future intervals, then they will include the unknown population parameter with the same specified probability.

Confidentiality procedure—A procedure that is used to protect confidential business information (including proprietary data and personnel records) from unauthorized access.

Configuration—The functional, physical, and procedural characteristics of an item, experiment, or document.

Conformance—An affirmative indication or judgment that a product or service has met the requirements of the relevant specification, contract, or regulation; also, the state of meeting the requirements.

Consensus standard—A standard established by a group representing a cross section of a specific industry or trade, or a part thereof.

Contractor—Any organization or individual contracting to furnish services or items or to perform work.

Control chart—A graphical presentation of quality control (QC) information over a period of time. If a procedure is "in control," the results usually fall within established control limits. The chart is useful in detecting defective performance and abnormal trends or cycles, which can then be corrected promptly.

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

Correlation coefficient—A number between −1 and 1 that indicates the degree of linearity between two variables or sets of numbers. The closer to −1 or +1, the stronger the linear relationship between the two (i.e., the better the correlation). Values close to zero suggest no correlation between the two variables. The most common correlation coefficient is the product–moment, which is a measure of the degree of linear relationship between two variables.

Data of known quality—Data that have the qualitative and quantitative components associated with their derivation documented appropriately for their intended use; documentation is verifiable and defensible.

Data Quality Assessment (DQA)—The scientific and statistical evaluation of data to determine if data obtained from environmental operations are of the right type, quality, and quantity to support their intended use. The five steps of the DQA process include: 1) reviewing the Data Quality Objectives

(DQOs) and sampling design, 2) conducting a preliminary data review, 3) selecting the statistical test, 4) verifying the assumptions of the statistical test, and 5) drawing conclusions from the data.

Data Quality Indicators (DQIs)—The quantitative statistics and qualitative descriptors that are used to interpret the degree of acceptability or utility of data to the user. The principal data quality indicators are bias, precision, and accuracy (bias is preferred); comparability; completeness; and representativeness.

Data Quality Objectives (DQO) Process—A systematic planning tool to facilitate the planning of environmental data collection activities. DQOs are the qualitative and quantitative outputs from the DQO process.

Data Quality Objectives (DQOs)—The qualitative and quantitative statements derived from the DQO process that clarify a study's technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

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

Data usability—The process of ensuring or determining whether the quality of the data produced meets the intended use of the data.

Deficiency—An unauthorized deviation from acceptable procedures or practices or a defect in an item.

Demonstrated capability—The capability to meet a procurement's technical and quality specifications through evidence presented by the supplier to substantiate its claims and in a manner defined by the customer.

Design change—Any revision or alteration of the technical requirements defined by approved and issued design output documents and by approved and issued changes thereto.

Design review—A documented evaluation by a team, including personnel such as the responsible designers, the client for whom the work or product is being designed, and a quality assurance (QA) representative, but excluding the original designers, to determine if a proposed design will meet the established design criteria and perform as expected when implemented.

Design—The design refers to specifications, drawings, design criteria, and performance requirements, as well as the result of deliberate planning, analysis, mathematical manipulations, and design processes.

Detection limit (DL)—A measure of the capability of an analytical method to distinguish samples that do not contain a specific analyte from samples that contain low concentrations of the analyte; the lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated level of probability. DLs are analyte and matrix specific and may be laboratory dependent.

Distribution—This term refers to 1) the appointment of an environmental contaminant at a point over time, over an area, or within a volume; and 2) a probability function (density function, mass function, or

distribution function) used to describe a set of observations (statistical sample) or a population from which the observations are generated.

Document control—The policies and procedures used by an organization to ensure that its documents and their revisions are proposed, reviewed, approved for release, inventoried, distributed, archived, stored, and retrieved in accordance with the organization's requirements.

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

Dry-bulb temperature—The actual temperature of the air, which is used for comparison with the wet-bulb temperature.

Duplicate samples—Two samples taken from and representative of the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variance of the total method, including sampling and analysis (see also *collocated samples*).

Electrostatic charge buildup—A buildup of static electrical charge on an item, such as the $PM_{2.5}$ filter, which makes it difficult to handle, attracts or repels particles, and can influence its proper weighing.

Environmental conditions—The description of a physical medium (e.g., air, water, soil, sediment) or a biological system expressed in terms of its physical, chemical, radiological, or biological characteristics.

Environmental data operations—Any work performed to obtain, use, or report information pertaining to environmental processes and conditions.

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

Environmental monitoring—The process of measuring or collecting environmental data.

Environmental processes—Any manufactured or natural processes that produce discharges to, or that impact, the ambient environment.

