Wyoming Department of Environmental Quality, Air Quality
Division Quality Assurance Project Plan for
Particulate Matter Ambient Air Monitoring Program

Summary of Revisions,
Revision 2.0
Date: October 2023

Section	Page (s)	Revision Made
All	1-65	Writing of QAPP Version 1.0, T&B Systems, 3.15.21
All	1-67	Revisions made to QAPP per comments T&B Systems 7.28.21
All	1-69	Updated all Originations charts and tables 2.25.22
1	1	Updated Signature Page with current staff
3	11	Updated Table 1 -Distribution list with current staff
4	17	Updated Figure 1 -Organizational Chart
5	20	Updated Figure 2 – WDEQ-AQD PM10 Monitoring Sites
5	21	Updated Figure 3 – WDEQ-AQD PM2.5 Monitoring Sites
6	24	Updated Table 2 – Project Reports
7	28	Update made to Table 4 DQIs for PM_{10} Beta Attenuation Monitor (Monthly Leak Check Acceptance Criteria)
7	29	Update made to Table 5 DQIs for PM2.5 Beta Attenuation Monitor
7	30	Update to Table 6 DQIs for the $PM_{2.5}$ Filter-Based Methods
16	47	Update to Table 11 BAM Recommended Maintenance Activities I Broke out PM2.5 and PM10
19	53	Updated Section 19.9 Data Flagging to include the link for AQS' Qualifier Codes
23	61	Updated Section 23.3 with link for additional AQS'Qualifier Codes
All	All	Headings, tables, maps updated
Appendix A.2	109-112	Added Section 10 to Appendix A.2 for Zero BKGD
Appendix B	113-115	Update Table One -Monitoring Station Details
Appendix B	115-117	Update Table Two -Site Specific PM

Wyoming
Department of Environmental Quality
Air Quality Division

Quality Assurance Project Plan For the Particulate Matter Ambient Air Monitoring Program

October 2023
Revision No. 2.0

Section A. Project Management

1.0 QA Project Plan Identification and Approval

Title: Wyoming Department of Environmental Quality, Air Quality Division (WDEQ-AQD) Quality Assurance Project Plan (QAPP) for the Particulate Matter Air Pollution Monitoring Program.

This QAPP for the Particulate Matter Ambient Air Quality Monitoring Program is hereby recommended for approval and commits from the Department to follow the elements described within.

Wyoming Department of Environmental Quality, Air Quality Division

Leif Olson Paulson — 11/29/2023
Air Pollution Monitoring Program Supervisor, Leif Paulson — Date

Joseph Mazza — 11/28/2023
Quality Assurance Coordinator, Joe Mazza — Date

Mark R. Gagen — 11/28/2023
Air Pollution Monitoring Program Manager, Mark R. Gagen — Date

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Acknowledgments

Documents such as a Quality Assurance Quality Plan (QAPP) require the work and commitment of many dedicated people. This section will acknowledge those who have provided their time and effort to create this document.

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Acronyms

AGL	Above Ground Level
AMTIC	Ambient Monitoring Technology Information Center
APTI	Air Pollution Training Institute
AQD	Wyoming Air Quality Division
APMP	Air Pollutant Monitoring Program
AQS	Air Quality System
ASQ	American Society for Quality
AWMA	Air & Waste Management Association
BAM	Beta Attenuation Monitor
CFR	Code of Federal Regulations
CSN	Chemical Speciation Network
DAS	Data Acquisition System
DQIs	Data Quality Indicators
DQOs	Data Quality Objectives
E-log	Electronic Logbook
EPA	U.S. Environmental Protection Agency
FEM	Federal Equivalent Method
FRM	Federal Reference Method
HVAC	Heating, Ventilation, and Air Conditioning
IMPACT	Inventory, Monitoring, Permitting, and Compliance Tracking
IMPROVE	Interagency Monitoring of Protected Visual Environment
IMS	Industrial Monitoring Stations
MFC	Mass Flow Calibrator
MQOs	Measurement Quality Objectives
NAAQS	National Ambient Air Quality Standards
NPAP	National Performance Audit Program
NIST	National Institute of Standards and Technology
NCore	National Core Air Measurement Network
PM	Particulate Matter
PM_{10}	Particulate Matter that is less than 10 microns in aerodynamic size
$PM_{2.5}$	Particulate Matter that is less than 2.5 microns in aerodynamic size
PM_{coarse}	Particulate Matter that is between 10 and 2.5 microns in aerodynamic size
PEs	Performance Evaluations
PEP	Performance Evaluation Program
PQAO	Primary Quality Assurance Organization
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
SLAMS	State and Local Air Monitoring Stations
SLT	State/Local/Tribal
SOP	Standard Operating Procedure
SPMS	Special Purpose Monitoring Stations

Acronyms (cont.)

SSI	Size Selective Inlet
UCD-ARQC	University of Davis - Air Quality Research Center
URG	University Research Group
VSCC	Very Sharp Cut Cyclone
WAAQS	Wyoming Ambient Air Quality Standards
WDEQ	Wyoming Department of Environmental Quality3.0 Distribution List

3.0 Distribution List

The following individuals listed in **Table 1** have been provided a copy of this QAPP.

Table 1. Distribution List.

Wyoming Department of Environmental Quality, Air Quality Division	
Name	**Position**
Nancy Vehr	Administrator
Mark Gagen	Air Pollutant Monitoring Program Manager
Leif Paulson	Air Pollutant Monitoring Program Supervisor
Joseph Mazza	Quality Assurance Coordinator
Jacob Berreth	CEMS/SLAMS Coordinator
Miriam Montana	Exceptional Events Analyst/Project Manager
Vacant	Data Manager
Lauren Deverse	Project Manager
Vacant	Project Manager
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Paul Bailey	Monitoring Specialist
Cortney Dekeyser	Monitoring Specialist
EPA Region VIII	
Name	**Position**
Aaron Worstell	EPA Region 8, Air Program Tech Unit
Adam Eisele	EPA Region 8, Air Permitting and Monitoring Branch Manager

4.0 Project/Task Organization

Since the early 1970s, the Air Pollutant Monitoring Program (APMP) has been committed to monitoring the air quality of Wyoming with the goal of protecting, conserving, and enhancing the quality of Wyoming's environment for the benefit of current and future generations. The APMP provides the WDEQ-AQD with valuable information that allows for determination of future policy considerations.

The WDEQ-AQD plans, operates, and maintains a number of different types of ambient monitoring stations, including National Core (NCore), State and Local Air Monitoring Stations (SLAMS), Special Purpose Monitoring Stations (SPMS), Interagency Monitoring of Protected Visual Environment (IMPROVE) monitoring stations, and Industrial Monitoring Stations (IMS).

The SLAMS are sited in populated areas to monitor public health and demonstrate compliance with the National Ambient Air Quality Standards (NAAQS) but may serve other purposes, such as:

- Providing air pollution data to the general public in a timely manner
- Supporting compliance with air quality standards and emissions strategy development
- Supporting air pollution research studies

The SPMS collectively have multiple objectives. These objectives include:

- Providing air pollution data to the general public in a timely manner
- Monitoring public health
- Investigating pollutant concentrations downwind of sources
- Determining background pollutant concentrations

Since 2011, the WDEQ-AQD has operated a fleet of mobile monitoring stations ("mobile stations") to investigate questions or concerns about air quality on a short-term basis (typically one year). Additionally, the WDEQ-AQD administers an NCore station as part of the national network to evaluate long-term trends in air quality. The IMS are independently operated stations that meet the requirements of their permits. Although WDEQ-AQD has oversight authority for the permit-required monitoring networks, the IMS operate as independent Primary Quality Assurance Organizations (PQAOs) under separate AQD and EPA approved QAPPs. IMPROVE monitoring stations are also independently operated, where AQD funds the operations and analysis through EPA Grants.

The WDEQ-AQD is committed to quality and the implementation of the procedures and practices found in this QAPP. Quality assurance (QA) is 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 as expected. Quality control (QC) is 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. The QC system includes the operational techniques and activities that are used to fulfill requirements for quality.

Quality control is largely implemented through the QAPP and the Standard Operating Procedures (SOPs). Each instrument in the various monitoring programs have unique requirements, statutory standards, and support equipment that must be in place in order for the instrumentation to be operated according to the guidelines, rules, and policies that must be followed. This QAPP incorporates the unique qualities that are specific to Particulate Matter (PM) for the WDEQ-AQD programs.

Implementation of the WDEQ-AQD monitoring program requires an investment by the entire management team all the way to the Air Pollution Monitoring Program Manager. WDEQ-AQD management recognizes and accepts this responsibility to identify the QA requirements that will meet the needs and expectations of the monitoring program. Any worthwhile monitoring program focuses on preventing quality problems.

Since the WDEQ-AQD has an overarching Quality Management Plan (QMP) in place, this and all QAPPs will be mandated by the WDEQ-AQD QMP. The QMP describes the quality system in terms of the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, assessing, and reporting activities involving environmental data operations.

The following subsections describe the project participants and roles and responsibilities of each participant. **Figure 1**, which is in the last portion of this section, illustrates that management structure.

4.1 Air Pollutant Monitoring Program Manager

The APMP Manager has overall responsibility for managing the AQD according to WDEQ-AQD policy. The direct responsibility for assuring data quality rests with line management. Ultimately, the APMP Manager is responsible for establishing QA policy and for resolving QA issues identified through the QA program.

Major QA related responsibilities of the APMP Manager include:

- Participating in the budget and planning processes.
- Assuring that the WDEQ-AQD develops and maintains a current and germane quality system.
- Assuring that the WDEQ-AQD develops and maintains current QAPPs.
- Assuring adherence to the QA documents by staff and, where appropriate, other extramural cooperators establishing policies to ensure that QA requirements are incorporated in all environmental data operations.
- Maintaining an active line of communication with the APMP Supervisor, QA Coordinator, and Project Managers conducting management systems reviews.

The WDEQ-AQD APMP Manager delegates the responsibility of QA development and implementation in accordance with WDEQ-AQD policies. Oversight of the WDEQ-AQD's QA program is delegated to the Quality Assurance Coordinator.

4.2 Air Pollutant Monitoring Program Supervisor

The WDEQ-AQD APMP Supervisor is the delegated manager of the routine monitoring programs, which includes the QA/QC activities that are implemented as part of normal data collection activities.

Responsibilities of the APMP Supervisor include:

- Communicating with EPA Project Officers and QA Personnel regarding sampling and quality assurance activities.
- Understanding EPA monitoring and QA regulations and guidance to ensure subordinates understand and follow the regulations and guidance.
- Understanding the WDEQ-AQD's QA policy and ensuring subordinates do as well.
- Understanding and ensuring adherence to the QAPP.
- Reviewing acquisition packages (contracts, grants, cooperative agreements, and interagency agreements) to determine the necessary QA requirements.
- Developing budgets and providing program costs necessary for EPA allocation activities.
- Ensuring that all personnel involved in environmental data collection have access to any training or QA information needed to be knowledgeable in QA requirements, protocols, and technology.
- Certifying to EPA that data are true, correct, and reported to EPA per Title 40 Code of Federal Regulations (CFR) Part 58.15[1].

4.3 Quality Assurance Coordinator

The QA Coordinator is the delegated manager of the WDEQ-AQD's QA Program. The QA Coordinator has direct access to the Administrator, APMP Manager and APMP Supervisor on all matters pertaining to QA. The QA Coordinator’s main responsibility is QA oversight and ensuring that all personnel understand the WDEQ-AQD's QA policy and all pertinent EPA QA policies and regulations specific to the APMP. The QA Coordinator provides technical support and reviews and approves QA products. Responsibilities include:

- Developing and interpreting WDEQ-AQD QA policy and revising it as necessary.
- Developing a QA Annual Report for the Administrator.
- Assisting Monitoring Specialists and Project Managers in developing QA documentation and in providing answers to technical questions.
- Ensuring that all personnel involved in environmental data operations have access to any training or QA information needed to be knowledgeable in QA requirements, protocols, and technology.
- Ensuring that environmental data operations are covered by appropriate QA planning documentation (e.g., QAPPs, data quality objectives, etc.).
- Ensuring that reviews, assessments, performance evaluations, and audits are scheduled and completed and, if needed, conducting or participating in QA activities.
- Tracking the QA/QC status of all programs.
- Recommending required management-level corrective actions.
- Serving as the program's QA liaison with EPA Regional QA Managers or QA Officers and the Regional Project Officer.
- Uploads Quality Assurance data to EPA’s AQS System.

The QA Coordinator has the authority to carry out these responsibilities and to bring to the attention of the APMP Manager any issues associated with these responsibilities. The QA Coordinator either performs or delegates the responsibility of QA development and implementation.

4.4 Project Manager

Project Managers are responsible for project coordination; oversight of contractor activities; maintaining the official, approved QAPP; and QAPP distribution. Responsibilities include:

- Ensuring the day-to-day operation and upkeep of all monitors are maintained.
- Overseeing data processing, reporting, and assuring data collection are performed in a timely fashion.
- Understanding EPA monitoring, QA regulations and guidance, and ensuring contractors, Monitoring Specialist and Site Operators understand and follow those standards.
- Understanding WDEQ-AQD QA policy and ensuring subordinates understand and follow the policy.
- Understanding and ensuring adherence to the QAPP as it relates to program support activities.
- Participating in the development of data quality requirements with the appropriate QA staff.
- Writing and modifying QAPPs and SOPs.
- Verifying that all required QA activities were performed and quality standards were met as required in the QAPP.

4.5 Monitoring Specialist

The field personnel, either WDEQ-AQD or contractor, are responsible for carrying out required tasks and ensuring the data quality results of the tasks by adhering to the guidance and protocols specified by the QAPP and SOPs for the field activities. Responsibilities include:

- Change PM filters (gravimetric and speciation) on the filter-based instruments (weekly or as needed).
- Participating in the implementation of standards, as laid out in the QAPP.
- Keeping up-to-date in training and certification activities.
- Verifying that all required QA activities are performed and quality standards are met (as required by the QAPP).
- Following manufacturer specifications for any equipment used.
- Documenting deviations from established procedures and methods.
- Thoroughly document and keep all routine maintenance activities performed at the stations all problems and report corrective actions to the Site Operator and Project Manager.
- Preparing and delivering reports to the Project Manager.
- Reviewing data and assessing and reporting on data quality.

4.6 Site Operator

For the Particulate Matter network, the Site Operators visit the monitoring station once a month. The Site Operators role is to do the routine maintenance on the monitoring station and instrumentation. For the purpose of this PM QAPP, either WDEQ-AQD Specialists or contractors can perform the duties of Site Operator. Responsibilities include:

- Change PM filters (gravimetric and speciation) on the filter-based instruments (weekly or as needed).
- Perform unexpected tasks such as run a manual calibration (if necessary after a repair).
- Replace electronic or pneumatic components at the direction of a Monitoring Specialist.
- Reporting all problems and corrective actions to the Contractor, Monitoring Specialist or Project Manager.
- Thoroughly documents all activities performed at a station and reports activities and results to Project Manager.
- Reviewing data and assessing and reporting on data quality.

4.7 Data Manager

The Data Manager reports to the APMP Manager and is in charge of the WyVisNet website and the AirVision data management system, which runs WyVisNet. Responsibilities include:

- The Data Manager is in charge of uploading data to the EPA's Air Quality System (AQS), which is the National database for all air pollution and meteorological data.
- Ensures data are moved to/from the IMPACT system, AirVision, and shared drives per our WDEQ Records Management Plan.
- Performs data queries within the central database in Cheyenne headquarters.
- Works with the vendors that supply and maintain the WyVisNet software system.
- Performs data analyses as described in Sections 22 and 23 of this QAPP.
- Programs AirVision to produce monthly and quarterly reports for project manager review.

Please note that an annual review of the QAPP will be performed and, if no changes are needed, the WDEQ-AQD will document that no changes were necessary. If changes are required, revised pages with the revisions will be inserted/changed, revisions will be tracked, and a new revision number will be assigned to the document.

4.8 Data Validator

For AQD operated PM stations, the Data Validator is responsible for data validation and reporting. The validator may hold other duties in the APMP, but may not be the Specialist or Project Manager of the PM station that produces the data they are validating.

- The Data Validator performs daily validation (on business days) of AQD operated stations in the AirVision software.
- The Data Validator communicates with the Project Manager and Monitoring Specialist if the data shows an operational issue at a monitor.

Figure 1 on this page illustrates the organization structure for the WDEQ-AQD. For a list of project participants, please see Appendix B.

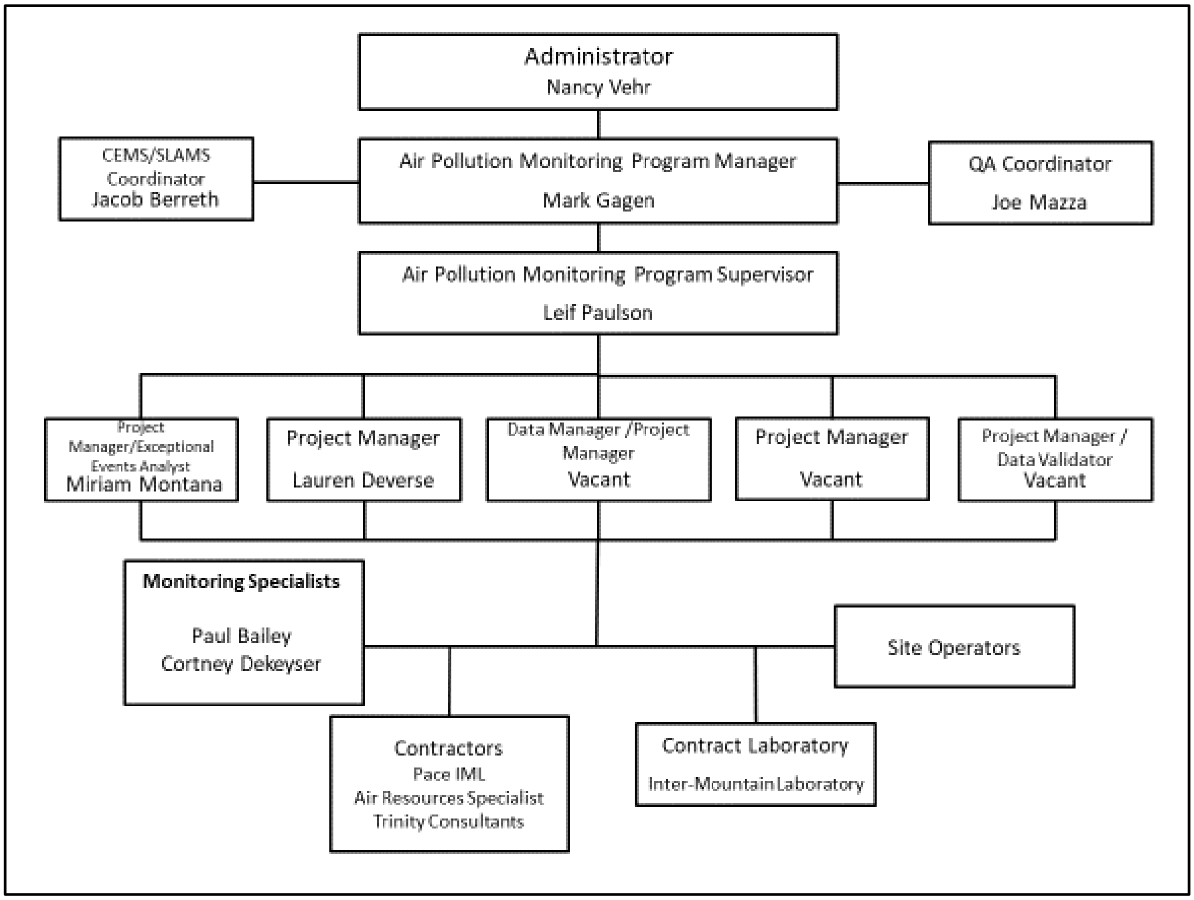

Figure 1. WDEQ-ADQ Organizational Chart.

5.0 Problem Definition/Background

This QAPP pertains strictly to the collection and analysis of Particulate Matter (PM) operated by the WDEQ-AQD and its contractors and details the methodologies to establish precise and accurate measurements at the stations that are operated within the State, regardless of the type of monitoring that is performed. The objective of the PM monitoring network is to provide the necessary information for developing a representative air quality data set capable of determining whether the National and State of Wyoming air quality standards for PM are being exceeded and delineating differences among geographical and climatological regions. The monitored data are used to characterize and monitor trends in air quality and ensure compliance to air quality standards, and may be used for national health assessments, model evaluations, and comparison with other ambient air monitoring data.

Historically, in July 1997, EPA completed its review of evidence on exposure to ambient fine particulates and revised the Particulate Matter – aerodynamic range of less than 10 microns (PM_{10}) National Ambient Air Quality Standard (NAAQS) by creating a PM – aerodynamic range of less than 2.5 microns ($PM_{2.5}$). EPA determined that the NAAQS would continue to focus on PM_{10}, but also determined that the fine and coarse fractions of PM_{10} should be considered separately. In 2006, EPA revised the NAAQS for PM with the final standards addressing two categories of PM emissions: $PM_{2.5}$ and PM_{10}.

The procedures outlined in this QAPP have been developed to meet the goals and objectives of the WDEQ-AQD PM monitoring network. Revisions to the QAPP are made, as necessary, to reflect changes to the regulations or goals of the monitoring network. At a minimum, the QAPP is reviewed and revisions are made as necessary, generally on an annual basis.

The background and rationale for the implementation of the $PM_{2.5}$ and PM_{10} ambient air monitoring network can be found in the Federal Register.[1] In general, some of the findings are listed below:

- The characteristics, sources, and potential health effects of larger or "coarse" particles (from 2.5 to 10 micrometers in diameter) and smaller or "fine" particles (smaller than 2.5 micrometers in diameter) are very different.
- Coarse particles come from sources such as windblown dust from the desert or agricultural fields and dust kicked up on unpaved roads from vehicle traffic.
- Fine particles (i.e., $PM_{2.5}$) 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 sulfur dioxide, nitrogen oxides, and volatile organic compounds that are emitted from combustion activities and then become particles as a result of chemical transformations in the air.
- Health effects from PM inhalation include premature death and increased hospital admissions and emergency room visits (primarily among the elderly and individuals with cardiopulmonary disease); increased respiratory symptoms and disease (among children and individuals with cardiopulmonary 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.

According to the WDEQ-AQD Annual Network Plan[2], the WDEQ-AQD monitors for PM_{10} and $PM_{2.5}$ at numerous stations in Wyoming. Please note that this QAPP only covers WDEQ-AQD monitored PM: the continuous Beta Attenuation Monitors (BAMs), the filter based Federal Reference Method (FRM) and the Chemical Speciation Network (CSN) filter based instruments. It should be noted that the BAM is a Federal Equivalent Method (FEM). From the 24-hourly readings, daily values are estimated. These daily averages are ranked throughout the calendar year. The CSN samplers are neither FRM nor FEM instruments. The CSN samplers collect samples that are sent to a laboratory for chemical speciation to provide data that can be used for source apportionment.

5.1 National and State of Wyoming Air Quality Standards

The national primary and secondary ambient air quality standard for PM_{10} is 150 micrograms per cubic meter ($\mu g/m^3$) 24-hour averaged concentration measured in ambient air. The primary ambient air quality standard for $PM_{2.5}$ is 12.0 $\mu g/m^3$ annual arithmetic mean concentration measured in ambient air and 35 $\mu g/m^3$ 24-hour averaged concentration measured in ambient air.

To comply with the 24-hour PM_{10} NAAQS, a monitor may only have one exceedance (a 24-hour average concentration greater than 150 $\mu g/m^3$) per year on average over a three-year period. A design value of zero means the station has not recorded any values over 150 $\mu g/m^3$ during the three-year period. Wyoming also has an ambient air quality standard for PM_{10} in its State regulations. Compliance with the annual Wyoming Ambient Air Quality Standards (WAAQS) is determined by the three-year average of the annual mean. The three-year average of the mean must be below 50 $\mu g/m^3$.

For stations that monitor $PM_{2.5}$, the primary annual NAAQS and WAAQS is attained when the three-year average does not exceed 12.0 $\mu g/m^3$. The 24-hour $PM_{2.5}$ NAAQS and WAAQS is 35 $\mu g/m^3$. Compliance with this standard is determined from the 3-year average of the 98th percentile concentration.

The WDEQ-AQD's current $PM_{2.5}$ network uses a combination of Thermo Scientific Partisol 2000i FRM monitors (Partisol), Met One BAM models 1020 and 1022 FEM analyzers, the Met One SuperSASS, and the URG 3000N CSN instruments. The Partisol monitors are filter-based, meaning that filters capture $PM_{2.5}$ on an EPA determined 1-in-3-day schedule; those filters are then shipped to a laboratory to be weighed; data from these monitors cannot be shared on a near-real time basis since it can take up to 3 weeks to get filter weight results. The Partisols in WDEQ-AQD's network require a WDEQ-AQD Monitoring Specialist or WDEQ-AQD Operator to collect filters and to visit the stations once a month to perform required maintenance. The BAMs are continuous (measuring concentrations each hour) and report data electronically to a database for further validation and can be shared with the public on a near-real time basis. The BAMs in WDEQ-AQD's Network require a WDEQ-AQD Site Operator, WDEQ-AQD Monitoring Specialist or Contractor Monitoring Specialist to perform a monthly maintenance visit. The Met One Sass and URG 3000N are filter based instruments and require either a WDEQ-AQD Site Operator or WDEQ-AQD Monitoring Specialists to collect filters and a WDEQ-AQD Monitoring Specialist to visit the stations once a month to perform required maintenance.

Figures 2 and 3 below illustrate the WDEQ-AQD past and current PM monitoring stations. As shown in the maps, the PM air monitoring network covers the entire state. It should be noted that not every site measures continuous PM, filter-based monitors or CSN instruments.

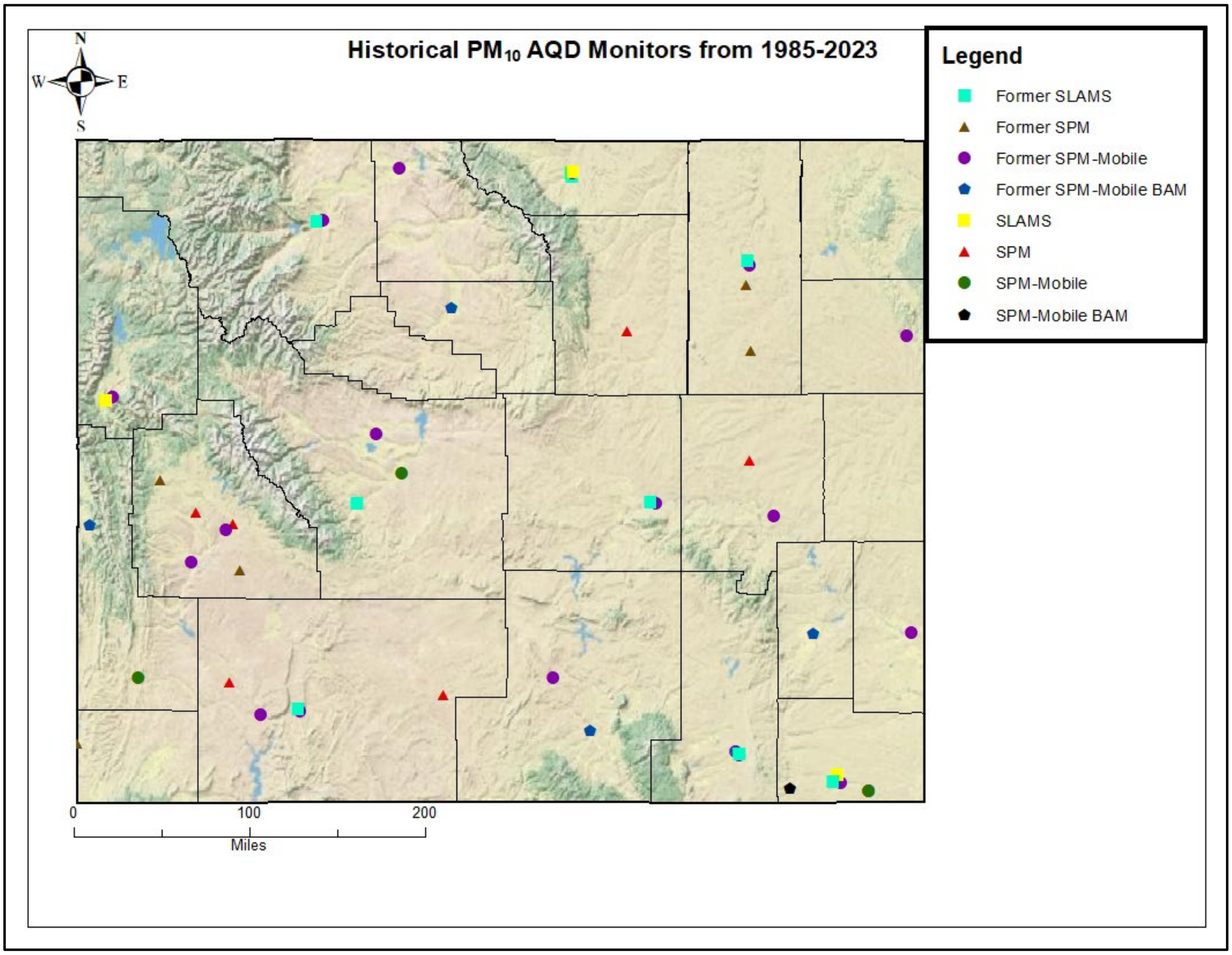

Figure 2 WDEQ-AQD PM$_{10}$ Monitoring Site Locations from 1985 - 2023 (October).

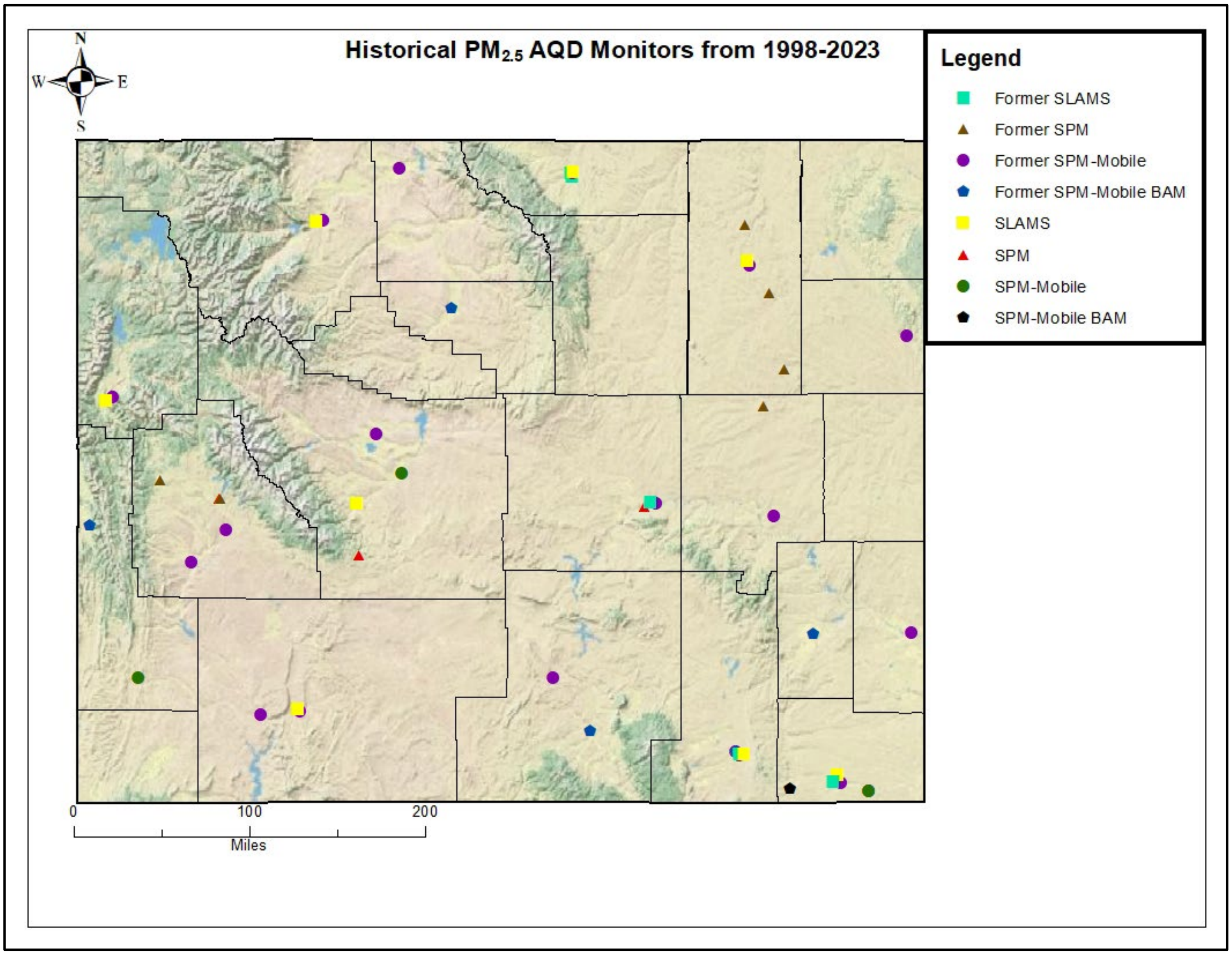

Figure 3. WDEQ-AQD $PM_{2.5}$ Monitoring Site Locations from 1998 - 2023 (October).

5.2 Supporting Documentation

The information collected for this monitoring program will meet requirements, as found in the following documents:

- 40 CFR Part 58 Appendix A, Quality Assurance Requirements for Monitors Used in Evaluations of National Ambient Air Quality Standards.[3]
- EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, EPA-454/B-17-001, January 2017. [4]
- Quality Assurance Guidance Document Quality Assurance Project Plan: $PM_{2.5}$ Chemical Speciation Sampling at Trends, NCore, Supplemental and Tribal Sites EPA-454/B-12-003 June 2012[5]
- U.S. EPA (1997a) National Ambient Air Quality Standard for Particulate Matter – Final Rule 40 CFR Part 50. Federal Register 62(138): 38651-38760. July 18, 2011.[6]
- Wyoming Department of Environmental Quality Air Quality Division Standards and Regulations Chapter 2 Ambient Standards
- WDEQ-AQD Annual Network Plan, 2020[2]

The guidance presented in the above listed documents and to be followed for this monitoring program are intended to ensure that data and technical information measured are documented and of appropriate quality and usability.

6.0 Project Task Description

6.1 Particulate Matter Measurements.

The analytical principles for PM samplers are twofold: beta attenuation and gravimetric analysis of 26 or 47 mm filters.

BAM technology is based on the difference between the substrate sampling tape that has no PM (blank) and after PM has deposited onto the tape. At the beginning of each sample hour, a small carbon-14 source emits a constant source of high-energy beta rays through a spot of clean filter tape. These beta rays are detected and counted by a sensitive scintillation detector to determine a zero reading (background or blank). The BAM then advances this spot of tape to the sample nozzle, where a vacuum pump pulls a measured and controlled amount of outside air through the filter tape, loading it with ambient dust. At the end of the sample hour, this dust spot is placed back between the beta source and the detector, thereby causing attenuation of the beta signal which is used to determine the mass of the particulate matter on the filter tape. This mass is used to calculate the volumetric concentration of particulate matter in ambient air. For PM_{10} samplers, the inlets are size selective inlets (SSIs) that separate out PM that is 10 microns and smaller. For the continuous $PM_{2.5}$ sampler, an additional very sharp cut cyclone (VSCC) is installed after the SSI and removes the portion that is PM_{10} minus $PM_{2.5}$, which is known as the PM_{coarse} portion of the PM.

