BX-302 ZERO FILTER CALIBRATION KIT MANUAL

REVISION F

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Overview:

This document describes the procedure for using the BX-302 Zero Filter Calibration Kit to audit or adjust the background (BKGD) value on the BAM-1020 particulate monitor. These instructions must be followed carefully to obtain the best accuracy from the unit. Refer to the BAM-1020 operation manual for more information.

BX-302 Zero Filter Kits

About the Background:

The Background (BKGD) value is the zero correction (slope offset) for all BAM-1020 concentration data. This is determined by running the unit for two to three days with a HEPA zero filter installed on the inlet so that no particulate enters the instrument. The concentration data values over this time are averaged, and the BKGD value is the negative of this average. All of the subsequently stored concentration data contains this correction. The BKGD value varies from unit to unit, and is typically a number between +0.001 and -0.005 mg/m^3. **Warning: This is a user-settable calibration value which may significantly affect the accuracy of the unit.**

The BKGD value is factory calibrated for each BAM-1020 under laboratory conditions. Units configured as $PM_{2.5}$ or $PM_{10\text{-}2.5}$ FEM monitors **must** have this value verified and/or adjusted by the user during initial field deployment of the instrument, using the BX-302 zero filter kit. For PM_{10} units, the BKGD value may optionally be tested and adjusted for best accuracy, though it is not technically a requirement. The BKGD value should also be audited either seasonally or at least annually afterward.

This field zero test corrects the BKGD value to compensate for minor variations caused by local conditions such as inlet heater operation, grounding, RFI/EMI, and shelter temperature control characteristics. It is not uncommon for the initial field zero test to result in a BKGD value that varies from the factory-set value by up to several micrograms. Subsequent field zero tests should usually result in the BKGD value staying consistent within about 1ug.

If possible, the zero test should not be performed during a period of rapidly changing barometric pressure. The room air temperature also should not change rapidly from hour to hour during the test. This is because changes in air density can be measured as mass noise, and may adversely effect the test results. Shelter temperature changes of 2 degrees C or less between the beginning and the end of each sample hour are usually considered acceptable. The exact shelter temperature is not important, as long as it remains fairly constant.

Equipment Required:

- BX-302 Zero Filter Calibration Kit.
- Fully installed and operational BAM-1020 monitor.

- Computer with Comet or HyperTerminal communication software, a spreadsheet program such as Microsoft Excel® , and a BAM-1020 serial communication cable.

Test Setup:

- The BAM-1020 should be installed in its normal shelter at the field site where sampling is to be performed. The unit must be configured for normal operation in its usual environment. The BAM-1020 and especially any shelter temperature control system should ideally be powered up for about one day before starting the zero test, or the first day of data after power-up can be ignored. This allows the temperatures in the BAM and the shelter to equilibrate to a stable state for optimal accuracy and stability.
- The Smart Inlet Heater must be installed and operating normally. It must be set for the normal control parameters per the BAM-1020 manual, such as the normal RH setpoint of 35%.
- Remove the PM_{10} and $PM_{2.5}$ inlets, and install the BX-302 zero filter assembly onto the top of the inlet tube as shown above. Install the white plastic sun/rain shield by screwing it onto the filter. This keeps rain out of the filter and shades it to help prevent condensation from forming inside. **Note:** The 90 degree nylon inlet fitting and short length of clear tubing that used to be supplied with the filter kit is no longer recommended due to the fact that it does not reliably keep moisture out of the filter under some conditions.
- As an alternative setup, the zero filter may be installed inside the BAM shelter, on a short inlet tube just above the smart heater. In any case, the inlet heater must be installed and running normally.
- The BKGD (Background) value is located in the SETUP > CALIBRATE menu. **Record the previous BKGD value, then change it to 0.0000**, so that the BAM is not performing any background corrections during the test. This simplifies the math and reduces mistakes. Exit back to the main menu.

Leak Check:

A leak check must be performed before proceeding with the Background test. Leaks at the nozzle can appear as background noise or a data offset. See the BAM-1020 manual for more information on the leak check, nozzle cleaning, and leak repairs. Perform the following steps to check for leaks:

1. Clean the sample nozzle and tape support vane (located under the filter tape) with isopropyl alcohol and cotton-tipped applicators as described in the BAM-1020 manual.
2. Turn the leak check valve on the BX-302 filter to the OFF position (handle perpendicular to valve body) to prevent any air from entering the inlet tube.
3. In the TEST > PUMP menu, turn on the pump. The flow rate should drop below 1.0 L/min. If the leak value is 1.0 L/min or greater, then the nozzle and vane may need cleaning, or there may be another leak in the system.
4. Resolve the leak and perform the check again. A properly functioning BAM will usually have a leak value of about 0.5 L/min with a clean nozzle and vane using this method.
5. Turn the pump off and exit to the main menu. Open the valve on the BX-302 (handle parallel to valve body).

Background Test Process:

1. After the warm-up period, start the BAM sampling for about 72 hours. The unit should be operating just like it would for regular $PM_{2.5}$ sampling, only with the zero filter installed instead of the PM_{10} inlet and cyclone.
2. After at least 72 hours of sampling, download the hourly concentration data from the unit (.csv output per the manual) using Comet or HyperTerminal and import it into Excel for analysis. An Excel template to expedite the zero test data evaluation (shown below) is available from Met One Instruments.
3. The data should not contain error flags during the test period. Investigate any errors.

4. The first four hours of data may optionally be discarded and the remaining hours used for analysis. This sometimes improves the data set because of the tape tracking for the first few hours, if not perfectly centered when installed.
5. Graph the concentration data. The zero noise levels of the BAM-1020 from the test will be visible. The example below shows a typical zero data set from a BAM-1020.
6. Calculate the average of the zero data to four decimal places. Calculate a new **BKGD** value for the unit by taking the negative of the average. For example, on the data below the average of the zero data was +0.0016 (+1.6μg), so the correct new BKGD value is -0.0016 (-1.6μg). Enter the new BKGD value into the BAM in the SETUP > CALIBRATE menu. **Note:** Be careful to observe the decimal point position, because the BKGD value in the BAM is always entered in milligrams, not micrograms.
7. Compare the new BKGD to the previous BKGD value recorded before the test. The two values should usually be similar within a microgram or two. If the values are considerably different, check the BAM for leaks at the nozzle and verify the temperature stability of the shelter. **Note:** The initial field BKGD value will often be several micrograms different than the factory value, because the factory value is set without an inlet heater.
8. Calculate the standard deviation of the data (STDEV function in Excel) to four decimal places. This value varies from unit-to-unit, but should usually be less than 2.4 micrograms. The lower the number, the better the noise characteristics. A large standard deviation of noise is a clue that the test data average may not be ideal for setting a new BKGD correction. Noisy data should be investigated and resolved. Check for BAM or inlet tube grounding problems, leaks, zero filter condensation, close RFI or EMI sources, large changes in shelter temp or pressure, improper filter RH control, etc. Excessive noise can also indicate a failing beta detector.
9. **Make a record of the test results and any BKGD value changes, and keep it with the other calibration records for the BAM-1020.** The Met One Excel template shown below can serve as a good test record.
10. After the test, remove the BX-302 filter and reinstall the PM_{10} and $PM_{2.5}$ inlets. Resume normal operation.

	A	B
1	Time	Concentration
2	10/1/2009 18:00	0.001
3	10/1/2009 19:00	0.005
4	10/1/2009 20:00	0.002
5	10/1/2009 21:00	-0.001
6	10/1/2009 22:00	-0.002
7	10/1/2009 23:00	-0.001
8	10/2/2009 0:00	0.001
9	10/2/2009 1:00	0.000
10	10/2/2009 2:00	0.001
11	10/2/2009 3:00	0.003
12	10/2/2009 4:00	0.002
13	10/2/2009 5:00	0.000
14	10/2/2009 6:00	0.001
15	10/2/2009 7:00	0.004
16	10/2/2009 8:00	0.003
17	10/2/2009 9:00	0.002
18	10/2/2009 10:00	0.002
19	10/2/2009 11:00	0.002
20	10/2/2009 12:00	0.003
21	10/2/2009 13:00	0.003
22	10/2/2009 14:00	0.003
23	10/2/2009 15:00	0.001
24	10/2/2009 16:00	0.000
25	10/2/2009 17:00	0.003
26	10/2/2009 18:00	0.004
27	10/2/2009 19:00	0.004
28	10/2/2009 20:00	0.002
29	10/2/2009 21:00	-0.001
30	10/2/2009 22:00	0.002
31	10/2/2009 23:00	0.003
32	10/3/2009 0:00	0.003
33	10/3/2009 1:00	0.003
34	10/3/2009 2:00	0.001
35	10/3/2009 3:00	0.003
36	10/3/2009 4:00	0.004
37	10/3/2009 5:00	0.000
38	10/3/2009 6:00	-0.002
39	10/3/2009 7:00	-0.002
40	10/3/2009 8:00	0.002
41	10/3/2009 9:00	0.001
42	10/3/2009 10:00	0.001

Test Records	
BAM-1020 Serial Number:	J4860
Test Performed By:	Dennis Hart
Test Start Date:	10/1/2009
Test End Date:	10/4/2009
Previous BKGD Value:	-0.0014
BKGD Value During Test:	0.0000

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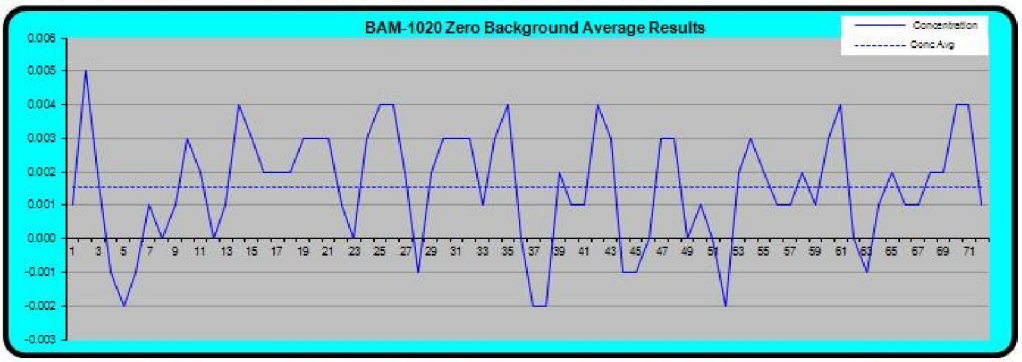
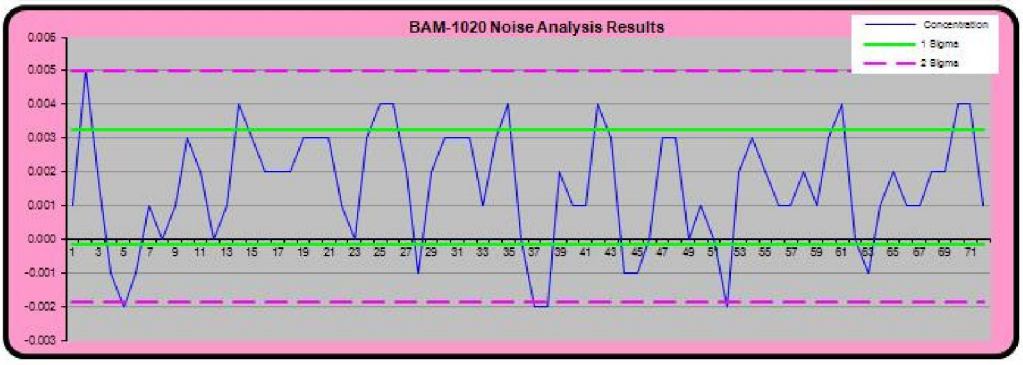
Dataset Statistics (milligrams)		
Zero Data Average	0.0016	
Hourly Standard Deviation (σ)	0.0017	Within Lab Spec < .0024 mg
Background Setting (BKGD)	-0.0016	Set this value in the BAM-1020





Met One Zero Data Analysis Excel Template Sample (actual test data shown)