STATEWIDE STANDARD OPERATING PROCEDURE FOR MET ONE E-BAM PLUS SEMI-CONTINUOUS PM_{10} MONITOR

DEP 03-24

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF AIR MONITORING

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REVISION HISTORY

Revision No.	Date	Responsible Person	Description of Change
0	June 2018	PQAO	Initial Release
1	June 2021	PQAO	Revision: Including update of warning and critical limits and audit limits to those for PM10, leak check limits, required and recommended flow verification frequency, rearrangement of sections for installation and calibration/verifications, and clarifications for better flow of document.
2	May 2022	PQAO	Added semi-annual audit information and associated form to Section 11 and Appendix F respectively.

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to document the procedures used in the State of Florida for local ambient air monitoring organizations to measure PM10 concentrations using the Met One Environmental Beta Attenuation Monitor Plus (E-BAM Plus). This SOP is designed to provide a set of uniform protocols for installation, routine operation, maintenance, calibration, quality control (QC), and quality assurance (QA) of the Met One E-BAM PLUS Continuous Ambient Particulate Monitor for data collection. This document is not designed to cover all the technical details that are included in the E-BAM Plus instruction manual or quality assurance information in 40 Code of Federal Regulations (CFR) Parts 50, 53, and 58, and other related reference materials.

2.0 SCOPE AND APPLICABILITY

The E-BAM PLUS is designed as a simple, compact, and self-contained beta gauge, for portable applications where rapid deployment and short interval real-time measurements are required. In addition to the main housing, the monitor includes an external AC pump, a multi- parameter ambient sensor, and a mounting tripod.

The procedures in this document are based on instructions contained in the manufacturer's manual and requirements in Appendix A to 40 CFR part 58, 40 CFR part 53 and 40 CFR 50 Appendix L, as well as the FDEP Particulate Matter Quality Assurance Project Plan and Data Handling and Data Validation SOP. They are intended for use by the operator during routine, periodic, and unscheduled visits to the monitoring station.

2.1 PM10 FEM Requirements

The E-BAM Plus is a U.S. EPA Federal Equivalency Method for PM10 under Designation Number EQPM-1215-226 as of January 26, 2016. It is configured for 24 1-hour average measurements of PM10 by beta attenuation, using a glass fiber filter tape roll (460130 or 460180), a sample flow rate of 16.67 liters/min, with the standard (BX-802) EPA PM10 inlet (meeting 40 CFR 50 Appendix L specifications) and equipped with 9250 ambient temperature sensor. The monitor must be operated in accordance with the E-BAM + Particulate Monitor operation manual, revision 1 or later. Verify CONCENTRATION TYPE calculation setting is STANDARD. Additionally, theTIMESTAMP must be set to BEGINNING so that concentration data correspond with thehour during which it was collected.

IMPORTANT: Before beginning any operation described in this document, ensure that any related manuals and SOPs are available for reference.

3.0 SUMMARY OF THE METHOD

The E-BAM PLUS uses the principle of beta ray attenuation to automatically measure and record airborne PM10 particulate concentration levels. It provides a simple determination of concentration in units of milligrams of particulate per cubic meter of air. Reporting units are

set to microgram per cubic meter of air. A small 14C (Carbon 14) element emits a constant source of high-energy electrons known as beta rays. The beta rays are detected and counted by a sensitive scintillation detector. The vacuum pump pulls a measured amount of dust-laden air through the BX-802 PM10 inlet (at 16.67 liters/min). This air flows through the filter tape which is positioned between the source and the detector thereby causing an attenuation of the beta ray signal. The degree of attenuation of the beta ray signal is used to determine the mass concentration of particulate matter on the filter tape and the volumetric concentration of particulate matter in ambient air.

NOTE: An in-depth scientific explanation of the theory of operation, its related equations and measurement cycles is included toward the back of the manufacturer's manual.

4.0 DEFINITIONS AND CONVERSION FACTORS

Most of the technical terms in this SOP are defined and listed below so that their meaning is made clear in context:

Audit - is often used in a generic way to mean check, inspect, examine, or assess, and many SOPs use the term to refer to QC procedures, such as flow checks or leak checks, that are carried out by field operators during the course of normal operations and maintenance.

Calibration- is the comparison of a measurement standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustment.

Certified Calibration Transfer Standard (CTS) – used to verify or calibrate the flow, temperature or pressure sensors.

Quality Control (QC) - refers to the operational techniques and activities used to fulfill the requirements for quality control.

Quality Assurance (QA) - refers to the planned or systematic activities used to provide confidence that the requirements for quality are fulfilled. An independent audit is an example of a QA activity. QA protocols determine whether the QC procedures are adequate.

Verification - review of interim work steps to ensure they are acceptable and to determine whether the system is consistent, adheres to standards, uses reliable techniques, and performs the selected functions in the correct manner.

Validation - determining whether the system complies with requirements, performs the functions for which it is intended, and meets the organization’s goals and user needs. It is a determination of correctness of the data and is usually performed only periodically (e.g., quarterly) or at the end of a project.

5.0 HEALTH AND SAFETY PRECUATIONS

Safety precautions should be followed during the setup and operation of the E-BAM Plus. General safety rules regarding electricity and power tools should be observed. Users of the E-

BAM PLUS need to be aware that it contains a radioactive component. The following paragraph is a direct quote from the E-BAM PLUS-9800 Operation Manual (Rev C):

> *"The Met One Instruments E-BAM PLUS contains a small ^{14}C (Carbon 14) beta radiation-emitting source. The activity of the source is 60 microcuries, which is below the "Exempt Concentration Limit" as defined in 10 CFR Section 30.71 – Schedule B. The owner of an E-BAM PLUS is not required to obtain any license in the United States to own or operate the unit. The owner of an E-BAM PLUS may elect to return the entire unit to Met One Instrumentsfor recycling of the ^{14}C source when the unit has reached the end of its service life, although the owner is under no obligation to do so. Under no circumstances should anyone but factory technicians attempt to remove or access the beta source. The beta source has a half-life of about 5730 years and should never need to be replaced unless it becomes damaged or corroded. Neither the ^{14}C source nor the beta particle detector are serviceable in the field. Should these components require repair or replacement, the E-BAM PLUS must be returnedto the factory for service and recalibration. The E-BAM PLUS is manufactured in compliance with the U.S. NRC safety criteria in 10 CFR 32.27."*

If the E-BAM PLUS is to be installed more than three meters above ground level, then the tripod legs must be bolted down to prevent the unit from falling to the ground. An accidental fall of more than three meters may compromise the containment of the radioactive source and the unit will need to be returned to the factory for testing. In addition, dropping the E-BAM PLUS from any height will cause a potential safety hazard for those below, and may damage the unit beyond repair. The E-BAM PLUS tripod should be secured to the mounting surface in windy conditions to prevent the unit from falling over, even at ground level. This is especially important in winds over 30 mph. If the tripod legs cannot be bolted down, then the tripod legs may be weighted down with sandbags to secure the unit.

6.0 INTERFERENCES

To avoid possible errors in the concentration measurements, the inlet must be located as far as possible from any artificial sources of particulate matter, such as blowers, vents, or air conditioners on a rooftop, especially if any of these types of devices blow air across the inlet of the E-BAM PLUS. Even sources of filtered air must not be blown across the inlet. Proper site selection for the E-BAM PLUS is critical for accurate measurements. In many cases, theseitems must be correctly addressed in order for the collected data to be acceptable for regulatory requirements, such as FEM, ARM or SPM methods. U.S. EPA Specifications for the site selection can be found in the EPA document 40 CFR, Part 58 Appendix E.

7.0 PERSONNEL QUALIFICATIONS

Installation, operation, maintenance, repair and calibration of the instrument and all support equipment should only be performed by properly trained personnel. Training documentation will be maintained by each agency. All field personnel should be familiar with environmental field measurement techniques. Operators must be very conscientious and attentive to detail in order to report complete and high-quality PM10 data. Persons qualified to perform PM10 field operations should be able to:

- Operate the PM_{10} sampler, including familiarization with the manufacturer's instruction manual prior to attempting any operation.
- Calibrate, audit, and troubleshoot the PM_{10} sampler; and use common methods to determine temperature, pressure, and flow rate.
- Understand the operation and use of temperature, pressure and humidity calibration instruments, following ancillary equipment manuals and SOPs when available.

NOTE: It is recommended that operators read the manufacturer's instruction manual supplied with the monitor to become familiar with the various controls and components prior to attempting any operation described in this procedure. The manufacturer's manual contains useful operation, maintenance, and diagnostic information that may not be contained in this SOP.

8.0 EQUIPMENT AND SUPPLIES

The following equipment and supplies are necessary for ambient air monitoring of PM10 with the E-BAM PLUS particulate monitor.

- Certified Transfer Standards (CTS)
  - Flow Meter - Used to verify sample flow rate duringflow verifications and calibrations.
  - Thermometer – Used to verify or calibrate the monitor's temperature sensor.
  - Barometer – Used to verify or calibrate the monitor's barometric pressure sensor.
- Sample filter tape - as specified in the EPA designation for the E-BAM PLUS.
- USB 2.0 flash Drive – Used to download stored record types (routine data collection)
- Computer – Equipped with data processing spreadsheet to convert E-BAM Plus data to AQS format. The computer is also used for electronic documentation of calibrations, checks, maintenance, and other operations using MS-Excel or other software.
- Logbooks, Log Forms, etc. –Approved forms and spreadsheets to accommodate all pertinent information in an organized manner.
- Spare parts or accessories, as needed. The Tables and figure below show common ones.

Table 8-1. Items supplied with a standard E-BAM PLUS PM10 FEM

Component	Part Number
Mounting Tripod	EX-905
External AC Pump Box	EX-225 (120 VAC) or EX-226 (230 VAC)
PM10 Size Selective Inlet	BX-802
Inlet Tube (10 inches)	81183
Ambient Combination Sensor (AT, BP, RH)	597 w/ 82170 Cable Assembly
Filter Tape	460180
Accessory Kit*	82388

Table 8-2. Parts available from Met One for maintenance, replacement, service, and upgrades

Category	Components	Part Number	Graphic
Consumables	Filter Tape Roll, Glass Fiber, 30 mm x 21 m	**460180**	
	Filter Tape Core Tube, Grey Plastic	**8150**	
	Cotton-Tipped Applicators, nozzle cleaning, 100 pack Solon #362	**995217**	
	0.2 Micron Sheath Air Filter	**460182**	
	5 Micron Filter (Used for the Sheath Air Pre-Filter and Flow Sensor Debris Filter	**580345**	
	O-Ring, Nozzle, 1 required	**720066**	
	O-Ring, Inlet Tube Receiver, 4 required	**720069**	
	O-Ring Kit, for BX-807 Cyclone, set of 6	**720097**	
	O-Ring Kit, for BX-802 PM10 Head, set of 3	**8965**	
Tools	Zero Filter Calibration Kit, with valve Same as BX-305 but with 0.2 micron filter	**BX-302**	
	Volumetric Flow Calibration Kit (BGI deltaCal™) Flow, Temp, and Pressure Reference Standards Met One recommended flow audit meter	**BX-307**	
Flow System Components	E-BAM PLUS External Pump Option, 115 VAC	**EX-225**	
	E-BAM PLUS External Pump Option, 230 VAC	**EX-226**	
	Flow Sensor, Mass, 0-200 LPM, Internal Assembly	**970611**	
	Filter RH Sensor, Replacement Only	**8624**	
	Filter Temperature Sensor, Replacement Only	**8131**	
Inlet Components	PM10 Inlet Head, EPA Specified	**BX-802**	
	TSP Sampling Inlet Cap, Harsh Environment with insect screen and rain cap	**BX-803**	
	FRM Inlet Tube, E-BAM PLUS, Aluminum, 10 inches	**81183**	

Figure 8.1. Accessory Kit (PN 82388)

Table 8-3. Parts in Accessory Kit (PN 82388)

Description	*Part Number*	*Initial Qty.*
Pipe Seal Assembly	***8119***	1
FRM Inlet Tube, E-BAM PLUS, Aluminum, 10 inches	***81183***	1
6" Applicator, Wooden, Cotton Tip, Pack of 10	***995217***	1
Fuse, Glass Tube, 3AG, 15 Amp, Time Delay	***590842***	2
Rubber Nozzle Seal Tool	***7440***	1
Grounding Cable	***9035***	1
Comet Software CD	***80248***	1
Span Foil Set (includes zero and span tools)	***82393***	1
USB Cable, A-B	***500784***	1
Tubing, Polyurethane, 6.5 mm ID x 10 mm OD	***960025***	6 FT
Flow Inlet Adapter Kit (Leak Test Valve with coupler)	***BX-305***	1
Tubing, 1/4" ID X 3/8" OD, Clear Tygon	***960200***	18 IN
Filter Tape	***460180***	1

9.0 INSTALLATION AND STARTUP

9.1 Unpacking

Ensure all items on the packing list are present. Retain original shipping boxes for sampler relocation and/or shipment to Met One. Any damage incurred to the equipment during shipping are the responsibility of the carrier. Be sure to follow any special unpacking instructions provided by the carrier and inspect each component. It is recommended to document and photograph all damaged packages during the process of unpacking. If damage occurred, contact Met One Instruments (see section 12.5 of the Monitor's Manual, Technical Support) to arrange for replacement items.