The gravimetric and speciation methods utilize the difference in filter weight before the sampler collects PM and after it has collected PM. Some of the $PM_{2.5}$ samplers (Thermo 2000i and URG 3000N) have SSI inlets and cyclonic separator VSCC to selectively separate $PM_{2.5}$ from the rest of the PM_{10}. However, the Met One SuperSASS speciation sampler only has a VSCC inlet, and thus removes all PM above the $PM_{2.5}$ size.

6.2 Sampling Frequency

Data from the continuous BAM instruments are sampled every hour by the Data Acquisition System (DAS). The DAS then stores the data in hourly increments. These data are then transmitted and reviewed by WDEQ-AQD staff and contractors on a defined interval. The filter based FRM instruments (Thermo Scientific 2000i), are operated on a 1-in-3 day schedule. The CSN instruments (Met One SuperSASS and URG 3000N) are operated on a 1 in 3 day schedule.

6.3 Project Schedule

Personnel working on this project are fully qualified, trained, and capable of performing their assigned duties. Work schedules include: daily data review; quarterly and semi-annual air quality and meteorological equipment calibrations, respectively; quarterly data summaries within 60 days of quarter completion; annual reports within 90 days of year completion; secondary review of quarterly reports, and maintenance and corrective action.

6.4 Project Reports

Table 2 presents the reports that will be produced as part of this project.

Table 2. Project Reports.

Reports	Frequency	Content	Responsible Position
Quarterly Air Quality Reports	Quarterly	Summarizes data following EPA guidelines, includes accuracy and precision	Contractors with review by Project Managers or AQD Data Validator with review by Project Manager.
Air Quality Annual Data Report	Annually	Summarizes data following EPA guidelines	Contractors with review by Project Managers
Performance Audit Reports	Quarterly/Semi-annually	Summarizes audit results following EPA guidelines	WDEQ-AQD QA Coordinator or Contractor with review by Project Manager
Corrective Action Reports	As Needed	Summarizes corrective actions taken to return the monitoring station to compliant status	Contractors with review by Project Managers or Monitoring Specialists with review by Project Managers
Response to Corrective Action Reports	As Needed	Reports the results of the corrective actions taken	Contractors with review by Project Managers or Monitoring Specialists with review by Project Managers

7.0 Quality Objectives and Criteria for Measurement of Data

This section discusses the Data Quality Objectives (DQOs), Measurement Quality Objectives (MQOs), and Data Quality Indicators (DQIs) that are mandatory for all monitoring programs.

Generally, the DQOs for any program are created by the stakeholders. The DQO process is a seven-step decision tree that allows the stakeholders for the WDEQ-AQD to define parameters for the program. The DQO process has been in existence for many years, first by the EPA and then utilized by the State, Local and Tribal governments that are required to collect data on behalf of the EPA. Please note that it is outside the scope of this document to discuss whether or not the State of Wyoming, or parts of the state, are in attainment. That distinction is discussed in the WDEQ-AQD Annual Network Plan[2]. Please refer to that document for the discussion of attainment for PM.

As mentioned, the DQO is a seven-step process that takes the form of a discussion of the important aspects of the program. It is encouraged and useful that the DQO process be performed from time to time to ensure that the objectives are clear and concise.

7.1 The DQO Process

On August 12, 2020, the WDEQ-AQD met to discuss the DQOs for the programs and define the objectives. **Table 3** below outlines the discussion and the outputs of the DQO process in each step.

In order for the DQOs to be fulfilled, MQOs are designed to evaluate and control various phases (sampling, preparation, and analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. MQOs can be defined in terms of the following DQIs: precision, bias, representativeness; detectability; completeness; and comparability.

Table 3. DQO Process Write-up.

DQO Step	Output to Discussion by Decision Makers
Step 1. State the Problem.	The State of Wyoming, being within the bounds of the United States, must adhere to the Clean Air Act Amendments. 40 CFR Part 50[2] set the NAAQS and state measures for the NAAQS pollutants. In addition, the State of Wyoming promulgated their own Wyoming Ambient Air Quality Standards (WAAQS), which are nearly identical to the NAAQS. The State must comply with these standards and thus measure in various locations to meet the requirements.
Step 2. Identify the Goal of the Study	Not only does the State of Wyoming have to measure for these NAAQS pollutants, they must adhere to the level of the standard (attainment vs. nonattainment as promulgated in 40 CFR Part 50[7]).
Step 3. Identify Information Input	The input information is the hourly (BAM) and daily (speciated and gravimetric) PM data that are collected at the locations where PM is monitored (see Appendix B).

DQO Step	Output to Discussion by Decision Makers
Step 4. Define the Boundaries of the Study	The boundary of the study is the entire State of Wyoming. This applies to the WDEQ-AQD Primary Quality Assessment Organizations (PQAO).
Step 5. Develop the Analytical Approach	The WDEQ-AQD will collect PM data (hourly BAM, gravimetric and chemical speciation) at designated monitoring locations, as stated in Appendix B. At the end of the year, the WDEQ-AQD will review, analyze, and certify that the data collected within the state networks are valid within the parameters laid out in this QAPP.
Step 6. Specify Performance Criteria	The performance criteria are described in this QAPP under the MQOs and thus the DQIs. If the data collected adhere to these performance criteria, then the data, (hourly BAM and gravimetric), can be used to ascertain if the State of Wyoming is within nonattainment or attainment status for the NAAQS and WAAQS. In addition, If the CSN data collected adhere to their performance criteria for the chemical speciation $PM_{2.5}$ data, then this data can be used to perform source apportionment to understand the sources of fine particulate in the State of Wyoming. The results of these decisions are discussed in detail within the WDEQ-AQD Annual Network Plan[2].
Step 7. Develop the Plan for Obtaining Data	Having developed these DQOs, the WDEQ-AQD has developed this PM QAPP and SOPs to ensure that the QA and QC procedures are documented and followed by WDEQ-AQD staff and their contractors.

7.2 Data Quality Indicators

The DQIs are a set of indicators that can be easily measured. For instance, precision and bias can be calculated using statistical methods upon the data. The other DQIs are either inherent in the PM instrument or indicate how the samples are handled and analyzed.

Here is a discussion of each DQI:

- **Precision** - a measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions. This is the random component of error. Precision is estimated by a statistical technique typically using a derivation of the standard deviation. Precision is determined based on measurement uncertainty as defined as 10 percent coefficient of variation (CV) for total precision based on comparison of the 24-hour PM samplers (both continuous and filter based) that are collocated at the same location or a check of total flow rate.

- **Bias -** the systematic or persistent distortion of a measurement process, which causes error in one direction. Bias will be determined by estimating the positive and negative deviation from the true value. Bias is determined by using the paired data and is measured as +/- 10 percent for total bias. For the gravimetric instruments (Thermo 2000i, which is a FRM), the EPA or its designee will place a mobile Performance Evaluation (PE) gravimetric sampler, next to the station sampler. Both samplers (PE and station samplers) will collect samples on the same day, typically for 24 hours. The EPA designee will then retrieve the sample and ship it to an independent laboratory for gravimetric analysis. The site sampler will be operated in its normal fashion and the sample collected on its normal schedule. The WDEQ-AQD will send the gravimetric data to EPA via the Air Quality System (AQS) for comparison with the EPA sampler. For the CSN instruments (Met One SuperSASS and URG 3000N) and the BAM instruments, the bias is calculated using the flow rate of samplers against a NIST traceable flow device. The goal for acceptable bias is <15.0%.
- **Detection Limit -** the lowest concentration or amount of the target analytic that can be determined to be different from zero by a single measurement at a stated level of probability. This is performed by analyzing the blank tape of the BAM instrument and field blanks that travel with the samples from and to the analytical laboratory.
- **Completeness -** describes the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Data completeness requirements are generally 75% of all possible samples in a given time frame.
- **Comparability** - generally falls under the auspice of equipment specifications and monitoring methods. For continuous PM, only Federal Equivalent Method (FEM) instruments are used for the collection of PM_{10} and $PM_{2.5}$ data. The methodology used is to draw the air samples through an inlet and downtube into the instrument with the PM being deposited upon Teflon tape. For the FRM Thermo 2000i, this also falls under the auspice of the equipment specifications as set forth by the EPA that creates the FRM designation.
- **Representativeness -** this DQI deals with whether or not the location of the PM instrument represents the type of monitoring that is necessary—i.e., whether the station is sited appropriately for the objective. This is further discussed in Section 7.3 below.
- **Accuracy -** a measure of the overall agreement of a measurement to a known value, including a combination of random error (precision) and systematic error (bias) components of sampling.

7.3 Representativeness of the Particulate Matter Measurements

Site selection and probe placement followed guidelines from the following EPA documents to ensure that measurements are representative of meteorological and air quality monitoring conditions near the monitoring stations:

- EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, EPA-454/B-17-001, January 2017[4].
- 40 CFR 58, Appendices A and E [3, 8].

The sites that were selected to house the PM instruments were selected to be as representative as possible to the general region of interest. Placement of monitors considered local interferences; distance to structures, trees, and roadways; and height of probe above ground.

Table 4. DQIs for PM_{10} Beta Attenuation Monitors

Parameter (Manufacturer/ Model)	Requirement	Frequency	Acceptance Criteria	Reference	Data Completeness
PM_{10} Met One BAM 1020	Average PM_{10} flow rate	Every 24 hours of operation	Average within <±5.1% of design	Recommendation	**DEQ/AQD Objective 90% EPA Requirement 75%**
	Temperature	Monthly	<±2.1 °C	40 CFR Part 50, App. L Sec. 9.3[9]	
	Pressure	Monthly	<±10.1 mmHg		
	Calibration (PM_{10})	Annually	3 of 4 calibration points within <±10.1% of design	40 CFR Part 50, App. J, Section 8.0[9]	
	One-point PM_{10} Flow rate verified.	Monthly with at least 14 days between verifications	<±7.1% of transfer standard Action Limit< 3.1%	40 CFR Part 58, App. A, Section 3.3[3]	
	Monthly Leak Check	Monthly	<1.5 lpm (acceptance limit) < 1.0 lpm (action limit)	40 CFR Part 50 App L, Sec. 7.4.6.1	
	Variability in flow rate (24 hours)	Every 24 hours of operations	CV < 2.1	40 CFR Part 50, App. L Sec. 7.4.3.2	
	Annual Zero Test	Annually	Std. Dev. < 3.5 µg/m³	Recommendation: Std. Dev not defined in Operators manual	
	Annual Calibration Temp and pressure	On installation, then 365 days and once a calendar year	Temp: < 2.1 deg. C Pressure: < 10 mm Hg	40 CFR Part 50, App. L, Sec. 9.3	
	Semi-annual flow rate	Every Six months	<± 10.1% of audit Std. Dev.	Part 58, App A, Sec. 3.3.3	
	Reporting Units	µg/m³	NA	40 CFR Part 50 App. N[9]	
	Sampling Period	Every Sampling Day	1440 min. +/- 60 min. Midnight to Midnight	40 CFR Part 50 App J Section 7.1.5[10]	
	Clock Timer Verification	Monthly	5 min/month	Per Operators manual	

Table 5. DQIs for $PM_{2.5}$ Beta Attenuation Monitors

Parameter (Manufacturer/ Model)	Requirement	Frequency	Acceptance Criteria	Reference	Data Completeness
$PM_{2.5}$ Met One BAM 1022	Average $PM_{2.5}$ flow rate	Every 24 hours of Operation	Average within <± 5% of 16.67 LPM	40 CFR Part 50 App. L, Sec. 7.4.3.1[9]	**DEQ/AQD Objective 90%** **EPA Requirement 75%**
	$PM_{2.5}$ Calibration	Annually	<±2.1% of transfer standard	40 CFR Part 50 App. L, Sec. 9.2[9]	
	One-point $PM_{2.5}$ Flow rate verified.	Monthly with 14 days between verifications.	<±4.1% of transfer standard <±5.1% of flow rate design value	40 CFR Part 58 App. A,	
	Variability in flow rate (24 hours)	Monthly with 14 days between verifications.	<2.1 lpm	40 CFR 50, App L, Section 7.4.6.1[9]	
	Monthly Leak Check	Monthly	<1.5 lpm (acceptance limit) < 1.0 lpm (action limit)	40 CFR Part 50 App L, Sec. 7.4.6.1	
	Annual Calibration Temp and pressure	Annually	Temp: <2.1 deg. C Pressure: < 10.1 mm Hg	40 CFR Part 50, App.L, Sec. 9.3	
	Semi-annual flow rate	Every six months	<±4.1% of transfer standard <±5.1% of flow rate design value	Part 58, App A, Sec. 3.3.3	
	Zero Test	Annually	Std. Dev. < 2.4 µg/m³	Per Operators Manual	
	Reporting Units	µg/m³	NA	40 CFR Part 50 App. N[9]	
	Sampling Period	Every Sampling Day	1440 min. +/- 60 min. Midnight to Midnight	40 CFR Part 50 App J Section 7.1.5[10]	
	Clock Timer Verification	Monthly	5 min/month	Per Operators manual	

Table 6.DQIs for PM2.5 Filter Based Methods

Parameter (Manufacturer/ Model)	Requirement	Frequency	Acceptance Criteria	Reference	Data Completeness
$PM_{2.5}$ – Thermo Scientific 2000i	Annual Performance Evaluation	Annually	< 15% between EPA sampler and station sampler	40 CFR part 58 Appendix A section 3.2.7[3]	**DEQ/AQD Objective 90%** **EPA Requirement 75%**
	Semi-Annual Flow Rate Audit	Every six months	< 15% between EPA sampler and station sampler	40 CFR part 58 Appendix A section 3.2.7[3]	
	Post Sampling Conditioning and Weighing.	Annually	<10 days from sample end date if shipped at ambient temp or <30 days if shipped below avg. ambient (or 4°C or below for avg. sampling temps <4°C) from sample end date	40 CFR Part 50 App L Sec. 8.3.6	
	Transport Temperature	Continuous	Protected from exposure to temperatures above 25°C from sample retrieval to conditioning	40 CFR part 58 Appendix A section 3.2.7[3]	
	Temperature Audit	Semi Annually	< + 2.1° C	40 CFR Part 50, App. L, Sec. 9.3	
	Pressure Audit	Semi Annually	< +10.1 mm Hg	40 CFR Part 50, App. L, Sec. 9.3	
	Precision of Collocated Samples	Every 90 days	(CV) < 10.1% for values > 3.0 µg/m^3	40 CFR Part 58, App A, Sec. 4.2.1	

Parameter (Manufacturer/ Model)	Requirement	Frequency	Acceptance Criteria	Reference	Data Completeness
$PM_{2.5}$ – Thermo Scientific 2000i	Sampling Period	All filters	1380 – 1500 minutes midnight to midnight	40 CFR Part 50, App. L, Section 3.3[9]	**DEQ/AQD Objective 90%** **EPA Requirement 75%**
	Leak Check	Every 30 days	80.1 mL/min	40 CFR Part 50 App. L, Section 7.4.6.1[9]	
	Average Flow Rate	Every 24 hours of operation	Average within < +/- 5% of 16.67 liters per minute (LPM)	40 CFR Part 50 App. L, Section 7.4.3.1[9]	
	Variability in Flow Rate	Every 24 hours of operation	CV ≤ 2%	40 CFR Part 50 App. L, Section 9.2.5[9]	
	One-point Flow Rate Verification	Monthly	± 4.1% of transfer standard ± 5.1% of flow rate design value	40 CFR Part 50 App. L, Section 9.2.6[9]	
	Calibration	Once per quarter	<±2.1% of design flow rate	40 CFR Part 50 App. L, Sec. 9.2.6[9]	
$PM_{2.5}$ – Met One SuperSASS	Leak Check	Every 30 days	≤0.1 LPM	Per Operators Manual Section 6.0	**DEQ/AQD Objective 90%** **EPA Requirement 75%**
	One-point Flow Rate Verification	Monthly	± 10% of transfer and design standards	Per Operators Manual Section 3.4.7	
	Calibration	Annually	<±10% of transfer and design standards	Per Operators Manual Section 6.3	
	Temperature	Monthly	<±2.1 °C	Per Operators Manual Section 3.4.4	
	Pressure	Monthly	<±10.1 mm Hg	Per Operators Manual Section 3.4.5	
$PM_{2.5}$ – URG-3000N	Leak Check	Every 30 days	≤225 mmHg	Per Operators Manual Section 8.2	**DEQ/AQD Objective 90%** **EPA Requirement 75%**
	One-point Flow Rate Verification	Monthly	± 10% of transfer and design standards	Per Operators Manual Section 8.3	
	Calibration	Annually	<±10% of transfer and design	Per Operators Manual Section 6.0	
	Temperature	Monthly	<±2.1 °C	Per Operators Manual Section 8.4	
	Pressure	Monthly	<±10.1 mm Hg	Per Operators Manual Section 8.5	

8.0 Special Training/Certifications

Personnel assigned to the APMP will meet the educational, work experience, responsibility, and training requirements for their positions. Records on personnel qualifications and training will be maintained in personnel files and will be accessible for review during audit activities. All WDEQ-AQD staff will follow the WDEQ-AQD APMP's training plan and provide proper documentation and tracking.

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. It is recommended that monitoring organizations maintain some requirements for air personnel qualifications (combination of education and experience). Training is aimed at increasing the effectiveness of employees and their organization.

As part of a QA program, the procedures should include information on:

- Personnel qualifications - general and position-specific
- Training requirements - by position
- Frequency of training

Appropriate training is available to employees supporting the APMP, commensurate with their duties. Such training may consist of classroom lectures, workshops, web-based courses, teleconferences, and vendor-provided and on-the-job training. Training also includes appropriate reading materials, such as the CFR, EPA guidance documents, and the monitoring organization's QAPPs and SOPs, to name a few.

EPA encourages monitoring organizations to maintain documentation that details the training provided to all monitoring staff, along with documentation that illustrates the successful completion of those training requirements. Along with suggested training, there are some EPA programs that require mandatory training and/or certifications. These programs include, but are not limited to, the National Performance Audit Program (NPAP) and the Performance Evaluation Program (PEP). All personnel performing audits in these projects or programs are required to possess mandatory training or a current certification issued by the EPA office responsible for the monitoring program. Over the years, a number of courses have been developed for personnel involved with ambient air monitoring and quality assurance aspects.

Formal QA/QC training is offered through the following organizations:

- Air Pollution Training Institute (APTI): http://www.epa.gov/apti
- Air & Waste Management Association (AWMA): http://www.awma.org
- American Society for Quality (ASQ): http://www.asq.org
- EPA Quality Staff: http://www.epa.gov/quality
- EPA Regional Offices: https://www.epa.gov/aboutepa
- EPA Ambient Monitoring Technology Information Center (AMTIC) Technology Transfer Network: http://www.epa.gov/ttn/amtic/training.html and http://www.epa.gov/quality1/qs-docs/g10-final.pdf

WDEQ-AQD will add manufacturer-provided training to the equipment purchase cost as budget allows. Persons with experience in the subject matter described in the courses would select courses according to their appropriate experience level. Courses not included in the core sequence would be selected according to individual responsibilities, preferences, and available resources.9.0 Documents and Records

9.0 Documents and Records

The WDEQ-AQD is committed to fully documenting all activities related to data collection, analysis, validation, and reporting. **Table 6** contains a list of the records maintained by the APMP. These records can be electronic, bound in notebooks, and/or forms that are used for specific applications. Electronic records will be stored according to the APMP Records Management Plan. All continuous BAM data are backed up daily and the networks are back up per contractor's schedules. The gravimetric analysis is performed by Pace Analytical/Inter-Mountain Laboratory. This laboratory analyses the $PM_{2.5}$ filters that are collected with the Thermo Scientific 2000i samplers. The CSN filters, which are collected using the Met One SuperSASS and URG 3000N, are weighed and analyzed by the University of Davis - Air Quality Research Center (UCD-AQRC). These two laboratories have their own independent QA/QC documentation. Their QAPPs and SOPs are available upon request.

Other details on WDEQ-AQD records, central database and station contractor server disaster recovery plans can be found in the Monitoring Section Records Management Plan. Hard copy field logbooks are stored in the WDEQ-AQD Cheyenne office for 5 years.

Table 7. Documentation and Reports

Documentation Type	Frequency of Update	Report Submission	Archive	Retention Period
Monitoring Data	Daily downloads	Project Managers	WDEQ-AQD and contractor Server (with backup)	5 years
QAPP and SOPs	Annually or more frequently as needed	WDEQ-AQD QA Coordinator Manager	WDEQ-AQD	5 years
Copies of Field Logbooks	After each site visit	Project Managers	WDEQ-AQD and contractor	5 years
Quarterly Reports	Quarterly	Project Managers	WDEQ-AQD and contractor	5 years
Annual Data Report	Annually	Project Managers	WDEQ-AQD and contractor	5 years
WDEQ-WDEQ-AQD Performance Audit Summaries	Semi-annually	Project Managers	WDEQ-WDEQ-AQD	5 years

All monitoring data, reports and program documentation will be retained by WDEQ-AQD for a minimum of five years. The WDEQ-AQD will review and approve updates or changes to the QAPP given updates in the Records Management Plan.

Section B. Data Generation and Acquisition

10.0 Network Description

For the list of current locations of the Particulate Matter Monitoring Network, please see Appendix B, Instrument Locations.

11.0 Sampling Method

This section gives brief details on how each type of PM sampler and analyzer in the WDEQ-AQD network operates.

11.0 Continuous PM_{10} (BAM)

The Met One BAM-1020 instrument models have been designated by EPA, in accordance with 40 CFR Part 53, an equivalent method for measuring concentrations of particulate matter as PM_{10} in the ambient air using the Size Selective Inlet (SSI). PM_{10} concentrations are automatically measured and recorded using beta ray attenuation. At the beginning of each sample hour, a small C^{14} (carbon-14) element emits a constant source of high-energy electrons (known as beta rays) through a spot of clean filter tape. These beta rays are detected and counted by a sensitive scintillation detector to determine a zero reading. The BAM-1020 then advances this spot of tape to the sample nozzle, where a vacuum pump pulls a measured and controlled amount of outside air through the filter tape, loading it with ambient dust. At the end of the sample hour, this dust spot is placed back between the beta source and the detector, thereby causing an attenuation of the beta ray signal which is used to determine the mass of the particulate matter on the filter tape. This mass is used to calculate the volumetric concentration of PM_{10} in ambient air. The BAM carries a US EPA designation of EQPM-0798-122.

11.1 Continuous $PM_{2.5}$ (BAM)

In addition to the SSI inlet, the Met One BAM-1020/1022 instrument models can be equipped with an additional VSCC cyclone and has been designated by EPA, in accordance with 40 CFR Part 53, as an equivalent method for measuring concentrations of particulate matter as $PM_{2.5}$ in the ambient air. $PM_{2.5}$ concentrations are automatically measured and recorded using beta ray attenuation. At the beginning of each sample hour, a small C^{14} (carbon-14) element emits a constant source of high-energy electrons (known as beta rays) through a spot of clean filter tape. These beta rays are detected and counted by a sensitive scintillation detector to determine a zero reading. The BAM-1020/1022 then advances this spot of tape to the sample nozzle, where a vacuum pump pulls a measured and controlled amount of outside air through the filter tape, loading it with ambient dust. At the end of the sample hour, this dust spot is placed back between the beta source and the detector, thereby causing an attenuation of the beta ray signal which is used to determine the mass of the particulate matter on the filter tape. This mass is used to calculate the volumetric concentration of $PM_{2.5}$ in ambient air. The BAM 1020 carries a US EPA designation of EQPM-0308-170. The BAM 1022 carries an US EPA designation of EQPM-1013-209. Two BAM-1020 units can additionally be operated together as an EPA designated PM_{10} minus $PM_{2.5}$ (PM_{coarse}) method with a US EPA designation of EQPM-0709-185.

11.2 Filter-Based $PM_{2.5}$ FRM

The Thermo Scientific Partisol 2000i air samplers with a SSI and VSCC are FRM ambient samplers with an EPA designation RFPS-0498-117. The 2000i features enhanced communication capabilities and long-term unattended operation. The 2000i provides reliable and quiet operation, low maintenance requirements and a single-action filter exchange mechanism for added convenience. Generally, the

2000i $PM_{2.5}$ samplers are operated on a 1-in-3 day schedule, however at the NCore stations, 2 of the samplers are operated on a 1-in-6 or 1-in-12 day schedules depending on the type of monitoring required.

11.3 Filter-Based $PM_{2.5}$ (Speciated Aerosol Measurements)

A Met One SuperSASS speciation sampler is being operated at the NCore site as part of EPA's CSN to collect sulfate, nitrate, and other ions and $PM_{2.5}$ mass and trace metals. The SuperSASS is an eight channel, multi-event sequential sample system that conforms to EPA specifications. A sharp cut cyclone (SCC) with a flow of 6.7 liters/min is integrated in every sampling canister to remove particulates larger than 2.5 microns in diameter. The sampling canisters are designed to accommodate denuders and one or two filters for sampling of semi-volatile species and for collection of gases such as nitric acid, ammonia, and formic acid. Filter-based $PM_{2.5}$ speciated aerosol measurements are made in accordance with EPA's 1-in- 3 day sampling schedule.

11.4 Filter-Based $PM_{2.5}$ (Carbon)

The URG 3000N, being operated at the NCore site, is designed to sample for organic and elemental carbon found in ambient $PM_{2.5}$. The measurement of ambient carbon species is an important part of the EPA's CSN. The URG 3000N has been designed for the USEPA to achieve comparable data with the carbon measurements of the Interagency Monitoring of Protected Visual Environments (IMPROVE) $PM_{2.5}$ carbon module. $PM_{2.5}$ is collected on quartz filters. These filters are analyzed for organic and elemental carbon using Thermal Optic Reflective (TOR) analysis method. Please note that filter based $PM_{2.5}$ speciated aerosol samples are made in accordance with the EPA's 1-in-3 day sampling schedule.

11.5 Particulate Matter Samplers

For a list of the current instruments and their locations utilized throughout the monitoring network, please see Appendix B, Instrument Locations and Types of Instruments.

11.6 Support Monitoring Equipment

This section summarizes the PM instrumentation used in the WDEQ-AQD PM network. The operating ranges for the sensors and monitors easily brackets the range of environmental conditions expected at the site. The equipment manufacturer and model numbers are discussed in the following sections. The PM SOPs detail the calibration and operation of the equipment. See Appendix A for the three SOPs: Beta Attenuation Monitor, Chemical Speciation Network (SuperSass and URG 3000N), and Thermo Scientific Inc., Partisol 2000i Sampler.

11.7 Data Acquisition System

Instantaneous data from the BAM instruments are transferred to the DAS on an hourly basis at contractor operated SPM stations. The DAS is a self-contained box with the ability to measure and control electronics and communicate with on-site computers or remote systems. Data is generally stored in a table format.

11.8 Telecommunications

Telecommunication services are used for high-speed remote communication to all on-site equipment, including the DAS. Additionally, each instrument on-site is configured with a unique IP address for remote maintenance and control purposes. The gateway has all of the firewall protection and routing DAS, and battery backup equipment.

11.9 Shelter Temperature

The BAM 1020 instruments reside inside of the shelters while in the field, all other PM instruments are operated outside. Only the inlets for the BAM 1020 models are outside of the shelter. The shelter temperature is maintained by a heating, ventilating, air conditioning (HVAC) system. The temperature is controlled by a thermostat located within the shelter. The shelter temperature is set between 20-30°C at and monitored, however, there is no temperature dependence criteria in the equivalency designation.

11.10 Sampler Support

In most cases, the samplers either are situated on a platform or deck. In some instances, the samplers are mounted on the roof of the monitoring shelter. The important factor for the placement of the samplers is that they are mounted in accordance with 40 CFR Part 58, Appendix E[8]. When the samplers are collocated, they must be at least 1 meter apart. **Figure 4** illustrates the configuration of the monitoring equipment and placement of this equipment at the NCore Station. Note that some of the samplers are mounted on the platform. **Figures 5 and 6** illustrate the BAM 1020 instruments that are mounted inside of the shelter and the PM_{10} and $PM_{2.5}$ inlets extend through the roof and are at least one meter above the roof.

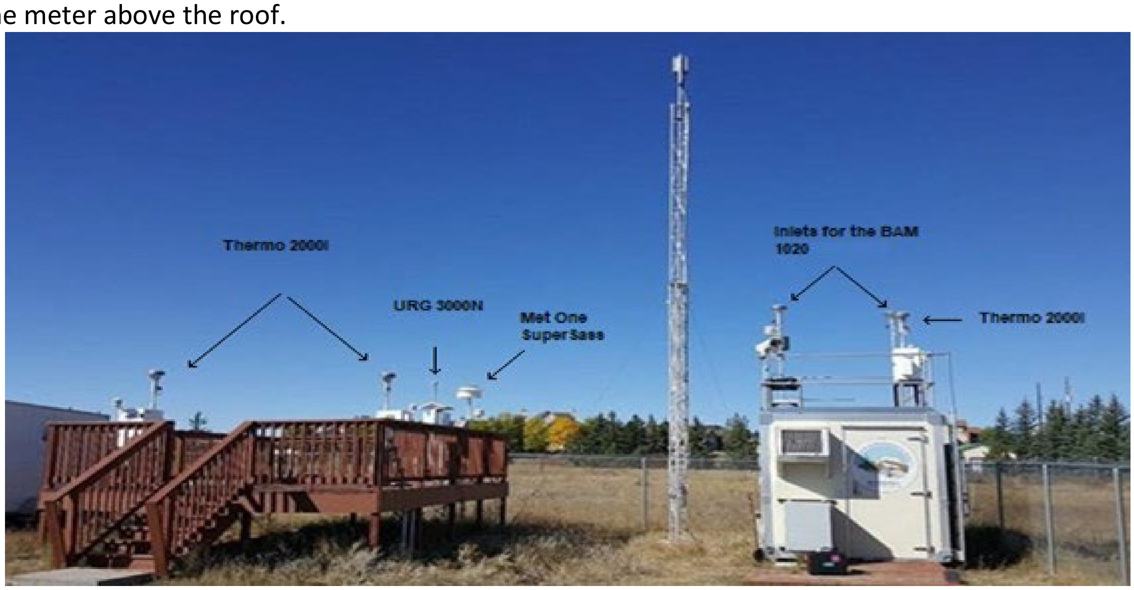

Figure 4. The PM Samplers on the Roof and Sampling Platform

Figure 5. The PM Instruments on a platform at the NCore Station

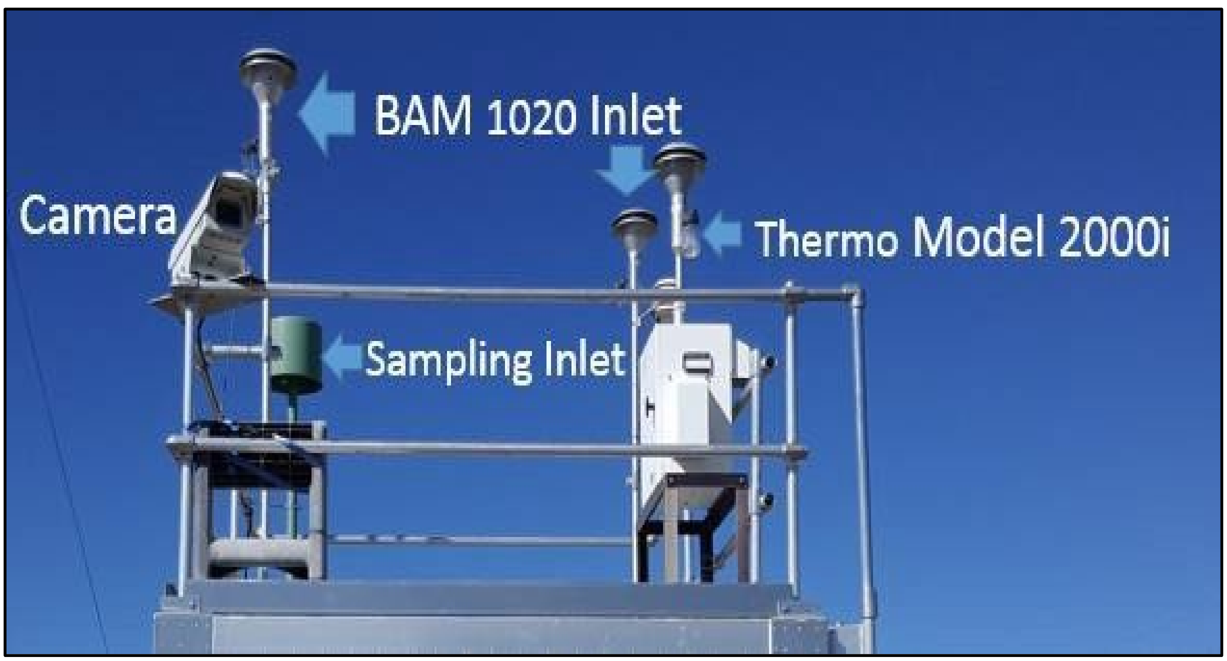

Figure 6. Samplers and Inlets for the BAMs on Roof of the NCore Shelter

11.11 Standard Operating Procedures

SOPs have been developed to provide instructions to the Monitoring Specialists and Site Operators regarding routine operation of the PM equipment. These SOPs cover equipment inspection and acceptance testing, visual inspections, preventive maintenance, temperature, pressure and flow checks. The PM SOPs are independent documents that are companions to this QAPP. The identification, cause, and corrective action for conditions adverse to quality will be documented on the Corrective Action Report form (SOP). Follow-up action will be taken by the Project Manager to verify the corrective action was taken. As mentioned in Section 11.7, the PM SOPs detail the calibration and operation of the equipment. See Appendix A for three SOPs: Beta Attenuation Monitor, Chemical Special Samplers, and Partisol SOPs. Appendix C covers AQD specific Data Handling SOPs for use with the AQD operated SLAMS stations. Contractor data handling procedures are dictated by contracts and tiered contractor specific quality practices.

12.0 Sample Handling and Custody

The Met One 1020 and 1022 BAM instruments collect ambient air samples through a SSI inlet and an aluminum downtube to the instrument. The instrument's flow rate of 16.7 liters/minute ensures that the particulates do not interact with the walls of the tubing. The residence time is defined as the amount of time it takes for a sample of air to travel from the opening of the cane to the inlet of the analyzer and is required to be 20 seconds or less (recommended 10 seconds or less). Bi-Monthly, the filter tape upon which the PM is deposited is removed and replaced.

The Thermo 2000i, URG 3000N and the Met One SuperSASS all collect PM onto discrete 47 or 26 mm filters. The Thermo 2000i filters are 47 mm Teflon filters that are pre-weighed and post weighed by a contract laboratory, Pace Analytical. The filters are shipped to the Monitoring Specialists who install, program the samplers, remove the filters and ship them back to the laboratory for analysis in Sheridan, Wyoming. The CSN samplers (URG 3000N and SuperSASS) collect PM onto quartz, Teflon, and nylon filters. These filters are received from and shipped to the UCD-AQRC for analysis in Davis, California. Sample handling and custody are discussed in detail in the WDEQ-AQD’s Thermo 2000i and CSN SOPs.

