User Guide Revision History

<table>
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<tr>
<th>Date</th>
<th>Revision number</th>
<th>Description of change</th>
<th>Affected Sections</th>
</tr>
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<tbody>
<tr>
<td>June 2017</td>
<td>1.0</td>
<td>First release</td>
<td>-</td>
</tr>
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<td>2.0</td>
<td>NO2 and VOC added</td>
<td>1, 1.1</td>
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<td>4.0</td>
<td>Combining AQS, Dust Sentry, Dust Sentry Profiler</td>
<td>All</td>
</tr>
</tbody>
</table>

Alternative sources of information and help

In addition to this user guide, Aeroqual offers other sources of information which can assist in the operation of the monitors. The Aeroqual website contains brochures, technical notes and user guides for all products.

www.aeroqual.com

Aeroqual's training website contains a comprehensive document library of technical notes and service and calibration templates to download and print. The training website has detailed descriptions of service activities and calibration and installation examples and is updated regularly. Video tutorials are featured heavily.

www.training.aeroqual.com

To receive access contact technical@aeroqual.com

For technical support, contact the Aeroqual distributor in your local country. If local technical support is not available contact the Aeroqual support team: technical@aeroqual.com.

Where possible, references to further material will be provided throughout this document

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<th>Online reference</th>
<th>training.aeroqual.com</th>
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1 Dust Sentry / Dust Sentry Pro / AQS 1 Introduction

1.1 Overview

Dust Sentry / Dust Sentry Pro / AQS 1 (collectively referred to herein as ‘monitors’) are tools for air quality professionals to target specific applications of interest in industrial, urban environment and regulatory applications. It is a flexible air quality monitoring system that can be configured for a range of uses.

Key technology features of the monitors enable them to deliver data with very strong correlation to EPA-approved monitors – ‘Near Reference’ – over extended periods of time; several years with appropriate maintenance.

Housed in a rugged, lockable weatherproof (IP 65) enclosure, the monitors include an embedded PC and full software system for remote technical support, data management and analytics.

Users can make use of the embedded PC running proprietary Aeroqual Connect software, or optional web-based Aeroqual Cloud software for data storage and management of networks of monitors.

Figure 1-1 Key components
1.2 Product comparison

Dust Sentry and Dust Sentry Pro both measure particulate concentrations using laser light scattering but the methodology and optics design are different, this means that the Dust Sentry measures a single size fraction selected by the user but the Dust Sentry Pro measures four size fractions simultaneously.

AQS 1 also measures gases in addition to particulate, up to three gas modules may be integrated.

<table>
<thead>
<tr>
<th>Product</th>
<th>Particulate Measurement</th>
<th>Gas Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust Sentry</td>
<td>TSP or PM10 or PM2.5 or PM1.0</td>
<td>None</td>
</tr>
<tr>
<td>Dust Sentry Pro</td>
<td>TSP and PM10 and PM2.5 and PM1.0 and 8 size counts</td>
<td>None</td>
</tr>
<tr>
<td>AQS 1</td>
<td>TSP or PM10 or PM2.5 or PM1.0</td>
<td>O₃, NO₂ VOC</td>
</tr>
<tr>
<td></td>
<td>TSP and PM10 and PM2.5 and PM1.0 and 8 size counts</td>
<td></td>
</tr>
</tbody>
</table>

1.3 Applications by product

Applications for Dust Sentry

Designed for those who need to monitor and manage specific outdoor dust and particulate emissions continuously and in real-time.

The Dust Sentry is a nephelometer-based monitor that delivers defensible and accurate mass measurement for PM₁₀, PM₂.₅, PM₁, or TSP.

MCERTS certified and SCAQMD 1466 pre-approved.

For more detail see: https://www.aeroqual.com/product/dust-sentry-pm10-monitor

Applications for Dust Sentry Pro

Designed for those who need to monitor and manage multiple outdoor dust and particle size fractions simultaneously and in real-time.

The Dust Sentry Pro delivers simultaneous measurement of PM10, PM2.5, PM1, TSP, and particulate counts for 8 channels: 0.3, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0, 10 microns.

For more detail see: https://www.aeroqual.com/product/dust-profiler-particle-counter

Applications for AQS 1

Designed for those who need to monitor and manage specific outdoor dust and particulates, and gases continuously and in real-time.

The AQS 1 delivers affordable and defensible measurement of PM₁₀, or PM₂.₅, or PM₁, or TSP, and up to three gases, all simultaneously.

For more detail see: https://www.aeroqual.com/outdoor-air-quality/aqs-mini-air-quality-stations
1.4 Optional external sensors

The monitors can integrate a number of external sensors such as weather sensors, solar radiation and noise sensors. These sensors are mounted outside the monitor enclosure. The external sensors below are available factory tested and ready to connect to the monitors.

- MetOne MSO weather station
- Cirrus MK427 noise meter
- Vaisala WXT536 weather station
- Gill Instruments Windsonic
- Li-Cor LI-200 Pyranometer

See Section 2.6.1 for wiring external sensors.

1.5 Dimensions

These dimensions are for a visual representation only, for full details—see section 1.6 Specifications.

Dimensions are in millimetres (mm).
### 1.6 Specifications

Specifications are subject to change, please check [www.aeroqual.com](http://www.aeroqual.com) for the current specifications.

<table>
<thead>
<tr>
<th>Particulate Measurement</th>
<th>Dust Sentry</th>
<th>Dust Sentry Pro</th>
<th>AQS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement technology</td>
<td>Near forward angle laser scattering nephelometer</td>
<td>Right angle laser scattering particle counter</td>
<td></td>
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<tr>
<td>Particle Counts</td>
<td>N/A</td>
<td>0-1,000,000 particles/L</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>0.3, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0, 10.0 µm</td>
<td></td>
</tr>
<tr>
<td>Size channels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particle Mass Measurement</td>
<td>Range / µg/m³</td>
<td>Range / µg/m³</td>
<td></td>
</tr>
<tr>
<td>PM1</td>
<td>0 - 60000</td>
<td>0 - 200</td>
<td></td>
</tr>
<tr>
<td>PM2.5</td>
<td>0 - 60000</td>
<td>0 - 5000</td>
<td></td>
</tr>
<tr>
<td>PM10</td>
<td>0 - 60000</td>
<td>0 - 5000</td>
<td></td>
</tr>
<tr>
<td>TSP</td>
<td>0 - 60000</td>
<td></td>
<td></td>
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<tr>
<td>Simultaneous?</td>
<td>No – requires cyclone</td>
<td>Yes</td>
<td>The AQS 1 can be specified with either a Near forward angle laser scattering nephelometer OR Right angle laser scattering particle counter</td>
</tr>
<tr>
<td>Accuracy</td>
<td>&lt;±(2 µg/m³ + 5 % of reading)</td>
<td>&lt;±(5 µg/m³ + 15 % of reading)</td>
<td></td>
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<tr>
<td>Resolution</td>
<td>0.1 µg/m³</td>
<td>0.1 µg/m³</td>
<td>Particulate measurement specifications will reflect the measurement technology chosen – see panels to the left.</td>
</tr>
<tr>
<td>MCERTS certified</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>SCAQMD Rule 1466</td>
<td>Pre-approved</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Auto zero check</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Sample flow</td>
<td>2 LPM</td>
<td>1 LPM</td>
<td></td>
</tr>
<tr>
<td>Connect/ Cloud software</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Factory calibration interval</td>
<td>24 months</td>
<td>12 months</td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-10 °C to +50 °C (14 °F to 122 °F)</td>
<td>-10 °C to +45 °C (14 °F to 122 °F)</td>
<td></td>
</tr>
<tr>
<td>Heated inlet</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Power consumption</td>
<td>24 W Max, depends upon configuration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional sensors</td>
<td>Weather station / Wind Speed and Direction / Noise / Solar incidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensions (H x W x D)</td>
<td>483 x 330 x 187 mm (19 x 13 x 7.4 inches) &lt;13 kg (28.6 lbs)</td>
<td>483 x 330 x 187 mm (19 x 13 x 7.4 inches) &lt;13 kg (28.6 lbs)</td>
<td>483 x 330 x 187 mm (19 x 13 x 7.4 inches) &lt;15 kg (33 lbs)</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Measurement</td>
<td>Ozone (GSS)</td>
<td>Nitrogen Dioxide (GSE)</td>
<td>Volatile Organic Compounds (PID)</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>0 -500 ppb (0.1 ppb)</td>
<td>0 -500 ppb (0.1 ppb)</td>
<td>0 -500 ppb (0.1 ppb)</td>
</tr>
<tr>
<td>Gas calibration interval</td>
<td>-</td>
<td>-</td>
<td>As required</td>
</tr>
</tbody>
</table>

*Above 40 °C the laser may require more frequent servicing.

All monitors use the same software platform: [https://www.aeroqual.com/product/air-monitoring-software](https://www.aeroqual.com/product/air-monitoring-software)
2 Quick Setup Guide

2.1.1 Before the monitor arrives (for full pre-planning details see section 2.2)

1. Visit the site and assess monitor location and suitability
   - Site will be representative of the pollutants you intend to measure.
   - Site is secure but with adequate access.
   - Site is appropriately open to all wind directions.
   - If you are planning a permanent deployment, check that there is nothing nearby which could change and affect your project – like trees, planned buildings or new roads and other potential interferences.

2. Ensure power is available on site
   - Ensure power is available Both Mains and Solar power can be used, but these will need to be available and/or installed before the monitor arrives.
   - When installing power outlets (110 VAC to 230 VAC) for the monitor, they should be weatherproof and installed safely.
   - Allow for 2 power outlets, one for the monitor and one for calibration equipment.

   **NOTE:** A power lead with local plug will need to be supplied and wired to a connector supplied with the monitor.

3. Install any additional infrastructure required for the installation
   - Mounting location and method has been identified. Most sites will require a way of securely mounting the monitor. Pole Brackets (50.8 mm / 2 " 304 Stainless U-Bolt) are included to mount the monitor on a pole, anchored to the ground. Small platforms have also been used successfully too.
   - If you have ordered Auxiliary sensors (Weather, noise etc.) you will need to provide a means of mounting these also. You will need to supply a pole and fixings to mount the sensor. Siting may be subject to local regulations.
   - Check you have the required tools.

4. Confirm communications specification (WIFI and/or cellular)
   - Check communications specifications and how the monitor software will be accessed on site.
   - For cellular access, purchase a dynamic IP network SIM card with at least 1 GB data / month.

5. Plan for your time on site
   - When setting up for the first time allow at least four hours on site.
   - Allow for travel time to and from the site.
   - Confirm site operation times available for access.
   - Confirm personal protective equipment (PPE) that may be required on site.

6. Read the user guide
   - Familiarise yourself with the assembly steps.
   - Confirm the method of data access that will be supplied with the monitor (e.g. Aeroqual Connect or Aeroqual Cloud).
   - Send any questions about things you are unsure about to technical@aeroqual.com

7. Write a checklist
   - Write your own checklist to ensure a smooth installation and setup.
   - Include any reporting requirements that will be required.
2.1.2 After the monitor arrives

1. Unpack the monitor and inspect
   - Inspect the packaging and monitor for damage. (Section 2.3)
   - Check all items have been supplied.

   **NOTE:** A power lead with local plug will need to be supplied and wired to a connector supplied with the monitor.

2. Mount monitor
   - Mount the monitor to your platform or pole. (Section 2)
   - Attach the PM inlet. (Section 2.4.1)
   - Attach the gas inlet. (Section 2.4.3)
   - Open the door and check that all tubing, power and data connections are secure.

3. Power on the unit
   - Turn on the unit by pushing in the fuse. (Section 2.5.4)
   - Check that the Status LEDs on the modules, Embedded PC and Modem (if fitted) are on and green.
   - Check that the sampling pump (PM only) or pumps (PM and Gas) are running.

4. Set up Wi-Fi / Modem and connect to the monitor
   - Connect to Aeroqual Connect (Section 4.1)
   - Connect to Aeroqual Cloud (Section 4.2)

5. Check sampling flow rates
   - Put the monitor into Service mode (Section 5.1)
   - Write a comment in the Journal that you are on site for monitor commissioning. (Section 6.4)
   - Check the sampling system for leaks, rectify any leaks. (Section 6.5.4)
   - Check and adjust gas module flow rates to specification. (Section 6.5.4.2)
   - Check PM inlet flow rates and adjust if required. (Section 6.5.4.3)

6. Attach optional auxiliary sensors
   - If you have purchased any auxiliary sensors (Weather, Noise) mount these and run the cabling through the external glands, and connect to the AUX module. (Section 2.6)

7. Document setup in Journal
   - Note in the Journal that commissioning is complete. (Section 6.4)
   - Exit Service mode. (Section 5.1)

2.1.3 Installation and commissioning
Commissioning is the process of setting up a new monitor to work correctly on site. It is important that the correct procedure for commissioning the monitors is followed to ensure reliable monitor operation and to meet or exceed your data quality objectives. All monitors are supplied with a traceable factory calibration. This calibration is applicable to the commissioning phase and accordingly Aeroqual does not recommend an initial calibration as part of monitor commissioning.

Aeroqual provides a commissioning procedure which should be completed during this period. This report details the tasks carried out during commissioning, and can be used to demonstrate correct commissioning to end customers.

The commissioning procedure is available from: https://www.aeroqual.com/support/resources/agm-65

**NOTE:** Please allow at least 30 min for the monitor to warm up to counter the effects of humidity.

2.1.4 Complete the Commissioning report and provide to customer
This report details the settings of the monitor at the time of commissioning. The completed report should be provided to the customer, along with the factory logbook which is provided with every monitor.
2.2 Pre-planning

The monitors require only basic assembly out of the box.

- Wire a mains AC power cable
- Attach Particle Monitor inlet
- Attach gas inlet (AQS only)
- Attach third party sensors (where supplied)
- Configure MOXA modem (where supplied)

Aeroqual recommends these steps be performed in an office or laboratory as part of a quality control check of the monitor to make sure the monitor has arrived undamaged and the flow system, electrical system and communication system are working as expected.

Some of the steps described here will be repeated in the field as part of the installation and commissioning process.

After these steps have been carried out, the Monitor can be safely transported to the monitoring site for installation and commissioning.

Key points to consider for assembly and first power up:

- The monitors run on single phase mains AC power 100 - 260 VAC (standard): 21W / 30W, or if required a regulated 12 VDC: 21W / 30W. For more details see section 2.4. Configuration used for power calculations: base unit, nephelometer, PM10 sharp cut, O3 module, modem, heater off / heater on.
- You need to supply a mains power cable and local plug, Aeroqual recommends a residual current device (RCD) be used to protect against power spikes.
- You will need a Phillips head screwdriver, and if you have an external sensor you will also need a small flat blade screwdriver.
- There is no software to download and install, and no cables are required for communication. Communication to the monitor is through your web browser on your laptop, tablet or smartphone using WIFI.
- If you have purchased a MOXA modem, this needs a local SIM (dynamic IP) same as you would have in your smart phone, but you must know the APN of your chosen telecommunications provider, you can look this up: www.apnchanger.org

2.3 Unpacking

The monitors are packaged in a cardboard carton with moulded protective inserts.

