

U.S. EPA
Technical Systems Audit
Supplementary Checklist for PM_{2.5} Continuous Monitors
Met One Instruments BAM-1022 PM_{2.5} FEM

Introduction and Overview:

This checklist is intended to support EPA Regional staff conducting Technical Systems Audits of PM_{2.5} continuous monitors operated by State, Local, or Tribal monitoring Agencies. This checklist supplements Appendix H of the QA Handbook Volume II (<http://www.epa.gov/ttn/amtic/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf>). The checklist attempts to address the most important aspects of ensuring a PM_{2.5} continuous monitor is set-up, operating, and reporting data to meet the intended monitoring objectives (e.g., NAAQS and AQI). This checklist does not attempt to redundantly capture the activities already addressed in the Appendix H checklist; however, there are a few places where an item already addressed in Appendix H is further detailed to ensure the auditor has the key information to conduct the audit.

The audit is performed by looking at several documents and assessments prior to travelling to a site and then by inspecting how the monitor is set-up, operated, maintained, and reporting data at the site to ensure the method can appropriately support its intended monitoring objectives.

While this checklist is detailed, it attempts to balance calling attention to the best practices without having so much detail that the auditor might not be able to successfully complete addressing all parts of the checklist. Additionally, and where appropriate, illustrations and images are included to provide a reference for the auditor. If there is a need for a visual to illustrate a setting or practice that is not included, please ask so that we can continue to improve this checklist.

This checklist is organized into three basic areas that cover the Technical Systems Audit (TSA). An addendum includes references to help achieve satisfactory TSA.

1. Preparation and Planning:

Prior to travelling to an agency, the auditor should review the agency’s Quality Assurance Project Plan (QAPP), annual monitoring network plan, assessments of data, and other documentation (e.g., list of designated reference and equivalent methods) to determine if the monitor is meeting its stated objectives and producing data that meets the needs of the data users. (i.e., meeting DQOs). This preparation and planning should be very similar regardless of the specific method being operated by the monitoring agency.

2. On-Site Technical Systems Audit:

While on site the auditor should spend time reviewing the set-up, operation, maintenance, and reporting of data to ensure the method is functioning appropriately. If there are items observed during the audit that can be addressed while on-site without compromising data quality (e.g., cleaning the VSCC during the period the monitor is not pulling air), then these should be communicated immediately to the agency staff. The on-site audit activities are organized in a method-specific checklist.

3. Follow-Up and Review:

The auditor should ensure a written report is provided in a timely manner to the monitoring agency. Audit findings should be grouped into one of three areas: a) Significant Findings, b) Observational Concerns, or c) Best Practices. Significant findings should address those items that appear to affect data quality in an adverse way. Observational concerns should include items that help ensure the method is operating appropriately such as adherence to the operations manual. Best practices are areas that would be beneficial to implement that are not expected to affect data quality but may be useful to implement for efficiency or to ensure the monitor is appropriately protected. Additionally, for Significant Findings, the auditor should request that the agency provide documentation to the EPA Regional office that the items are addressed. For example, zero test data could be provided to document that a new zero test was conducted.

4. Addendum

The auditor should reference the extra resources to help the agency achieve a successful TSA.

1. Preparation and Planning:

Regional staff should prepare for a TSA prior to travelling to meet with an agency and their sites by reviewing several documents, assessments, and reports of data. This preparation will help to ensure the auditor becomes familiar with the method and use of the data as well as to help inform area(s) of focus during the TSA. The preparation table below with recommended documents, assessments, and databases that should be reviewed prior to going into the field.

Table 1 – Preparation Table:

Document or Assessment or To Do	Where or who to find	What to look for or Document or Data?	Comments
Quality Assurance Project Plan (QAPP)	Ask agency in advance for current copy	Ensure QAPP is signed by all parties, is no older than 5-years, meets EPA QAPP Standard and Part 58 regulatory monitoring requirements	Inspect for inclusion of Validation Tables from QA-Handbook are present and measurement results are validated against these criteria.
Annual Monitoring Network Plan.	Agency’s current and/or planned annual Monitoring Network Plan.	Review and identify the sites you will visit that have PM _{2.5} continuous monitors; whether they are pre-FEM or FEM; and their stated monitoring objectives.	Note any FEMs that are either already approved for exclusion or requested for exclusion from the PM _{2.5} NAAQS due to not meeting performance requirements.
Review latest copy of “List of Reference and Equivalent Methods” and compare to annual plan.	https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants	Read method designation description for PM _{2.5} continuous FEMs that are at sites you will visit. Document method designation number and minimum firmware requirements in descriptions.	
Instrument company web site.	Look online for the instrument company.	Look for latest version of instrument manual and firmware for FEMs; however, you should not need to download these.	Notes: 1. Some instrument company web sites may be password protected. 2. In cases where a pre-FEM monitor is being run, but the latest manual is specific to the FEM version, the agency may not need the latest version of the manual.
Run AQS reports (e.g., AMP450NC) and ensure all PM _{2.5} continuous monitors identified in Annual Plan are reporting to AQS.	Use AQS if you have an active user login and password. Alternatively, use AirData (http://www.epa.gov/airdata/) if you do not have ready access to AQS. All ambient PM data in AirData originates from AQS via the DataMart.		Monitors reporting to parameter code 88101 will be used in NAAQS and AQI. Monitors reporting to parameter code 88502 will be used in the AQI.

Document or Assessment or To Do	Where or who to find	What to look for or Document or Data?	Comments
PM _{2.5} continuous monitor comparability assessment tool.	https://www.epa.gov/outdoor-air-quality-data/pm25-continuous-monitor-comparability-assessments	For sites that will be visited, run assessment and identify any performance issues (primarily focus on additive and multiplicative bias).	Notes: A collocated FRM is required for the assessment to run.
Run an hourly data report for the PM _{2.5} continuous monitor.	AMP 350 or download data.	Verify the following: 1. What is the lowest hourly reading recorded to AQS? There should be some data less than 0. If not, note and review data farther back in time. 2. What is the highest hourly value recorded to AQS? There should be no data at 985 or 99999. Also, the hourly data record is a good way to check that the instrument was offline during period of zero test.	An absence of any slightly negative (down to -10 µg/m ³) data may be biasing the 24-hour averages high. Among PM _{2.5} FEMs, only the GRIMM is known to never have a negative hourly value. Significantly high data at or near 99999 µg/m ³ indicate that the instrument has gone to full scale. This is usually associated with an error code and should not have been reported.
Assessment of collocated FRM data. Where appropriate, this will help to determine whether the issue with the PM _{2.5} data is the continuous FEM monitor or FRM sampler.	AMP 256 or PM _{2.5} FRM data Quality Dashboard at: https://www.epa.gov/amtic/ambient-air-monitoring-assessmentsdata	Where there are comparability issues between the FRM and continuous FEM, we would like to verify that the FRM to FRM collocation meets DQOs. Look to see that the FRM to FRM CV UB is less than or equal to the 10% CV?	In cases where the “Collocated Detail Report” is providing the CV UB for the PM _{2.5} continuous monitor collocated with an FRM, the calculation is often relatively higher than the FRM to FRM collocation, even in cases where the additive and multiplicative biases statistic are met.
Reports of flow verifications and audits.	AMP 251	Are flow rate verifications and audits acceptable?	
Interview staff associated with operations, QA, or data use and ask what is working well or any concerns.		Ask if there are any known or potential issues in the set-up, operation, maintenance, or reporting of the PM _{2.5} continuous monitors?	
SOP	Ask agency in advance	1. Adherence to method requirements prescribed in instrument company manual (e.g., settings in firmware) 2. Incorporation of best practices (e.g., are more frequent zero tests performed, where appropriate?)	