13.0 Analytical Method

The Met One BAM-1020 has the USEPA equivalency designation for PM_{10} as EQPM-0798-122 and EQPM-0308-170 for $PM_{2.5}$. There is not currently a FEM for the MetOne BAM-1022 to measure PM_{10}; however, the BAM 1022 has the USEPA equivalency designation for $PM_{2.5}$ as EQPM-1013-209. The Thermo Model 2000i Partisol $PM_{2.5}$ samplers have an EPA Federal Reference designation of RFPS-0498-117.

Gravimetric analysis will be performed on the filter samples from the Thermo Partisol 2000i samplers by a subcontracted analytical laboratory. Samples from the SuperSass and URG 3000N will be analyzed by an EPA contracted analytical laboratory to quantify $PM_{2.5}$ mass constituents.

As mentioned in Section 9, the gravimetric and chemical speciation analyses are performed by two laboratories, UCD-AQRC and the Pace Analytical/IML laboratories. The analytical methodologies are detailed in their QA/QC quality documentation. Both of these laboratories must adhere to EPA National quality specifications as outlined within their quality documentation. The laboratory quality documents are available upon request. Please contact the appropriate personnel listed in Table 1 in Section 3 of this QAPP.

14.0 Quality Control Requirements

This section describes the routine quality control procedures used for the Particulate Matter monitoring program. All procedures have been specifically designed to provide the appropriate QC measures and ensure that valid data recovery meets or exceeds the WDEQ-AQD data recovery objective of 90 percent per quarter for Particulate Matter monitoring.

The air quality monitoring program will follow the QC guidelines as stated in the following documents:

- 40 CFR 58, Appendix A and E [3, 9].
- EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, January 2017[4].

14.1 Instrument/Equipment Calibration and Frequency

Please see **Tables 4, 5, 8 and 9** for the critical criteria, calibration and audit requirements and frequencies for Particulate Matter instruments.

14.2 Visual Inspection of Equipment

The Site Operator or Monitoring Specialist visits the site at least once per month to check that the analyzers are operational and recording concentrations typical for the environment. At this time, the Site Operator will inspect the shelter temperature and adjust the thermostat, if necessary.

14.3 Remote Interrogation of Monitoring Station and Inspection of Data

The DAS at the monitoring stations will be interrogated daily via internet connection to download and process the data. Abnormal data values or problems will be reported as soon as possible to the Project Manager, who will initiate corrective action and determine if a special site visit is required.

Computerized inspection and visual inspection of the data will be performed daily and may use an automated outlier program. Values that fall outside of prescribed limits will be evaluated by a qualified air quality specialist, data manager or project manager and corrections to data will be documented.

14.4 Equipment Calibration

The equipment required to calibrate and verify the performance of the PM instruments consist of flow devices, electronic thermometers and barometric pressure meters. All of these instruments must be traceable to the National Institute of Standards and Technology (NIST). The WDEQ-AQD and its contractors maintain a set of NIST traceable standards that are calibrated or verified annually either by WDEQ-AQD staff or contractors. Table 9 on the subsequent page illustrates the verification checks schedule and parameters that require the calibration of the instruments.

Table 8. PM_{10} Instrument Verification and Validation Requirements

Requirement	Frequency	Acceptance Criteria	Reference	Action
Verification/ Calibration	Upon receipt, adjustment, repair, installation, and annually	PM_{10} (cont.): 3 of 4 points within <±10.1% of design PM_{10} (filter) flow: <±2.1% of transfer std. PM_{10} Temp. (filter): <±2.1°C PM_{10} Pressure (filter): <±10.1 mmHg	40 CFR Part 50, App. L[9]	Calibrate if points outside acceptance criteria
Continuous PM_{10} Average Flow Rate	Every 24 hours of operation	Average within <±5.1% of design	Recommend.	Flag Data with QX code
Continuous PM_{10} One-point flow rate verification	1/month	<±7.1% of transfer standard	40 CFR Part 58, App A, Section 3.3[3]	Invalidate data to last acceptable check.

Table 9. $PM_{2.5}$ Instrument Verification and Validation Requirements

Requirement	Frequency	Acceptance Criteria	Reference	Action
Verification/ Calibration	Upon receipt, adjustment, repair, installation, and annually	$PM_{2.5}$ (continuous): 3 of 4 points within <±10.1% of design $PM_{2.5}$ Temp. (cont.): <±2.1°C $PM_{2.5}$ Pressure (cont.): <±10.1 mmHg $PM_{2.5}$ (cont): Annual zero test	40 CFR Part 50, App. L[9]	Calibrate if points outside acceptance criteria
Continuous $PM_{2.5}$ Average Flow Rate	Every 24 hours of operation	Average within 5% of 16.67 LPM at local conditions	40 CFR Part 50 App. L, Sec. 7.4.3.1[9]	Invalidate data to last acceptable check.
Variability in flow (Cont. $PM_{2.5}$)	Every 24 hours of operation	CV≤2%	40 CFR Part 50 App. L, Sec. 7.4.3.2[9]	Invalidate data to last acceptable check.
Continuous $PM_{2.5}$ One-point flow rate verification	1/month	<±4.1% of transfer standard <±5.1% of flow rate design value	40 CFR Part 50 App. L, Sec. 9.2.5[9]	Invalidate data to last acceptable check.
Continuous $PM_{2.5}$ Design flow rate Adjustment	After multi-point cal. or verification	<±2.1% design flow rate	40 CFR Part 50 App. L, Sec. 9.2.6[9]	Invalidate data to last acceptable check.

14.5 Flow, Temperature and Pressure Verification and Calibration

As illustrated in Tables 8 and 9, numerous verification checks are required. The pertinent reference sections and their required action are also illustrated. The SOPs associated with the instruments discussed in this QAPP detail the verification checks required in Table 9. Please reference these SOPs for further details.

15.0 Site and Equipment Maintenance

Manufacturer's recommendations for maintenance will be followed. Instrument manuals are available at the site for reference of preventive and remedial maintenance procedures. Preventive and corrective maintenance will be documented on the calibration forms completed immediately after any maintenance. See Section 16.3 for equipment maintenance procedures. Maintenance of the individual instruments is detailed the operations manual of each instrument. Please refer to those documents for detailed maintenance instructions. Below is some general (**Table 10**) maintenance on the support equipment and platforms for the Particulate Matter network.

Table 10. Support Equipment Maintenance Activity

Recommendation Maintenance Activity	Frequency
Monitoring shelter floor cleaning	Monthly or as needed
Monitoring shelter trash removal	As needed
Monitoring shelter light bulb replacement	As needed
Heating/AC system filter replacement	As needed
Platform inspection	Annually
Platform repair	As needed

16.0 Instrument Equipment Testing and Inspection

16.1 Acceptance Testing of Instrumentation and Equipment Integration

Prior to installation, all equipment will be visually inspected to ensure there is no physical damage. Acceptance testing of instrumentation will be performed to verify that the instruments meet the required U.S. EPA performance specifications. Particulate Matter analyzers that fail to meet specifications will be returned to the manufacturer. After installation, the analyzers are calibrated according to the SOPs. Preventive maintenance will be conducted on a routine basis, as described in the operations manuals that accompanied the instruments upon delivery.

To ensure that the monitors are operating properly, semi-annual performance evaluations are conducted by the WDEQ-AQD.

16.2 Site Surveillance and System Check Procedures

At least monthly, the Site Operator or Monitoring Specialist will visit the monitoring station to inspect the monitoring equipment. The Site Operator will conduct filter exchanges and will perform any required maintenance.

During each site visit, entries will be made in the site and/or electronic logbook (E-log) documenting all site activities conducted. These entries will include the date of the visit, reason for the visit, time weather conditions, and the maintenance or calibration activities performed. If changes are made to the equipment or configuration of the system, these changes will also be entered in the site logbook. Entries will be made anytime there is a change or modification in the way a sample is obtained or the station configuration altered. If the Site Operator encounters a problem that cannot be rectified, he/she will contact the contractor and/or Project Managers who will be responsible for resolving the issue. The contractor and/or Project Manager will initiate a plan for corrective action and, upon approval of the project manager, will employ necessary resources required to rectify the situation.

16.3 Site and Equipment Maintenance

Manufacturer's recommendations for maintenance of the air quality analyzer is outlined below. Instrument instruction manuals are available for reference of preventative and remedial maintenance procedures. Preventive and corrective maintenance will be documented on the calibration forms immediately after any maintenance. See **Table 11** for maintenance activities and frequencies for the BAMs.

Table 11. BAM 1020 &1022 Recommended Maintenance Activities

Recommended Maintenance Activity	Frequency	
	BAM Model 1020	BAM Model 1022
Nozzle and vane cleaning	Monthly or as needed	2 Months or as needed
Leak check	Monthly or as needed	Monthly or as needed
Flow system check/audit	Monthly or as needed	Monthly or as needed
Clean capstan shaft and pinch roller tires	Monthly or as needed	Monthly or as needed
Clean PM_{10} Head and inlet & $PM_{2.5}$ VSCC separator (if applicable)	Monthly or as needed	Monthly or as needed
Flow, BP, and temperature verifications	Monthly or as needed	Monthly or as needed

Recommended Maintenance Activity	Frequency	
	BAM Model 1020	BAM Model 1022
Check error log	As necessary	As necessary
Check or set BAM clock	Minimum monthly or as needed	Minimum monthly or as needed
Run self-test function	Monthly post-flow check or as needed	Monthly post-flow check or as needed
Test filter RH	As needed	As Needed
Replace filter tape	As needed	As needed
Verify BAM setting	As needed	As needed
Clean internal debris filter	As needed	As needed
Check membrane span foil	As needed	As needed
Beta detector count rate and dark count test	As needed	As needed
Mass Audit	N/A	Minimum 6 months or as needed
ZBKG Test	Minimum 12 months or as needed (48-72 hrs.)	Minimum 12 months or as needed (72 hrs.)
Rebuild vacuum pump	As needed	As needed
Replace Nozzle O-ring	As needed	A needed
Replace pump tubing, if necessary	As needed	As needed

16.4 Continuous PM_{10} and $PM_{2.5}$ (BAM)

Annual calibration, or as needed, of the continuous PM_{10} and $PM_{2.5}$ Met One BAM samplers consists of several procedures which include measuring the flow with a certified flow transfer standard and calculating the deviations from the inlet design and the set point flow rates. In addition to the flow check, a leak test is also performed. The BAM ambient temperature and pressure sensors are compared to calibrated reference sensors during calibration. All calibration equipment will be traceable to NIST standards. Continuous PM_{10} and $PM_{2.5}$ calibration procedures are found in the SOPs.

16.5 Filter-Based $PM_{2.5}$ Thermo Model 2000i

Quarterly calibration of the $PM_{2.5}$ filter-based samplers consists of several procedures which include measuring the flow with a certified flow transfer standard and calculating the deviations from the inlet design and the set point flow rates. In addition to the flow check, a leak test is also performed. The ambient temperature and pressure sensors of each sampler will be compared to calibrated reference sensors during calibration. **Table 12** lists the Maintenance Activities for the Thermo Partisol sampler.

Table 12. Thermo 2000i Maintenance Activity

Maintenance Activity	Frequency
Thermo 2000i	
Check sampling inlets, down tubes for bugs and obstructions, and water intrusion	Each site visit, clean as needed.
VSCC cleaning ($PM_{3.5}$)	Quarterly
Sampling inlet cleaning	Monthly
Filter Housing Assembly Cleaning	Monthly.
Circulation Fan Cleaning	Monthly
Inspect filter cassettes for contamination or damage	Each site visit
Clean interior of sampler case (if applicable).	Each site visit

Maintenance Activity	Frequency
Thermo 2000i	
Inspect upper and lower cassette seals	Each site visit
External leak check	Performed before Flow Verification or Calibration
Internal leak check	Only performed if the External leak check fails
Clean SSI inlet	Monthly
Clean rain hood and air screen	Every six months
Overhaul or replace sampling pump and solenoids.	12-18 months

16.6 $PM_{2.5}$ SuperSASS and URG 3000N

The SuperSASS has four flow lines. These same four lines are used by the second set of four sample canisters. All channels should be within ±0.67 LPM or ±10% of the reference standard. The temperature and pressure sensors will be compared to calibrated reference sensors during calibration. All calibration equipment will be traceable to NIST standards. $PM_{2.5}$ SuperSass calibration procedures are found in the CSN SOP. The URG 3000N sampler will be calibrated for ambient temperature, barometric pressure, and flow rate. A three-point flow calibration is conducted on the URG 3000N samplers after a successful leak check has been performed. The flow rate calibration is conducted by inserting an "audit" cartridge. The flow adapter is connected to the top of the downtube. The tubing is connected from the reference standard to the flow audit adapter to begin the flow rate verification. The temperature and pressure sensors will be compared to calibrated reference sensors during calibration. $PM_{2.5}$ URG calibration procedures are found in the CSN SOP. **Table 13** lists the Maintenance Activities for the CSN samplers.

Table 13. SuperSASS and URG Maintenance Activity

Maintenance Activity	Frequency
SuperSASS and URG-3000N	
Check sampling inlets, URG downtube for bugs and obstructions, and water intrusion	Each site visit, clean as needed.
Clean sampler inlet surfaces.	Monthly
Clean interior of sampler case (if applicable).	Each site visit
Inspect denuder for breakage. (URG)	Replace denuders with freshly coated ones and return used denuder to the laboratory for refurbishment.
Inspect and service cooling air intake filter and fans	Every 30 sampling events or more often as needed or as specified by the network
Inspect and service O-rings of inlet and water seal gasket at down-tube entry to case.	Apply a very light coat of vacuum grease if required.
Clean cyclones and manifolds upstream of the sampler module.	As needed
Inspect and service O-rings in sampler head or platform assembly of URG 3000N.	As needed
Inspect and service vacuum tubing, tube fittings, and other connections to pump and electrical components.	As needed
Overhaul or replace sampling pump and solenoids.	Quarterly (every 3 months)

17.0 Inspection/Acceptance of Supplies and Consumables

17.1 Spare Parts

Spare parts for the continuous PM analyzers and filter-based sampler will be stored in the monitoring shelter and will be used as needed. These spare parts include, but are not limited to, pump re-build kits, various O-rings, and filter tape. Any additional parts that are not stored at the monitoring station will be stored at the WDEQ-AQD and contractors' central operating facilities.

17.2 Inspection/Acceptance of Supplies and Consumables

Spare parts will be purchased only from the instrumentation manufacturer by the Monitoring Specialists, Project Managers or contractors. Parts will be inspected by the Contract Operator or the Monitoring Specialist for shipping damage upon receipt. Spare parts will be kept in the monitoring shelter for use when needed. The use of spare parts will be documented on calibration forms or Corrective Action Sheets.

18.0 Non-Direct Measurements

The data collected from the PM monitoring program are used for NAAQS and WAAQS nonattainment decisions, compliance, dispersion modeling, and/or comparison with other ambient air monitoring data.

The national primary and secondary ambient air quality standard for PM_{10} is 150 micrograms per cubic meter ($\mu g/m^3$) 24-hour averaged concentration measured in ambient air. The primary ambient air quality standard for $PM_{2.5}$ is 12.0 $\mu g/m^3$ annual arithmetic mean concentration measured in ambient air and 35 $\mu g/m^3$ 24-hour averaged concentration measured in ambient air.

To comply with the 24-hour PM_{10} NAAQS, a monitor may only have one exceedance (a 24-hour average concentration greater than 150 $\mu g/m^3$) per year on average over a three-year period. A design value of zero means the station has not recorded any values over 150 $\mu g/m^3$ during the three-year period. Wyoming also has an ambient air quality standard for PM_{10} in its State regulations. Compliance with the annual Wyoming Ambient Air Quality Standards (WAAQS) is determined by the three-year average of the annual mean. The three-year average of the mean must be below 50 $\mu g/m^3$.

For stations that monitor PM2.5, the primary annual NAAQS and WAAQS is attained when the three-year average does not exceed 12.0 µg/m3. The 24-hour PM2.5 NAAQS and WAAQS is 35 µg/m3. Compliance with this standard is determined from the 3-year average of the 98th percentile concentration.

19.0 Data Management

The proper management of all data is critical to assuring the quality and usability of the monitoring results. As such, procedures have been implemented to ensure robust data acquisition, validation, reduction, reporting, and storage of electronic data. Continuous PM data will be retrieved from the monitoring site daily via internet connection.

All electronic calculations and statistical analyses will be performed using standard software that can be easily verified. All project documentation, records, data, and reports will be stored for at least five years following project completion. Data is stored on the WDEQ-AQD network servers once reported to AQS and will be archived at a separate location.

PM data will be reviewed routinely by the Project Managers or his/her designee assigned to the program. The data will be subjected to several levels of QC, validation, and QA. Validated data are compiled into the final database for further analysis and report preparation. The final data is processed and archived on the contractor's or the WDEQ central databases. For more details, please see Sections 21 and 22.

19.1 Data Retrieval

Continuous PM data (i.e., from the BAM 1020 or 1022) is retrieved from the site by connecting the instrument to the DAS, and then remotely telemetering to the central database either the contractor's or WDEQ's. Non-continuous PM data (i.e., filter based) data are created in the laboratories. The laboratories send this data to the contractors or WDEQ usually 30 days after the end of the calendar month. The flow data, collected from the instruments and gravimetric data from the laboratories is then combined to create the data submitted to AQS. Recently, the WDEQ-AQD changed over to the AirVision platform, which supports the website known as WyVisNet. This is a WDEQ-AQD housed data storage system that is accessible by both the contractors and WDEQ-AQD staff. For the State operated continuous SLAMS, the WDEQ-AQD data is housed in the AirVision system and the WDEQ-AQD staff perform validation on the data.

19.2 Raw Data

Raw data are records, notes, memoranda, worksheets, or exact copies and are the result of original observations and activities of the monitoring project. Raw data include data from the DAS and data entered directly into a system.

19.3 Data Transfer

The BAM analyzers produce digital data that are collected by a DAS and averaged for a particular time period. The data are stored on a network and are validated quarterly. The hourly air quality data are uploaded to WyVisNet on an hourly basis. For the gravimetric mass data from the Thermo 2000i, the contract laboratory transfers the data via email. For the CSN data, the data is housed in the UCD-AQRC database (DART). This database is accessible to the WDEQ-AQD through username and password access.

19.4 DAS Data Review

Data review is performed by the Monitoring Specialists and Site Operators. The data review includes reviewing the calibration information, flow checks, maintenance logs, hourly data, and flags, and recording any information that might be vital to proper review of the data. Information used in the review may be used to invalidate data.

19.5 Data Validation

Data validation ensures that data processing operations have been carried out correctly and that the quality of field operations have been performed properly and in accordance with written procedures. Once data validation has identified problems, the data can be corrected, flagged, or invalidated, and corrective actions can be taken when necessary. In the event of a failed audit or out-of-range calibration, the Data Validator will be responsible for checking or invalidating data. Data validation procedures are described in detail in Section 22.

19.6 Data Transmittal

Data transmittal occurs when data are transferred from one location to another or from one person or group to another. An example of data transfer is the electronic transfer of data over a computer network. WDEQ-AQD requires that data be prepared in the AQS format on a quarterly basis and stored in zip files with a specific name format that incorporates the reported year and quarter.

The Data Manager and/or the QA coordinator will report all ambient air quality data and information, as specified by the AQS Users Guide[13], and coded in the AQS format. Such data will be fully validated and will be submitted directly to the AQS via electronic transmission. The only exception to this is the CSN data, which is transferred to the EPA AQS database once the WDEQ-AQD has reviewed and certified the data in DART.

19.7 Data Processing

Data processing includes aggregating and summarizing results so they can be easily understood and interpreted in various ways. EPA regulations require certain summary data be computed and reported on a regular basis such as precision, accuracy, bias, and so on.

19.8 Data Analyses

Data summary and analysis requirements, as presented in 40 CFR Part 58, Appendix A[3], will be followed for this program.

19.9 Data Flagging

Data will be flagged if a numeric result was available but has been qualified in some respect related to the validity of the result. Null data codes will be generated for invalid data as they are entered into the AQS database. A QX or other quality assurance qualifier code should be added when a critical criteria check is missed (e.g. flow check does not take place in the month) or a quality assurance audit fails to be conducted. Other qualifiers will be evaluated on a case-by-case basis if a systematic or operational criteria is deviated from. Additional AQS qualifier codes can be found at; https://aqs.epa.gov/aqsweb/documents/codetables/qualifiers.html

An exceptional event, as defined in 40 CFR Part 50.1 (j)[13], provides that an exceptional event is one that affects air quality, is not reasonably controllable or preventable, and is caused by human activity that is unlikely to recur at a particular location or a natural event. Additional requirements in 40 CFR Part 50.14 (1) (2) and (b)(1)[13] identify that a state must demonstrate a "clean and casual relationship between the measured exceedances or violation of such standard and the event" and that "an exceptional event caused a specific air pollution concentration in excess of one or more National Ambient Air Quality Standards." Thus, WDEQ-AQD and the contractors will flag data related to an exceptional event at the request of the WDEQ-AQD. Electronic copies of the data will be stored at WDEQ-AQD office in Cheyenne, Wyoming.

19.10 Data Submittal to the Air Quality System

Each quarter, WDEQ-AQD files of observed data that are ready for AQS upload ("RD" transaction) are prepared and submitted to WDEQ's Inventory, Monitoring, Permitting, and Compliance Tracking (IMPACT) system. These files are prepared from validated hourly data and conform to the EPA's central database—the AQS coding guidelines found on the AQS website[14]. Missing data will carry the null code that best describes the reason for each missing data point. The most common reasons for missing data include calibration, maintenance, an audit, weather related or power outage.

Data may also be marked with a qualifier code to denote suspect data if necessary. Data in the AQS files may be reported in standard or alternative units, which are defined by the AQS. Criteria pollutants will be reported in a manner consistent with guidelines set forth in the 40 CFR Part 5013. For details on WDEQ-AQD AQS coding, please see Appendix B and Section 3.0**.**

Section C. Assessment and Oversight

20.0 Assessment and Response Actions

Audit procedures and techniques followed by the WDEQ-AQD are established by EPA audit guidelines. Each of the samplers and instruments (i.e., BAMs) has individual techniques that are performed. Each of the sampler's audit procedures are outlined in the sections below.

Performance audits may be attended by site operators, contractors, WDEQ-AQD staff, and/or the QA Coordinator from the Cheyenne office. The auditor will use the on-site logbook to record the times and parameters audited, as well as any witnesses to the audit. Electronic documentation of audit results will be kept for a period of five years following the audit. Audit summaries are available on WDEQ's IMPACT system. WDEQ-AQD is responsible for inputting audit results in EPA's AQS system.

20.1 Thermo Partisol 2000i

The Thermo Partisol 2000i is a FRM, it is also required to be part of EPA's Performance Evaluation Program (PEP). EPA chooses ⅓ of the $PM_{2.5}$ network to audit each year. The audit is described here briefly. Since the EPA oversees the PEP program, this QAPP only details the WDEQ-AQD portion of the audit.

Annually, the EPA or its designee places a mobile (PEP) gravimetric sampler, next to the station sampler. Both samplers, PE and station samplers, will collect samples on the same day, typically for 24 hours. The EPA designee will then retrieve the sample and ship it to an independent laboratory for gravimetric analysis. The site sampler will be operated in its normal fashion and the sample collected on its normal schedule. The WDEQ-AQD will send the gravimetric data to EPA for comparison with the EPA sampler. The goal for acceptable measurement between the samplers is <15.0%.

In addition to the PEP audit, an internal flow "audit" is performed annually. For the flow audit, the volumetric flow rate is measured using a flow device that is not used during normal operations, such as monthly flow checks and adjustments to the flow of the instrument.

20.2 BAM 1020 and 1022

The BAM sampler audit consists of measuring the flow rate of the instrument and comparing the pressure and temperature sensors against NIST traceable field standards.

For the flow audit, the volumetric flow rate is measured using a flow device that is not used during normal operations, such as monthly flow checks and adjustments to the flow of the instrument. The BAM instruments operate at a flow rate of 16.7 lpm. The PM_{10} head is removed from the inlet and tubing is attached to the inlet opening and the flow device. Make certain the BAM has warmed up for 60 minutes

There are two temperature sensors and one pressure sensor on the BAM instruments. One of the temperature sensors is outside of the instrument in a Gill temperature housing attached to the inlet. A NIST traceable sensor probe is placed next to the Gill housing and the external temperature is compared against the NIST standard. The internal temperature and pressure probes are next to the filter tape. The

NIST traceable probe is placed as close to the temperature sensor and the pressure and temperature are recorded from the sampler and the audit device.

20.3 URG 3000N

The URG sampler audit consists of checking the flow rate of the sampler, the temperature sensor and pressure sensors. The first thing that needs to occur is that the filter cartridge on the cassette manifold is removed and an "audit" cassette is put in its place. Once this is done, the audit can commence. First, the temperature probe is removed from the bottom of the sampler and placed next to a NIST traceable temperature probe. The pressure sensor is read in the sampler and compared to the NIST traceable barometer. A flow device is attached to the inlet of the sampler and the sampler is operated. The flow rate, temperature and pressure are then compared between the sampler readouts and the NIST traceable device.

20.4 Met One SuperSass

Similar to the URG sampler, the audit consists of checking the flow rate of the sampler, the temperature sensor and pressure sensors. The first thing that needs to occur is that the canister that houses the VSCC and filter are removed and a canister with a "dummy" filter is put into its place. The sampler is switched on and tubing from the NIST traceable flow device is connected between the inlet of the canister and the flow device. The flow rate is measured at each of the 4 canister stations. The canister for each station is then removed and a NIST traceable temperature probe is placed next to the temperature sensor at each station. The pressure sensor is read in the sampler and compared to the NIST traceable barometer. The flow rate, temperature and pressure are then compared between the sampler readouts and the NIST traceable device.

20.5 Corrective Actions

All deficiencies identified during routine data surveillance, performance audits, and/or site surveillance will be documented and reported to the Project Manager no later than one working day of discovery, and depending on the nature of the deficiency, corrective action will be made no later than seven working days after the notification. Corrective actions to deficiencies will be addressed and documented in the station logbook and a Corrective Action Report. Follow-up action shall be taken to verify implementation of the corrective action. A Corrective Action Report form (in the SOPs) will be filled out that identifies the problem or deficiency, the proposed corrective action, and the results of the corrective action. Corrective Action Reports will also be included in the station's quarterly summary report. A copy of a Corrective Action Report is presented in the SOP in Appendix A. WDEQ-AQD has the authority to issue stop work orders to contractors, if necessary.

20.6 QAPP Revisions

If revisions to the QAPPs are needed, any modifications will be performed or approved by the WDEQ-AQD on an annual basis. If a QAPP is submitted to WDEQ-AQD for review and comment, a revised edition will be distributed to all appropriate individuals on the distribution list. QAPP reviews will be performed annually by WDEQ-AQD.

21.0 Reports to Management

A summary of the reports to be generated is presented in **Table 14**. The QA Coordinator or his/her designate will generate reports to management.

Table 14. Reports to Management.

Reports	Frequency	Content	Responsible Position/ Individual	Distribution
Quarterly Summaries (Includes Precision and Accuracy)	Quarterly	Summarize Data for Quarterly Summaries	Project Manager or Contractor AirVision and reviewed by Project Manager	See Section 3 Distribution List
Annual Report	Annually	Summarize Data for Annual Reports	Contractor and reviewed by Project Manager	See Section 3 Distribution List
Email notification of Action Limit reached	As Needed	Discuss instrument issues, flow rates, temperature probes or pressure sensors out of range	Contractor or AirVision	Project Manager
Corrective Action Reports	As Needed	Summarize Corrective Actions Taken to Return the Monitoring Station into Compliant Status	Contractor Project Manager or WDEQ-AQD Project Manager	See Section 3 Distribution List
Response to Corrective Action Reports	As Needed	Reports the Results of the Corrective Actions Taken	Contractor or Project Manager	See Section 3 Distribution List

Quarterly summaries will be submitted to the WDEQ-AQD within 60 days of the end of the monitoring quarter. The annual report will be submitted to the WDEQ-AQD within 90 days of the end of the monitoring year. Corrective Action Reports are submitted in the quarterly report, or as requested.

A notification will be submitted to the WDEQ-AQD Project Manager whenever the PM concentration measured at a site by a BAM exceeds 150 µg/m^3 for PM_{10} in a 1-hour averaged concentration. A notification will also be submitted if the $PM_{2.5}$ exceeds 35 µg/m^3 in a 24-hour period. Since the gravimetric analysis requires laboratory analyses, when the data are generated and exceed the levels stated earlier, then a notification will be submitted to the WDEQ-AQD Project Manager.

Notifications via email will be sent the following business day and will include a graph of the data from the day the elevated value occurred, along with a brief explanation of the event. Section D. Data Validation and Usability

22.0 Data Review, Validation, and Verification Requirements

The air quality data validation criteria are based on the U.S. EPA's Quality Assurance Handbooks for Air Pollution Measurement Systems, Volumes I and II[8]. The data validation templates detailed in Tables 4 and 5 are based on the EPA QA Handbook II templates. Tables 4 and 5 are composed of critical criteria, operational evaluations, and systematic issues. Data that do not meet each and every criterion on the Criteria Table should be invalidated unless there is a compelling justification for not doing so. Violation of a criterion on the Evaluations Table may be cause for invalidation and the reason for not meeting the criterion must be investigated, mitigated, or justified. If a criterion on this QAPP validation is not met, it does not invalidate these data but may impact the "error rate associated with the attainment/nonattainment decision."

The Project Managers, contractors, Monitoring Specialists and Site Operators are responsible for verifying proper operation of the monitoring equipment under their control. For AQD operated PM stations, there will be an assigned internal Data Validator to review data whom will communicate with the Monitoring Specialist or Project Manager.

For contracted stations, the contractors will review the incoming data to the standards discussed in this document. During each quarter, the data will be reviewed again by the Project Manager to ensure that the data are complete, accurate, and representative and that erroneous data have been removed in preparation for the final data report.

The contractors will routinely check for irregularities during the daily data review. Data review includes evaluation of the raw data, QC checks (e.g., flow rate, temperature, and pressure), maintenance records, calibration and audit data. Any abnormalities in the data will be flagged and noted on the appropriate checklists. Any suspect data will be brought to the attention of the Project Manager as soon as possible. All other documentation pertaining to the project (e.g., station logs, field notes, calibration, and audit sheets) will be reviewed to ensure that erroneous data are identified and removed as necessary from the final data set. Calibration procedures for the PM samplers are presented in Table 4 and 5 of this QAPP. For PM samplers, precision, bias, and accuracy will be determined using the collocated and audit data where indicated.

For AQD operated PM monitors, the Data Validator will perform validation checks during the workday for the previous day's data and, as necessary, the previous weekend's and holiday's data to investigate irregularities during the daily data review. Daily data review includes evaluation of the raw data, verification of data communication to the AQD's AirVision software and WyVisNet website, flow rate, temperature, pressure, and any instrument generated codes. A monthly evaluation to validate the data will include monthly flow rate, temperature and pressure evaluations, maintenance records, calibration and audit data including the AirVision logbook. Any abnormalities in the data will be flagged and noted on the appropriate checklists. Any suspect data will be brought to the attention of the Project Manager as soon as possible. All other documentation pertaining to the project (e.g., station logs, field notes, calibration, and audit sheets) will be reviewed to ensure that erroneous data are identified and removed as necessary from the final data set.

22.1 Data Acceptance Limits for Particulate Matter

Independent performance audits will be conducted to verify that calibration and maintenance of the instruments is correct. Audit results will be used to invalidate periods of data when the PM samplers were not operating within EPA specifications as discussed in **Tables 4, 5, 8 and 9**.

For the determination of Particulate Matter, data will be valid and acceptable if the following conditions apply:

- An independent PE (Thermo 2000i) has an absolute difference $\leq$ 10.1% for values >3.0 $\mu g/m^3$ when compared against an EPA PEP sampler
- When any collocated samplers of the same make and model are operated and the precision coefficient of variance (CV) is < 10%.
- The sampler performance is within tolerance as specified in **Tables 4, 5, 8 and 9** of this QAPP.

23.0 Data Validation and Verification Methods

The Contractors or AQD Data Validator are responsible for verifying Particulate Matter data by reviewing the QC checks, flow checks, calibration records, audit results, and field notes from the Site Operator or Monitoring Specialist prior to formal acceptance of these data. Precision and bias calculations will also be reviewed. The Project Managers will use **Tables 4, 5, 8 and 9** in Sections 7 and 14, to ensure that the reported data meet the appropriate MQOs.

23.1 Level 0 Data Validation

Level 0 data validation is essentially raw data obtained directly from the data acquisition systems in the field. These data have not received any adjustments for known biases or problems that may have been identified during preventive maintenance checks or audits. Level 0 data validation is accomplished by:

- Collecting data via modem, and
- Initially screening the daily data for anomalies (for the BAM)

Stacked parameter plots will be generated that consist of every data point downloaded since the last site interrogation, which will be reviewed by the Contractor or WDEQ-AQD Data Validator for consistency and possible problems. This redundancy assures that problems that might go unnoticed by the software will always be caught by the reviewer.

To aid in data validation, contractors or AQD websites will be hosted and updated daily. The site contains 24-hr meteorological chart graphics; daily minimums, maximums, and averages; QA reports; and wind roses. Historical data can also be reviewed at this website. **Figures 7 and 8** present examples of these graphics. By using this approach, data collection percentages are greatly enhanced and data management personnel can quickly note and resolve any potential instrumentation problems.

23.2 Quality Control Checks for Data Validation

Once the data are downloaded via modem, and the data from the FRM are calculated, they will be subjected to a series of QC checks by a software package or AQD Data Validator. The software package performs extensive quality control checks of the data and generates a data summary report that lists means, maximums, minimums, time of occurrence, data values that fall outside of prescribed ranges, periods of constant values, and periods of rapid value changes. These criteria may be adjusted as data are collected to more accurately encompass site-specific conditions.

The QA software is used to generate flags or warnings that the parameter value is outside of a normally acceptable range. The outlier program does not invalidate data or erase file records on the basis of these outlier tests. Raw data files are never modified and are archived. It will be left to the Contractors or Data Validator to review the results of the outlier program in conjunction with the data parameter plots and initiate corrective actions if warranted (via a site visit or data invalidation).

23.3 Level 1 Data Validation

After the QC software is run, visual inspection of the data is performed to identify suspect data values that warrant further investigation. These values will be flagged. Per EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program[8], EPA recommends the use of flags or result qualifiers to identify potential problems with data (or a sample). According to the EPA, a flag is an indicator of the fact and the reason that a data value (a) did not produce a numeric result, (b) produced a numeric result but it is qualified in some respect relating to the type or validity of the result, or (c) produced a numeric result but for administrative reasons is not to be reported outside the organization.

Thus, QC flags and codes consisting of a letter and value will be assigned to each datum to indicate its quality. Multiple flags will be applied to each invalid data point, such as data invalid due to calibration. **Table 15** presents the data flags and codes that will be applied to the data. Additional AQS qualifier codes can be found at https://aqs.epa.gov/aqsweb/documents/codetables/qualifiers.html

Table 15. Data Flags.

