MiniVol™ TAS

Tactical Air Sampler

Operation Manual

Rev. 1.2

AIRMETRICS™
INNOVATIVE AIR SAMPLING EQUIPMENT

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1 INTRODUCTION

The MiniVol™ Tactical Air Sampler (TAS) is a portable ambient air sampler for particulate matter that can also be configured for sampling various air toxics. The patented low flow technology used in the MiniVol™ TAS was developed jointly with the U. S. Environmental Protection Agency (EPA) in an effort to address the need for portable air pollution sampling technology.

While not a reference method sampler, the mass concentrations of the MiniVol™ TAS gives results that closely agree with reference method concentrations. Both accurate and precise, the battery operated, lightweight MiniVol™ TAS is ideal for sampling at remote sites or areas without power. In addition, the low cost of the sampler allows a network of MiniVol™ TAS to be deployed at a fraction of the cost for a similar reference method network.

The MiniVol™ TAS features a 7-day programmable timer, a constant flow control system, an elapsed time totalizer, rechargeable battery packs, and an all-weather enclosure.

1.1 Principles of Operation

The MiniVol™ TAS is basically a pump controlled by a programmable timer which can be set to make up to six "runs" within 24 hours or throughout a week. When used outdoors it may be hung from a universal mounting bracket mounted on a variety of structures, utility poles, trees, fence posts or on the ground using a tripod.

The sampler is equipped to operate from either AC or DC power sources. In the DC operational mode, the sampler operates from a battery pack, thus making the sampling site independent of line power. The MiniVol™ TAS comes with two battery packs to accomplish continuous field sampling. A charged battery pack is capable of operating the sampler for a minimum of 24 hours on a single charge.

The sampler is equipped with two "fault circuits":

- A **low battery circuit** automatically shuts the sampler down should the lithium-ion (Li-ion) battery fail to supply sufficient voltage (above 13.0 volts) to the pump. This feature helps protect the battery which could be damaged if used continuously at low voltage. A "low-battery" indicator light alerts the operator of this condition.

- A **low flow circuit** monitors the flow rate. Should excessive accumulation of particulate matter or some restriction in the tubing cause the air flow to fall below approximately 10% of the set flow rate, the sampler shuts down and a "low flow" indicator light alerts the operator.

An Elapsed Time Totalizer linked in parallel with the pump records the total time in hours of pump operation.

1.2 Particulate Matter Sampling Mode

In the particulate matter (PM) sampling mode, air is drawn through a particle size separator and then through a filter medium. Particle size separation is achieved by impaction. Critical to the collection of the correct particle size is the correct flow rate through the impactor. For the MiniVol™ TAS, the actual volumetric flow rate must be 5 liters per minute (5 lpm) at ambient conditions. To assure a constant 5 lpm flow rate through the size separator at differing air temperatures and atmospheric pressures, the sampler must be adjusted for each sampling project (see Section 8.2 “Sampling at Ambient Conditions”).

Impactors are available with a 10 micron cut-point (PM_{10}) and a 2.5 micron cut-point ($PM_{2.5}$). Operating the sampler without an impactor allows for collection of total suspended particulate matter (TSP).

The inlet tube downstream from the filter takes the air to the twin cylinder diaphragm pump. From the pump, air is forced through a standard flowmeter where it is exhausted to the atmosphere inside the sampler body.

The programmable timer will automatically turn the pump off at the end of a sampling period. The sampler must then be serviced and set up for the next sampling period. Servicing includes removing the filter holder with the exposed filter inside from the sampler, and attaching a new filter holder with a fresh filter and replacing the battery pack with a fully charged pack.

1.3 Air Toxics Sampling Mode

In the air toxics sampling mode the particle size separator and filter holder assembly are replaced by an adsorbent cartridge selected by the user. A wide variety of sampling media are available. Contact Airmetrics for information on adapting your selected media to the sampler.

The sampling technique used by the MiniVol™ TAS is a modification of the PM_{10} reference method described in the U. S. Code of Federal Regulations (40 CFR part 50, Appendix J). Under this criteria, a PM_{10} sampler must have: 1) a sample air inlet system to provide particle size discrimination, 2) a flow control device capable of maintaining a flow rate within specified limits, 3) means to measure the flow rate during the sampling period, and 4) a timing control device capable of starting and stopping the sampler.

The Airmetrics MiniVol™ TAS meets all of these specifications. It is equipped with: 1) an inlet impactor capable of separating particulate matter to ≤10 µm, 2) a flow control device which will maintain a specified flow rate, 3) a flowmeter to measure the flow rate during the sampling period, 4) an elapsed time meter, and 5) a programmable timer that starts and stops the sampler unattended.

The MiniVol™ TAS flow rate is less than the flow rates used by reference method devices. The lower flow rate results in a greater deviation in accuracy at low concentrations of particulate matter where precision can be lost through the handling and weighing of the sample. However, at moderate particulate concentrations the sampler produces results that are precise and comparable to reference method samplers. While the MiniVol™ TAS sampling method is not a reference or equivalent method, it has proven to be an excellent indicator of absolute ambient particulate concentrations. The data collected by the sampler still serves as a useful supplement to data generated by reference methods.

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2 GETTING STARTED

2.1 Inspecting Components

A standard MiniVol™ TAS comes packed in an all weather carrying case containing the following;

- 1 MiniVol™ TAS Pump Module
- 2 Filter Holder Assemblies with customer selected size selective inlets.
- 2 Battery Packs and a Battery Charger
- 1 All Weather Carrying Case
- 1 Universal Mounting Bracket or Light Weight Tripod
- Operation Manual

On receipt, inspect the contents of the case to account for all components. Compare the equipment delivered with the enclosed packing slip. Notify Airmetrics of any missing or damaged equipment. (See Section 10).

2.2 Batteries

1. Connect the charging plug of the battery charger to the charging jack on the battery pack.

2. Plug the charger into an AC outlet.

3. The LED on the top of the battery charger will light indicating the status of the battery being charged. When this light is green the battery is charged. A fully discharged battery requires about 5 hours to be completely recharged.

Battery Charger LED Status Modes

LED Status	Battery Status
Green	Battery Fully Charged
Red	Battery Partially Charged
Flashing Red	Battery Fully Discharged

4. The batteries have built in protection circuitry that may be activated if the battery output is shorted. The battery may be reset by plugging it into the battery charger.

Airmetrics suggests the batteries not be stored in the sampler. The life of Lithium-Ion batteries can be prolonged by storing the batteries in a cool environment at less than a full charge (about 40%). Storing the battery in the sampler will eventually deplete the battery and will decrease its useful life.

Permanent Capacity Loss versus Storage Conditions

Storage Temperature	40% Charge	100% Charge
0 °C (32 °F)	**2%** loss after 1 year	**6%** loss after 1 year
25 °C (77 °F)	**4%** loss after 1 year	**20%** loss after 1 year
40 °C (104 °F)	**15%** loss after 1 year	**35%** loss after 1 year
60 °C (140 °F)	**25%** loss after 1 year	**40%** loss after 3 months
Source: BatteryUniversity.com		

2.3 Turning the Sampler On/Off

The ON/AUTO/OFF button on the Programmable Timer allows the operator to manually turn the sampler on or off (or to place it in the "Auto" mode in which it is controlled by programmed on/off sequences). As the ON/AUTO/OFF button is pressed, a bar at the lower edge of the LCD display moves horizontally over the words "On", "Auto" and "Off" which are printed on the timer case (see Figure 2.1).

With the battery pack inserted into the sampler, press the ON/AUTO/OFF button until the bar is above the "ON" legend. The red power indicator (to the right of the ON/AUTO/OFF button) should light and the pump motor should start.

If the timer display does not respond, press the small black reset button located next to the red power led.

While the sampler is running press the ON/AUTO/OFF button, until the bar indicator is over the “OFF” legend. The power indicator light will go off and the pump will stop running.

Figure 2.1 - Programmable Timer

2.4 Programming the Timer

The Programmable Timer can be set to run up to six on/off cycles within a 24 hour period, as well as to run for separate time periods on separate days within a 7-day period. To set the timer, first set the real-time clock to establish the correct time frame in which the cycles are to run. Next, enter the on/off times at which the programmed cycles are to begin and end. Finally, set the timer to "Auto" mode.

Refer to Figure 2.1 when performing the following procedures.

2.4.1 Setting the Real-Time Clock

1. DAY SET: Hold down the CLOCK button and press the WEEK button until the correct day appears at the top of the display.

2. TIME SET (Hour): Hold down the CLOCK button and press the HOUR button until the display indicates the correct hour. You may have to cycle through the hours twice to obtain the proper AM or PM (on the left side of the display). Seconds will automatically reset to zero.

3. TIME SET (Minutes): Hold down the CLOCK button and press the MIN button until the display indicates the correct minutes. Seconds will automatically reset to zero.

2.4.2 Setting the On/Off Times

1. Press the PROG button once. 1^{ON} will appear near the lower left corner of the display indicating that the Power-on time for the first cycle is ready to be programmed.

2. Press the HOUR and MIN buttons to enter the power-on time for the first cycle.

3. Press the WEEK button to select the desired day. The days appear along the top of the display. Continuously pressing the WEEK button will sequentially display "Mo Tu We Th Fr Sa Su", "Mo", "Tu", "We", "Th", "Fr", "Sa", "Su", "Mo Tu We Th Fr", "Sa Su" and finally back to "Mo Tu We Th Fr Sa Su". When more than one day is displayed, these days will all have the same power-on time.

4. After you have entered the power-on time and date for the first cycle, press the PROG button. 1OFF now appears on the display to indicate that the power-off time for the first cycle is ready to be programmed. Repeat steps 2 and 3 to enter the desired power-off time.

5. The power-off time does not have to occur on the same day as the on time. In this way, sampling may start on one day and end on the next day.

