

Met One BAM-1020 Operation Key Points

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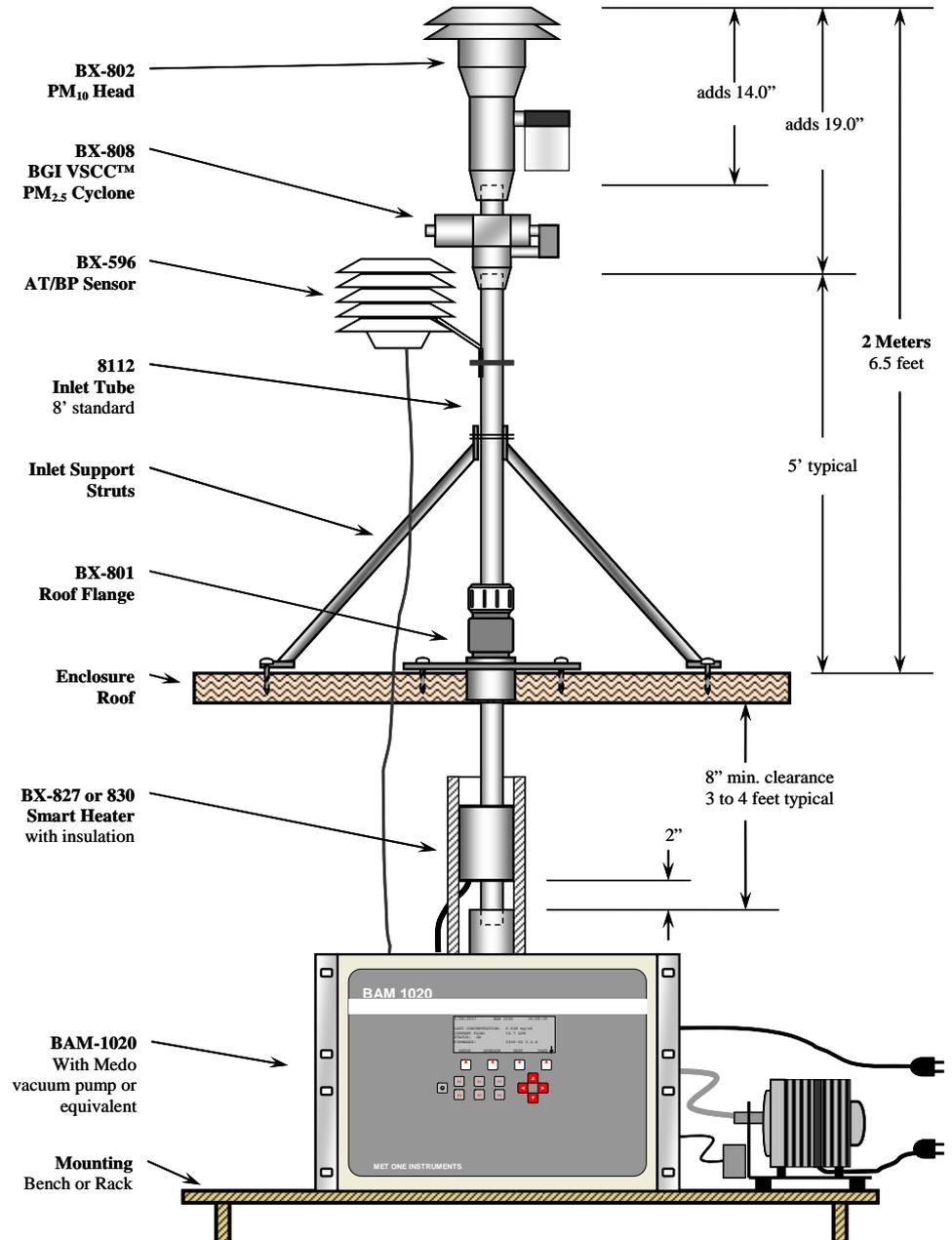


Introduction

- A consensus standard operating procedure (SOP) is available for the new Met One Beta Attenuation Monitor (BAM)-1020 PM_{2.5}, now designated Federal Equivalent Method EQPM-0308-170.
- SOPs help ensure consistency in operation, validation, and ultimately reporting of high quality data in real-time on AIRNow.gov and state and local web sites and for comparison to the National Ambient Air Quality Standards (NAAQS).
- These slides summarize key BAM operational issues.



Schematic for Met One
 BAM-1020 PM_{2.5} Federal
 Equivalent Method
 EQPM-0308-170



Topics

- Performing an acceptance test
- Selecting an enclosure
- Installing the BAM
- Setting up and configuring
- Maintaining and quality controlling
- Validating data and quality assuring



Performing an Acceptance Test

- Key steps in an acceptance test
 - Load tape and run self-test
 - Perform a leak check
 - Verify flow, temperature, and pressure
 - Perform a bench zero test (before transport to a less stable field environment)
- The 72-hr zero filter, or background, test is required at the time of field installation.
 - It is important that this test be conducted at the field site to account for site-specific background noise, which is input as the BKGD value in the BAM configuration.
 - From a practical standpoint, the more remotely located the actual field site is, the more thorough the bench testing should be.



Selecting an Enclosure

- The enclosure needs to meet the following specifications:
 - Temperature range of 0-50°C
 - RH range of 0-90%, non-condensing
- It is vital to minimize within-hour temperature fluctuations.
 - Fluctuations > a few degrees C within an hour can perturb concentration measurements on the order of several micrograms.
 - Because heating, ventilating, and air conditioning (HVAC) cycling commonly occurs multiple times per hour in small or poorly insulated enclosures, BAM performance can be compromised.



Installing the BAM

“Nuts and bolts” precautions

- Select a location in the shelter with minimum temperature fluctuation.
- Ensure that the inlet is perpendicular.
- Provide adequate clearance for access, including the top and rear of the instrument.
- **Properly ground the BAM to ensure stable background: inlet to chassis and chassis to ground.**
- Use an Uninterruptable Power Supply (UPS) to mitigate data loss. However, the UPS should be capable of powering BOTH the BAM and the pump. Powering the BAM during a sample cycle with no air flow can potentially damage the mass flow controller.
- Replace the pump muffler with a 2-3 ft length of Tygon tubing which will provide noise control and improve pump performance.
- Equip high altitude sites specifically with the GAST model pump (not MEDO).



Setting Up and Configuring

- Power on and warm up
 - Verify that all wiring connections are attached appropriately. Sensors that are not properly connected, or that are connected after the BAM-1020 is powered up, may not be recognized.
 - Allow the unit to warm up for at least one hour which allows the vacuum tube in the beta detector to stabilize.
 - Discard the first two or three hours of data following power-up.



Setting Up and Configuring (Cont'd)

- Load tape and self test
 - When tape loading is complete, the pinch roller assembly must be unlatched and lowered into place.
 - Tighten the tape spool covers sufficiently; they can loosen during operation and cause a Tape Error and loss of data. Do not over-tighten to avoid damaging the spool threads.
 - Align the filter tape so that it is centered on all the rollers. Rollers on newer units are scored (marked) to visually help center the tape.
 - Always use an empty core tube on the take-up spool and never fasten the tape to the aluminum hub.
 - One roll of tape should last more than 60 days under normal operation. Keep several spare rolls of tape to avoid data interruptions. Some agencies save the used rolls of tape for post-sampling analysis.



Setting Up and Configuring (Cont'd)

- Verify pneumatic system performance
 - Perform leak check
 - Verify flow rate
 - First, verify temperature
 - Second, verify pressure
 - Third, verify flow

A single point flow verification is sufficient at setup. If pump capacity or flow controller operation is in question, a multi-point flow verification may be used.



Setting Up and Configuring (Cont'd)

- Settings required to meet FEM EQPM-0308-170
 - Sample time of 42 minutes
 - Count time of 8 minutes
 - CONC TYPE: ACTUAL
 - FLOW TYPE: ACTUAL
 - FLOW RATE: 16.7 lpm
 - HEATER: AUTO, RH setpoint 35%, Delta-T control “off”
- Other recommended settings
 - Offset of $-15 \mu\text{g}/\text{m}^3$
 - Lower limit clamp of $-15 \mu\text{g}/\text{m}^3$



Setting Up and Configuring (Concl'd)

- **Mandatory 72-hr background zero test**
 - Allow to run for a day to equilibrate before the test.
 - Use only digital data to calculate background.
 - Minimize temperature fluctuations during test.
 - Remove the first 4 hours of data from the zero test results (i.e., need to run 76 hours).
 - The maximum allowable value is $20 \mu\text{g}/\text{m}^3$.
 - No values below $-14 \mu\text{g}/\text{m}^3$ (due to FEM BAM default lower limit clamp of $-15 \mu\text{g}/\text{m}^3$).
 - If the BAM reports errors, rerun the test.



Maintaining and Quality Controlling

- Verify flow rate monthly ($\pm 4\%$)
 - Flow rates outside $\pm 4\%$ of the 16.7 lpm design flow require calibration.
- Perform leak check monthly (< 1.0 lpm)
 - Leak check tolerances vary by agency; ideal is < 0.4 lpm.
- Check error log monthly
- For FEM, follow FRM cleaning protocols
 - Clean nozzle and vane monthly
 - Clean PM_{10} inlet monthly
 - Clean VSCC monthly



Maintaining and Quality Controlling (Cont'd)

- Replace filter tape every 2 months
- Run self-test every 2 months or when any significant maintenance is performed
- Conduct volumetric flow calibration every 2 months
 - Calibrate the temperature and pressure sensors first. It is important that the reference temperature instrument be thoroughly equilibrated to ambient conditions; this may take up to an hour if the sensor is in the body of the device.
- Verify critical BAM settings every 2 months
 - These settings include calibration constants, sample time, count time, flow settings, heater settings, and clock
- Test filter temperature and RH every 6 months
- Test Smart Heater every 6 months



Maintaining and Quality Controlling (Concl'd)

- Replace the board stack coin-cell battery annually
 - Battery CR2032 or equivalent
 - This battery maintains the configuration parameters, data log, and error log when the BAM-1020 is powered down
 - Even with adequate charge, corrosion can cause unpredictable symptoms, such as incorrect display of flow rates or other screen data
 - The BAM-1020 must remain powered up when replacing the battery or data will be lost
 - Note that the BAM-1020 manual troubleshooting section says to replace the battery every *10 years*. This is a misprint.



Validating Data and QA

- Verify that externally acquired (data logger) data agree with directly downloaded digital data from the BAM
 - Analog data should be within $\pm 1.0 \mu\text{g}/\text{m}^3$ of BAM internal data
 - Digitally logged data should agree exactly with BAM internal data
 - Time stamping errors can occur with digital and analog data acquisition
 - Analog data logger must be programmed to account for BAM offset
- Identify 900 range values (assuming $15 \mu\text{g}/\text{m}^3$ BAM offset)
 - Value of $985 \mu\text{g}/\text{m}^3$ indicates full-scale output on error
 - Value of $905 \mu\text{g}/\text{m}^3$ indicates invalid data in Early Mode operation
- Verify that sample volume (Q_{tot} : 0.700 m^3) is rock solid
- Download and evaluate error log
- Download the configuration file and check for any configuration file changes



A Consensus SOP is planned for availability on AMTIC
www.epa.gov/ttn/amtic

* Vaughn D.L. (2009) Standard operating procedure for the continuous measurement of particulate matter: Met One BAM-1020 PM_{2.5} Federal Equivalent Method EQPM-0308-170. Prepared for the U.S. Environmental Agency, Research Triangle Park, NC, by Sonoma Technology, Inc., Petaluma, CA, STI-905505.5-3645-SOP, September.

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