Flag	Code	Description
V	0	Valid
C	1	Corrected or Estimated
S	7	Suspect: data appears to be a data spike or outside normal data range
I	8	Invalid data
M	9999	Missing data: measurement not taken
BJ	9963	Operator Error
AC	9969	Construction in Area
AE	9971	Shelter Temperature Outside Limits
AH	9974	Sample Flow Rate Out of Limits
AL	9978	Voided by Operator
AM	9979	Miscellaneous Void
AN	9980	Instrument Malfunction
AP	9982	Vandalism
AQ	9983	Collection Failure
AS	9985	Poor QA Results
AT	9986	Calibration
AV	9988	Power Failure
AW	9989	Wildlife Damage
AX	9990	Precision Check
AY	9991	QA Control Points
AZ	9992	QC Audit
BA	9993	Maintenance
BB	9994	Unable to Reach Site
BR	NA	Value Below: -5 µg/m^3 for PM_{10} / -10 µg/m^3 for $PM_{2.5}$
QX	9994	Quality in Question

To assist in data validation, a copy of the site electronic logbook will be examined to confirm periods when instrumentation may have been offline due to power outages, maintenance or repair, audits, or other QA activities. Significant events will be checked against the graphs for consistency.

Calibration data will be reviewed to assess the precision and bias of the data. If the calibrations indicate invalid or low precision, data values may be invalidated or adjusted as necessary and the appropriate flags will be applied. QC checks will also be reviewed to determine if the air quality data should be considered invalid. Especially high values will be checked to be sure that 1) there are no exceedances and 2) that an exceptional event did not occur. It is important to maintain detailed, accurate records of changes to the data. The justification for all data invalidations will be permanently documented in a data validation summary spreadsheet.

23.4 Minimum Acceptable Data Recovery Percentage

The data recovery goal for the Particulate Matter data will be at least 75 percent per quarter annually and DEQ/AQD objective of 90% quarterly.

23.5 Data Report QA Checklist

As part of the data validation process to prepare data for reports, report table content versus data files, missing data, offline periods, percent data recovery, and mathematical calculations are routinely verified.

24.0 Reconciliation with User Requirements

The objective of the Particulate Matter network is to collect data that will provide the necessary information for the WDEQ-AQD to assess whether the DQOs are met, and thus, that the data can be compared to the NAAQS and WAAQS. The PM data will be used to characterize and monitor trends in air quality and compliance with national and state air quality standards, and may be used for national health assessments, model evaluations, and comparison with other ambient air monitoring data. Following the procedures described in this QAPP and the SOPs will ensure that the DQOs are met, and the data will be representative of air quality conditions and be of acceptable quality for precision, bias, and completeness.

For the CSN data, this data will be utilized to understand the source apportionment of the gravimetric data.

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APPENDIX A: Standard Operating Procedures for Particulate Matter Instruments

Appendix A.1 - URG 3000N and Met One SuperSASS Chemical Speciation Monitors

Appendix A.2 – Met One 1020 and 1022 Beta Attenuation Monitor

Appendix A.3 – Thermo 2000i

Appendix A.4 – PM Audit

Appendix A.1 - URG 3000N and Met One SuperSASS Chemical Speciation Monitors

Wyoming
Department of Environmental Quality
Air Quality Division

Standard Operating Procedure

For the

Chemical Speciation Network Instruments

October2023
Revision 2.0

1.0 Scope and Applicability

The Chemical Speciation Network (CSN) Particulate Matter (PM) instruments collect PM in the ambient air. This document will focus on the two separate instruments: the Met One SuperSass and the URG 3000N. Both of these instruments have a specific "cuts" of PM; particulate matter that is less than 2.5 microns in aerodynamic size, i.e., $PM_{2.5}$, Neither of these instruments are Federal Reference or Equivalent instruments.

In April 2005, the Clean Air Scientific Advisory Committee gave strong general support for making changes to the EPA $PM_{2.5}$ CSN to improve comparability with the rural Interagency Monitoring of Protected Visual Environments (IMPROVE) $PM_{2.5}$ carbon concentration data. The program's objectives are to:

- Provide data to support the development of modeling tools.
- Assess the effectiveness of emission reduction strategies.
- Support other air quality programs and the National Ambient Air Quality Standards **(**NAAQS).
- Support research studies.

For this reason, the URG 3000N is the preferred instrument for collecting PM carbon. This SOP is applicable to the collection of $PM_{2.5}$ Carbon using the URG 3000N. The Met One SuperSass collects $PM_{2.5}$ on Nylon (ions) and Teflon (metals) filters.

2.0 Summary of Method

Both of the instruments pull ambient air using a vacuum pump to draw PM onto the filter that captures and holds the PM. The URG 3000N instrument works differently from the SuperSass. As the PM travels through the down tube, it encounters a sharp cut cyclone that removes all of the PM that is larger than $PM_{2.5.}$ The particles that remain are deposited onto a quartz filter.

The Met One SuperSass operates by pulling ambient air into a canister that houses a Sharp Cut Cyclone (VSCC) which is outside under a radiation and rain shield. The PM enters the SCC and the PM larger than $PM_{2.5}$ is removed from the ambient air and the remaining particulate is deposited and captured onto Nylon or Teflon 47 millimeter (mm) filters. The flow is automatically measured and recorded internally. Both the URG and the SuperSass provide a determination of concentration in units of micrograms per cubic meter (µg/m3). The filters must be removed on a 1 in 3 day schedule and are shipped to an analytical laboratory, the University of California Davis – Air Research Center (UCD-AQRC) in Davis, California. The UCD laboratory, which is under contract with the Environmental Protection Agency (EPA), provides the pre-weigh filters and performs the post-sampled filters for Elemental Carbon, Organic Carbon (EC/OC), ionic compounds and metals. This SOP only describes the field operations portion of the system that is performed by the WDEQ-AQD.

2.1 Definitions

The following terms that are used throughout this document are defined here:

- NIST Traceable Standard: This refers to a National Institute of Standards and Technology (NIST) flow, pressure, Relative Humidity (RH)/temperature measurement device. The device has been regularly compared against NIST traceable standards of a higher comparability.
- Field Standard: This refers to a standard that travels back and forth from the central laboratory to the field stations and is used to check the flow rates, pressure and RH/temperature sensors within the instruments.
- Quality Control (QC) checks: These are one-point verification check of the flow rate, pressure or temperature sensors. Please see Table 9 of the PM QAPP.

3.0 Health and Safety Warnings

The following health and safety warnings must be followed in order for safe operation of the instrument.

3.1 URG 3000N

- To avoid electrical hazards, all sampler installation procedures should be conducted with the sampler disconnected from the AC power source.
- Observe proper lifting procedures when unpacking and moving sampler components.
- Read, understand, and follow all safety precautions for the sampler outlined in the sampler's operations manual.
- Once sampler installation is complete, secure the sampler to the field sampling platform to ensure that it does not tip over during high wind speed events.
- The sampler weighs 135 pounds when completely installed. If a move is necessary, dissemble and remove the sample and controller modules and rain shield assembly from the lower stand (pump enclosure) so they can be moved separately.
- Care must be taken when operating or calibrating the units in inclement weather. Safety is paramount.
- If you are planning to dismantle and reconstruct the sampler for any reason, ensure that all electrical connections, both cords and sockets, are color-coded with tape prior to disconnecting.

3.2 SuperSass

- Read and thoroughly understand the operator's manual before beginning field operations. The flow rate and temperature calibrations of the sampler must be checked and, if necessary, adjusted to specifications prior to taking the first sample. Consult the operator's manual for calibration instructions.
- Use only the sampling canisters, sent to you from the laboratory, for the designated sampler and location.
- Exercise great care in placement and handling of sampling canisters to avoid contamination.
- The VSCC must be attached to the inlet of the sampling canister before sampling.

4.0 Cautions

- For the URG 3000N, clean the SSI and VSCC on a period basis. For the SuperSass, the VSCC is removed from the canister before it is shipped to the UCD laboratory. This should be established for each monitor station. Carefully clean the interior of the down tubes on a periodic basis (URG 3000N). Use cleaning procedures outlined in the manufacturer's instruction manual.
- Inspect the SuperSass tubing from the inlet to the flow controller unit. Check for cracks, pinholes or kinks in the tubing.
- Keep the interior of both of the samplers clean.
- Inspect the samplers regularly for structural integrity, leaks or rust.
- To prevent leaks, it is recommended that leak tests procedures be performed on the instruments whenever any work is performed that could affect the flow of the sample in the instrument.

4.0 Interferences

There are no interferences with these methods. However, it is important that the SSI and VSCCs be cleaned periodically because not servicing these components can allow PM of larger size to be sampled.

5.0 Personnel Qualifications

It is the responsibility of WDEQ-AQD and/or contractor to train their field staff on instrument operation and maintenance. It is a requirement of the WDEQ-AQD to train their staff but also keep records of all training that is performed per WDEQ-AQD’s Training Plan. Although these instruments are self-contained, computer operated instrument, there is a level of knowledge of electronics and know-how involved in the operation and maintenance of the instrument. The instrument manual is the best training tool for this.

6.0 Equipment

WDEQ-AQD and its contractors specifically utilize CSN instruments, because it is required by the EPA. These instruments have been thoroughly vetted by the EPA. The instrument, when initially received, should operate within the parameters set down by the EPA. These parameters are available in the operating manual that comes with the instrument. Thoroughly read and familiarize yourself with this instrument.

The following supplies are required for the operation of this instrument.

6.1 URG 3000N

- Inlets: The SCC must be in use at all times during operation.
- NIST Traceable flow, pressure and temperature and RH device: As described in Section 2.1 of this SOP, the NIST traceable device is necessary to carry out the necessary QC checks required to keep the instrument running correctly. It is also good field practice to leave the tubing that is used from the inlet of the flow device to the inlet be left at the station. Replace this tubing if cracks or holes appear in the tubing.
- Pump rebuilds kit: Periodically, the flow pump must be rebuilt. It is good practice to keep the pump rebuild kit on site in case the pump flow rate decreases or seizes.

- QC Check Forms: These are attached to the Appendix to this SOP.

6.2 SuperSass

- Read and thoroughly understand the operator's manual before beginning field operations. The flow rate and temperature calibrations of the sampler must be checked and, if necessary, adjusted to specifications prior to taking the first sample. Consult the operator's manual for calibration instructions.
- Use only the sampling canisters, sent to you from the UCD laboratory, for the designated sampler and location.
- Exercise great care in placement and handling of sampling canisters to avoid contamination.
- The VSCC must be attached to the inlet of the sampling canister before sampling.
- To check for leaks, a device to close sample flow pathway (i.e., plug for inlet to the SCC).
- NIST Traceable flow, pressure and temperature and RH device: As described in Section 2.1 of this SOP, the NIST traceable device is necessary to carry out the necessary QC checks required to keep the instrument running correctly. It is also good field practice to leave the tubing that is used from the inlet of the flow device to the inlet be left at the station. Replace this tubing if cracks or holes appear in the tubing.
- Pump rebuild kit: Periodically, the flow pump must be rebuilt. It is good practice to keep the pump rebuild kit on site in case the pump flow rate decreases or seizes.
- QC Check Forms: These are attached to the Appendix to this SOP.

For the WEDQ–AQD operated sites, parts will be inspected by the Project Managers or Monitoring Specialist for shipping damage upon receipt. Spare parts will be kept in the monitoring shelter for use when needed. The use of spare parts will be documented on calibration forms. Please note that some parts will be stored at the monitoring stations while some less utilized parts will be stored at the contractors' and WEQD-AQD central facilities. The AQD will use AirVision software to track spare samplers.

7.0 Quality Control Procedures

7.1 URG 3000N

Read and thoroughly understand the operations manual before beginning field sampling operations. The ambient temperature, barometric pressure and flow rate calibrations of the sampler must be checked and, if necessary, adjusted to specifications prior to taking the first sample. Prior to any flow rate calibration or verification, a leak check must be performed. Consult the operations manual for calibration instructions. Use only the sampling cartridges, sent to you from the laboratory, for the designated sampler and location. Exercise great care in placement and handling of sampling cartridges to avoid contamination.

7.1.1 Sampler Operation

The URG-3000N sampler is designed to sample on a 1-in-3 day or a 1-in-6 day schedule. After the correct date and time are programmed, the software default is set at a 1-in-3 schedule. If you are sampling on a 1-in-6 day schedule, please see operator's manual for steps to change the program to run the 1-in-6 schedule. The sample also can be programmed to run an alternative sample date.

The sampler software identifies two types of filters, Exposed Filter and New Filter. The Exposed Filter is the filter in the sampler from the previous sample run. The New Filter is the filter for the next sample run. See the two display screens below to understand where the designation (in bold) is on the screen. The Mod:[1] represents sampling from Module 1.

When the Station Operator or Site Technician goes to the site to recover exposed filter and set-up new sampling events, they should bring the following equipment and supplies:

- Operations Manual or this SOP with Menu Trees for operating the sampler
- Field notebook
- Marker (indelible ink)
- Quartz filter(s) in a filter cassette mounted on a filter cartridge in a 9" x 12" sealable plastic shipping bag (provided by the support laboratory)
- Compact Flash memory card in a 3" x 4" anti-static sealable plastic shipping bag (provided by the support laboratory)
- CSN Custody and Field Data Form (CAFDF) provide by the support laboratory (See Appendix A).
- "AUDIT" filter cartridge (provided by manufacturer)
- NIST-traceable calibration standard(s) for ambient temperature, barometric pressure, and flow rate with connecting tubing
- Leak check assembly (flow audit adaptor and shutoff pump valve provided by the manufacturer)
- Laboratory tissue

It is highly recommended that the exposed filter be recovered from the sampler as soon as practical, but no later than 120 hours.

This section describes the filter changing procedures.

- Prior to opening the Controller or Sample Module doors, check for moisture buildup from rain or snow on the sample housing; remove as necessary. Report the findings on the CAFDF and field notebook.
- Open the Controller Module and confirm that the sampler has power by viewing the display screen. The AUTO MODE screen should be visible.
- The keypad has an extension cord and magnetic strips. Remove the keypad from its holder and move it with attached extension cord to the front of the Sample Module. Open the Sample Module door and attach the keypad (magnetic strips) to the inside of the Sample Module door.

- Inspect the Sample Module for moisture and wipe out with a laboratory tissue if necessary. Inspect the seating around the filter manifold and filter cassette. Report the findings on the CAFDF and field notebook.
- From the AUTO MODE display screen, record the sample cartridge removal date and time on the Exposed Filter CAFDF in the Retrieval Date and Retrieval Time columns.
- Use the Filter Change and Scheduling Menu Tree to assist in applying the proper keystrokes for the software program. Begin by pressing the “ENTER” key. The display screen below should appear.
- Press the “F1” key and then the “YES” key to proceed to the filter change menu. The sampler will read the ambient temperature and barometric pressure for the Exposed Filter and record the information on the Compact Flash memory card. After a brief pause, the Mass Flow Controller (MFC) will initiate.
- After five minutes, the program will show the final flow rate and vacuum pressure. Press the “ENTER” key, and the final flow rate values will be stored for the Exposed Filter on the memory card.
- After a brief pause, the program will display the results for the Exposed Filter.
- These results are stored on the memory card and should be transcribed to the CAFDF assigned to the Exposed Filter.

The first screen shows the elapsed time for the Exposed Filter sampling event. Record this value (*1445 minutes*) in the Run Time column on the CAFDF. An accepted sample run is 24 hours ± 1 hour (1440 minutes ± 60 minutes). If the elapsed time was less than 1380 minutes or more than 1500 minutes, record “YES” in the Run Time Flag column. Remember the sampler performed a final flow rate and vacuum check for 5 minutes. The sampler is designed to start at midnight and run until midnight the following day. Since the URG 3000N does not display the Start Date, Start Time, End Date, or End Time on the display screens, the operator need to determine the Stop Time and Stop Date based on the elapsed time. The Start Date was recorded on the CAFDF when the sample run was initially programmed and if the sampler ran as programmed; the Start Time would be 0:00.

- Press the “**F4**” key to advance to the next screen below shows the sample volume in m3. Report the volume on the CAFDF under the Sample Volume column.
- Press the “**F4**” key to view the flow average in L/min (*22.1*) and the coefficient of variation (CV) in percent (*0.1*). Report the flow average and CV on the CAFDF under the Average Flow and Average CV columns.
- Press the “**F4**” key to view the average (*25.0*), maximum (*26.1*), and minimum ambient temperatures during the sample run in ºC. Report these results on the CAFDF under the Average Ambient Temperature, Maximum Ambient Temperature, and Minimum Ambient Temperature columns.
- After displaying the Exposed Filter data, the controller will prompt the operator to replace the memory card (see screen below). Replace the old memory card by pulling lightly (see below) and placing a new memory card provided by the support laboratory. The memory card will only fit in the memory card slot one way. Do not force it into the slot. Place the old memory card in a 3” x 4” anti-static sealable plastic shipping bag provided by the support laboratory.
- Place the white and pink copies of the Exposed Filter CAFDF in the 9” x 12” sealable plastic shipping bag. The site operator will maintain the yellow copy for their records. Place the 3” x 4” anti-static sealable plastic containing the Exposed Filter memory card in the larger 9” x 12” bag. This larger bag will be shipped to the support laboratory.

- Prior to removing the New Filter cartridge from the sealable plastic shipping bag, check that all four filter inlets are covered with red caps. If any of these caps came off during shipping, please note on the CAFDF for the New Filter. Now remove the New Filter cartridge from the sealable plastic shipping bag provided by the support laboratory. Align with the hole forward as below to the left. Insert the cartridge into the cassette manifold and press the bottom “down” button on the electronic box to lower the solenoid manifold until it stops.

7.2 Met One SuperSass

7.2.1 Sampler Operation

The Met One SuperSass sampler is designed to sample on a 1-in-3 day schedule. After the correct date and time are programmed, the software default is set at a 1-in-6.

- Record information about the sample, or the field blank on an individual CSN CAFDF.
- Remove the protective end caps from the canister. Attach a dedicated sharp cut cyclone to each canister. Install loaded filter canisters in predetermined (color-coded) sampling channel locations according to the information given on the CAFDF sent from the support laboratory. When field blank canister(s) are loaded, do not activate flow to field blank channel(s). Place canister caps in a clean plastic bag and store for later use to seal used canisters for return to the laboratory.
- Press F2 key to set up Start/Stop times in the sampler.
- If possible, key in information (including the unique custody/data form number assigned by the laboratory) to the sampler memory to allow later matching of the stored data with the analytical results.
- Edit START Date/Time, and END Date/Time using the arrow keys. The CSN collects 24-hour samples, beginning at midnight.
- Select “SAVE” to save the programmed event.
- Press F1 to review the programmed event, and then select “EXIT”.
- Make entries to the CAFDF.
- At the end of the sample run, select “SUMMARY” option from the main screen.
- Record end date/time, sample retrieval date/time, specified post-sampling information, and free-form comments on the CAFDF. Please double-check entries and write clearly!
- Download sampler data from RS232 port to laptop computer or to MetOne Sass data transfer module.
- Retain data file disk file for later use in data validation. Do not ship it to the support laboratory.

The field operator will receive several filter canisters for several uses. These are for routine (every third day) sampling and field blanks (sent from the laboratory). It is highly recommended that sampling modules (i.e. canisters, filter packs) be recovered from the sampler as soon as is practical, but no later than 120 hours. Once the sampled canisters are removed, separate the sharp cut cyclone for reinstallation with the next set of canisters, cap or cover the canister openings, store the canisters in the shipping container, complete the CAFDF, and return all to the field office. The sampled canisters and paperwork must be properly packaged in a shipping container, ready for pickup by UPS, within 96 hours after the sampling modules have been recovered. The support laboratory will provide specific directions for packaging and shipment and days for shipment. Protect samples from direct sunlight and extreme heat during transport from the site to the field office; store them in a secure, air-conditioned area until just before packaging them in the shipping container. Please follow these instructions:

- At the end of the sample run, lower the sampler's lower radiation shield.
- Rotate each canister counterclockwise to remove from its sampling position. Remove the cyclone.
- Cap the canister inlet and outlet with yellow end caps. Place or store the cyclones in a clean spot. Reinstall cyclones on the canisters for the next sampling run. Every 30 days of use, clean the cyclone per instructions given in the operator's manual.
- Place each filter canister into a zip-lock style bag and then place it in the proper location in the storage bin or shipping container.
- Complete all paperwork.
- Clean the area around the sample head; wipe connections with a clean cloth or paper towel. Install a new filter canister by aligning screws in slots and rotate it counterclockwise to secure. Take care to properly match the Sass canister to the correct sampler inlet.

Field Blank Filters are handled separately. Field blank filters, loaded into canisters, will be shipped from the laboratory. They will have a separate CAFDF with them. They are to be used during the same time interval as the routine sample canisters.

- Visit site at the time regularly scheduled for setting up a new sampler run. Install the field blank canisters (and sharp-cut cyclones) in the channel locations as indicated by the CAFDF.
- After a minute or two, remove the field blank canisters from the sampler, detach the cyclones, cap the canisters, and return them to their spot in the shipping bin or shipping container.
- Proceed to install the routine sample canisters according to schedule.
- Complete and sign the CAFDF for the field blank canisters and ship them back to the laboratory, in their own shipping container, at the same time as the routine samples.

7.3 URG 3000N and SuperSass Maintenance Activities

Table 1 illustrates the maintenance actions and their frequency.

Table 1. Equipment Maintenance Activities.

Maintenance Activity	Frequency
SuperSass and URG-3000N	
Check sampling inlets, URG down-tubes for bugs and obstructions, and water intrusion	Each visit to site, clean as needed.
Clean sampler inlet surfaces.	Monthly
Clean interior of sampler case (if applicable).	Each visit to site
Inspect denuder for breakage. (URG)	Replace denuders with freshly coated ones and return used denuder to laboratory for refurbishment.
inspect and service cooling air intake filter and fans	Every 30 sampling events or more often as needed or as specified by the network
Inspect and service O-rings of inlet and water seal gasket at down-tube entry to case.	Apply very light coat of vacuum grease if required.
Clean cyclones and manifolds upstream of sampler module.	As needed
Inspect and service O-rings in sampler head or platform assembly of URG 3000N.	As needed
Inspect and service vacuum tubing, tube fittings, and other connections to pump and electrical components.	As needed.
Overhaul or replace sampling pump and solenoids.	Quarterly or As needed.

8.0 Quality Control Checks

The procedure below describes the steps that are performed when a QC checks are performed. The description below refer to the monthly QC checks. Quarterly QC checks are also required. However, the procedures are not the same.

8.1 URG 3000N

Certain quality control checks must be conducted at the time of sampler startup and at monthly or quarterly intervals thereafter. The monthly checks are to be conducted by the site operator, while the quarterly audits are to be conducted by an independent third party. Carry out these checks before making any adjustments to the sampler. Record information about the site, the sampler, and the results of scheduled or special (unscheduled) quality control checks on the CSN QA/QC Spreadsheet. The information on the spreadsheet is to be returned to the support laboratory, which will then upload the results into AQS. Any actions taken to service or calibrate the speciation sampler after the check must be recorded in brief on the form and in detail in the field operator's notebook.

8.1.1 Date and Time Check

Conduct these checks monthly or whenever daylight savings time changes occur. Compare the date and time displayed on the sampler to the known date and to an atomic watch or cell phone. Record the information on the QA/QC data form.

8.1.2 Rotation of the filters in the AUDIT cartridge

The filter cassettes in the AUDIT cartridge should be rotated quarterly. Remove the filter cassette in the Number "1" position by popping off the retaining ring that holds the cassette in the cartridge.
The Number "1" position is located to the right of the pin used to position the cartridge in the sampler when installed. Move a clean filter cassette to the Number "1" position. Mark the used filter cassette with a colored dot and replace all filter cassettes in the AUDIT cartridge.

8.1.3 Monthly Leak Check

Perform leak check upon startup and then monthly.

- From the AUTO MODE screen, Press the "**ENTER**" key to move from the AUTO MODE to the Authentication screen. Then enter "**1123**" to proceed to Choose Operator screen (for samplers deployed during Phases II and III, pressing "ENTER" allows the operator to proceed). Choose "**1**, **2**, or **3**" to proceed to the Main Menu screen. Press the "**F4**" key to show the second Main Menu. At the second Main Menu, press the "**F3**" key for the Audit Menu screen.
- 8.3.2 At the Audit Menu, press the "**F1**" key and then the "**ENTER**" key to begin the leak check. Inspect that the flow audit adapter is in the open position. If not, open and remove the inlet cap at the top of the down tube. Place the flow audit adapter on the top of the down tube. Press the "**ENTER**" key when directed by the on screen commands.
- Inspect and assure the pump shutoff valve is in the open position. Disconnect the vacuum from the side of the pump enclosure. Connect the pump shutoff valve to the vacuum (air) line and reconnect to the side of the pump enclosure.
- Press the "**ENTER**" key when directed by the on screen commands.
- Rotate the lever on the flow audit adapter 90º to close the adapter. Press the "**ENTER**" key and rotate the lever on the pump shutoff valve 90º to close the valve. Press the "**ENTER**" key and the vacuum will begin to drop and when it reaches 380 mm Hg, a timer will count for a maximum of 35 seconds.
- After the countdown from 35 seconds, the results will be displayed as either PASSED or FAILED. The acceptance criterion is a vacuum drop of less than 225 mm Hg in 35 seconds. The timer will stop if the leak is greater than 225 mm Hg inside the 35 seconds. If the sampler fails the leak check, attempt another leak check. If the sampler fails both times, refer to Section 10 Troubleshooting or the Operations Manual.
- Record the pressure drop in mm Hg on the CSN QA/QC Spreadsheet and the field notebook. Press the "**ENTER**" key and slowly release the pressure in the sampler by turning the lever on the flow audit adapter.

- Remove the flow audit adapter, the pump shutoff valve, and “AUDIT” cartridge and store in a safe place.
- Restore the software program to the AUTO MODE screen.

8.1.4 Monthly Temperature Control

Perform the temperature control checks upon startup and then monthly.

- Holding the ambient temperature probe cable, gently push the black plastic disc through the bottom of the Sample Module. Slowly loosen the nut holding the ambient temperature probe and carefully remove the probe plug and set it inside the module, away from direct sunlight (exposing the probe to ambient conditions).
- Place the reference temperature probe alongside the sampler’s ambient temperature probe and allow both temperatures to equilibrate.
- From the Audit Menu, press the “**F3**” key.
- After the two probes equilibrate, enter in the reference standard temperature value in degrees Celsius. Press the “**F1”** key to toggle between positive and negative values whereas pressing “**F2”** to toggle between Celsius and Fahrenheit. (Example: for 25.2 ºC; enter “**252**”. The decimal place is fixed for a tenth degree.)
- The sampler and reference standard values in degrees Celsius on the CSN QA/QC Spreadsheet and the field notebook. **The agreement should be within ±2 ºC**. If the results are out of tolerance, refer to the Operations Manual.
- The temperature reference standard and securely place the sampler’s temperature probe back in the bottom of the inlet tee. Replace the black plastic disc.
- Restore the software program to the AUTO MODE screen.

8.1.5 Monthly Flow Rate Control Check

Perform the flow rate check upon startup and then monthly.

- Prior to conducting flow rate verification, a successful leak check must be completed. The monthly flow rate check must be conducted with the "AUDIT" cartridge.
- Remove the inlet cap and place the flow audit adapter on the top of the down tube. Connect tubing from reference standard to the flow audit adapter and begin the flow rate verification.
- From the Audit Menu, press the "**F2**" key and press the "**YES**" key. Check the connections to reference flow meter, and press the "**ENTER**" key to continue.
- The MCF initiates and runs for 5 minutes at the design flow rate of 22.0 L/min.
- Press the "**ENTER**" key and enter the reference standard's flow rate in L/min. Use the keypad to enter the reference standard's flow rate value. The decimal place is fixed at two decimal places so for a flow rate of 21.75 L/min., enter "**2175**". The sampler's flow rate, the reference standard's flow rate, and the difference (sampler – reference standard) between the two values (all in L/min) are displayed.
- Record the sampler and reference standard values in L/min on the CSN QA/QC Spreadsheet and the field notebook. **The agreement should be within ±10 %**. If the results are out of tolerance, refer to the Operations Manual.
- Remove the flow audit adapter and replace the inlet cap. Remove the "AUDIT" cartridge and place in a safe place. Restore the software program to the AUTO MODE screen.

8.2 Met One SuperSass

Certain QC checks must be conducted at the time of sampler startup and at monthly or quarterly intervals thereafter. The monthly checks are to be conducted by the site operator, while the quarterly audits are to be conducted by an independent third party. Carry out these checks before making any adjustments to the sampler. Record information about the site, the sampler, and the results of scheduled QC checks on the CSN QA/QC Spreadsheet.

8.2.1 Date and Time Checks

Conduct these checks monthly or whenever daylight savings time changes occur. Compare the date and time displayed on the sampler to the known date and to an accurately set watch. Record information on the QA/QC spreadsheet.

8.2.2 Monthly Leak Check

Performed upon startup, then monthly.

- Place canister containing filter/denuder and attached sharp cut point cyclone at the channel location to be leak-checked. Use this canister assembly for leak checks and flow rate checks only. The canister must contain the type of filter (and denuder, if included in the canister) normally used at this sampling channel location. Press F3 key, and select "PUMP ON".

- Plug the Sample Inlet (e.g., Channel 1) with cap. Note the displayed flow. The indicated flow rate should drop to 0.0 L/min. If it does not, check for leaks and repeat the procedure until the leak check is completed successfully. Repeat for all channels in use.
- Select "PUMP OFF" to stop the pump, and "EXIT".
- Release the vacuum slowly to avoid damaging the leak check filter.

8.2.3 Monthly Temperature Control Check

Performed upon startup and then monthly.

- Check the ambient and filter temperature sensors of the sample by positioning the probe of a certified transfer standard digital thermometer in close proximity to the sampler sensors.
- Allow time to achieve stable readings and record the results in the field notebook and on the CSN QA/QC report form. If the sampler and control check temperature readings differ by more than ± 2 degrees C, trouble-shoot the system and recheck. If still out of tolerance, conduct a multipoint calibration or replace the faulty sensor.
- Consult the manufacturer and the operator's manual for procedures.

8.2.4 Monthly Pressure Control Check

- Compare the ambient barometric pressure readout from the sampler display screen with the reading from a certified transfer standard barometer.
- If the pressure readings differ by more than ± 10 mm Hg, perform a multipoint calibration of the sensor or replace the faulty sensor.

8.2.5 Monthly Flow Rate Control Check

Perform flow rate check upon startup, then monthly.

- Use same canister assembly called for in monthly Leak Check procedure.
- Connect an external flow audit device to the cyclone sample inlet (e.g., Channel 1). Use a low pressure drop certified flow transfer standard.
- Press the F3 key, and select "PUMP ON".
- Compare the flow rate measured by the external flow device with displayed value. (The sampler is preset at 6.7 L/min). If the flow deviation exceeds + 4% (+ 0.27 L/min), perform a flow rate calibration as specified in the operations manual. If there are issues with the calibration, contact Met One for technical support.
- Repeat the procedure for all flow channels in use.
- Record the results on the CSN QA/QC spreadsheet.

9.0 Instrument Performance Calibrations Procedure

9.1 URG 3000N

The URG 3000N sampler can be calibrated for ambient temperature, barometric pressure, and flow rate. The calibration procedure should be performed if the sampler fails verification. See Section 8.1 for verification procedures.

The overall procedures for performing a calibration are similar to the verification procedures on the URG 3000N with one major difference. The results from the verification checks are merely stored on the sampler's Compact Flash memory card. When a calibration of ambient temperature, barometric pressure, or flow rate is conducted, the results are also saved on the memory card, but will change the settings in the sampler for that parameter.
Before conducting a calibration, confirm the reference standards are certified as NIST-traceable and in good working condition. Allow the calibration standards to equilibrate to ambient conditions. Follow the procedures provided by standard's manufacturer regarding the length of time for the standard to obtain stable conditions.

- From the AUTO MODE screen, Press the "**ENTER**" key to move from the AUTO MODE to the Authentication screen. Then enter "**1123**" to proceed to Choose Operator screen (for samplers deployed during Phases II and III, pressing "ENTER" allows the operator to proceed). Choose "**1**, **2**, or **3**" to proceed to the Main Menu screen. Press the "**F4**" key to show the second Main Menu. At the second Main Menu, press the "**F1**" key for the Calibration Menu screen (see screens for AUTO MODE

If the sampler does not respond after performing the proper ambient temperature, barometric pressure, and flow rate calibration procedures, refer to Section 10.0 Troubleshooting or the Operations Manual. If you are still unable to solve the problem, contact URG at (919) 942-2753, http://www.urgcorp.com/index.php/email-form or info@urgcorp.com..

9.1.1 Ambient Temperature Calibration (1-Point)

- At the base of the inlet tee, locate the ambient temperature probe. While holding the ambient temperature probe cable, gently push the black plastic disc through the bottom of the Sample Module. Slowly loosen the nut holding the ambient temperature probe and carefully remove the probe plug and set it inside the module, away from direct sunlight (exposing the probe to ambient conditions).
- Place the reference temperature probe alongside the sampler's ambient temperature probe and allow both temperatures to equilibrate. If it is windy, it might be a good idea to place probes into the module for reading.
- After the two probes equilibrate, record the sampler and reference standard values in degrees Celsius on the CSN QA/QC Spreadsheet and the field.
- At the Calibration Menu, press the "F1" key to proceed to the ambient temperature calibration screen.
- Press the "SPACE" key to begin the ambient temperature calibration and the notebook. The agreement should be within ±2 ºC.
- Enter the reference standard temperature value in degrees Celsius. Press the "F1" key to toggle between positive and negative values whereas pressing "F2" to toggle between Celsius and Fahrenheit. (Example: for 25.2 ºC; enter "252". The decimal place is fixed for a tenth degree.) The next screen shows the sampler's calibrated temperature in degrees Celsius.

9.1.2 Barometric Pressure (BP) Calibration (1-Point)

At the Calibration Menu, press the "F2" key to proceed to the barometric pressure calibration screen.

- Press the “SPACE” key to begin the barometric pressure calibration.
- Record the sampler and reference standard BP values in mm Hg on the CSN QA/QC Spreadsheet and the field notebook. Record the sampler and the reference standard barometric pressure values in The agreement should be within ±10 mm Hg.
- Enter the barometric pressure (in mm Hg) of an equilibrated NIST-traceable reference standard using the keypad. (Example: for 754 mm Hg; enter 7540, the display screen will show 754.0 mm Hg. The decimal place is fixed for a tenth degree. If you entered “754”, the display screen will show 75.4 mm Hg which is incorrect.)
- After entering the reference standard’s barometric pressure, the next screen shows the sampler’s calibrated barometric pressure (see screen below).
- Press the “YES” key to save to the Compact Flash memory card (see below). After a brief pause, the operator is returned to the Calibration Menu.

9.1.3 Flow Rate Calibration (3-Point)

Prior to conducting flow rate verification, a successful leak check must be completed. The operator should use a NIST-traceable calibration standard that has been equilibrated to ambient conditions. Follow the procedures provided by standard’s manufacturer regarding the length of time for the standard to obtain stable conditions. The flow rate calibration must be conducted with the “AUDIT” cartridge. If the flow audit adapter is not connected to the top of the down tube, remove the inlet cap and place the flow audit adapter on the top of the down tube. Connect tubing from reference standard to the flow audit adapter and begin the flow rate verification.