**Dimensions:** 62 x 32 x 55 cm (L x W x H)

**Weight:** < 12.5 kg (Configuration used for weight calculations: base unit, nephelometer, PM10 sharp cut, O3 module, modem, heater off / heater on.

Additional components such as weather or noise sensors will be packaged in additional boxes.

a) Examine the ShockWatch® label on the side of the shipping box. If the indicator is red do not refuse the shipment. Make a notification on delivery receipt and inspect for damage. If damage is discovered, leave item in original packaging and request immediate inspection from carrier within 15 days of delivery date (3 days international).

b) Verify the serial number label on the documentation matches the serial label on the monitor – the label is located inside the monitor on the bottom right side.

c) Verify that all components have been shipped as per the packing slip. Contact your Distributor or Aeroqual if you suspect any parts are missing.
## 2.4 Assembly

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<tbody>
<tr>
<td>Online video</td>
<td><a href="https://training.aeroqual.com/mod/page/view.php?id=624">YouTube Channel: Aeroqual Service and Maintenance playlist</a></td>
</tr>
</tbody>
</table>

### 2.4.1 Assemble the PM inlet

The particle sampling inlet is easy to assemble by push fitting the various supplied parts together. If no sharp cut cyclone has been ordered then only a sampling inlet assembly and TSP head will need to be assembled.

![Particle sampling inlet parts including (L-R): inlet tube, cyclone adaptor, cyclone, TSP head.](image)

**Figure 2-1** Particle sampling inlet parts including (L-R): inlet tube, cyclone adaptor, cyclone, TSP head.

### 2.4.2 Attach PM inlet

- Turn off power to the monitor during this process by pulling out the 12 DC fuse as show in Figure 2-8.
- If not already fitted, attach a PM inlet O-ring to the aluminium retaining ring and apply a small amount of lubricant.

![Add the O-ring and a small amount of lubricant.](image)

**Figure 2-2** Add the O-ring and a small amount of lubricant.

- Inside the sampling inlet assembly has a sampling tube extending out of it. The sampling tube has a thin film heater further up the shaft which is powered by the black and red cable exiting the bottom of the assembly with white plug on the end.
- Carefully thread the white plug through the PM inlet port on the roof of the monitor.

Continued next page.
IMPORTANT  The Particle Monitor ships from the factory with a thin film of tape or coloured cap which protects the inlet, this must first be removed as shown in Figure 2-3.

![Remove protective tape or cap from the PM inlet](image)

Figure 2-3 Remove the protective tape or cap from the PM inlet

![Gently feed in the power cable and over the particle engine mounting bracket on the left. The aluminium tube must push all the way in to the PM module.](image)

Figure 2-4 Gently feed in the power cable and over the particle engine mounting bracket on the left. The aluminium tube must push all the way in to the PM module.

**IMPORTANT**  Ensure sure that the aluminium inlet tube is pushed all the way into the optical engine block.

- If the aluminium tube does not fully push down in to the optical engine block, then create more length in the aluminium tube by removing the grey retaining nut and then sliding up the rubber grommet on the top of the inlet. Replace the nut after you have done this.
Create more length to the inlet by sliding the black rubber grommet up the tube.

- You need to make sure you have correctly and securely inserted the aluminium tube fully in to the optical engine block.
- When you are satisfied the inlet is fully pushed in to the engine block, then connect the heater plug on the inlet to the plug coming from the adjacent particle engine control module.
- Insert the three supplied 6/32 UNC retaining screws to secure the inlet to the aluminium retaining ring.
- Push the fuse holder in to the “On” position to begin flowing air through the inlet.
- Then perform a leak check and flow check. See Section 6.5.6 and 6.5.7.

During field installation, secure the PM inlet using the retaining screws and plug in the heater.

2.4.3 Attach gas inlet (AQS Only)

The gas inlet is held by a ¼ inch Swagelok compression fitting.

Attach the inlet and perform a flow check to make sure the inlet is fitted correctly and the sample pump is working properly.

When the AQS is sampling ambient air in the field, a Kynar inlet fitting with mesh is attached to the Swagelok nut at the end of the sample cane.
2.5 Power Requirements

Caution: The high voltage mains supply must be wired by a certified electrician in compliance with local electrical regulations.

The internal power requires regulated 12 VDC to maintain a constant pump speed. An external mains to 12VDC power supply (Meanwell HLG80-12A 60W 12V) is fitted on the outside of the enclosure and comes with an IP rated outdoor electrical plug. You must wire the other end of the plug to mains power.

Where possible, visit the site and assess monitor location and suitability

2.5.1 AC power source

Both Mains and Solar power can be used, but these will need to be available and installed before the monitor arrives. When installing power outlets (110 VAC to 230 VAC) for the monitor, they should be weatherproof and installed safely. Install 2 power outlets, 1 for the monitor and one for calibration equipment.

NOTE: Aeroqual does not supply the mains power cable or the electrical plug for your local power socket, you must supply this yourself.

2.5.2 DC power source

Occasionally mains AC power is not available at the site where the Monitor is installed and an alternative power solution is required. More detailed information is in a Technical Note for remote powering the monitor available from https://www.aeroqual.com/support/technical-documents

2.5.3 Wiring the power supply connector

1. Locate the power connector terminal which is situated outside the enclosure at the bottom. The power supply will already be wired to the connector however the cable to connect to mains power needs to be wired.

2. Feed the power cable through the nut gland plugs and connector and wire the cable to the terminal block according to the diagram.

3. Reconnect into the connector ensuring the plugs are fitted securely and the nut gland tightened.

A wiring color guide is in section 12.3

To separate the connectors, twist the nut gland to loosen the terminal blocks, then pull connectors apart
### 2.5.4 Powering monitor On/Off

**NOTE:** Pull the 12 VDC fuse out from the fuse holder “off position” before testing the mains connection. See Figure 2-8.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Online video</td>
<td><a href="https://www.youtube.com/playlist?list=PL42_96F2A2D9B608D">YouTube Channel: Aeroqual Service and Maintenance playlist</a></td>
</tr>
</tbody>
</table>

![12 V DC fuse pushed in, the “on” position](image1.png) ![12 V DC fuse pulled out, the “off” position](image2.png)

**Figure 2-8** The 12V DC fuse can be pulled out to turn off the monitor or pushed in to power the monitor.

Push in the 12 DC fuse to the “on” position as shown on the left in Figure 2-8.
The pump/s will start and the ePC will boot up with a series of beeps.
The green power LED lights should light up on the modules when power is applied, this confirms the power is being correctly delivered to the modules.

### 2.6 Wiring auxiliary sensors

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Online video</td>
<td><a href="https://www.youtube.com/playlist?list=PL42_96F2A2D9B608D">YouTube Channel: Aeroqual Service and Maintenance playlist</a></td>
</tr>
</tbody>
</table>

**NOTE:** To check the operation of the third party sensor in your office or laboratory prior to site installation it is not required to feed the cable through the gland.

External sensors such as weather stations and noise meters need to be wired to the green connector plug on the front of the auxiliary module. To connect third party sensors such as weather sensors, feed the cable through a free cable gland and wire to the green plug.

#### 2.6.1 AUX module

An AUX module is used to provide power to an external sensor and to process data from the sensor. The AUX module is shown to the right.
The AUX module uses a 12 way green connector plug to connect to the external sensor. The cable from the external sensor is passed through a waterproof gland on the underside of the monitors and then connected to the green plug on the front of the AUX module. Each third party sensor requires a different wiring configuration. See 2.6.2 Auxiliary sensor wiring diagrams.

When you are happy with the wiring then apply power, and log on to the Aeroqual Connect software as described in section 4.1 Aeroqual Connect (via Direct WIFI / LAN). After some minutes you should see the parameters associated with the third party sensor being shown in the software in the APP “Configure Instrument”, view settings then the active sensor column.

To See the data, go to “Manage Data”, then Charts or Table, adjust the “Averaging Period” as required.

**NOTE:** Retain the certificate of compliance that is shipped with the monitor.
2.6.2 Auxiliary sensor wiring diagrams

IMPORTANT The auxiliary module orientation may vary, observe the correct numbering order as labelled on the green connector.

- Gill Ultrasonic Wind Sensor
- Cirrus MK427 Noise Sensor
- Vaisala WXT536 Weather Sensor
- Met One MSO Weather Sensor
- Novalynx Silicon Pyranometer

Online reference: training.aeroqual.com DM 1.3 Tech training Section 2.3
3 Mounting and Site Positioning Guidelines

It is important that the positioning of the monitor is suitable so as to yield data which is representative of that specific location.

3.1 Mounting

The monitor comes with 2x mounting brackets and 3x U-bolts for 2 inch poles. The same brackets are used for both pole and wall mounting. To wall mount the monitor the brackets are screwed into the wall instead of using the U-bolts.

For pole mounting:
1. Secure top mounting bracket at a suitable height using 2x U-bolts provided
2. Fix lower mounting bracket to the Dust Sentry chassis with screws
3. Hang the monitor on the top mounting bracket
4. Place U-bolt through lower mounting bracket
5. Add nuts and washers and tighten the bottom U-bolt into position

**NOTE:** Only one U-bolt is used to secure the bottom bracket.

3.2 Inlet height

- If monitoring is related to human exposure, the sampling inlet height should be positioned in the “breathing zone”. This is located between 2 and 15 meters above ground level.
- If monitoring is related to specific emission sources, the position of the sampling inlet can be more flexible. It is more important that there is no obstruction between the approaching air from the emission source and the sampling inlet.
- If more than one monitor, or any other particulate instrument, is being used at the site, the height of the inlets should be uniform.
- If the monitor inlet is the highest point at the site, a lightning rod must be installed to prevent damage to the unit during electrical storms.

3.3 Measurement Interference

- The meteorological conditions of the site should be taken into consideration when positioning the monitor. For example, there should be no obstruction to the air flow in the predominant wind direction. A minimum clear sky angle of 120 degrees is recommended.
- The inlet should be at least 1 meter away from any objects that could potentially influence the airflow characteristics e.g. trees, vertical surfaces or walls.
- Avoid overhead high-voltage cables which may cause electrical interference with the sampling equipment.
- Demolition/construction activities and change to normal transport patterns due to road works etc. can significantly affect the data. Ensure a record of such events is kept to account for unexpected peaks in concentration.

3.4 Safety

- The intended data capture rate should be considered when positioning the monitor. If data capture above 90% is essential, the unit should be located in an area which has 24 hour access available.
- The positioning should allow for routine maintenance checks to be performed safely by personnel.
- If using a tripod, ensure the tripod legs are bolted to the ground to prevent the unit from falling.
- Ensure the monitor is in a secure location to avoid vandalism or theft.
4 Connectivity

The monitors use an industrial embedded PC (ePC) for data logging and monitor control. A cellular modem can be fitted underneath the ePC to facilitate remote connection and support from Aeroqual technical support. – see section 4.2.2 Connecting using a cellular modem.

There are two ways to connect to your monitors:

- **Aeroqual Connect (via Direct WIFI / LAN)** for initial set up and when access to the internet is limited;
- **Aeroqual Cloud (via Network WIFI / Modem)** for remote access, visibility of all your monitors, and remote technical support from Aeroqual Care.

Aeroqual highly recommends every monitor is connected to Aeroqual Cloud for the best user experience, additional data features, and Aeroqual Care.

Engineers who need to perform service or data analysts who need to view or download data can do so using a web browser on their PC, tablet or smart phone. There is no software to download and install.

Data Security

The data belongs to you. We look after it in the same way that a bank looks after your money. Who you let access your data is entirely up to you – our job is to carry out your instructions.

If you do choose to store data with us, then here are some of the security assurances we provide:

- We use only ISO 27001 approved data centres
- Infrastructure is monitored and protected 24/7
- Data is accessed via a secure website with 256-bit SSL encryption
- User defined passwords

4.1 Aeroqual Connect (via Direct WIFI / LAN)

Aeroqual Connect contains all of the tools necessary to view and download the data and maintain and calibrate a single monitor.

No internet connection is required for Aeroqual Connect. Aeroqual Connect is always running on the monitor and can be accessed via WIFI through an internet browser on any device, there is no software to install.

![Aeroqual Connect Home page](image)

**Figure 4-1 Aeroqual Connect Home page**

4.1.1 Connect to Aeroqual Connect via Direct WIFI

A few minutes after powering on, you should see a new WIFI network in your device’s list of WIFI networks. The WIFI name (SSID) will match your serial number, connect to this network using the password below.

- WIFI SSID: **DS DDMYYYYYYY-XXX** or **AQS1 DDMYYYYYYY-XXX**
- Password: **Aeroqual**
**NOTE:** If you are accessing the internet on your device using WIFI, you will lose your internet connection.

### 4.1.2 Connect to Aeroqual Connect via LAN

The monitors can be added to a LAN, in two ways:

- Using the WIFI function to connect to a WIFI network
- Using an Ethernet cable to plug into a LAN network router

When connected to the LAN, the monitor will automatically be assigned an IP address by the LAN router.

You must find out what this IP address is so you can connect to the monitor. The WIFI or wired LAN IP address will likely be in the format: **192.168.XXX.XXX**

If your laptop also has access to the same LAN, then this IP address can be typed into a browser address bar and a connection to the monitor can be established over the LAN connection.

### 4.1.3 Access your monitor on Aeroqual Connect

After connecting your monitor to your device, open an internet browser window and enter **10.10.0.1** in the address bar. You should see the Aeroqual Connect login screen. Log in with the default user name and password provided.

- **URL:** 10.10.0.1
- **Username:** administrator
- **Password:** aqmadmin

**NOTE:** Depending on your device WIFI settings, and how long you take to enter complete the steps above, your device may reconnect to the previous WIFI connection.

After logging in to Aeroqual Connect, you will be presented with a screen with five ‘apps’; Manage Data, Calibration and Service, Configure Instrument, Diagnostics and Advanced, and Administration. You are now accessing your monitor in “Access Point” mode.

Next, open the Administration app and create a new user and secure password, then delete the default username and password.

### 4.2 Aeroqual Cloud (via Network WIFI / Modem)

Aeroqual Cloud is cloud-based software. It gives you and other trusted users access to all of your monitors via secure third party servers. Use Cloud to:

- Communicate with your monitor from anywhere in the world at any time
- Use advanced charting features such as wind roses and pollution roses
- Receive fast and comprehensive technical support from your Aeroqual distributor or Aeroqual technical support team.
- Automatically export data to multiple users via email or to an FTP server.
- Securely back up data in case of local data access issues.
- Maintain service records in the Cloud Journal for auditing and engineer certification.