6. Press the PROG button again. 2ON appears on the display to indicate that the second power-on time is ready to be programmed. Repeat steps 2 through 4 to enter the remaining power-on/power-off times (up to 6 on/off times).

7. Press the PROG button to step through the times you entered to make sure they are correct.
   Press the RST/RCL button to disable (ReSeT) or reactivate (ReCalL) any time entries. When you disable a particular power-on/off entry, four dashes will appear instead of the time. When you reactivate an entry, it will return to the values that were set before you performed a reset.

8. Be sure to clear or reset all unwanted time entries prior to sampling in the AUTO mode. **Both** ON and OFF entries need to be disabled for the unwanted programs to be inactive.

9. Press the CLOCK button to return to the real-time clock display.

10. Press the ON/AUTO/OFF button until the bar is positioned above the desired setting (see below).

2.4.3 Setting the Time to "ON," "AUTO," and "OFF" Modes

The ON/AUTO/OFF button is used to manually turn the sampler on or off, or to place it in the "Auto" mode. A bar on the lower edge of the LCD display moves from "Off" to "Auto" to "On" as the button is pressed. In the "Auto" mode the sampler is controlled by the programmed on/off sequences.

- To manually turn the sampler ON, press the ON/AUTO/OFF button until the bar on the lower edge of the display is above the "ON" legend. The pump will start and the power indicator will light.

- To manually turn the sampler OFF, press the ON/AUTO/OFF button until the bar is above the "OFF" legend.

- To set the timer to "AUTO" mode in which the sampler will be automatically controlled by programmed sequences, first turn the sampler OFF. Then press the ON/AUTO/OFF button until the bar is above the "AUTO" legend.

2.5 Checking for Leaks

To check for leaks, remove the impactor/filter holder assembly from the inlet tube. Make sure that the inlet tube is fully extended and the compression fitting is tight. Cover the air inlet tube with the palm of the hand while the pump is running. The ball in the flowmeter should drop to zero and remain there without movement. *Note: the "Low Flow" indicator LED will activate and the sampler will shutdown after 15-20 seconds, push the reset button twice to reactivate the sampler.* If the ball does not drop to zero, a leak exists somewhere in the hoses and fittings between the inlet and the flowmeter. Leaks on the *inlet* side of the pump are especially critical, since flow measurement will not accurately reflect the amount of air passing through the filter. The sampler will be measuring air passing through the filter, *plus* whatever air may be entering through the leak. If there is a leak use the following procedures to isolate the leak. After each procedure check the sampler for leaks before moving to the next step.

- Verify that the inlet tube is extended and the compression fitting is tight.

  Remove the four faceplate thumbscrews and the sampler mount thumbscrew to access the sampler pump and plumbing.

- Verify that all push-on hose fittings are secure.
- Check for cracks in the flowmeter inlet and outlet.
- Check for cracks in the pulse dampener.
- Check and tighten all compression fittings.

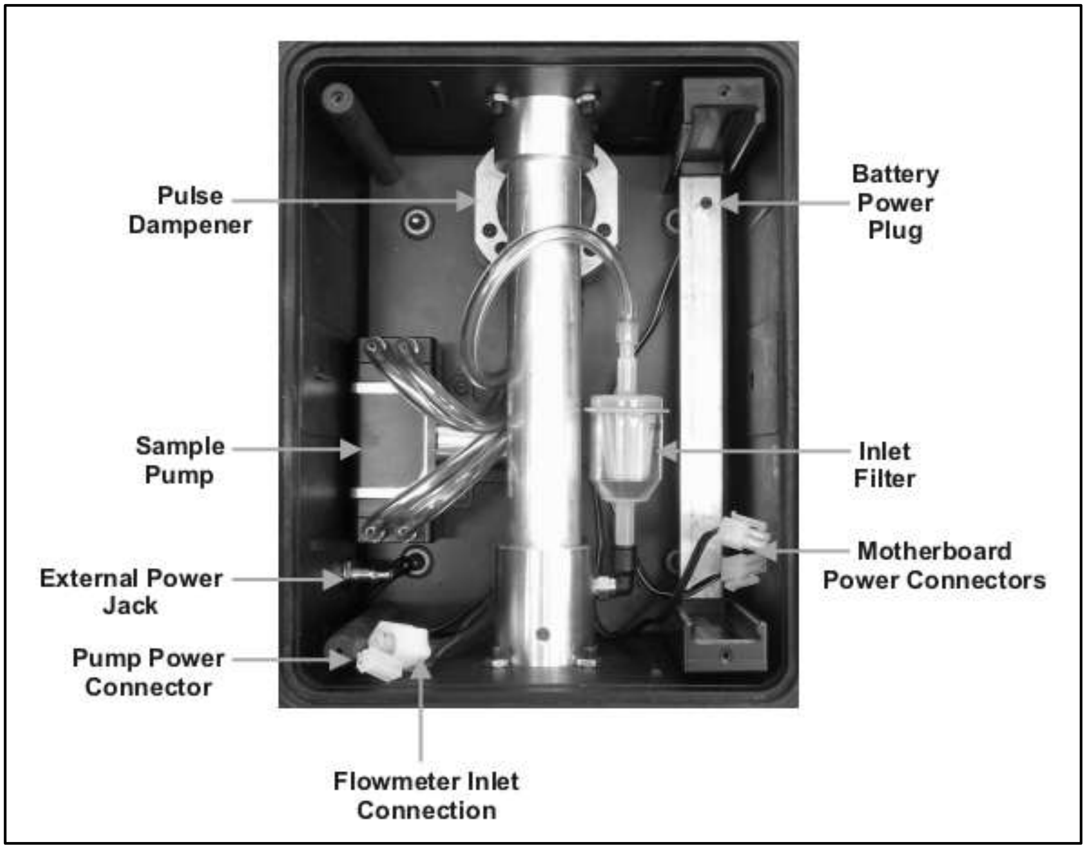

Figure 2.2 – Interior Sampler Case Hardware

3 CONTROLS AND ADJUSTMENTS

3.1 All Operating Modes

The following controls (see Figure 3.1) are used in the operation of the MiniVol™ TAS.

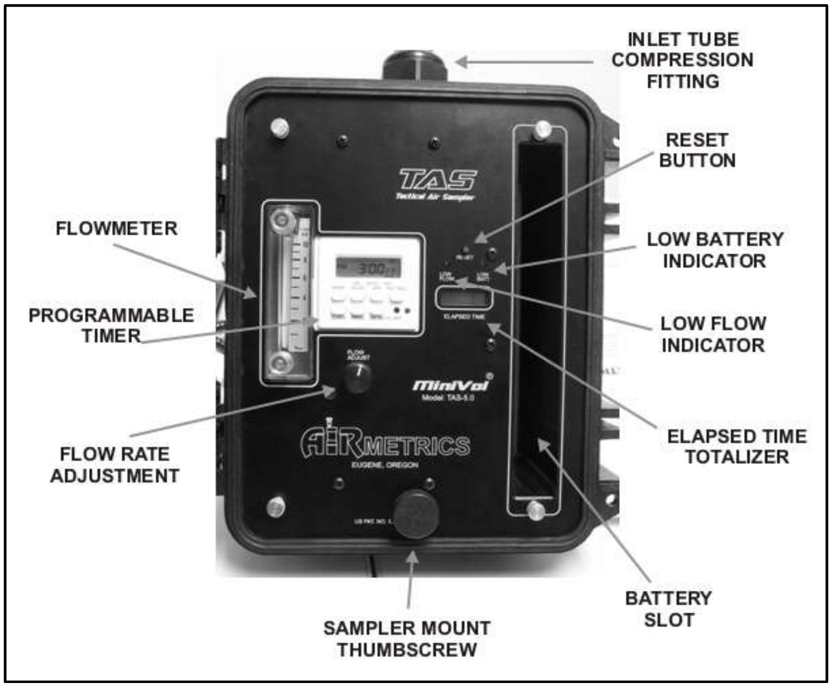

Figure 3.1 - Sampler Layout

3.2 Elapsed Time Totalizer

The Elapsed Time Totalizer displays the total number of hours, with a resolution of tenths of hours that the pump has run. The totalizer accumulates time only while the pump is running. It cannot be reset to zero. The total hours should be recorded at the beginning and end of each sampling period.

3.3 Programmable Timer

The Programmable Timer controls the on/auto/off operation of the sampler. The timer allows up to six sampling times to be preprogrammed over twenty-four hours or throughout a week (see Section 2.4 "Programming the Timer").

3.4 Flowmeter

The Flowmeter indicates the flow rate of air through the system in liters/minute. The flow rate is adjusted using the "Flow Rate Adjustment". The flowmeter readings must be taken from the center of the ball.

3.5 Flow Rate Adjustment

The Flow Rate Adjustment knob varies the sampler's flow rate as indicated by the level of the ball (read from the center of the ball) in the flowmeter. Slowly turn the knob until the air flow reaches the desired level. When adjusting the flow rate the two indicator LED’s will light, this lets the operator know that the flow set point is being changed. The LED’s will turn off when the microcontroller has stored the set point. **Do NOT turn the sampler off while the LED’s are lit.** Doing so will cause the microcontroller to store an erroneous set point. If this happens the sampler may be returned to factory presets by momentarily rotating the Flow Rate Adjustment knob immediately after turning on the sampler. This will be indicated by the two indicator LED’s lighting up. **Do NOT make any adjustments until the LED’s have turned off.**

3.6 Low Flow Indicator

The Low Flow Indicator LED is activated when the flow sensor determines that the air flow rate has dropped by approximately 10% below the set flow rate

If a low flow condition exists for an extended period of time (several seconds), the flow sensor will shut off the sampler's pump and turn on the Low Flow Indicator LED. The red LED will flash to alert the operator that the sampling was aborted because air flow could not be maintained at the desired rate. The pump is turned off because the cut-point of the PM size selective inlet is determined by the air flow rate through the inlet. For the inlet to have constant particle size cut-point, it is necessary to maintain a constant flow rate throughout the sampling period.