The E-BAM PLUS is shipped with the plastic shipping shim installed under the nozzle which prevents the moving parts of the vane assembly from being damaged in transit. The shim must be installed anytime the mass monitor is being transported to avoid damaging the vane control mechanism. In addition, do not ship or transport the E-BAM PLUS with filter tape installed.

9.2 Equipment Assembly

Be sure to use the supplied parts and tools for assembly. Refer to the photos and diagrams below to assemble the unit:

9.2.1 Remove the three stainless steel detent pins from the tripod base, unfold the legs, and reinsert the pins. Ensure the tripod is rigid and stable. See Figure 9-1.

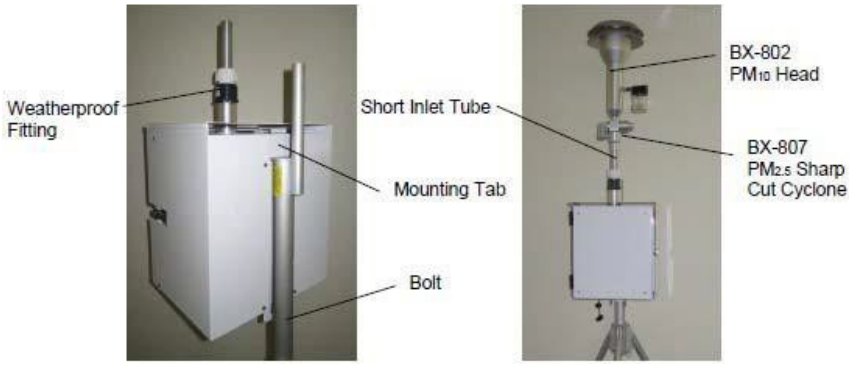
Figure 9-1. Tripod Deployment

9.2.2 Lift the E-BAM Plus assembly and slide the slot on the back of the E-BAM Plus over the tab on the top of the tripod. Insert the ¼-20 bolt through the tab on the bottom of the E-BAM PLUS and through the hole in the body of the tripod. Secure it with the washer and nut to prevent shifting of the assembly on the tripod.

9.2.3 Loosen the weatherproof fitting on top of the E-BAM Plus and insert the short inlet tube into the top of the unit. The tube must go through the fitting and the two O-rings in the top of the E-BAM Plus. Rotate the tube back and forth to ensure it is seated properly. Tighten the weatherproof fitting to secure the inlet tube. Install the BX-802 PM10 inlet directly onto the top of the short inlet tube.

Lubricate the O-rings as necessary.

Figure 9-2. Tripod Mounting of the E-BAM PLUS



9.2.4 Connect the 597 sensor to the post on the back of the tripod facing away from the monitor as shown in Figure 9-3 below.

Figure 9-3. Mounting the 597 Sensor

9.2.5 Refer to the manufacturer's operation manual on assembly of the Optional Wind Sensor.

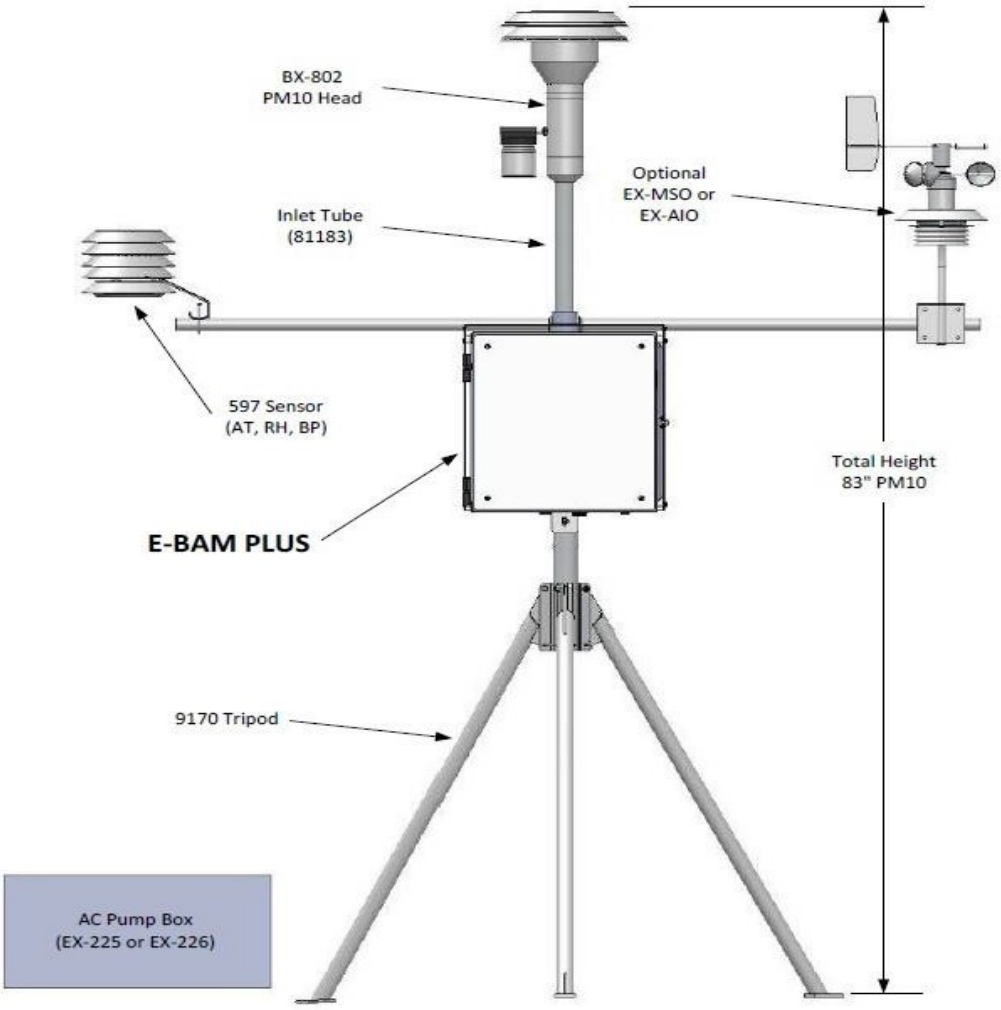
9.2.6 The external pump box enclosure sits on the ground under the tripod. Plug the Pump Box Power cable into the Pump Box Power connector on the E-BAM PLUS. This will provide DC power to the monitor, alarm signal outputs and controls for regulating the flow.

***CAUTION**: Prevent the pump from ingesting water or foreign materials by providing a raised platform to lift the box up off the ground in adverse conditions.*

9.2.7 Connect the 10 mm OD vacuum tubing from the monitor to the pump box.

Figure 9-4. Connecting the EX-225 or EX-226 Pump Box

Figure 9-5. E-BAM PLUS Topology

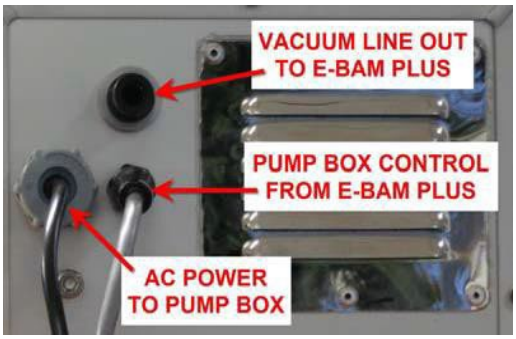


9.3 Electrical Connections

The E-BAM PLUS has a set of weatherproof connectors on the bottom of the unit. These connectors provide the connections for the power supply, external sensors, communications, and control of the external pump box. The E-BAM PLUS must have a 597-sensor connected and properly configured for operation. If the 597 is not present, the E-BAM PLUS will not begin sampling. The E-BAM PLUS chassis ground lug should be connected to an earth ground whenever possible, to reduce electrical noise in the unit.

Figure 9-6. E-BAM PLUS Connectors

Figure 9-7. E-BAM PLUS Pump Box



NOTE: Refer to the manufacture's operation manual (Section 2) for diagrams of connector pin functions, and details concerning the configuration of external sensors.

9.4 Startup

The E-BAM PLUS is designed to turn on automatically when power is applied and will prompt you through several set-up screens

9.4.1 Power-up and Automatic Operation

The unit will ask if you are ready to start, then will prompt you to verify several setup parameters. An automatic self-test routine will follow which takes several minutes. After the self-test, the unit will begin sampling automatically.

Note: *If no user activity is detected for several minutes after power-up, the E-BAM PLUS will automatically begin sampling based on the existing SETUP options and settings, as long as filter tape is installed and no hardware or voltage failures are detected.*

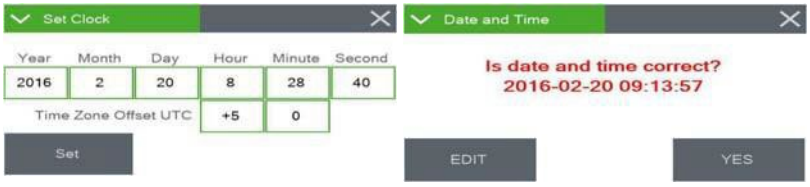
9.4.2 Power-up Settings Verification and Automatic Self-Test

A. The E-BAM PLUS will prompt you to verify several setup parameters whenever it is powered on. These setup screens can also be viewed or editedin the SETUP menu under the main E-BAM PLUS menu system. Once the unit powers it will show the startup splash screen for the touchscreen displayfor a moment, then display the welcome screen. Press the YES button and theclock screen will display as shown in Figure 9-8.

Figure 9-8. Welcome Screen

B. If the time and date are correct, press the YES button again. If the date or time are incorrect, press the EDIT button. Press the green box of the field you wish to modify. A numerical entry keypad will show and allow you to enter the value for that parameter. Once all fields have been entered, press the grey Set button in the lower left corner to save. See Figure 9-9.

Figure 9-9. Verifying the Clock



C. After the time is verified, the unit will display the Settings screen shown in Figure 9-10. Data Average should be set to 1 HR. If the settings need to be changed, press the green bordered value box to update. The associated edit screen will be displayed. It is imperative this menu be set correctly, see manual for detailed descriptions of parameters. Press OK once settings are correct.

Figure 9-10. Verifying the Averaging Time

D. After confirming or setting the Location and Data Average settings, the setup proceeds to the PM Inlet screen shown in Figure 9-11. Concentration Type should be set to STANDARD. If settings are incorrect, press the green bordered value box to update. This menu must also be set up correctly. See manual for detailed descriptions of these parameters. Press OK once settings are correct.

Figure 9-11. Verifying theConcentration Type

E. After verifying the CONCENTRATION TYPE, the E-BAM PLUS will check if filter tape is installed. Remove the shipping vane if installed. The monitor will then check the tape installation. If no tape is detected, the unit will prompt you to install a new roll.

F. Install a roll of filter tape as described below. When the filter tape is installed, press MOVE. The unit will again try to detect the tape. If tape is detected, the unit will proceed with a self-test. After a successful self-test, the monitor will wait for one minute and then begin sampling.

Figure 9-12. Verifying Filter Tape is loaded

9.4.3 Filter Tape Loading

Filter tape must be loaded into the E-BAM PLUS for sampling. Make sure to have spare rolls of tape available to avoid data interruptions. Used filter tape should never be “flipped over” or re-used. This will result in inaccurate measurements!