Connection to Aeroqual Cloud makes technical support fast and efficient for the end user.

---

**Figure 4-2** Aeroqual Cloud has many useful features such as plotting multiple channels on a single graph
Generate advanced graphical presentations such as wind roses and pollution roses.

Select multiple monitors by region, and plot data from multiple different monitors on the same graph.

Receive SMS text alerts directly to your smart phone or by email.

4.2.1 Connecting over a local area network (LAN)

The monitors can be added to a LAN, in two ways:

- The WIFI function of the monitor is used to connect to a WIFI network that is connected to the internet.
- An Ethernet cable is used to connect the monitor to router that is connected to a LAN.

When this happens the monitor will automatically be assigned an IP address by the LAN router. You must find out what this IP address is so you can connect to the monitor and access the monitor software. The WIFI or wired LAN IP address will likely be in the format: 192.168.XXX.XXX

Figure 4-7 shows the Connect software with an assigned IP address in the address bar in the browser.
If your laptop also has access to the same LAN, then this IP address can be typed into a browser address bar and a connection to the monitor can be established over the LAN connection.

### 4.2.2 Connecting using a cellular modem

The monitors can be fitted with a cellular modem as shown in Figure 4-6 and have a built in cellular antenna on the outside roof of the enclosure. The modem requires a SIM card and the modem must be configured. Set up MOXA G3111 HSPA modem for remote communication.

|------------------|------------------------------------------------------------------------------------------------|

- Aeroqual supplies an optional cellular modem (MOXA G3111 HSPA) for remote communication. This is Aeroqual part number R38. This must be correctly configured to work on the local telecommunications network in your country.
- The modem requires a standard SIM card (dynamic IP) which you can buy from a cell phone store. The SIM card fits in a slot underneath the modem as shown in Figure 2-6.
- You must know the APN of your cellular provider, you can find out the APN by going to [www/APNChanger.org](http://www/APNChanger.org) and looking up your country and cellular provider.
- Directly connect the MOXA modem to your PC using an Ethernet cable.
- Then enter the APN into the correct field through the MOXA configuration interface shown in Figure 2-6.

![MOXA modem](image)

**Figure 4-6 The MOXA modem uses a SIM card and it must be configured for use.**

The Ethernet Mode must be set to Auto DHCP client to use the MOXA modem, as shown in Figure 4-9 (c). Other options for connecting to the monitor.

There are several options to establish a communication connection to the monitors. These require the communication settings to be changed in the Configure Instrument App shown in Figure 4-7. The communications settings are entered in to the third column. Details of each of these communication methods and how to set them up in the Configure Instrument App are given in the online training.
4.2.3 Ethernet connection

The ePC has a separate wired Ethernet connection, this can be used in a number of ways:

- To directly connect to a PC
- To connect to a wired LAN via a router
- To connect to an IP modem to provide cellular communication.

The WiFi connection and Ethernet connection are independent from each other, both can be used at the same time. The recommended configuration for connection is to set the WiFi mode to Access Point and the wired Ethernet to Client mode to use with the MOXA modem.

To use an Ethernet cable, ensure the blue Ethernet cable from the ePC is plugged in to the Ethernet plug in the bottom of the instrument, as shown in Figure 4-8. Ethernet mode is set to DCHP (server) in this method.

Figure 4-8 To establish a direct connection, a laptop must be connected to the ePC using an Ethernet cable
4.3 Communication settings

Figure 4-9 The different connection types require different settings in the Configure Instrument app

- **a)** The Ethernet mode is set to Auto (DHCP client). In this configuration the MOXA modem can be used. The MOXA modem will assign IP address **192.168.127.10** to the ePC. The WIFI mode is set to Access Point so a direct connection to the EPC can be made over local WIFI.

- **b)** The Ethernet mode is set to Auto (DHCP client). In this example the ePC has been plugged in an office router using an Ethernet cable. The router has assigned IP address **192.168.85.177** to the ePC. The WIFI mode is set to Access Point so a direct connection to the ePC can be made over local WIFI, the Ethernet mode is set to Auto (DHCP client). In this configuration the MOXA modem can be used. The MOXA modem will assign IP address **192.168.127.10** to the ePC.

- **c)** The WIFI mode is set to Client and is connected to the office WIFI network. The ePC has been given a WIFI IP address **192.168.0.158** by the router. This IP address can be entered directly in the browser to connect to the monitors.

- **d)** The Ethernet mode is set to Direct (DHCP Server). In this configuration a laptop can be directly connected to the ePC using an Ethernet cable. Enter **10.10.0.1** to connect directly to the monitors.

**NOTE:** Should you need to reset the communication settings, see the following section, Section 4.4.
4.4 Resetting the communication settings back to factory settings

The monitor communication settings can be set back to factory defaults. One situation where this might be useful is if the WIFI SSID name or password has been incorrectly entered and therefore the ePC cannot establish a connection to the local WIFI network.

The WIFI settings can be set back to Access Point mode and the monitor will again appear as a WIFI network with the SSID name “Aeroqual AQM” and WIFI password “Aeroqual”.

To achieve this you will need a USB flash drive.

1. Create a file on the flash drive called .resetnetwork.aqm (yes there is a “dot” at the beginning of the file name).
   The file extension must be .aqm it cannot be a .aqm.txt file.
   In Windows OS you can create a new .txt document and give the file name .resetnetwork.aqm. Check the Type column to make sure it is an .aqm file. You might need to unhide file extensions and delete the .txt from the end of the file name. Figure 4-10 shows the correct file.

![Figure 4-10 Create an empty file called .resetnetwork.aqm](image)

2. Then insert the USB drive into any of the USB ports on the ePC.
3. Wait several minutes, the ePC will reboot automatically and then you should see a WIFI network appear called “Aeroqual AQM” with password Aeroqual.
   You can then remove the USB stick.
5 Operation

Data visualisation, monitor configuration, calibration and control of user access is achieved using apps which are accessible from the main page.

Access to the apps, and the individual features within each app is controlled by the monitor licence and the user privileges for the different user types, which are described in Section 5.5.

5.1 Manage Data

The Manage Data app is used to view data within the browser and also to download data (export) data for use in other software. The available features in the Manage Data app will depend upon the monitor licence and the user permission level. The features within the Manage Data app appear in a column on the left hand side of the screen.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Aeroqual Licence</th>
<th>User permission required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charts</td>
<td>Connect / Cloud</td>
<td>User or higher</td>
</tr>
<tr>
<td>Table</td>
<td>Connect / Cloud</td>
<td>User or higher</td>
</tr>
<tr>
<td>Download data</td>
<td>Connect / Cloud</td>
<td>User or higher</td>
</tr>
<tr>
<td>Auto Export</td>
<td>Cloud</td>
<td>Engineer or higher</td>
</tr>
<tr>
<td>Manual sync</td>
<td>Connect</td>
<td>Engineer or higher</td>
</tr>
</tbody>
</table>

Table 5-1 Software tools available to different user permissions

5.1.1 Charts

The charts tool, in the Manage Data app shows each data channel in a stack of charts.

5.1.2 Table

The data from each module can be viewed on screen in a Table. The from and to dates can be selected using a calendar tool, and the averaging period such as daily, hourly or minute can also be selected.
The table tool in the Manage Data app shows the data in a table with user configured date range and averaging.

5.1.3 Download data

The data can be downloaded by selecting a From and To date and Averaging Period. The format is comma separated values (.csv). This file format can easily be opened in Microsoft Excel.

5.1.4 Manual sync

The manual sync feature allows all of the data, and diagnostics and journal entries to be downloaded from Connect to a PC. The manual sync file cannot be read by any software. The manual sync file is later uploaded from a PC to Aeroqual Cloud.

This feature is used if the Monitor does not have an active data connection to Aeroqual Cloud at the monitoring site but the data is required to be in Aeroqual Cloud for data storage and so all stakeholders can access the data.

Figure 5-5 shows the Manual Sync download tool in Aeroqual Connect and the Manual Sync upload tool in Aeroqual Cloud.

**NOTE:** You might need to manual sync multiple times. The first time the “From Date” is “1900”, then it creates a file with a maximum number of records of 1 million. Therefore the file might only synchronize for a limited dataset. At the end of that sync the “From Date” will show up to where the last data was downloaded. You run the sync command again and it gives you a new file starting at that date and including the max number of records. You keep running this process until you get to today’s date.
These files are then uploaded one by one using the manual sync upload tool in Aeroqual Cloud.

Figure 5-5 The manual sync tool in the Manage Data app allow all data from the Monitor to be manually uploaded to the Cloud if a local data connection is not available

5.2 Calibration and Service

<table>
<thead>
<tr>
<th>Aeroqual Licence</th>
<th>User permission required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect / Cloud</td>
<td>User or higher</td>
</tr>
</tbody>
</table>

The Calibration and Service app has two functions, Service mode initiation, and changing gain and offset during calibration.

5.2.1 Service Mode button

When a service engineer visits the monitor to perform routine service such as filter changes or flow checks, this can cause the data to read very high or very low. During service activities the monitor can be put in to Service Mode by clicking the service mode button. This will tag the data as “service data” which can later be filtered when daily or hourly averages are being calculated.

For further discussion on Service Mode see section 6.3.

5.2.2 Gain and offset adjustment

Gain and offset adjustments are made as part of the monitor gas calibration procedure.

5.3 Configure Instrument

<table>
<thead>
<tr>
<th>Aeroqual Licence</th>
<th>User permission required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect</td>
<td>Engineer or higher</td>
</tr>
</tbody>
</table>

The Configure Instrument app provides useful information about the monitor, including:

- The list of configured licences.
- When data was last sent to the Aeroqual cloud database.
- How many text alerts remain
  
  **NOTE:** These come from cloud.aeroqual.com not from the monitor.
- Setting measurement units to ppm, ppb, µgm-3 or mg-3, degrees °C or °F
- Set up text (SMS) and Email alerts.
- If a module is removed or added then a software change is required. The software module configuration can be found in the Configure Instrument app.
5.4  Diagnostics and Advanced

<table>
<thead>
<tr>
<th>Aeroqual Licence</th>
<th>User permission required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect</td>
<td>Engineer or higher</td>
</tr>
</tbody>
</table>

The Diagnostic and Advanced App provides access to monitor and individual module operating parameters and is used by Aeroqual technical support to troubleshoot and diagnose monitor condition. It provides real time information about the status of the modules and also allows operational settings of the modules to be viewed or edited.

5.4.1  Diagnostics
Each module can be selected and real time module operation parameters can be viewed.

5.4.2  Module settings
Each module has a set of operational parameters which control the module. These can be viewed or edited using the module settings dialogue.

IMPORTANT: These settings should not be changed without instruction from Aeroqual.

![Image of Diagnostics and Advanced app](image)

Figure 5-6 The Diagnostics and Advanced app displays real time monitor operational readings and settings which control how the modules are controlled.

5.4.3  Journal
Any changes to monitor settings are automatically recorded in the monitor journal with a date and time stamp and the username of the user who performed the change.

The journal entries are categorised to make it easier to search for specific entries. The categories are selected from the drop down list.

Service activities such as filter replacements or flow checks are not automatically recorded by the software.

Engineers performing service or calibration can make specific user entries to describe their service activities.

NOTE: Keeping service records is a requirement under Aeroqual's factory warranty.
5.5 Administration

The monitor ships from the Aeroqual factory with a default username and password:

Username: **administrator**
Password: **aqadmin**

**Security**

These access credentials are published in multiple public documents and are only used to first connect to and configure the monitor. Aeroqual recommends that a new Administrator user is created with secure password and the default Administrator user is deleted which will make the monitor more secure.

There are three different user permissions which can be applied to individual users on the monitor. Each individual user of the monitor may be given an individual username and password to access the monitor. There is no limit to the number of users which can be created.

<table>
<thead>
<tr>
<th>Access / Profile</th>
<th>User</th>
<th>Engineer</th>
<th>Administrator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can view and download data.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Can perform a calibration and change calibration settings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Has full control over all monitor settings.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Can control access login and password for other users.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Engineers cannot access the Administration App.

An administrator can access all of the apps in Connect, and is the only user type who can access the Administration app. New users are created using the Administration App.

5.5.1 Monitor licences

The Connect software has some features which may need to be enabled through a licence, such as the application programming interface (API) feature and the FTP export feature. For information about Connect features which require a licence, contact the Aeroqual distributor in your local country for technical support.
6 Service & Maintenance

Routine service and maintenance is required to ensure the monitor performs optimally. The frequency of some service activities such as filter changes will depend upon local environmental conditions. Environments with higher particle concentrations, for example, will require more frequent filter changes.

Other service activities such as flow checks and pump replacements can be scheduled at routine intervals and other service activities such as module replacements are performed only when required.

Recommended service frequencies for each service activity are given in Section 6.1. Further detail on each of the service activities can be found on the Aeroqual training website: training.aeroqual.com (The training website requires a login, please email technical@aeroqual.com)

It is very important to keep service records. The Journal is used for this purpose. See Section 4.3 for a discussion of use of the Journal for service record keeping.

For some of the service activities described a video is also available on YouTube. If a video is available, a web-link will be provided next to this symbol.

Safety requirements

- Replacement of any part should only be carried out by qualified personnel using only parts from the manufacturer
- Surfaces marked with a "Caution, Hot Surface" and an internationally recognised symbol may get hot and deliver burns
- If installed, the 80180 Particle Monitor is a Class 1 laser product and is not considered dangerous if used correctly. It should not be powered up with the cover removed.

6.1 Service frequency guidelines

The frequency of some of the service activities described above can depend upon environmental conditions and also upon data quality objectives. Some service activities are required at fixed frequencies (scheduled maintenance), and some are performed only as required (unscheduled maintenance).

Service intervals will vary depending on site conditions. For instance, particulate matter levels will impact the frequency of filter changes – high PM levels = more frequent filter changes.

It is important to change the filter when it gets dirty. Once the local site conditions are understood, a filter change schedule can be developed for that site.

![Filters](image)

Figure 6-1 Filters should be changed before they get too dirty. The frequency of filter changes will depend upon local site conditions.

Data quality objectives will also influence the service frequencies for some operations. In monitoring situations where data quality objectives are high, for example where monitoring is performed for compliance or where a high amount of scrutiny will be placed on the data, service frequencies may be higher.

It is recommended that the monitor engineer, over time, develops an appropriate servicing schedule for a particular site.
6.2 Flow meters and flow measurement

Accurate and precise flow rate measurement is critical for monitor service and calibration. Flow rates can be measured and reported in a number of different ways. It is important to understand the terminology and equipment associated with flow rate measurement.

6.2.1 Flow meters for gas flow measurement

For gas flow measurements, Aeroqual recommends either the Bios Defender DryCal or the TSI 4040 (AQM R7) flow meter. These can both be used to measure gas flow and Particle Monitor flow.

Figure 6-2 A high quality flow meter is required for gas flow measurement of the AQS monitor.

6.2.2 Flow meter for PM flow measurements

For PM flow rate measurements a 0.2 - 2.5 L/min rotameter is suitable, or the flow meters noted above. A rotameter is included in the Dust Sentry service kit (DS R20), but not the AQS service kit (AQS R20). It is also available separately (DS R8).

Figure 6-3 0.2 - 2.5 L/min rotameter for PM flow measurements.

6.3 Manual Service Mode

Performing service work on the monitor such as changing filters or measuring flow rates can cause the gas or particle readings to fluctuate. It is important to exclude these data from air quality reports. The monitor can be put in to “Manual Service Mode” by pushing the start button in the Calibration and Service app. This will cause the data to be labelled as “service”, normally the data is labelled as “sample”. This is illustrated in Figure 6-4 and allows a data analyst to easily filter out service data when performing quality control, calculating hourly or daily averages or writing air quality reports.

Figure 6-4 The monitor can be put into Service Mode by clicking the button in the Calibration and Service app. This will label the data as “Service” in the inlet column so the data can be filtered.
6.4 Journal

All service activities should be documented. The Journal is accessed by clicking the Journal button next to the username at the top right of the screen, then selecting user entry.

![Journal](image)

Figure 6-5 All service activities can be recorded in the Journal manually.

6.5 Maintenance procedures

The following section describes all of the common service activities required to ensure good operation of the monitor.

Some of the service activities need to be performed regularly such as filter changes and flow checks, and other service actives are performed only as required. A summary of expected service activities and how often they should be performed is described in Section 6.7.

For each service activity, the tools required are listed and references to additional information on the training website or video website is also given if available.

**NOTE:** Whenever these service activities are performed it is important to record the activity in the Journal using a manual user entry. See Section 6.4

6.5.1 Tools required for regular service and maintenance

Service and maintenance of the monitor requires basic tools such as Phillips head screw driver and adjustable spanner, and multimeter for checking electrical connections.

The Dust Sentry or AQS monitor service kits (R20) are recommended for maintenance. A description of the components of the service kits can be found on the main page of the training website [www.training.aeroqual.com](http://www.training.aeroqual.com).

6.5.2 Recommended tools for regular servicing and maintenance

- Large and small Phillips head screwdriver and large and small flat head screwdriver
- Gas flow meter AQM R7 – Ordered separately, only required for AQS (see section 6.1 for a discussion of requirements for flow meters)
- Rotameter for PM flow DS R8 (included in the Dust Sentry service kit DS R20)
- Vacuum gauge R23 (Included in both Dust Sentry and AQS R20 Service Kits, also available separately)
- Electrical multi meter (Only required for troubleshooting)
- Adjustable spanner
6.5.3 Replace gas sample inlet filter (AQS only)
The gas inlet filter is held inside the enclosure at the top left. This must be changed to ensure accurate readings. The filter is disposable and can be thrown away.
The filter should be changed when it becomes dirty as shown in Figure 6-6. The frequency of filter changes depends upon local environmental conditions.

<table>
<thead>
<tr>
<th>Tools required</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts required</td>
<td>AQS R12 (bag of 25 filters)</td>
</tr>
<tr>
<td>Service interval</td>
<td>Recommended Monthly (depends on local conditions) See Section 6.1 for further discussion on filter change frequencies.</td>
</tr>
</tbody>
</table>

Do not turn off the monitor, this procedure can be done with the monitor turned on.

**NOTE:** It is very important to check the monitor inlet flow rate is correct after changing the filter to ensure there are no leaks

![Image of particle filters]

Figure 6-6 The particle filter on the gas inlet can be easily replaced, it should be replaced when it gets dirty as shown in the image on the right (a new filter is shown on the left, dirty filter on the right).

6.5.4 Measure and adjust monitor inlet flowrate and module flow rate
Maintaining a consistent flow rate is very important for ensuring accurate measurements. Leaks, or an aging pump may lead to reduced flow. Regularly measuring the flow rate will ensure any changes to flow rate are identified as soon as possible.

<table>
<thead>
<tr>
<th>Tools required</th>
<th>AQM R7, Inlet flow adaptor (comes with monitor accessories box) Small Philips head screwdriver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts required</td>
<td>None</td>
</tr>
<tr>
<td>Service interval</td>
<td>Recommended Monthly.</td>
</tr>
<tr>
<td>Online reference</td>
<td>training.aeroqual.com: Dust Monitor technical Training Section 4.2</td>
</tr>
<tr>
<td>Online video</td>
<td>YouTube Channel: Aeroqual Service and Maintenance playlist</td>
</tr>
</tbody>
</table>
6.5.4.1 Measure main gas inlet flow rate
- Remove the white inlet fitting containing the mesh filter and attach the inlet flow adaptor.
- Attach a high quality flow meter such as the Aeroqual R7 or Bios Dry Cal. See section 6.1.
- Record the inlet flow rate in the Journal by making a manual user entry.

The gas inlet rate is controlled, for a description of the expected flow rate for the module see Table 12-1.

When the monitor is new, the inlet flow rate is recorded in the monitor log book which is provided from the Aeroqual factory. The measured flow rate should be equal to the previously measured flow rate which is recorded in the monitor journal.

6.5.4.2 Measure the flow rate of the module
The module flow rate is measured using a high quality flow meter such as the Aeroqual R7 or the Bios Dry Cal. See Section 6.1

- Attach the flow meter to the inlet port (white ring) of the gas module
- Reconnect the inlet fitting after measuring the gas module
- Record the flow rate of the module in the Journal by making a manual user entry

6.5.4.3 Adjust the PM inlet flow rate
If the PM inlet flow rate is found to be lower than expected, it could be because one of the modules has a leak or is blocked.

To check this perform a flow check on the individual modules as described in Section 6.5.11

If one of the modules is found to be blocked or has a leak then this will need to be corrected.

If all of the modules showed reduced flow, then it is likely that the gas flow pump is aging.

The flow adjustment valve can be used to provide more flow to the module inlets, and return the flow rate to the expected flow rate.

Attach a flow meter to the inlet and begin measuring the inlet flow. Adjust pump flow adjustment valve until the monitor inlet flow rate has returned to the expected flowrate. The valve is shown in Figure 6-8.

Figure 6-7 To measure the flow rate, remove the inlet filter and attach the inlet flow adaptor.

Figure 6-8 The flow adaptor valve is used to adjust the monitor inlet flow to the correct value.
If the correct flow rate cannot be set then it may be required to replace the gas sample pump. The pump is part number **AQS R10**. The pump can easily be removed from the bracket for replacement.

**IMPORTANT** Use fresh Tygon Tube (CS Tube 10) when re-connecting the tube back on the pump. This is because the barbs on the pump stretch the tube.

The online training website contains details on how to replace the gas sample pump.

### 6.5.5 Replace filter on Particle Monitor or Particle Profiler

The Particle Monitor and Particle Profiler have filters which need to be replaced. Disconnect the pump module power when replacing the filter, see Figure 6-15 and Figure 6-16.

<table>
<thead>
<tr>
<th>Tools required</th>
<th>Large flathead screwdriver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts required</td>
<td>DS R31 (Particle Monitor) DS R32 Particle Profiler</td>
</tr>
<tr>
<td>Service Interval</td>
<td>Recommended <strong>Monthly</strong> (depends on local conditions) See Section 6.1 for further discussion on filter change frequencies.</td>
</tr>
<tr>
<td>Online reference</td>
<td>training.aeroqual.com: Dust Monitor technical Training, section 5.1</td>
</tr>
<tr>
<td>Online video</td>
<td>YouTube Channel: Aeroqual Service and Maintenance playlist</td>
</tr>
</tbody>
</table>

The filters for the Particle Monitor are located inside the optical module. Use a large flat head screwdriver to unscrew the filter housing on the front panel of the optical module.

The filters for the Particle Profiler are located in a filter casing outside the optical module and within the Particle Profiler Pump Module.

![AQM R31 for particle monitor](image1.jpg) ![AQM R32 for particle profiler](image2.jpg)

**Figure 6-9** The Particle Monitor (shown on the left) requires AQS R31 and the Particle Profiler (shown on the right) requires AQS R32

Section 6.1 discusses frequencies for changing the filters on the Particle Monitor and Particle Profiler. However if the filters look visibly blackened they should be replaced, regardless of the time elapsed.

![New filter to Replace now](image3.jpg)

**Figure 6-10** The AQS R31 sample filter should be replaced once the filter begins to blacken
6.5.6 Flow check and flow adjustment of the Particle Monitor and Particle Profiler

It is important to maintain the correct flow rate through the Particle Monitor or Particle Profiler. The flow rate of the Particle Monitor and Particle Profiler are different.

**NOTE:** The flow rate of the Particle Monitor is $2.0 \pm 0.05$ LPM

The flow rate of the Particle Profiler is $1.0 \pm 0.05$ LPM

<table>
<thead>
<tr>
<th>Tool</th>
<th>Small Philips head screw driver, AQS R56 and DS R8 or AQM R7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part</td>
<td>None</td>
</tr>
<tr>
<td>Serv</td>
<td>Recommended Monthly. (See Section 6.1)</td>
</tr>
<tr>
<td>Ref</td>
<td>training.aeroqual.com: Dust Monitor technical Training Section 4.1</td>
</tr>
<tr>
<td>Vide</td>
<td><a href="#">YouTube Channel: Aeroqual Service and Maintenance playlist</a></td>
</tr>
</tbody>
</table>

The AQS R56 includes a flow adaptor which is fitted on the inlet, for the Particle Monitor it is fitted above the cyclone as shown in Figure 6-11.

![Image of Flow Check and Adjustment](image)

**Figure 6-11 When checking the flow rate of the Particle Monitor (left) place the flow measurement adaptor above the cyclone. The position of the flow adaptor when measuring the Particle Profiler is shown on the right.**

6.5.6.1 Using the buffer chamber when checking the flow of the Particle Profiler

When measuring (or adjusting) the flow rate of the Particle Profiler it is important to use the buffer chamber to ensure accurate measurement. The buffer chamber is part of the AQS R56 Zero Filter and Flow assembly. It is also part of the R20 Service kits. Figure 6-12 shows the buffer chamber installed between the flow meter and the profiler inlet.

![Image of Flow Buffer Chamber](image)

**Figure 6-12 When measuring the flow on the Particle Profiler it is important to use the flow buffer chamber**

The flow buffer chamber smooths the flow coming from the diaphragm pump.

It is installed between the flow meter and the Particle Profiler inlet.
6.5.6.2 Flow adjustment of Particle Monitor

The flow rate of the Particle Monitor must be 2.0 LPM ± 0.05 (between 1.95 and 2.05 LPM)

![Image of Particle Monitor]

Figure 6-13 The flow rate of the Particle Monitor is set by adjusting the purge and exhaust valves

The flow rate of the Particle Monitor must be 2.0 LPM ± 0.05 (between 1.95 and 2.05 LPM)

- Fully close the purge valve by pushing the valve handle towards the module
- Adjust the exhaust valve until the flow reads 2.2 LPM
- Adjust the purge valve until the flow reads 2.0 LPM ± 0.05

The final adjustment can be a little tricky, turn the purge valve slowly. If it is not possible to reach 2.2 LPM at step 2 then there may be a leak or the pump might need to be replaced.

6.5.6.3 Flow adjustment of Particle Profiler

**NOTE:** It is important to use the buffer chamber when measuring or adjusting the flow rate of the Particle Profiler. Section 6.5.6.1

![Image of Particle Profiler]

Figure 6-14 The flow rate of the Particle Profiler is set by adjusting the flow adjustment valve

The flow rate of the Particle Profiler is adjusted to 1.0 LPM ± 0.05 LPM using the flow adjustment valve as shown in Figure 6-14.
6.5.7 Leak check Particle Monitor and Particle Profiler

If the aluminium inlet is not correctly installed (see Section 0) or if the tubing is split then the PM can have a leak. The vacuum gauge (AQS R23) is used to check for leaks in the Particle Monitor system and should be performed as part of regular service.

<table>
<thead>
<tr>
<th>Tools required</th>
<th>AQS R23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts required</td>
<td>None</td>
</tr>
<tr>
<td>Service Interval</td>
<td>Recommended Every three months (See Section 6.1)</td>
</tr>
<tr>
<td>Online reference</td>
<td>training.aeroqual.com: Dust Monitor technical Training Section 4.2</td>
</tr>
<tr>
<td>Online video</td>
<td>None</td>
</tr>
</tbody>
</table>

6.5.7.1 Leak check a Particle Monitor

1. Remove the TSP head and install the R23 vacuum gauge above the sharp cut cyclone
2. Fully close the purge valve and fully open the exhaust valve
3. The vacuum gauge should reach at least -60 kPa
4. Then remove power (pull out black and red cable) to the electronics module to turn off the pump.
5. Count how long it takes for the pressure to change by 10 kPa.

![Vacuum Gauge and Valve](image)

Figure 6-15 Fit the vacuum gauge, adjust the valves. Then stop the pump by removing power from the module, observe the change in pressure. If the leak rate is greater than 10 kPa in 10 seconds then there may be a leak in the system. Check all the tube connections.

**NOTE:** The pressure change (leak rate) should be no more than 10 kPa in 10 seconds.
6.5.7.2 Leak check a Particle Profiler

1. Fully open the sample valve
2. The next step is to block the purge flow:
   a. For older Particle Profiler modules, disconnect the purge line and cap the purge line and purge ports with luer caps as shown in Figure 6-16
   b. For current Particle Profiler modules, pinch the tube as shown in Figure 6-17
3. Remove the TSP inlet and place the vacuum gauge on the inlet
4. Wait for the vacuum gauge to stabilise
5. Remove black and red power cable from electronics box

**Figure 6-16** Original Particle Profiler Cap the purge and exhaust lines. Place the vacuum gauge on the inlet. Disconnect the power, observe the change in pressure.

**Figure 6-17** Pinch the tube with the newer Particle Profiler pump module

**NOTE:** The pressure change (leak rate) should be no more than 10 kPa in 10 seconds
6.5.8 Zero calibration check and flow check of Particle Module

<table>
<thead>
<tr>
<th>Tools required</th>
<th>R56, and DS R8 or AQM R7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts required</td>
<td>None</td>
</tr>
<tr>
<td>Service interval</td>
<td>Recommended Monthly. (See Section 6.1)</td>
</tr>
<tr>
<td>Online reference</td>
<td>training.aeroqual.com: Dust Monitor technical training Section 4.4</td>
</tr>
<tr>
<td>Online video</td>
<td>YouTube Channel: Aeroqual Service and Maintenance playlist</td>
</tr>
</tbody>
</table>

6.5.8.1 Check zero baseline of Particle Monitor
The Particle Monitor (nephelometer) has an automatic zero calibration function which runs every 12 hours, this procedure automatically changes the zero offset of the Particle Monitor.

The zero response of the Particle Monitor can be checked by removing the TSP head and placing the R56 adaptor and zero filter assembly on the inlet above the cyclone as shown in Figure 6-18. The Particle Monitor should read between ±3 µg m⁻³.

If the zero check shows negative numbers there may be a problem with the auto zero cycle. See the troubleshooting section. Troubleshooting in Section.

Check that the gain and offset values for the Particle Monitor are set to sensible settings. The gain should be between about 0.6 and 4.0. The offset should be 0.000.

See Section 7.2 for a discussion on gain adjustment of the Particle Monitor.

![Figure 6-18 The zero filter is fitted above the cyclone for a Particle Monitor (left) and directly on the inlet for a Particle Profiler (right)](image)

6.5.8.2 Check the auto zero calibration flow rate of the Particle Monitor
The Particle Monitor executes an automatic zero calibration every 720 minutes (12 hours). The auto zero process resets a parameter in the modules settings. The value which is changed is the H0 parameter.

**NOTE:** The particle profiler does not have this feature.

The auto zero procedure on the Particle Monitor causes the baseline to be adjusted. Negative readings on the Particle Monitor are often a result of the auto zero cycle failing to work correctly.

The zero cycle works by switching off the sample pump and switching on a zero pump. The flow rate during the zero cycle is reversed and is a positive flow out through the inlet. The flow rate is approximately 0.2 to 0.6 LPM.

This flow rate does not need to be set to a specific value but it is important that the flow rate is at least 0.2 LPM positive flow out from the inlet.
When measuring the sample flow of the Particle Monitor a vacuum is measured. When measuring the zero flow a positive pressure is measured.

The auto zero can be executed manually by temporarily changing one of the module settings. Once the auto zero cycle is complete the setting needs to be returned back to the original setting.

- Go to the Diagnostic and Advanced app in Connect software.
- Select Module settings from the list on the left column.
- Locate the Particle Monitor settings, these will be either PM10.0 or PM2.5.
- Locate the TIMA parameter (it should be 720).
- Change this value to 1 by clicking in the cell and typing 1, then save the setting change.

This will cause the auto zero to start. The flow will change from 2,000 LPM negative flow into the inlet to approximately 0.2 to 0.6 positive flow out from the inlet.

You will need to change the port on the flow meter to measure this flow as shown in Figure 6-18.

- If no flow is measured there may be an issue with the zero cycle or zero pump. See Appendix 1 for trouble shooting.
- Measure the positive flow coming out from the inlet and record this in the journal.

The zero cycle takes approximately 6 minutes to complete.

**NOTE:** Once the flow has been measured the TIMA parameter must be set back to 720.

### 6.5.9 Clean the Particle Monitor TSP inlet, particle trap and cyclone.

The Particle Monitor cyclone uses a small particle trap to remove larger particles. The trap needs to be emptied and cleaned for optimum operation of the Particle Monitor. If the particle trap overfills then the entire cyclone needs to be cleaned.

<table>
<thead>
<tr>
<th><strong>Tools required</strong></th>
<th>Can of compressed air, cloth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parts required</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>Service interval</strong></td>
<td>Recommended 6 <strong>Monthly</strong>. (See Section 6.1)</td>
</tr>
<tr>
<td><strong>Online reference</strong></td>
<td>training.aeroqual.com: Dust Sentry technical Training Section 5.1</td>
</tr>
<tr>
<td><strong>Online video</strong></td>
<td><strong>YouTube Channel: Aeroqual Service and Maintenance playlist</strong></td>
</tr>
</tbody>
</table>
The TSP head, particle trap and cyclone disassemble easily for cleaning.

![Image](image1.png)

**Figure 6-20** The TSP head and cyclone can be disassembled for cleaning.

### 6.5.10 Replace pumps in pump module

The pumps in the Particle Monitor pump module and in the Particle Profiler pump module can easily be replaced.

The Particle Monitor contains a sample pump: *(AQS R10)* and a purge pump *(AQS R34)*. The Particle Profiler only has a sample pump *(AQS R10)*

Typically the pumps last between 12 and 18 months. However the pumps should be replaced when the correct flow can no longer be maintained.

![Image](image2.png)

**Figure 6-21** The Particle Monitor contains two pumps, the Particle Profiler has one pump.

### 6.5.11 Leak check gas module

If the correct flow rate cannot be achieved through a gas module, this may indicate a leak. An individual gas module can be checked for leaks by using a small diaphragm pump and a flow meter in the configuration shown in Figure 6-22

<table>
<thead>
<tr>
<th><strong>Tools required</strong></th>
<th>Diaphragm pump R10, flowmeter DS R8 or AQM R7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parts required</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>Service interval</strong></td>
<td>Only as required. (See Section 6.1)</td>
</tr>
<tr>
<td><strong>Online reference</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>Online video</strong></td>
<td>None</td>
</tr>
</tbody>
</table>

![Image](image3.png)

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A gas module should be leak tight.

![Diagram of gas module with leak tightness concept]

**Figure 6-22** A gas module can be checked for leaks by using a diaphragm pump and R7 flow meter

**NOTE:** If the module is found to have a leak, contact the Aeroqual distributor in your local country for technical support.

### 6.5.12 Remove and replace a gas module

Replacing the module configuration can be done easily on site.

A change in the module can result in a change of inlet flow rate. It is important to measure the inlet flow rate after the module change and document this in the monitor journal.

<table>
<thead>
<tr>
<th>Tools required</th>
<th>Tube Cutter, Large Phillips head screw driver, AQM R7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts required</td>
<td>Tubing: CS Tube10 CS Tube11, power cable, communication cable, 2x luer cap</td>
</tr>
<tr>
<td>Service interval</td>
<td>As required</td>
</tr>
</tbody>
</table>

If a module is removed or added then a software change is required. The software module configuration can be found in the Configure Instrument app. Sensor modules can be added or removed using this tool, shown in Figure 6-23.

**Figure 6-23** Change the module configuration in the software in the Configure Instrument app.
6.5.12.1 Replacing a module with another of the same type
This can be done with the monitor power left on. There is no software change required when removing a module.

- Disconnect the vacuum and sample lines
- Remove one blue communications cable and one red and black power cable
- Loosen the retaining screws and remove the module
- Replace the module with the new module
- Reconnect the blue communication cable and black and red power cable to ensure all modules have power and communications.

**IMPORTANT** Ensure the polarity of the red and black cable is the correct orientation.

- Cap off the vacuum and sample lines using a luer cap
- Remove the module from the sensor list in the software (Configure Instrument app)
- Measure the total inlet flow rate and document this in the journal

6.5.12.2 Adding a new module
This can be done with the monitor power left on. There is a software change required when adding a module.

You will need one blue communications cable and one black and red power cable. You need 4 x 10mm M4 screws.

It may be necessary to cut in to the sample and exhaust lines in order to add additional gas fittings. For this you will need a tube cutter, **do not use scissors**. You will also need tee fittings and luer fitting, and tubing. It may be possible to connect a new module directly to manifold on the left side of the enclosure.

It is important to use the PFA (CS Tube 11) for the gas sampling and Tygon (CS Tube 10) for the exhaust (See Section 12.1.2 for a description of the sample and exhaust manifold).

It important to use the large barb tee for the exhaust tubing and the small barb tee for the sample tubing.

![Image of adding a new module](image-url)

**Figure 6-24** Adding a new module requires adding additional sample and exhaust lines.

6.6 Factory calibration of Particle Monitor
Dust and other debris can settle upon the internal optics of the optical engine which can lead to inaccurate readings. The laser and detector may also need to be replaced.

The Particle Monitor optical module (nephelometer) requires a factory service and calibration every two years.

For information about factory service and calibration of the Particle Monitor, please check with the Aeroqual distributor nearest to you.
6.7 Scheduled maintenance

The service frequencies should be considered conservative. Monitor operators are encouraged to develop a service schedule suitable for their local conditions and data quality objectives.

<table>
<thead>
<tr>
<th>Service activity</th>
<th>Section</th>
<th>Service frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas inlet filter change</td>
<td>6.5.3</td>
<td>4-12 weeks Initially 4 weeks. Later this can be modified to suit local conditions and data quality objectives</td>
</tr>
<tr>
<td>PM inlet filter change</td>
<td>6.5.5</td>
<td>4-12 weeks Initially 4 weeks. Later this can be modified to suit local conditions and data quality objectives</td>
</tr>
<tr>
<td>Gas inlet flow check</td>
<td>6.5.4.1</td>
<td>4-12 weeks Initially 4 weeks. Later this can be modified to suit local conditions and data quality objectives</td>
</tr>
<tr>
<td>PM inlet flow check</td>
<td>6.5.6</td>
<td>4-12 weeks Initially 4 weeks. Later this can be modified to suit local conditions and data quality objectives</td>
</tr>
<tr>
<td>Gas inlet flow adjustment</td>
<td>6.5.4.3</td>
<td>Adjust as required following gas inlet flow check</td>
</tr>
<tr>
<td>PM inlet flow adjustment</td>
<td>6.5.6</td>
<td>Adjust as required following PM inlet flow check</td>
</tr>
<tr>
<td>PM leak check</td>
<td>6.5.7</td>
<td>Every 3 months (Quarterly)</td>
</tr>
<tr>
<td>PM zero calibration check</td>
<td>6.5.8</td>
<td>Every 3 months (Quarterly)</td>
</tr>
<tr>
<td>PM zero calibration flow check</td>
<td>6.5.8.1</td>
<td>Every 3 months (Quarterly)</td>
</tr>
<tr>
<td>PM inlet cleaning</td>
<td>6.5.9</td>
<td>Every 3 months (Quarterly)</td>
</tr>
<tr>
<td>Change gas flow pump</td>
<td>6.5.10</td>
<td>Every 12 to 18 months or if flow rate cannot be set correctly</td>
</tr>
<tr>
<td>Change Particle Monitor flow pumps</td>
<td>6.5.10</td>
<td>Every 12 to 18 months or if flow rate cannot be set correctly</td>
</tr>
<tr>
<td>Factory calibration of Particle Monitor</td>
<td>6.6</td>
<td>Every 24 months (2 years)</td>
</tr>
<tr>
<td>Factory calibration of Particle Profiler</td>
<td>6.6</td>
<td>Every 12 months (1 year)</td>
</tr>
<tr>
<td>Gas module calibration</td>
<td>5.1</td>
<td>See section 7.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unscheduled maintenance</th>
<th>Section</th>
<th>Service frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure flow rate of gas modules</td>
<td>6.5.4.2</td>
<td>As required following gas inlet flow check</td>
</tr>
<tr>
<td>Leak check a gas module</td>
<td>6.5.11</td>
<td>As required following module flow check</td>
</tr>
<tr>
<td>Add, remove, replace gas module</td>
<td>6.5.12</td>
<td>As required</td>
</tr>
</tbody>
</table>

Table 6-1 Service frequency guidelines for various service activities
7 Calibration

**NOTE:** A calibration record is supplied with the monitor, additional copies can be requested by contacting technical@aeroqual.com

7.1 Gas module calibration

There are three types of calibration of the gas module:

1. **Factory calibration pre-shipment.** All gas modules are calibrated and must meet rigorous performance standards before being shipped. This is captured by the factory calibration certificate. Experience shows that Aeroqual’s factory calibration transfers well to the field, meaning that field calibration is not required during initial set up.

2. **Field calibration.** The monitor is designed so that the gas module can be calibrated in the monitor in the field. The field calibration set up and process is very similar to calibration of US / EU EPA approved ‘reference’ analyzers.
   - Field calibration is only recommended when:
     a) the gas module is clearly operating out of specification and the appropriate trouble-shooting steps have been taken, or;
     b) periodical validation of the data is required (recommended for advanced users only).

3. **Factory calibration post-shipment.** At any time the gas module can be removed from the monitor and returned to the factory or one of our authorised service providers for factory calibration. If the gas module has not been field calibrated then it is recommended to have the gas module factory calibrated every 12 months

The following instructions relate to field calibration only.

Field calibration is an activity that requires attention to detail and accuracy. You should read this entire calibration section and understand it before starting, even if you are an experienced practitioner.

- The monitor is calibrated using a two-point calibration procedure, first by delivering zero air to the monitor inlet and adjusting the offset, and then delivering span gas to the monitor inlet and adjusting the gain.
- Aeroqual provides all of the equipment required to perform field calibration. Aeroqual offers a portable calibrator called the AirCal 1000.
- Offset and gain adjustments are performed using the software tools provided by Aeroqual Connect or Aeroqual Cloud.
- If the AirCal 1000 is being used, there is a separate PC desktop software application which can be downloaded from the website.

Some important considerations for field calibration:

- Gas module calibration is achieved using certified calibration gas and a gas dilution calibrator.
- For ozone, an ozone generator, (ozone calibrator) must be used, Aeroqual recommends the 2B Tech Ozone generator part number AQM O3CAL.
- Aeroqual does not recommend calibration when first commissioning a new monitor. We recommend first calibrating 1-3 months after commissioning.
- The quality of the calibration gas makes a big difference to success of a calibration, only purchase calibration gas from a reputable calibration gas supplier.
- The monitor must be in a stable condition before calibration can be attempted. The monitor must have been running for at least 6 hours before calibration, ideally 24 hours.
- The zero calibration step takes approximately 30 minutes total across all modules. The span calibration takes approximately 30 minutes per-module. Therefore a monitor with 2 gas modules will take 30 + (2 *30) minutes (approximately 1.5 hours) to calibrate.
- Record keeping is a crucial part of calibration, the journal feature in Connect and Cloud is where calibration record keeping is performed.

Calibration is discussed in detail in the online training. Several supporting videos are also available.

<table>
<thead>
<tr>
<th>Online reference</th>
<th>training.aeroqual.com Dust Sentry Technical Training Section 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online video</td>
<td>YouTube Channel: Aeroqual Service and Maintenance playlist</td>
</tr>
</tbody>
</table>
7.1.1 Equipment required
Calibration of the gas modules inside the monitor requires specialist equipment which Aeroqual can provide.

<table>
<thead>
<tr>
<th>Gas Module</th>
<th>Equipment</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₃</td>
<td>O3Cal</td>
<td>Tubing and gas fittings are not supplied with the O3Cal. The calibration tubing and fittings can be ordered separately using part number: AOM CALKIT.</td>
</tr>
<tr>
<td>NO₂</td>
<td>Aeroqual AirCal 1000</td>
<td>Tubing and gas fittings are supplied with the AirCal 1000.</td>
</tr>
</tbody>
</table>

NOTE: Both the AirCal 1000 and the Ozone calibrator take time to warm up and become stable.
- Turn on the AirCal 1000 and switch on the pump override switch on the back panel for at least 30 mins before starting calibration.
- Turn on the Ozone generator and set it to deliver 0.1 ppm Ozone for at least 30 mins before starting calibration, this allows time for the lamp in the ozone generator to stabilise at 0.1 ppm.

7.1.2 Calibration gases
Aeroqual cannot supply calibration gas cylinders, these must be purchased locally. Aeroqual recommends small size portable gas cylinders be purchased from Calgaz: [www.calgaz.com](http://www.calgaz.com).

<table>
<thead>
<tr>
<th>Gas Description</th>
<th>Description</th>
<th>Calgaz Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO₂ (Nitrogen Dioxide)</td>
<td>20 ppm NO₂ Balance AIR 8AL 58 litres C10 fitting</td>
<td>A0446046</td>
</tr>
<tr>
<td>C₄H₈ (Isobutylene)</td>
<td>Isobutylene 1000 ppm Balance Air 6D 103 litres C10 fitting</td>
<td>A0436843</td>
</tr>
</tbody>
</table>

Table 7-1 Recommended gas cylinders from Calgaz.

A two-stage pressure regulator is required for use with these gas cylinders. Aeroqual can supply the regulator, part number AIC GASREG01, for use with C10 fitting. The Aeroqual regulator is shown attached to the Calgaz cylinder in Figure 5-1.
7.1.3 Flow meters for gas flow measurement

It is important to have a high quality flow meter for the gas flow measurement.

![Flow meters](image)

**Figure 7-2 Recommended high quality flow meters. Left: Bios DryCal, Right: Aeroqual R7 flow meter.**

7.1.4 Gas module field calibration frequency

Typically only advanced users will need to field calibrate their monitor. All other users can depend upon 12 monthly factory calibration of the gas module.

For some monitoring applications such as compliance monitoring the calibration frequency may be regulated. Some monitoring applications may require periodical validation of the data and field calibration is the best way to achieve this.

Field calibration frequency is a balance between cost and data quality objectives. Field calibration will incur cost of time and materials. Therefore more frequent calibration costs more because it requires more time and materials.

At the high cost end of the spectrum are national ambient monitoring networks. The US EPA Quality Assurance Handbook (see [http://www.epa.gov/ttnamti1/qalist.html](http://www.epa.gov/ttnamti1/qalist.html)) is a good example of how prescriptive calibration requirements for such applications can be.

Aeroqual makes the following recommendations about calibration frequency for the monitor:

- Follow all local regulatory calibration requirements if these are defined for the monitoring activity.
- Plan routine calibrations at an interval that is consistent with the data quality objectives for your monitoring purpose.
- Field calibration may be necessary if the gas module is operating out of specification and all other trouble-shooting steps have been taken.

**Record your observations and calibration results in the calibration records.**

- The service and calibration forms at the end of this document in Appendix 5 are used with this procedure, information arising from the calibration should be entered into the appropriate sections of the forms.
- The Journal feature in Connect/Cloud can also be used to record observations and make comments throughout the calibration process.

**Assumptions**

This SOP assumes the monitor and calibration equipment are in good working condition and the monitor is “ready for calibration”.

- The monitor has been running for at least 6 hours.
- The gas lines and inlet filter is clean.
- You are familiar with the operation of all of the calibration equipment.
- All calibration equipment, such as calibrators and gas bottles are working and within calibration where necessary.

**You will need to know:**

- The total flow rate measured last time the monitor was serviced. Record this in Table 5.
- The individual gas module flow rates last time the monitor was serviced. Record this in Table 6.
- The current gain and offset for each module. See Figure 3. Record these in Tables 7 and 8 in the Calibration form in Appendix 5.
You will need to bring:

- Gas inlet filters
- Gas dilution calibrator / Zero air generator (combined or separate ozone generator)
- Gas cylinders with suitable gas concentrations
- Flow meter: Aeroqual R7

Before you begin

**NOTE:** Both the AirCal 1000 and the Ozone calibrator take time to warm up and become stable.

- **Turn on the AirCal 1000 and switch on the pump override switch on the back panel** for at least 30 mins before staring the calibration.
- **Turn on the Ozone generator and set it to deliver 0.1 ppm Ozone** for at least 30 mins before starting the calibration, this allow time for the lamp in the ozone generator to stabilise at 0.1 ppm.

The Calibration screen in the Calibration and Service App in the Aeroqual software is where you will perform the calibration and change any monitor settings.

![Image of the Calibration screen](image1)

**Figure 7-3** The main calibration screen is where the average and standard deviation can be read. This is also where the gain and offset can be read and set.

![Image of the Manual Entry section](image2)

**Figure 7-4** The Manual Entry section of the Calibration and Service App is where the gain and offset and the a value on the NO2 module is set.

**NOTE:** The connection to the monitor inlet differs depending on whether you are using the AirCal 1000 or the Ozone calibrator. See images below for how the connections differ.
The NO$_2$ measurement is determined by the difference between two measurement modules; the O$_x$ module and the Ozone module.

The O$_x$ module responds towards both NO$_2$ and Ozone. The NO$_2$ concentration is determined by difference according to Equation 1.

$$[\text{NO}_2] = [\text{O}_x] - a[\text{O}_3]$$

The NO$_2$ $a$ value is set at the Aeroqual factory and adjusts for the relative response of the O$_x$ module towards ozone calibration gas.

The $a$ value should be checked and adjusted as part of routine field calibration, see Figure 3b.

Note that only the $a$ value is set for NO$_2$, the offset should be left at 0.000 and the gain should be left at 1.000.

Below is a brief summary of the calibration steps for the NO$_2$/O$_3$ system. These steps must be carried out in the order described here. A detailed step by step process is described later in this document.

### 7.1.6 NO$_2$ calibration steps

**NOTE:** Gain and value adjustments vary as follows

- The O$_x$ module gain adjustment is made during the NO2 calibration gas delivery
- The NO2 $a$ value adjustment is made during the Ozone gas delivery
- The NO2 gain value is NOT adjusted as part of the calibration process

1. Deliver zero air from the AirCal 1000 (or a suitable gas dilution calibrator) to the monitor.
2. Adjust the zero offset on the O\textsubscript{x} and O\textsubscript{3} module so that O\textsubscript{x} and O\textsubscript{3} read zero. (Confirm NO\textsubscript{2} reads zero but do not adjust calibration settings on the NO\textsubscript{2} channel).
3. Deliver 0.1 ppm NO\textsubscript{2} gas from the calibrator.
4. Adjust O\textsubscript{x} gain so the O\textsubscript{x} reads 0.1 ppm.

**NOTE:** The NO\textsubscript{2} module should be reading 0.1 ppm during the 0.1 ppm Ox span calibration. The NO\textsubscript{2} may read slightly less than 0.1, this is normal, do not adjust the NO\textsubscript{2} gain.
5. Deliver zero air for 10 minutes to allow the sensors to return to baseline.
6. Then deliver 0.1 ppm Ozone.
7. Adjust O\textsubscript{3} gain so that the O\textsubscript{3} module reads 0.1. The Ox module will be showing a response towards Ozone during the O3 calibration, this is expected.

If the NO\textsubscript{2} shows a response during the Ozone calibration then a new a value must be calculated according to equation 3 and applied as shown in Figure 5-4.

\[
\text{[NO}_2\text{]} = \text{[Ox]} - [aO3] = 0.00  \\
\text{a} = \frac{\text{[Ox]}}{[O3]} \text{ span concentration}
\]

Set the a value in the Manual Entry dialogue in the Service and Calibration App (Figure 5-4).

Check the NO\textsubscript{2} reads zero under these conditions.
8. Deliver Zero air for 10 mins to purge the gas lines before returning to sampling ambient air.

### 7.1.6.1 Calibration pre-checks:

You will need to record a range of details as part of the calibration process. Use the Calibration Record document in section 12.3.

The list of record capture tables are listed below:

<table>
<thead>
<tr>
<th>Table</th>
<th>Details to record</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Monitor, customer, and calibration technician details</td>
</tr>
<tr>
<td>2</td>
<td>Calibration equipment used</td>
</tr>
<tr>
<td>3</td>
<td>Calibration gas details</td>
</tr>
<tr>
<td>4</td>
<td>Changes to the local surroundings which may have an impact on the measurements</td>
</tr>
<tr>
<td>5</td>
<td>Monitor pre check results</td>
</tr>
</tbody>
</table>

**Before you open the door**

**Monitor pre-checks**

- 5.1 Put the monitor into Service Mode.
- 5.2 Check that the gas inlet is secure, if yes pass
- 5.3 Check that the particle inlet is secure, if yes pass
- 5.4 Check that door locks are operational, if yes pass
- 5.5 Measure and record the gas inlet flow rate
- 5.6 Record the previously measured flow rate, this value should be recorded in the monitor journal.

**Open the door**

**NOTE:** To keep the sensor readings stable, minimise the time the door is open.

- 5.7 Replace the inlet filters
- 5.8 Measure and record the inlet flow rate again after changing the filter.
  - If the inlet flow has changed compared to step 5.6, (but less than ±20 %) since last time it was measured then check the gas connections for obvious leaks, then use the flow adjustment valve to correct the flow.
  - If adjustment was unsuccessful then go to Step 6.
  - If the inlet flow has changed (more than ±20 %) since last time it was measured (step 5.6) then go to Step 6.

**Close the door**

- 5.9 Record the final total flow.
7.1.7 Check and adjust module flow rates

<table>
<thead>
<tr>
<th>Table</th>
<th>Details to record</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Monitor, customer, and calibration technician details</td>
</tr>
</tbody>
</table>

**NOTE:** *It is important to have a high quality flow meter to perform these flow checks. See Figure 9.2.*

Flow checks in this section are performed separately for each module. One or more modules can fail the flow check, but others can pass. Calibration can continue on those modules which pass, modules which fail can be removed and checked without affecting the calibration on the remaining modules.

6.1. Check all of the individual gas connections for any obvious leaks.
   - If a leak is found then correct it, go back to Step 5.9.
6.2 Perform a leak check on the sampling manifold.
   - If a leak is found then correct it, go back to Step 5.9.
6.3 Measure the individual flow rates, then add up the flows to equal total module flow. Record the sum of the flows in the last column.
   - For each module, if the flow rate measured now equals the previously measured flow rate (± 20 % LPM) then pass for that module, otherwise fail for that module.
   - If no specific module is causing a problem and all module flow rates are low then go to 6.4 otherwise go to 6.6.
6.4 Adjust the flow rate using the bypass valve, circle yes if valve adjusted.
6.5 Re-measure and record module flow rates for each module.
   - If the flow rate measured now equals the previously measured flow rate then pass. Go to zero calibration.
   - For those modules which do not have the correct flow rate and cannot be corrected with the bypass valve then perform a leak check or check for blockages.
   - If the problem can be corrected then correct it, otherwise replace the module. Go to zero calibration.
   - If the problem cannot be resolved then remove the module and cap off the gas connections. Record fail in the calibration report. Go to zero calibration.

**NOTE:** *The total flow rate will be reduced because of the module which has been removed.*

7.1.8 Zero Calibration

<table>
<thead>
<tr>
<th>Table</th>
<th>Details to record</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Zero calibration results</td>
</tr>
</tbody>
</table>

Zero calibration is performed simultaneously on all gas modules. One or more gas modules may fail a criterion for calibration and others can pass completely. It is acceptable to fail a module but continue with the zero calibration on the remaining modules, and to continue with a span calibration on those modules which passed their zero calibration.

It is recommended to leave any failed modules running in the monitor throughout the zero and span calibration process. After the calibration is complete on the remaining modules, the door to the monitor can be opened and the failed modules can be removed for inspection.

The order in which modules should be zero calibrated is:

1) Ox, 2) O3, 3) PID  
*NO2 does not have a zero or gain adjustment applied.*

Use the AirCal 1000 to deliver zero air, connect the monitor to the AirCal 1000 with the tee open as shown in Figure 5-6.

7.1.1. Record the current offsets in Table 7, column 7.1.1. Start the zero air flowing. Make sure there is excess flow out from the tee at the monitor inlet as shown in Figure 5-6 with the tee open.

7.2.2 Wait for the module to stabilise. This means the standard deviation is within the acceptable range listed in Table 7, Column 7.2.3 (c).
   - If the values have not stabilised then write fail in the last column in Table 7 column 7.2.7 for this module. Move on to next module and *go back to Step 7.2.1.*
7.2.3 Record the stabilised reading in Table 7, column 7.2.3 from the 10 minute average.
If the values are within the accepted range, listed in Table 7 column 7.2.3 (b) then no offset adjustment is required, write **pass** in column 7.2.7. Move on to next module and **go to Step 7.2.1**.

**7.2.4** If the stabilised value is outside the acceptable range then an offset adjustment is required. Calculate and record the new offset using Equation 4.

\[ \text{New offset} = \text{Current offset} + \left( \frac{\text{AQM gas reading}}{\text{Gain}} \right) \]

You can use the calibration app “Recommend” button (Figure 5-3), this will perform the calculation but you must accept this offset by pushing the “Apply” button, this will upload the new offset.

**7.2.5** If the new calculated offset is within the acceptable range listed in Table 7 column 7.2.4 (b) then upload the new offset.

\[ \Rightarrow \text{If the required offset is outside the recommend limits listed in Table 7 do not upload the offset, write } \text{fail} \text{ in column 7.2.7. Move on to next module and } \text{go back to Step 7.2.1}. \]

**7.2.6** After 2 or 3 minutes record the readings after the new offset has been uploaded. Confirm the readings are within acceptable limits.

\[ \Rightarrow \text{If yes then } \text{pass}, \text{ if no then } \text{fail}. \text{ Move on to next module and } \text{go to Step 7.2.1}. \]

**7.1.9 Span Calibration**

<table>
<thead>
<tr>
<th>Table</th>
<th>Details to record</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Span calibration results</td>
</tr>
</tbody>
</table>

Span Calibration is performed separately in sequence for each gas module. Span calibration should only be performed on modules that have been successfully Zero calibrated.

It is recommended to leave any failed modules running in the monitor throughout the zero and span calibration process. After the calibration is complete on the remaining modules, then the door to the monitor can be opened and the failed modules can be removed for inspection.

The NO\(_2\) calibration, *(a adjustment)* should be performed at the appropriate step during the Ozone span gas delivery, Step 8.1.16

**NOTE:** The order in which modules should be span calibrated is very important, see section 5.3

1) \(O_x\) gain *(using NO\(_2\) calibration gas)*,
2) \(O_3\) gain *(using \(O_3\) calibration gas)*,
3) \(NO_2\) a value *(using \(O_3\) calibration gas)*,
4) PID gain *(using Isobutylene calibration gas)*

*NO\(_2\)* does not have a zero or gain adjustment applied.

**8.1.1** Start here for each module. Once all modules have been span calibrated go to Step 9.

- Record all initial gains in Table 8 Column 8.1.1
- Record the initial NO\(_2\) a value in Table 8 Column 8.1.2

**8.1.2** Start the NO\(_2\) calibration gas flowing at your chosen span point, Aeroqual recommends 0.1 ppm. Make sure there is excess flow out from the tee at the monitor inlet as shown in Figure 5-6.

**8.1.3** Record the span gas concentration. In Table 8 column 8.1.3.

**8.1.4** Wait for the \(O_x\) module values to stabilise to the NO\(_2\) span gas, this means the readings are within the acceptable noise limits listed in Table 8 Column 8.1.5 (c).

If the values have not stabilised then write **fail** in the column 8.1.10. Move on to next module and **go to Step 8.1.1**.

**NOTE:** If the \(O_x\) module fails calibration then the NO\(_2\) measurement cannot be used. The \(O_3\) module can calibrated even if the \(O_x\) module fails calibration.

**8.1.5** Record the stabilised \(O_x\) values in the calibration form Table 8 Column 8.1.5 from the 10 minute average

If the values are stable and within the accepted range listed in Table 8 Column 8.1.5 (b) then write **pass** in column 8.1.10. Move on to next module and **go to Step 8.1.1**.
8.1.6 If the values are stable but outside the acceptable range listed in Table 8 Column 8.1.5 (b) then a new gain must be calculated and applied. Calculate and record new Ox gain using Equation 5.

New Gain = Current Gain x (Span concentration / Gas reading)

You can use the calibration app “Recommend” button (Figure 5-3), this will perform the gain calculation but you must accept this gain by pushing the “Apply” button, this will upload the new gain.

**NOTE:** The calibration app restricts the gain between 0.2 and 5.0. The manual entry screen will allow the gain to be set outside these limits.

8.1.7 Calculate and record the ratio of the gain change by using Equation 6. Record the ratio in Table 8, column 8.1.7.

Gain Change Ratio = New Gain / Current Gain

8.1.8 If the calculated gain is within acceptable limits listed in Table 8 Column 8.1.5 (d), upload the new gain.

If the required gain is outside the recommend limits do not upload the gain, write fail in the column 8.1.10. Move on to next module and go to Step 8.1.1.

8.1.9 Record the Ox readings after the new Ox gain has been uploaded. Confirm the readings are within acceptable limits.

If yes then write pass in column 8.1.10, if no then fail. Move on to next module and go to Step 8.1.1.

8.1.10 Deliver zero air for 10 minutes to purge the gas lines.

**NOTE:** Change the gas connection from the AirCal 1000 over to the Ozone calibrator. Make sure to cap the end of the tee as shown in Figure 5-5.

8.1.11 Deliver ozone from the ozone calibrator at your chosen span point, Aeroqual recommends 0.1 ppm, make sure the tee is closed using the cap as shown in Figure 5-5.

**NOTE:** It takes a while for the ozone delivery to stabilise at the chosen span point, you should have previously set the output of the ozone generator to your chosen span point and left the generator running at this span point for at least 30 mins, to allow the output to stabilise.

8.1.12 Record the ozone span concentration in Table 8 Column 8.1.3.

8.1.13 Wait for the O3 values to stabilise towards O3 calibration gas, as described in Table 8 Column 8.1.5 (c) If the values have not stabilised then write fail in the last column.

**NOTE:** If the O3 module fails calibration then the NO2 measurement cannot be used.

8.1.14 Record the stabilised O3 values in Table 8 Column 8.1.5 from the 10 minute average. If the values are stable and within the accepted range listed in Table 8 column 8.1.5 (b), then no gain change is required, then write pass in column 8.1.10.

8.1.15 If the values are stable but outside the acceptable range Calculate and record new O3 gain using Equation 5.

New Gain = Current Gain x (Span concentration / Gas reading)

You can use the calibration app “Recommend” button (Figure 5-3), this will perform the gain calculation but you must accept this gain by pushing the “Apply” button, this will upload the new gain.

8.1.16 Wait for the Ox values to stabilise towards O3 calibration gas. After the Ox values have stabilised calculate the a value. The a value is calculated according to this equation:

\[
a = \frac{\text{Ox reading}}{\text{O3 span concentration}}
\]

The a value should be in the range 0.3 to 1.5. If your calculated a value falls outside this range do not change the a value, contact Aeroqual for technical support: [technical@aeroqual.com](mailto:technical@aeroqual.com).

8.1.17 Upload the a value in the manual entry screen shown in Figure 5-4. Record the new a value in Table 8 column 8.1.6b.

8.1.18 **After the Ox and O3 gains, and the a value have been applied** record the NO2 readings in Table 8 Column 8.1.9. Do not adjust any calibration settings of the NO2 channel.

8.1.19 Turn off the Ozone gas and return the monitor sampling zero air from the AirCal 1000.

**NOTE:** Change the gas connection from the Ozone calibrator over to the AirCal 1000 calibrator. Make sure to remove the cap from the end of the tee as shown in Figure 5-6.
8.1.19 If your monitor contains a PID gas module, repeat steps 8.1.2 to 8.1.10 for PID.

7.1.10 Post-calibration checks

<table>
<thead>
<tr>
<th>Table</th>
<th>Details to record</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Post-calibration checks</td>
</tr>
</tbody>
</table>

Follow these post-calibration checks and record the results in Table 9 from the Calibration form in Appendix 5.

9.1 Disconnect calibration equipment
9.2 Record the inlet flow rate
9.3 Replace the mesh inlet and cap
9.4 Lock door
9.5 Secure the site
9.6 Take monitor out of service mode and record the time in the form.

7.2 Particle Monitor calibration

Field calibration of monitor with Particle Monitor is typically not required. However in some applications that have very high data quality objectives, field calibration may be appropriate. Such applications may include:

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

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

For all other applications the Aeroqual factory calibration is sufficient.

All PM monitors are calibrated at the factory against a standard aerosol (NIST traceable monodisperse spheres). The factory calibration is traceable and results in good data quality when the monitor is operated in accordance with Aeroqual’s servicing and maintenance procedures.

7.2.1 Factory servicing and calibration

Factory servicing includes cleaning and calibration of the PM module only. The PM module can be removed from the monitor 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 Particle Monitor: 24 Months
- Dust Sentry 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.

7.2.2 Field calibration

In order to perform a field calibration, your Aeroqual monitor must be located at the same site as a Reference PM monitor. This is called ‘Co-location’ and is widely performed in ambient air quality monitoring to assess the performance of a new monitor. The two monitors 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 monitor Gain. This corrects the data to the known reference monitor.

\[
K \text{ Factor} = \frac{Average \ PM \ (Reference)}{Average \ PM \ (Aeroqual)}
\]

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

\[
New \ Gain = Old \ Gain \times K \ Factor
\]

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 monitor. Aeroqual recommends that calibration only be carried out using high quality Reference PM Data. If you don’t have access to a
reference monitor, or aren’t confident that you can access a well-run reference monitor, then you should always rely upon the factory calibration.

**Important considerations for field calibration:**

- **Location of monitor:** The Aeroqual monitor and the Reference monitor 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.

- **Monitor set up:** Both the Aeroqual monitor and the reference monitor 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 monitor, 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. 1-2 weeks is preferred and no shorter than 48 hrs.

- **Reference monitor selection:** Selection of the right reference monitor is critical for a successful K factor correction. Ideally, reference monitors should be operated in accordance with local reference method specification. Monitor methods are listed below, in descending order of preference:
  - **GRIMM / BAM / TEOM:** Are best 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 if PM levels are low. 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. High-Volume samplers
  - Other Non-Reference methods (Optical, Open-Path): Existing instrumentation can be used to establish variance between Aeroqual and a known monitor. This method can be used to assess new versus old instrumentation, but is not a calibration to a reference monitor.

### 7.2.3 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 monitors 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.

- Install and commission your Aeroqual monitor alongside your reference monitor. Operate both monitors together. The longer you collocate the monitors, the better.

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

- (Gravimetric only) calculate your concentrations using the following equation:

  \[
  \text{Concentration} = \frac{\text{Filter weight at end} - \text{filter weight at start}}{\text{Total volume of air sampled}}
  \]

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

  \[
  \text{Average} = \frac{\text{Sum of readings}}{\text{Number of readings}}
  \]

- 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.

**NOTE:** Your zero check data should be included as a point.
Using Microsoft excel plot your 2 data sets in an x-y scatter plot. Add a trend line and equation as below.

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

The Aeroqual monitor will need a new gain, calculated using the formula below:

\[ \text{New Gain} = \text{Old Gain} \times K \text{ Factor} \]

\[ \text{New Gain} = 1 \times 0.6568 = 0.6568 \]

Upload the new gain into the gain parameter in the gain and offset table using the calibration and service app.
8 Troubleshooting

The following section provides basic troubleshooting for the monitor. Common problems, and how to solve them are given in Table 8-1.

Not all known issues are listed in Table 8-1 especially if not known to Aeroqual when this user guide was written. The Aeroqual training website provides a comprehensive and up to date list of known issues and provides solutions as soon as solutions become available.

| Online reference | training.aeroqual.com DM 1.3 Tech training |

The Aeroqual technical support team are available to provide assistance when required.

| Online reference | technical@aeroqual.com |

Use manual sync to assist Aeroqual technical support in troubleshooting

When the Aeroqual technical support team are required to help with troubleshooting it is necessary to see a comprehensive dataset from the Dust Sentry. This can easily be achieved if the instrument is online.

If the instrument is not online, use the Manual Sync tool (Section 5.1.4) to upload data to Aeroqual Cloud so the technical support team can provide fast and comprehensive support.

Error conditions reported by Aeroqual Connect and Aeroqual Cloud software

Connect and Cloud software will report two different types of error condition in the banner at the top of the page, these are “sensor offline” and “sensor failed” The error will also be listed in the monitor journal.

Sensor offline

A sensor offline error is usually caused by either a loose power connection or a loose communications connection. Check the module connections are secure. If the power connections and the communications connections are secure then the issue may be inside the module.

Contact the Aeroqual distributor in your local country for technical support.

Sensor failure

A sensor failure error can occur for different reasons, sometimes this can be related to a sensor parameter exceeding an allowable value.

If you get a “sensor failure” error contact the Aeroqual distributor in your local country for technical support.

Communication errors:

1. Failure to see the WIFI network broadcast by the monitor

If you cannot see the monitor in your list of WIFI networks it is most likely because the WIFI setting is set to “Client Mode” and is not broadcasting. See section 4.1 Error! Reference source not found.

To resolve this, connect to the monitor through the WIFI LAN and then reset the WIFI mode to “Access Point”.

Alternatively the monitor can be reset to factory communication settings by using the USB reset procedure. See section 4.4.

2. Error 500 Database error

An error is known to occur with the internal database which causes the following error report when trying to connect to the monitor. The may be able to be resolved over a remote connection. Or a component in the embedded PC will need to be replaced.
If this error occurs contact the Aeroqual distributor in your local country for technical support.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Fault isolation / Solution</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas module troubleshooting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative readings</td>
<td>Flow leak or incorrect flow</td>
<td></td>
<td>Section 6.5.4</td>
</tr>
<tr>
<td></td>
<td>Dirty inlet gas filter</td>
<td></td>
<td>Section 6.5.5</td>
</tr>
<tr>
<td></td>
<td>Incorrect zero calibration</td>
<td></td>
<td>Section 2</td>
</tr>
<tr>
<td>Gas readings noisy or unstable</td>
<td>Flow leak or incorrect flow</td>
<td></td>
<td>Section 6.5.11</td>
</tr>
<tr>
<td></td>
<td>Module is aging</td>
<td></td>
<td>Section 6.5.12</td>
</tr>
<tr>
<td></td>
<td>Incorrect gain or offset applied</td>
<td></td>
<td>Section 7.2</td>
</tr>
<tr>
<td>Gas readings significantly different than expected</td>
<td>Incorrect calibration performed</td>
<td>Incorrect gas cylinder used or gain calculated incorrectly</td>
<td>Redo calibration or identify error and correct it</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Particle Monitor and Particle Profiler troubleshooting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM 2.5 &gt; PM 10.0</td>
<td>Cyclones fitted on the wrong side</td>
<td>Swap cyclones to correct side</td>
<td>Section 0</td>
</tr>
<tr>
<td></td>
<td>Auto zero calibration failing on the PM10.0</td>
<td>Check baseline calibration of PM10.</td>
<td>Section 6.5.8</td>
</tr>
<tr>
<td></td>
<td>Incorrect gain applied</td>
<td>Check gain on module</td>
<td>Section 6</td>
</tr>
<tr>
<td></td>
<td>Leak in flow system</td>
<td>Check for leaks</td>
<td>Section 6.5.7</td>
</tr>
<tr>
<td>Negative numbers</td>
<td>Auto zero calibration failing...</td>
<td>Check baseline calibration of PM10.0</td>
<td>Section 6.5.8.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Readings lower than expected</td>
<td>Flow rate too low</td>
<td>Check flow rate change pump if required</td>
<td>Section 6.5.10</td>
</tr>
<tr>
<td></td>
<td>Dirty optics</td>
<td>Have optical module serviced</td>
<td>Section 6.6</td>
</tr>
<tr>
<td></td>
<td>Failed laser</td>
<td>Have optical module serviced</td>
<td>Section 6.6</td>
</tr>
<tr>
<td></td>
<td>Dirty sample filters</td>
<td>Change filter</td>
<td>Section 6.5.5</td>
</tr>
</tbody>
</table>

Table 8-1 Common troubleshooting tasks and how to solve them
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10 Compliance

1. The Aeroqual Dust Sentry, Dust Sentry Pro and AQS 1 comply with the following standards:
   - EN 61000-6-1:2001
   - EN 61000-6-3:2001
   - Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) these devices may not cause harmful interference, and (2) these devices must accept any interference received, including interference that may cause undesired operation.

2. The Aeroqual Dust Sentry PM10 has achieved MCERTs certification for indicative ambient particulate monitor

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult your Aeroqual distributor or an experienced radio/TV technician for help.

11 Warranty

The monitor warranty policy can be found on the main company website: [www.aeroqual.com/support/warranty](http://www.aeroqual.com/support/warranty)
12 Appendix

12.1 Gas module design

Figure 12-1 Gas module sizes and key components labelled (Modules may vary from that shown)

The list of gas modules available for integration in to the monitor is provided in Table 12-1.

<table>
<thead>
<tr>
<th>GAS MODULE (PPM)</th>
<th>GAS MODULE RANGE (PPB)</th>
<th>RESOLUTION (PPB)</th>
<th>SENSOR TYPE</th>
<th>MODULE SIZE</th>
<th>MODULE FLOW RATE</th>
<th>NOISE ZERO (PPB)</th>
<th>LOWER DETECTABLE LIMIT (PPB)</th>
<th>PRECISION LINEARITY % OF F.S.</th>
<th>DRIFT 24 HOUR EXPECTED MODULE LIFETIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₃</td>
<td>0 – 500 ppm</td>
<td>0.1</td>
<td>GSS</td>
<td>Small</td>
<td>110 – 130 ml / min⁻¹</td>
<td>&lt;1; &lt;1%</td>
<td>1</td>
<td>&lt; 2% of reading or 2 ppb</td>
<td>&lt; 1.5%</td>
</tr>
<tr>
<td>NO₂</td>
<td>0 – 500 ppm</td>
<td>0.1</td>
<td>GSE</td>
<td>Medium</td>
<td>55 – 65 ml / min⁻¹</td>
<td>&lt;1; &lt;1%</td>
<td>2</td>
<td>&lt; 2% of reading or 3 ppb</td>
<td>&lt; 2.0%</td>
</tr>
<tr>
<td>VOC</td>
<td>0 – 30 ppm</td>
<td>10</td>
<td>PID</td>
<td>Medium</td>
<td>140 – 160 ml / min⁻¹</td>
<td>&lt;100; &lt;0.20 or 1%</td>
<td>&lt;50</td>
<td>&lt; 2% of reading or 20 ppb</td>
<td>&lt; 2.0%</td>
</tr>
</tbody>
</table>

Table 12-1 Gas modules available for integration in to the monitor

NOTE: O₃ and NO₂ Modules have no serviceable parts. The VOC analyzer module uses a replaceable 10.6 eV UV lamp, if the lamp needs replacing contact the Aeroqual distributor in your local country for technical support.

12.1.1 Gas Module design

Gas modules come in two different designs. These two designs are shown schematically in Figure 12-1. A list of which gas modules use which design is given in Table 12-1.

- **Direct design** (Ozone): The gas is passed directly to the sensor continuously.
- **Zero switching design** (VOC and NO₂): The module uses a solenoid to switch between a zero path which removes the target gas and creates a “zero” or baseline measurement, and a measurement path which measures the ambient air. The final measurement in ppm is an arithmetic combination of the zero and sample measurement. This technique is referred to as Automatic Baseline Correction.
Figure 12-2 Direct and Zero switching gas module design

The gas flow rate is controlled using a critical orifice shown in red in Figure 12-2. The flow rate is listed in Table 12-1.

Each gas module contains: a gas inlet port (white ring), a gas exhaust port (blue ring), two 12 V power connectors to allow the module to be connected to a 12 V power bus, two RJ-45 connections to allow the module to be connected to the RS-485 communications bus, and a module status LED.

12.1.2 Gas flow through modules

The gas flow through all of the gas modules is powered by a single diaphragm pump inside the monitor enclosure. The pump pulls sample air through the gas module. After it has been measured the sample air passes through the pump and is exhausted outside the monitor.

There are two different types of tubing material used to handle the gas flow.

- Before the gas reaches the sensor, all of the tubing material is rigid non-reactive PFA.
- After the sample has passed the sensor all of the tubing is flexible R3603 Tygon

The vacuum side of the pump is to the gas outlet (exhaust) of each module with Tygon tubing. This is illustrated in Figure 12-3.

Figure 12-3 A single pump is used for all gas modules. The vacuum port of the pump is connected to the outlet of each gas module.
12.2 Particulate Matter module design

The Dust Sentry can measure a range of pre-defined particulate matter (PM) such as TSP, PM$_{10}$, PM$_{2.5}$ or PM$_{1}$. The sample flow for the particle measurements is separate from the gas sample flow. There is a separate pump, a separate inlet and a separate exhaust.

The Dust Sentry can measure particulate matter such as PM10 and PM2.5. There are three separate modules:

1. for measuring the particulate (optical engine), there are two options to choose from:
2. Particle Monitor uses a nephelometer combined with a sharp cut cyclone (See Figure 12-4) and measures a single size fraction such as TSP or PM$_{10}$ or PM$_{2.5}$ or PM$_{1}$.
3. Particle Profiler uses an optical particle counter (See Figure 12-6) and measures four size fractions simultaneously, TSP and PM$_{10}$, and PM$_{2.5}$ and PM$_{1}$.
4. for handling the data transfer (I/O module)
5. for controlling the flow rate (pump module)

The sample flow for the Particle Monitor and Particle Profiler is separate from the gas sample flow. There is a separate pump, a separate inlet and a separate exhaust.

12.2.1 Comparison between the Particle Monitor and the Particle Profiler

- The Particle Profiler measures particulate concentrations using particle counting, it outputs multiple size fractions at the same time.
- The Particle Profiler can measure TSP and PM$_{10}$ and PM$_{2.5}$ and PM$_{1}$ without requiring a sharp cut cyclone.
- The Particle Monitor measures particulate concentrations by nephelometry; it measures TSP or PM$_{10}$ or PM$_{2.5}$ or PM$_{1}$ using a sharp cut cyclone.

<table>
<thead>
<tr>
<th></th>
<th>Particle Monitor</th>
<th>Particle Profiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass outputs</td>
<td>TSP or PM$<em>{10}$ or PM$</em>{2.5}$ or PM$_{1.0}$</td>
<td>TSP and PM$<em>{10}$ and PM$</em>{2.5}$ and PM$_{1.0}$</td>
</tr>
<tr>
<td>Particle count outputs</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Accuracy</td>
<td>$&lt;\pm(2 \mu g/m^3 + 5% \text{ of reading})$</td>
<td>$&lt;\pm(5 \mu g/m^3 + 15% \text{ of reading})$</td>
</tr>
<tr>
<td>Factory calibration period</td>
<td>Every two years (24 months)</td>
<td>Every year (12 months)</td>
</tr>
<tr>
<td>Inlet flow rate</td>
<td>2.0 LPM</td>
<td>1.0 LPM</td>
</tr>
</tbody>
</table>

Table 12-2 Summary of the difference between the Particle Monitor and the Particle Profiler.
12.2.2 Particle Monitor module
The Particle Monitor uses a custom Met One near forward light-scattering nephelometer to measure particle concentration and a sharp cut inlet cyclone to physically select the particle size. This module is shown on the far right in Figure 12-4.

Figure 12-4 The Particle Monitor uses three modules: a) the optical engine on the far right, b) the pump module in the middle, c) the I/O module on the left

The particulate size selection (TSP or PM\textsubscript{10} or PM\textsubscript{2.5} or PM\textsubscript{1.0}) is determined by the sharp cut cyclone on the Particle Monitor inlet on the outside of the Dust Sentry shown in Figure 12-5. The Particle Monitor can be configured to measure either of these four size fractions simply by changing the inlet cyclone and making a small change in the software.

Figure 12-5 The size selection in the Particle Monitor is determined by the sharp cut cyclone on the inlet.
12.2.3 Particle Profiler module
The Dust Sentry uses a custom-designed Met One optical particle counter (OPC) to measure four particle size fractions simultaneously. There is no sharp cut cyclone used in the Particle Profiler; both the concentration and size are measured inside the optical particle counter.

The three modules for the Particle Profiler are installed in the top right side of the Dust Sentry enclosure. The Particle Profiler has the sample and purge filters mounted on the outside of the optical module, (in the Particle Monitor they are held inside).

![Image of Particle Profiler modules]

Figure 12-6 The Particle Profiler uses three modules: a) the optical module on the far right, b) the pump module in the middle, c) the electronics module on the left

12.3 Mains wiring color guide

<table>
<thead>
<tr>
<th>Wire</th>
<th>US AC power circuit wiring color codes</th>
<th>UK AC power circuit wiring color codes</th>
<th>IEC (most of Europe) AC power circuit wiring color codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live / Phase</td>
<td>Black or Red</td>
<td>Brown or Red</td>
<td>Brown or Black</td>
</tr>
<tr>
<td>Neutral</td>
<td>White or Grey</td>
<td>Blue or Black</td>
<td>Blue</td>
</tr>
<tr>
<td>Earth / Ground</td>
<td>Green or Green-yellow</td>
<td>Green-yellow</td>
<td>Green-yellow</td>
</tr>
</tbody>
</table>

Caution: The high voltage mains supply must be wired by a certified electrician in compliance with local electrical regulations.

The following table is only intended as a reminder, always check your local guidelines.
12.5 Calibration Records
The following records should be used in conjunction with this user guide.

**Table 1: Calibration details**

<table>
<thead>
<tr>
<th>Date Time</th>
<th>Serial number</th>
<th>Date of previous calibration</th>
<th>Customer name</th>
<th>Site name</th>
<th>Engineer name</th>
</tr>
</thead>
</table>

**Table 2: Equipment details**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Brand / Model number</th>
<th>Serial number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas dilution calibrator:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ozone generator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero air source</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow meter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Regulator 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Regulator 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 3: Gas cylinder details**

<table>
<thead>
<tr>
<th>#</th>
<th>Gas Type</th>
<th>Gas Balance</th>
<th>Manufacturer</th>
<th>Expiry date</th>
<th>Cylinder pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NO₂</td>
<td>Air N₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Isobutylene</td>
<td>Air N₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4: Site inspection
Check the local surroundings to see if anything has changed which could influence the ongoing ambient gas measurements.

Observations

Table 5: Monitor pre-checks

<table>
<thead>
<tr>
<th>Before opening the door</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ID</strong></td>
</tr>
<tr>
<td>5.1</td>
</tr>
<tr>
<td>5.2</td>
</tr>
<tr>
<td>5.3</td>
</tr>
<tr>
<td>5.4</td>
</tr>
<tr>
<td>5.5</td>
</tr>
<tr>
<td>5.6</td>
</tr>
</tbody>
</table>

**After opening the door**

| 5.7 | Replace the inlet filters | | |
| 5.8 | Measure flow rate again | | |
| 5.9 | Go to section 6 if required then record final inlet flow rate here | | |
Table 6: Individual module flow rates, leak check manifold and bypass valve

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Check all gas connections</td>
<td></td>
<td></td>
<td></td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>6.2</td>
<td>Leak check sampling manifold</td>
<td></td>
<td></td>
<td></td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>6.5</td>
<td>Flow Rate</td>
<td>NO₂</td>
<td>O₃</td>
<td>PID</td>
<td>Total module flow</td>
</tr>
<tr>
<td>Flow rate last measured</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow rate measured now</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If flow rate is the same then pass, if changed then fail</td>
<td></td>
<td>Pass / Fail</td>
<td>Pass / Fail</td>
<td>Pass / Fail</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>6.6</td>
<td>Adjust bypass valve</td>
<td></td>
<td>If all of the modules show reduced flow and there is no leak then the adjustment bypass valve can be used</td>
<td></td>
<td>Yes / No</td>
</tr>
<tr>
<td>Flow rate measured following adjustment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If flow rate is the same as section 6.3 then pass, if changed then fail</td>
<td></td>
<td>Pass / Fail</td>
<td>Pass / Fail</td>
<td>Pass / Fail</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>What was the reason for the change in flow rate?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7: Zero calibration results

<table>
<thead>
<tr>
<th>Module</th>
<th>Current offset From monitor settings</th>
<th>Reading after stabilisation 10 minute average</th>
<th>Acceptable reading during zero calibration (ppm) 10 min average</th>
<th>Acceptable standard deviation during zero calibration (10 minute average)</th>
<th>New Calculated offset1</th>
<th>Minimum and Maximum recommended offset (ppm)</th>
<th>Offset uploaded</th>
<th>Reading after offset changed</th>
<th>Pass / Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>New Calculated offset1</td>
<td>Minimum and Maximum recommended offset (ppm)</td>
<td>Offset uploaded</td>
<td>Reading after offset changed</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>New Calculated offset1</td>
<td>Minimum and Maximum recommended offset (ppm)</td>
<td>Offset uploaded</td>
<td>Reading after offset changed</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>NO₂</td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O₃</td>
<td>0.0 0.005</td>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ox</td>
<td>0.0 0.005</td>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PID</td>
<td>0.0 0.002</td>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Equation 4: New offset = Current offset + (AQM gas reading / Gain)
<table>
<thead>
<tr>
<th>Module</th>
<th>Initial gain</th>
<th>Initial a value</th>
<th>Span point</th>
<th>Reading after stabilisation 10 minute average</th>
<th>Acceptable range during span calibration (ppm) 10 minute average</th>
<th>Maximum acceptable noise during span calibration 10 min std deviation</th>
<th>Maximum Minimum recommended gain</th>
<th>New gain</th>
<th>New a value</th>
<th>Ratio of gain change</th>
<th>New gain / Initial gain</th>
<th>Gain uploaded</th>
<th>Reading after gain changed</th>
<th>Pass / Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO₂</td>
<td>1.000</td>
<td></td>
<td>8.1.1</td>
<td>8.1.3</td>
<td>8.1.5 (b)</td>
<td>8.1.5 (c)</td>
<td>8.1.5 (d)</td>
<td>8.1.6</td>
<td>8.1.6 (b)</td>
<td>8.1.7</td>
<td>8.1.8</td>
<td>8.1.9</td>
<td>8.1.10</td>
<td></td>
</tr>
<tr>
<td>O₃</td>
<td>N/A</td>
<td></td>
<td>8.1.2</td>
<td></td>
<td>span ± 5 %</td>
<td>2 % of span</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Max 5.000 min 0.2</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ox</td>
<td>N/A</td>
<td></td>
<td>8.1.3</td>
<td></td>
<td>span ± 5 %</td>
<td>2 % of span</td>
<td>max 5.000 min 0.2</td>
<td>N/A</td>
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<td>8.1.5</td>
<td></td>
<td>span ± 5 %</td>
<td>2 % of span</td>
<td>max 5.000 min 0.2</td>
<td>N/A</td>
<td>N/A</td>
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</tbody>
</table>

Comments:

Equation 5: New Gain = Current Gain x (Span concentration / Gas reading)

Equation 3: \[ a = \frac{\text{Ox reading}}{\text{O}_{3} \text{ span concentration}} \]

**NOTE:**
The Ox module gain adjustment is made during the NO2 calibration gas delivery
The NO2 a value adjustment is made during the Ozone gas delivery
The NO2 gain value is NOT adjusted as part of the calibration process
<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Observation / reading</th>
<th>Pass / Fail / Done</th>
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</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Disconnect calibration equipment</td>
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<tr>
<td>9.2</td>
<td>Record total inlet flow rate</td>
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<tr>
<td>9.3</td>
<td>Replace the mesh inlet and cap</td>
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<tr>
<td>9.4</td>
<td>Lock door</td>
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<td>9.5</td>
<td>Secure the site</td>
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<td>9.6</td>
<td>Service mode</td>
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