When a low flow cutoff condition arises, the error can be cleared by pressing the "Reset Button" twice. (see Figure 3.1).

3.7 Low Battery Indicator

When lit, the Low Battery Indicator means that the battery voltage has dropped to a limit too low (13.0 volts) to permit continued operation. When the low voltage limit is reached, the pump shuts off and the low battery indicator turns on and remains lit to alert the operator. If the pump was not turned off and the battery voltage continued to drop, the battery could be permanently damaged or its life significantly shortened.

When a low battery condition arises, the error can be cleared by pressing the "Reset Button" twice. (see Figure 3.1).

3.8 Low Flow / Low Battery Reset Button

The Reset Button momentarily interrupts power to the sampler then restarts the sampler when the system has been shut down due to low flow or low battery voltage conditions. **Any error condition requires the reset button to be pushed twice to reset the sampler.** This allows the sampler to retain the error condition if it loses power since the power needs to be interrupted twice for a complete reset (see "Low Flow Indicator" and "Low Battery Indicator" above).

3.9 ON/AUTO/OFF Button

The ON/AUTO/OFF Button manually turns the sampler on, off, or places it in the "Auto" mode. In the "Auto" position, the sampler is controlled by whatever programmed on/off sequences have been entered. A bar on the lower edge of the Programmable Timer's LCD display moves from "On" to "Auto" to "Off" as the button is pressed (see "Programming the Timer" in Section 2.4).

4 PARTICULATE MATTER SAMPLING

Sampling procedures for TSP, PM_{10}, and $PM_{2.5}$ are identical except for the configuration of the impactor/filter holder assembly.

4.1 Consumables

During particulate matter sampling, the following consumables are needed for proper operation of the MiniVol™ TAS:

- Impactor grease - Glisseal® Ht, Apiezon® M Grease, etc.
- 47 mm filters - pure quartz, pure Teflon®, Teflon®-coated glass, etc.
- Petrislides™ - for storage and transport of the filters.

A microbalance accurate to one microgram is needed to weigh the filters.

Airmetrics offers all of the above consumables, along with filter weighing services.

4.2 Siting Requirements

Siting recommendations in this manual conform to the U. S. Environmental Protection Agency requirements as stated in the U. S. Code of Federal Regulations (40 CFR part 58, Appendix E). When operating the sampler in locations under another jurisdiction, the operator should follow the appropriate guidelines.

The MiniVol™ TAS should be positioned with the intake upward and should be located in an unobstructed area at least 30 cm from any obstacle to air flow. Accessibility to the unit under all weather conditions, along with safety and security of the monitoring personnel and equipment, should be prime considerations.

4.3 Universal Mounting Bracket

The MiniVol™ TAS universal mounting bracket is designed to be used in a variety of situations. It comes configured to be mounted on a 2" OD or smaller pipe, fence post or other metal tubing. The quick release bracket extension also allows the bracket to be mounted either vertically or horizontally (see Figure 4.1). By removing the stainless steel u-bolts and plastic vee blocks, the bracket may strapped to a larger diameter object such as a light or power pole. Using the included ratchet straps (see Figure 4.1)

Figure 4.1 – Vertical Mount **Horizontal Mount** **Strap Mount**

4.4 Preparing the Sampler

- **TSP** - Remove the impactors from the filter holder assembly prior to sampling. Since the impactor will not be used, greasing and cleaning of the impactor's target disk need not be done.

- **PM10 -** Use a PM_{10} impactor in the filter holder assembly (see Figure 4.2). Greasing and cleaning of the impactor's target disk should be performed initially and after every fifth sample (or more often if heavy loading is observed). Refer to Section 7, Maintenance, "Impactor Cleaning."

- **PM2.5** - Use a $PM_{2.5}$ impactor in the filter holder assembly and a PM_{10} impactor in a multiple impactor adapter mounted on the filter holder assembly tube (see Figure 4.3). Greasing and cleaning of the impactors' target disks should be performed initially and after every fifth sample (or more often if heavy loading is observed). Refer to Section 7, Maintenance, "Impactor Cleaning."

To remove impactors, use your thumb to simply push the impactor out of its tube from bottom to top. When correctly installed, the impactor's top is flush with the surrounding filter holder assembly tube or multiple impactor adapter tube.

Before transporting the MiniVol™ TAS to the field, perform a laboratory check to determine if it is operational. Turn the sampler on and observe the motor performance. Perform a leak check. Investigate and correct any malfunctions before proceeding. Perform a single-point flow rate check using a calibrated orifice, soap-bubble meter or other flow measuring device of known accuracy and compare to the curve established during calibration. The flow should be within ±10% of 5 lpm at current conditions. If the unit fails to operate in this range, check the sampler for obvious leaks and malfunctions. The sampler must be repaired or recalibrated if the flow criteria are not met.

4.5 Flow Rate

The particle size cut point of the impactor is a function of the velocity with which the air stream passes through the impactor and impacts on the target. The impactor is designed to have the correct cut point at an air flow rate of 5 lpm at ambient conditions. Since the density of air and the behavior of the flowmeter are functions of the ambient air temperature and atmospheric pressure, a flow rate set point must be calculated for each different sampling project.

The sampler air flow calibration curves that are supplied with each sampler contain the necessary information needed to determine the flowmeter set point for a particular ambient condition. Section 8.2 contains the complete instructions in calculating the flow set points.

4.6 Flowmeter Calibration

The sampler should be recalibrated once a year and/or if the flowmeter is replaced.

4.7 Impactor/Filter Holder Assembly

Depending on the required particle size separation, the configuration of the impactor/filter holder assembly changes. The filter holder assembly contains a filter cassette in which the 47mm filter is supported by a filter support screen (see Figure 4.2 for PM_{10} and Figure 4.3 for $PM_{2.5}$).

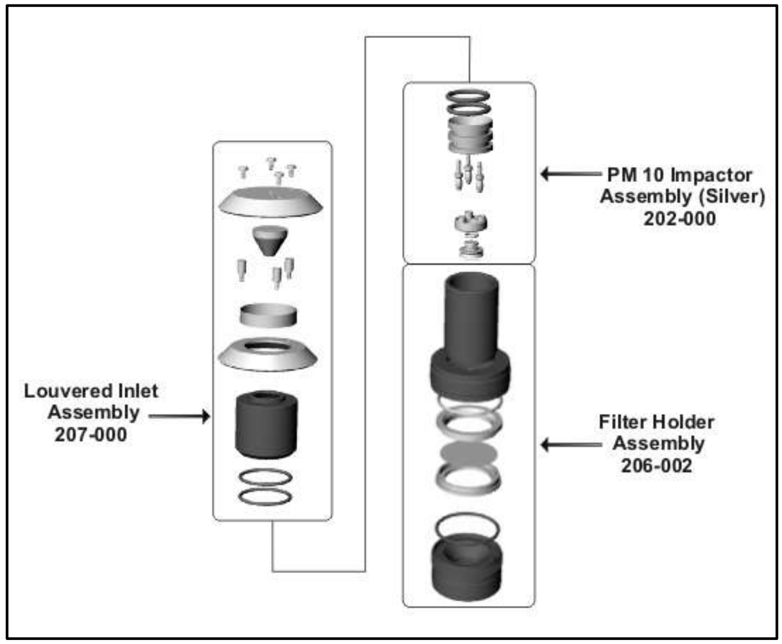

Figure 4.2 - PM10 Impactor/Filter Holder Assembly

4.8 Clean and Grease Impactor

Initially, and after every fifth sample, the impactor target should be cleaned. The cleaning frequency can be increased or decreased depending on the ambient loadings and degree of soiling observed on the Easy Maintenance Target (EMT). (See section 6.1.2)

(For Impactor cleaning procedures, see Section 6.1.1, “Impactor Cleaning”)

4.9 Installing Filters

This procedure should take place in a laboratory or other clean area. Contact with and handling of all filters should be limited to the edges of the filters with forceps. Also, the use of non-serrated, Teflon®-tipped forceps is strongly recommended. Filters should be kept in protective Petrislides™. Filters must never be bent or folded.

1. Select a filter and remove cover from Petrislide™.
2. Using forceps, install the new filter into the filter cassette.
3. Place the filter cassette in the filter holder.
4. Place an identifying tag on the filter holder so that the ID number of the filter mounted in the holder is known.
5. Place the entire clean filter assembly into a plastic bag, or other case, for transporting to the site. It is best to keep the filter assembly in a vertical position until installed on the sampler.

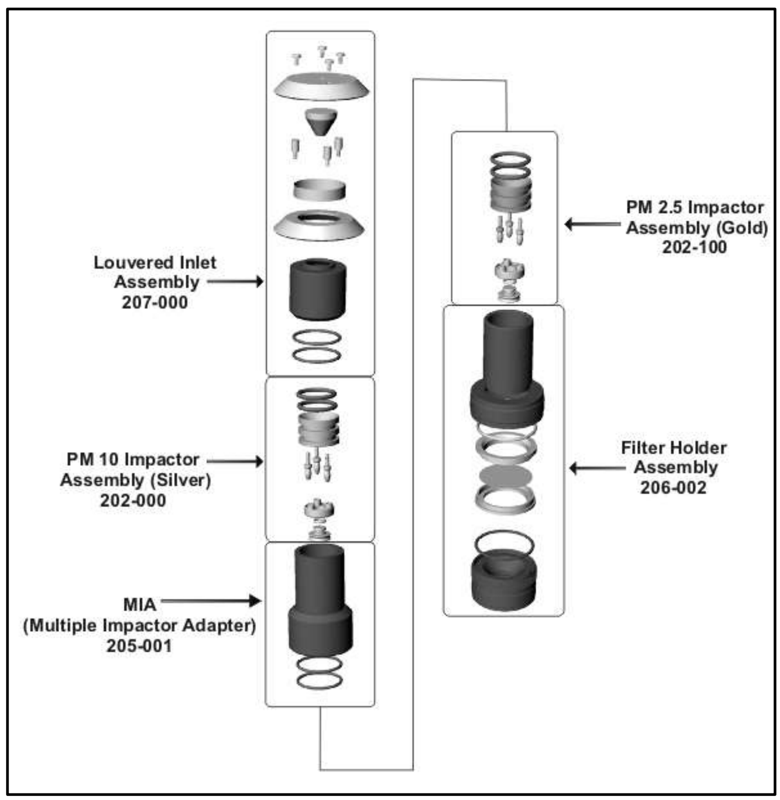

Figure 4.3 - PM2.5 Impactor/Filter Holder Assembly

4.10 Cassette Separator

The top and bottom halves of the filter cassette are machined for a press fit. Separating the two halves can be simplified by using a cassette separator*.

Insert the cassette in the cassette separator and while applying a light downward pressure slide it from left to right as in figure 4.4 below. This motion will separate the top and bottom cassette halves allowing for filter insertion and/or removal.

Figure 4.4 - Cassette Separator

* the cassette separator is available as Airmetrics part number 600-007

4.11 Battery Charging

Recharge the battery pack before each use. If the battery pack is to be stored for more than a month it best to store it at less than full charge and in a cool location. The typical battery pack life is ≥ 500 charging cycles.

Airmetrics suggests the batteries not be stored in the sampler. The life of Lithium-Ion batteries can be prolonged by storing the batteries in a cool environment at less than a full charge (about 40%). Storing the battery in the sampler will eventually deplete the battery and will decrease its useful life.

See Section 2.2 “Charging Batteries” in the Getting Started section for instructions in the proper procedure to follow in recharging the batteries.

4.12 Changing/Installing Battery Pack

Installing or changing the battery pack is a simple process.

1. Insert the battery pack vertically into the sampler battery slot with the arrow on the battery pack label pointing down and towards the left side of the sampler.

2. To remove the battery pack grip the exposed end of the battery pack and pull. The battery pack should release with very little effort.

4.13 Other Battery Checks

A single AA battery located on the back of the circuit board operates the Programmable Timer. The lifetime for this battery is approximately six months when it is left in place on the circuit board. Be sure to observe the correct polarity when inserting a new AA battery into the battery compartment.

4.14 Setting the Desired Sampling Time

Determine the time of the day when the sampler is to turn on and off. Program the timer to turn the sampler on and off at these times (see "Programming the Timer" in Section 2.4).

4.15 Particulate Matter Sampling Procedure

After the sampler has been assembled, adjusted, verified to be in proper working order, and a filter loaded in the Filter Assembly, the sampler is ready to collect air samples. **Note**: For a quick reference to the following steps, see "Particulate Matter Sampling Routine at Site" (Section 9.1).

1. Carefully transport the sampler to the field site. Verify that the sampler, when finally installed will be positioned with the intake upward in an unobstructed area at least 30 cm from any obstacle to airflow.

2. Place the sampler on a firm level surface.

3. Loosen the inlet tube compression nut and extend the inlet tube to the maximum height and re-tighten the nut. Check for leaks using the procedure in Section 2.5.

4. Remove the clean Impactor/Filter Holder Assembly from the plastic transport bag or case. Attach the assembly to the top of the sampler inlet tube.

5. Record the following information on the PM Field Data Sheet: Site ID, number of the filter, the battery ID, sampler ID, ambient temperature and pressure, flowmeter reading, and elapsed time meter reading. (a copy of the data sheet may be downloaded from the Airmetrics website, www.airmetrics.com).

6. Open the sampler case and obtain the beginning flow rate, press the ON/AUTO/OFF button to start the pump. On the LCD display, the horizontal bar should move to "ON".

7. If the flowmeter, which should be in the vertical position, indicates zero or a very low reading, check for restrictions.

8. Using the Flow Rate Adjustment control (see Figure 3.1), set the flowmeter within specifications for the project temperature and pressure conditions. Take the reading of the flowmeter from the center of the ball. (See Section 3.5 “Flow Rate Adjustment”).

9. Press the ON/AUTO/OFF button twice to stop pump.

10. Press the ON/AUTO/OFF button to set the timer to "Auto" mode. The Sampler **MUST** be in “Auto” mode before the operator leaves if the sampler is to run at a pre-programmed time.

11. Close the sampler case.

4.16 Particulate Matter Sample Retrieval

As soon as possible after the end of the sampling period, the operator should return to the monitoring site to retrieve the exposed filter. Potential for filter damage or changes in sample mass due to particle loss, passive deposition, or volatilization increases if the filter is left in the sampler for extended periods. On the Field Data Sheet record the ambient temperature (T_a), barometric pressure (P_a), flowmeter reading and elapsed time.

Note: T_a and P_a readings may be estimated on site or may be obtained from a nearby US National Weather Service Forecast Office or airport weather station. Barometric pressure readings obtained from airports must be at station pressure (not corrected to sea level), and they may have to be corrected for differences between the elevation of the monitoring site and that of the airport. If T_a and P_a readings are not available, seasonal average temperature (T_{avg}) and barometric pressure (P_{avg}) may be substituted. Care must be taken that the actual conditions at the site can be reasonably represented by such averages. It is therefore recommended that seasonal values represent actual values within 20 °C and 40 mmHg.

1. Open the sampler case check the sampler for any error conditions. If an error condition exists, refer to the “Error Conditions” section at the end of this chapter.
2. Verify correct time and day of week on time LCD.
3. Record elapsed time as shown on the Elapsed Time Totalizer.
4. Obtain ending flow rate:
    - Press the ON/AUTO/OFF button to start the pump.
    - With the flowmeter in a vertical position, record flow rate to the nearest 0.25 lpm (read at center of ball).
    - Press the ON/AUTO/OFF button twice to stop the pump.
5. Exchange a new impactor/filter holder assembly for the exposed filter holder assembly. Perform a cross-check of the exposed filter number with the filter number recorded on the Field Data Sheet for the run just completed. Also, check the filter number against the site number.
6. Change Battery Pack.
7. Obtain beginning flow rate (see above, step 4).
8. Make sure the timer is set for the desired period and in the “AUTO” mode.

4.17 Exposed Filter

1. In the laboratory, unscrew the filter holder and remove the filter cassette.
2. Locate the Petrislide™ with the filter number which matches the number on the side of the filter holder assembly. This is the original Petrislide™ in which the filter came.
3. Use the cassette separator (P/N 600-007) to remove the top half of the filter cassette.
4. Using forceps carefully remove the exposed filter from the filter cassette and place it into its original Petrislide™ with the exposed side of the filter facing up, replacing the Petrislide™ lid when finished. (Be sure to replace the filter support screen in the filter cassette assembly).
5. Remove the old ID tag from the filter holder assembly base and discard. (Recheck this number to be sure it matches the number on the Petrislide™.)

4.18 Error Conditions

4.18.1 Low Battery Indicator ON

Should the Low Battery Indicator be ON at the end of a sampling period, check the Elapsed Time Totalizer to determine the length of time the sampler ran before shutting off. If the time is short (*e.g.*, only 18 hours out of a programmed 24 hour sample), perhaps the battery was not completely charged or is failing to hold a charge. Note the battery number and, after recharging in the lab, observe performance in the next sampling period. If the battery fails again, it is most likely defective and should be replaced.

If a different battery performs in the same manner after shown to be fully charged, the pump motor is perhaps drawing more current than it should. If possible, install a pump from another sampler. If this solves the problem, the previous pump motor is likely defective and should be replaced. If the problem continues, a more serious fault is occurring which should be referred to Airmetrics (see Section 10).

4.18.2 Low Flow Indicator ON

Should the Low Flow Indicator be ON at the end of sampling period, first check the Elapsed Time Totalizer to determine the length of time the sampler ran before shutting off. The possible causes for low flow are:

- **Low Battery:** Although power did not fall to the 13.0V lower limit that would shut down the system, the pump may not have been receiving enough voltage to maintain the desired air flow. This will usually only occur if the pump needs to be rebuilt or replaced.

- **Air Restriction:** If the battery is sound, the problem may be due to a restriction in the air inlet, filter holder, or tubing. Check for crimps or other possible restrictions. Also, a broken or loose tubing fitting on the outlet side of the pump could cause a low flow condition. It is also possible for excessive moisture on the filter (rain, condensation) to cause enough flow resistance for the Low Flow Indicator to come on.

- **Pump Malfunction:** The low flow condition could be the result of decreased pump efficiency, which is usually caused by damaged or contaminated pump head components (valves, diaphragms). Check to see if the pump can maintain a free (unrestricted) airflow rate of at least 5 lpm. If not, see Section 6.4 for pump maintenance instructions.

4.18.3 Overriding Low Flow/Low Battery Indicators

When Low Flow and Low Battery Indicator LED’s are flashing, the system can be restarted by pressing the Reset Button twice. The system will usually run enough to perform a brief field inspection and to obtain final flow rates.

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5 HARDWARE DESCRIPTION

5.1 Pneumatic System

5.1.1 Filter Holder Assembly

A 47 mm diameter filter cassette and filter holder assembly is used to hold the filter media.

5.1.2 Flowmeter

A standard flowmeter with a range of 1 to 10 lpm is used to indicate sampling flow rate. The flowmeter is calibrated at the factory to an accuracy of ± 2%.

5.1.3 Flow Control System

A monitoring system designed by Airmetrics electronically controls pump speed to maintain a specified flow setting by measuring the drop in air pressure at the outlet of the flowmeter. The Flow Control System is temperature compensated for changes in ambient temperature and pressure.