- At the Calibration Menu, press the“F3” key and then the “ENTER” key to proceed to the flow rate calibration screen.
- To continue with the flow rate calibration, press the “YES” key. The screen below shows the first calibration point of 19.80 L/min. Press the “ENTER” key to advance to the next screen and then press the “ENTER” key again to proceed to calibrate the first point.
- After entering the reference standard’s flow rate for Calibration Point 1, the Press the “ENTER” key. The MFC begins sampling at the second calibration point and displays the flow rate (see below). After the reference standard stabilizes, use the keypad to enter the reference standard’s flow rate value. Record the sampler and reference standard values in L/min for Calibration Point 2 on the CSN QA/QC Spreadsheet.
- Repeat previous Steps for Calibration Point 3 (24.20 L/min).
- After entering the reference standard’s flow rate for Calibration Point 3, the screen below appears showing the new Gain, Offset, and Correlation Coefficient. Press the “YES” key to save the flow rate calibration to Compact Flash memory card. Press the “ENTER” key to return to the Calibration Menu screen. If the operator wishes to return to the AUTO MODE, press the “ENTER” key twice. This concludes the verification of the routine URG 3000N sampler.

9.2 Met One SuperSass

The calibration procedure performed in the field for the Sass is flow rate measurement, ambient filter, ambient temperature and barometric pressure measurement.

Using a set of NIST traceable standards, for volumetric flow, barometric pressure and temperature, the Sass

Unit can be easily calibrated using the calibration screens in the Sass Control Unit. From the main screen menu select the “Calibrate” key. This action will display the following Utility Menu Screen.

9.2.1. Temperature Calibration

- From the Utility Menu Screen, select the F3 key on the control unit keyboard. This will bring up the Temperature Calibration Screen as shown below.
- Before beginning it will be necessary to have a reference temperature measurement device that has a calibration traceable to NIST.
- From the menu, if the menu is not already in the “ambient” temperature measurement mode, use the arrow keys to move the cursor to the upper left hand selection and choose the “ambient” measurement.
- The indication under the Sass menu item indicates the current ambient temperature, and this will be used to determine if the system needs to have the calibration changed.
- Collocate the reference thermometer with the ambient temperature probe in the shield. The temperature should be within ±2°C of the reference thermometer.
- If the measurements is within the temperature tolerance then it is not necessary to calibrate the ambient temperature probe. If the temperature is in excess of the tolerance then use the following procedure to reset the calibration of the ambient temperature probe.
- Insert the probe in the ice bath with the reference thermometer, and allow several minutes for the measurements to stabilize. It is best to try and stir the bath while both probes are in the ice mixture. When the probes are stable, enter the value measured from the reference thermometer in the top reference window. When completed press F1 to save this value.
- Now insert the probe in the heated water mixture and allow time for the probe and the reference thermometer to stabilize. When the probes are stable, enter the value measured from the reference thermometer in the second reference window. When completed press F4 to save this value.
- Now press the “Calibrate” key and the new values will be saved in memory of the control unit.
- This calibrated the temperature probe to the reference thermometer. Re-run the temperature checks previously outlined and verify that at the two measurement points the temperatures are within the ±2° C tolerance. If they are not, then rerun the calibration test one more time.
- If it fails the test a second, time, there is the possibility that the temperature probe is damaged, and will need to be replaced. If a new probe is installed, be sure to set the replacement probe using the “Default” menu selection. This will return to the original measurement factors.

This same procedure can also be used for the filter temperature measurement, except that for the temperature check, use the local ambient as a single reference point. From the temperature menu, use the arrow keys to change the value from 0 to 1 which will now indicated “Filter” Temperature. Insert a temperature probe into the open hole after canister #1 has been removed. Allow 10 minutes for the temperatures to stabilize, and then compare the reference thermometer with the filter temperature screen. They should be within ±2°C of each other. If the error is greater, then use the procedure outlined above for this temperature probe except that the upper temperature is based on a reference thermometer placed near the filter temperature probe located above the canister. Continue this same procedure for the remaining filter temperature probes.

9.2.2 Pressure Calibration

From the Utility Menu Screen, select the F4 key on the control unit keyboard. This will bring up the Volumetric Flow Calibration Screen.

- Comparing the current Sass pressure measurement with a reference barometer can make a preliminary check. The pressure indicated for the Sass should be within ±10 mm Hg of the reference pressure device. If the measurement is in excess of this value, then it may be necessary to recalibrate the sensor in the Sass using a two-point barometric pressure measurement.
- To perform a pressure calibration, a few items will be required. This includes a precision barometer or other pressure-monitoring device that has a range of 600 to 800 mm Hg with accuracy in excess of 0.1mm Hg. Located inside the pump enclosure just under the power supply on the center wall on the pump side is a nylon right angle connection that attaches to the pressure transducer.
- To perform a calibration, two measurement points will be necessary. This can be accomplished by using a syringe, some tubing, a tee, and the precision reference pressure device. Connect from the pressure test point to a tee connector using some tubing, one side of the tee goes to the pressure measurement device and the other to the syringe. The size syringe required is dependent upon the length (total air volume) of tubing used to make this test apparatus. The syringe is used to change the pressure inside the tubing from below ambient to above ambient.
- Adjust the syringe in and out to change the simulated test pressure measured by the reference device and transferred to the sensor inside the Sass. Two typical readings would be 600 and 760 mmHg. First verify that the syringe is able to adjust the simulated barometric pressure to 600 mmHg and 800 mmHg. Adjust the size of the syringe or the lengths of tubing to provide the necessary adjustments.
  Set the simulated pressure value to 600 mmHg as measured from the reference pressure sensor. When the measurement is stable, enter the value measured from the reference in the top reference window. When completed press F1 to save this value. Now set the simulated pressure value to 800 mmHg as measured from the reference sensor. When the measurement is stable, enter the value measured from the reference in the second reference window. When completed press F4 to save this value.
- Now press the “Calibrate” key and the new values will be saved in memory of the control unit.
- This calibrated the pressure sensor in the pump box to the reference barometer. Re-run the pressure checks previously outlined and verify that the new measurement is within the ±10 mmHg tolerance. If they are not, then rerun the calibration test one more time.
- If it fails the test a second, time, there is the possibility that the pressure sensor is damaged, and will need to be replaced. If a new sensor is installed, be sure to set the replacement sensor using the “Default” menu selection. This will return to the original measurement factors.

9.2.4 Flow Calibration

From the Utility Menu Screen, select the F2 key on the control unit keyboard. This will bring up the Volumetric Flow Calibration Screen. Note that there are only 4 flow channels in the Super Sass. Before beginning the calibration, it will be necessary to have some type of reference flow device that has a calibration that is traceable to NIST. The best type of flow unit to use is one that is a direct reading device that has minimal inline flow restriction. Some of the flow measurement devices can restrict the flow, to a point that it is difficult to measure at the operating flow rate of the system. It is recommended that the Sass pump be run for approximately 20 minutes to allow the flow system to reach operating temperature before performing a flow calibration.

- Using a flow test device, and any adapter that might be necessary to adapt to the input tube of the SCC, measure the flow at each of the canisters. The VSCC inlet adapter can be used.
- Using the Up/Down key select each of the flow line positions. The SuperSass has 4 flow lines. In the SuperSass these same four lines are also used by the second set of 4 sample canisters. These keys are used to change the channel being monitored. All measured flows, should be within ±0.67 LPM or ±10% of the reference standard. The channels 4&5 of the Sass are set to ± 0.69 LPM or ±10%. If any value is in excess of this tolerance, entering the value of the reference in the Reference position and then hitting the “Calibrate” key can calibrate the channel. This will enter in the correctly measured value for that channel. Use this same procedure for any other channels that may require recalibration. Record all changes to the system in a logbook.

10.0 References

1. Quality Assurance Guidance Document Quality Assurance Project Plan: PM2.5 Chemical Speciation Sampling at Trends, NCore, Supplemental and Tribal Sites, EPA-454/B-12-003, June 2012

2. SOP # 5100CSN Standard Operating Procedure for the Met One SASS Revision 2 Date: July 27, 2011

3. Standard Operating Procedures (SOP) For the URG-3000N Sequential Particulate Speciation System, SOP: URG-3000N Revision: 2 Date: August 11, 2011

4. Quality Assurance Project Plan State of Wyoming Cheyenne NCore Monitoring Station By Meteorological Solutions Inc., Project No. 08191870, August 2019 Revision 0

APPENDIX A.1 FORMS

Corrective Action Form

CORRECTIVE ACTION REPORT

PROJECT NAME ____________________

Identification of a Problem or Deficiency:

Created By: ____________________
Assigned To: ____________________
Date: ____________________

Summary:

Corrective Action Taken and Results:

From: ____________________

Corrective Action Description:

Chain of Custody Form

BAR CODE GOES HERE Custody/Data Form No.	$PM_{2.5}$ CSN CUSTODY AND FIELD DATA FORM	White – return to lab Yellow – site retains Pink – lab retains

. CUSTODY RECORD (Name, Date)

1. Laboratory, Out	3. Site, Out ______
2. Site, In	4. Lab, In ______

B. SITE AND SAMPLER INFORMATION

1. Site AIRS Code	5. Site Name ______
2. Sampler S/N ____	6. Intended date of use ______
3. Sampler Type ____	7. Date of sampler set-up ______
4. Sampler POC ____	8. Operator's name __

C. SAMPLER CHANNEL COMPONENTS

Channel Number	Component ID No.	Component Description
1	kept at site	SASS cyclone
1	I1234568	SASS canister (Teflon filter) (GREEN)
2	kept at site	SASS cyclone
2	I1234570	SASS canister (MgO denuder, nylon filter) (RED)

D. START, END, AND RETRIEVAL TIMES

Channel No.	Start date	Start time	End date	End time	Retrieval date	Retrieval time
1						
2						
3						

E. SAMPLER CHANNEL INFORMATION (Post-Sampling)

Channel No.	Run Time	Run Time, Flag	Sample Volume (m3)	Avg. flow (L/min)	Avg. flow CV (L/min)	Avg. ambient T (□C)	Max. ambient T (□C)	Min. ambient T (□C)
1								
2								
3								

Channel No.	□T Flag	Avg. Filter T (□C)	Max. Filter T (□C)	Min. Filter T (□C)	Avg. BP (mm Hg)	Max. BP (mm Hg)	Min. BP (mm Hg)
1							
2							
3							

MetOne SASS - Primary Sampler								
Clock Test:								
If Local Time is under daylight savings, convert Ref Std to Local Standard Time. Daylight Saving Time begins for most of the United States at 2:00 a.m. on the first Sunday of April. Time reverts to standard time at 2:00 a.m. on the last Sunday of Octobe								
	Time (hh:mm)				Difference		5 minutes or less?	
	Ref Std		SASS		Minutes		Pass	Fail
Audit								
Recalibrated								
Date								
Leak Test								
	Initial Check			After Correction		0.10 L/min or greater fails		
	A L/min			B L/min		Fail A	Fail B	Pass
Channel 1			Channel 1					
Channel 2			Channel 2					
Channel 3			Channel 3					
Channel 4			Channel 4					
Channel 5			Channel 5					
Channel 6			Channel 6					
Channel 7			Channel 7					
Channel 8			Channel 8					
Flow Test				**Calibration**				
For the reference standard, enter "UR" for under range and "OR" for over range flow readings.								
		L/min					Less than 10%?	
	Lower Limit	Ref Std	Upper Limit	SASS	% Difference		Pass	Fail
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					
Retest after Calibration								
		L/min					Less than 10%?	
	Lower Limit	Ref Std	Upper Limit	SASS	% Difference		Pass	Fail
Channel 1	NA		NA					
Channel 2	NA		NA					
Channel 3	NA		NA					
Channel 4	NA		NA					
Channel 5	NA		NA					
Channel 6	NA		NA					
Channel 7	NA		NA					
Channel 8	NA		NA					

Chemical Speciation Network Performance Audit Worksheet URG 3000N - Primary Sampler		**US Environmental Protection Agency**	
Note - Cyan fields are entered from TSA worksheet or calculated - yellow fields are to be filled in here			
Location		Date	
AQS Site ID			
AQS Sampler POC			
Audit Information			
Auditor(s)		Affiliation	US Environmental Protection Age
Audit Type	Select From Dropdown List		
Operator		Affiliation	
Phone No.	-		
Sampler Model	URG 3000 N	Controller S/N	
		Pump S/N	
		Sampler S/N	
Last Calibration Date			
Audit Reference Standards			
Flow Reference Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
Temperature Ref Std Mod	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
BP Std Model	Select From Dropdown List	Standard S/N	
Specify if "Other"		Calibration Date	
Significant Findings:			
General Findings:			

Super SASS Monthly Flow Check

MSi
Meteorological Solutions Inc.
A Trinity Consultants Company

Date: ____________________ Start Time: ____________________
Site Name: ____________________ Stop Time: ____________________
Sampler Model: ____________________ Site Location: ____________________
Sampler SN: ____________________ Sampler ID: ____________________

Temperature Calibration Device, Model and Serial Number: ____________________
Pressure Calibration Device, Model and Serial Number: ____________________
Flow Rate Calibration Device, Model and Serial Number: ____________________

Clock Check:	SASS	MST	(Mountain Standard Time)
			As Found
			As Left

Criteria:

Leak Check:	As Found	As Left
Channel 1		
Channel 2		
Channel 3		
Channel 4		
Channel 5		
Channel 6		
Channel 7		
Channel 8	0	0

Leak Check Criteria < 0.1 LPM (10 cc/min)

Ambient Temperature Sensor Calibration (°C):

	SASS Temp. Display:	Ref. Std. Temp. Display	Diff.
As Found			
As Left			

Criteria: ≤ 2.1 degrees C

Comments: ____________________

Filter Temperature Sensor Calibration (°C):

	SASS Temp. Display:	Ref. Std. Temp. Display	Diff.
As Found			
As Left			

Criteria: ≤ 2.1 degrees C

Comments: ____________________

Pressure Sensor Calibration (mmHg):

	SASS Press. Display:	Ref. Std. Press. Display	Diff.
As Found			
As Left			

Criteria: ≤10.1 mm Hg

Comments: ____________________

Flow Check As Found (lpm):

SASS Target:	SASS Flow Display:	Ref. Std. Display:	% Diff.
Channel 1			
Channel 2			
Channel 3			
Channel 4			

Criteria: < 4% of Flow Std.

Comments: ____________________

Flow Check As Left (lpm):

	SASS Flow Display:	Ref. Std. Display:	% Diff.
Channel 1			
Channel 2			
Channel 3			
Channel 4			

Criteria: < 4% of Flow Std.

Call MET ONE for service: 541-471-7111

Monthly Maintenance:
- Cyclone Cleaning
- Leak Check
- Flow Rate Verification
- Temperature Check(s)
- Pressure Check
- Clock Verification
- Check Error Log
- Download Digital Data Log
- Filter Exchange
- Other ____________________

Flow Check By: ____________________

Enter monthly verification data into Yellow cells

URG 3000N Monthly Flow Check

Meteorological Solutions Inc.
A Trinity Consultants Company

Date: ____________ **Start Time:** ____________
Site Name: Cheyenne NCORE WDEQ **Stop Time:** ____________
Sampler Model: URG 3000N **Site Location:** Cheyenne, Wyoming
Sampler SN: ____________ **Sampler ID:** NCORE

Temperature Calibration Device, Model and Serial Number: ____________
Pressure Calibration Device, Model and Serial Number: ____________
Flow Rate Calibration Device, Model and Serial Number: ____________

Clock Check:

	URG	MST	(Mountain Standard Time)
	16:08	16:08	As Found
	16:08	16:08	As Left

Criteria: < 1 min/month

As Found Leak Check:

	A mm Hg	B mm Hg	Pass Y/N?
Channel 1			
As Left Leak Check: Channel 1			

Leak Check Criteria: if drop is 225mm Hg or more in 35 seconds = Fail

Ambient Temperature Sensor Calibration (°C):

	URG Temp. Display:	Ref. Std. Temp. Displa	Diff.
As Found			
As Left			

Criteria: ≤ 2.1 degrees C

Comments:

Pressure Sensor Calibration (mmHg):

	URG Press. Display:	Ref. Std. Press. Displa	Diff.
As Found			
As Left			

Criteria: ≤10.1 mm Hg

Comments:

Flow Check As Found (lpm):

URG Target:	URG Flow Display:	Ref. Std. Display:	% Diff.
19.80			
22.00			
24.20			

Criteria: < 4% of Flow Std.

Comments:

Flow Check As Left (lpm):

	URG Flow Display:	Ref. Std. Display:	% Diff.
19.8			
22.0			
24.2			

Criteria: < 4% of Flow Std.

Call URG for service: 919-942-2753

Monthly Maintenance:

- ☐ Cyclone Cleaning
- ☐ Leak Check
- ☐ Flow Rate Verification
- ☐ Temperature Check(s)
- ☐ Pressure Check
- ☐ Clock Verification
- ☐ Check Error Log
- ☐ Download Digital Data Log
- ☐ Filter Exchange
- ☐ Other ____________

Flow Check By: ____________ **Enter monthly verification data into Yellow cells**

Appendix A.2 – Met One 1020 and 1022 Beta Attenuation Monitor

Wyoming
Department of Environmental Quality
Air Quality Division

Standard Operating Procedure

For Beta Attenuation Monitor

October 2023
Revision 2.0

1.0 Scope and Applicability

A Beta Attenuation Monitor (BAM), is a continuous Particulate Matter (PM) instrument that measures PM in the ambient air. This document will focus on the two separate “cuts” of PM: PM_{10}, PM with an aerodynamic size range below 10 microns, and $PM_{2.5}$, PM with an aerodynamic size range less than 2.5 microns. An additional size cut, PM_{coarse}, is defined as the size cut that is PM_{10} minus $PM_{2.5}$. The PM_{coarse} is determined by operating a PM_{10} and a $PM_{2.5}$ BAM simultaneously at the same location. The WDEQ-AQD does not have any PM_{10} or $PM_{2.5}$ non-attainment areas.

2.0 Summary of Method

The Met One BAM-1020 and 1022 instrument models automatically measure and record PM concentration levels using the principle of beta ray attenuation. This method provides a simple determination of concentration in units of micrograms per cubic meter (µg/m^3). A small Carbon^{14} element emits a constant source of high-energy electrons known as beta particles. These beta particles are detected and counted by a sensitive scintillation detector. An external pump pulls a measured amount of ambient air through the filter tape. The PM is deposited on the filter tape. After the filter tape is loaded with PM for an hour, it is automatically placed between the source and the detector thereby causing an attenuation of the beta particle signal. The degree of attenuation of the beta particle signal is used to determine the mass concentration of PM on the filter tape, and hence the volumetric concentration of PM in ambient air. Please note that the Met One 1020 BAM PM_{10} has an Environmental Protection Agency (EPA) equivalent designation; EQPM-0798-122.

For the $PM_{2.5}$ 1020 BAM, the designation is EQPM-0308-170. The BAM 1022 EPA designation for $PM_{2.5}$ is EQPM-1013-209. The following conditions must be observed when a pair of BAM-1020 units is operated as a PM_{coarse} FEM continuous measurement system:

- One of the BAM 1020 units is configured as a $PM_{2.5}$ FEM
- The other unit is configurable as a $PM_{2.5}$ FEM, but set to measure PM_{10} by excluding the $PM_{2.5}$ cyclone.
- The two monitors are collocated within 1 and 4 meters apart at the inlet.
- The units are equipped with the BX-COARSE sampling kit, which allows the two units to be directly connected together to provide concurrent sampling and reporting of the PM_{coarse} concentrations.
- To report mass concentrations under actual conditions set CONC TYPE to ACTUAL. This configuration is almost always used for $PM_{2.5}$ concentration reporting. It is also used when reporting PM_{10} concentrations when paired BAM 1020 monitors are used for $PM_{10-2.5}$ monitoring.

2.1 Definitions

The following terms that are used throughout this document are defined here:

- NIST Traceable Standard: This refers to a National Institute of Standards and Technology (NIST) flow, pressure, and Relative Humidity (RH)/temperature measurement device. The device has been regularly compared against NIST traceable standards of a higher comparability.

- Field Standard: This refers to a standard that travels back and forth from the central laboratory to the field stations and is used to check the flow rates, pressure and RH/temperature sensors within the BAM instruments.
- Quality Control (QC) checks: This is a one-point verification check of the flow rate, pressure and temperature sensors. These are performed according to Table 1. All of the QC checks must be performed in order for the BAM to remain an FEM.

3.0 Health and Safety Warnings

The following health and safety warnings must be followed in order for safe operation of the instrument.

- BAM instruments generally operate using 110 VAC current. Therefore, if troubleshooting, be extremely cautious against electric shock. This can both harm a person and possibly harm the instrument.
- The Met One Instruments BAM 1020 and 1022 contains a small $Carbon^{14}$ beta radiation-emitting source. The activity of the source is 60 cu ± 15 µCi (micro curries). Please note that only Met One factory technicians should attempt to remove or access the beta source. The beta source should never need to be replaced. Neither the $Carbon^{14}$ source nor the beta particle detector is serviceable in the field. Should these components require repair or replacement, the BAM 1020 or 1022 must be returned to the factory for service and recalibration.
- Always use a third ground wire on all instruments.
- Always unplug the instrument when servicing or replacing parts.
- Refer to the manufacturer's instruction manual and know the precise locations of electronic components before working on the instrument.
- Avoid electrical contact with jewelry. Remove rings, watches, bracelets, and necklaces to prevent electrical burns.

4.0 Cautions

- Clean the Size Selective Inlets (SSI) and the Very Sharp Cut Cyclone (VSCC) on a periodic basis. This should be established for each monitor station. Carefully clean the interior of the downtubes on a periodic basis. Use the cleaning procedures outlined in the manufacturer's instruction manual.
- Keep the interior of the analyzer clean.
- Inspect the BAMs regularly for structural integrity.
- To prevent leaks, it is recommended that the leak test procedures are performed on the instruments whenever any work is performed that could affect the flow of the sample in the instrument.

4.1 Interferences

There are no interferences with these methods. However, it is important that the SSI and VSCC be cleaned periodically because not servicing these components can allow PM of larger size to be sampled.

5.0 Personnel Qualifications

It is the responsibility of WDEQ-AQD or the contractor to train their field staff on instrument operation and maintenance. It is a requirement of the WDEQ-AQD to train their staff and keep records of all training that is performed per WDEQ-AQD's Training Plan. Although a BAM instrument is a self-contained, computer operated instrument, there is a level of knowledge of electronics and know-how involved in the operation and maintenance of the instrument. The instrument manual is the best training tool for this.

6.0 Equipment

WDEQ-AQD and its contractors specifically utilize FEM BAM instruments, because it is required by the EPA. FEMs are thoroughly vetted by the EPA. The instrument, when initially received, should operate within the parameters set down by the EPA. These parameters are available in the operating manual that comes with the instrument. Thoroughly read and familiarize yourself with this instrument.

The following supplies are required for the operation of this instrument:

- Inlets: For the $PM_{2.5}$ BAM, the SSI and VSCC must be installed. For the PM_{10} BAM, only the SSI needs to be installed.
- NIST Traceable flow, pressure and RH/temperature device: As described in Section 2.1 of this SOP, the NIST traceable device is necessary to carry out the required QC checks to maintain and verify that the instrument is running correctly. It is also good field practice to leave the tubing that is used from the inlet of the flow device to the inlet of the BAM at the station. Replace this tubing if cracks or holes appear.
- Replacement Teflon Tape: This is the major replacement component for the instrument. The filter tape must be replaced approximately every two months.
- Lithium Batteries: If necessary, replace every year.
- Pump rebuilds Kit: Periodically, the flow pump must be rebuilt. It is good practice to keep the pump rebuild kit on site in case the pump flow rate decreases or seizes.

Spare parts will be purchased only from the instrument manufacturer by the Project Managers or the contractors. For the WDEQ–AQD operated sites, parts will be inspected by the Project Managers or Monitoring Specialist for shipping damage upon receipt. Spare parts will be kept in the monitoring station for use when needed. The use of spare parts will be documented on calibration forms. Please note that some parts will be stored at the monitoring stations while some less utilized parts will be stored at the contractors' and WDEQ-AQD central facilities. The WDEQ-AQD will use AirVision software to track spare analyzer usage.

7.0 Quality Control Procedures

7.1 Initial Setup

This section describes the process for setting up and configuring a BAM, as well as the basic steps required to put the unit into operation. Some of the topics in this section will direct you to other sections of this manual for more detailed information. The following steps for starting up the unit are described in this section:

- Power on and warm up the unit.
- Familiarize yourself with the user interface.
- Load a roll of filter tape.
- Perform a Self-Test.

- Set the real-time clock, and review your SETUP parameters.
- Perform a leak check and a flow check.
- Return to the top-level menu and wait for automatic start at the top of the hour.
- View the OPERATE menus during the cycle.

7.2 Warm-Up

The BAM power switch is located on the back of the unit above the power cord. Verify that the unit is plugged in to the correct AC voltage, and that any electrical accessories are correctly wired before turning the unit on. When the power is switched on, the main menu screen should appear after a few seconds (see **Figure 1**). The unit will probably flash an error indicating that there is no filter tape installed.

7.3 Warm-up Period

The BAM must warm up for at least one hour before valid concentration data can be obtained. This is because the beta detector contains a vacuum tube which must stabilize every time the unit is powered up. This also allows the electronics to stabilize for optimal operation. This applies any time the unit is powered up after being off. Instrument setup and filter tape installation can be performed during this warm up time. It is recommended that the first few hours of concentration data be discarded or flagged after the BAM is powered up.

7.4 Main Menu and Using the Keypad and Display

When the BAM 1020 is powered up, it will display the main menu (top level menu) on the LCD display. This menu is the starting point for all functions of the BAM user interface. See **Figure 1**. Note: The main menu will have a slightly different layout on BAMs configured in the dual-unit PM-coarse configuration.

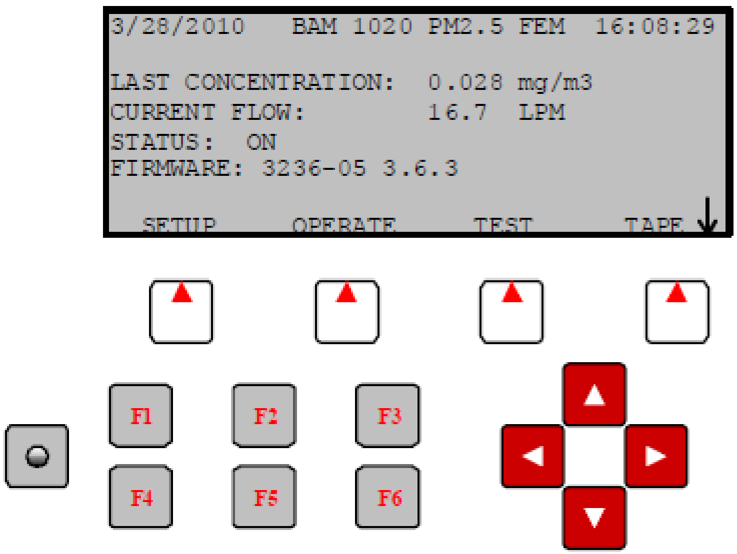


Figure 1. Standard User Interface and Keypad for the BAM 1020

Soft Keys: Directly beneath the display are four white buttons called “soft-keys” or “hot-keys”. These are dynamic keys where the function changes in response to a menu option displayed directly above each key on the bottom row of the display. Whatever menu option is displayed above one of these keys is the function which that key will perform in that particular menu. These are used throughout the entire menu system for a variety of functions. For example, modifications made within a menu are usually not saved unless a SAVE soft-key is pressed. EXIT is also another common soft-key function.

Arrow (Cursor) Keys: The four red arrow keys are used to scroll up, down, left, and right to navigate in the menu system, and to select items or change fields on the screen. The arrow keys are also often used to change parameters or increment/decrement values in the menu system.

Contrast Key: The key with a circular symbol on it is for adjusting the light/dark contrast on the LCD display. Press and hold the key until the desired contrast is achieved. It is possible to over-adjust the contrast and make the entire display completely blank or completely dark, so be careful to set it to a visible level or it may appear that the unit is not operating.

Function Keys F1 to F6: The function keys serve as shortcuts to commonly used menu screens. The “F” keys are only functional from the main menu screen, or for entering passwords. Here is a description of each:

- **F1 “Current”:** This key is a shortcut to the OPERATE > INST screen, used to display instantaneous data values being measured by the BAM 1020.

- **F2 "Average":** This key is a shortcut to the OPERATE > AVERAGE screen, used to display the latest average of the data recorded by the BAM.
- **F3 "Error Recall":** This key allows the user to view the errors logged by the BAM. The errors are sorted by date. The last 12 days which contain error records are available, and the last 100 errors can be viewed.
- **F4 "Data Recall":** This key allows the user to view the data stored in the BAM including concentrations, flow, and all six external channels. The data is sorted by date, and the user can scroll through the data hour-by-hour using the soft-keys. Only the last 12 days which contain data records are available for viewing in this menu.

When the BAM 1022 is powered up, it will display the Main Operating Screen. Note that the display has a limited amount of space and cannot show all of the real time data on one screen. Tap the up or down arrow keys in the lower left corner of the display to navigate between the two screens.

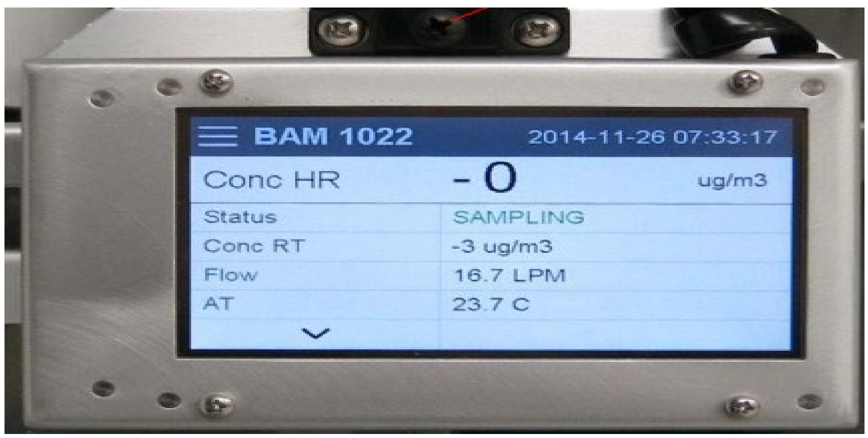


Figure 2. Startup Screen of the BAM 1020

7.5 Filter Tape Loading

7.5.1 BAM 1020

A roll of Met One glass fiber filter tape must be loaded into the BAM for sampling. A roll of tape will last approximately 8 weeks under normal operation. It is important to have spare rolls available to avoid data interruptions. Some agencies save and archive the used filter tape, although the used sample spots are not protected from contamination, and are not marked to indicate the sample hour or site. Chemical analysis may be affected by the binder agent in the tape. Loading a roll of filter tape into the BAM is a simple matter using the following steps:

1. If the monitor is off, turn on the BAM. The unit should automatically raise the sample nozzle.
2. Lift the rubber pinch roller assembly and latch it in the UP position.
3. Unscrew and remove the two clear plastic reel covers.
4. Install an empty core tube on the left (take-up) reel hub. This provides a surface for the used tape to spool upon. Met One supplies a plastic core tube to use with the first roll of tape. After that, you can use the empty core tube left over from the previous roll. Never fasten the filter tape to the aluminum hub.

5. Load the new roll of filter tape onto the right (supply) reel, and route the tape through the transport assembly as shown in the drawing. Attach the loose end of the filter tape to the empty core tube with adhesive cellophane tape or equivalent.
6. Rotate the tape roll by hand to remove excess slack, and then install the clear plastic reel covers. The covers must be tight in order to properly clamp the tape in place and prevent slipping.
7. Align the filter tape so that it is centered on all of the rollers. Newer units have score marks on the rollers to aid in visually centering the tape.
8. Unlatch and lower the pinch roller assembly onto the tape. The BAM-1020 cannot automatically lower the rollers, and the unit will not operate if the pinch rollers are left latched in the up position.
9. Press the TENSION soft-key in the TAPE menu. The BAM-1020 will set the tape to the correct tension and alert you if there was an error with the process. Exit the menu.

7.5.2 BAM 1022

One roll of filter tape will last approximately 8 weeks when the BAM 1022 is set up to operate as a U.S. EPA PM2.5 FEM. For continuous monitoring it is important to have spare filter tape rolls on-site. Use the following steps to load filter tape:

1. Press the “Operate Menu” button and select the “LOAD FILTER TAPE” option. Entering this screen will cause the nozzle to raise and instructions to load the tape per the door mounted diagram are displayed.
2. Remove the Plexiglas cover by pulling out at the bottom to release the Velcro holding strip, and then lifting the cover off of the two alignment pins at the top.
3. Unscrew and remove the two clear plastic reel covers and both tape spool cores.
4. Make sure the BAM nozzle and vane are completely clean of debris. Cleaning procedures are detailed in Section 6.6 of this manual.
5. Slide an empty tape spool core on to the take-up reel (on the left). You may use the empty spool core that was just removed from the supply reel (on the right) or the grey core tube (part number 8150) supplied with the instrument
6. Unwrap a new roll of filter tape. Place the full roll on the supply reel and route the tape through the nozzle and vane as indicated on the inside of the door of the instrument.
7. Fasten the loose end of the new filter tape to the take-up spool core with a piece of tape.
8. Rotate the spools by hand to remove tape slack.
9. Replace the two clear plastic reel covers and fasten the screws tightly by hand.
10. Press the grey MOVE button to move the tape and verify it has been properly loaded.
11. If the tape is correctly installed, the display will report “TAPE IS OK!” in green letters beside the grey button.
12. If there is a problem, it will report “TAPE FAIL” in red letters.
13. Verify the tape is properly routed
14. Remove any slack by rolling up loose tape on the tape spools.
15. Press the MOVE button again to take out any additional slack and verify the tape is loaded correctly.

7.6 The NORMAL Operation Screen

Normal Mode (BAM 1020) or Main Operating (BAM 1020) is the primary operation screen which displays most of the important parameters of the sample progress in one place, as shown below. It is acceptable to leave the operation screen in normal mode instead of the main menu.

7.7 BAM Recommended Maintenance Activities

Table 1 illustrates the recommended maintenance actions and their frequency.

Table 1. Recommended Maintenance Activities.

Recommended Maintenance Activity	Frequency	
	BAM Model 1020	BAM Model 1022
Clean capstan shaft and pinch roller tires	Monthly or as needed	Monthly or as needed
Clean PM_{10} Head and inlet	Monthly	Monthly
Clean $PM_{2.5}$ VSCC Separator	Monthly	Monthly
Check Error log	As necessary	As necessary
Replace filter tape	As needed	As needed
Run self-test function	Monthly post flow check	Monthly post flow check
Verify BAM settings	Quarterly or as needed	Quarterly or as needed
Set real-time clock	As needed	As needed
Flow Verification/calibration	Monthly/as needed	Monthly/as needed
Test RH and filter temperature sensors	6 months	6 months
Clean internal debris filter	12 months	NA
Check membrane span foil	NA	12 months
Beta detector count rate and dark count test	12 months	12 months
Background test	Annually/12 months	Annually/12 months
Rebuild vacuum pump	24 months or as needed	24 months or as needed
Replace Nozzle O-ring	24 months or as needed	24 months or as needed
Replace pump tubing	24 months or as needed	24 months or as needed
Replace or Clean pump muffler	If necessary	If necessary

8.0 Quality Control Checks

The procedure below describes the steps that are performed when QC checks are performed. There are three critical aspects of the BAM: flow system maintenance, routine leak checks, nozzle and vane cleaning. The WDEQ-AQD and its contractors must routinely verify these three aspects to obtain high-quality concentration data from the unit. Complete flow system maintenance typically requires less than 10 minutes to perform.

The best order for the monthly flow system checks is:

1. **1.** As-found leak check.
2. **2.** Nozzle and vane cleaning.
3. **3.** As-left leak check. (If a leak was corrected)
4. **4.** QC checks if required.

If an air leak is found in a BAM, it is almost certain to occur at the interface between the nozzle and the filter tape due to debris buildup. There is normally an insignificant amount of leakage at the tape interface, but an excessive leak lets an unknown portion of the 16.7 L/min sample flow enter the system at the leak point instead of the inlet. This could cause the total volume of air sampled through the inlet to be incorrect, and the resulting concentration data could be unpredictably biased. The BAM has no way of automatically detecting a leak at the tape/nozzle interface because the airflow sensor is located downstream of the filter tape. Allowing a significant leak to persist may result in concentration data being invalidated. Routine leak checks and nozzle cleaning prevent any significant leaks from occurring. Performing an as-found leak check before cleaning the nozzle or performing any service is a key method for validating previous data.
Even if the leak check value is found to be within acceptable bounds, the nozzle and vane should still be cleaned anyway to ensure continued leak-free operation.

8.1 Leak Check Procedure

8.1.1 BAM 1020

Perform the following steps to check for leaks in the BAM system:

1. Enter the TEST > TAPE menu on the BAM. This will stop the operation cycle of the unit. Press the FWD soft key to advance the tape 1 “window” to a clean, unused spot.
2. Perform an as-found flow check/audit before performing any further service. Install a flow reference on the inlet and check the 16.7 flow point in the TEST > FLOW screen. Use NEXT soft key to select the parameter desired. Record the as-found flow rate, but do not calibrate any of the flow parameters until the leak checks and nozzle cleaning are finished.
3. Remove any PM_{10} and $PM_{2.5}$ heads from the inlet tube and install a leak test valve onto the inlet tube. If a $PM_{2.5}$ cyclone is used, install the leak check valve on top of the cyclone, since the cyclone is a possible source of leaks and should be tested. Turn the valve to the OFF position to prevent any air from entering the inlet tube.
4. Enter the TEST > PUMP menu and turn the pump on. The standard flow rate shown on the BAM display should stabilize at less than 1.0 L/min in about 20 seconds. Record the as-found results. If the leak flow value is greater than 1.0 L/min, then there may be a very small amount of leakage in the system. If the leak value is greater than 1.5 L/min, then there may be a more significant leak.
5. If a leak is indicated, resolve it. First, attempt the leak check again with the $PM_{2.5}$ cyclone removed (if used). Then clean the nozzle and vane as described below and perform the leak check again. When the leak is resolved and the leak check value is less than 1.0 L/min, record the as-left leak value.
6. Turn the pump off and remove the leak test valve. Go on to the nozzle and vane cleaning and the flow tests as described below.

8.1.2 BAM 1022

Use the following steps to conduct the basic leak check:

1. Go to the TEST>TAPE TEST menu. This will stop the current sample, if one is in progress, and then raise the nozzle.
2. Advance the tape one time by pressing the MOVE TAPE button. If the last sample spot is not clearly visible, advance the tape a second time.
3. Inspect the last sample spot on the tape roll. Examine it closely for any abnormal deformation or holes. The presence of abnormalities indicates debris build up at the nozzle / vane interface. This will need to be cleaned to restore proper operation.
4. Remove the PM10 size selective inlet from the sample tube and install the BX-305 leak check valve (or BX-302 zero filter). If a PM2.5 cyclone is being used, it should be left in place and included in the leak check. Verify that the leak valve is in the open position.
5. Navigate to the TEST>LEAK TEST menu. See section 3.4.1 for details on how the buttons on this screen function. Verify the nozzle is in the down position. If it is not, press the nozzle control button to lower it. The BAM 1022 is ready to begin the leak test.
6. Press the PUMP ON button and the BAM 1022 will start the pump. Monitor the flow rate on the BAM 1022 display and allow it to stabilize at 16.7 LPM
7. Press the LEAK ON button.
8. Close the BX-305 valve as shown in the image below. The flow rate should begin dropping as the sampling system is evacuated.
9. The pump flow rate should drop below 1.5 LPM.
    a. If the flow rate is 1.5 LPM or less, the leak check is satisfactory. Proceed to step 10.
    b. If the flow rate is greater than 1.5 LPM, then cleaning is required. Thoroughly clean the nozzle / vane interface and then perform this test again. If it passes, proceed to step
10. If it fails a second time, go to section 6.3. 10. Exit to the main menu.
11. Slowly open the BX-305 valve to release the vacuum inside the BAM 1022.
12. Remove the BX-305 and replace the PM10 size selective inlet.
13. Resume normal sampling operations

8.2 Nozzle and Vane Cleaning Procedure

8.2.1 BAM 1020

The nozzle and tape support vane (located under the nozzle) must be cleaned regularly to prevent leaks. The cleaning must be done at least when the filter tape is changed; though monthly cleaning is highly recommended. Some sites will require more frequent cleaning if PM and dust are prevalent at that site. Debris and dirt buildup in humid, hot areas, because the filter tape fibers more easily adhere to the nozzle and vane. The fibers can build up and dry out into a hard mass which can create flow leaks or punch small holes in the filter tape. This can cause measurement errors. Use the following steps to clean the nozzle and vane parts:

1. Latch up the tape pinch rollers, and raise the nozzle in the TEST > PUMP menu. Slide the filter tape out of the slot in the beta block nozzle area. It is not necessary to completely remove the filter tape from the unit.

2. With the nozzle up, inspect the vane (use a small flashlight if needed). Any debris will usually be visible. Clean the vane surface with a cotton-tipped applicator and isopropyl alcohol. Hardened deposits may have to be carefully scraped off with the wooden end of the applicator.
3. Lower the nozzle in the TEST > PUMP menu. Lift the nozzle with your finger and insert another wet cotton applicator between the nozzle and the vane. Let the nozzle press down onto the swab with its spring pressure. Use your thumb to rotate the nozzle while keeping the swab in place. A few rotations should clean the nozzle lip.
4. Repeat the nozzle cleaning until the swabs come out clean, then inspect the nozzle lip and vane again, looking for any burrs which may cause tape damage.

8.2.2 BAM 1022

Over time, a gradual build-up of filter tape debris and particulate may form on the nozzle and vane sealing surfaces. Follow the steps below to clean particulate filter tape debris from these surfaces.

Required Tools:	Cotton Tipped Swabs Isopropyl Alcohol Canned Air (a.k.a. Compressed Air Duster) with Tube
Suggested Interval:	Upon filter tape replacement (8 weeks).

Use the following steps to clean the nozzle and vane assembly:

1. Navigate to the Test>Leak Test menu and raise the nozzle, if needed.
2. Remove the BAM 1022 filter tape.
3. Thoroughly clean the nozzle seal and vane with a clean swab dipped in alcohol. Do not use any sharp tools. Allow the alcohol to dissolve hardened deposits. Since the beta detector is located beneath the vane, prevent debris from falling through the holes.
4. If debris falls through or is found beneath the vane, carefully clean the cavity with a blast of compressed air.
5. Re-install the BAM 1022 filter tape and perform a leak check.

9.0 Instrument Performance Calibrations Procedure

To perform BAM QC checks, the site operator should include: NIST traceable calibration transfer standards, tubing and record forms.

9.1 Field Calibration of the Flow System

9.1.1 BAM 1020

Flow calibrations, checks, or audits on any BAM set for actual flow control must be performed periodically. The temperature sensor must be connected to input channel 6. The FLOW TYPE setting must be set to ACTUAL in the SETUP > CALIBRATE menu, or the flow calibration screen will not even appear as an option in the TEST menu. Perform a leak check and nozzle cleaning before doing any flow calibrations.

The TEST > FLOW calibration screen is shown below. The “BAM” column displays what the BAM measures for each parameter. The “STD” column is where you can enter the correct values from your traceable reference standard device. The <CAL> symbol appears to the left of the row of the active selected parameter. The selected parameter can be changed by pressing the NEXT key. No calibration changes are made to the selected parameter unless the CAL or DEFAULT key is pressed. The ambient temperature and pressure are always calibrated before the flow, because the BAM uses these parameters to calculate the air flow rate in actual mode.

1. Enter the TEST > FLOW menu. The nozzle will lower automatically when this screen is entered.
2. To perform a simple flow "check" or "audit" in which no BAM calibrations are to be changed, simply use the NEXT soft key to select the AT (temperature), BP (pressure), and FLOW 3 (16.7) parameters one at a time. Compare the BAM column reading to your standard device for each parameter, and record the results. No calibrations are altered if the CAL or DEFAULT keys are not pressed. If calibration is required, go on to step 3.
3. Select the AT parameter if not already selected. Measure the ambient temperature with your reference standard device positioned near the BAM ambient temperature probe. Enter the value from your reference standard into the STD field using the arrow keys. Press the CAL soft key to calibrate the BAM reading. The BAM and STD temperature values should now be the same.
4. Press the NEXT key to select the BP field. Enter the barometric pressure value from your reference standard into the STD field, and press the CAL soft key to calibrate the BAM reading. The BAM and STD pressure values should now be the same.
5. After the temperature and pressure readings are both correct, remove the $PM_{2.5}$ or PM_{10} head from the inlet tube and install the tubing between the NIST traceable reference flow meter and the inlet opening. Press the NEXT key to select the first flow point of 15.0 L/min. The pump will turn on automatically. Allow the unit to regulate the flow until the BAM reading stabilizes at the target flow rate. Enter the flow value from your standard device into the STD field. Repeat for the other two flow points (add flow points here 15.0, 18.3, and 16.7).
6. After the flow check, re-install the $PM_{2.5}$ or PM_{10} head and put the sampler back into NORMAL operation mode.

9.1.2 BAM 1022

The accuracy of the BAM 1022 flow control system should be periodically verified. If the flow, temperature or pressure sensors are not operating within desired specification, they should be calibrated.

Required Tools: Certified Calibration Transfer Standard
Minimum Suggested Interval: Complete calibration upon commissioning. Verification required after replacing filter tape (8 weeks).

All calibration transfer standards should be certified, and have a valid certificate of traceability to NIST standards. If a flow audit is desired (and not a full calibration) the same procedure detailed in this section is followed, but no changes are made; the results are observed and recorded only. A flow audit confirms operation of the flow system without making any alterations. This may be necessary to validate collected data.

Use the following steps to verify and calibrate sensors associated with the BAM 1022 sample flow control system.

1. Make certain that the BAM 1022 has warmed up for at least 60 minutes prior to performing calibrations. Also, allow the calibration transfer standard (CTS) to equilibrate to ambient conditions for no less than 30 minutes.
2. Go to the Operate menu and select Stop Sample to stop the current sample.
3. Remove the size selective inlet(s) from the sample tube and install the calibration transfer standard

(CTS). 4. Enter the Test > Ambient Temperature screen.

5. Compare the BAM 1022 temperature measurement and CTS temperature reading.
6. If the BAM 1022 temperature sensor exceeds the criteria listed in the table above, press the grey DEFAULT button to remove any previous offsets. If the temperature now passes, skip the next step.
7. If the temperature still needs to be adjusted, press the green bordered value box and the numerical entry keypad will be displayed. Enter the CTS value in the Standard field, and press OK to return to the Ambient Temperature screen. Press the grey CALIBRATE button to enter the new calibration offset.
8. Return to the TEST menu and go to the Ambient Pressure screen.
9. Compare the BAM 1022 pressure measurement and CTS pressure reading.
10. If the BAM 1022 pressure sensor exceeds the criteria listed in the table above, press the grey DEFAULT button to remove any previous offsets. If the pressure now passes, skip the next step.
11. If the pressure still needs to be adjusted, press the green bordered value box and the numerical entry keypad will be displayed. Enter the CTS value in the Standard field, and press OK to return to the Ambient Pressure screen. Press the grey CALIBRATE button to enter the new calibration offset.
12. Return to the TEST menu and go to the Flow Calibration screen. The pump will start automatically and adjust flow to the 16.7 lpm test point.
13. Press the green bordered value box the flow rate test set point selection will appear.
14. Select the 14.0 lpm set point and then press the OK button. The display will return to the Flow Calibrate screen and adjust the flow to the new test point.
15. Allow the BAM and CTS reading to stabilize (at least one minute) and then compare the BAM 1022 flow measurement and CTS flow reading.
16. If the BAM 1022 flow rate exceeds the criteria listed in the table above, press the grey DEFAULT button to remove any previous offsets for all three flow settings. If the flow rate now passes, skip the next step.
17. If the flow rate still needs to be adjusted, press the green bordered value box and the numerical entry keypad will be displayed. Enter the CTS value in the Standard field, and press OK to return to the Flow Calibrate screen. Press the grey CALIBRATE button to enter the new calibration offset.
18. Press SET to apply the change. When setting the 16.7 lpm flow rate, the SET option will change to read CALIBRATE.
19. Repeat steps 13 through 16 above for the 17.5 lpm flow rate.
20. Repeat steps 13 through 16 above for the 16.7 lpm flow rate.
21. Return to the Main Operating Screen and remove the CTS from the inlet tube and replace the size selective inlet(s).
22. Resume normal sampling operations.

10.0 BAM 1020/1022 Zero Filter Background Test

10.1 BAM 1020 -Performing the 72-Hour Zero Filter Background Test

All BAM 1020 monitors should have a zero-filter test performed before the equipment is first deployed so that an initial BKGD adjustment may be made, if necessary. This test should be repeated periodically as part of a QA/QC program, the frequency of which is up to the user.

When the BAM 1020 is set up for the first time, a minimum of 48-72 valid 1-hour zero-test data points should be collected in order to accurately determine the BKGD value. Subsequent, periodic zero tests may be performed with fewer 1-hour values, but this will result in a less accurate BKGD calculation.

The initial zero-test is used to determine the instrument noise (σ) and to confirm that the lower limit of detection (LLD), which is 2σ, is within specifications. For an 8-minute count cycle, the LLD is <4.8 µg/m3 for a 1-hour measurement cycle and for a 4-minute count cycle the LLD is <7 µg/m3. The initial zero test and all subsequent zero tests should be performed using an 8-minute count cycle if the BAM 1020 will be operated with an 8-minute count cycle. The zero tests should be performed with a 4-minute count cycle if the BAM 1020 will be operated with a 4-minute count cycle.

The initial zero-filter test should be performed after the BAM 1020 is installed at the monitoring site. **If this is not feasible, then performing the test with the monitor sitting on a nearby laboratory bench before deployment is acceptable.**

If the BAM 1020 is to be operated with a “smart heater” (BX-826 or BX-827), the zero-filter test should be performed with the smart heater engaged, but running in “low power mode” for the duration of the test. Low power mode is activated by setting the FRH CONTROL parameter to NO (see section 6.9).

Weather (rain, mist, very high humidity, high dew point, etc.) can sometimes make it difficult to perform the zero-filter test with the filter mounted outdoors at the monitoring site. In these situations, the BX-302 zero filter assembly should be mounted inside the shelter. Replace the standard inlet tube, with the short 1.5-foot-long inlet tube (this tube is included with each BAM 1020 to sample room air). Mount the smart heater and the BX-302 zero filter assembly on this shorter tube inside the shelter.

The ambient temperature sensors (BX-592, BX-596, or BX-597) should always be placed in the same environment from which the air is sampled. If the BX-302 is mounted inside the shelter, the ambient temperature sensor should also be placed inside the shelter. It is recommended that the BAM 1020 be operated for at least 24 hours before commencing the zero-filter test. A leak check and flow check should be performed before proceeding on to the following steps for the zero-test. Although it is not necessary to reset the existing BKGD value to 0 for the purpose of conducting the zero-test, doing this will minimize the chance of a miscalculation.

1. Enter the SETUP > CALIBRATE menu.
    a. Record the existing BKGD value, then change it to 0.0000 (optional).
    b. Note the Conc type and set it to Actual if it is not.
    c. Note the Flow type and set it to Actual if it is not.
    d. Save and exit back to the main menu.

2. Install the BX-302 zero filter assembly onto the top of the inlet tube.

   Note: When it is necessary, the BX-302 zero filter assembly may be inside the shelter to avoid aspiration of water through the zero filter.

3. Allow the BAM 1020 to sample for 48-72 consecutive hours, not counting the warm-up period for the initial zero-test. For the zero-test to be valid, no errors should be logged either during the warm-up period or during the 48-72-hour sampling period. For subsequent zero tests, the user may decide to use fewer valid data points (such as 24 for example).

1. Calculate the average of the hourly BAM 1020 concentrations to the nearest 0.1 µg/m3. The new BKGD value is the negative of this average. For example, if the average of the data sample is 0.0021 mg (2.1 µg), the correct BKGD value is -0.0021. Record the new BKGD value.

Note: If the BAM 1020 is being deployed for the first time, replace the factory-set BKGD with the new BKGD value. As Met One Instruments runs the initial factory zero test without the smart heater engaged, the initial zero test performed by the end user may differ from this value if the end user used a smart heater during the test.

2. Calculate the standard deviation of the sample (STDEV on MS Excel) to the closest 0.1 µg/m3. Confirm that the LLD of the BAM 1020 meets the factory-specified value.

Note: Older non-FEM compatible units may not meet these noise specifications.

3. If the results of the zero test indicate that the instrument LLD is higher than the factory-specified value or that the BKGD value has changed by more than 2 µg/m3 since the most recent field (not factory) zero-filter test, repeat the zero-filter test. If the problem persists contact the factory.

7. Enter the new BKGD value into the SETUP > CALIBRATE menu on the BAM 1020. Restore the CONC and FLOW type settings to their pre-test configuration, if applicable. Save and exit back to the main menu.

8. Set the FRH Control back to YES to exit low power mode. Save and exit back to the main menu.
9. Resume normal operations or continue with additional testing, as needed.

BAM 1020 BKGD Template;
https://metone.com/wp-content/uploads/2019/04/Zero-Test-Template-and-Sample-Rev-D-1.xlsx

10.2 Background Determination 1022 (Mass Offset)

It is recommended that the BAM 1022 undergo a background test upon initial deployment, annually, and after any major repairs have been performed. Required Tools: Zero Filter (Met One Instruments Part No. BX-302).

1. Ensure that the BAM 1022 has been calibrated and that leaks are not present.

2. Go to the Operate menu and select Stop Sample to stop the current sample.

3. Remove the size-selective inlet(s) from the sample tube and install the zero filter.

BX-302 Zero Filter Assembly

4. Verify that the zero filter leak valve is in the open position.

5. Go to the Setup menu and select Calibration.

6. Set the Background value to zero (see section 3.5.4 for details).

7. Exit the Background menu, go to the Operate menu, select Start Sample, and begin sampling.

8. After no less than 76 hours, retrieve the BAM 1022 hourly concentration data. Confirm that the monitor ran without disruption. If errors, power outages or maintenance occurred, the test will have to be restarted.

9. Calculate the average of the most recent 72 hourly PM concentrations. Record this value.

10. Calculate the new Mass Offset value determining the negative of the 72 hour average calculated in Step 9. For example, if the 72-hour mean = 1.07 µg /m3, the new Mass Offset would be -1.07 µg/m3. Since all Background values are entered in units of mg/m3, you would round to the fourth decimal place and use -0.0011 mg/m3.

11. Return to the Setup menu and select Calibration.

12. Enter the new background value.

13. Go to the Operate menu and select Stop Sample to stop the current sample, if the monitor is still sampling.

14. Remove the zero filter from the inlet tube and install the size-selective inlet(s)

15. Resume normal sampling.

NOTES: For best results, the zero filter background test should be performed during a period of fairly stable weather.

The zero filter cartridge should be replaced if there are any obvious signs of discoloration due to aging or the aspiration of water. See section 9.1 for ordering details.

To determine the hourly zero noise and hourly lower detection limit, calculate the standard deviation of the most recent 72 hourly PM concentrations (the values used in step 9 above). The standard deviation (σ) should be less than or equal to 2.4 µg. The hourly detection limit is defined as two times the standard deviation (2σ).

If the standard deviation is greater than 2.4 µg, the cause should be investigated. Contact your local Met One Instruments representative for assistance.

BAM 1020 BKGD Template;
https://metone.com/wp-content/uploads/2019/04/Zero-Test-Template-and-Sample-Rev-D-1.xlsx

11.0 References

1. Standard Operating Procedures for the Operation of the Met-One Instruments Beta Attenuation Mass Monitor (BAM-1020) AQSB SOP 400, California Air Resources Board, August 2019, Second Edition
2. Quality Assurance Plan Cheyenne NCore Monitoring Station by Meteorological Solutions Inc. Project No. 08191870 August 2019, Revision 0
3. BAM 1020 Particulate Monitor Operation Manual, BAM 1020-9800 Rev U
4. BAM 1022 Particulate Monitor Operation Manual, BAM 1022-9805 Rev C.

APPENDIX A.2 FORMS

Corrective Action Form

CORRECTIVE ACTION REPORT

PROJECT NAME ____________________

Identification of a Problem or Deficiency:

Created By: ____________________
Assigned To: ____________________
Date: ____________________

Summary:

Corrective Action Taken and Results:

From: ____________________

Corrective Action Description:

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

MET ONE BETA ATTENUATION MASS MONITOR - PM2.5

FLOW CHECK

SITE NAME/LOCATION ____________ Date ____________ Start Time ____________
PROJECT ____________ Stop Time ____________
SITE OPERATOR ____________

Analyzer Mfg ____________
Analyzer Model ____________ [ ] = Cell Containing Equations
Analyzer s/n ____________

VERIFICATION EQUIPMENT:

	Model	Serial Number
Temperature Standard		
Pressure Standard	BGI Delta Cal	
Flow Standard		
Certification Date		

LEAK CHECK

Initial Sampler Indicated Leak ______ LPM
Final Sampler Indicated Leak ______ LPM

LEAK CHECK CRITERIA
LEAK < 1.0 LPM

TEMPERATURE SENSOR VERIFICATION

BAM Temp.	Ref. Std. Temp.	DIFF.
		0.0

TEMPERATURE CRITERIA
DIFFERENCE < ±2.1°C

PRESSURE SENSOR VERIFICATION

BAM Press.	Ref. Std. Press.	DIFF.
		0

PRESSURE CRITERIA
DIFFERENCE < ±10.1 mm Hg

FLOW VERIFICATION

FLOW CRITERIA
DIFF. OF STANDARD REFERENCE < ± 4.1%,
DESIGN < ± 5.1%, ACTION LEVEL OF < 3%

			% DIFFERENCE			
BAM TARGET	BAM Flow	Ref. Std. Flow	Standard Reference 4.1%	Standard Reference Span	Design 5.1%	Design Span
15.0			#DIV/0!	14.39 - 15.62	100.0%	14.24 - 15.77
18.4			#DIV/0!	17.65 - 19.15	100.0%	17.46 - 19.34
16.7			#DIV/0!	16.01 - 17.39	100.0%	15.85 - 17.55

COMMENTS

MONTHLY MAINTENANCE

- [ ] Nozzle and vane cleaning
- [ ] Leak Check
- [ ] Flow Rate Verification
- [ ] Clean PM_{10} Head
- [ ] Clean Capstan & Pinch Rollers, Replace Filter Tape (every 8 weeks unless broken)
- [ ] Clean $PM_{2.5}$ Inlet
- [ ] Check Error Log (F3 to recall last 10 errors)
- [ ] Download Digital Data Log (continuous remote communication)
- [ ] Other ____________

Tested By ____________

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

MET ONE BETA ATTENUATION MASS MONITOR - PM_{10}

SITE NAME/LOCATION ______________ Date __________ Start Time __________
PROJECT ______________ Stop Time __________
SITE OPERATOR ______________

Analyzer Mfg ______________
Analyzer Model ______________ = Cell Containing Equations
Analyzer s/n ______________

VERIFICATION EQUIPMENT:

	Model	Serial Number
Temperature Standard		
Pressure Standard		
Flow Standard		
Certification Date		

LEAK CHECK

Initial Sampler Indicated Leak ______ LPM
Final Sampler Indicated Leak ______ LPM

LEAK CHECK CRITERIA
LEAK < 1.0 LPM

TEMPERATURE SENSOR VERIFICATION

BAM Temp.	Ref. Std. Temp.	DIFF.
		0

TEMPERATURE CRITERIA
DIFFERENCE < ±2.1°C

PRESSURE SENSOR VERIFICATION

BAM Press.	Ref. Std. Press.	DIFF.
		0

PRESSURE CRITERIA
DIFFERENCE < ±10.1 mm Hg

FLOW VERIFICATION

FLOW CRITERIA
DIFF. OF REFERENCE < ± 7.1%, DESIGN < ± 5.1%, ACTION LEVEL OF < 3%

			% DIFFERENCE			
BAM TARGET	BAM Flow	Ref. Std. Flow	Standard Reference 7.1%	Standard Reference Span	Design 5.1%	Design Span
15.0			#DIV/0!	13.94 - 16.07	100.0%	14.24 - 15.77
18.4			#DIV/0!	17.09 - 19.71	100.0%	17.46 - 19.34
16.7			#DIV/0!	15.51 - 17.89	100.0%	15.85 - 17.55

COMMENTS

Working well

MONTHLY MAINTENANCE

	Nozzle and vane cleaning		Clean $PM_{2.5}$ Inlet
	Leak Check		Check Error Log (F3 to recall last 10 errors)
	Flow Rate Verification		Download Digital Data Log (continuous remote communication)
	Clean PM_{10} Head		Other
	Clean Capstan & Pinch Rollers, Replace Filter Tape (every 8 weeks unless broken)		

Tested By ______________

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

MET ONE BETA ATTENUATION MASS MONITOR - PM2.5

Monthly Flowrate Verification Sheet

Start Time 3:15 PM
Date 04/27/22 **Stop Time** 3:40 PM

SITE NAME/LOCATION	Gillette SLAMS/Gillette, WY
PROJECT	SLAMS
SITE OPERATOR	PB
Analyzer Mfg	MET ONE
Analyzer Model	BAM 1022
Analyzer s/n	A18624
Analyzer Mode	Continuous

VERIFICATION EQUIPMENT:

	Model
Temperature Standard	BGI Delta Cal
Pressure Standard	
Flow Standard	
Certification Date	10/21/2021
Serial Number	294495

Monthly Verifications

	Sampler	Ref. Std	DIFF.	Difference
Flow Set Point 16.7	16.68	16.58	-0.1	≤ 4.1 % (16.01-17.38)
Initial Leak Check	0.03			≤ 1.1 LPM
Final Leak Check	0.3			≤ 1.1 LPM
Ambient Temp (°C)	15.7	15.24	-0.46	≤ 2.1° C
Ambient Pressure	639	639.03	0.03	≤10.1 mmHg

*Most leaks occur at the nozzle where it contcts the Filter tape. Clean nozzle and repeat leak check.

General Maintenance

x	Clean nozzel & Seals (1 /month)	3/30/2022	Replace Filter Tape (1/60 days)
x	Clean VSCC (1/month)	x	Count Test Greater 1000Hz
x	Clean PM10 Inlet Head (1/ month)	x	Time within ± 1 minute of cell phone
x	Self Test Passed (after maintenance, troubleshooting or calibration)		

Span Mass Audit

	Sampler	Ref. Std	DIFF.	Difference
Need to add value- e.g., 0.749				

Every 6 months. Section 6.8 in manual. Zero & Span Foils. % difference should be less than 5%. If it fails redo test and minimize tape movement

Calibrations as needed

	Sampler	Ref. Std	DIFF.	Difference
Temperature At (°C)			0	≤ 2.1° C
Barometric Pressure			0	≤10.1 mmHg

Flow Calibrations as needed

Pre-Calibrations		
Set Point	Sampler	Actual
14.0		
17.5		
16.7		
Post-Calibrations		
Set Point	Sampler	Actual
14.0		
17.5		
16.7		

Set Point: 14.0		
$\left(\frac{Sampler - Actual}{Actual}\right) x\ 100$	#DIV/0!	≤ 2.1 %
$\left(\frac{14.0 - Actual}{14.0}\right) x\ 100$	100.0	≤ 5.1 %
$\left(\frac{14.0 - Sampler}{14.0}\right) x\ 100$	100.0	≤ 2.1 %
Set Point: 17.5		
$\left(\frac{Sampler - Actual}{Actual}\right) x\ 100$	#DIV/0!	≤ 2.1 %
$\left(\frac{17.5 - Actual}{17.5}\right) x\ 100$	100.0	≤ 5.1 %
$\left(\frac{17.5 - Sampler}{17.5}\right) x\ 100$	100.0	≤ 2.1 %
Set Point: 16.7		
$\left(\frac{Sampler - Actual}{Actual}\right) x\ 100$	#DIV/0!	≤ 2.1 %
$\left(\frac{16.7 - Actual}{16.7}\right) x\ 100$	100.0	≤ 5.1 %
$\left(\frac{16.7 - Sampler}{16.7}\right) x\ 100$	100.0	≤ 2.1 %

Cleaded PM inlet and sharpcut also drained water out of the inlet jar and cleaned out jar.

Air Resource SPECIALISTS

BAM 1020 VERIFICATION & CALIBRATION ($PM_{2.5}$)

ABBR.					
CLIENT		FIELD SPECIALIST		DATE	
SITE NAME				DATE OF LAST VISIT	

	MANUFACTURER	MODEL	SERIAL NUMBER	EXPIRATION DATE
PM Flow Standard #1				
PM Temperature Standard #1				
PM Barometric Pressure Standard #1				

AS FOUND		AS LEFT	
MANUFACTURER		MANUFACTURER	
MODEL		MODEL	
SERIAL NUMBER		SERIAL NUMBER	
SETTINGS		**SETTINGS**	
Total Flow	16.7	Total Flow	16.7
Background		Background	

Date and Time correct?	☐ Yes ☐ No
If no, time off by:	0 min
Corrected?	☐ Yes ☐ No

FLOW VERIFICATION					
AS FOUND	Reference	Instrument	Actual Diff	Design Diff	
Total Flow					

ACCEPTANCE CRITERIA (<=)	Field	Data
Actual Flow % Diff	2%	4%
Design Flow % Diff	2%	5%

LEAK CHECK			
	Pump off	Stopcock Closed	
AS FOUND Total Flow			

ACCEPTANCE CRITERIA (<=)	Field	Data
Leak Check Flow (LPM)	1.0	1.5

TEMPERATURE SENSOR (°C)				
	Reference	Instrument	Difference	
AS FOUND				
AS LEFT				

ACCEPTANCE CRITERIA (<=)	Field
Temperature Difference (°C)	2.0

PRESSURE SENSOR (mmHg)				
	Reference	Instrument	Difference	
AS FOUND				
AS LEFT				

ACCEPTANCE CRITERIA (<=)	Field
Pressure Difference (mmHg)	10

REFERENCE MEMBRANE CHECK				
	Target	Instrument	Difference	
AS FOUND				

ACCEPTANCE CRITERIA (<=)	Field
% Difference	5%

BETA COUNTS DURING MEMBRANE CHECK		
	W/O Membrane	With Membrane
AS FOUND		

Vane cleaned?	☐ Yes ☐ No	PM_{10} inlet cleaned?	☐ Yes ☐ No
Nozzle cleaned?	☐ Yes ☐ No	$PM_{2.5}$ cyclone cleaned?	☐ Yes ☐ No

Downtube cleaned?	☐ Yes ☐ No
Pump?	☐ Replaced ☐ Rebuilt ☐ N/A
Lithium Battery* Replaced?	☐ Yes ☐ No

*SR2032

LEAK CHECK			
	Pump off	Stopcock Closed	
AS LEFT Total Flow			

ACCEPTANCE CRITERIA (<=)	Field	Data
Leak Check Flow (LPM)	1.0	1.5

Flow recalibrated?	☐ Yes ☐ No

REFERENCE MEMBRANE CHECK				
	Target	Instrument	Difference	
AS LEFT				

ACCEPTANCE CRITERIA (<=)	Field
% Difference	5%

BETA COUNTS DURING MEMBRANE CHECK		
	W/O Membrane	With Membrane
AS LEFT		

FLOW VERIFICATION					
AS LEFT	Reference	Instrument	Actual Diff	Design Diff	
Total Flow					

ACCEPTANCE CRITERIA (<=)	Field	Data
Actual Flow % Diff	2%	4%
Design Flow % Diff	2%	5%

Background Test started?	☐ Yes ☐ No
Date & Time	
1/1/1900	0:00

NOTES:

Air Resource SPECIALISTS

BAM 1020 VERIFICATION & CALIBRATION (PM_{10})

ABBR.					
CLIENT		FIELD SPECIALIST		DATE	
SITE NAME				DATE OF LAST VISIT	

	MANUFACTURER	MODEL	SERIAL NUMBER	EXPIRATION DATE
PM Flow Standard #1				
PM Temperature Standard #1				
PM Barometric Pressure Standard #1				

AS FOUND		AS LEFT	
MANUFACTURER		MANUFACTURER	
MODEL		MODEL	
SERIAL NUMBER		SERIAL NUMBER	
SETTINGS		**SETTINGS**	
Total Flow	16.7	Total Flow	16.7
Background		Background	

Date and Time correct?	☐ Yes ☐ No
If no, time off by:	0 min
Corrected?	☐ Yes ☐ No

FLOW VERIFICATION					
AS FOUND	Reference	Instrument	Actual Diff	Design Diff	
Total Flow					

ACCEPTANCE CRITERIA (<=)	Field	Data
Actual Flow % Diff	4%	7%
Design Flow % Diff	4%	10%

LEAK CHECK			
		Pump off	Stopcock Closed
AS FOUND	Total Flow		

ACCEPTANCE CRITERIA (<=)	Field	Data
Leak Check Flow (LPM)	1.0	1.5

TEMPERATURE SENSOR (°C)			
	Reference	Instrument	Difference
AS FOUND			
AS LEFT			

ACCEPTANCE CRITERIA (<=)	Field
Temperature Difference (°C)	2.0

PRESSURE SENSOR (mmHg)			
	Reference	Instrument	Difference
AS FOUND			
AS LEFT			

ACCEPTANCE CRITERIA (<=)	Field
Pressure Difference (mmHg)	10

REFERENCE MEMBRANE CHECK			
	Target	Instrument	Difference
AS FOUND			

ACCEPTANCE CRITERIA (<=)	Field
% Difference	5%

BETA COUNTS DURING MEMBRANE CHECK		
	W/O Membrane	With Membrane
AS FOUND		

Vane cleaned?	☐ Yes ☐ No	PM_{10} inlet cleaned?	☐ Yes ☐ No
Nozzle cleaned?	☐ Yes ☐ No	Downtube cleaned?	☐ Yes ☐ No

Pump?	☐ Replaced ☐ Rebuilt ☐ N/A
Lithium Battery* Replaced?	☐ Yes ☐ No

*BR2032

LEAK CHECK			
		Pump off	Stopcock Closed
AS LEFT	Total Flow		

ACCEPTANCE CRITERIA (<=)	Field	Data
Leak Check Flow (LPM)	1.0	1.5

Flow recalibrated?	☐ Yes ☐ No

REFERENCE MEMBRANE CHECK			
	Target	Instrument	Difference
AS LEFT			

ACCEPTANCE CRITERIA (<=)	Field
% Difference	5%

BETA COUNTS DURING MEMBRANE CHECK		
	W/O Membrane	With Membrane
AS LEFT		

FLOW VERIFICATION					
AS LEFT	Reference	Instrument	Actual Diff	Design Diff	
Total Flow					

ACCEPTANCE CRITERIA (<=)	Field	Data
Actual Flow % Diff	4%	7%
Design Flow % Diff	4%	10%

Background Test started?	☐ Yes ☐ No
Date & Time	
1/1/1900	0:00

NOTES:

Trinity Consultants

MET ONE BETA ATTENUATION MASS MONITOR - PM_{10}

FLOW CHECK

SITE NAME ____________ **Date** ________ **Start Time** ________
PROJECT ____________ **Stop Time** ________
SITE OPERATOR ____________

Analyzer Mfg ____________
Analyzer Model ____________ [shaded cell] = Cell Containing Equations
Analyzer s/n ____________

VERIFICATION EQUIPMENT:

	Model	Serial Number
Temperature Standard		
Pressure Standard		
Flow Standard		
Certification Date		

LEAK CHECK

Sampler Indicated Leak [ ] LPM

LEAK CHECK CRITERIA
LEAK < 1.0 LPM

TEMPERATURE SENSOR VERIFICATION

BAM Temp.	Ref. Std. Temp.	DIFF.