Follow the steps below to load filter tape:

A. If the vane is in the up position, it will need to be lowered. Enter the Load Filter Tape screen in the Operate menu. The unit will lower the vane and prompt you to load the tape.
B. If you are replacing a used roll of tape remove the old roll, thoroughly clean the nozzle and vane crosshairs with a cotton-tipped applicator and isopropyl alcohol.
C. The empty core tube must be installed on the left reel hub. This provides a surface for the used tape to spool-up. Met One supplies a plastic core tube to use with the first roll of tape. After that, use the empty cardboard core tube left from the last roll used. Never fasten the filter tape directly to the aluminum hub.
D. Load the new roll of filter tape onto the right reel and place the tape through the nozzle area as shown in Figure 9-13. Attach the loose end of the filter tape to the empty core tube with tape.
E. Rotate the tape roll to remove excess slack, then install the plastic spool covers tightly.
F. Press the grey MOVE button to verify tape is properly loaded.
G. Press the X button to return to the Operate menu

Figure 9-13. Proper Loading of the Filter Tape

9.4.4 Setup Menu

The Setup Menu grants access to the configuration of the majority of the operating parameters for the E-BAM PLUS. It allows you to change offsets, clear the memory, set the date and time, and much more. Because of the changes able to be made, the Setup Menu is password protected.

Note: *The display has a limited amount of space and cannot show all options on one screen. Tap the ">More…" and ">Back…" keys in the lower right corner of the display to navigate between the screens.*

A. Background

The background value is the zero correction (offset) for the E-BAM

PLUS concentrations. It is applied to all data collected to compensate for measured mass in the absence of any particulate matter. This screen allows you to edit your background zero correction factor after performing a zero test with the BX-302 Zero Filter.

Steps to edit background information are listed below:

1. Press the green bordered value box and the numerical entry keypad will be displayed.
2. Enter the new calculated correction factor. Regardless of the concentration units setting, the background is always entered in units of mg/m^3. Met One supplies the E-BAM PLUS with a factory-set background value. Use the BX-302 zero filter kit to audit the background value and set it for local conditions. See the BX-302-9800 manual for the zero-test procedure or contact the Met One Instruments service department for more information.

   WARNING: This calibration value may significantly affect the accuracy of the unit. *The grey ADVANCED button in the lower left corner provides access to the K factor setting for the E-BAM PLUS. This should* ***NOT*** *be adjusted unless directed by factory personnel. It is set at the factory and altering it will void the unit's calibration.*

B. Hourly Reporting

The hourly report time stamp can be set to mark the data with the time from either the beginning or ending of the hour. The factory default setting is set to ENDING. Press the green borderedvalue box and a list of the settings available will be displayed. Tap BEGINNING to use and it will be applied.

NOTE: If set to BEGINNING, data collected during the hour from 8:00 to 9:00 would be marked as 8:00, whereas if set to ENDING the data time stamp would be 9:00.

9.4.5 Warm-Up Period

The E-BAM PLUS must warm up for at least one hour before optimum accuracy of the concentration data can be obtained. This is because the beta detector contains a vacuum tube which must stabilize. This applies any time the unit is powered up after being off for more than a moment. Setups, tests, and flow calibrations can be performed during this warm-up time. The first hour of data should often be discarded or ignored.

9.5 E-BAM PLUS User Interface and Menu System

This section describes the E-BAM PLUS user interface system and describes the functions of the main menu options, including how to view data and errors. The interfaceis a touchscreen display used to control almost all of the features and

functionality of the E-BAM PLUS.

Figure 9-14. The E-BAM PLUS User Interface

9.5.1 Main Operating Screen

In addition to the last hourly concentration reading, this screen shows the current real-time values being measured and the operational state of the E-BAM PLUS. Figure 9-15, show the screens that will normally be displayed on the E-BAM. Due to the limited amount of space on the display it cannot show all ofthe real time data. Tap the down arrow key in the lower left corner of the display to navigate between the four screens.

Figure 9-15. The E-BAM PLUS Main Operating Screens

The table below describes the other parameters visible in the main samplingdisplay. These are all of the logged parameters in the E-BAM PLUS:

Table 9-1. Main Display Parameter Descriptions

Parameter	Description
FLOW	Primary air flow rate in actual LPM.
AT	Ambient temperature in degrees C.
RH	Ambient RH.
BP	External barometric pressure.
FT	Filter temperature in degrees C.
FRH	Internal filter RH.
BV	DC power supply voltage.
WS	Wind speed in meters per second (if equipped).
WD	Wind direction in degrees (if equipped).

Table 9-2. Main Display Parameter Description

Main Menu	*Sub Menu Options*	*Overview*
Operate See section 3.4	Start Sample Load Filter Tape Transfer Data About	Begin or resume monitoring. Load and properly tension the filter tape Download stored data to a USB memory stick Details the current E-BAM PLUS firmware type and version number
Test See section 3.4.5	Leak Test Ambient Temperature Ambient Pressure Flow Calibration Run Self-Test Parameters Filter Sensors Span Mass Audit Tape Test Vane/Count Test Analog Output Cal Analog Output Test Inlet Heater Relay Test Input Test Digital Link	Perform the leak test Calibrate ambient temperature or restore default settings Calibrate ambient pressure or restore default settings Calibrate flow rate or restore default settings Run the E-BAM PLUS Self-Test Review current settings Calibrate filter temp, pressure, and RH or restore default settings Run the zero and span foil tests Verify tape travels expected distance Test vane operation and verify beta counting Calibrate the analog output Test the analog output Manually turn the inlet heater on and off Manually open and close the alarm relay Test the digital clock sync input Test and configure communications with digital sensors
Setup See section 3.6	Set Clock Clear memory Background Serial Port Location Data Average Real-Time Period Hourly Report Analog Outputs Conc. Units Inlet Heater Tape Advance Change Password Sound Volume Touch Calibrate Standard Temp PM Inlet	Set the date and time Clear all stored data Change the concentration offset Set the baud rate and connection type for serial communications Set the location number used to identify the E-BAM PLUS Set the averaging interval for collecting other than hourly data Set the averaging interval for collecting real time data Set the type of time stamp to use for the hourly report Set the parameters for both analog outputs Set the concentration units Set the RH threshold for the inlet heater to activate Set the differential pressure threshold for advancing the filter tape Change the master password Adjust the volume of the touchscreen sounds Calibrate the touch screen Set the Standard Temp to use for standard conditions flow calculations Set sampling (PM_{10}/$PM_{2.5}$) and flow calculation types
Alarms See section 3.7	No sub menu	View alarms

To access the various main menus, press the three horizontal lines in thetop left corner of the screen. A drop-down menu will appear to allow selection of any of the four main menus. See Table 9-2 for menu parameters.

To return to the main operating screen, press the Home icon located in the upper right corner. Some parameters, such as the Date and Time settings or a Location value, require numeric entry. When you press the button to edit, a visual keypad willopen up and allow you to input the value. Press the OK to accept the changes or the Cancel to return to the previous screen. The X key performs as a backspace operation. To cancel and action and return to the previous menu screen, press the X icon located in the upper right corner.

10.0 MONITOR VERIFICATION AND CALIBRATION PROCEDURES

The procedures described in this section are for calibrating the temperature, relative humidity, pressure, volumetric flow, and radiation detector for mass concentration measurements of the E-BAM Plus. The calibrations are performed by the operator upon initial installation of the monitor at an air monitoring station, every 365 days and 1/calendar year, and subsequent to a QC check or instrument audit which exceeds the performance criteria specified in the QAPP and this SOP. If an abnormality in the equipment operation is detected during any calibration, immediately halt the calibration procedure and determine its cause. If corrective action is required to ensure proper operation, the necessary maintenance must be completed before restarting the calibration procedure.

The monitor verifications are conducted at minimum every 30 days (each separated by 14 days). Verifications can be done more frequently, and it is recommended they be performed on a bi-weekly basis to limit potential data loss. During the verifications, an "as-found" leak check, ambient temperature check, ambient pressure check and the flow rate check at 3.0 and 16.7 liters per minute are performed. If any check results are outside the control limits during the verification, troubleshooting and any necessary calibrations must be performed, and form DEP-03-24-C must be completed. An "as-found" leak and flow verification must be performed before any calibration to bracket data prior to any adjustment or calibration that may impact previously collected data. The operator should plan on starting the work 10 minutes past the hour or later (if done within first 10 minutes of the hour the past hour's data average will be affected) and completing the work prior to the beginning of the following hour in order to limit data loss to one hour.

The operator should document all activities (e.g., flow verifications, calibrations, maintenance) on specified forms. The designated quality assurance personnel must review all calibration logs to verify all data entries and determine data validity.

10.1 Routine QC Checks

Routine site visits and associated tasks are essential for maintaining optimal instrument performance. All data pertinent to the bi-weekly maintenance and QC procedures must be documented, using specified forms by either electronic or a hard copy provided in the Appendix. Additionally, monthly (every 2 weeks recommended) monitor's QC checks of flow rate, temperature sensor and pressure sensors are verified against transfer standards to verify operation between monthly maintenance and QC checks.

Routine Monthly QC Checks:

1. Date and Time Check
2. Check for alarms
3. Leak check (as found Sheath and Total)
4. Nozzle and vane cleaning
5. Ambient Temperature Sensor Audit
6. Ambient Barometric Pressure Sensor Audit
7. Sheath Flow Verification
8. Volumetric Flow verification
9. Inspect Water Collector and Seals
10. Transfer Data to USB Flash Drive

Table 10-1. Routine maintenance items and QCprotocols, frequencies, and SOP section references

Maintenance or QC Item	Frequency	SOP Section(s)
Replace the filter tape (for alternative tape advance settings)	**As needed**	**Sec. 9.4.3**
Basic leak check	**30 days or less**	**Sec. 10.2.1**
Nozzle and vane cleaning	**30 days or less**	**Sec. 10.2.2**
Flow audit (verify and/or calibrate flow system)	**30 days or less**	**Sec. 10.2.5**
Clean PM_{10} inlet particle trap	**30 days or less**	**Sec 10.2.6**
Verify or set the clock	**30 days or less**	**Sec 9.4.2**
Mass Audit	**6 Months**	**Sec. 10.4.1**
Background determination	**Annually**	**Sec 10.5.2**
Internal Nozzle Cleaning	**6 Months**	**Sec. 10.4.3**
Replace the pump muffler	**As needed**	**n/a**
Rebuild AC pump	**24 Months**	**n/a**

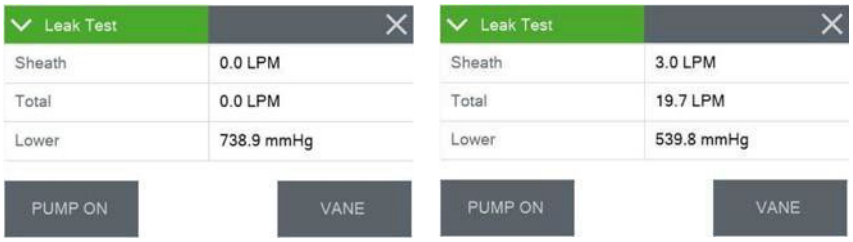
Table 10-2. Quality Control Action and Critical Criteria

QC Check	Tolerance	Class	Procedure
Flow Rate verification	≥ ±4% of transfer standard	Warning	Troubleshoot / re-calibrate
Flow rate verification	≥ ±7% of transfer standard	Control	Troubleshoot/ re-calibrate. Notify supervisor. Data potentially invalidated back to last good QC check
Design Value Flow Verification (Flow Rate = 16.7 LPM)	≥ ±5% of design value over 24 hrs (15.89-17.67 LPM)	Control	Troubleshoot/ re-calibrate. Notify supervisor. Data potentially invalidated.
Leak Check	>1.0 LPM	Warning	Troubleshoot for leaks; re-check.
Leak Check	>1.5 LPM	Control	Troubleshoot for leaks. Notify supervisor. Data potentially invalidated.
Pressure	± 10 mm Hg	Warning	Troubleshoot/ re-calibrate
Temperature	± 2.0 °C	Warning	Troubleshoot/ re-calibrate.

10.1.1 Basic Leak Check

The E-BAM PLUS flow system must be checked for leaks on a bi-weekly basis, after every filter tape change, and before any flow calibrations are performed.