5.1.4 Miniature D.C. Double Diaphragm Pump

The Airmetrics designed pump has two pumping sections or heads that are connected in parallel for increased flow. The pumping sections consist of synthetic rubber diaphragms and valves driven from the motor shaft by a yoke-crank assembly. All moving parts are completely enclosed. The service life of the motor is in excess of 10,000 hours continuous duty. The diaphragm and valve assemblies are easily replaceable. The service life expectancy of these assemblies is a function of the environmental conditions, including the gases being pumped, delivery rate, and back pressure. Minimum service life for the pumping sections is on the order of 5000 or more hours continuous duty.

5.2 Electronics System

5.2.1 Motherboard

Virtually all sampler components connect to the motherboard: the pump, programmable timer, elapsed time totalizer, flowmeter, and flow control components. Flow control and fault circuits, are built into this board.

5.2.2 Power Supply

The sampler is powered by a removable Li-Ion battery pack. The separate charger is designed to charge the battery and then switch to a "maintenance" mode to avoid an overcharge condition. The charger may also be used to directly power the sampler by plugging it into the power jack on the side of the sampler. The battery also has built in protection circuitry that may be activated if the battery output is shorted. The battery can be reset by plugging it into the charger.

5.2.3 Programmable Timer

The Programmable Timer can switch power on and off up to 6 times in one day or over a 7-day period and is capable of individual or multi-day timer settings. It has an easy to read liquid-crystal display and is powered by an on board AA battery.

5.2.4 Flow Controller Circuit

The Flow Controller Circuit is designed to maintain a constant pressure drop across an orifice at the output of the flowmeter. Feedback from the pressure sensor is used to control the pump speed. The system is temperature compensated and is capable of maintaining a constant volumetric flow rate within ±5% of the set point over the range of 0 to 40°C.

5.2.5 Elapsed Time Totalizer

The Elapsed Time Totalizer is a non-resettable time totalizer which is activated when the programmable time controller is in the "ON" mode. The meter reads hours and tenths of hours.

6 MAINTENANCE

Ideally, records reflecting the history of maintenance (including all replacement parts, supplies, costs, expenditures) should be kept for each MiniVol™ TAS.

Check sheets should be used to record preventative and/or corrective maintenance activities and the subsequent sampler calibration curve.

The sampler is comprised of four basic components: impactor/filter holder assembly, flow control system, timer, and battery pack. Following are recommended, routine maintenance procedures for the sampler's basic components.

6.1 Impactor/Filter Holder Assembly

6.1.1 Impactor/Filter Holder Cleaning

The maintenance schedule for the cleaning of the impactor/filter holder assembly varies with the quality of the air being sampled and sample runtimes. Under average conditions, and assuming 24 hour sample runtimes, the Easy Maintenance Target (EMT) should be cleaned and greased every fifth sample run and the rest of the impactor/filter holder assembly cleaned with soapy water and rinsed. The cleaning frequency can be increased or decreased depending on the ambient loadings and degree of soiling observed.

1. Separate the sections of the filter holder assembly and remove the louvered inlet.
2. Pushing with the thumb from the bottom, remove the impactor through top of the tube into the palm of your free hand.
3. Remove the EMT from the impactor by pulling on it with your fingers and set aside (see Figure 6.1).
4. Clean the impactor/filter holder assembly using soapy water and rinse thoroughly.
5. Let the impactor/filter holder assembly air dry.

Figure 6.1 - EMT Removal

6. Inspect the o-rings on the impactor/filterholder assembly and replace if necessary.
7. Apply a thin coat of low vapor pressure grease* to the o-rings on the impactor and the o-rings in the filter holder outlet and louvered inlet.

   NOTE: it is **NOT** necessary to grease the o-rings inside the filter holder that seal against the filter cassette. This could contaminate the sample filter.

8. Re-insert the EMT after it has been cleaned and greased, (see next section "EMT Cleaning").

Remove any extraneous, loose, or hair-like shredded material from the exterior of the impactor unit since this material could fall onto the filter below and cause erroneous gravimetric results. Carefully re-insert the impactor into the top of the filter holder assembly tube until the top of the impactor is flush with the top of the tube.

* low vapor pressure grease is available from Airmetrics as part number 903-004

6.1.2 EMT Cleaning

Airmetrics developed the Easy Maintenance Target (EMT) Impactor to simplify the preparation and maintenance of the impactor assembly. The EMT is a removable impactor target that is easily prepared and cleaned. Low vapor pressure grease* can be applied directly to the target and is easily wiped clean without the need for solvents.

1. Clean the EMT by wiping with a clean lint free cloth or paper towel.
2. Apply a small amount of low vapor pressure grease to the applicator, in this example we are using a smalll stainless steel ruler; any semi-rigid straight edge will work (see Figure 6.2).
3. Use the straight edge to apply the grease to the EMT in a spreading or "buttering" motion (see Figure 6.3).

Figure 6.2 - Grease

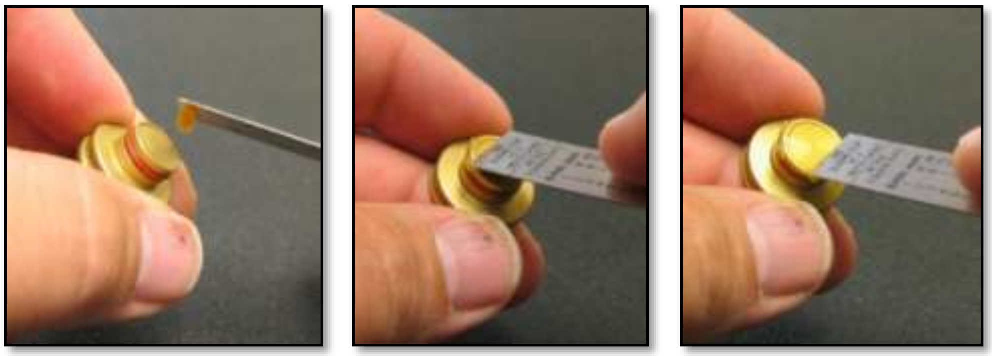

Figure 6.3 - Applying low vapor pressure grease to the EMT

4. After application and excess grease can be wiped from the edges of the EMT.
5. After the EMT has been greased reinsert it into the impactor.

*low vapor pressure grease is available from Airmetrics as part number 903-004

6.2 Flow Control System

Tubing, pulse dampener, inlet filter should be routinely checked for crimps, cracks, or obstructions. Fittings should be inspected periodically for tightness. The flowmeter should be cleaned or replaced if it indicates no flow, low flow, excessive flow, or erratic flow that cannot be traced to a leak. The flowmeter can be easily cleaned using warm water and detergent.

1. Remove the inlet and outlet tubing and detach the flowmeter from the main circuit board.
2. Remove the flowmeter end caps and submerge in detergent solution. Slosh water back and forth using the ball as a self-cleaning agitator. Follow with a rinse in clean water.
3. Air dry and reinstall.

6.3 Programmable Timer

A single AA alkaline battery powers the programmable timer. It should last at least 6 months. Since the clock and timer are sealed electronic devices, any failure requires replacement of the entire unit.

6.4 Cleaning/Inspecting Pump Valves and Diaphragms

After continued use, the pump valves and diaphragms will become dirty or worn. This condition usually manifests as an irregular flow rate or an inability to accurately adjust the flow rate. The pump may be unable to achieve or sustain a maximum flow rate (above 6 lpm). When these conditions occur, the pump valves must be cleaned or replaced. While the pump diaphragms are not usually affected by dirt, they will become worn and need replacement.

The side of the pump on which the valves are worn or dirty is easily determined by pinching the inlet tubes leading to the pump (first one side and then the other). Under normal conditions, the flow rate will drop by the same amount for both sides as the lines are restricted. If the flow rate drops less for one side, the valves on that side need cleaning or replacing.

When cleaning or replacing valves and diaphragms, replace or clean all valves and diaphragms. (A "Double Diaphragm Pump Rebuild Kit" can be obtained from Airmetrics.)

6.4.1 Cleaning/Inspecting Pump Head Valves

1. Remove a pump head, making note of the orientation of the head and valves. Inspect and replace the valves and diaphragms that are worn or damaged.

2. Clean the diaphragm and valves that are still in good working order with soapy water, rinse and dry. Flip each component and replace in the same order.

3. Screw on the pump head, taking care to match the alignment of the in flow and out flow ports on each pump head. Repeat for opposite side of the pump.

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7 TROUBLESHOOTING

Problem	Solution
The flowmeter will not zero when performing a leak check.	Remove the inlet assembly and with the pump running cover the inlet tube with your hand. The flowmeter should drop to zero, if not a leak is present. Verify that the inlet tube compression fitting is tight Remove the four faceplate thumbscrews and the sampler mount thumbscrew to access the pump, pulse dampener and tubing. Check that all push-on hose fittings are secure. Check for cracks in the flowmeter inlet and outlet Check for cracks in the pulse dampener diaphragms. Check that all compression fittings are snug.
The flowmeter will not register a flow rate above 6.5 lpm or the flow rate cannot be adjusted accurately and there is no apparent leak or obstruction	The pump diaphragms and/or valves are dirty or worn (see section 6.4, “Cleaning/Inspecting the Pump Valves and Diaphragms”). Check the Pulse Dampener for cracks.
The charger light fails to light red or green when plugged into a battery pack.	The charging LED on top of the charger should light even if the battery is fully charged. If the LED fails to light up the charger is either defective is not receiving line voltage.
The battery charger light does not turn green after charging more than 8 hours.	The battery may be defective. Connect a previously charged battery to the charger if the same condition results then the charger is most likely defective. If the light turns green then the battery is most likely defective.
The battery has no output	The battery has built in protection circuitry that may have been activated if the battery connection is shorted. The battery can be reset by plugging it into the charger.

8 SAMPLING CALCULATIONS

8.1 Sampler Flow Rate Calculation

The MiniVol™ TAS is designed to operate at 5 lpm at ambient conditions. At the factory the sampler is calibrated to standard conditions, and is adjusted to operate at 5 lpm at these conditions. (See calibration curve shipped with sampler.) In other localities, the sampler must be adjusted to account for the different ambient temperature and barometric pressure. Adjustment within a range previously established by calibration is usually performed before every sampling project. This section explains how to use the calibration information shipped with the MiniVol™ TAS to determine the flow rate that will equal 5 lpm at local ambient conditions.

In the calibration procedure used by Airmetrics, the flowmeter is calibrated against a NIST Traceable Laminar Flow Element (LFE) flow measuring device. Six flow rates, ranging from approximately 4 to 6.5 liters/minute, are typically measured. The inlet of the LFE is open to the atmosphere while the outlet is attached to the inlet of the sampler.

Figure 8.1 shows a typical sampler calibration report. The columns the in the report are defined as:

Qind Flow rate as indicated by the rotameter on the sampler.

Qact Flow rate at the actual calibration conditions as determined from the LFE.

Q@std The flow rate at standard conditions for the indicated LFE pressure drop. (Note that this is not the same as converting the actual flow rate to standard conditions.) Standard conditions are defined as an atmospheric pressure ($\mathbf{P_{std}}$) of 760 millimeters of mercury and a temperature ($\mathbf{T_{std}}$) of 298°K.

Qcalc The calculated flow rate of the sampler that is determined from the linear regression results.

Diff The percentage difference in flow rates between the measured and the calculated flow rates.

For each point in the calibration procedure, the flow rate indicated by the flowmeter, "**Qind**", is recorded, and the actual flow rate, "**Qact**" and "**Q@std**" are calculated from the pressure drop across the LFE.

The **Linear Regression Results** in Figure 8.1 shows the results of the best fit line of Qind (independent) to Q@std (dependent) variables:

Equation 1 – MiniVol™ Calibration Factor

$$Q_{@std} = m_{vol} \times Q_{ind} + b_{vol}$$

Where m_{vol} = slope of the least square line
b_{vol} = intercept of the least square line

The coefficient of determination ($\mathbf{r^2}$) is also listed in Figure 8.1.

MiniVol Portable Sampler
NIST Traceable Flow Calibration
Unit: 4623

Calibration Date: 07/31/2007 Primary Flow Std: LFE774300 By: __________
Ambient Temp, °C: 22.6
Atmos Press, mmHg: 754.0 Chk: __________

Q_{ind} (lpm)	Q_{act} (alpm)	$Q_{@std}$ (slpm)	Q_{calc} (slpm)	Diff (%)
6.50	6.794	6.795	6.794	0.01
6.00	6.284	6.285	6.280	0.08
5.40	5.665	5.666	5.663	0.05
5.00	5.234	5.235	5.252	-0.34
4.40	4.640	4.640	4.636	0.10
3.90	4.125	4.126	4.122	0.10

Linear Regression Results:

m_{vol} = 1.0277
b_{vol} = 0.1137
r^2 = 0.9999

The MiniVol Calibration is performed with an NIST-traceable standard. Each unit has a unique pair of calibration constants derived from the calibration which are used to calculate the Sampler's actual flow rate at all ambient conditions. The Sampler's calibration should be recertified annually.

For an indicated rotameter flow rate (Q_{ind}), the flow rate at actual sampling conditions (Q_{act}) is given by the following equation (Eq.1):

$$Q_{act} = (m_{vol} Q_{ind} + b_{vol}) \times \sqrt{\frac{P_{std}}{P_{act}} \times \frac{T_{act}}{T_{std}}} \qquad \text{Eq.1}$$

The Sampler is designed to operate at 5.0 lpm at actual conditions. The rotameter setting for this nominal flow rate (Isp) can be calculated by using the following equation (Eq.2):

$$I_{sp} = \frac{5.0 \times \sqrt{\frac{P_{act}}{P_{std}} \times \frac{T_{std}}{T_{act}}} - b_{vol}}{m_{vol}} \qquad \text{Eq.2}$$

Where:

- I_{sp} = Calculated Rotameter Setpoint, liters/min.
- P_{std} = Standard Atmospheric Pressure (760 mm Hg)
- T_{std} = Standard Temperature (298 °K)
- P_{act} = Actual Ambient Pressure, mm Hg
- T_{act} = Actual Ambient Temperature, °K
- Q_{act} = Actual Flow Rate, liters/min.
- Q_{ind} = Rotameter Indicated Flow Rate, liters/min.

Airmetrics
2095 Garden Ave, Suite 102
Eugene, OR 97403
(541) 683-5420

Figure 8.1 - Sampler Calibration Report

8.2 Sampling at Ambient Conditions

The sampler's size-selective inlet is an impactor whose particle size selection characteristic is dependent upon the velocity with which the air stream impacts upon the impaction plate also known as the target (see Section 8.4). The impactor is designed to have a nominal 10µm (part 206-000) or 2.5µm (part 206-100) cutpoint at an actual air flow rate of 5.0 liters per minute. To maintain this cut off size, the sampler's flow rate must be adjusted (flowmeter set point - $\mathbf{I_{sp}}$) so that the flow rate through the size-selective inlet is maintained at 5.0 lpm at **ambient** conditions.

To calculate the flowmeter set point, you need:

- The sampler's calibration slope, $\mathbf{m_{vol}}$, and intercept, $\mathbf{b_{vol}}$. This information is supplied to you on the "MiniVol™ Portable Sampler NIST Traceable Flow Calibration" that came with your sampler (Figure A.1);

- The expected ambient temperature, $\mathbf{T_{act}}$, in K°, and pressure, $\mathbf{P_{act}}$, in mmHg, expected during the sampling event. This data may be estimated from local weather service data or from other reported historical data. If the U.S Weather Service atmospheric pressure is used, be sure that the "station pressure" is used. That is, atmospheric pressure **not** corrected for the reporting site's elevation above sea level.

If the local "station pressure", $\mathbf{P_{act}}$ is not readily available, it can be reasonably estimated by using Equation 2.

Equation 2 – Pressure Correction

$$P_{act} = P_{sea} \times \left(1 - \frac{E}{145330}\right)^{5.25}$$

Where P_{act} = ambient atmospheric pressure
P_{sea} = sea level atmospheric pressure (nominally 760 mmHg)
E = site elevation in feet

The Flowmeter Set Point, $\mathbf{I_{sp}}$, is calculated using Equation 3.

Equation 3 – Flowmeter Setpoint

$$I_{sp} = \frac{5.0 \times \left(\sqrt{\frac{P_{act}}{P_{std}} \times \frac{T_{std}}{T_{act}}}\right) - b_{vol}}{m_{vol}}$$

Where I_{sp} = flowmeter set point, liters/minute
P_{std} = standard atmospheric pressure, 760 mmHg
T_{std} = standard temperature, 298 K°
P_{act} = actual ambient pressure, mmHg
T_{act} = actual ambient temperature, K°

8.3 PM Concentration Calculation

To calculate the PM concentration for a sample taken with the MiniVol™ TAS, the volume of air that passed through the filter at standard conditions, $\mathbf{V_{std}}$, or at ambient conditions, $\mathbf{V_{amb}}$, must be calculated. This is most easily done in a multi-step procedure.

Calculate the air flow rate at ambient conditions, $\mathbf{Q_{act}}$, using Equation 4.

Equation 4 – Flow Rate @ Ambient

$$Q_{act} = (m_{vol} \times Q_{ind} + b_{vol}) \times \sqrt{\frac{P_{std}}{P_{act}} \times \frac{T_{act}}{T_{std}}}$$

Calculate the volume of air that passed through the filter during the sampling period at actual ambient conditions, $\mathbf{V_{act}}$ (in cubic meters).

Equation 5 – Volume @ Ambient

$$V_{act} = \frac{60_{min/hr} \times Q_{act} \times t_{hr}}{1000_{l/m3}}$$

Where t_{hr} = sampling period, in hours

In the equation above, time is expressed in hours since the MiniVol™ TAS elapsed time meter records time in hours. The units of $\mathbf{V_{act}}$ are *cubic meters*.

In the actual use of the portable samplers, the *temperatures*, *pressures* and *flowmeter readings* are only noted at the start (when the sampler is set up for a run) and end (when sampler is retrieved) of the sampling period. Therefore, calculate $\mathbf{Q_{act}}$ for the starting and ending conditions and use the average $\mathbf{Q_{act}}$ to determine $\mathbf{V_{act}}$.

To calculate the concentration at standard conditions, correct the volume of the air at actual ambient conditions, $\mathbf{V_{act}}$, to the volume of air at standard conditions, $\mathbf{V_{std}}$.

Equation 6 – Volume Correction to Std

$$V_{std} = V_{act} \times \left(\frac{P_{act}}{P_{std}}\right) \times \left(\frac{T_{std}}{T_{act}}\right)$$

To finally calculate the concentration of PM, divide the net mass gain of the filter by the volume of air that passed through the filter. Use equation 7 for mass at actual conditions and Equation 8 for mass at standard conditions.

Equation 7 – PM Concentration @ Act

$$PM_{act} = \frac{M_{PM}}{V_{act}}$$

OR

Equation 8 – PM Concentration @ Std

$$PM_{std} = \frac{M_{PM}}{V_{std}}$$

Where PM_{act} = PM concentration, in micrograms (µg) per cubic meter (actual)
PM_{std} = PM concentration, in micrograms (µg) per cubic meter (standard)
M_{PM} = Mass of particulate matter collected on the filter, in micrograms (µg)

8.4 Impactor Cutpoint

The impactor is designed to provide a specific particle cutpoint at a set flow rate. The Airmetrics impactors are designed for a nominal flow rate of 5 lpm. If the user samples at a flow rate other than 5 lpm the actual impactor cutpoint, $\mathbf{C_{act}}$, can be calculated using Equation 9.

Equation 9 – Impactor Cutpoint

$$C_{act} = \sqrt{\frac{Q_{design}}{Q_{act}}} \times C_{design}$$

Where C_{act} = Actual cutpoint at set flow
C_{design} = Cutpoint at designed flow rate (e.g. 10_{μ} or 2.5_{μ})
Q_{design} = Design flow rate (5 lpm)
Q_{act} = Actual sampler flow rate

9 QUICK REFERENCE

9.1 Particulate Matter Sampling Routine at Site

1. Open sampler case
2. Record the hours shown on the elapsed time totalizer.
3. Check for any error conditions that exist. If either the “Low Flow” or “Low Battery” error indicators are lit record the error and press the reset button.
4. Press the On/Auto/Off button to start the sampler pump.
5. With the sampler running (in a vertical position) and the flow stable read the flowmeter (to the nearest 0.25 lpm at the center of the ball) and record the ending flow rate.
6. Press the On/Auto/Off button to stop the sampler pump
7. Before removing the impactor/filter holder assembly from the sampler. Cross check the filter sticker number on the assembly with the filter number on the field data worksheet. If the numbers are different make a note and record the actual filter number on the worksheet.
8. Remove the impactor/filter holder assembly from the inlet tube and place it in a clean plastic bag or case for transport.
9. Change the battery pack (Do not inadvertently reuse the spent battery pack). If either the “Low Flow” or “Low Battery” indicators were lit, make a note and record the battery pack number since it may be defective.
10. Check the sampler for leaks by pressing the On/Auto/Off button to start the sampler pump and covering the inlet tube with the palm of your hand. The ball should drop to zero *Note: the pump may stall momentarily until the flow control circuit compensates*. If the sampler will not pass a leak check go to section 2.5 “Checking for Leaks.” Make sure the sampler is leak free before moving on.
11. Attach a new impactor/filter holder assembly containing a new filter.
12. Press the On/Auto/Off button to start the sampler pump.
13. With the sampler running (in a vertical position) adjust the flow rate to the correct set point. Press the On/Auto/Off button to stop the sampler pump.
14. On a new “Field Data Log” worksheet record the site ID, sampler #, filter #, beginning flow rate, elapsed time totalizer reading and any other pertinent data.
15. Program the programmable timer (see section 2.4 “Programmable Timer” if needed).
16. Place the sampler in the “Auto” mode.
17. Close the sampler case.

10 WARRANTY POLICY

10.1 What is Covered

The MiniVol™ TAS is warranted by Airmetrics against defects in materials and workmanship for a period of one year from the date of original purchase with the exception of the rechargeable lithium-ion batteries which are warranted for a period of six months from the date of purchase. During the warranty period, we will repair or, at our option, replace at no charge a sampler or battery that proves to be defective, provided you return the sampler or battery, shipping prepaid, to Airmetrics. (Replacement may be with a newer model of equivalent or better functionality.)

This warranty gives you specific legal rights, and you may also have other rights that vary from state to state, province to province, or country to country.

10.2 What is Not Covered

AA batteries, and damages caused by AA batteries, are not covered by the Airmetrics warranty.

This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by other than an Airmetrics technician.

No other express warranty is given. The repair or replacement of a product is your exclusive remedy. Any other implied warranty of merchantability or fitness is limited to the one-year duration of this written warranty.

Some states, provinces, or countries do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. In no event shall Airmetrics be liable for consequential damages. Some states, provinces, or countries do not allow the exclusion of limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

10.3 Warranty Service

In the event that a MiniVol™ TAS component is missing, damaged, or defective, follow these steps to obtain a replacement part:

- Call or email Airmetrics tech support and explain the problem.
- Obtain authorization to return the defective or damaged components.
- Package the item(s) carefully to prevent further damage.
- Identify the item(s) being returned on a clearly marked packing list with your name, company name, address, and phone number.

Ship to:

Airmetrics
2095 Garden Ave.
Suite 102
Eugene, OR 97403
U.S.A.
(541) 683-5420
sales@airmetrics.com

Items will be repaired or replaced at Airmetrics discretion and returned as soon as possible.

11 PARTS LIST

The following figures and tables identify some of the components and parts of the MiniVol™ TAS.

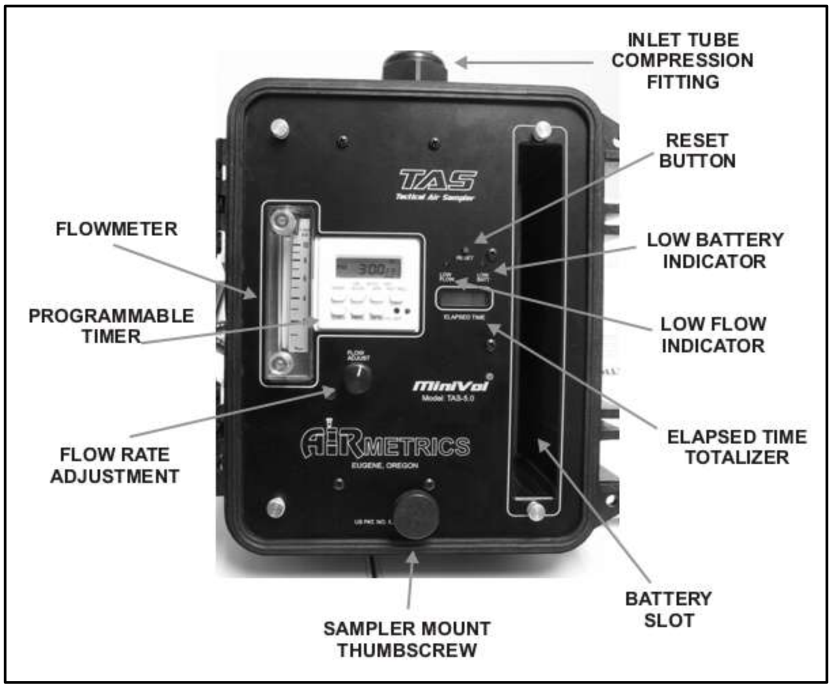

Figure 11.1 - Exterior Sampler

PART DESCRIPTION	PART NUMBER
Flowmeter	**101-003**
Programmable Timer	**101-002**
Elapsed Time Totalizer	**101-001**
Inlet Tube Compression Fitting	**700-006**
Sampler Mount Thumbscrew	**700-011**

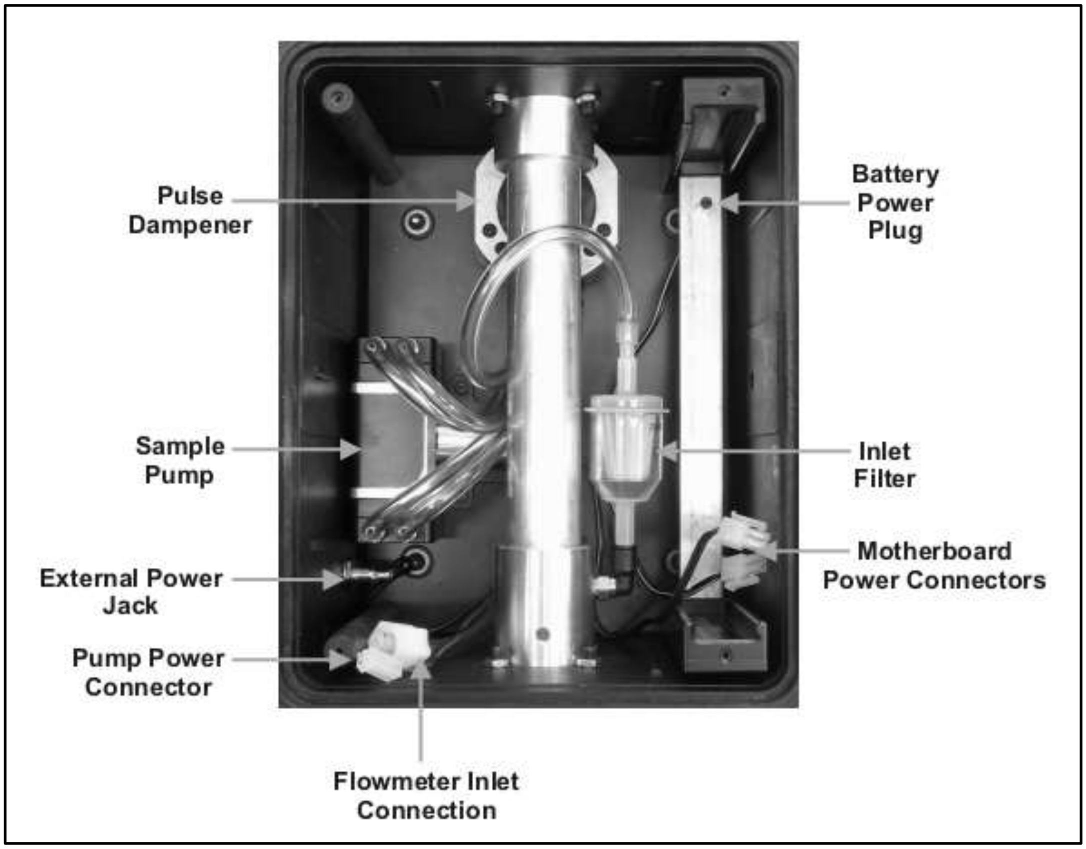

Figure 11.2 - Interior Sampler

PART DESCRIPTION	PART NUMBER
Pulse Dampener	101-011
Pulse Dampener Diaphragm	101-011-01
Sample Pump	100-003
Sample Pump Diaphragm	108-004
Sample Pump Valves	108-005
Inlet Filter	101-012-03

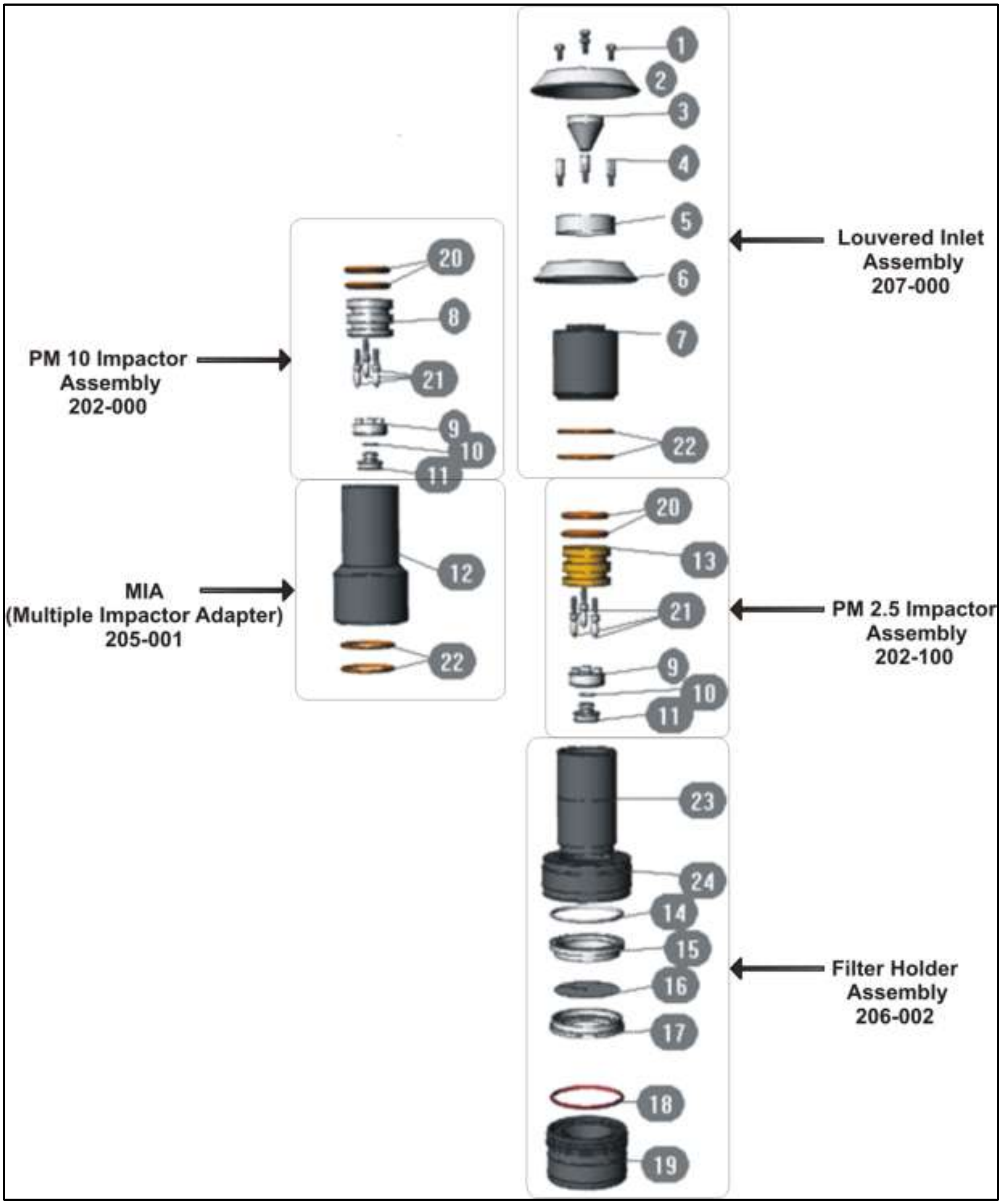

Figure 11.3 - Impactor/Filter Holder Assembly

KEY	PART DESCRIPTION	PART NUMBER
1	Machine Screw	301-005
2	Shield - Upper	207-003
3	Deflector Cone	207-005
4	Standoff	207-007
5	Bug Screen	207-004
6	Shield - Lower	207-002
7	Inlet Body	207-001
8	PM-10 Jet	202-001
9	EMT Socket	208-001
10	O-ring	208-002
11	EMT Impactor Plug	208-003
12	MIA body	205-001-01
13	Pm-2.5 Jet	202-101
14	O-ring, Teflon	206-002-04
15	Filter Cassette Top	206-001-01
16	Filter Support Screen	206-001-03
17	Filter Cassette Bottom	206-002-02
18	O-ring, viton	206-002-03
19	Filter Holder Bottom	206-001-02
20	O-ring	202-003
21	Spring Clip Standoff	202-004
22	O-Ring	205-002
23	Impactor Adaptor	206-004
24	Filter Holder Top	206-002-01

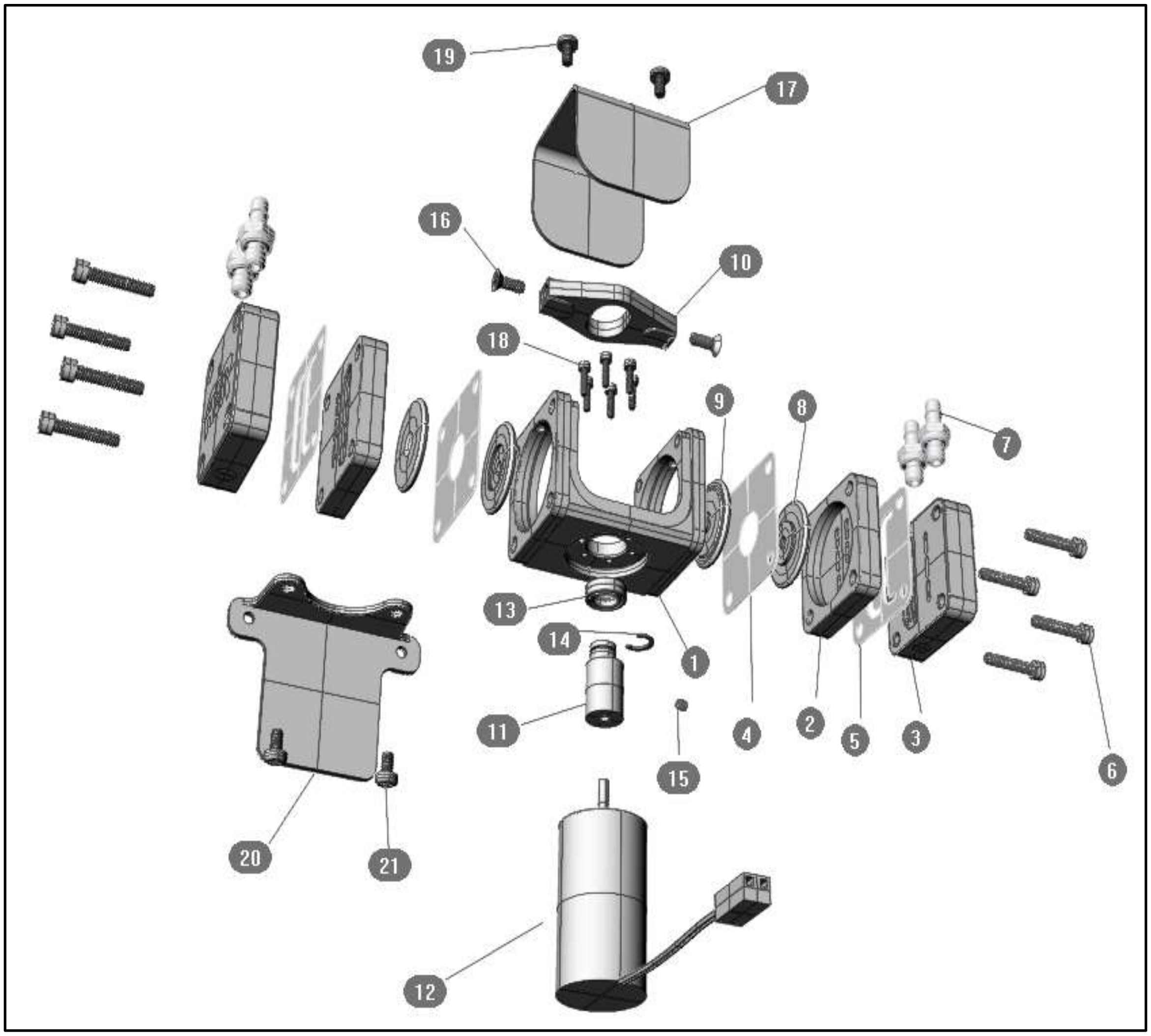

Figure 11.4 - Pump

KEY	DESCRIPTION	PART NUMBER	REQD
	Pump Assembly, 12V,complete	108-000	
1	Frame	108-001	1
2	Head-Lower	108-002	2
3	Head-Upper	108-003	2
4	Diaphragm	108-004	2
5	Valves	108-005	2
6	Socket Cap Screw	901-004	8
7	Hose Barb	108-007	4
8	Piston-Upper	108-008	2
9	Piston-Lower	108-009	2
10	Yoke	108-010	1
11	Cam	108-011	1
12	Motor	108-012	1
13	Bearing	108-013	1
14	Retainer	108-014	1
15	Socket Set Screw	108-015	1
16	Flat Head Screw	106-010	2
17	Cover	108-017	1
18	Socket Cap Screw	108-018	6
19	Pan Head Screw	301-005	2
20	Mounting Bracket	108-020	1
21	Pan Head Screw	301-005	2

PM Sampling - Field Data Log

Project: ____

Sampling Date: ______________ Page _____ of _____

Start - AtmPres[mmHg]: ______ End - AtmPres[mmHg]:______

Start - AmbTemp[°C]: ______ End - AmbTemp[°C]: ______

For Data Entry Use:
Project ID ______________
Filter ID ______________
Logged ______________
File Name ______________
Verified ______________

Site ID	Sampler Serial #	Filter No.	Start		End		Your Notes
			RotoFlow	ElapTime	RotoFlow	ElapTime	
	Filter Cmt:						
	Site Cmt:						
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	Site Cmt:						

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