2. On-site Technical Systems Audit of Met One Instruments BAM-1022

Conducting the on-site audit of the Met One Instruments BAM-1022 involves evaluating several aspects of the set-up, operation, maintenance, and reporting of the monitor. For this checklist, questions are grouped into four areas:

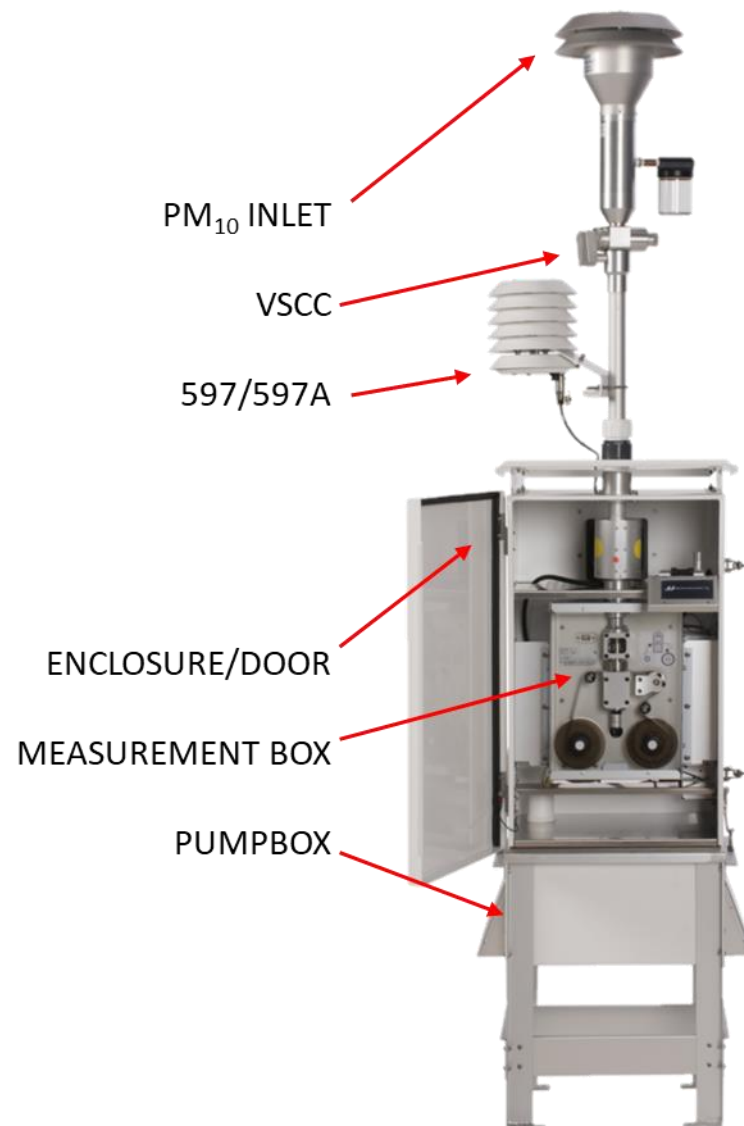
- a. Items to review prior to travelling to site.
- b. Items to review at the monitor.
- c. Items to review in the firmware and data logger.
- d. Maintenance and QC records to review.

This checklist is applied to FEM Met One Instruments BAM-1022 monitors.

To minimize data loss, be cognizant of when the BAM-1022 is taken out of sample mode. For example: stop the sample at close to after the top of the hour as possible – XX:01, XX:02, XX:03. This will allow most of the hour to complete the TSA.

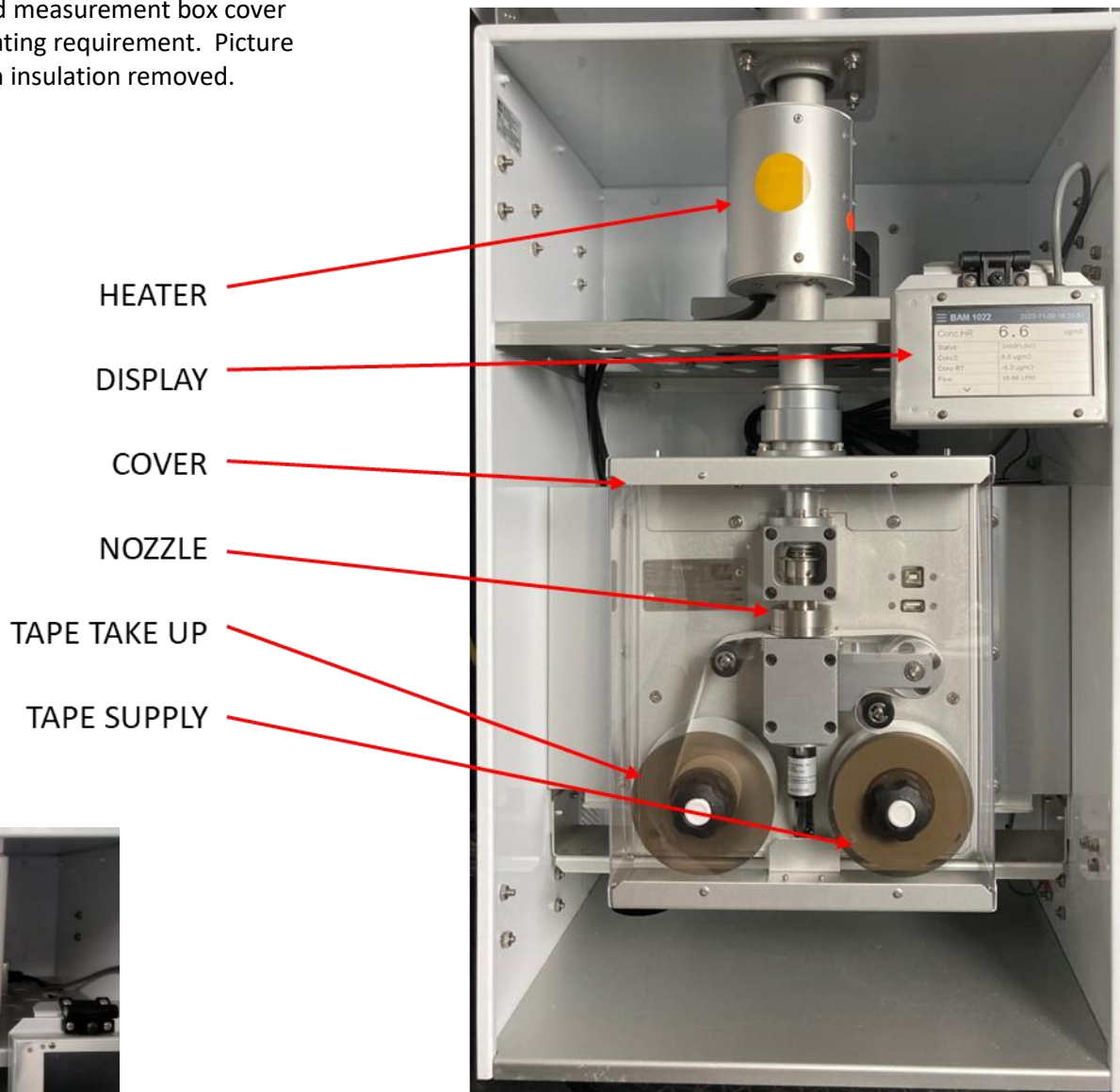
Typical Met One Instruments BAM-1022 PM_{2.5} set-up:

Note: 22" W x 18" D x 55" H dimensions are necessary part of a requirement.