Figure 10-1. The E-BAM PLUS Leak Test Menu



Use the following steps to conduct the basic leak check:

A. Navigate to TEST >LEAK TEST menu as seen in Figure 10-2. The tape will automatically advance to a clean spot and the vane will rise when thisscreen is entered.

B. Remove the PM10 head from the inlet tube. Install a leak test valve onto the inlet tube. Turn the valve to the OFF position to prevent any air from entering the inlet tube.

C. Remove the internal flow system cover to expose the various flow filters and sheath air pre-filter inlet.

Figure 10-2. Flow System with Cover and Cover Removed

D. Verify the vane is in the up position. If not, press the VANE control button to raise it.

E. Cover and seal the sheath air inlet fitting with your finger or a device and safely seal the sheath as shown in Figure 10-3.

Figure 10-3. Sheath Air Inlet Location and Covered

F. Press the grey PUMP control button in the lower left corner to turn onthe pump to begin drawing a vacuum on the sampling system. Monitorthe flow rate on the display. It will initially rise and then drop.
G. If the flow rate falls below 1.0 LPM, the leak check is successful. Pressthe PUMP control button again to turn off the pump and proceed to step number 10.
H. If the flow rate does not fall below 1.0 LPM, a leak is present. Turn offthe pump. Make sure the nozzle and vane are completely clean of debris bycleaning the nozzle sealing surface and the vane crosshairs with a cotton- tipped applicator and isopropyl alcohol. Also, make sure that the inlet tubeis properly seated in the receiver, and that the leak test filter is correctly installed on the inlet tube.
I. Repeat steps 2 thru 8, as needed. If the leak is persistent complete all checks required on the verification Form DEP 03-24-B first, then go to the troubleshooting section of this operating manual and follow the Advanced Leak Check procedures to find the leak location.
J. If continuing on to another test, slowly open valve, return to the Operate Menu and select the test.
K. If there is no other test to perform, press PUMP to turn the pump off, openthe leak check valve slowly, remove the leak check valve and replace the PM10 inlet.
L. Return to the Operate Menu and select START SAMPLE to resume normal operations.

If a leak is found during this test and is less than or equal to 1.0 LPM, it should not be a significant leak during normal operation. A leak greater than 1.0 LPM must be corrected immediately.

As-found leak checks that are performed before cleaning the nozzle and vane may be performed for data validation purposes. Routine cleaning of the Nozzle/Vane interface is recommended to prevent leaks from developing.

10.1.2 Ambient Temperature Sensor Verification

A. From the E-BAM PLUS Main Operating Screen user interface, tap the down arrow on the bottom left side of the screen. This next screen shows the current Ambient Temperature (AT) readings by the attached 597 sensor.
B. Place or hold the temperature transfer standard near the EBAM PLUS 597- temperature sensor probe being sure to shield the transfer standard from direct sunlight and radiant heat. Allow the calibration transfer standard and the E-BAM PLUS to equilibrate to ambient conditions
C. Compare the AT readings from the E-BAM PLUS screen to the transfer standard and record the values on the verification Form DEP 03-24-B. If values indicate corrective action is needed, complete the ambient barometric pressure and flow checks first before following the ambient temperature sensor calibration procedures.

10.1.3 Ambient Barometric Pressure Sensor Verification

A. From the E-BAM PLUS Main Operating Screen user interface, tap the down arrow on the bottom left side of the screen. This next screen shows the current Ambient Barometric Pressure (BP) readings of the E-BAM PLUS.
B. Allow the calibration transfer standard and the E-BAM PLUS to equilibrate to ambient conditions
C. Compare the BP readings from the E-BAM PLUS screen to the transfer standard and record the values on the verification Form DEP 03-24-B. If values indicate corrective action is needed, complete the ambient temperature and flow verifications first before following the ambient barometric pressure sensor calibration procedures

10.1.4 Flow Verification

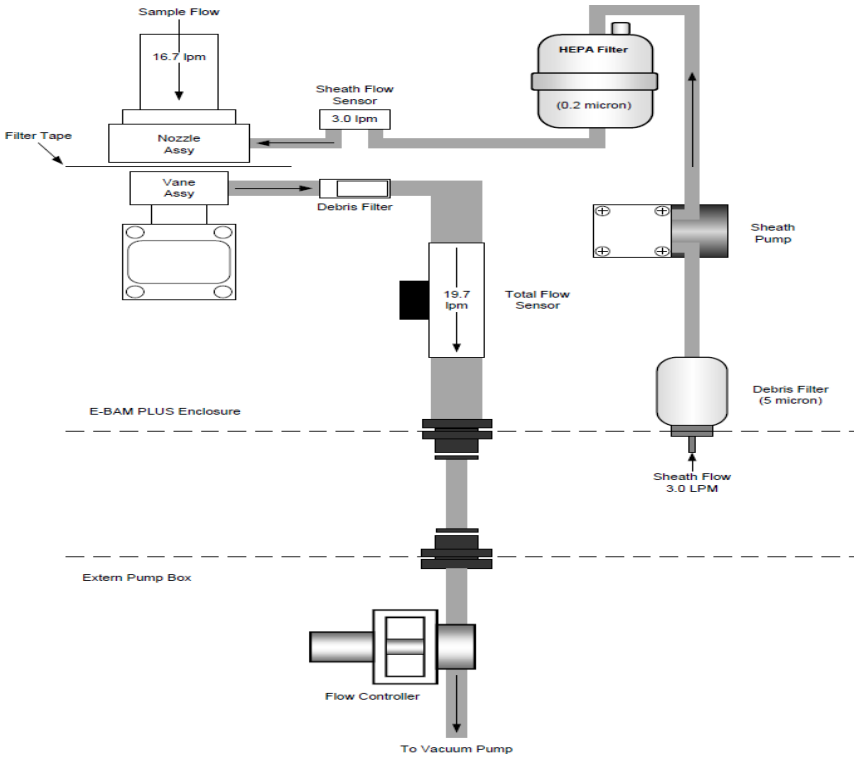
A flow verification must be performed after the ambient temperature and pressure sensors are audited because the E-BAM PLUS uses these parameters to calculate flow. In addition, a leak check must be performed before the flow verification.

The E-BAM PLUS requires calibration of two monitor flows. A diagram of the flow system is found in Figure 10-4.

A. **The sheath flow:** Measure the sheath air at the sheath air pre-filter inlet with a transfer standard flow audit device. The sheath air flow is verified at the target flow rate of 3.0 LPM.

B. **The inlet flow**: Measure the inlet flow with a transfer standard audit device. The main sample air is verified at the target flow rate of 16.7LPM.

Figure 10-4. The E-BAM PLUS Flow System Diagram



To audit the flow system without performing any calibrations, use the CONTINUE button to advance through the various screens explained below and view the parameters without making any changes. For the flow, skip to the final review display. Allow the E-BAM PLUS time to stabilize the flow rate, then compare the E-BAM PLUS flow readings to your traceable standard and record the results. If the transfer standard indicated flow and the E-BAM PLUS flow differ by 4% or more, then troubleshooting and a full flow calibration should be performed as corrective action for reaching a "warning" limit. Critical limit to invalidate data is ±>7.1% difference from the transfer standard or ±>5.1% average difference from the design value flow for a 24-hour period.

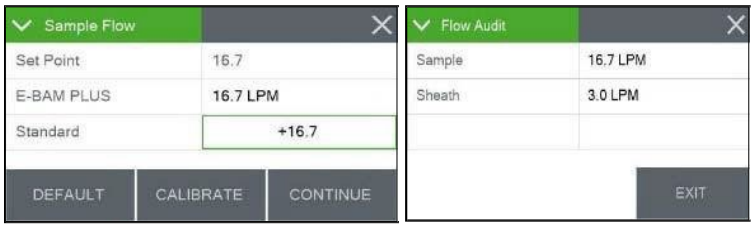
Use the following steps to conduct the flow audit verification:

1. Go to the Operate Menu and select STOP SAMPLE to stop the current sample.
2. Remove the PM10 head from the inlet tube. Install a leak test valve onto the inlet tube. Make sure the valve is open.
3. Navigate to TEST >FLOW CALIBRATION.
4. Remove the internal flow system cover to expose the various flow filters and sheath air pre-filter inlet.

5. Connect a calibration transfer standard to the sheath air pre-filter inlet
6. Press the grey CONTINUE button several times to advance to the final screen named **Flow Audit**.

   ***CAUTION**: It is important that the main sample inlet be free of all obstructions during this test. Any restrictions will affect the flow rate of the sheath air and will result in an inaccurate flow calibration.*
7. The expected target value for the sheath air is 3.0 LPM. The monitor flow is indicated in the **Sheath** field.
8. Allow the calibration transfer standard (CTS) and the E-BAM PLUS to equilibrate and record the results on verification Form DEP 03-24-B.
9. Remove the CTS and tubing from the sheath air pre-filter inlet and install the CTS on the main sample inlet tube
10. The expected target value for the sample air is 16.7 LPM. This is indicated in the **Sample** field.
11. Allow the flow sufficient time to stabilize, verify the flow meets the criteria listed in Table 10-2, and record results verification Form DEP 03-24-B.

Figure 10-5. Main Sample Air Calibration and Final Review Screens



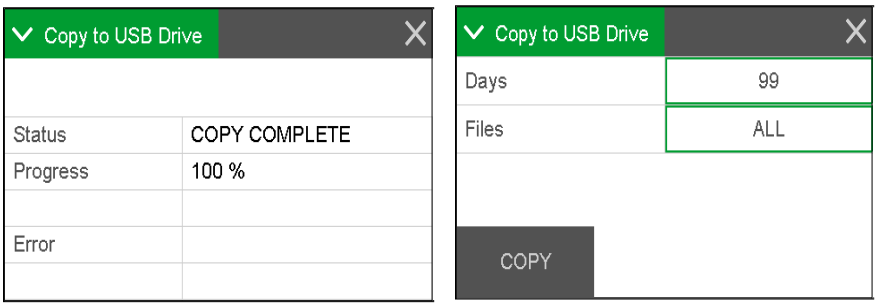
12. Press the EXIT key to return to the Test Menu
13. Return to the Main Operating Screen, remove the CTS from the inlet tube, and replace the PM10 inlet.
14. Resume normal sampling operations if no other maintenance or actions are needed.

10.1.5 Transfer Data to USB Flash Drive

It is very important to transfer the data log from the E-BAM as frequent as possible. It is important to remember that any catastrophic failure (e.g., lightning strike) may cause loss of all stored data. As a precaution it should at least be part of the regular maintenance schedule.

The E-BAM PLUS can copy data files directly to a user-supplied USB flash drive. This drive must be installed in the USB port located on the right hand side of the tape transport plate inside the monitor.

Figure 10-6. Data Transfer Interface Screens



Perform these steps to transfer data from the E-BAM Plus:

A. Enter the Operate > Transfer Data menu.

1. The Days field determines how many records you download. If you wish to change the number of days being copied, press the green bordered value box and the numerical entry keypad will be displayed. Enter the number of days between 001 and 999.
2. The FILES field determines whether you download all of the stored record types or only the user selected records. The USER files are ones which are used for all routine data collection purposes. The ALL option includes additional factory diagnostics files which are only used if data is being sent to Met One Instruments for factory support. The default setting is USER. If you need to change this field, press the green bordered value box and a list of the options available will be displayed. Tap the one you wish to use, and it will be applied. Note: USB 3.0 devices have been found to have issues downloading USER files.

B. Locate the USB slot above the tape take up spool and insert a USB memory stick into it.

C. Press the grey COPY button to copy the selected data to the USB memory stick.

D. When the COPY COMPLETE message is displayed, remove the USB memory stick and close the front door of the E-BAM PLUS.

10.2 Routine Maintenance

10.2.1 Nozzle/Vane Cleaning

The inside of the E-BAM PLUS sample nozzle should be periodically cleaned to remove any buildup of particulates which may have settled on the inside surfaces which could result in artifacts falling out of the nozzle and onto the tape, causing undesired positive concentration spikes. The nozzle and vane must also be cleaned regularly to prevent leaks and measurement errors. The cleaning at a minimum must be done each time the filter tape is changed, although monthly or more frequent cleaning is highly recommended. Some sites will require more frequent cleaning as determined by the site administrator. The worst environment for nozzle contamination is hot, humid environments. This is because damp filter tape fibers easily stickto the nozzle and vane. The fibers can quickly build up, creating air leaks or punching small holes in the filter tape which will cause measurement errors.