TEMPERATURE CRITERIA
DIFFERENCE < ±2.1°C

PRESSURE SENSOR VERIFICATION

BAM Press.	Ref. Std. Press.	DIFF.

PRESSURE CRITERIA
DIFFERENCE < ±10.1 mm Hg

FLOW VERIFICATION

BAM TARGET	BAM Flow	Ref. Std. Flow	% DIFFERENCE REFERENCE	% DIFFERENCE DESIGN
15.0				
18.4				
16.7				

FLOW CRITERIA
DIFF. OF REFERENCE < ± 7.1%

COMMENTS

[ ]

MONTHLY MAINTENANCE

- ☐ Nozzle and vane cleaning
- ☐ Leak Check
- ☐ Flow Rate Verification
- ☐ Clean Capstan & Pinch Rollers
- ☐ Clean PM_{10} Head
- ☐ Check Error Log
- ☐ Download Digital Data Log
- ☐ Replace Filter Tape
- ☐ Other ____________

Tested By ____________

Trinity Consultants

MET ONE BETA ATTENUATION MASS MONITOR - $PM_{2.5}$

FLOW CHECK

SITE NAME ____________ **Date** ________ **Start Time** ________
PROJECT ____________ **Stop Time** ________
SITE OPERATOR ____________

Analyzer Mfg ____________
Analyzer Model ____________ [ ] = Cell Containing Equations
Analyzer s/n ____________

VERIFICATION EQUIPMENT:

	Model	Serial Number
Temperature Standard		
Pressure Standard		
Flow Standard		
Certification Date		

LEAK CHECK

Sampler Indicated Leak ________ LPM

LEAK CHECK CRITERIA
LEAK < 1.0 LPM

TEMPERATURE SENSOR VERIFICATION

BAM Temp.	Ref. Std. Temp.	DIFF.

TEMPERATURE CRITERIA
DIFFERENCE < ±2.1°C

PRESSURE SENSOR VERIFICATION

BAM Press.	Ref. Std. Press.	DIFF.

PRESSURE CRITERIA
DIFFERENCE < ±10.1 mm Hg

FLOW VERIFICATION

BAM TARGET	BAM Flow	Ref. Std. Flow	% DIFFERENCE REFERENCE	% DIFFERENCE DESIGN
15.0				
18.4				
16.7				

FLOW CRITERIA
DIFFERENCE < ±4.1% of Ref.
DIFFERENCE < ±5.1% of Design

COMMENTS
dfdf

MONTHLY MAINTENANCE

- [ ] Nozzle and vane cleaning
- [ ] Leak Check
- [ ] Flow Rate Verification
- [ ] Clean Capstan & Pinch Rollers
- [ ] Clean PM_{10} Head
- [ ] Clean $PM_{2.5}$ Inlet
- [ ] Check Error Log
- [ ] Download Digital Data Log
- [ ] Replace Filter Tape
- [ ] Other ____________

Tested By ____________

Appendix A.3 – Thermo 2000i

Wyoming
Department of Environmental Quality
Air Quality Division

Standard Operating Procedure

For the

Thermo Scientific Inc.
Partisol 2000i Air Sampler

October 2023
Revision # 2.0

1.0 Scope and Applicability

The Thermo Scientific Partisol 2000i (Thermo 2000i) air sampler is an air quality sampler that collects particulate matter (PM) in an aerodynamic size cut less than 2.5 microns, i.e., $PM_{2.5}$. The goal of this SOP is twofold; to outline the Thermo 2000i operation and calibration procedures in order to ensure comparability of all Thermo 2000i Federal Reference method (FRM) samplers within the WDEQ-AQD network.

2.0 Summary of Method

The Thermo 2000i sampler is designated as a FRM for collection of $PM_{2.5}$. The sampler meets the United States Environmental Protection Agency (U.S. EPA) requirements for $PM_{2.5}$ sampling (40 CFR part 50, Appendix L).

Ambient air is sampled through the top of the instrument at the PM_{10} size selective inlet (SSI) then through the $PM_{2.5}$ very sharp cut cyclone (VSCC). The PM_{10} and VSCC size selective inlets (SSIs) utilize angular velocity to remove particles larger than 2.5 microns. The sampler maintains a constant volumetric flow rate of 16.67 liters per minute (LPM) utilizing a mass flow controller (MFC) and real-time ambient temperature/pressure compensation. The sample is collected on a 47 millimeter (mm) filter housed in Delrin 52 mm Teflon cassette. These cassettes are mounted in a single-filter tray for easy exchange and transportation to and from the sampling site.

2.1 Definitions

The following terms that are used throughout this document are defined here:

- NIST Traceable Standard: This refers to a National Institute of Standards and Technology (NIST) flow, pressure, and temperature measurement device. The device has been regularly compared against NIST traceable standards of higher comparability.
- Field Standard: This refers to a standard that travels back and forth from the central laboratory to the field stations and is used to check the flow rates, pressure and temperature sensors within the sampler.
- Quality Control (QC) checks: This is a one-point verification check of the flow rate, pressure and temperature sensors. These are detailed In Section 8.0 of this SOP.

3.0 Health and Safety Warnings

The following health and safety warnings must be followed in order for safe operation of the instrument.

- To avoid electrical hazards, all sampler installation procedures should be conducted with the sampler disconnected from the AC power source.
- Observe proper lifting procedures when unpacking and moving sampler components.
- Read, understand, and follow all safety precautions for the sampler outlined in the sampler's operations manual.
- Once sampler installation is complete, secure the sampler to the field sampling platform to ensure that it does not tip over during high wind speed events.

- Care must be taken when operating or calibrating the units in inclement weather. Safety is paramount.

4.0 Cautions

- If you are planning to dismantle and reconstruct the sampler for any reason, ensure that all electrical connections, both cords and sockets, are color-coded with tape prior to disconnecting.
- Due to typical rooftop installations, the risks of working outdoors at elevation should also be considered. To prevent injury or damage to the equipment, the sampler should be securely mounted to the stand using the included hex head bolt hardware and washers.

4.0 Interferences

There are no interferences with these methods. However, it is important that the SSI and VSCCs be cleaned periodically because not servicing these components can allow PM of larger size to be sampled. Also, take care to handle the Teflon filters in the Delrin Ring. Always handle the outside of the ring and never touch the filter itself. Dirt or grease on your fingers can contaminate the filter and void the filter altogether.

5.0 Personnel Qualifications

It is the responsibility of WDEQ-AQD and their contractors to train their field staff on instrument operation and maintenance. It is a requirement of the WDEQ-AQD to train their staff but also keep records of all training that is performed per WDEQ-AQD's Training Plan. Although a Thermo 2000i sampler is a self-contained, computer operated instrument, there is a level of knowledge of electronics and know-how involved in the operation and maintenance of the instrument. The instrument manual is the best training tool for this.

6.0 Equipment

WDEQ-AQD and its contractors specifically utilize the Thermo 2000i samplers, because it is an FRM. For PM2.5, $_{\text{only}}$ gravimetric samplers designated as FRMs can be operated in accordance with EPA regulations. These instruments have been thoroughly vetted by the EPA. In addition, these instruments, when initially received, should operate within the parameters set down by the EPA. These parameters are available in the operating manual that comes with the instrument. Thoroughly read and familiarize yourself with this instrument.

The following supplies are required for the operation of this instrument.

- Partisol enclosure
- PM_{10} inlet
- VSCC $PM_{2.5}$ cut cyclone
- Filter transport container with 2 cassettes
- Vent rain hoods and associated hardware
- Sample tube
- Partisol stand
- Ambient temperature sensor and cable
- Flow audit adapter

- Solid filter leak check/separator disk
- 9-to-9 pin null modem computer cable
- Null modem adapter
- 1 iPort software package
- 1 RP Comm package

Other equipment that is necessary for the operation and maintenance of the instrument are:

- NIST Traceable flow, pressure and temperature device: As described in Section 2.1 of this SOP, the NIST traceable device is necessary to carry out the necessary QC checks required to ensure that the instrument is running correctly.
- Rubber or flexible plastic tubing that is used from the inlet of the flow device to the inlet be left at the station. Replace this tubing if cracks or holes appear in the tubing.
- QC Check Forms: These are attached to the Appendix to this SOP.

Spare parts are purchased from the instrumentation manufacturer by the Project Managers. For the WDEQ–AQD operated sites, parts will be inspected by the Project Managers or Monitoring Specialist for shipping damage upon receipt. Spare parts will be kept in the monitoring shelter for use when needed. The use of spare parts will be documented on calibration forms. Please note that some parts will be stored at the monitoring stations while some less utilized parts will be stored at the contractors' and WDEQ-AQD central facilities. The WDEQ-AQD will use AirVision software to track spare samplers.

7.0 Quality Control Procedures

Federal regulations clearly specify time frames and dates for FRM $PM_{2.5}$ sample filters to be sampled. The EPA publishes the schedule on their website (www.epa.gov/amtic). If these time frames and dates are not met, sample filters may be flagged or invalidated by the receiving laboratory. In addition to these requirements, operators should practice good field practices to prevent or minimize contamination of the sample filters, filter cassettes, or anything else which may come in contact with the sample filters.

7.1 Pre-Sampling Filter Handling Procedures

Sample filters must be used within 30 days of the pre-weighing procedure. If 30 days have elapsed before the cassette is to be used, do not use the filter and return it to the laboratory for a replacement. The sample filter temperature must be within 5 °C of the ambient temperature while installed in the sampler.

7.2 Post Sampling Filter Handling Procedures

Sampled filters must be removed from the sampler within 177 hours after the end of sampling and placed in cold storage immediately (see 40 CFR Part 50, Appendix L Section 10.10). Sampled filters should be kept at a temperature of 4 °C or less during storage and shipping which allows the laboratory up to 30 days from the end of sampling for analysis. If at any time during storage or shipping the temperature exceeds but is kept at no greater than 25 °C, the laboratory has up to 10 days to analyze the filters. Sampled filters and the Chain of Custody report form will be shipped in an insulated shipping container containing sufficient Blue Ice or other chilled media to assure that sample filters arrive at the laboratory at a temperature no greater than 25 °C, preferably 4 °C or less. Other cold storage methods may also be employed if they comply with these temperature requirements. Shipping containers will contain an irreversible temperature indicator or other suitable means to determine whether temperature requirements of the sample filters have been exceeded during transit. This requirement also applies when sampled filters are being transported by staff from remote or satellite sites to central or main locations. Samples received at the laboratory at temperatures of 4 °C or less will be noted. Sampled filters should be shipped to the laboratory weekly on Monday, Tuesday or Wednesday to avoid Saturday, Sunday, or holiday arrivals when staff may not be present to receive the samples.

7.3 Field and Trip Blank Handling Procedures

Upon receipt and identification of filter blanks, treat these filters the same as filters to be sampled with the exception that no air will be drawn through the filter. A field blank is loaded into the sampler and removed after 5 minutes. The filter is placed in the freezer and treated like a standard filter.

Trip blanks are to accompany all standard filters and field blanks, but are not loaded into the instrument. For Trip blanks, the Chain of Custody field sample report form with exception of run data. For Field blanks, in addition to the above, fill in the sample start date/time, total elapsed time, volume, sample load time, and sample removal time. The elapsed time and volume should be zero. The frequency for Field and Trip blanks are 10% of the site sampling schedule. Upon receipt and identification of filter blanks, treat these filters the same as filters to be sampled with the exception that no air will be drawn through the filter.

Trip blanks are to accompany all standard filters and field blanks, but are not loaded into the instrument. For Trip blanks, fill out the field sample report form with exception of run data. For Field blanks, in addition to the above, fill in the sample start date/time, total elapsed time, volume, sample load time, and sample removal time. The elapsed time and volume should be zero. Field and Trip Blank frequency is 10% of the site sampling schedule.

7.4 Maintenance Activities

Table 1 illustrates the maintenance actions and their frequency.

Table 1. Equipment Maintenance Activities

Maintenance Activity	Frequency
Thermo 2000i	
Check sampling inlet and down tube for bugs and obstructions, and water intrusion	**Each site visit, clean as needed.**
Inspect filter cassettes for contamination or damage	**Each site visit**
Clean interior of sampler case (if applicable)	**Each site visit**
Inspect upper and lower cassette seals	**Each site visit**
External leak check	**Every 5 days of usage**
Internal leak check	**Every 4 weeks**
Clean SSI inlet	**Monthly**
Clean rain hood and air screen	**Every six months**
Overhaul or replace sampling pump and solenoids.	**12-18 months**

8.0 Quality Control Checks

The procedure below describes the steps that are performed when QC checks are performed. The description below refers to the monthly QC checks. Quarterly QC checks are also required. However, the procedures are the same.

8.1 Verification Overview

A verification, also known as the AS-IS calibration, is required to verify that the sampler is operating within criteria. This also verifies that the data collected from the last check to present date are valid. A passing AS-IS verification ensures the integrity of the previous collected samples.

The following verification procedures can be performed in the Audit mode which allows the user to resume the sampling event immediately after the verification is complete. It's best practice to perform verification checks and/or calibrations on non-sampling days.

Flow rate and Leak check verifications require a white Delrin filter cassette or Thermo's leak check filter set (audit cassette). The set includes a green audit cassette and a solid red audit cassette. The green audit cassette is only utilized when troubleshooting flow and external leaks checks. If the external leak fails, the solid red audit cassette is utilized for the internal leak process to troubleshoot the leak location.
Note: Using an internal leak check filter while performing an external leak, may cause damage to the sampler.

A QC check should be completed on a monthly basis by the Monitoring Specialist. During a QC check, all parameters must meet the acceptable criteria: flow ±4.1% of true or between 16.02 and 17.38 LPM, temperature ±2°C from true, and ambient pressure ±10 mmHg from true, an external leak check value of <25 mmHg/min and clock time is within 2 minutes of true. If any parameter does not meet the specified criteria, a calibration must be performed. In addition, samples collected after the previous flow check must be evaluated to determine validity.

8.2 Verification Procedures

8.2.1 Ambient Temperature and Barometric Pressure Sensor Verification

- Install the NIST transfer standard on the down tube. Allow time for the transfer standard to equilibrate to ambient conditions.
- From the main menu, select Audit and Calibration then select Audit Mode.
- Place an audit cassette into the filter holder and close filter assembly.
- Select Audit from the menu. The Audit screen will display the ambient temperature and pressure readings. Verify the readings with your standard and record all values into the Partisol-FRM Model 2000i Verification & Maintenance Calibration Forms .
- The ambient pressure reading should be within 10 mmHg of the transfer standard. The ambient temperature reading should be within 2 °C of the temperature standard. If the temperature and pressure readings are out of tolerance, the ambient temperature sensor and/or barometer must be re-calibrated. Calibration procedures are listed in Section 9.0 of this SOP.

8.2.2 Filter Temperature Sensor Verification

- Install the NIST transfer standard on the down tube with the external thermometer plugged in. Allow time for the transfer standard to equilibrate to ambient conditions.
- From the main menu, select Audit and Calibration then select Audit Mode.
- Open the filter assembly and remove the audit cassette. The sampler's filter temperature sensor is located under the filter cassette holder.
- Verify the sampler's filter temperature by measuring the temperature at the location of the filter temperature sensor. Record the value on the Partisol-FRM Model 2000i Verification & Maintenance Calibration Forms .

The filter temperature reading should be within 2 °C of the temperature standard. If the temperature readings are out of tolerance, the filter temperature sensor must be re-calibrated. Calibration procedures are listed in Section 9.0 of this SOP.

8.2.3 Flow Rate Verification

- Replace the leak check adaptor with the measuring head of a NIST transfer standard. Allow time for the transfer standard to equilibrate to ambient conditions.
- In the Audit and Calibration menu, scroll down to the Flow field. Press the → key to start the pump. Allow the pump to warm up for 15 minutes.
- Once the flow readings on your standard have stabilized, compare the volumetric flow on the transfer standard to the sampler's flow reading. Record the value on your Partisol-FRM Model 2000i Verification & Maintenance Calibration Forms.

- A passing flow verification will be between 16.02 and 17.38 LPM. If the flow readings are out of tolerance a flow calibration is required. Calibration procedures are listed in Section 9.
- Stop the pump after verifying the flow rate by pressing the ← key.
- Select Audit Mode from the Audit and Calibration Menu. Exit Audit Mode. This will place the sampler back in WAIT mode. Do not use the button to return to wait mode as it will only place the sampler in STOP mode.

8.2.4 External Leak Check Verification

- Remove the SSI and replace it with the leak check adaptor. Ensure that the adaptor is in the closed position.
- Place an audit cassette into the filter holder and close the filter assembly.
- From the Audit and Calibration menu select Leak Check. Select External and follow the instructions on the screen to complete the leak check. A passing leak check value is <25 mmHg/min. If the leak check fails, troubleshoot the error and perform an additional leak check. Refer to Section 9.0 for more information. Record the value on your Partisol-FRM Model 2000i Verification & Maintenance Calibration Forms.
- Slowly open the leak check adaptor to release the vacuum.
- Before proceeding to the Flow Rate Verification the instrument must pass the Leak Check Verification. Any issues causing leaks must be addressed with the appropriate repairs.

8.2.5 Clock Verification & Adjustment

Units of time are used in several aspects of sampler operation. Examples are the start and stop times, volume/flow calculations, run dates, etc. Therefore, it is necessary to document the time setting of the sampler.

- Observe the sampler time from the Main Screen. Record this value on the calibration or monthly check data sheet.
- At the same time, record the value of your time keeping device.
- Identify your time keeping device on the data sheet (i.e. cell phone). Cell phones maintain accurate time.
- If the sampler time is off by more than 2 minutes, an adjustment to the clock must be made. Navigate to the Main Menu > Instrument Setup > Date/Time to make the necessary adjustments to the clock. Record that clock adjustment was performed on QC sheet.
- The sampler will need to be in STOP mode to correct the clock.

9.0 Instrument Performance Calibrations Procedure

A calibration is performed after AS-IS verification checks (Section 8) and before adjusting the Thermo 2000i flow, temperature, or pressure. The calibration will verify that the adjustments performed are within acceptable criteria and will validate samples collected moving forward.

9.1 Calibration Overview

Flow calibrations and leak checks must be performed with a white Delrin cassette, with a dummy filter in

the cassette. Calibrations should be performed by someone independent of the day-to-day site operations. Calibrations should also be completed using a NIST-traceable standard and one that is not used for the monthly quality control checks.
The adjustments made on the Thermo 2000i sampler should be performed in the following order:

- Filter and Ambient Temperature
- Pressure
- Leak Check
- Flow Check
- Verification of Flow Rate/Final Calibration)

Before adjustments are made, flow, pressure, and temperature verifications should be performed. These steps are detailed in Section 8.0 of this SOP and are known as AS-IS verifications. The AS-IS verification will allow the site operator to certify that all prior samples were sampled under valid conditions. A passing verification requires that the following parameters be within the control limits: flow ±4.1% of true (16.02 - 17.38 LPM), temperature ±2 °C from true, and ambient pressure ±10 mmHg from true.

Parameters that are out of the acceptable criteria must be adjusted and a final calibration must be performed. A passing flow calibration must be between 16.02 and 17.38 LPM, but an adjustment and final calibration must be performed if the flow is not within 2% of expected flow (16.34 - 17.00 LPM). If temperature or pressure requires adjustment, the flow must be calibrated and adjusted afterwards, if needed.

All calibration information and data must be recorded on the Partisol-FRM Model 2000i Verification & Maintenance Calibration Forms (See Appendix). A calibration can only be completed while the instrument is stopped and in Service Mode. To stop the instrument, press the start button confirm to place it in Stop mode. To place it in Service Mode, press (Main Menu) repeatedly to display Main Menu, scroll to Service mode and press to toggle the Service mode to on. Press to return to Main Menu.

9.2 Calibration Procedures

If the calibration is performed at ambient conditions, the reference temperature measurement can be taken with the probe installed in the Thermo 2000i radiation sensor housing. Install the NIST transfer standard and tubing on the down tube. Allow time for the transfer standard to equilibrate to ambient conditions.

9.2.1 Ambient Temperature Sensor Calibration

- Navigate to the main menu and select the Calibration menu, scroll to Ambient Temp and press the enter key.
- The instrument will display the current reading and will allow you to input the reading from your temperature standard. With the temperature probe inserted into the radiation housing, input the ambient temperature reading from your standard into the reference field. Press the Enter key to save any changes. The sampler automatically adjusts the corresponding offset based on this input.
- Verify the Thermo 2000i sampler value matches the standard. Document the values on the Partisol-FRM Model 2000i Verification & Maintenance Calibration Forms. Record previous and new offset.

9.2.2 Filter Temperature Sensor Calibration

- Install the NIST transfer standard in the down tube with the external thermometer plugged in. Allow time for the transfer standard to equilibrate to ambient conditions.
- Navigate to the main menu and select the Calibration menu, scroll to Filter Temp and press the enter key.
- Open the filter assembly and remove the audit cassette. The samplers filter temperature sensor is located under the filter cassette holder.
- The instrument will display the current reading and will allow you to input the reading from your external temperature standard. Input the filter temperature reading from your standard into the reference field. Press the Enter key to save any changes. The sampler automatically adjusts the corresponding offset based on this input.
- Verify the Thermo 2000i sampler value matches the standard. Document the values on the Partisol-FRM Model 2000i Verification & Maintenance Calibration Forms. Record previous and new offset.

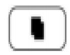
9.2.3 Barometric Pressure Calibration

- With the NIST transfer standard installed on the down tube. Allow time for the transfer standard to equilibrate to ambient conditions.
- Navigate to the main menu and select the Calibration menu, scroll to Ambient Pres and press the enter key.
- The instrument will display the current reading and will allow you to input the reading from your transfer standard. Input the ambient pressure reading from your standard into the reference field. Press the Enter key to save any changes. The sampler automatically adjusts the corresponding offset based on this input.
- Verify the Thermo 2000i sampler value matches the standard. Document the values on the Partisol-FRM Model 2000i Verification & Maintenance Calibration Forms. Record previous and new offset.
- Select Main Menu button, scrolling to Audit and Calibrations to return to the Calibration menu.

9.2.4 External Leak Checks

- Before adjusting the flow of the sampler it is important to ensure that the sampling train does not have a leak.
- Remove the PM_{10} inlet from the instrument and place the leak check adaptor/valve on the down tube. Close the valve on the leak check adaptor.
- Load an audit filter into the filter carrier and filter exchange mechanism and close.
- Return to the Audit and Calibration menu by pressing the main menu button.
- Choose External leak check and follow the onscreen instructions to start the test. Once the countdown ends, record your results on the Partisol-FRM Model 2000i Verification & Maintenance Forms. An external leak check value of less than 25 mmHg/min is considered passing.
- If a leak check fails, ensure the audit filter is in place and the leak check adapter is closed. Repeat the leak check. If the external leak check fails a second time, isolate the leak and repair.
- After a successful leak check, open the valve on the leak check adapter slowly.

9.2.5 Flow Rate Calibration (Multi-Point)

- Record current slope and offset in the Partisol-FRM Model 2000i Verification & Maintenance Form.
- Install the NIST transfer standard on the down tube. Allow time for the transfer standard to equilibrate to ambient conditions.
- Load an audit filter into the filter carrier and filter exchange mechanism and close.
- Return to the Main menu by pressing the  main menu button. Scroll to Audit and Calibration, press the ↵ key to display Audit and Calibration menu. Scroll to Calibration and press ↵ to display calibration menu. Scroll to Flow and press ↵ to display the Calibration for Flow menu.
- The display will show the 3 calibration points. Scroll to Set point 1 and press enter to display Set point. The system will start the flow calibration at 15.0 LPM.
- Let the flow stabilize and change the "Actual" field to match the flow standard and select the enter key. The Thermo 2000i will automatically minutes of the time standard and the date should be correct. Clock adjustment only needs to be recorded on the QC sheet (calibration sheet not required if only adjusting the clock time).
- Record results for all calibration procedures.
- Disassemble, clean, and inspect the SSI. Lubricate the O-rings if necessary. Replace the O-rings if the rubber is cracked or if they are damaged.
- Disassemble, clean, and inspect VSCC inlet.
- Check V-seals at the top and bottom of the $PM_{2.5}$ VSCC. Lightly lubricate with Dow vacuum grease if necessary. Replace the V-seals if the rubber is cracked or if they are damaged.
- Clean interior compartment and the sample down tube.

10.0 References

1. United States Code of Federal Regulations, (2006) Title 40 Part 50 Appendix L, Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere.
2. Thermo Scientific Partisol 2000i Air Sampler Instructional Manual (PN110735-00)
3. EPA Ambient Monitoring Technology Information Center (AMTIC), www.epa.gov/amtic
4. United States Code of Federal Regulations, (2013) Title 40 Part 50 Appendix N, Interpretation of the National Ambient Air Quality Standards for $PM_{2.5}$.
5. California Air Resources Board Standard Operating Procedures for Thermo Scientific Inc. Partisol 2000i Air Sampler, first edition, February 2020.

APPENDIX A.3 FORMS

Corrective Action Form

CORRECTIVE ACTION REPORT

PROJECT NAME ____________________

Identification of a Problem or Deficiency:

Created By: ____________________
Assigned To: ____________________
Date: ____________________

Summary:

Corrective Action Taken and Results:

From: ____________________

Corrective Action Description:

Partisol-FRM Model 2000i Verification & Maintenance Calibration Forms

Revision No. 1
May 2019

Wyoming DEQ-AQD Partisol-Model 2000i Verification & Maintenance Form				
Date:	Actual Time (MST):	Sampler Time:	Location:	Sampler Type
Inspector:			Sampler ID#:	☐ PM10
Network:			Status:	☐ PM2.5
Test Equipment:		Serial #:	Mode:	

Monthly Maintenance and Verification

As Found Flow Calibration Values: | Slope: | | Intercept: | |

Leak Check:

	Pass	Fail	
External Leak Check:	☐	☐	*If External Leak Check fails, complete Internal Leak check
Internal Leak Check:	☐	☐	

Sensor Verification:	Indicated	Actual	DEQ-AQD Sensor Adjustment Requirements
Ambient Temp:			<±2.1°C Verification
Filter Temp:			<±2.1°C Verification
Ambient Pressure:			<±10.1° mmHg
Flow:			16.7 l/min <±4.1 (16.05-17.37)

Sensor Adjustment (As Needed):	Indicated	Corrected
Ambient Temp:		
Filter Temp:		
Ambient Pressure:		
Flow:		

Tasks Completed:

Clean PM 2.5 W/Sharp:	☐ Yes	☐ No	☐ N/A
Clean Filter Cassette Chamber:	☐ Yes	☐ No	☐ N/A
Check Fans for Operation:	☐ Yes	☐ No	☐ N/A
Clean & Inspect Fan Filter/Screens:	☐ Yes	☐ No	☐ N/A
Clean & Inspect PM-10 Inlet & Down Tubes:	☐ Yes	☐ No	☐ N/A
Download Data:	☐ Yes	☐ No	☐ N/A
Onsite Logbook Updated:	☐ Yes	☐ No	☐ N/A

Semi-Annual Maintenance and Verification (2nd & 4th Quarters)

Inspect & Replace Filters in Lower Cabinet:	☐ Yes	☐ No	☐ N/A
Onsite Logbook Updated:	☐ Yes	☐ No	☐ N/A

Annual Maintenance and Calibration (2nd Quarter)

Clean Pump Compartment::	☐ Yes	☐ No	☐ N/A
Onsite Logbook Updated::	☐ Yes	☐ No	☐ N/A

3-Point Flow Calibration			
Levels	Indicated	Actual	Corrected
15.0			
16.7			
18.4			

Post Calibration Flow	
Indicated	Actual

Annual Calibration Values:	Indicated	Corrected
Ambient Temp:		
Filter Temp:		
Pressure:		

As Left Flow Calibration Values: | Slope: | | Intercept: | |

Comment Section

Appendix A.4 – PM Audits

Wyoming
Department of Environmental Quality
Air Quality Division

Standard Operating Procedure

For Particulate Matter Monitors Audits

October 2023
Revision 2.0

1.0 Scope and Applicability

This SOP applies to the quality assurance activities involving the semi-annual flow rate audits for particulate matter monitors within the WDEQ-AQD air quality monitoring network. Per 40 CFR Part 58 Appendix A, there must be two semi-annual flow rate audits that occur 5-7 months apart, with the exception of Boulder and NCore which require four audits per year. This SOP details the procedures WDEQ-AQD will take to perform the audits in the field. Occasionally, the WDEQ-AQD may contract out the audits. If this is the case, the Contractor may have their own SOP to follow.

WDEQ-AQD has both FRM and FEM particulate matter monitors:

- Thermo Scientific Partisol 2000i Air Sampler – PM2.5 (FRM EPA designation RFPS-0498-117)
- Met One BAM 1020 – PM10 (FEM EPA designation EQPM-0798-122)
- Met One BAM 1020 – PM2.5 (FEM EPA designation EQPM-0308-170)
- Met One BAM 1022 – PM2.5 (FEM EPA designation EQPM-1013-209)
- Met One SuperSASS (Not FRM or FEM)
- URG 3000N (Not FRM or FEM)

1.1 Introduction

Semi-annual flow rate audits are performed with independent equipment and personnel from data generation. For WDEQ-AQD, the QA Coordinator or designated Contractor will travel to the site location with independent equipment to perform the audit. The audit is performed by using a certified flow rate standard.

It is a requirement for all particulate matter monitors to be audited twice a year with 5 to 7 months in-between.

2.0 Summary of Method

This method is for use for auditing WDEQ-AQD particulate matter monitors. These parameters will be audited twice a year with 5 to 7 months in-between.

2.1 Definitions

The following terms that are used throughout this document are defined here:

- **NIST:** This acronym refers to the National Institute of Standards and Technology. This is a laboratory in Washington D.C. that creates standards for instruments and materials for government and non-governmental entities and also cooperates with other countries to create international standards. This is performed so that a value of one thing in data collected anywhere in the world or U.S. is comparable to the same information collected somewhere else.
- **NIST Traceability:** This term refers to a “transfer” of a standard or technique that allows the known standardization of one material or instrument to another. For example with sulfur dioxide, this is done by using sulfur dioxide gas that has been tested by a NIST traceable instrument and then

placed into a compressed gas aluminum cylinder. In addition, the flow rates of the mass flow calibration (MFC) unit is also calibrated using NIST traceable flow devices, so that the operator in the field will know the level of gas that is being delivered within a known level of confidence. All gaseous analyzers within the WDEQ-AQD network are NIST traceable.

- **Flow Standard:** This refers to a standard that travels back and forth from the central laboratory to the field stations and is used to check the flow rates, pressure and temperature sensors within the sampler.

3.0 Health and Safety Warnings

The following health and safety warning must be followed in order for safe operation of the instrument.

- Read, understand, and follow all safety precautions for the sampler outlined in the sampler's operations manual.
- Care must be taken when operating or calibrating the units in inclement weather. Safety is paramount.

4.0 Cautions

- Due to typical rooftop installations, the risks of working outdoors at elevation should also be considered.

4.1 Interferences

There are no interferences with these methods. However, it is important that the SSI and VSCCs be cleaned periodically because not servicing these components can allow PM of larger size to be sampled. Also, take care to handle the Teflon filters in the Delrin Ring. Always handle the outside of the ring and never touch the filter itself. Dirt or grease on your fingers can contaminate the filter and void the filter altogether.

5.0 Personal Qualifications

It is the responsibility of WDEQ-AQD or the Contractor to train their auditing staff on instrument operation and maintenance. It is a requirement of the WDEQ-AQD to train their staff and keep records of all training that is performed. Although particulate matter monitors are self-contained, computer operated instruments, there is a level of knowledge of electronics and know-how involved in the operation and maintenance of the instrument. The instrument manual is the best training tool for this.

6.0 Equipment

The following supplies are required for the operation of this instrument:

- Audit flow standards with temperature probe
- Audit filter disks (one solid disk and one open/with a filter screen disk)
- Leak check adapter

6.1 Inspection/Acceptance of Supplies and Consumables

Spare parts will be purchased only from the instrumentation manufacturer by the QA Coordinator. Parts will be inspected by the QA Coordinator for shipping damage upon receipt. Spare parts will be kept in the WDEQ-AQD workshop for use when needed.

The audit flow standard and all other flow standards will be sent off for annual certification.

7.0 Quality Assurance Procedures

Semi-annual flow rate audits are required to be performed at a minimum of twice a year and 5 to 7 months apart per 40 CFR Part 58 Appendix A.

The audits are performed by checking the flow rate of the monitor, ambient temperature, barometric pressure, filter temperature (when applicable), and performing a leak check. The procedure for each type of monitor is listed in this section. On all audit forms, record the monitor information including the make/model/serial number, time of the audit, if the date and time on the instrument are correct.

7.1 Thermo Scientific Partisol 2000i Audit

1. Check EPA sampling schedule and try to perform the audit on a non-sample day. If you must interrupt sampling, document the time stopped and restarted.
2. Date and Time Audit
   a. Record the start time of the audit in MST.
   b. Verify the date and time on the instrument in MST. Record the accuracy on the audit form.
3. Turn on audit flow standard by zeroing the flow (you can ensure zero flow by pressing the opening of the flow standard up against your leg when you turn it on).
4. Attach the temperature probe to the audit flow standard.
5. Place the monitor in Audit Mode
   a. Press to display the Main Menu. In the Main Menu, scroll to Audit and Calibration, and press . In the Audit and Calibration menu, scroll to Audit mode and press At the Audit mode screen, press to enter the Audit mode, and press to confirm the change.
6. Flow Rate Audit
   a. Remove PM10 head
   b. Place audit flow standard on the inlet tube.
   c. Insert the open/filter screen audit disk into the filter chamber of the sampler.

   d. Press repeatedly to display the Main Menu. Scroll to Audit and Calibration, press , scroll to Audit, press , scroll to Flow, press to turn on the flow, and wait for the flow to stabilize.
   e. Record the flow for the audit standard and sampler.
   f. The measured flow should be within 4% of the flow displayed by the sampler and within 5% of the design.
7. Ambient Temperature Sensor Audit
   a. Collocate the audit temperature probe with the external temperature probe.
   b. Press repeatedly to display the Main Menu. Scroll to Audit and Calibration, press , scroll to Audit, press , scroll to Amb Temp.
   c. Record the value displayed for the sampler and the "T_f" value on the audit flow standard (Delta Cal) once stabilized.
   d. The ambient temperature measured by the sampler needs to be within 2 °C of the measured ambient temperature.
8. Ambient Pressure Sensor Audit
   a. Press repeatedly to display the Main Menu. Scroll to Audit and Calibration, press , scroll to Audit, press , scroll to Amb Press.
   b. Record the value displayed for the sampler and the "BP" value on the audit flow standard (Delta Cal) once stabilized.
   c. The ambient pressure read by the sampler needs to be within 10 mmHg of the measure ambient pressure.
9. Filter Temperature Sensor Audit
   a. Collocate the audit temperature probe with the internal filter temperature probe.
   b. Press repeatedly to display the Main Menu. Scroll to Audit and Calibration, press , scroll to Audit, press , scroll to Filter Temp.
   c. Record the value displayed for the sampler and the "T_f" value on the audit flow standard (Delta Cal) once stabilized.
   d. The filter temperature measured by the sampler needs to be within 2 °C of the measured temperature.
10. Leak Checks
   a. Perform an external leak check. If the external leak check fails, perform an internal leak check to provide information about the possible source of the leak.
   b. External Leak Check
      i) Insert the open/filter screen audit disk into the filter chamber.
      ii) Install a leak check adapter on the inlet tube. Turn the valve to the closed position.
      iii) Press repeatedly to display the Main Menu. Scroll to Audit and Calibration, press , scroll to leak checks, press , scroll to external and press .
      iv) The message "MAKE SURE THAT FILTER IS IN PLACE AND LEAK CHECK ADAPTER IS CLOSED!!!" will appear. Press to begin testing.
      v) A pass or fail message will display at the end of the leak check cycle. The leak check will pass if the pressure drop is less than 25 mmHg.
      vi) If a fail message appears, re-attempt the leak check and then perform an internal leak check if a failure still occurs.
      vii) Gently open the valve on the audit leak adapter.
   c. Internal Leak Check

        i) Insert the solid audit disk into the filter chamber.
        ii) Install a leak check adapter on the inlet tube. Turn the valve to the closed position.
        iii) Press repeatedly to display the Main Menu. Scroll to Audit and Calibration, press , scroll to leak checks, press , scroll to internal and press .
        iv) The message "MAKE SURE THAT FILTER IS IN PLACE AND LEAK CHECK ADAPTER IS CLOSED!!!" will appear. Press to begin testing.
        v) A pass or fail message will display at the end of the leak check cycle. The leak check will pass if the pressure drop is less than 140 mmHg.

11. Set Flow Verification
    a. Verify the set flow rate of the sample. This can be found in the main menu under the default sample setup. Be careful not to make any changes.

7.2 Met One BAM 1020 Audit

1. Turn on audit flow standard by zeroing the flow (you can ensure zero flow by pressing the opening of the flow standard up against your leg when you turn it on).
2. Attach the temperature probe to the audit flow standard.
3. Date and Time Audit
    a. Record the start time of the audit in MST.
    b. Verify the date and time on the instrument in MST. Record the accuracy on the audit form.
4. Flow Rate Audit
    a. Interrupt the normal sampling mode of the instrument by entering the TEST menu.
    b. Remove the PM_{10} head. The $PM_{2.5}$ Very Sharp Cut Cyclone (VSCC) should stay in place if possible.
    c. Place audit flow rate standard on the inlet tube.
    d. On the instrument, from the TEST menu, select FLOW.
        i) **<u>ONLY</u>** use the NEXT button to scroll down to FLOW 3. **<u>DO NOT hit the CAL or DEFAULT buttons</u>**.
    e. Wait for the flow on the audit standard and instrument to stabilize. Record values on the audit form.
    f. For PM_{10}, the instrument flow must be within 10% of the measured flow. For $PM_{2.5}$, the instrument flow must be within 4% of the measured flow.
5. Ambient Temperature Sensor Audit
    a. Collocate the audit temperature probe with the external temperature probe.
    b. On the instrument, from the TEST menu, select FLOW.
        i) **<u>ONLY</u>** use the NEXT button to scroll down to AT. **<u>DO NOT hit the CAL or DEFAULT buttons</u>**.
    c. Allow the temperatures to stabilize. Record the instrument and audit ("T_f" value on the Delta Cal) ambient temperatures.
    d. The ambient temperature from the instrument must be within 2 °C of the measured ambient temperature.
6. Ambient Pressure Sensor Audit
    a. On the instrument, from the TEST menu, select FLOW.
        i) **<u>ONLY</u>** use the NEXT button to scroll down to BP. **<u>DO NOT hit the CAL or DEFAULT buttons</u>**.
    b. Record the BP value from the audit standard while located near the inlet. Record the BP value from the instrument.
    c. The BP value from the instrument must be within 10 mmHg of the measured BP.
7. Leak Check

   a. Remove the PM_{10} head. The $PM_{2.5}$ Very Sharp Cut Cyclone (VSCC) should stay in place if possible.
   b. Interrupt the normal sampling mode of the instrument by entering the TEST menu
   c. From the TEST menu, select PUMP.
   d. Turn off the pump, if it is running.
   e. Place a leak check adapter on the inlet tube and close the valve.
   f. Turn on the pump.
   g. Record the flow.
   h. Turn off the pump. Carefully open the leak check adapter valve and remove from the inlet tube.
   i. A passing leak check has a flow of less than 1.0 when the leak check adapter is closed.
8. Reference Membrane Check
   a. From the TEST menu, select CALIBRATE.
   b. Press START to initiate the test.
   c. Record the results in the audit form.
   d. The target value can be found in the SETUP>CALIBRATE menu from the main menu. This value is the ABS value and will need to be multiplied by 1000.
   e. The difference between the target value and measured value should be less than 5%.
9. Settings
   a. From the main menu select SETUP>CALIBRATE.
   b. Record the set flow and background values.
10. The instrument should start sampling again at the top of the hour, just make sure to put it back into OPERATE mode.

7.3 Met One BAM 1022 Audit

1. Turn on audit flow standard by zeroing the flow (you can ensure zero flow by pressing the opening of the flow standard up against your leg when you turn it on).
2. Attach the temperature probe to the audit flow standard.
3. Date and Time Audit
   a. Record the start time of the audit in MST.
   b. Verify the date and time on the instrument in MST. Record the accuracy on the audit form.
4. Go to the OPERATE menu and select STOP SAMPLE to stop the current sample.
5. Flow Rate Audit
   a. Remove the PM_{10} head. The $PM_{2.5}$ Very Sharp Cut Cyclone (VSCC) should stay in place if possible.
   b. Place audit flow rate standard on the inlet tube.
   c. On the instrument, from the TEST menu, select FLOW CALIBRATION.
      i) **DO NOT hit the CALIBRATE or DEFAULT buttons**.
      ii) Wait for the flow on the audit standard and instrument to stabilize. Record values on the audit form.
      iii) The instrument flow must be within 4% of the measured flow.
      iv) Record the current SET POINT for the flow under the settings box of the audit form.
      v) Simply hit the X to get out of the menu. **DO NOT hit the CALIBRATE or DEFAULT buttons**.
6. Ambient Temperature Sensor Audit
   a. Collocate the audit temperature probe with the external temperature probe.
   b. On the instrument, from the TEST menu, select AMBIENT TEMP.
      i) **DO NOT hit the CALIBRATE or DEFAULT buttons**.

    ii) Wait for the temperature (“T_f” on the Delta Cal) on the audit standard and instrument to stabilize. Record values on the audit form.
    iii) Simply hit the X to get out of the menu. **<u>DO NOT hit the CALIBRATE or DEFAULT buttons</u>**.
  c. The ambient temperature from the instrument must be within 2 °C of the measured ambient temperature.

7. Ambient Pressure Sensor Audit
   a. On the instrument, from the TEST menu, select AMBIENT PRESSURE.
      i) **DO NOT hit the CALIBRATE or DEFAULT buttons**.
      ii) Wait for the pressure on the audit standard and instrument to stabilize. Record the BP value from the audit standard while located near the inlet. Record the BP value from the instrument.
      iii) Simply hit the X to get out of the menu. **DO NOT hit the CALIBRATE or DEFAULT buttons**.
   b. The BP value from the instrument must be within 10 mmHg of the measured BP.
8. Leak Check
   a. Remove the PM_{10} head. The $PM_{2.5}$ Very Sharp Cut Cyclone (VSCC) should stay in place if possible.
   b. From the TEST menu, select LEAK TEST.
   c. Place a leak check adapter on the inlet tube and close the valve.
   d. Make sure that the nozzle is down (NOZZLE UP would be showing), if not select NOZZLE DOWN to move the nozzle down.
   e. Turn on the pump by selecting PUMP ON.
   f. Record the flow.
   g. Turn off the pump by selecting PUMP OFF. Carefully open the leak check adapter valve and remove from the inlet tube.
   h. A passing leak check has a flow of less than 1.0 when the leak check adapter is closed.
9. Span Mass Audit
   a. From the TEST menu, select SPAN MASS AUDIT.
   b. You will need a zero and span foil to perform this test.
   c. The filter tape must be loaded. Insert the zero foil above the filter tape, between the nozzle and vane, with the label facing up. When the zero foil is detected, the nozzle will automatically lower on to the foil and the four minute measurement will commence. After four minutes, the nozzle will be raised and the screen will instruct you to remove the zero foil. Remove the zero foil, taking care to minimize the tape movement.
   d. The display will change to the list the current span foil setting. Compare this value to the value on the calibration certificate. It should be correctly entered at the factory, however, if the values do not match, tap the green bordered span value field and enter the value listed on the calibration certificate. Press the grey CONTINUE button.
   e. Now insert the span foil above the filter tape, with the label facing up. When the foil is detected, the nozzle with automatically lower on to the foil and the four minute measurement will commence. After four minutes, the display will change to list the results of the audit. The measured mass will be listed on the top and the programed span value will be in the middle. Record these values on the audit form.
   f. The error between the measured span value and programed span value should be less than 5%.
   g. Press the X button to exit the audit

10. Settings
    a. From the SETUP menu, select CALIBRATION.
       i) Record the BACKGROUND value and exit the screen.

11. Start Sample
    a. From the OPERATE menu, select START SAMPLE
    b. Select START
    c. This will ensure the instrument is sampling again prior to leaving the site.

7.4 Met One SuperSass Audit

There is only one sampler for WDEQ-AQD, which is located at the Cheyenne NCore station.

1. Check EPA sampling schedule and try to perform the audit on a non-sample day. If you must interrupt sampling, document the time stopped and restarted. The sampler is scheduled to run on the 1-in-6 day schedule.
2. Turn on audit flow standard by zeroing the flow (you can ensure zero flow by pressing the opening of the flow standard up against your leg when you turn it on).
3. Attach the temperature probe to the audit flow standard.
4. Date and Time Audit
    a. Record the start time of the audit in MST.
    b. Verify the date and time on the instrument in MST. Record the accuracy on the audit form.
5. Flow Rate Audit
    a. Remove any installed canisters on the instrument, make sure to put the same canister back in the same position it was found.
    b. Insert the audit canister in the instrument position #1 (located inside shelter)
    c. Attach the flow standard to the inlet tube. You will need an adapter for the tube on the flow standard and tubing.
    d. From the main screen, select the CALIBRATE menu.
    e. Select F1: SYSTEM TEST
    f. Turn the PUMP ON
    g. Let the flow rate stabilize on the instrument and audit standard. Record the results under position 1 on the audit form.
    h. Move the audit canister to the next position and repeat. Positions 1-4 on the SuperSass need to be audited as those positions share the same mass flow controller as positions 5-8 and are isolated by solenoid valves.
    i. The sampler is preset to 6.7 LPM. The flow rate from the instrument needs to be within 4% of the measured flow and 5% of the design.
6. Ambient Temperature Sensor Audit
    a. Collocate the audit temperature probe with the external temperature probe near the inlet.
    b. The ambient temperature should be displayed by selecting the CALIBRATE menu.
    c. Select F1: SYSTEM TEST
    d. Let the temperatures on the instrument and audit standard stabilize. Record on Audit form.
    e. The ambient temperature from the instrument must be within 2 °C of the measured ambient temperature.
7. Ambient Pressure Sensor Audit
    a. The ambient pressure should be displayed by selecting the CALIBRATE menu.
    b. Select F1: SYSTEM TEST
    c. Record the BP from the instrument and audit standard on the audit form.
    d. The BP value from the instrument must be within 10 mmHg of the measured BP.

8. Leak Check
    a. Remove any installed canisters on the instrument, make sure to put the same canister back in the same position it was found.
    b. Insert the audit canister in the instrument position #1 (can be found the Shelter)
    c. From the main screen, select the CALIBRATE menu.
    d. Select F1: SYSTEM TEST
    e. Turn the PUMP ON and wait for 5 – 10 minutes for the 6.7 LPM operating point to be reached.
    f. When the operating point has been reached, press the LEAK button to put the unit into leak test mode.
    g. While the pump is operating and the flow values are being displayed on the screen, block off the inlet tube of the audit canister. The FLOW 1 should drop to 0.0 or 0.1. Record this value.
    h. Repeat for all 8 positions.
        i) To see positions 5-8, press the CANS button.
9. Put all canisters back in their original positions.

7.5 URG 3000N Audit

There is only one sampler for WDEQ-AQD, which is located at the Cheyenne NCore station.

1. Check EPA sampling schedule and try to perform the audit on a non-sample day. If you must interrupt sampling, document the time stopped and restarted. The sampler is scheduled to run on the 1-in-6 day schedule.
2. Turn on audit flow standard by zeroing the flow (you can ensure zero flow by blocking the opening when turning on). This audit will require the Tetra Cal. Use of a separate temperature probe is acceptable as long as documented.
3. Date and Time Audit
    a. Record the start time of the audit in MST.
    b. Verify the date and time on the instrument in MST. Record the accuracy on the audit form.
4. Leak Check
    a. A leak check must proceed a Flow Audit.
    b. From the main screen, select F4=MORE
    c. Select F3=AUDIT
    d. Select F1=LEAK CK
    e. Remove routine sample filter in the instrument and place the audit cartridge in the instrument (located inside shelter)
    f. Remove the inlet cap and place a leak adapter in the open position on the top.
    g. Press YES to continue the leak check
    h. Follow the directions on the screen.
5. Flow Rate Audit
    a. Remove routine sample filter in the instrument and place the audit cartridge in the instrument (located inside shelter)
    b. Remove the inlet cap and place a leak adapter in the open position on the top. Using tubing, connect the leak adapter to the Tetra Cal.
    c. From the main screen, select the F4=MORE
    d. Select F3=AUDIT
    e. Select F2=FLOW

   f. Follow instructions on the screen
   g. Let the flow rate stabilize on the instrument and audit standard. Record values on audit form.
   h. The set flow rate is 22.0 LPM.
6. Ambient Temperature Sensor Audit
   a. The ambient temperature should be displayed by selecting the F4=MORE menu from the main menu.
   b. Select F3=AUDIT
   c. Select F3=TEMP.
   d. Follow directions on screen.
   e. Record the ambient temperature from the instrument and audit standard on the audit form.
      i) NOTE: if using the temperature probe from the Tetra Cal, you will have to turn off the Tetra Cal and turn it back on to get a proper reading.
   f. The ambient temperature from the instrument must be within 2 °C of the measured ambient temperature.
7. Ambient Pressure Sensor Audit
   a. The ambient pressure should be displayed by selecting the F4=MORE menu from the main menu.
   b. Select F3=AUDIT
   c. Select F4=BP
   d. Follow directions on screen
   e. Record the BP from the instrument and audit standard on the audit form.
   f. The BP value from the instrument must be within 10 mmHg of the measured BP.
8. Put the sample filter back in the correct way (it should be numbered).

8.0 References

1. Partisol 2000i Air Sampler/Partisol 2000i-D Dichotomous Air Sampler Instruction Manual
2. Met One Instruments, Inc. 2008 BAM 1020 Particulate Monitor Operation Manual, BAM-100-9800 Rev. K
3. Met One Instruments, Inc. BAM 1022 Particulate Monitor Operations Manual, BAM 1022-9800 Rev. F
4. Met One Instruments, Inc. Model Sass and SuperSass $PM_{2.5}$ Ambient Chemical Speciation Samplers Field Operation Manual, Document No. SASS-9800 Rev. J
5. URG 3000N Sequential Particle Speciation System Operations Manual
6. 40 CFR Part 58 Appendix A 3.2.2 Semi-Annual Flow Rate Audit for $PM_{2.5}$
7. 40 CFR Part 58 Appendix A 3.3.2 Semi-Annual Flow Rate Audit for PM_{10}
8. EPA QA Handbook Vol. II Appendix D
9. Environmental Protection Agency, January 2016, Quality Assurance Guidance Document 2.12, Monitoring PM2.5 in Ambient Air Using Designated Reference or Class I Equivalent Methods, EPA-454/B-16-001 (January 2016).

APPENDIX A.4
Particulate Matter Audit Forms

DEQ

$PM_{2.5}$ FRM Audit

Site Name		Auditor		Date	

	Manufacturer	Model	Serial Number	Expiration Date
PM Flow Standard				
PM Temperature Standard				
PM Barometric Pressure Standard				

Manfacturer	
Model	
Serial Number	

Date and Time correct?	Start (MST) of Audit
☐ Yes ☐ No	
If no, time off by:	End (MST) of Audit
0 min	

Settings	
Total Flow	

Flow Verification				
Reference	Instrument	Actual Diff	Design Diff	P/F

Audit Criteria	
Actual Flow % Diff	4%
Design Flow % Diff	5%
Temperature Difference (°C)	2
Pressure Difference (mmHg)	10

Automated/Manual Leak Check	
Vaccum Loss Rate	P/F

Ambient Temperature (°C)			
Reference	Instrument	Difference	P/F

Filter Temperature (°C)			
Reference	Instrument	Difference	P/F

Pressure (mmHg)			
Reference	Instrument	Difference	P/F

Notes:	

DEQ

PM_{10} FRM Audit

Site Name		Auditor		Date	

	Manufacturer	Model	Serial Number	Expiration Date
PM Flow Standard				
PM Temperature Standard				
PM Barometric Pressure Standard				

Manfacturer	
Model	
Serial Number	

Date and Time correct?	Start (MST) of Audit
☐ Yes ☐ No	
If no, time off by:	End (MST) of Audit
0 min	

Settings	
Total Flow	

Flow Verification				
Reference	Instrument	Actual Diff	Design Diff	P/F

Audit Criteria	
Actual Flow % Diff	10%
Design Flow % Diff	10%
Temperature Difference (°C)	2
Pressure Difference (mmHg)	10

Automated/Manual Leak Check	
Vaccum Loss Rate	P/F

Ambient Temperature (°C)			
Reference	Instrument	Difference	P/F

Filter Temperature (°C)			
Reference	Instrument	Difference	P/F

Pressure (mmHg)			
Reference	Instrument	Difference	P/F

Notes:	

DEQ

BAM 1020/1022 Audit ($PM_{2.5}$)

Site Name		Auditor		Date	

	Manufacturer	Model	Serial Number	Expiration Date
PM Flow Standard				
PM Temperature Standard				
PM Barometric Pressure Standard				

Manfacturer	
Model	
Serial Number	

Date and Time correct?	Start (MST) of Audit
☐ Yes ☐ No	
If no, time off by:	End (MST) of Audit
0 min	

Settings	
Total Flow	
Background	

Flow Verification				
Reference	Instrument	Actual Diff	Design Diff	P/F

Leak Check		
Pump off	Stopcock Closed	P/F

Temperature (°C)			
Reference	Instrument	Difference	P/F

Audit Criteria	
Actual Flow % Diff	4%
Design Flow % Diff	5%
Leak Check Flow (LPM)	1.0
Temperature Difference (°C)	2
Pressure Difference (mmHg)	10
Reference Membrane % Diff	5%

Pressure (mmHg)			
Reference	Instrument	Difference	P/F

Reference/Span Membrane Check			
Target	Instrument	Difference	P/F

Notes:	

BAM 1020 Audit (PM_{10})

Site Name		Auditor		Date	

	Manufacturer	Model	Serial Number	Expiration Date
PM Flow Standard				
PM Temperature Standard				
PM Barometric Pressure Standard				

Manfacturer	
Model	
Serial Number	

Date and Time correct?	Start (MST) of Audit
☐ Yes ☐ No	
If no, time off by:	End (MST) of Audit
0 min	

Settings	
Total Flow	
Background	

Flow Verification				
Reference	Instrument	Actual Diff	Design Diff	P/F

Leak Check		
Pump off	Stopcock Closed	P/F

Temperature (°C)			
Reference	Instrument	Difference	P/F

Audit Criteria	
Actual Flow % Diff	10%
Design Flow % Diff	10%
Leak Check Flow (LPM)	1.0
Temperature Difference (°C)	2
Pressure Difference (mmHg)	10
Reference Membrane % Diff	5%

Pressure (mmHg)			
Reference	Instrument	Difference	P/F

Reference Membrane Check			
Target	Instrument	Difference	P/F

Notes:	

Met One SASS / SuperSASS Audit ($PM_{2.5}$)

Site Name		Auditor		Date	

	Manufacturer	Model	Serial Number	Expiration Date
PM Flow Standard				
PM Temperature Standard				
PM Barometric Pressure Standard				

Manfacturer	
Model	
Serial Number	

Date and Time correct?	Start (MST) of Audit
☐ Yes ☐ No	
If no, time off by:	End (MST) of Audit
0 min	

Settings	
Total Flow	

Leak Checks		
Channel	Flow	P/F
1		
2		
3		
4		
5		
6		
7		
8		

Flow Verification					
Channel	Reference	Instrument	Actual Diff	Design Diff	P/F
1 and 5					
2 and 6					
3 and 7					
4 and 8					

Audit Criteria	
Actual Flow % Diff	5%
Design Flow % Diff	5%
Leak Check Flow (LPM)	0.1
Temperature Difference (°C)	2
Pressure Difference (mmHg)	10

TEMPERATURE SENSOR (°C)			
Reference	Instrument	Difference	P/F

PRESSURE SENSOR (mmHg)			
Reference	Instrument	Difference	P/F

NOTES:	

APPENDIX B: Ancillary Information

Wyoming Department of Environmental Quality – Air Quality Division

Appendix B – Ancillary Information For Particulate Matter Monitoring

October 2023
Revision 2.0

1.0 Instrument Locations

This table is based on the current WDEQ-AQD Ambient Air Monitoring Stations and Operations. For Historic locations, see **Figure 1** in the QAPP.

Table 1. Monitoring Station Details

Station Name	AQS ID	Latitude Longitude	AQD Project Manager	Project Manager Contractor	Site Operator
Boulder	56-035-0099	42.71900 - 109.75300	Mark Gagen	Casey Lenhart Trinity Consultants	Meghann Smith
Casper Gaseous	56-025-0100	42.82231 - 106.36501	Leif Paulson	Casey Lenhart Trinity Consultants	Curt Rissler
Cheyenne NCore	56-021-0100	41.18235 - 104.77842	Mark Gagen	Casey Lenhart Trinity Consultants	Paul Bailey/ Leif Paulson
Cody SLAMS	56-029-0001	44.52464 - 109.06851	Jacob Berreth	N/A	Cortney Dekeyser
Converse County	56-009-0010	43.10108 - 105.49896	Jacob Berreth	Casey Lenhart Trinity Consultants	Paul Bailey
Daniel South	56-035-0100	42.79070 - 110.05510	Leif Paulson	Emily Wiechman Air Resource Specialist	Charles Prior/Staff Polk
Gillette SLAMS	56-005-1002	44.288005 - 105.51702	Jacob Berreth	N/A	Paul Bailey
Kemmerer Mobile	56-023-0004	41.783083 - 110.53788	Leif Paulson	Emily Wiechman Air Resource Specialist	Lauren Deverse
Jackson SLAMS	56-039-1006	43.45776 - 110.79799	Jacob Berreth	N/A	Cortney Dekeyser
Johnson County	56-019-0004	43.87483 - 106.50974	Lauren Deverse	Casey Lenhart Trinity Consultants	Paul Bailey
Moxa Arch	56-037-0300	41.75056 - 109.78833	Mark Gagen	Casey Lenhart Trinity Consultants	Contact MSI

Station Name	AQS ID	Latitude Longitude	AQD Project Manager	Project Manager Contractor	Site Operator
Lander SLAMS	56-013-1003	42.84223 -108.73556	Jacob Berreth	N/A	Cortney Dekeyser
Laramie County Mobile	56-021-0004	41.08536 - 104.52277	Leif Paulson	Emily Wiechman Air Resource Specialist	Lauren Deverse
Laramie SLAMS	56-001-0012	41.30882 - 105.54913	Jacob Berreth	N/A	Paul Bailey
Pinedale Gaseous	56-035-0101	42.86982 - 109.87076	Leif Paulson	Casey Lenhart Trinity Consultants	Meghann Smith
Riverton Mobile	56-013-0004	43.02421 - 108.36370	Leif Paulson	Emily Wiechman Air Resource Specialist	Travis Guthrie
Rock Spring SLAMS	56-037-0007	41.59259 - 109.22013	Jacob Berreth	N/A	Cortney Dekeyser
Sheridan SLAMS	56-033-0002	44.81514 - 106.95593	Jacob Berreth	N/A	Paul Bailey
South Pass	56-013-0099	42.53000 - 108.72000	Jacob Berreth	Emily Wiechman Air Resource Specialist	Marty Hamilton
Wamsutter	56-037-0200	41.67771 - 108.02415	Jacob Berreth	Emily Wiechman Air Resource Specialist	Lauren Deverse

2.0 Type of Instruments

The Met One Instruments Model BAM-1020 has been designated by EPA, in accordance with 40 CFR Part 53, an equivalent method for measuring concentrations of particulate matter as PM10 in the ambient air. PM10 concentrations are automatically measured and recorded using beta ray attenuation. At the beginning of each sample hour, a small 14C (carbon-14) element emits a constant source of high-energy electrons (known as beta rays) through a spot of clean filter tape. These beta rays are detected and counted by a sensitive scintillation detector to determine a zero reading. The BAM-1020 then advances this spot of tape to the sample nozzle, where a vacuum pump pulls a measured and controlled amount of outside air through the filter tape, loading it with ambient dust. At the end of the sample hour, this dust spot is placed back between the beta source and the detector, thereby causing an attenuation of the beta ray signal which is used to determine the mass of the particulate matter on the filter tape. This mass is used to calculate the volumetric concentration of PM10 in ambient air. The BAM carries a US EPA designation of EQPM-0798-122.

The Met One Instruments Model BAM-1020, equipped with a VSCC cyclone, has been designated by EPA, in accordance with 40 CFR Part 53, an equivalent method for measuring concentrations of particulate matter as PM2.5 in the ambient air. PM2.5 concentrations are automatically measured and recorded using beta ray attenuation. At the beginning of each sample hour, a small 14C (carbon-14) element emits a constant source of high-energy electrons (known as beta rays) through a spot of clean filter tape. These beta rays are detected and counted by a sensitive scintillation detector to determine a zero reading. The BAM-1020 then advances this spot of tape to the sample nozzle, where a vacuum pump pulls a measured and controlled amount of outside air through the filter tape, loading it with ambient dust. At the end of the sample hour, this dust spot is placed back between the beta source and the detector, thereby causing an attenuation of the beta ray signal which is used to determine the mass of the particulate matter on the filter tape. This mass is used to calculate the volumetric concentration of PM2.5 in ambient air. The BAM carries a US EPA designation of EQPM-0308-170.

The two BAM-1020 units are also be operated together as an EPA-designated PM10-2.5 coarse method with a US EPA designation of EQPM-0709-185.

The Met One Instruments Model BAM 1022 Continuous PM Monitoring System utilizes the principle of beta ray attenuation to accurately measure and report the concentration of airborne particulate matter (PM) in ambient air. The centerpiece of the measurement system consists of a beta source that emits a consistent supply of electrons and a sensitive detector that counts the incident electrons. A vacuum pump draws air through a size-selective inlet, down the inlet tube, and deposits the airborne particulate on a filter tape that is located between the beta source and detector. The accumulation of mass onto the filter tape increasingly attenuates beta ray transmission through the media. Beta attenuation through the filter tape is continuously monitored throughout the measurement cycle. The degree of beta ray attenuation is used to determine the mass of particulate matter deposited on the filter tape. During sampling, the flow rate is precisely controlled. For proper performance, the BAM 1022 must be operated outdoors and should not be installed inside of a building, trailer, or other shelter. It must be allowed to run at ambient conditions. This is required for the BAM 1022 to operate as a U.S. EPA PM2.5 Class III Equivalent Method monitor. The BAM 1022 Beta Attenuation Mass Monitor is US-EPA designated for PM2.5 under the following designation number: EQPM-1013-209 (PM2.5 with BGI/Mesa Labs VSCC™).

The Partisol 2000i Air Sampler was designed to conform to the U.S. EPA Federal Reference Method for fine particulate sampling. The hardware was designed meet or exceed the requirements of CFR 40 Part 50 Appendix L and related drawings supplied by the U.S. EPA. The Partisol 2000i uses standard 47 mm filters and a variety of filter materials are available in this size. The type of filter media used for sampling depends on the specific requirements of the samples being collected. The U.S. EPA requires the use of Teflon® filters. PM10 sampling is typically performed using TX40, quartz fiber, or Teflon filters.

Table 2. Site-Specific PM Analyzer Details

Station Name	Instrument Make/Model	Serial Number	Calibrated Range (ppb)	Audit Frequency	EPA Method Code*
Boulder	Met One BAM 1020 (PM10)	K1553	N/A	Quarterly	122
Casper Gaseou s	Met One BAM 1020 (PM2.5)	H6763	N/A	Semi-annually	170
Cheyenne NCore	Met One BAM 1020 (PM2.5)	K17586	N/A	Quarterly	170
Cheyenne NCore	Met One BAM 1020 (PM10)	K1388	N/A	Quarterly	122
Cheyenne NCore	Thermo Scientific 2000i (PM2.5)	20748	N/A	Quarterly	143
Cheyenne NCore	Thermo Scientific 2000i (PM2.5)	20725	N/A	Quarterly	143
Cheyenne NCore	Thermo Scientific 2000i (PM2.5)	20378	N/A	Quarterly	143
Cody SLAMS	Met One BAM 1022 (PM2.5)	A24233	N/A	Semi-annually	209
Converse County	Met One BAM 1020 (PM10)	R19478	N/A	Semi-annually	122
Daniel South	Met One BAM 1020 (PM10)	U11743	N/A	Semi-annually	122
Gillette SLAMS	Met One BAM 1022 (PM2.5)	A18624	N/A	Semi-annually	209
Kemmerer Mobile	Met One BAM 1020 (PM2.5)	K1792	N/A	Semi-annually	170
Kemmerer Mobile	Met One BAM 1020 (PM10)	K1794	N/A	Semi-annually	122
Jackson SLAMS	Met One BAM 1020 (PM2.5)	N15087	N/A	Semi-annually	170
Jackson SLAMS	Met One BAM 1020 (PM10)	W14701 (In for repairs)	N/A	Semi-annually	122
Jackson SLAMS	Met One BAM 1022 (PM2.5)	A24237 (spare)	N/A	Semi-annually	209
Johnson County	Met One BAM 1020 (PM10)	U12345	N/A	Semi-annually	122
Lander SLAMS	Met One BAM 1022 (PM2.5)	A21149	N/A	Semi-annually	209
Laramie County Mobile	Met One BAM 1020 (PM2.5)	K1791	N/A	Semi-annually	170
Laramie County Mobile	Met One BAM 1020 (PM10)	K1792	N/A	Semi-annually	122

Station Name	Instrument Make/Model	Serial Number	Calibrated Range (ppb)	Audit Frequency	EPA Method Code*
Laramie SLAMS	Met One BAM 1022 (PM2.5)	A13659	N/A	Semi-annually	209
Laramie SLAMS	Partisol 2000i (PM2.5)	20711	N/A	Semi-annually	143
Moxa Arch	Met One BAM 1020 (PM10)	K1079	N/A	Semi-annually	122
Pinedale Gaseous	Met One BAM 1020 (PM2.5)	DN13728	N/A	Semi-annually	170
Riverton Mobile	Met One BAM 1020 (PM2.5)	K1793	N/A	Semi-annually	170
Riverton Mobile	Met One BAM 1020 (PM10)	K1795	N/A	Semi-annually	122
Rock Springs SLAMS	Met One BAM 1022 (PM2.5)	A21159	N/A	Semi-annually	209
Sheridan SLAMS	Met One BAM 1020 (PM2.5)	P16083	N/A	Semi-annually	170
Sheridan SLAMS	Met One BAM 1020 (PM10)	N15087	N/A	Semi-annually	122
Sheridan SLAMS	Met One BAM 1022 (PM2.5)	A18624	N/A	Semi-annually	209
South Pass	Met One BAM 1020 (PM2.5)	K1552	N/A	Semi-annually	170
Wamsutter	Met One BAM 1020 (PM10)	U12347	N/A	Semi-annually	122

3.0 AQS Coding

AQS numbers are assigned for each monitoring station and parameters. **Table 3** illustrates the AQS code used for the WDEQ-AQD program. A sample of the AQS raw data is presented below. Please note all data submitted to AQS is pipe-delimited.

```
RD|I|56|021|0100|44201|1|1|007|087|20181001|00:00|5.0||||||||||||||||
RD|I|56|021|0100|44201|1|1|007|087|20181001|00:00|5.0||||||||||||||||
RD|I|56|021|0100|44201|1|1|007|087|20181001|00:00|8.0||||||||||||||||
RD|I|56|021|0100|44201|1|1|007|087|20181001|00:00|9.0||||||||||||||||
RD|I|56|021|0100|44201|1|1|007|087|20181001|00:00|3.0||||||||||||||||
RD|I|56|021|0100|44201|1|1|007|087|20181001|00:00|9.0||||||||||||||||
RD|I|56|021|0100|44201|1|1|007|087|20181001|00:00|0.0||||||||||||||||
```

The column order is defined as follows in **Table 3**:

Table 3. Example Transaction Codes for AQS

Fields	Example
Transaction Type	RD (Raw Data Type)
Action Indicator	I (Insert)
State Code	56 (Wyoming)
County Code	021 (Laramie)
Site ID	0100 (NCORE)
Parameter Code	44201
POC	1
Duration Code	1 (Hourly)
Reported Unit Code	007 (parts per million)
Method Code	See Table 2*
Date	YYYYMMDD
Sample Time	HH: MM (hour- beginning)
Reported Sample Value	
Qualifier Code - Null Data	AN
Monitor Protocol ID	(N/A)
Qualifier Code	Up to ten (10) permitted