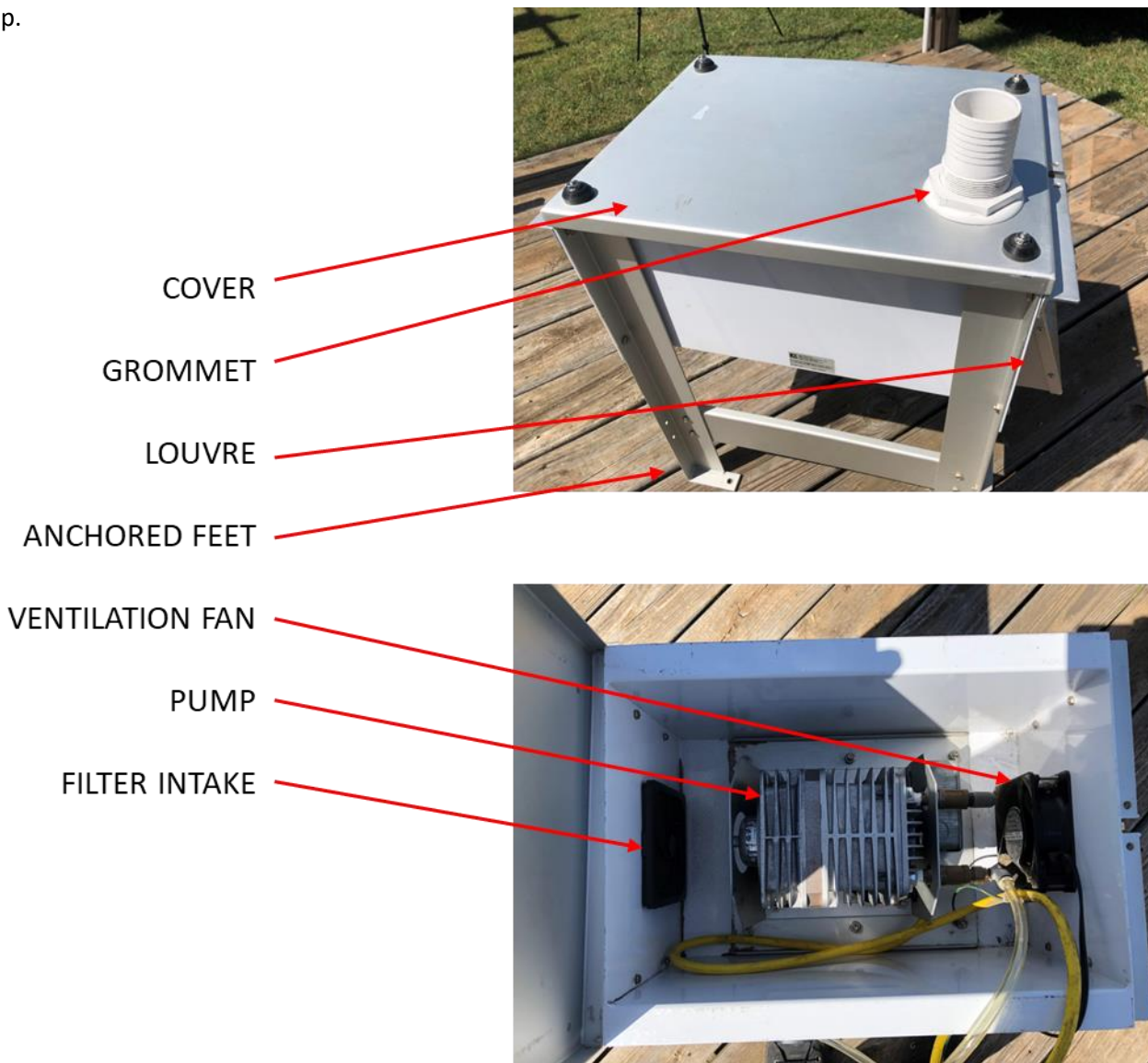
Inside Met One Instruments BAM-1022 PM_{2.5} set-up:

Note: Heater insulation and measurement box cover are necessary part of operating requirement. Picture on the right illustrated with insulation removed.



Inside Met One Instruments BAM-1022 PM_{2.5} set-up:

Note: Pump box closeup.



Met One Instruments BAM-1022 PM_{2.5} User Interface:

Note: BAM-1022 is touch screen interface. Illustrations below will help to navigate menus.

The screenshot shows the user interface for the BAM-1022 PM_{2.5} monitor. At the top, a dark grey header bar contains a hamburger menu icon on the left, the text "BAM 1022" in the center, and the date and time "2022-11-10 08:19:42" on the right. Below the header, the main display area shows "Conc HR" followed by a large "4.0" and "ug/m3". Below this, a table displays various measurement parameters. Red arrows from labels on the left point to specific UI elements: "DATE & TIME" points to the header bar; "MAIN MENU KEY" points to the hamburger menu icon; "LAST HOURLY MEASUREMENT (ACTUAL CONDITION)" points to the "Conc HR" label; "REAL TIME STATUS" points to the "Status" row in the table; "LAST HOURLY MEASUREMENT (STANDARD CONDITION)" points to the "ConcS" row; "REAL TIME FLOW" points to the "Flow" row; and "DOWN KEY" points to a downward-pointing chevron icon at the bottom of the table.

DATE & TIME	
MAIN MENU KEY	
LAST HOURLY MEASUREMENT (ACTUAL CONDITION)	
REAL TIME STATUS	
LAST HOURLY MEASUREMENT (STANDARD CONDITION)	
REAL TIME FLOW	
DOWN KEY	

BAM 1022		2022-11-10 08:19:42
Conc HR	4.0	ug/m3
Status	SAMPLING	
ConcS	4.1 ug/m3	
Conc RT	-3.4 ug/m3	
Flow	16.65 LPM	
	▼	

Met One Instruments BAM-1022 PM_{2.5} User Interface:

Note: BAM-1022 is touch screen interface. Illustrations below will help to navigate menus.

DOWN KEY SCREEN #1

☰ BAM 1022		2022-11-10 08:20:23
Conc HR	4.0	ug/m3
AT	24.5 C	
RH	50 %	
BP	747.9 mmHg	
∨		

Met One Instruments BAM-1022 PM_{2.5} User Interface:

Note: BAM-1022 is touch screen interface. Illustrations below will help to navigate menus.

DOWN KEY SCREEN #2

☰ BAM 1022		2022-11-10 08:20:47
Conc HR	4.0	ug/m3
FT	31.8 C	
FRH	26 %	
WS	0.0 m/s	
WD	0 Deg	
▼		

Met One Instruments BAM-1022 PM_{2.5} User Interface:

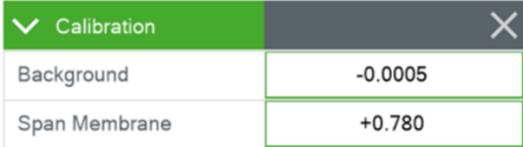
Note: BAM-1022 is touch screen interface. Illustrations below will help to navigate menus.


MAIN MENU SCREEN

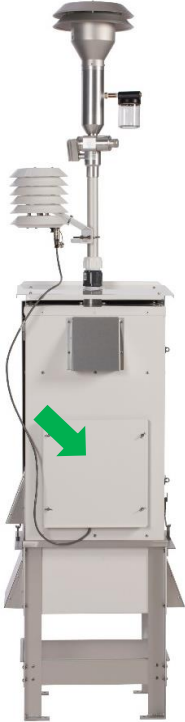

BAM 1022		2023-01-23 11:50:01
> Operate	4.3	ug/m3
> Test	SAMPLING	
> Setup	4.3 ug/m3	
> Alarms	11.6 ug/m3	
	16.74 LPM	
	∨	



Table 2 – Audit Questions for the Met One Instruments BAM-1022 PM_{2.5} Continuous Monitor:


Question #	Item	Response	Comments
a. Items to review prior to travelling to site:			
1	Confirm the make and model of the PM _{2.5} continuous monitor?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Met One Instruments BAM-1022. The SETTINGS.TXT file will indicate instrument model. If practical, look for approval prior to travelling to site.
2	Does this make and model match what is identified in the annual plan and reported to AQS?	<input type="checkbox"/> Yes <input type="checkbox"/> No	If practical, look for approval prior to travelling to site.
3	Is the latest SOP and instrument manual for the PM _{2.5} continuous monitor available at the station?	<input type="checkbox"/> Yes <input type="checkbox"/> No	The latest instrument manual versions are: V1-BAM-1022-9800 Rev G https://metone.com/wp-content/uploads/2022/02/BAM-1022-9800-Rev-G.pdf V2-BAM-1022-9805 Rev F https://metone.com/wp-content/uploads/2022/02/BAM-1022-9805-Rev-F.pdf
4	Is the SOP current? Identify approval date.	<input type="checkbox"/> Yes <input type="checkbox"/> No	If practical, look for approval prior to travelling to site.

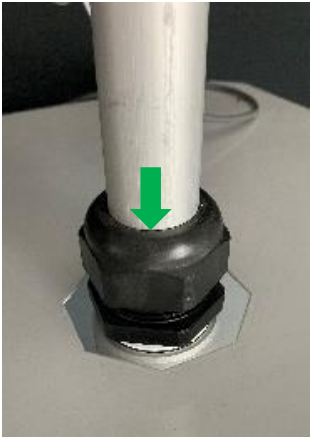

Question #	Item	Response	Comments
5	Review the most recent zero test data and verify that the BACKGROUND value calculated is the opposite of the average of that zero test data.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>It is critical that the value calculated is the opposite of the 72-hour average from the most recent zero test. For example, if the 72-hour zero test averaged +0.5 µg/m³, then the BACKGROUND value is “-0.0005.”</p> <p>Go to MAIN MENU > SET UP > CALIBRATION</p>  <p>ADVANCED</p> <p>The SETTINGS.TXT file will indicate current instrument background. If practical, look for approval prior to travelling to site.</p>
6	In reviewing the most recent zero test, was the standard deviation of the test data < 2.4 µg/m ³ ?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>If > 2.4 µg/m³, investigate. Remember the BAM-1022 is a full outdoor unit. Has BACKGROUND value shifted ± significantly; example > ± 2 µg/m³? If yes, is it apparent as to why?</p> <p>Use professional judgement based on historical zero tests. If practical, look for approval prior to travelling to site.</p>
7	In reviewing the most recent zero test, verify AT/FT, RH/FRH are maintained per the manufacturer.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>Parse the monitor’s raw zero test data to show if FT is 5-10 C > AT and FRH is 25-50% < RH. This indicates normal operations. Reference addendum. If practical, complete this prior to travelling to site.</p> <p>If practical, look for approval prior to travelling to site.</p>

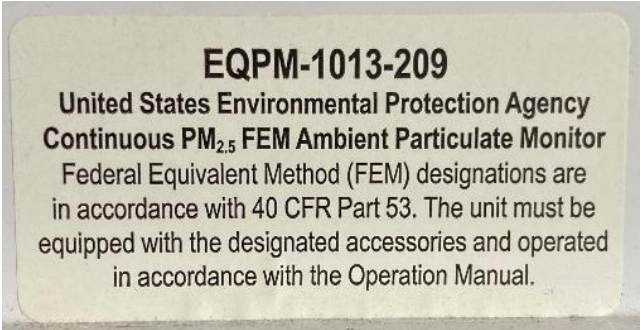
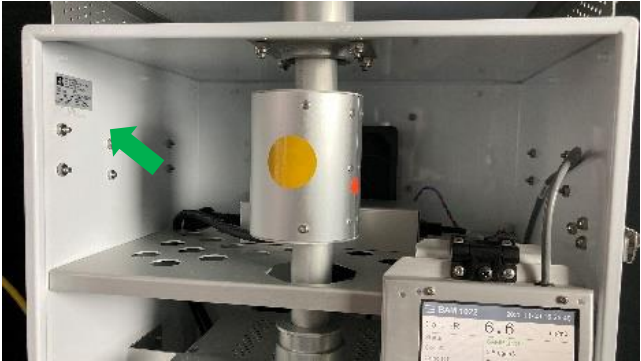
Question #	Item	Response	Comments
<i>b. Items to review at the monitor:</i>			
8	Are there any immediate concerns about the location of the monitor at the site?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Use professional judgement. Items of concern might include inlet obstruction(s), height, sun shield condition, unit's enclosure condition, pest(s), feet unanchored, visible damage(s), access to monitor.
9	Pump sound: The MEDO pump has a normal "low humming" sound. The GAST pump has a normal "high pitch" sound.	<input type="checkbox"/> MEDO <input type="checkbox"/> GAST	Noticeably loud or squealing pump sounds may indicate pump issues.
10	Pump box air flow: Is there air flow in and out of the pump box louvres?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>Pump box fan provides constant air flow in and out of pump box louvres.</p> 


Question #	Item	Response	Comments
11	Is the chassis of the monitor ground to an earth ground? How is this grounded?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>This is in addition to the ground associated with the electrical cord. Met One Instruments provide a ground cable in the monitor's accessory kit. This is apparent if there is a ground to earth wire exiting the back panel. Remove back panel to verify chassis ground post.</p>  


Question #	Item	Response	Comments
12	Is the PM ₁₀ inlet a “pie pan” design?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>Note: All PM_{2.5} continuous monitors nominally operating at 16.7 lpm should use the pie-pan inlet design.</p> 
13	Open the PM ₁₀ inlet, describe its cleanliness. Note any other issues.	<input type="checkbox"/> Very Dirty <input type="checkbox"/> Dirty <input type="checkbox"/> Slightly Dirty <input type="checkbox"/> Clean	<p>Note O-rings and silicone grease. PM₁₀ impactor well O-ring tend to break during disassembly. Do not disassemble unless agency has replacement O-rings on hand.</p>
14	Is the PM _{2.5} second stage separator an approved VSCC?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>Note there are two designs of the VSCC; however, all PM_{2.5} continuous monitors should use the designs below. The other VSCC design is used with BGI samplers.</p> 

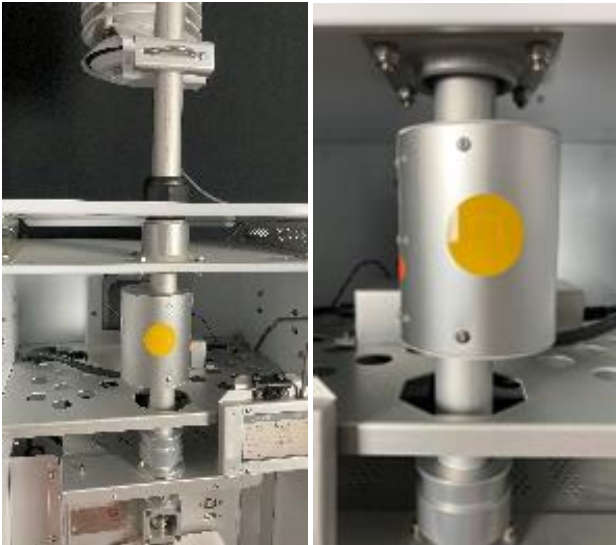

Question #	Item	Response	Comments
15	Open the VSCC, describe its cleanliness. Note any other issues.	<input type="checkbox"/> Very Dirty <input type="checkbox"/> Dirty <input type="checkbox"/> Slightly Dirty <input type="checkbox"/> Clean	Note dust pot, O-rings, silicone grease.
16	Is there a gill screen near the inlet that connects to the PM _{2.5} continuous monitor to provide an ambient temperature, ambient pressure, and ambient relative humidity readings?	<input type="checkbox"/> Yes <input type="checkbox"/> No	BAM-1022 FEM PM _{2.5} requires BX-597 or BX-597A. 
17	Describe the overall system plumbness. Describe any other issues.	<input type="checkbox"/> Yes <input type="checkbox"/> No	Use professional judgement.



Question #	Item	Response	Comments
18	Is the compression fitting around the downtube tight?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>This provides waterproofing for the BAM-1022 enclosure.</p> 
19	Describe any heat near the compression fitting and where the downtube inserts.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>This is normal part of the BAM-1022 operation.</p> 


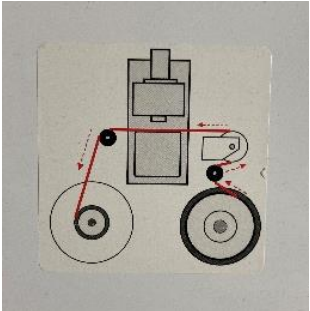
Question #	Item	Response	Comments
20	<p>Open the BAM-1022 door:</p> <p>If expected, is there an FEM sticker on the PM_{2.5} continuous Monitor?</p>	<p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p>	<p>EPA Class III Federal Equivalency Method (EQPM-1013-209) Designation sticker is on inside door. Serial sticker is inside enclosure left of heater.</p>  


Question #	Item	Response	Comments
21	<p>Open the BAM-1022 door:</p> <p>Are there any concerns about the inside of the enclosure?</p>	<p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p>	<p>Use professional judgement. Items of concern might include signs of water leak, excessive dust/dirt, enclosure condition, door insulation condition, bugs or bee's nest(s), measurement box cover missing, heater insulation missing. It is ok per the manufacturer to store some items inside the enclosure (filter tape, cotton swabs, manual, modem); but not cluttered.</p> 

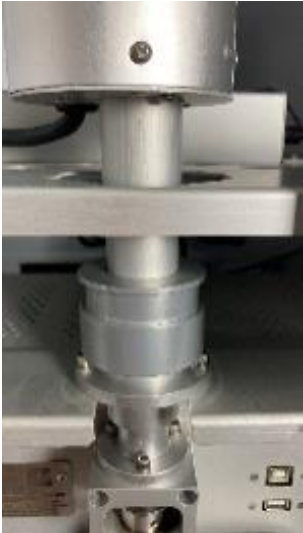
Question #	Item	Response	Comments
22	Open the BAM-1022 door: Is the aspiration fan running?	<input type="checkbox"/> Yes <input type="checkbox"/> No	This is normal part of the BAM-1022 operation. 



Question #	Item	Response	Comments
23	<p>Open the BAM-1022 door:</p> <p>Describe any heat on or near the smart heater? Does it appear the smart heater is operating? Is the heater insulated?</p>	<p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p>	<p>This is consistent heating system. A smart heater that is not working will have a cold down tube. BAM-1022 operates with a heater insulation.</p> 
24	<p>Remove heater insulation. Is it in good condition?</p> <p>Note where heater is mounted. Is it centered?</p>	<p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p>	<p>Use professional judgement. Heater set screws should be used to lock heater in place.</p> 

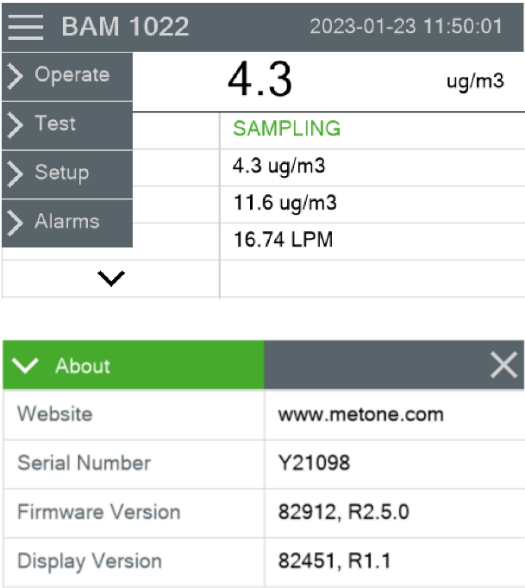
Question #	Item	Response	Comments
25	Remove measurement box cover. Is it in good condition?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>BAM-1022 operates with this cover.</p> 
26	Observe tape set-up. Has the tape run out or are there any other visible issues?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>The nozzle sits on the tape during sampling right in the center of the unit.</p> 

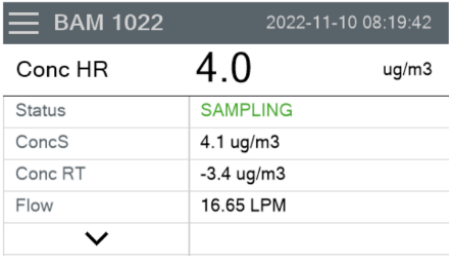
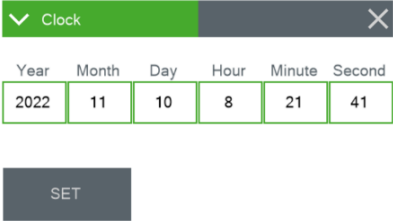
Question #	Item	Response	Comments
27	<p>Observe the tape that has already sampled. If applicable, describe any pin holes that may appear on the tape spots. Also note any water stains.</p>	<p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	<p>Pinholes are a symptom of the nozzle pinching down on the tape from lack of normal nozzle maintenance. Pinholes could result in lower readings in the data. Water stains are from loose downtube compression fitting or door seal issues.</p> 
28	<p>Observe the tape rollers and tape reels. Is the tape installed per the diagram? Is the tape aligned on the rollers? Is the tape tight on the reels?</p>	<p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	<p>Misaligned tape will cause tears. Slack in the tape on the take up side is a possible indicator of issues with tape movement system.</p> 


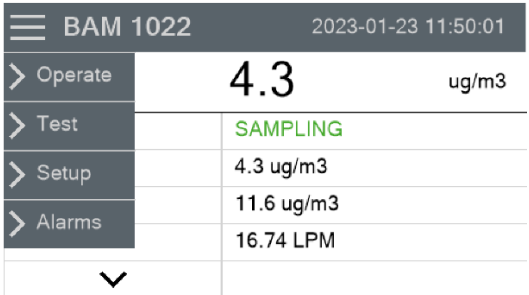
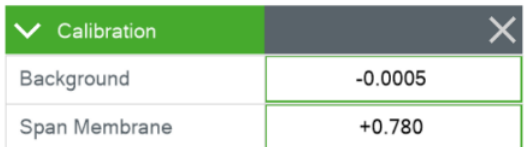

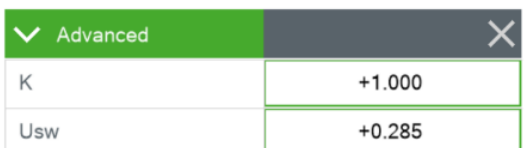
Question #	Item	Response	Comments
29	Observe the nozzle as it sits on the filter tape. If applicable, describe any visible debris on the bottom of the nozzle.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>The nozzle and vane are to be cleaned at regular intervals (typically monthly but every 2 months minimum) to mitigate debris build up.</p> 

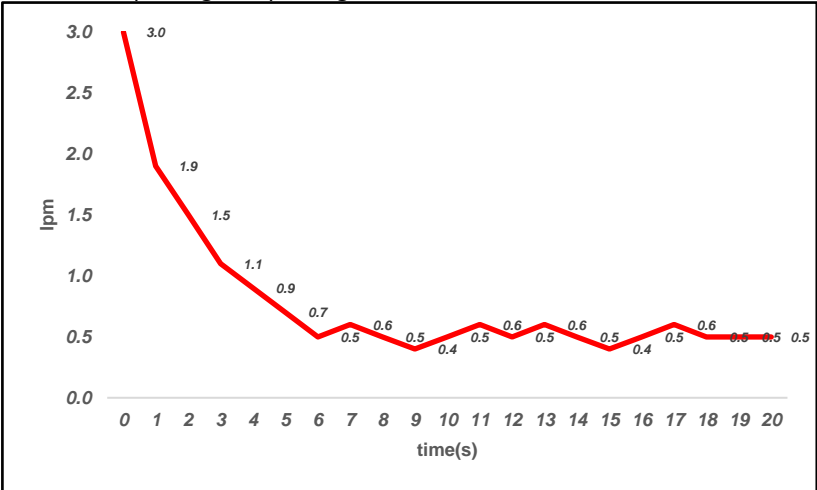
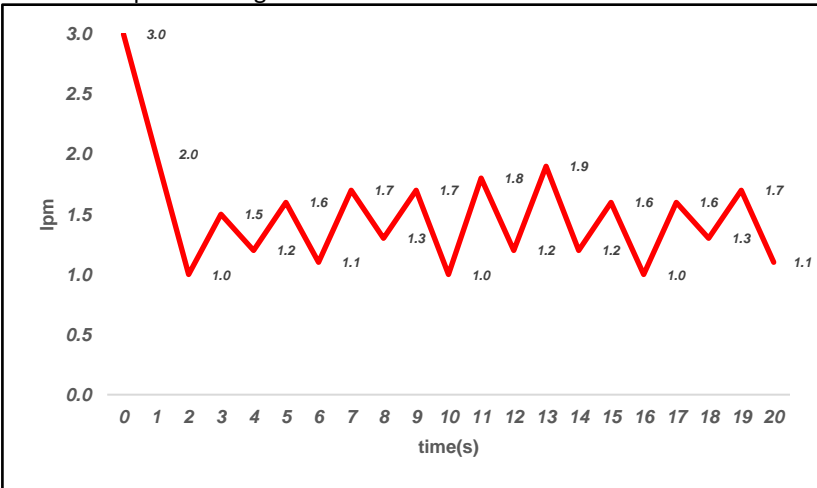
Question #	Item	Response	Comments
30	Inspect the inlet receiver where the downtube meets the measurement box. Is it inserted completely? Look for any signs of water leaks. Another sign of water may be stains on the tape or sampled tape spots.	<input type="checkbox"/> Yes <input type="checkbox"/> No	If water marks are found, this is an indication that the compression fitting around the downtube is leaking and either needs to be tightened or replaced. 

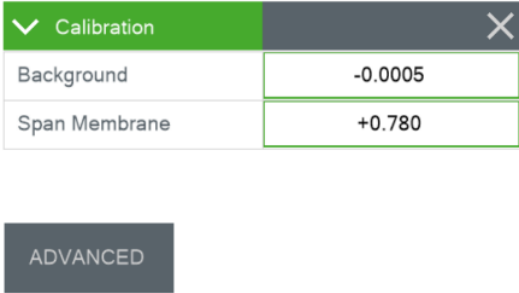
Question #	Item	Response	Comments
31	Separate enclosure box from pump box. Observe inside of pump box. Describe any issues.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>On this question, use professional discretion and judgement to minimize data loss. Issues with questions #7 and #8 will warrant pump box inspection. Items of concern might include signs of water leak, excessive dust/dirt, fan condition, fan filter condition, bugs or bee's nest(s), pump muffler, sample tube, power cable(s).</p>  
32	Describe any other issues with the monitor?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Use professional judgement.