Use the following steps to clean the nozzle/vane interface:

A. It is advisable to perform an as-found leak check and flow audit before cleaning the nozzle, in order to validate past data as being leak-free.

B. If the vane is up, lower it by pressing the VANE button in the Leak Test screen.

C. Remove the filter tape (if installed) from the nozzle area so that you have access to the vane.

D. Thoroughly clean the nozzle sealing surface and the vane crosshairs with a cotton-tipped applicator and isopropyl alcohol. Any hardened deposits may have to be carefully scraped off with the wooden end of the applicator.

E. Inspect the nozzle lip and vane for any burrs which may cause leaks or tape damage.

F. After the cleaning process, it is recommended to use canned dusting air to blow down through the vane crosshairs. This removes any filter debris from the face of the beta detector, which is located directly under the vane. Be careful not to damage the beta detector window.

G. Reinstall the filter tape and perform a final leak check.

Figure10-7. Cleaning the E-BAM PLUS Nozzle and Vane with a Cotton-Tipped Applicator

10.2.2 Clean Inlet Probe Line and Downtube

Quarterly cleaning of the inlet tube is recommended for the E-BAM PLUS, but the site administrator should determine what frequency is most

appropriate. Proper cleaning of the inlet tube requires that the tube be lifted out of the inlet at the top of the E-BAM. Make sure to protect the inlet of the E-BAM Plus receiver from any debris.

To clean the inlet tube:

A. Loosen the set screws on inlet receiver
B. Place a brush down the tube to clean the walls

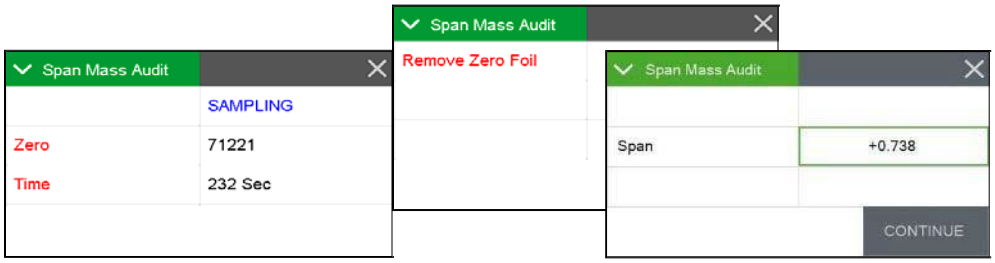
10.2.3 Span Mass Audit

A. The Mass Audit screen, located in the Test menu, is used to verify the performance of the E-BAM PLUS beta attenuation system. A zero and span foil (included in the E-BAM PLUS accessory kit) will be required to complete this procedure. When in this screen, the vane is lowered, and you will be instructed to enter the zero calibration foil.

B. The filter tape must be loaded for this test! Insert the zero foil (make sure it is the one that came with the instrument) above the filter tape between the nozzle and vane, with the label facing up as shown in the figure below. Note that the membrane is keyed and can only be inserted one way. Take care to minimize tape movement. When the zero foil is detected, the vane will automatically raise up to the foil and the four-minute measurement will commence.

C. After four minutes, the vane will be lowered, and the screen will instruct you to remove the zero foil. Remove the zero foil, try to minimize tape movement.

Figure 10-8. Completing the Zero Test

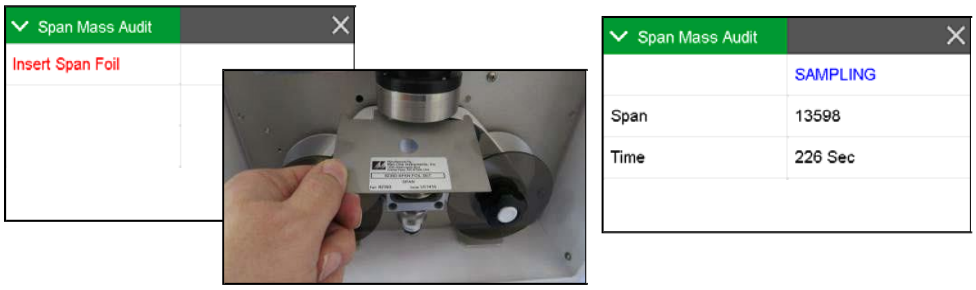


D. Once removed, the display will change to list the current span foil setting. Compare this value to the value written on your span membrane tool. If the values do not match, tap the green bordered span value field and enter the value listed on the span tool. Press the grey CONTINUE button to continue to the next step.

E. The display will instruct you to insert the span foil. Insert the span foil above the filter tape, with the label facing up. Note that this membrane is also keyed and can only be inserted one way. Try to minimize tape movement. When the span foil is detected, the vane will automatically rise

up to the foil and the four-minute measurement will commence.

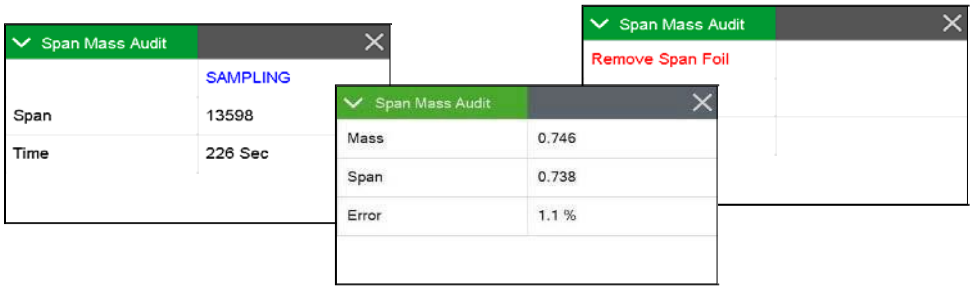
Figure 10-9. Starting the Span Test



F. After four minutes the display will change to list the results of the audit. The measured mass will be listed on the top, the programmed span value will be in the middle, and the error between the two will be listed on the bottom. If the error is greater than ± 5%, the audit has failed. See Section 10.2.2 of this document for cleaning instructions. If the audit continues to fail, contact the Met One Service team (see Section 1.2 of the manual) for assistance.

G. Press the X button in the upper right corner to exit the audit. The vane will be lowered. Remove the foil and the display will automatically return to the Test menu.

Figure 10-10. Completing the Span Test



10.3 Instrument Calibrations

Use the following steps to verify and calibrate sensors associated with the E- BAM PLUS sample flow control system. The DEFAULT key on any of the three flow verification screens can replace the current calibration factors with the factory default settings. If a problem is encountered during the flowcalibration process, press the DEFAULT key to simultaneously set all three flow parameters to factory values and then try the calibration

again

10.3.1 Temperature Calibrations

A. Allow the calibration transfer standard (CTS) and the E-BAM PLUSto equilibrate to ambient conditions.

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

C. Remove the size selective inlet(s) from the sample tube.

D. Remove the internal flow system cover to expose the various flow filters and sheath air pre-filter inlet (see Figure 10-7 in Section 10.2.1 of this document).

E. Enter the Test > Ambient Temperature screen

F. Compare the E-BAM PLUS and CTS temperature measurements.

1. If the E-BAM PLUS temperature sensor meets the criteria listed in Table 10-2, return to the TEST menu.

2. If the temperature needs to be adjusted, press the green bordered value box and the numerical entry keypad will be displayed. Enter the CTS temperature 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.

10.3.2 Ambient Barometric Pressure Calibration

A. Enter the Test > Ambient Pressure screen

B. Compare the E-BAM PLUS and CTS barometric pressure measurements.

1. If the E-BAM PLUS pressure sensor meets the criteria listed in Table 10-2, return to the TEST menu.

2. If the pressure needs to be adjusted, press the green bordered value box and the numerical entry keypad will be displayed. Enter the CTS pressure 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.

10.3.3 Flow Calibration

A. Enter the Test > Flow Calibration screen

B. The first screen is for verifying the sample and sheath flows indicate zero flow when a no flow condition exists. Wait until both the sample and sheath values read 0.0 (this could take up to a minute if the pump was recently running) and then press the CONTINUE key to turn on the pump and move to the sheath air flow calibration screen. If 0.0 cannot be achieved, press the grey ZERO button to manually set both values to zero.

C. Install the calibration transfer standard to the sheath air pre-filter inletand

then press the grey CONTINUE button to advance to the Sheath Air calibration screen. The pump should start and adjust flow to 3.0 LPM.

***CAUTION**: It is important that the main sample inlet be free of all obstructions during this test. Any restrictions will affect the flow rateof the sheath air and will result in an inaccurate flow calibration.*

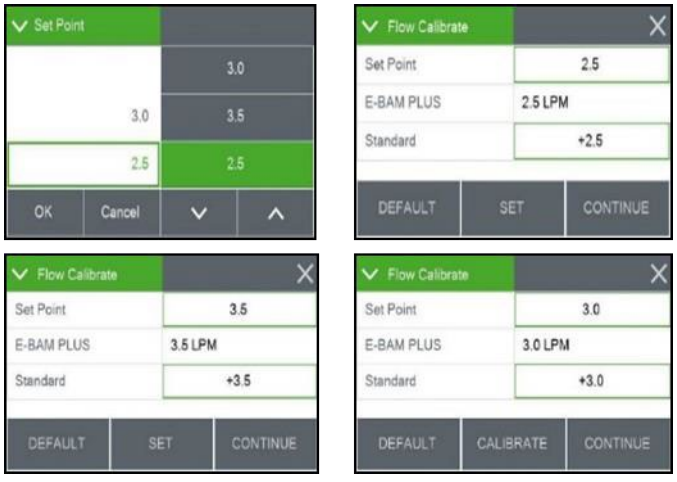
D. The Sheath Air calibration consists of low, high, and target flow rate points. Press the green bordered Set Point field and select 2.5 LPM (the low flow rate) and then press the grey OK button to return to the Flow Calibration screen.

E. The Set Point field should now read 2.5 LPM; this is the current flow rate being tested. The E-BAM PLUS field is the current sheath air flow sensor reading. It should be changing as the E-BAM PLUS attempts to lower the flow rate to the new goal. Allow the flow sufficient time to stabilize (it could take a few minutes).

F. Press the green bordered Standard field and the numerical entry keypad will be displayed. Enter the CTS flow value and press OK to return to the Flow Calibration screen.

G. Press the grey SET button. This will temporarily set the low flow point without changing the flow calibration of the monitor. This button should be pressed even if no changes are made.

Figure 10-11. Sheath Air Calibration Screens



H. Do not press the grey CONTINUE button at this time. Press the green bordered Set Point field and select 3.5 LPM (the high flow rate) and then press the grey OK button to return to the Flow Calibration screen.

I. The Set Point field should now read 3.5 LPM. The E-BAM PLUS field should be changing as the monitor attempts to raise the flow rate to the

new goal. Allow the flow sufficient time to stabilize (it could take a few minutes).

J. Press the green bordered Standard field and the numerical entry keypad will be displayed. Enter the CTS flow value and press OK to return to the Flow Calibration screen.

K. Press the grey SET button. This will temporarily set the high flow point without changing the flow calibration of the monitor. This button should be pressed even if no changes are made.

L. Do not press the grey CONTINUE button at this time. Press the green bordered Set Point field and select 3.0 LPM (the target flow rate) and then press the grey OK button to return to the Flow Calibration screen.

M. The Set Point field should now read 3.0 LPM. The E-BAM PLUS field should be changing as the monitor attempts to lower the flow rate to the target goal. Allow the flow sufficient time to stabilize (it could take a few minutes).

N. Press the green bordered Standard field and the numerical entry keypad will be displayed. Enter the CTS flow value and press OK to return to the Flow Calibration screen.

O. Press the grey CALIBRATE key. This will permanently set the instrument's flow calculation.

P. Press the grey CONTINUE key to proceed to the sample air flow calibration.

Q. Remove the CTS, the BX-305, and the adapter tubing from the sheath air pre-filter inlet.

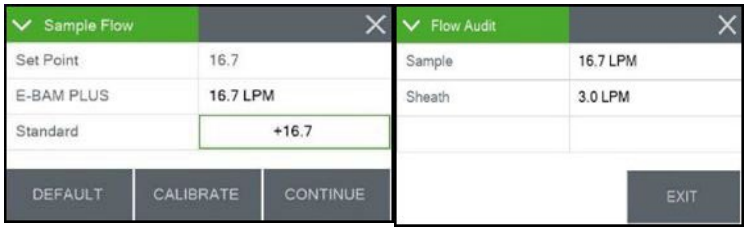
R. Install the CTS on the main sample inlet tube.