Environmental programs—An all-inclusive term that pertains to any work or activities involving the environment, including but not limited to, the characterization of environmental processes and conditions; environmental monitoring; environmental research and development; the design, construction, and operation of environmental technologies; and laboratory operations on environmental samples.

Environmental technology—An all-inclusive term used to describe pollution control devices and systems, waste treatment processes and storage facilities, and site remediation technologies and their components that may be used to remove pollutants or contaminants from, or to prevent them from entering, the environment. Examples include wet scrubbers (air), soil washing (soil), granulated activated carbon unit (water), and filtration (air, water). Usually, this term applies to hardware-based systems; however, it can also apply to methods or techniques used for pollution prevention, pollutant reduction, or

containment of contamination to prevent further movement of the contaminants, such as capping, solidification or vitrification, and biological treatment.

Equilibration chamber—A clean chamber that is usually constructed of plastic or glass, held at near constant temperature and relative humidity, and is used to store and condition $PM_{2.5}$ filters until they and their collected particulate sample (if the filters have been exposed) have reached a steady state of moisture equilibration.

Estimate—A characteristic from the sample from which inferences on parameters can be made.

Evidentiary records—Any records identified as part of litigation and subject to restricted access, custody, use, and disposal.

Expedited change—An abbreviated method of revising a document at the work location where the document is used when the normal change process would cause unnecessary or intolerable delay in the work.

Field (matrix) spike—A sample prepared at the sampling point (i.e., in the field) by adding a known mass of the target analyte to a specified amount of the sample. Field matrix spikes are used, for example, to determine the effect of the sample preservation, shipment, storage, and preparation on analyte recovery efficiency (the analytical bias).

Field blank filter—New, randomly selected filters that are weighed at the same time that pre-sampling weights are determined for a set of $PM_{2.5}$ filters and used for QA purposes. These field blank filters are transported to the sampling site in the same manner as the filter(s) intended for sampling, installed in the sampler, removed from the sampler without sampling, stored in their protective containers inside the sampler's case at the sampling site until the corresponding exposed filter(s) is (are) retrieved, and returned for post-sampling weighing in the laboratory, where they are handled in the same way as an actual sample filter and reweighed as a QC check to detect weight changes due to filter handling.

Field blank—A blank that provides information about contaminants that may be introduced during sample collection, storage, and transport. A clean sample is carried to the sampling site, exposed to sampling conditions, returned to the laboratory, and treated as an environmental sample.

Field Scientist—An individual that conducts $PM_{2.5}$-PEP sampling events and other field activities. This individual could be an EPA contractor staff, EPA Regional staff, or and independent field staff reporting to SLT agencies self-implementing the $PM_{2.5}$-PEP.

Field split samples—Two or more representative portions taken from the same sample and submitted for analysis to different laboratories to estimate inter-laboratory precision.

Filter chamber assembly—As shown in Figures 5.6 and 5.7 in the $PM_{2.5}$-PEP Field SOP, this is referencing the mechanism in the interior of the BGI main unit. This assembly contains the WINS impactor assembly in the upper half and the filter cassette or holder assembly in the lower half.

Financial assistance—The process by which funds are provided by one organization (usually governmental) to another organization for the purpose of performing work or furnishing services or items.

Financial assistance mechanisms include grants, cooperative agreements, and governmental interagency agreements.

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

Goodness-of-fit test—The application of the chi square distribution in comparing the frequency distribution of a statistic observed in a sample with the expected frequency distribution based on some theoretical model.

Graded approach—The process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and the degree of confidence needed in the quality of the results (see also *Data Quality Objectives (DQO) Process*).

Grade—The category or rank given to entities having the same functional use but different requirements for quality.

Guidance—A suggested practice that is not mandatory; it is intended to be an aid or example in complying with a standard or requirement.

Guideline—A suggested practice that is not mandatory in programs intended to comply with a standard.

Hazardous waste—Any waste material that satisfies the definition of hazardous waste given in 40 CFR 261, *Identification and Listing of Hazardous Waste*.

High-efficiency particulate air (HEPA) filter—A HEPA filter is an extended-media, dry-type filter with a minimum collection efficiency of 99.97% when tested with an aerosol of essentially monodisperse 0.3-μm particles.

Holding time—The period of time a sample may be stored prior to its required analysis. Although exceeding the holding time does not necessarily negate the veracity of analytical results, it causes the qualifying or "flagging" of any data not meeting all of the specified acceptance criteria.

Identification error—The misidentification of an analyte. In this error type, the contaminant of concern is unidentified and the measured concentration is incorrectly assigned to another contaminant.