Question #	Item	Response	Comments								
c. Items to review in the firmware and data logger:											
33	What version of software is identified on the monitor?	Go to MAIN MENU > OPERATE > ABOUT:	<p>All firmware versions are FEM approved. Current V1-BAM-1022 as of 2023 JAN 25: R1.0.10 Current V2-BAM-1022 as of 2023 JAN 25: R2.5.0</p>  <p>The screenshot shows the BAM 1022 monitor interface. At the top, it displays 'BAM 1022' and the date/time '2023-01-23 11:50:01'. Below this is a menu with options: 'Operate' (4.3 ug/m3), 'Test' (SAMPLING), 'Setup' (4.3 ug/m3), and 'Alarms' (11.6 ug/m3, 16.74 LPM). A dropdown arrow is visible below the menu. The 'About' screen is also shown, with a green header and a close button (X). The 'About' screen contains the following information:</p> <table border="1"> <tr> <td>Website</td> <td>www.metone.com</td> </tr> <tr> <td>Serial Number</td> <td>Y21098</td> </tr> <tr> <td>Firmware Version</td> <td>82912, R2.5.0</td> </tr> <tr> <td>Display Version</td> <td>82451, R1.1</td> </tr> </table>	Website	www.metone.com	Serial Number	Y21098	Firmware Version	82912, R2.5.0	Display Version	82451, R1.1
Website	www.metone.com										
Serial Number	Y21098										
Firmware Version	82912, R2.5.0										
Display Version	82451, R1.1										
34	Ensure monitor is not operating "alpha" firmware.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>Alpha firmware is not FEM approved. Example: R1.0.10a R2.5.0a</p>								

Question #	Item	Response	Comments
35	Observe the last hour reported on the display screen and compare this to data reported at the station data logger; are they the same?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>Note: The last hour reported may not be available for a couple minutes after the top of the hour; however, this data point represents the previous hour at the start of the hour. For example an updated value first posted at 10:02 AM should represent hour 09:00.</p> 
36	Is the clock on the BAM-1022 set to run on local standard time (i.e., not day light savings time)?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>MAIN MENU > SET UP > CLOCK</p> 
37	Compare time on BAM-1022 to time of data logger; is there any difference in time and if so how many minutes?	<input type="checkbox"/> Yes, Minutes: _____ <input type="checkbox"/> No	<p>Notes:</p> <ol style="list-style-type: none"> 1. In some cases, Met One Instruments BAM-1022 monitors are purposefully set to have an offset in the time reading. This is acceptable to ensure the latest BAM reading is interpreted by the data system to represent the previous hour. 2. The reported concentration value after the top of the hour needs to be reported to EPA databases for the previous start hour. For example, if a new value is reported on the BAM-1022 at 10:02 AM, then this value needs to be associated with a start hour of 09:00 AM.

Question #	Item	Response	Comments
38	<p>Verify factory settings against original factory calibration certificate* and note any discrepancies.</p> 	<p>Go to MAIN MENU > SET UP:</p> <p>1. > CALIBRATE > BACKGROUND > ADVANCED</p> <p>K: _____</p> <p>μsw: _____</p> <p>2. > TAPE ADVANCE</p> <p>Tape Period: 1 HOUR</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>3. > HEATER**</p> <p>Heater: 45</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA</p> <p>If No is checked, value observed: _____</p>	<p>Note 1: SAMPLE may or may not be stopped to verify settings. Note 2: An as found leak test is recommended prior to stopping flow. Question #39 will ask for the task. Note 3: **BAM-1022 V1 units only.</p>     <p>Note 3: All these items are listed in the SETTINGS.TXT file (reference addendum). *If needed, an electronic certificate can be provided by the factory.</p>

Question #	Item	Response	Comments
39	As found leak test performed? Or as left leak test performed?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<p>Passing leak rate is < 1.5 lpm, stable, over 20-30 seconds. Use illustration as guide.</p> <p>This is example of good, passing leak test:</p>  <p>This is example of failing leak test:</p> 

Question #	Item	Response	Comments
40	Verify the BACKGROUND value matches the last calculated BACKGROUND value from the most recent zero test.	<input type="checkbox"/> Yes <input type="checkbox"/> No Calculated Background: _____ Unit Background: _____	Go to MAIN MENU > SET UP > CALIBRATE > BACKGROUND 
41	If applicable, describe any other issues in the firmware or data logger?		Use professional judgement.

Question #	Item	Response	Comments	
d. Maintenance and QC Records to review:				
42	Does the agency use an audit sheet for regular maintenance and verifications? Or logbook?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Review audit sheets and/or logbook while on site to ensure maintenance and verifications are performed at expected frequencies. Electronic logs are acceptable.	
43	<u>Monthly and quarterly checks:</u> Is there a record documenting that the following checks are being performed at least monthly and/or quarterly, where identified?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Temperature audit/calibration within ± 2 C of reference <input type="checkbox"/> Barometric audit/calibration within ± 10 mmHg of reference <input type="checkbox"/> Flow audit/calibration within $\pm 4\%$ of reference SETTINGS.TXT file will show calibration factors.	<input type="checkbox"/> Leak check <input type="checkbox"/> Nozzle/vane cleaning <input type="checkbox"/> PM10 inlet cleaning (at least quarterly) <input type="checkbox"/> VSCC cleaning
44	<u>6 and 12-month checks:</u> Is there a record documenting that the following checks are being performed at least every 6 and 12 months, where identified?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> 12 month check - Perform 72-hour zero test. Nozzle/vane cleaning is recommended prior to zero test.	<input type="checkbox"/> Clean internal nozzle <input type="checkbox"/> Clean/replace pump muffler <input type="checkbox"/> Span mass audit <input type="checkbox"/> Analog voltage audits, if applicable

While on site, also perform the following:

- a. Interview the operator and have routine procedures described.
- b. Ask for documentation providing evidence that the flow standards being utilized by the operator and the agency’s own auditor (these are required to be separate devices) are NIST traceable and within certification. The Agency office may need to be contacted for these.
- c. Communicate any items that can be addressed in the field without compromising data quality.

3. Follow-Up and Review:

These activities are suggestions to help ensure the TSA leads to actionable improvements in the operation of the method, where appropriate. Regions that have their own policies for how TSAs are shared should follow those policies as directed by their management.

- a. Review your notes and checklist as soon as practicable and ideally on the same day after the TSA to ensure you completely document any activities of note.
- b. Begin drafting the TSA report of the audit findings as soon as possible after the TSA. It is important to get the TSA fully documented while it is fresh in your mind as well as to benefit the monitoring agency. If there are issues that need to be addressed quickly, they should be communicated during the exit briefing in addition to the formal TSA report.
- c. In the report, it is recommended to group findings into distinct categories as follows:
 - I. Significant Findings - Nonconformance with or absence of a specified requirement (regulatory, QMP, QAPP, SOP, etc.) or guidance deviation which could significantly impact data quality.
 - II. Observational Concerns - Practices with the potential detrimental effect on the ambient air monitoring program's operational effectiveness or the quality of sampling or measurement results.
 - III. Best practices - An infrequent deviation, error, or omission which does not impact the output of the quality of the work product but may impact the record for future reference.
- d. Share a draft electronic report with the appropriate manager(s) in the monitoring agency within 30 days of the TSA and request their review for factual errors in the report.
- e. With any comments received and/or actionable improvements already made by the agency, finalize the report for distribution to the agency. Include a recommended timeline to address any remaining significant findings.

4. Addendum

Below is example SETTINGS.TXT file for V1-BAM-1022.

Settings Report 2016-02-18 07:42:40 Firmware, 81650, R1.0.5 CPLD, 81699, R0.1.0 Serial Number, R23676 Location, 706 Baud Rate, 9600 Ethernet FlowControl, NONE Data Average, 1 HR RealTime Period, 15 Tape Period, 1 HR Tape Pressure, 250 K, 1.056 Background, -0.0014 Usw, 0.285 Audit Span, 0.713 Conc Units, ug/m3 USB Days, 1 USB Files, USER Analog Range 1, 0-5.0 V Analog Range 2, 0-5.0 V Conc Span, 1000 ug/m3 Conc Offset, -15 ug/m3 Hourly Timestamp, ENDING FT Set Point, 45.0 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 Name, Offset, Slope FLOW, -0.254, 1.004 AT, -0.490 BP, -2.080 FT, -1.182 UPPER, 0.796 LOWER, 1.159 FRH, 8.927 DAC Cal 1, 0.0,95,5.0,52970 DAC Cal 2, 0.0,25,5.0,52874
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Below is example ALARM.TXT file for **V1-BAM-1022**.

Alarm Report

2016-02-18 07:43:23

Location, 706, R23676

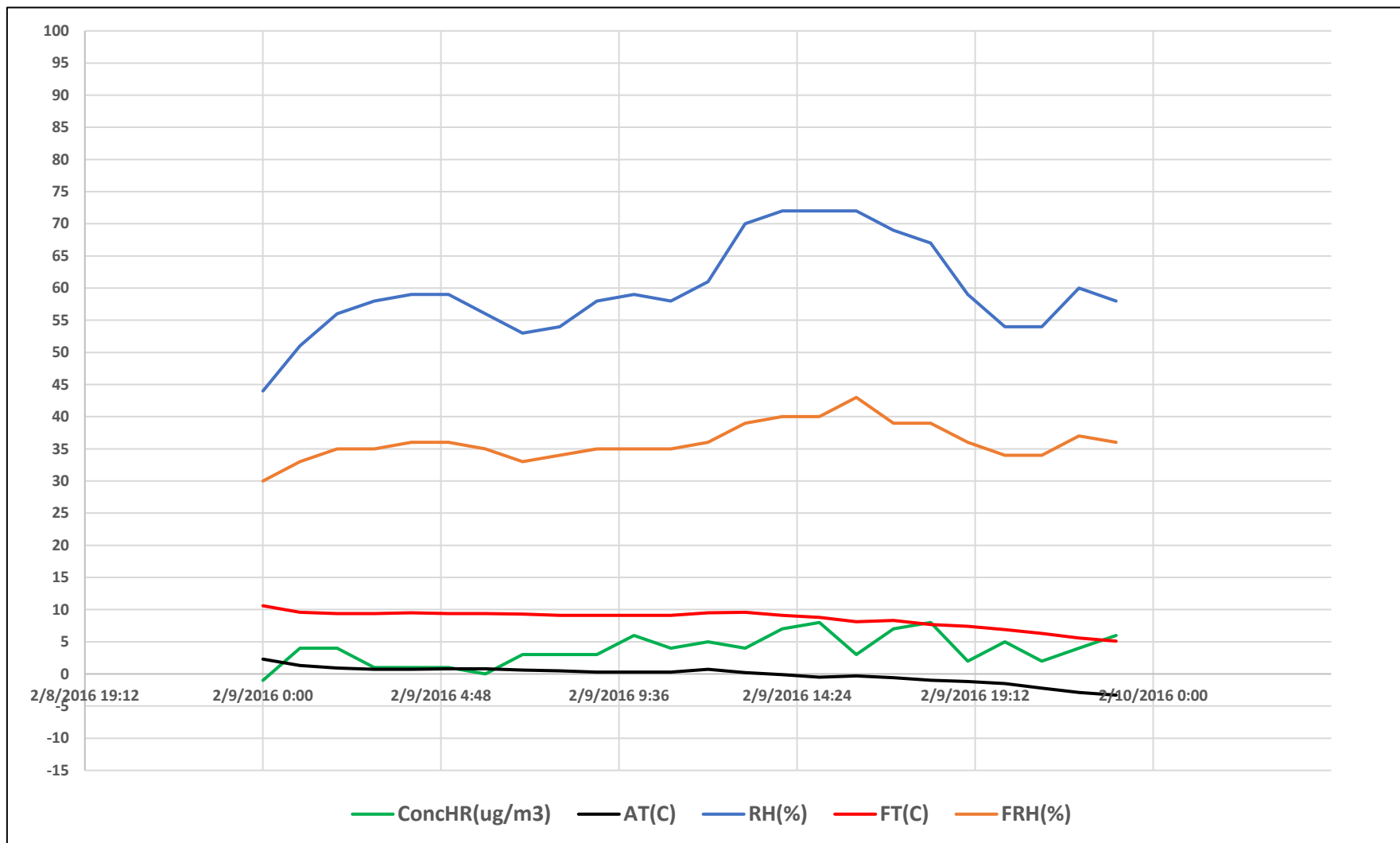
Time,Alarm

2015-02-07 10:58:45,POWER OUTAGE
2015-02-07 10:58:52,MAINTENANCE
2015-02-09 08:20:35,MAINTENANCE
2015-02-09 11:22:17,MAINTENANCE
2015-02-09 12:23:45,MAINTENANCE
2015-02-10 06:20:06,POWER OUTAGE
2015-02-10 06:21:07,SENSOR RANGE,BP,0.0
2015-02-10 06:27:04,POWER OUTAGE
2015-02-10 06:36:20,MAINTENANCE
2015-02-11 05:51:03,POWER OUTAGE
2015-02-11 05:51:47,MAINTENANCE
2015-02-11 06:29:33,MAINTENANCE
2015-02-11 07:20:02,MAINTENANCE
2015-03-16 06:31:50,POWER OUTAGE
2015-03-16 06:31:57,MAINTENANCE
2015-03-19 08:52:48,MAINTENANCE
2015-03-22 13:31:05,MAINTENANCE
2015-03-24 07:31:08,POWER OUTAGE
2015-03-24 07:31:14,MAINTENANCE
2015-03-25 03:36:07,POWER OUTAGE
2015-03-25 06:03:42,MAINTENANCE
2015-03-25 06:47:24,MAINTENANCE
2015-03-25 07:33:20,POWER OUTAGE
2015-03-25 12:14:26,MAINTENANCE
2015-03-26 03:41:08,POWER OUTAGE
2015-03-30 09:28:02,POWER OUTAGE
2015-04-01 10:44:58,MAINTENANCE
2015-04-02 06:58:17,MAINTENANCE
2015-04-02 07:29:00,MAINTENANCE
2015-04-06 06:13:02,POWER OUTAGE
2015-04-06 06:13:17,MAINTENANCE
2015-04-06 06:17:18,MAINTENANCE
2015-04-06 06:29:07,MAINTENANCE
2015-04-06 06:47:15,MAINTENANCE
2015-04-06 10:04:06,MAINTENANCE
2015-04-07 08:51:26,MAINTENANCE
2015-04-07 11:18:16,POWER OUTAGE
2015-04-07 11:20:51,MAINTENANCE

Below is example DATA.CSV file (24 hours) for **V1-BAM-1022**.

Time	ConcRT(ug/m3)	ConcHR(ug/m3)	Flow(lpm)	AT(C)	RH(%)	BP(mmHg)	FT(C)	FRH(%)	Status
2/9/2016 0:00	1	-1	16.7	2.3	44	735	10.6	30	0
2/9/2016 1:00	5	4	16.6	1.3	51	735	9.6	33	0
2/9/2016 2:00	7	4	16.6	0.9	56	735	9.4	35	0
2/9/2016 3:00	3	1	16.6	0.7	58	735	9.4	35	0
2/9/2016 4:00	3	1	16.6	0.7	59	734	9.5	36	0
2/9/2016 5:00	2	1	16.6	0.8	59	734	9.4	36	0
2/9/2016 6:00	3	0	16.6	0.8	56	735	9.4	35	0
2/9/2016 7:00	3	3	16.6	0.6	53	735	9.3	33	0
2/9/2016 8:00	1	3	16.6	0.5	54	735	9.1	34	0
2/9/2016 9:00	6	3	16.6	0.3	58	736	9.1	35	0
2/9/2016 10:00	4	6	16.6	0.3	59	736	9.1	35	0
2/9/2016 11:00	3	4	16.6	0.3	58	736	9.1	35	0
2/9/2016 12:00	8	5	16.6	0.7	61	736	9.5	36	0
2/9/2016 13:00	0	4	16.6	0.2	70	735	9.6	39	0
2/9/2016 14:00	8	7	16.6	-0.1	72	735	9.1	40	0
2/9/2016 15:00	10	8	16.7	-0.5	72	735	8.8	40	0
2/9/2016 16:00	2	3	16.7	-0.3	72	736	8.1	43	0
2/9/2016 17:00	9	7	16.6	-0.6	69	736	8.3	39	0
2/9/2016 18:00	2	8	16.6	-1	67	737	7.7	39	0
2/9/2016 19:00	7	2	16.6	-1.2	59	738	7.4	36	0
2/9/2016 20:00	5	5	16.6	-1.5	54	739	6.9	34	0
2/9/2016 21:00	4	2	16.6	-2.2	54	739	6.3	34	0
2/9/2016 22:00	6	4	16.6	-2.9	60	739	5.6	37	0
2/9/2016 23:00	10	6	16.6	-3.3	58	739	5.1	36	0

Below is the parsed 24-hour DATA.CSV file showing normal **V1-BAM-1022** operations.
FT is 5-10 C > AT and FRH is 25-50% < RH.