S. The expected target value for the sample air is 16.7 LPM. This is indicated in the Set Point field. The E-BAM PLUS field is the current sample air flow sensor reading. The Standard field is the field where you enter the correct flow as shown on your traceable reference standard if the E-BAM PLUS flow needs to be adjusted.

T. CAUTION: It is important that both sheath air inlet be free of all obstructions during this test. Any restrictions will affect the flow rate of the main sample air and will result in an inaccurate flow calibration.

U. Allow the flow sufficient time to stabilize (it could take a few minutes), verify the slow meets the criteria listed in Table 10-2, and enter any corrections needed. Press the CALIBRATE key to set any changes. The E-BAM PLUS and Standard fields should now match.

Figure 10-12. Main Sample Air Calibration and Final Review



V. Press the CONTINUE key to continue on to the flow review screen shown in Figure 6-15. The final screen shows the current measured values for the sample (INLET) and sheath air flows.

W. Press the EXIT key to return to the Test Menu

X. Return to the Main Operating Screen, remove the CTS from the inlet tube, and replace the size selective inlet(s).

Y. Resume normal sampling operations

10.4 Other Maintenance and Quality Checks

10.4.1 Filter Temperature Sensor Audit

The filter temperature sensor measures the temperature of the sample air and monitors the function of the inlet heater.

A. Set the Filter Sensor field to the TEMPERATURE option.
B. Position the CTS as closely as possible to the filter sensorand allow them to equilibrate.
C. Compare the E-BAM PLUS value to your standard.
D. If an adjustment is necessary, enter the correct temperaturein the Standard field and then press the CALIBRATE key to correct the E- BAM PLUS sensor reading.
E. The E-BAM PLUS and Standard parameters should now match.
F. Press the X key to exit the screen when finished.
G. If difficulty is encountered during the process, the DEFAULT keycan be pressed to erase all field calibration factors from the temperature sensor and to start over with factory default calibration factors. Then try the calibration again.

Note: *It is often difficult to calibrate the sensor if the monitor is warm. If the sensor is to be calibrated, it is best to do it when the it is cold (equilibrated to ambient) and the vane is lowered. It is recommended to leave the sensor at the factory default calibration. The E-BAM PLUS filter temperature sensor very rarely fails.*

10.4.2 Filter Relative Humidity Sensor Audit

The filter relative humidity sensor is used to measure the humidity of the sample air and to control the inlet heater to prevent moisture from being sampled as particulate mass.

A. Set the Filter Sensor field to the HUMIDITY option.
B. Position the CTS as closely as possible to the filter sensor and allow them to equilibrate.
C. Compare the E-BAM PLUS value to your standard.
D. If an adjustment is necessary, enter the correct RH in the Standard field and then press the CALIBRATE key to correct the E-BAM PLUS sensor reading.
E. The E-BAM PLUS and Standard parameters should now match. Press the X key to exit the screen when finished.
F. If difficulty is encountered during the process, the DEFAULT key can be pressed to erase all field calibration factors from the RH sensor and to start over with factory default calibration factors. Then try the calibration again.

Note: *It is often difficult to calibrate the sensor if the E-BAM PLUS is warm. It is best to do it when the E-BAM PLUS is cold (equilibrated to ambient) and the vane is lowered. It is recommended to just leave the sensor at the factory default calibration. The E-BAM PLUS filter RH sensor is only a ±4% device when functioning properly, and will typically read a completely unreasonable value if it fails, such as 135% or -25%.*

10.4.3 Upper and Lower Pressure Sensor Audit

The upper and lower pressure sensors are used to detect excessive tape loading due to heavy particulate sampling. If the user defined advanced to prevent damage to the pump and the tape itself.

A. To audit these sensors set the Filter Sensor field to theUPPER PRES or LOWER PRES option.
B. Position the CTS near the E-BAM PLUS and verify both the standard and the E-BAM PLUS values are stable.
C. Compare the E-BAM PLUS value to your standard.
D. If an adjustment is necessary, enter the correct pressure in the Standard field and then press the CALIBRATE key to correct the E-BAM PLUS sensor reading.
E. The E-BAM PLUS and Standard parameters should now match.
F. Press the X key to exit the screen when finished.

G. If difficulty is encountered during the process, the DEFAULT key can be pressed to erase all field calibration factors from the selected pressure sensor and to start over with factory default calibration factors. Then try the calibration again.

Note: *The pressure sensors must be audited individually and with the pump off. Selecting either pressure sensor for auditing should cause the pump to stop. If it does not, contact the Met One Instruments service department for assistance.*

10.4.4 Pump Muffler Change

The grey plastic pump muffler used on the vacuum pump clogs up after.

10.4.5 Background Determination (Mass Offset)

It is recommended that the E-BAM PLUS undergo a background test annually and after any major repairs have been performed.

Use the following steps to conduct a zero filter background test and set themass offset.

A. Ensure that the E-BAM PLUS has been calibrated and that leaks are not present.
B. Go to the Operate menu and select Stop Sample to stop the current sample.
C. Remove the PM10 inlet from the sample tube and install the zero filter.
D. Place the zero filter leak valve is in the open position.
E. Go to the Setup menu and select Background.
F. Record the current background value.
G. Set the Background value to zero.
H. Exit the Background menu, go to the Operate menu, select Start Sample, and begin sampling.

Figure 10-13. BX-302 Zero Filter Assembly

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

J. Calculate the average of the most recent 72 hourly PM concentrations. This allows the first few hours of the test to be used for warming up the system and allowing it to stabilize before collecting data for the 72 hour average. Record this value.

K. Calculate the new Background value by determining the inverse of the 72 hour average calculated in Step J. For example, if the 72 hour mean = 1.07 µg /m3, the new Background 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.

L. Return to the Setup menu and select Background.

M. Enter the new Background value. Press X.

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

O. Remove the zero filter from the inlet tube and install the PM10 inlet.

P. Resume normal sampling.

Q. Perform Flow Verification.

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 8.1 of the manual 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 5 µg. The hourly detection limit is defined as two times the standard deviation (2σ). If the standard deviation is greater than 5 µg, the cause should be investigated. Contact the Met One Instruments service department for assistance*

11.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance is a system of management and operational activities designed to ensure that the data produced will be of the type and quality needed and expected by thedata user. Quality control defines the procedures implemented to assure that acceptable precision, bias, completeness, representativeness, and comparability are obtained and maintained in the generated data set. Quality control procedures, when properly executed, provide data that meet or exceed the minimally acceptable quality criteria established to assist management in making confident decisions. It is the policyof the department to implement a QA program and QC procedures to assure that data of known and acceptable precision, bias, completeness, comparability, and representativeness are collected from all monitoring projects. The first line of defense against invalid data is the implementation of best practices in day- to-day QC operations affecting the data collection process:

- Understanding of the principle of operation of the equipment
- Acceptance testing of equipment.
- Diligence in site selection followed by rigid installation procedures
- Scheduling and implementation of routine maintenance procedures (e.g., inlet cleaning)
- Scheduling and implementation of QC protocols (e.g., flow checks, instrument settings)
- Documentation/reporting of all field QC results and related field activities
- Review of real-time data via agency central data system

11.1 QA Audits

The FDEP has decided field staff will be responsible for performing semi-annual flow rate audits, sensor checks, and span mass audits on particulate matter instrumentation in the PQAO. The semi-annual audits should be spaced between 5 and 7 months apart. The audit should be conducted by trained personnel other than the routine site operator. Ideally, this could be local QA staff (if available) trained in instrument operation. This audit must use independent standards for flow, temperature, and pressure not used for routine verifications or calibrations. These independent audit standards can either be borrowed from another agency or designated and reserved only for audit purposes by the local agency. Auditors should refer to this SOP for procedures how to conduct the associated flow, sensor, and mass checks (Section 10) and use Form DEP 03-24-O to document the semi-annual audit (see Appendix F).

11.2 Data Validation

Data validation is part of data Quality Assurance (QA). Two primary sources of information are directly related to validation of FEM PM_{10} data from the E-BAM PLUS. One is the sampling attribute data generated and stored by the instrument itself and the other is the site log information containing results from the periodic QC protocols. Refer to Data Handling SOP.

11.2.1 Field QC Generated Sampling Attribute Data

It is essential that the information, both qualitative and quantitative, be transmitted to the data analyst responsible for the data validation process. This information transfer should be prescribed–not left to chance. It may take the form of negative reporting, that is, only those field QC procedures that result in a "fail" condition need be reported, saving the data analyst from poring over data that the field technician has already documented as acceptable, or "passing". One method of implementing a negative reporting structure would be to keep a separate log of failed QC tests, containing information such as technician name, date, QC test performed, result, corrective action, retest result, etc., that would be periodically passed to the data analyst. Note, however, that some QC protocols are not "pass/fail", but only need verification that they were carried out (e.g., inlet cleaning). The instrument log shall be used to log activities and observations.

11.3 Data Validation Criteria

Table 11-1 below shows the QC check criteria required for acceptable data.

Table 11-1. QA/QC Flow Control Schedule for the E-BAM PLUS (PM10)

Parameter	Description			Frequency
Volumetric Flows	Check the volumetric flows and acceptance limits according to the following: Total Flow is 16.67 ≤ ± 4%			Bi-Weekly
	Validity	**NIST Traceable Standard**	**Design Flow**	
	Acceptable – No Action Required	< ±4% Diff	≤ ±5% Diff	
	Marginal - Corrective Action Required	±(4-6.9) % Diff	≤ ±5% Diff	
	Out of Tolerance – Corrective Action Required	≥ ± 7% Diff	≥ ±5% Diff	
	Data Validation: Acceptance Limits			
	PM10	≤±7% Diff	≤±5% Diff	
Leak Check	Leak Check- acceptance level ≤ 1.5 mmHg			
	Validity	**NIST Traceable Standard**	**Comment**	Bi-Weekly
	Acceptable – No Action Required	≤ 1.0 mmHg	Data satisfactory	
	Marginal - Corrective Action Required	1.0 - 1.5 mmHg	Data satisfactory	
	Out of Tolerance – Corrective Action Required	> 1.5 mmHg	Invalidate	
	Data Validation: Acceptance Limits ≤ 1.5 mmHg = Valid Level			

12.0 TROUBLESHOOTING

12.1 Advanced Leak Checks

If the basic leak check persistently fails, and the location of the leak cannot be identified, the following procedures will help isolate the problem.

12.1.1 Lower System Leak Test

Use this procedure to identify leaks between the vane and flow sensor.

A. Navigate to the TEST>LEAK TEST menu and lower the vane, if needed.

Figure 12-1. Nozzle Sealing Tool Lower System Test

B. Insert the Nozzle Seal Tool without the hole between the nozzle and vane. Note the proper alignment in the photo above.
C. Press the vane control button to raise the vane up to the sealing tool.
D. Press pump control button to turn on the pump. Monitor the flow rate on the E-BAM PLUS display. Remember the flow will temporarily rise before it drops.
E. If the flow rate falls below 1.0 LPM, the leak is not in thelower system. Turn off the pump and proceed to section 13.1.2 in the manual: Upper System Leak Test.
F. If the flow rate does not fall below 1.0 LPM, there is a leak located in the tubing or fittings between the vane and flow sensor. Contact the Met One service team for resolution.
G. Repeat steps B through F until the leak has been identifiedand corrected.
H. Remove the rubber sealing tool, remove the leak check valve, and replace the size selective inlet(s).
I. Return to the Operate Menu and select “Start Sample” to resume normal operations.

12.1.2 Upper System Leak Test

Use this procedure to identify leaks above the filter tape. The lower system leak test should be performed first.

A. Navigate to the TEST>LEAK TEST menu and lower the vane, if needed.
B. Insert the Nozzle Seal Tool with the hole between the nozzle and vane. Note the proper alignment in the photo below.