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

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

Internal standard—A standard added to a test portion of a sample in a known amount and carried through the entire determination procedure as a reference for calibrating and controlling the precision and bias of the applied analytical method.

Item—An all-inclusive term that is used in place of the following: appurtenance, facility, sample, assembly, component, equipment, material, module, part, product, structure, subassembly, subsystem, system, unit, documented concepts, or data.

Laboratory Analyst—A staff member who weighs the new and used filters and computes the concentration of $PM_{2.5}$ in $\mu g/m^3$.

Laboratory blank filters—New filters that are weighed at the time of determination of the presampling (tare) weight of each set of $PM_{2.5}$ filters intended for field use. These laboratory blank filters remain in the laboratory in protective containers during the field sampling and are reweighed in each weighing session as a QC check.

Laboratory split samples—Two or more representative portions taken from the same sample and analyzed by different laboratories to estimate the inter-laboratory precision or variability and the data comparability.

Limit of quantitation—The minimum concentration of an analyte or category of analytes in a specific matrix that can be identified and quantified above the method detection limit and within specified limits of precision and bias during routine analytical operating conditions.

Local Standard Time—The time used in the geographic location of the sample site that is set to standard time. Standard time is used in the Federal Reference Method (FRM) program to match continuous instruments to filter-based instruments. During the winter months, all areas of the country use standard time; however, in the summer months, some areas may go to Daylight Saving Time (1 hour ahead of standard time).

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

Management Systems Review (MSR)—The qualitative assessment of a data collection operation and/or organization(s) to establish whether the prevailing quality management structure, policies, practices, and procedures are adequate for ensuring that the type and quality of data needed are obtained.

Management—Those individuals who are directly responsible and accountable for planning, implementing, and assessing work.

Mass reference standard—The NIST-traceable weighing standards, generally in the range of weights expected for the filters.

Matrix spike—A sample that is prepared by adding a known mass of a target analyte to a specified amount of matrix sample for which an independent estimate of the target analyte concentration is available. Spiked samples are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

May—When used in a sentence, this term denotes permission but not a necessity.

Mean (arithmetic)—The sum of all the values of a set of measurements divided by the number of values in the set; a measure of central tendency.

Mean squared error—A statistical term for variance added to the square of the bias.

Measurement and Testing Equipment (M&TE)—Tools, gauges, instruments, sampling devices, or systems used to calibrate, measure, test, or inspect to control or acquire data to verify conformance to specified requirements.

Memory effects error—The effect that a relatively high concentration sample has on the measurement of a lower concentration sample of the same analyte when the higher concentration sample precedes the lower concentration sample in the same analytical instrument.

Method blank—A blank that is prepared to represent the sample matrix as closely as possible and analyzed exactly like the calibration standards, samples, and QC samples. Results of method blanks provide an estimate of the within-batch variability of the blank response and an indication of bias introduced by the analytical procedure.

Method—A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.

Microbalance—A type of analytical balance that can weigh to the nearest 0.001 μg (i.e., one microgram, or one-millionth of a gram).

Mid-range check—A standard used to establish whether the middle of a measurement method's calibrated range is still within specifications.

Mixed waste—A hazardous waste material as defined by 40 CFR 261 and the Resource Conservation and Recovery Act (RCRA) and mixed with radioactive waste subject to the requirements of the Atomic Energy Act.

Must—When used in a sentence, this term denotes a requirement that has to be met.

Nonconformance—A deficiency in a characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate; nonfulfillment of a specified requirement.

Objective evidence—Any documented statement of fact, other information, or record, either quantitative or qualitative, pertaining to the quality of an item or activity, based on observations, measurements, or tests that can be verified.

Observation—An assessment conclusion that identifies a condition (either positive or negative) that does not represent a significant impact on an item or activity. An observation may identify a condition that has not yet caused a degradation of quality.

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

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

Outlier—An extreme observation that is shown to have a low probability of belonging to a specified data population.

Parameter—A quantity, usually unknown, such as a mean or a standard deviation characterizing a population. Commonly misused for "*variable*," "*characteristic*," or "*property*."

Peer review—A documented, critical review of work generally beyond the state of the art or characterized by the existence of potential uncertainty. Conducted by qualified individuals (or an organization) who are independent of those who performed the work but collectively equivalent in technical expertise (i.e., peers) to those who performed the original work. Peer reviews are conducted to ensure that activities are technically adequate, competently performed, properly documented, and satisfy established technical and quality requirements. An in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, acceptance criteria, and conclusions pertaining to specific work and of the documentation that supports them. Peer reviews provide an evaluation of a subject where quantitative methods of analysis or measures of success are unavailable or undefined, such as in research and development.

Performance Evaluation (PE)—A type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of an analyst or laboratory.

$PM_{2.5}$—Particulate matter (suspended in the atmosphere) having an aerodynamic diameter less than or equal to a nominal 2.5 μm, as measured by a reference method based on 40 CFR Part 50, Appendix L, and designated in accordance with 40 CFR Part 53.

$PM_{2.5}$ sampler—A sampler that is used for monitoring $PM_{2.5}$ in the atmosphere that collects a sample of particulate matter from the air based on principles of inertial separation and filtration. The sampler also maintains a constant sample flow rate and may record the actual flow rate and the total volume sampled. $PM_{2.5}$ mass concentration is calculated as the weight of the filter catch divided by the sampled volume. A sampler cannot calculate $PM_{2.5}$ concentration directly.

POC (Parameter Occurrence Code)—A one-digit identifier used in AQS (see both defined in this glossary) to distinguish between multiple monitors at the same site that are measuring the same parameter (e.g., pollutant). For example, if two different samplers both measure $PM_{2.5}$, then one may be assigned a POC of 1 and the other a POC of 2. Note that replacement samplers are typically given the POC of the sampler that they replaced, even if the replacement is of a different model or type.

Pollution prevention—An organized, comprehensive effort to systematically reduce or eliminate pollutants or contaminants prior to their generation or their release or discharge into the environment.

Polonium-210 (^{210}Po) antistatic strip—A device that contains a small amount of ^{210}Po that emits α particles (He^{2+}) that neutralize the static charge on filters, making them easier to handle and their weights more accurate.

Polytetrafluoroethylene (PTFE)—Also known as Teflon, this is a polymer that is used to manufacture the 46.2-mm diameter filters for $PM_{2.5}$ FRM and Federal Equivalent Method (FEM) samplers.

Population—The totality of items or units of material under consideration or study.

Precision—A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions expressed generally in terms of the standard deviation.

Procedure—A specified way to perform an activity.

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

Project—An organized set of activities within a program.

Qualified data—Any data that have been modified or adjusted as part of statistical or mathematical evaluation, data validation, or data verification operations.

Qualified services—An indication that suppliers providing services have been evaluated and determined to meet the technical and quality requirements of the client as provided by approved procurement documents and demonstrated by the supplier to the client's satisfaction.

Quality Assurance (QA) Supervisor or Coordinator—A staff member who assists in preparation of the reporting organization's quality plan, makes recommendations to management on quality issues (including training), oversees the quality system's control and audit components, and reports the results.

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

Quality Assurance Program Description/Plan—See *Quality Management Plan*.

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

Quality control (QC) sample—An uncontaminated sample matrix that is spiked with known amounts of analytes from a source independent of the calibration standards. This type of sample is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system.

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

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

Quality management—That aspect of the overall management system of the organization that determines and implements the quality policy. Quality management includes strategic planning, allocation of resources, and other systematic activities (e.g., planning, implementation, and assessment) pertaining to the quality system.

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

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

Radioactive waste—This refers to waste material that contains or is contaminated by radionuclides and is subject to the requirements of the Atomic Energy Act.

Readability—The smallest difference between two measured values that can be read on the microbalance display. The term "*resolution*" is a commonly used synonym.

Readiness review—A systematic, documented review of the readiness for the startup or continued use of a facility, process, or activity. Readiness reviews are typically conducted before proceeding beyond program milestones and prior to initiation of a major phase of work.

Record (quality)—A document that furnishes objective evidence of the quality of items or activities and that has been verified and authenticated as technically complete and correct. Records may include photographs, drawings, magnetic tape, and other data recording media.

Records schedule—This schedule constitutes EPA's official policy on how long to keep Agency records (retention) and what to do with them afterwards (disposition). For more information, refer to http://www.epa.gov/records/policy/schedule on EPA's Web site or see *file plan*.

Recovery—The act of determining whether the methodology measures all of the analyte contained in a sample.

Remediation—The process of reducing the concentration of a contaminant (or contaminants) in air, water, or soil media to a level that poses an acceptable risk to human health.

Repeatability—This refers to a measure of the ability of a microbalance to display the same result in repetitive weighings of the same mass under the same measurement conditions. The term "*precision*" is sometimes used as a synonym. Repeatability also refers to the degree of agreement between independent test results produced by the same analyst, using the same test method and equipment on random aliquots of the same sample within a short time period.

Reporting limit—The lowest concentration or amount of the target analyte required to be reported from a data collection project. Reporting limits are generally greater than detection limits and are usually not associated with a probability level.

Representativeness—A measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition.

Reproducibility—The precision, usually expressed as variance, that measures the variability among the results of measurements of the same sample at different laboratories.

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

Research (applied)—A process, the objective of which is to gain the knowledge or understanding necessary for determining the means by which a recognized and specific need may be met.

Research (basic)—A process, the objective of which is to gain fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind.

Research development/demonstration—The systematic use of the knowledge and understanding gained from research and directed toward the production of useful materials, devices, systems, or methods, including prototypes and processes.

Round-robin study—A method validation study involving a predetermined number of laboratories or analysts, all analyzing the same sample(s) by the same method. In a round-robin study, all results are compared and used to develop summary statistics such as inter-laboratory precision and method bias or recovery efficiency.

Ruggedness study—The carefully ordered testing of an analytical method while making slight variations in test conditions (as might be expected in routine use) to determine how such variations affect test results. If a variation affects the results significantly, the method restrictions are tightened to minimize this variability.

Scientific method—The principles and processes regarded as necessary for scientific investigation, including rules for concept or hypothesis formulation, conduct of experiments, and validation of hypotheses by analysis of observations.

Self-assessment—The assessments of work conducted by individuals, groups, or organizations directly responsible for overseeing and/or performing the work.

Sensitivity—The capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest.

Service—The result generated by activities at the interface between the supplier and the customer, and the supplier internal activities to meet customer needs. Such activities in environmental programs include design, inspection, laboratory and/or field analysis, repair, and installation.

Shall—A term that denotes a requirement is mandatory whenever the criterion for conformance with the specification permits no deviation. This term does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled.

Should—A term that denotes a guideline or recommendation whenever noncompliance with the specification is permissible.

Significant condition—Any state, status, incident, or situation of an environmental process or condition, or environmental technology in which the work being performed will be adversely affected sufficiently to require corrective action to satisfy quality objectives or specifications and safety requirements.

Software life cycle—The period of time that starts when a software product is conceived and ends when the software product is no longer available for routine use. The software life cycle typically includes a requirement phase, a design phase, an implementation phase, a test phase, an installation and check-out phase, an operation and maintenance phase, and sometimes a retirement phase.

Source reduction—Any practice that reduces the quantity of hazardous substances, contaminants, or pollutants.

Span check—A standard used to establish that a measurement method is not deviating from its calibrated range.

Specification—A document that states requirements and refers to or includes drawings or other relevant documents. Specifications should indicate the means and criteria for determining conformance.

Spike—A substance that is added to an environmental sample to increase the concentration of target analytes by known amounts. Spikes are used to assess measurement accuracy (spike recovery), whereas spike duplicates are used to assess measurement precision.

Split samples—Two or more representative portions taken from one sample in the field or in the laboratory and analyzed by different analysts or laboratories. Split samples are QC samples that are used to assess analytical variability and comparability.

Standard deviation—A measure of the dispersion or imprecision of a sample or population distribution expressed as the positive square root of the variance and having the same unit of measurement as the mean.

Standard Operating Procedure (SOP)—A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps and that is officially approved as the method for performing certain routine or repetitive tasks.

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

Surrogate spike or analyte—A pure substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them to establish that the analytical method has been performed properly.

Surveillance (quality)—Continual or frequent monitoring and verification of the status of an entity and the analysis of records to ensure that specified requirements are being fulfilled.

Technical review—A documented critical review of work that has been performed within the state of the art. The review is accomplished by one or more qualified reviewers who are independent of those who performed the work, but are collectively equivalent in technical expertise to those who performed the original work. The review is an in-depth analysis and evaluation of documents, activities, material, data, or items that require technical verification or validation for applicability, correctness, adequacy, completeness, and assurance that established requirements have been satisfied.

Technical Systems Audit (TSA)—A thorough, systematic, on-site qualitative audit of facilities, equipment, personnel, training, procedures, recordkeeping, data validation, data management, and reporting aspects of a system.

Traceability—This term refers to the ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the program back to the requirements for the quality of the program. This term also refers to the property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons, all having stated uncertainties. Many QA programs demand traceability of standards to a national standard. In most cases this can be achieved through a standard traceable to NIST.

Trip blank—A clean sample of a matrix that is taken to the sampling site and transported to the laboratory for analysis without having been exposed to sampling procedures.

Validation—Confirmation by examination and provision of objective evidence that the specific requirements for a specific intended use have been fulfilled. In design and development, validation refers to the process of examining a product or result to determine conformance to user needs.

Variance (statistical)—A measure or dispersion of a sample or population distribution. Population variance is the sum of squares of deviation from the mean divided by the population size (number of Sections). Sample variance is the sum of squares of deviations from the mean divided by the degrees of freedom (number of observations minus one).

Verification—Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. In design and development, verification refers to the process of examining a result of a given activity to determine conformance to the stated requirements for that activity.

Wet-bulb temperature—The temperature of the wet-bulb thermometer at equilibrium with a constant flow of ambient air at a rate of from 2.5 meters to 10.0 meters per second.

Wet-bulb thermometer—A thermometer with a muslin-covered bulb, which is moistened and used to measure the wet-bulb temperature.

Will—A term that denotes a requirement is mandatory whenever the criterion for conformance with the specification permits no deviation. This term does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled.

Appendix B

Data Qualifiers/Flags

A sample qualifier or a result qualifier consists of three alphanumeric characters which act as an indicator of the fact and the reason that the subject analysis (1) did not produce a numeric result; (2) produced a numeric result, but it is qualified in some respect relating to the type or validity of the result; or (3) produced a numeric result, but for administrative reasons, it is not to be reported outside the laboratory.

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Field Qualifiers

Code	Definition	Description
CON	Contamination	Contamination, including observations of insects or other debris
DAM	Filter damage	Filter appeared damaged
EST [1/]	Elapsed sample time	Elapsed sample time out of specification
EVT	Event	Exceptional event expected to have effected sample (e.g., dust, fire , spraying)
FAC	Field accident	An accident in the field occurred that either destroyed the sample or rendered it not suitable for analysis
FLR [a]	Flow rate	Flow rate, 5-minute average out of specification
FLT [a]	Filter temperature	Filter temperature differential, 30-minute interval out of specification
FMC	Failed multipoint calibration verification	Failed the initial multipoint calibration verification
FPC	Failed pressure check	Barometric pressure check out of specification
FSC	Failed single-point calibration verification	Failed the initial single-point calibration verification
FVL	Flow volume	Flow volume suspect
GFI	Good filter integrity	Filter integrity, upon post-sampling field inspection looks good
LEK	Leak suspected	Internal/external leak suspected
SDM	Sampler damaged	Sampler appears to be damaged which may have affected filter

[a] Flag generated by sampling equipment

Laboratory Qualifiers

Code	Definition	Description
ALT	Alternate measurement	Subject parameter determined by using an alternate measurement method; value believed to be accurate but could be suspect
AVG	Average value	Average value (used to report a range of values)
BDL	Below detectable limits	There was not a sufficient concentration of the parameter in the sample to exceed the lower detection limit in force at the time the analysis was performed. Numeric results field, if present is at best, an approximate value.
BLQ	Below limit of quantitation	The sample was considered above the detection limit but there was not a sufficient concentration of the parameter in the sample to exceed the lower quantitation limit in force at the time the analysis was performed
CAN	Canceled	Analysis of this parameter was canceled and not performed
CBC	Cannot be calculated	Calculated analysis result cannot be calculated because an operand value is qualified
EER	Entry error	The recorded value is known to be incorrect but the correct value cannot be determined to enter a correction.
FBK	Found in blank	The subject parameter had a measurable value above the established QC limit when a blank was analyzed using the same equipment and analytical method. Therefore, the reported value may be erroneous.
FCS	Failed collocated sample	Collocated sample exceeded acceptance criteria limits
FFB	Failed field blank	Field blank samples exceeded acceptance criteria limits
FIS	Failed internal standard	Internal standards exceeded acceptance criteria limits
FLB	Failed laboratory blank	Laboratory blank samples exceeded acceptance criteria limits
FLD	Failed laboratory duplicate	Laboratory duplicate samples exceeded acceptance criteria limits
FLH	Failed laboratory humidity	Laboratory humidity exceeded acceptance criteria limits
FLT	Failed laboratory temperature	Laboratory temperature exceeded acceptance criteria limits
FQC	Failed quality control	The analysis result is not reliable because quality control criteria were exceeded when the analysis was conducted; numeric field, if present, is estimated value.
FTB	Failed trip blank	Trip blank sample exceeded acceptance criteria limits
GSI	Good shipping integrity	Integrity of filter upon receipt by shipping/receiving looked good
HTE	Holding time exceeded	Filter holding time exceeded acceptance criteria limits
ISP	Improper sample preservation	Due to improper preservation of the sample, it was rendered not suitable for analysis
INV	Invalid sample	Due to single or a number or flags or events, the sample was determined to be invalid.

Code	Definition	Description
LAC	Laboratory accident	There was an accident in the laboratory that either destroyed the sample or rendered it not suitable for analysis.
LLS	Less than lower standard	The analysis value is less than the lower quality control standard.
LTC	Less than criteria of detection	Value reported is less than the criteria of detection
NAR	No analysis result	There is no analysis result required for this subject parameter
REJ	Rejected	The analysis results have been rejected for an unspecified reason by the laboratory. For any results where a mean is being determined, these data were not used to calculate the mean.
REQ	Re-que for re-analysis	The analysis is not approved and must be re-analyzed using a different method.
RET	Return(ed) for re-analysis	The analysis result is not approved by laboratory management and re-analysis is required by the bench analyst with no change in the method.
RIN	Re-analyzed	The indicated analysis results were generated from a re-analysis
STD	Internal standard	The subject parameter is being used as an internal standard for other subject parameters in the sample. There is no analysis result report, although the theoretical and/or limit value(s) may be present
UND	Analyzed but undetected	Indicates material was analyzed for but not detect

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Appendix C

Validation Template used by the PED in the first level Validation Algorithm

Figure C-1 below is a two-page validation template from in the PED application that is filled with critical and non-critical criteria that are compiled through the collection of field and laboratory data. The $PM_{2.5}$-PEP Laboratory Manager and EPA Laboratory Task Monitor use this form to assist in validating data.

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PM2.5 Performance Evaluations

Record Last Changed:

PE Filter ID: **AIRS Site Code:** POC: Site Name

Distance from AQS Lat/long (m): **Sampler ID:** AQS Site Addr:

AQS Site Name:

Filter Lot: Sampler Serial No.: Audited By:

PE Cassette ID: Companion Filter: Sampler Model:

Companion Cassette: Secondary Separator Type:

PE Run Time	
PE Start Date:	
Elapsed Time (days):	
PE Stop Date:	
Filter Removed Date:	

Concentration	
Measured by PE Sampler (µg/m³):	
Measured by Site (µg/m³):	
Percent Difference:	

Field Flag:

Comment:

Sample Flow/Volume	
Flow Avg (L/min).:	
Flow CV:	
Sample Vol. (m³):	

Ambient Sample Temperature (ºC)	
Average:	
Minimum:	
Maximum:	

Barometric Pressure (mm Hg)	
Average:	
Minimum:	
Maximum:	

Out of Spec.	
Time:	☐
Temperature:	☐
Flow:	☐

Field Verifications	
BP:	☐
Temperature:	☐
Flow:	☐

Field Blank	
Cassette ID:	
Filter ID:	
Pre- Wt. (mg):	
Post- Wt. (mg):	
Wt. Change (mg):	

Trip Blank	
Cassette ID:	
Filter ID:	
Pre- Wt. (mg):	
Post- Wt. (mg):	
Wt. Change (mg):	

Lab Blank	
Cassette ID:	
Filter ID:	
Pre- Wt. (mg):	
Post- Wt. (mg):	
Wt. Change (mg):	

Collocated Samplers	
Collocated:	☐
Count.:	
Std. Dev.:	
Mean:	
Max CV (%):	

	Pre-sample (Unexposed)		Post-sample (Exposed)		Pre/Post
Weigh Sessions					
Equilibration Tray:					
Equilibration Time (hours):					
Weigh Session ID:					(Sample Mass)
Holding Time (days):					
Filter Weight (mg):					
Weighing Room Conditions					
Avg. Temperature (ºC):					
Temp. Std. Dev. (ºC):					(RH Diff.)
Avg. Relative Humidity (%):					
RH Std. Dev. (%):					
Batch Duplicates					
Filter ID:					
Primary Weight (mg):					
Duplicate Weight (mg):					
Weight Change (mg):					
Low Mass Balance Checks					
Verified Weight (mg):					
Minimum Weight (mg):					(Max. Overall Wt. Diff.)
Maximum Weight (mg)					
Maximum Wt. Diff. (mg)					
High Mass Balance Checks					
Verified Weight (mg):					
Minimum Weight (mg):					(Max. Overall Wt. Diff.)
Maximum Weight (mg):					
Maximum Wt. Diff. (mg):					

Lab Approval	
Valid Data:	☐
PE Rejected:	☐
Complete:	☐

QA Manager Approval	
Approval:	☐
Initials:	
Date:	

PM2.5 Performance Evaluations

Record Last Changed:

PE Filter ID: **AIRS Site Code:** POC: Site Name

Distance from AQS Lat/long (m): **Sampler ID:** AQS Site Addr:

AQS Site Name:

Quality Control Checks Check Date:

Check ID	Code	Description	Check Value	Auto QC Pass	Auto QC Fail	Override Pass	Override Fail	Comment
Critical criteria			**3 points per failure, if not overridden**					
1	DAM	no filter damage (visual defect)		☐	☐	☐	☐	
2	EST	sample period 1380-1500 min	min	☐	☐	☐	☐	
3	FLR_1	flow rate <= ± 5% of 16.67 L/min	L/min	☐	☐	☐	☐	
4	FLR_2	flow rate <= 2% CV		☐	☐	☐	☐	
5	FVL	no flow rate excursions > ± 5% for > 5 min		☐	☐	☐	☐	
6	HTE_1	sample recovery <= 96 hours from sample end date	hours	☐	☐	☐	☐	
7	HTE_2	post-sample weighing <= 10 days at 25 deg C or <= 30 days at 4 deg C	days, deg C (cold pack:)	☐	☐	☐	☐	
8	ISP_1	pre-sample minimum 24 hour equilibration	hours	☐	☐	☐	☐	
9	ISP_2	pre-sample mean temperature 20-23 degrees C	degrees C	☐	☐	☐	☐	
10	ISP_3	pre-sample temperature control ± 2 degrees C over 24 hours	degrees C	☐	☐	☐	☐	
11	ISP_4	pre-sample mean RH 30-40%	percent	☐	☐	☐	☐	
12	ISP_5	pre-sample RH SD control ± 5%	percent	☐	☐	☐	☐	
13	ISP_6	post-sample minimum 24 hour equilibration	hours	☐	☐	☐	☐	
14	ISP_7	post-sample mean temperature 20-23 degrees C	degrees C	☐	☐	☐	☐	
15	ISP_8	post-sample temperature control ± 2 degrees C over 24 hours	degrees C	☐	☐	☐	☐	
16	ISP_9	post-sample mean RH 30-40%	percent	☐	☐	☐	☐	
17	ISP_10	post-sample RH SD control ± 5%	percent	☐	☐	☐	☐	
18	ISP_11	pre/post sample RH ± 5%	percent	☐	☐	☐	☐	
Sample batch validation with major and minor flags			**3 points per failure, if not overridden**					
19	FIS_1	pre-sample 100 mg balance check (max diff from verified wt) <= ± 3 ug	ug	☐	☐	☐	☐	
20	FIS_2	pre-sample 200 mg balance check (max diff from verified wt) <= ± 3 ug	ug	☐	☐	☐	☐	
21	FLD_1	pre-sample duplicate filter weight ± 15 ug	ug	☐	☐	☐	☐	
22	FIS_3	post-sample 100 mg balance check (max diff from verified wt) <= ± 3 ug	ug	☐	☐	☐	☐	
23	FIS_4	post-sample 200 mg balance check (max diff from verified wt) <= ± 3 ug	ug	☐	☐	☐	☐	
24	FLD_2	post-sample duplicate filter weight ± 15 ug	ug	☐	☐	☐	☐	
25	FLB	lab blanks ± 15 ug	ug	☐	☐	☐	☐	
26	FFB	field blanks ± 30 ug		☐	☐	☐	☐	
Operational evaluation criteria			**1 point per failure, if not overridden**					
27	FLT	filter temperature, no excursions of > 5 degrees C lasting longer than 30 min		☐	☐	☐	☐	
28	FAT	temperature verification ± 2 degrees C		☐	☐	☐	☐	
29	FPC	barometric pressure verification ± 10 mm Hg		☐	☐	☐	☐	
30	FSC	flow rate verification ± 4%		☐	☐	☐	☐	
31	HTE_3	(pre-sample) filter holding <= 30 days from pre-weigh	days	☐	☐	☐	☐	
32	BDL	lower detection limit (PM2.5 conc. >= 2 ug/m3)	ug/m3	☐	☐	☐	☐	
33		upper concentration limit (PM2.5 conc. <= 200 ug/m3)	ug/m3	☐	☐	☐	☐	
34	FCS	collocated CV <= 10%	%	☐	☐	☐	☐	
39	FRW_5	pre-sample filter replicates <= 5 ug between weighings (single filter)	ug (diff.)	☐	☐	☐	☐	
40	FRW_6	post-sample batch stability test < 15 ug between weighings (consecutive weights for 2 of 3 filters)	of filters < 15 ug	☐	☐	☐	☐	

Total Score: **(Events with total score < 3 meet scoring criteria.)**

Appendix D

Revision History

Revision Number	Date	Responsible Party	Description of Change
1	March, 2009	OAQPS	
2	May 2022	OAQPS	Changes made throughout the entire document based on the evolution of the program over time as well as anticipated software updates (i.e., MoPED and LIMS).

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