Below is example SETTINGS.TXT file for **V2-BAM-1022**.

<p>BAM 1022 Settings Report 2021-06-01 10:30:35</p> <p>Station ID, 1 Serial Number, A15455 Firmware, 82912, R2.1.0 Display, 82451, R1.2 Digital 1, 597A, 10893, R1.0.1 Digital 2, MSO, 10463-03, R1.2.0</p> <p>MET Average, 1 HR Time Stamp, BEGINNING Conc Units, ug/m3 Standard Temp, 25 C</p> <p>Tape Period, 1 HR Tape Pressure, 250 RealTime Period, 15 K, 1.022 Background, -0.0003 Usw, 0.269 Span Membrane, 0.836 Factory Mode, OFF</p> <p>FT Set Point, 45.0 FT P-Gain, 0.500 FT I-Gain, 0.300</p> <p>RS-232, 115200 Flow Control-232, NONE RS-485, 115200 Modbus Port, RS-232 Modbus Address, 1 Byte Order, 512</p>	<p>IP Config, Static, DHCP IP Address, 192.168.13.99, 192.168.13.99:7500 Subnet Mask, 255.255.255.0, 255.255.255.0 Gateway, 192.168.13.31, 192.168.13.31</p> <p>Name, Offset, Slope Flow, -0.048, 1.004 AT, 0.400 BP, -0.800 FT, 1.729 UPPER, -0.836 LOWER, -0.928 FRH, 3.691</p> <p>Conc Range, 1000 ug/m3 Conc Offset, 0 ug/m3 Analog Range 1, 0-2.5 V Analog Range 2, 0-2.5 V DAC Cal 1, 0.0,-6,2.5,29558 DAC Cal 2, 0.0,0,2.5,29578</p> <p>RealTime Alpha, 0.2316 RealTime Gamma, 0.1500</p> <p>Sound Volume, 10 Language, English</p> <p>Factory Settings DQogICAgICAgUGFzc3dvcnQsIDYzMjkNCiAgICAgICBDYWwgU3BhbiwgMS4wMDgN CiAgICBGbG93IFAtR2FpbWwMTEwMC4wMDANCiAgICBGbG93IEktR2FpbWwNDUw LjAwMA0KICBOYW1ILCBPZmZzZXQsICBTbG9wZQ0KICAgRIRDLCAGMC4wMDANCiAg ICBCVcwglDAuMDAwDQo=</p>
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Below is example ALARM.TXT file for V2-BAM-1022.

Alarm Report

2021-06-01 10:31:35

Station, 1, A15455

Time,Alarm

2020-12-27 22:12:37,POWER OUTAGE,POWER CYCLE
2021-01-08 11:43:47,MAINTENANCE
2021-01-08 12:39:35,MAINTENANCE
2021-02-04 16:01:18,MAINTENANCE
2021-02-04 17:37:18,MAINTENANCE
2021-02-11 10:15:06,POWER OUTAGE,POWER CYCLE
2021-02-11 16:37:28,MAINTENANCE
2021-03-04 16:17:55,MAINTENANCE
2021-03-04 17:26:43,MAINTENANCE
2021-03-04 17:27:50,MAINTENANCE
2021-04-02 14:29:09,MAINTENANCE
2021-04-05 17:26:25,FLOW FAILURE,3.7
2021-04-19 12:14:46,POWER OUTAGE,POWER CYCLE
2021-04-19 12:33:04,MAINTENANCE
2021-04-19 13:01:44,MAINTENANCE
2021-04-19 13:05:19,POWER OUTAGE,POWER CYCLE
2021-04-19 13:15:00,MAINTENANCE
2021-04-19 13:16:53,POWER OUTAGE,POWER CYCLE
2021-04-19 13:17:09,MAINTENANCE
2021-04-19 13:27:04,POWER OUTAGE,POWER CYCLE
2021-04-19 13:28:10,SENSOR RANGE,BP,0.0
2021-04-19 13:49:24,DIGITAL LINK DOWN
2021-04-19 13:50:34,SENSOR RANGE,BP,0.0
2021-04-19 13:54:41,SENSOR RANGE,AT,999.9
2021-04-26 16:49:46,FLOW FAILURE,13.4
2021-05-02 05:08:26,POWER OUTAGE,POWER CYCLE
2021-05-02 05:09:16,POWER OUTAGE,POWER CYCLE
2021-05-02 05:11:14,POWER OUTAGE,POWER CYCLE
2021-05-02 05:11:29,POWER OUTAGE,POWER CYCLE
2021-05-02 05:12:51,POWER OUTAGE,POWER CYCLE
2021-05-03 15:45:25,MAINTENANCE
2021-05-03 16:02:53,MAINTENANCE
2021-05-10 01:27:08,POWER OUTAGE,PIN,0x04
2021-05-10 08:58:00,POWER OUTAGE,POWER CYCLE
2021-05-10 16:42:12,FLOW FAILURE,9.4
2021-05-12 07:26:05,POWER OUTAGE,POWER CYCLE
2021-05-18 09:53:02,FLOW FAILURE,11.6
2021-05-22 21:11:55,POWER OUTAGE,POWER CYCLE
2021-05-26 15:48:01,FLOW FAILURE,6.3

Below is example DATA.CSV file (24 hours) for **V2-BAM-1022**.

Time	ConcRT (ug/m3)	ConcHR (ug/m3)	ConcS (ug/m3)	Flow (lpm)	WS (m/s)	WD (Deg)	AT (C)	RH (%)	BP (mmHg)	FT (C)	FRH (%)	Status
12/17/2020 0:00	5.9	3.2	2.9	16.61	0	0	4	74	766.3	15.1	42	0
12/17/2020 1:00	1.4	2	1.8	16.6	0	0	3.8	73	766.5	14.7	42	0
12/17/2020 2:00	6.5	7.3	6.7	16.61	0	0	3.7	72	766.3	14.4	42	0
12/17/2020 3:00	4.2	7.1	6.5	16.6	0	0	3.5	72	766.4	14.3	41	0
12/17/2020 4:00	10.7	9.7	8.9	16.61	0	0	3.2	71	766.6	14.1	40	0
12/17/2020 5:00	14.6	8.5	7.7	16.6	0	0	3.1	71	766.8	13.9	41	0
12/17/2020 6:00	9.7	9.1	8.3	16.6	0	0	3	71	766.9	13.9	41	0
12/17/2020 7:00	12.3	11.1	10.1	16.6	0	0	2.9	71	767.6	13.8	41	0
12/17/2020 8:00	16.7	10.5	9.6	16.6	0	0	2.8	70	768.2	13.6	40	0
12/17/2020 9:00	6	7.1	6.5	16.6	0	0	3	69	769	13.7	40	0
12/17/2020 10:00	10.3	7.7	7	16.6	0	0	3.4	68	769.7	14.2	39	0
12/17/2020 11:00	6.6	8	7.3	16.6	0	0	4.2	64	770.1	15	36	0
12/17/2020 12:00	12.9	10.2	9.4	16.6	0	0	6	58	770	17.6	32	0
12/17/2020 13:00	6	9	8.4	16.61	0	0	7.7	54	769.6	19.6	29	0
12/17/2020 14:00	5.2	4.6	4.3	16.61	0	0	8.9	50	769.1	21	27	0
12/17/2020 15:00	7	7.3	6.8	16.61	0	0	9.9	48	768.6	21.8	27	0
12/17/2020 16:00	4.4	7.7	7.2	16.61	0	0	10.5	46	768.4	22	26	0
12/17/2020 17:00	10	6	5.6	16.62	0	0	10.4	48	768.6	21.1	28	0
12/17/2020 18:00	10.4	12.7	11.9	16.61	0	0	9.8	52	768.8	20.3	31	0
12/17/2020 19:00	13.7	9.8	9.1	16.61	0	0	7.4	61	769	18.2	36	0
12/17/2020 20:00	6.9	14	12.9	16.61	0	0	5.1	72	769.4	15.9	42	0
12/17/2020 21:00	16.9	15.6	14.2	16.61	0	0	3.5	78	769.7	14.1	46	0
12/17/2020 22:00	12.7	17	15.4	16.6	0	0	2.3	84	770	13.2	48	0
12/17/2020 23:00	13.9	13.5	12.2	16.6	0	0	1.7	85	770.1	12.4	49	0

Below is the parsed 24-hour DATA.CSV file showing normal **V2-BAM-1022** operations.
FT is 5-10 C > AT and FRH is 25-50% < RH.