Figure 12-2. Nozzle Sealing Tool Upper System Test Configuration

C. Press the nozzle control button to raise the vane up to the sealing tool.
D. Cover the sheath air pre-filter inlet fitting with your finger.
E. Press pump control button to turn on the pump. Monitor the flow rate on the E-BAM PLUS display. Remember the flow will temporarily rise before it drops.
F. If the flow rate falls below 1.0 LPM, the leak check is successful. Turn off the pump.
G. If the flow rate does not fall below 1.0 LPM (and the lower system leak test was successful), there is a leak located above the nozzle. The issue is likely due to faulty or failed O-rings within the receiver, faulty O-rings in the PM2.5 size selector (if installed), or improper inlet tube connection.

12.1.3 Filter Tape Leak Test

Use this procedure to identify a leak at the filter tape interface. The lower and upper system leak tests above should be performed first.

A. Navigate to the TEST>LEAK TEST menu and lower the vane, ifneeded.
B. Remove all tape from the nozzle area. Remove the size selective inlet(s) from the sample tube and install a calibration transfer standard (CTS), such as the BX-307 volumetric flow calibrator.
C. Insert the Nozzle Seal Tool with Hole between the nozzle and vane as mentioned in Upper System Leak Test. The rubber willguarantee a positive seal at the nozzle/vane interface, regardlessof any debris or imperfections.
D. Press the nozzle control button to raise the vane up to the sealingtool.
E. Press pump control button to turn on the pump. Monitor the flow rate on the E-BAM PLUS display. Remember the flowwill temporarily rise before it drops.
F. When the flow rate stabilizes, write down the CTS flow ratevalue. This is the “Without Tape” value.
G. Turn off the pump and lower the vane.

H. Remove the Nozzle Seal Tool.

I. Place a 3 inch long piece of filter tape directly below the nozzleand raise the vane again.

J. Press pump control button to turn on the pump. Monitor theflow rate on the E-BAM PLUS display.

K. When the flow rate stabilizes, write down the CTS flow ratevalue. This is the "With Tape" value.

L. Turn off the pump and then lower the vane.

M. Remove the strip of filter tape.

N. Subtract the "Without Tape" value from the "With Tape" value. If the difference is greater than 0.2 LPM (liters per minute) a leakexists at the nozzle / tape interface. To resolve this issue, refer to Section 6.5.1 of the User Manual. Repeat steps 3 through 14 until the leak has been corrected.

O. Once the leak has been resolved, remove the CTS and replacethe size selective inlets on the sample tube. Reinstall the tape (see section 2.8) and resume normal sampling operations.

12.2 E-BAM PLUS Error Displays, Error Logs, and Error Codes

This section provides information about routine maintenance of the E-BAM PLUS, and for performing more detailed diagnostic tests if a problem is encountered. The E-BAM PLUS often generates error messages on the display or in the data log if a failure or other problem is detected. Many times there is a simple solution, but persistent errors often signify a failure which will require investigation. The E-BAM PLUS error codes are described in this section. In the event a measured parameter or sequence is not within design specifications, the E-BAM PLUS will generate an alarm. These alarms can be monitored via the alarm log, output files or the alarm relay. A list of alarms is detailed listed below.

An alarm is indicated and logged at the time it occurs. The resolution time is not recorded. See section 3.7 of the manual for an explanation of viewing alarms through the E-BAM PLUS panel display.

Note: *If multiple errors or alarms occur in the same data period, then the logged alarm code will be the sum of the two individual code numbers. This is a rare occurrence.*

Table 12-1. The E-BAM PLUS Alarm Conditions

Code	Description	Cause
1	Tape Break	No tape movement was detected during the tape move process.
2	Beta Detector	The event occurs when the Beta detector count rate is less than 500 Hz during the sampling cycle.
4	Sensor Range	The event occurs when an analog sensor reading (AT, RH, BP, UPPER, LOWER, FT, FRH) is outside the designated limits.
8	Tape Advance	The event occurs when the pressure drop across the tape exceeded the Tape Advance Pressure setting.
16	Flow Failure	The event occurs when the total flow or sheath flow is less than 1.0 LPM for greater than 1 minute. The event occurs when the sample flow is +/-10% out of regulation for 1 minute.
32	Vane Failure	The event occurs when the vane failed to move and stops at the up or down position.
64	Digital Link Failure	The event occurs when communication with the 597 sensor has ceased for greater than 10-seconds.
128	Power Failure	The event occurs for a power cycle or a micro-processor reset.
256	Short Sample	The event occurs when the first sample cycle is less than 1-hour.
512	Maintenance	The event occurs when the user stops normal operation.

12.3 E-BAM PLUS Hardware Failure Screen

This screen is presented to the user when a hardware failure occurs with the type of alarm (Tape Break, Sensor Range, Flow Failure, etc.) indicated in red text. Pressing the grey ALARMS button will present the View Alarms screen. See section 3.7 for more information about viewing alarms.

Figure 12-3. Sample Alarm Screen

12.3.1 Sensor Out of Range

The sensor outside range alarm event occurs when one of the E-BAM PLUS sensors is reading outside of its designated limit. Each sensor, along with its upper and lower range limits, is shown in Table 12-2. The Stop column indicates whether or not the error will cause the E-BAM PLUS to stop sampling.

Table 12-2. Sensor Ranges

Sensor	Minimum	Maximum	Stop
AT	-50	70	Yes
RH	0	100	No
BP	375	825	Yes
UPPER	228	818	Yes
LOWER	228	818	Yes
FT	-40	60	Yes
FRH	0	98.9	No
BOX	-40	60	No
BETA	500	20000	Yes

12.4 Basic Problem and Cause/Solution Table

The following table contains information on some of the more common problems that may be encountered, and some steps to identify and remedy the problems. Met One Instruments welcomes customer suggestions for new items to include in this section of future manual revisions. If the solution cannot be found in the following table, then contact one of our expert service technicians for help in resolving your problem.

Table 12-3. Basic Problem and Cause/Solution Table

Problem:	**The mass monitor won't start a measurement cycle.**
Cause/Solution:	• The mass monitor will not start a measurement cycle if it detects a hardware failure, such as low beta count signal, pressure sensor failure, or pump failure. • The mass monitor will not start a cycle if either the zero-membrane plate or the shipping shim is inserted. • The mass monitor will not start a cycle if the 597 sensor is not connected. • The mass monitor will not start a cycle if the filter tape is not installed correctly. • The mass monitor will usually display an error message on the display if it cannot start a cycle. • If the mass monitor is left in a SETUP or FIELD CALIBRATION screen, it should still try to start a cycle after several minutes of inactivity, unless a failure is detected.

Problem:	**The analog output voltage concentration readings are full-scale.**
Cause/Solution:	• The mass monitor will force the analog output to the full-scale voltage to indicate an error. Review the History / Alarm log to view any possible errors. • If the configured full-scale analog output is recorded by a connected external data logger, then either there is an error in the mass monitor, or the particulate concentrations have exceeded the range of the analog output.
Problem:	**The mass monitor records frequent "Pressure Drop Excessive" errors.**
Cause/Solution:	• This usually indicates that the filter tape is automatically advancing in response to being clogged due to heavy particulateloading. • If frequent pressure-drop errors are encountered, try setting the TAPE ADVANCE setting to a shorter interval. See section 3.6.12. When hourly PM readings are high, more frequent tape advance intervals may be required.
Problem:	**The concentration indicates negative values.**
Cause/Solution:	• It is possible for the mass monitor to occasionally record negative hourly values if the actual particulate concentration is extremely low. This is because the mass monitor has an hourly random noise band of several micrograms. • The real-time averages of the mass monitor (especially the 1- and 5-minute averages) are considerably noisier than the hourly measurements. These noise spikes may indicate negative concentrations unless the true concentrations are high. • The noise performance of the mass monitor may be audited. Met One Instruments supplies the BX-302 zero filter kit for auditing the zero readings of the mass monitor.
Problem:	**The airflow won't regulate at the correct rate of 16.7 LPM.**
Cause/Solution:	• This usually indicates that the air pump is losing vacuum capacity due to wear. • Check for leaks at the nozzle. This will often cause the inlet flow to be low even though the flow sensor is measuring the correct flow rate. This is because the flow sensor is downstream of the filter tape and nozzle. Clean the nozzle and vane. • Perform a flow calibration. If the flow regulates at the lower calibration point, but not the higher point, the pump is probably worn out or there is a leak.
Problem:	**The mass monitor has flow leaks, even after cleaning the nozzle and vane.**
Cause/Solution:	• The vane may be sticking. Verify that the vane up/down motion is smooth and complete. If the vane movement is sticky or gritty, it will not seal properly. • Check the O-rings on the sharp-cut cyclone (if used). These frequently leak. • Check for bad O-rings on the inlet receiver.

Problem:	**The mass monitor will not pass the span membrane test.**
Cause/Solution:	• This often just indicates the membrane foil surface is dirty or damaged. It can be cleaned with distilled water. Damaged membranes must be replaced. • If the membrane is in good condition, but the mass monitor fails span tests, then the most common problem is debris on the beta detector window. Carefully blow through the vane with canned dusting air to blow debris off of the detector window and try again. • If the detector is clean and the membrane is in good condition, then failed span tests can indicate that the detector is wearing out. Contact
Problem:	**The clock settings are lost when the mass monitor is powered down.**
Cause/Solution:	• There is a lithium coin cell battery inside the mass monitor that maintains the clock when the mass monitor is powered off. The battery may need to be replaced if the clock resets when the mass monitor is powered off.

12.5 Technical Service

This manual is structured to provide the required information for setup, operation, testing, maintaining, and troubleshooting your E-BAM PLUS unit. Should you still require support after consulting your printed documentation, contact a Technical Service representatives during normal business hours of 7:00 a.m. to 4:00 p.m. Pacific Standard Time, Monday through Friday. In addition, technical information and service bulletins are often posted on Met One website. Please contact us and obtain a Return Authorization (RA) number before sending any equipment back to the factory. This allows Met One to track and schedule service work and to expedite customer service. Please have your instrument serial number available when contacting the manufacturer.

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13.0 RECORDS MANAGEMENT

Records Management is the process to manage, store, back-up, and protect all the documents associated with operation, quality assurance, and the data associated with the E-BAM PLUS monitoring instrument. Documentation of the quality control activities suchas, bi-weekly and quarterly QC checks, audits, and annual calibrations are documented on hardcopy or electronic forms and then submitted by the operator for data verification and validation processes. The forms and reports included in Appendix A of this SOP were developed in an electronic spreadsheet format and therefore contain embedded formulas for performing calculations and data validity checks. The reporting agency may retain these records in hardcopy or in electronic format.

All records must be backed up, stored securely, and retained for a minimum of 5 years. State law dictates retention schedules for various records. Refer to the specific SOPs that delineate this process, including DEP 18-27 Data Handling and Data Validation.

14.0 REFERENCES

Code of Federal Regulation, Title 40, Part 53

Code of Federal Regulation, Title 40, Part 58, Appendix A

Code of Federal Regulation, Title 40, Appendix L to Part 50—Reference Method for the Determination of Fine Particulate Matter as PM2.5 in the Atmosphere

Met One E-BAM PLUS Particulate Monitor Operational Manual, E-BAM PLUS -9800 Manual, Rev C, Met One Instruments, Inc., Grants Pass, OR 97526

Quality Assurance Guidance Document 2.12, Monitoring PM2.5 in Ambient Air Using Designated Reference or Class I Equivalent Methods U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Air Quality Assessment Division

Quality Assurance Project Plan for the State of Florida Ambient Air Quality Monitoring Program, FDEP QAPP-002, Revision 1, April 2016, Florida Department of Environmental Protection, Tallahassee, FL.

Standard Operating Procedure for Data Handling and Data Validation, DEP 18-27, Revision No.
1, June 2016, Florida Department of Environmental Protection, Tallahassee, FL.

