Technical Note: MRK-D-0308

Field calibration of Aeroqual PM instruments

Field calibration of Aeroqual instruments with PM (Particulate Matter) monitoring (Dust Sentry, Dust Profiler and AQM 65 with Particle Monitor or Particle Profiler modules) is recommended for applications that have very high data quality objectives, such as:

- Supplementary monitoring to a reference network (so inter-comparison to reference is important)
- Research studies that need to demonstrate traceability to another instrument
- Consultancy projects that need to demonstrate traceability to another instrument

In summary, field calibration of Aeroqual PM instruments is recommended when comparison or traceability to reference PM instruments is an important factor in the monitoring project.

For all other applications the Aeroqual factory calibration is sufficient. All PM instruments are calibrated at the factory against a standard aerosol ('Arizona Road Dust'). The factory calibration is traceable and results in good data quality when the instrument is operated in accordance with Aeroqual's servicing and maintenance procedures.

Factory Servicing?
Factory servicing includes cleaning and calibration of the PM module only. The PM module can be removed from the instrument (AQM 65, Dust Sentry and Dust Profiler) and returned to the factory. All Aeroqual PM Modules need to be returned to the factory for service and calibration at the following intervals:

- Dust Sentry or AQM 65 Particle Monitor: **24 Months**
- Dust Profiler or AQM 65 Particle Profiler: **12 Months**

Note: Field calibration is not a substitute for the specified factory service intervals above. Factory servicing is essential maintenance, and checks the 'health' of the internal components.

Field Calibration
In order to perform a field calibration, your Aeroqual instrument must be located at the same site as a **Reference** PM instrument. This is called **'Co-location'** and is widely performed in ambient air quality monitoring to assess the performance of a new instrument. The two instruments are operated for a given period of time, and their data are compared. An adjustment factor, called **'K Factor'** is then calculated, and applied to the Aeroqual instrument **Gain**. This corrects the data to the known reference instrument (**Error! Reference source not found.**).

$$\boldsymbol{K\ Factor} = \frac{\boldsymbol{Average\ PM\ (Reference)}}{\boldsymbol{Average\ PM\ (Aeroqual)}}$$

The K Factor is the applied to the instrument, using the Gain setting for each PM channel:

$$\boldsymbol{New\ Gain = Old\ Gain\ X\ K\ Factor}$$

You can also perform the adjustment in Microsoft excel or similar.

Field calibration is only as good as the reference data which is used. Using poor quality reference data for calibration will result in poor quality PM data from your Aeroqual instrument. Aeroqual recommends that calibration only be carried out using high quality Reference PM Data. If you don't have access to a reference instrument, or aren't confident that you can access a well-run reference instrument, then you should always rely upon the factory calibration.

Important considerations for field calibration:

- **Location of instrument:** The Aeroqual instrument and the Reference instrument need to be located at the same site preferably with their inlets within 10m of each other, and must be sampling at the same height. At reference sites using a monitoring shed, on the rooftop of the shed is usually the best location.

- **Instrument set up:** Both the Aeroqual instrument and the reference instrument need to be set up in accordance with the manufacturer's recommendations, with correctly set flow rates and fresh filters. If you are using a gravimetric method reference instrument, you must follow appropriate filter conditioning and weighing methods.

- **Duration of colocation:** As a general rule, longer is better, as this will give you more data points and therefore more confidence in your field calibration. It's important that the colocation is carried out during the same environmental conditions expected during deployment. **Two weeks is ideal, and no shorter than 72 hrs.**

- **Reference instrument selection:** Selection of the right reference instrument is critical for a successful K factor correction. Ideally, reference instruments should be operated in accordance with local reference method specification. Instrument methods are listed below, in descending order of preference:

    - BAM / TEOM: Are ideal as they are continuous methods, meaning more data can be collected in a shorter period of time, giving a more accurate K-Factor. BAM data can be noisy at hourly averages, so consider using 24hr averages. **This is Aeroqual's suggested method, as lots of data can be collected quickly, with no need for expensive lab work.**

    - Partisol / Low volume samplers (47mm Filter): Can also be used, however will need to be run for a longer period of time as they operate on 24hr averages (i.e. 1 data point per 24hrs). Filters must be appropriately prepared and transported. Lab and field blank filters should also be used. Balance accuracy for pre and post weighing should be better than ±0.0001 µg.

    - Other Non-Reference methods (Optical, Open-Path): Existing instrumentation can be used to establish variance between Aeroqual and a known instrument. This method can be used to assess new versus old instrumentation, **but is not a calibration to a reference instrument.**

    - High-Volume samplers: Not recommended due to documented variance between these and other methods and potential for filter contamination.

Steps to performing a K factor correction

Beta Attenuation Monitors (BAM) measure PM loading on a filter tape, using a radioactive source and a detector. The amount of PM measured is proportional to the amount of beta rays which are blocked from passing from the source to detector by the PM on the filter tape. TEOMs use a high precision microbalance with a special filter to calculate PM concentration. BAM and TEOM instruments run continuously and data is available at as low as 10 minute averages. This data can be noisy, so Aeroqual recommend that 1 hour or 24hr averages are used to minimise this noise.

Gravimetric methods (Partisol, Low volume samplers using 47mm filters) have some additional steps. It is critical that correct filter conditioning and pre/post weighing processes are carried out.

1. Install and commission your Aeroqual instrument alongside your reference instrument. Operate both instruments together. The longer you collocate the instruments, the better.

2. Collect the data from both instruments. Using Microsoft Excel or similar, remove any odd spikes, error, or automated zero calibration data.

3. **(Gravimetric only)** calculate your concentrations using the following equation:

$$\boldsymbol{Concentration = \frac{Filter\ weight\ at\ end - filter\ weight\ at\ start}{Total\ volume\ of\ air\ sampled}}$$

4. Select an appropriate averaging period, 24hrs is usually appropriate. Calculate your averages for both reference and Aeroqual using this formula:

$$\boldsymbol{Average = \frac{Sum\ of\ readings}{Number\ of\ readings}}$$

   The goal is to create an excel spreadsheet, with 1 column of reference data, and 1 column of Aeroqual data, in the averaging period you have selected, for instance 1 hour or 24 hour or 24hr averages for the period of your co location.

5. Using Microsoft excel plot your 2 data sets in an x-y scatter plot. Add a trend line and equation as below.

6. The graph to the left below shows the time series of the two instruments. The graph to the right below shows the slope calculation. In this example the Dust Sentry is reading higher than the reference instrument. The slope of the curve Reference vs Dust Monitor is 0.6568. So a gain of 0.6568 needs to be applied to the instrument.

7. The Aeroqual instrument will need a new gain, calculated using the formula below:

$$\boldsymbol{New\ Gain = Old\ Gain\ X\ K\ Factor}$$

$$\boldsymbol{New\ Gain = \ 1\ \times 0.6568 = 0.6568}$$

Dust Monitor side-by-side calibration data

10 June to 21 June Monitoring site 1

Date	Reference Gravimetric, daily mass ug m-3	Aeroqual Dust Monitor daily average ug m-3
10/06/12	12.0	14.8
11/06/12	27.2	43.9
12/06/12	34.5	50.1
13/06/12	10.0	14.9
14/06/12	9.3	15.1
15/06/12	31.7	52.8
16/06/12	43.1	73.7
17/06/12	52.3	73.6
18/06/12	23.2	27.2
19/06/12	10.7	16.2
20/06/12	13.5	15.6
21/06/12	11.9	16.3