Met One Technical Bulletin

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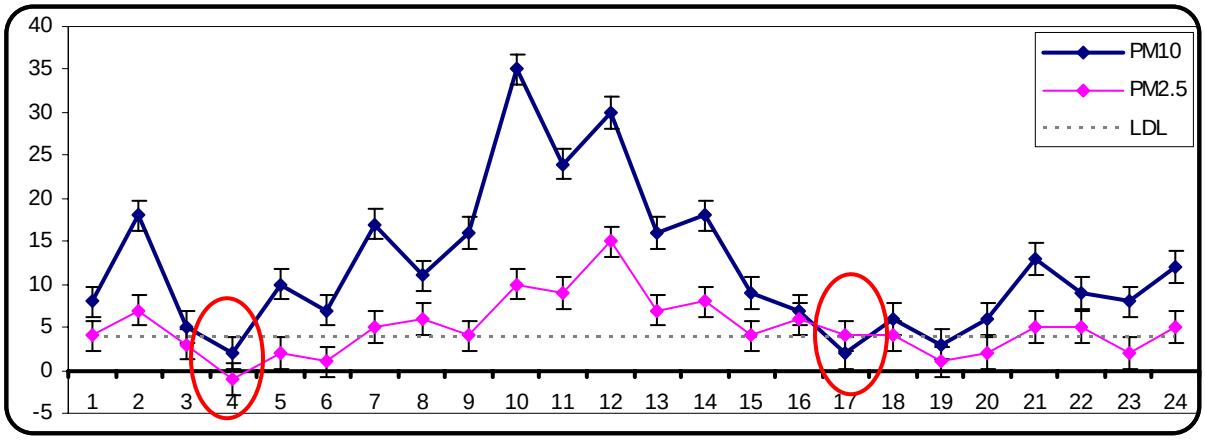
BAM-1020 $PM_{10-2.5}$ Measurement Resolution

Considerations for Monitoring PM_{10} and $PM_{2.5}$ Simultaneously in Low Concentrations

The BAM-1020 is designed to measure either PM_{10} (particulate matter 10 microns and smaller) or $PM_{2.5}$ (2.5 microns and smaller) as a mass concentration in milligrams per cubic meter of air. $PM_{2.5}$ is a subset of PM_{10} for a given site, and is referred to as "fine" particulate. In some cases, the difference between the PM_{10} and $PM_{2.5}$ concentrations is evaluated as the $PM_{10-2.5}$ or "coarse" value. This coarse subset of PM_{10} consists of particulate larger than 2.5 microns, but smaller than 10 microns. The PM_{10} dust concentration at a given site consist of a blend of coarse and fine particulate, and in some cases the blend may be heavily biased toward smaller or larger particulate depending on the particle spectrum in that area.

It is common for two BAM-1020 units to be collocated, with one unit configured for PM_{10} and the other for $PM_{2.5}$. Each BAM-1020 unit has an hourly sensitivity (1 standard deviation) of typically about 1.8 micrograms, and an hourly detection limit (2 standard deviations) of typically about 3.6 µg. This is due to the small inherent noise band of the beta source used by the BAM. This means that two thirds of the hourly BAM data points are accurate to within about 1.8 µg of the actual value, and about 90% of the points are accurate within 3.8 µg.

In very clean air where the true mass concentration is close to zero and below the detection limit of the instrument, it is statistically possible to see the BAM-1020 generate a small negative hourly concentration value on occasion. An example is shown below for the $PM_{2.5}$ unit at the 4:00 am data point.



24 hours data set showing 1.8 µg error bars and 3.6 µg instrument lower detection limit. (all data simulated)

The subject is more complicated when $PM_{10-2.5}$ concentrations are measured using two BAM-1020s in the coarse-by-subtraction configuration. At times when the true PM_{10} concentration is low, it is statistically possible to get an occasional hourly $PM_{2.5}$ data point which is higher than the corresponding PM_{10} value for the same hour, which is of course impossible. An example is shown above at the 17:00 hour where the PM_{10} and $PM_{2.5}$ error bars overlap, and PM_{10} value was lower than the $PM_{2.5}$ value, resulting in a negative $PM_{10-2.5}$ value even though both BAM-1020s are working correctly. This may also occasionally occur even at higher concentrations if the particle spectra in that area is such that the PM_{10} dust consists almost entirely of 2.5 micron particulate.

Because the noise band in the BAM-1020 is statistically random, small negative hourly PM_{10} or $PM_{2.5}$ data points are usually not removed from the daily average calculations, because this would result in an artificial positive bias in the resulting average.

What you should NOT see:

- Negative hourly concentrations which are considerably more negative than the instrument's detection limit. That is to say, hourly concentration values below about -4 µg are statistically unlikely if the BKGD offset is set correctly in the BAM-1020.
- Negative 24-hour daily averages for PM_{10}, $PM_{2.5}$, or $PM_{10-2.5}$ concentrations. This always means something is wrong.
- Multi-hour periods of continuing negative concentrations.

Mitigation:

- The 72-hour zero filter test MUST be correctly performed under field conditions on all $PM_{2.5}$ FEM-designated BAM-1020 units, and MUST be performed on both BAM-1020 units in the $PM_{10-2.5}$ FEM designated coarse configuration. This establishes that the BAM is using the correct background correction to measure an average of zero on clean air, and also demonstrates the exact noise band and detection limit for each unit. The zero test is optional for stand-alone PM_{10} units. Complete instructions are included with the BX-302 zero filter and in the BAM-1020 manual rev H or later.
- All data from BAM-1020 coarse configurations must be collected digitally from the master unit of the pair. This eliminates analog output scaling errors.
- The PM_{10} unit should be set for 8-minute counts and ACTUAL concentration reporting. This matches the settings used for the $PM_{2.5}$ unit. If the PM_{10} unit is set for 4-minute counts, the hourly noise band will be higher. If it is set for STANDARD concentration reporting, there will be additional variability between the two units due to the different temperature and pressure values used to calculate the sampled air volume.