APPENDIX A: EQUIPMENT STATUS REPORT

Downloaded with sample and alarm data.

```
E-BAM PLUS Settings Report
2018-01-29 08:09:13

      Firmware, 82102, R1.1.3
          CPLD, 81699, R1.0.0
       Display, 82451, R1.0
 Digital Sen 1, 597, 10503-01, R01.0.0

 Serial Number, W20769
      Location, 1
     Baud Rate, 9600
Ethernet FlowControl, NONE
        AIRSIS, OFF
  Data Average, 1 HR
RealTime Period, 60
   Tape Period, 1 HR
 Tape Pressure, 250
 Standard Temp, 25 C
 PM Inlet Type, PM10
     Conc Type, STANDARD
             K, 1.014
    Background, -0.0004
           Usw, 0.325
    Audit Span, 0.724
    Conc Units, ug/m3
      USB Days, 30
     USB Files, USER
Analog Range 1, 0-5.0 V
Analog Range 2, 0-5.0 V
     Conc Span, 1000 ug/m3
   Conc Offset, 0 ug/m3
Hourly Timestamp, ENDING
  FT Set Point, 40.0
     FT P-Gain, 0.500
     FT I-Gain, 0.300
RealTime Alpha, 0.2316
RealTime Gamma, 0.1500
   Beep Volume, 10
ModBus Address, 1
    Byte Order, 512
  Factory Mode, OFF
 Flow 1 P-Gain, 10000.000
 Flow 1 I-Gain, 5000.000
 Flow 2 P-Gain, 10000.000
 Flow 2 I-Gain, 5000.000
   Cloud Modem, NONE
     Time Zone, UTC -01:00
    Clock Sync, NONE

  Name, Offset,  Slope
 FLOW1, -0.052,  1.043
 FLOW2, -0.358,  1.064
    AT, -0.910
    BP, -1.920
    FT,  0.414
 UPPER,  2.971
 LOWER,  3.194
   FRH,  0.000


     DAC Cal 1, 0.0,45,5.0,52925
     DAC Cal 2, 0.0,10,5.0,52829
```

```
Alarm Report
2018-01-29 08:09:13
Location, 1, W20769

Time,Alarm
2018-01-10 08:16:56,MAINTENANCE
2018-01-10 09:43:58,MAINTENANCE
```

APPENDIX B: FLOW VERIFICATION FORM

Form No. DEP 03-24-B							Effective on: 8/2021
Met One E-BAM Plus Particulate Matter10 Flow Verification Form							
Identification Block							
Serial #:				Date Installed:		Date Calibrated:	
Site Name:				AQS #:			
Standards Block							
Flow Standard Mfg:		Model:		Serial #:		Date Certified:	
Temp. Standard Mfg:		Model:		Serial #:		Date Certified:	
BP Standard Mfg:		Model:		Serial #:		Date Certified:	
Time Standard Mfg:		Model:		Serial #:		Date Certified:	

Verfication Block		Instrument	Ref. Std.	Difference	Limits	Pass/Fail	NOTES
Date					0 days		
Time					± 2 minutes		
Leak Test (LPM)	Sheath				≤ 1.0 LPM		
	Total				≤ 1.0 LPM		
Ambient Temp (°C)					± 2 °C		
Barometric Pres.(mmHg)					±10 mmHg		
Sheath Flow Verification (LPM), ± 7%					< 7.0%		
Volumetric Flow Verification (LPM) ± 7%					< 7.0%		
Design Flow Verification (LPM) ± 5%			16.67		< 5.0%		
Post readings if maintanence is performed							
Leak Test (LPM)	Sheath				≤ 1.0 LPM		
	Total				≤ 1.0 LPM		
Sheath Flow Verification (LPM), ± 7%					< 7.0%		
Volumetric Flow Verification (LPM), ± 7%					< 7.0%		
Design Flow Verification (LPM) ± 5%			16.67		< 5.0%		

Data Downloaded		Checked & Updated Maintenance Form	

Operator Comments:

Performed by:		Date:	

QA Comments:

Verified by:		Date:	

APPENDIX C: CALIBRATION FORM

Form No. DEP 03-24-C — Effective on: 8/2021

Met One E-BAM Plus Particulate Matter10 Flow Calibration Form

Identification Block							
Serial #:				Date Installed:		Date Calibrated:	
Site Name:				AQS #:			
Standards Block							
Flow Standard Mfg:		Model:		Serial #:		Date Certified:	
Temp. Standard Mfg:		Model:		Serial #:		Date Certified:	
BP Standard Mfg:		Model:		Serial #:		Date Certified:	
Time Standard Mfg:		Model:		Serial #:		Date Certified:	

Calibration Block		Instrument	Ref. Std.	Difference	Limits	RESULT	NOTES
Date	As Found				0 days		
	Post-Calibration						
Time	As Found				± 2 minutes		
	Post-Calibration						
Ambient Temp (°C)	As Found				± 2 °C		
	Post-Calibration						
Barometric Pres.(mmHg)	As Found				±10 mmHg		
	Post-Calibration						

Leak Check		Instrument		Limits	Pass/Fail	NOTES
Leak (LPM)	Sheath As Found			≤ 1.0 LPM		
	Sheath Post-Cal			≤ 1.0 LPM		
	Total As Found			≤ 1.0 LPM		
	Total Post-Cal			≤ 1.0 LPM		

Flow Verificaiton/ Calibration Block		Instrument	Ref. Std.	Difference	Limits	RESULT	NOTES
Sheath Flow (LPM)	As Found				7.0%		
	Flow Calibration						
	Flow - 2.50			SHEATH FLOW CALIBRATION			
	Flow - 3.50						
	Flow - 3.00						
	Post-Cal				7.0%		
Volumetric Flow (LPM)	As Found				7.0%		
	Vs. Design Value		16.67		5.0%		
	Post-Cal				7.0%		
	Vs. Design Value		16.67		5.0%		

Maintenance and Checks Performed					
Inlet Cleaned		Inspect Water Collector and Seals		Inlet/Downtube Cleaned	
Nozzel and Vane Cleaned				Tape Changed	
Internal Nozzle Cleaned		Replace Pump Muffler		Data Downloaded	

FILTER SENSOR AUDIT				
Sensor	Instrument	Standard	LIMIT	Post-Adjustment
Filter Temperature			2ºC	
Upper Pressure			± 10 mmHg	
Lower Pressure			± 10 mmHg	

MASS AUDIT	Passing ≤ ±5%
Result:	

☐ ☐

TIMESTAMP SETTING	
FLOW SETTING	

Operator Comments:

Performed by: _____ Date: _____

QA Comments:

Verified by: _____ Date: _____

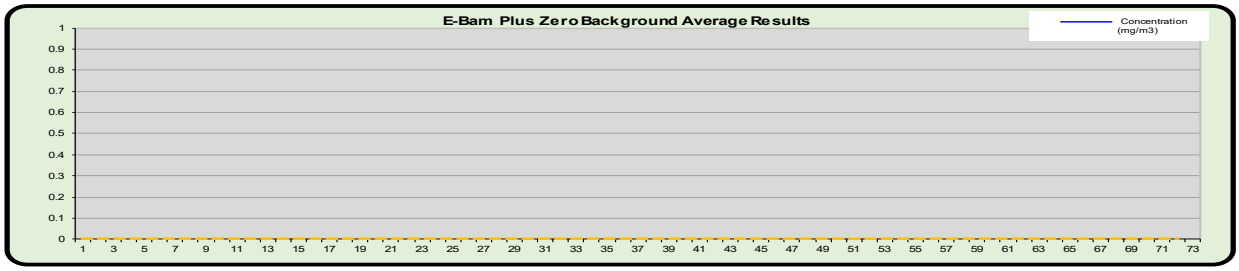
APPENDIX D: BACKGROUND DETERMINATION

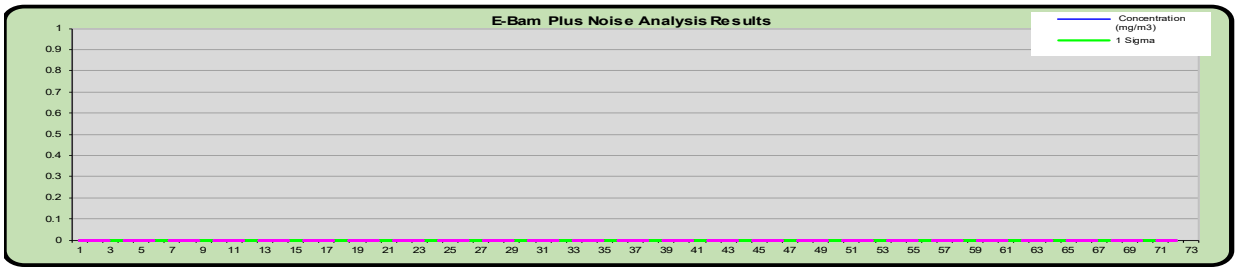
›rm No. DEP 03-24-D Effective xxxx 2021

Met One E-BAM Plus Particulate Matter10 Background Determination Form

Identification Block					
Year		Site Name		AQS #	
Instrument	Met One E-BAM Plus	Serial No.	E-Bam Plus	Date Calibrated	

Test Start Date	
Test End Date	
Previous BKGD Value	
BKGD set to "0" during Test	Yes
Zero Data Average (µg)	#DIV/0!
Hourly Standard Deviation (σ)	#DIV/0!
Hourly Standard Deviation wihting < 5 µg	#DIV/0!
Enter Background Value in E-BAM Plus (mg)	#DIV/0!





Operator Comments:

Performed by: Date:

Operator Comments:

Verified by Date:

Test Instructions

1) The E-Bam Plus should be completely installed, operational and at its field site before starting the background determination test.
2) Allow the E-Bam Plus to run no less than 76 hours and discard the first 4 hours.
3) Ensure the E-Bam Plus has been calibrated and that no leaks are present.
4) Go to the Operate menu to select Stop Sample, then go to the Setup menu to select Background, record the existing BKGD value, then set the BKGD to zero.
5) Remove the PM10 inlet and install the BX-302 zero filter. Run the E-BAM Plus for at least 76 hours with the zero filter.
6) Exit the Background menu, go to the Operate menu, select Start Sample to begin sampling.
7) Copy the most recent 72 hourly concentration data points into this sheet and analyze the results.
8) The negative of the zero average is the correct BKGD (background) setting. Enter it into the E-BAM Plus.
9) Remove the BX-302 zero filter and resume normal operations.
10) Save the results of this test. The test may be performed annually to audit the performance of the E-BAM Plus.

APPENDIX E: MAINTENANCE FORM

Form No. DEP 03-24-E Effective on: xxxx/2021

Met One E-BAM Plus Particulate Matter 10 Monitor Maintenance Log

Identification Block							
Year:		Site Name:		AQS #:		Parameter:	PM10
Instrument Mfr:		Model:		Serial #:		Date Calibrated:	

	Maintenance Activity	Nozzle/Vane Cleaning/ Inspection	Inspect Water Collector and Seals	Clean PM10 Inlet	Clean Inlet Probe line & downtube	Clean Temp & Rh Shield	Nozzle Interior Cleaning	Pump Muffler Change	Background Determination	Rebuild Pump		
	Frequency	Bi-Weekly	Bi-Weekly	Monthly	Quarterly	Quarterly	Semi-Annual	Semi-Annual	Annual	As Needed		
	Date Last Performed											
	Date Due											
Maintenance Date	Operator										QA Reviewer	Review Date

Comments

APPENDIX F: SEMI-ANNUAL AUDIT FORM

FLORIDA PRIMARY QUALITY ASSURANCE ORGANIZATION
SEMI-ANNUAL AUDIT, E-BAM PLUS

Agency:		Performed By:	
Site Name:		Parameter:	PM10 Continuous
Site AQS#:		Audit Date:	

Audit Start Time: _____ Audit End Time: _____

Ambeint Particulate Monitoring Equipment			
Data Acquisition System			
Brand/Model	Serial #:	Channel #:	Comparison Date
Particulate Analyzer			
Analyzer:	Met One E-BAM PLUS	Head Inlet # :	
Serial Number:		Filter RH%:	
Mass Foil Set # :		Ambient RH%:	
Firmware Version		ilter Temperature (°C	
CPLD Version:		Date Calibrated:	

Audit Equipment				
Measurement Device	Brand/Make	Model	Serial #	Certification Date
Flow Standard				
emperature Standar				
Pressure Standar				
Time Standard				

Meterological Audit			
Analayzer Component	Analyzer Measurement	Audit Device Measurement	Difference
Chronometer (hh:mm)			
Ambient Temperature (°C)			
Ambient Pressure (mmHg)			

Volumetric Flow Rate Audit				
Pre Audit Leak Check			Analyzer Reading	Audit Reading
Sheath Flow:		Sheath Flow		
Total Flow:		Total Flow		
				Acceptance Results
Post Audit Leak Check		Sheath Flow		
Sheath Flow:		Total Flow		
Total Flow:		Design Flow		

Span Membrane Check:	Span	Mass	Error

Audit Comments:

QA Reviewer: _____ Review Date: _____

QA Comments: