Audit Procedure for the MetOne SASS and SuperSASS Speciation Sampler

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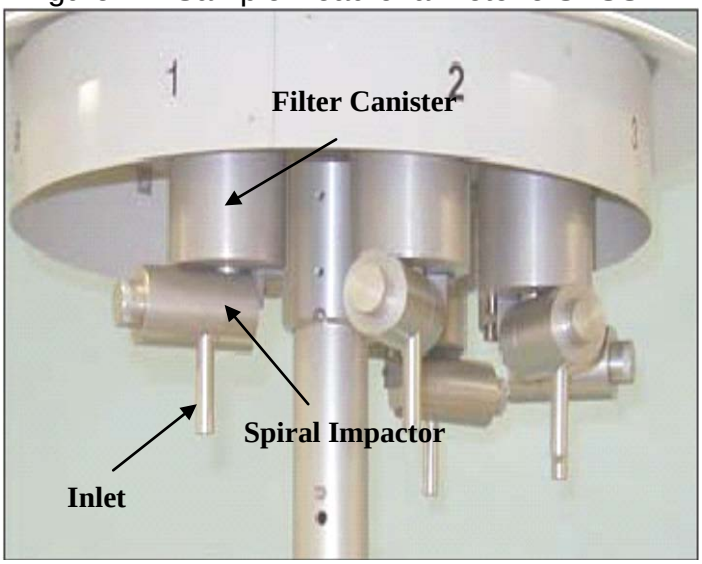
4.1 Background

The MetOne SASS chemical speciation sampler was developed in order to collect samples for the chemical and gravimetric analysis of PM2.5 ambient air particulate matter. These particles are comprised of sulfates, nitrates, organic carbon, soot-like carbon and metals.

Figure 4.1 Sample Head of a Metone SASS



The MetOne SASS utilizes five independent channels (the Met One Super SASS utilizes eight independent channels) with spiral impactors (very sharp cut cyclones) attached directly to the filter cartridges that are arrayed in a raised carousel. Each canister has its own PM2.5 inlet, space for a denuder if needed and tandem 47mm Federal Reference Method/Monitor (FRM) filter holders. The canisters are mounted in a wind aspirated radiation shield that maintains sample line temperature close to ambient. Inlets point downward and sample flow rate is designed to be 6.7 L/min. The PM2.5 separation is produced by a sharp cut cyclone (SCC) that removes both solid and liquid coarse particles with equal efficiency without the use of impaction grease or oil.

The field audit of this sampler includes the determination of the accuracy of the total flow rate reading for channels 1, 2, and 3 under normal operating conditions (nominally 6.7 Liters/min), ambient and filter temperature readings, and the barometric pressure reading as compared to those measured with a NIST traceable audit device (that must be recertified on an annual basis). The audit procedures contained in this SOP will utilize the BGI deltacal, triCal or tetracal. The BGI deltaCal will need minor adaptations, as illustrated in Figure. Before using the audit device, the auditor must check the NIST traceable standard certificate accompanying the instrument. If the instrument's NIST traceable certificate is out of date it is not eligible for conducting a valid audit. (Other flow, temperature, and pressure standards can be used, but they must be certified with a NIST traceable standard within 365 days prior to the date that the audit is performed). In addition to reference standards, three audit MetOne filter canisters (a canister is frequently referred to as a "filter module") with sharp cut cyclone (SCC) inlets are necessary for conducting audits of the MetOne SASS.

EPA will supply a performance audit worksheet. The first page contains general monitoring site information such as:

- Location of the monitoring site and AQS Site ID number;
- Date of Audit;
- Auditor(s) and Agency Affiliation;
- Operator(s) and Agency Affiliation;
- Sampler Model and Serial Number (s/n);
- Most Recent Sampler Calibration Date and Next Due Date;

- Reference Model, Calibration Date, and Serial Number; and
- Sampler Operating Agency, Sampler Operator's Name.

The following pages contain a checklist of site characteristics to be inspected and questions to be answered by the site operators and their supervisors. The TSA also lists procedures that the auditor will review as the operator performs them. The auditor should complete as much preliminary information as possible on both the Worksheet and TSA Form prior to arriving at the monitoring site.

4.2 Preparing the Audit Reference Standard for Service

Figure 4-2 is a picture of the triCal basic unit. Figure 4-3 is the tetraCal which is the triCal's model upgrade. The triCal and tetraCal's accessories, illustrated in Figure 4-4 are common to both instruments. Note that the external temperature probe does not come with the basic unit but must be requested with the original purchase order. Figure 4-5 is the deltaCal; Figure 4-6 shows the accessories associated with the deltaCal needed for auditing a Metone SASS or Super Sass.

Figure 4-2: triCal Multi-parameter measurement unit

Figure 4-3: tetraCal Multi-parameter measurement unit

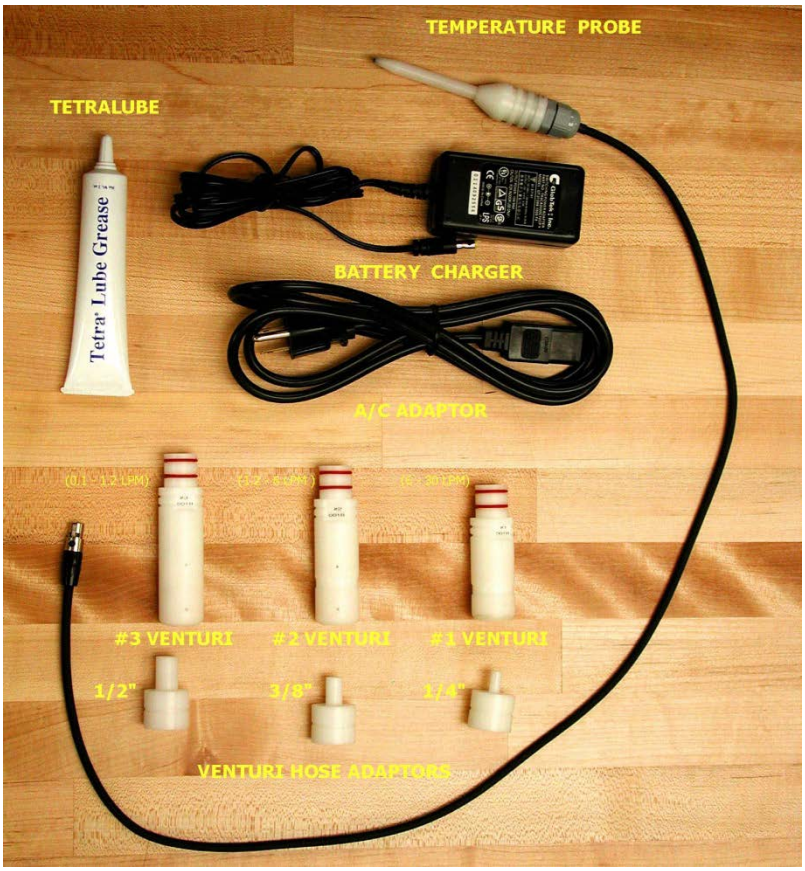


Figure 4-4: triCal & tetraCal Accessories

Figure 4-5: deltaCal with temperature probe as standard equipment

Figure 4-6: Tubing adapter assembly (from a URG 3000N audit kit) can be used for flow checks with deltaCal. Note, BGI sells an adapter that plugs directly into the deltaCal's aluminum downtube.

4.2.1 Initial on-site preparations

Upon arrival at the site location, the auditor must first place the audit reference standard in a location to equilibrate with the local ambient conditions prior to conducting any measurements. It is important to ensure that the equipment is in thermal equilibrium with the ambient environment of the sampler. The shady side of a building or deck is a suitable location. The audit reference standard must be set out of its carrying case on a level surface and turned on. Equilibration will require about an hour (60 minutes) for the triCal, unless its recent storage temperature is close to the current ambient temperature. The tetraCal and deltaCal require about 20-30 minutes. A convenient test is to turn off the audit reference standard, then restart it; determine if the temperature probe, or another accurate temperature standard, provides a reading within 1 ^{o}C of the ambient temperature reading on the audit reference standard.

During equilibration, there are several tasks, which will require up to one hour, which must be performed prior to auditing the sampler.

4.2.2.1 Assembling and initializing the triCal & tetraCal

Attach the external temperature probe (Figure 4-7). Insert venturi #1 that is designed to measure flows from 6-30 Lpm (Figure 4-8). Venturi #2, or #3 are used to measure lower flow rates than those exhibited by speciation samplers, although #2 may sometimes be used for calibrations if the flow has fallen below 6 Lpm. For more information refer to the service and operation booklet supplied by BGI. Next, attach the tygon or surgical rubber tubing to the venturi hose adapter, and then attach the hose adapter to the venturi. (Figure 4-5) Note: The correct venturi hose adapter is determined by the size of the sampler inlet adapter to which the audit reference standard. Turn on the instrument by pressing the on/off switch. It will perform a self-calibration of the venturi (Figure 4-10).

Figures 4-7 and 4-8: Inserting temperature probe and venturi into triCal or tetraCal

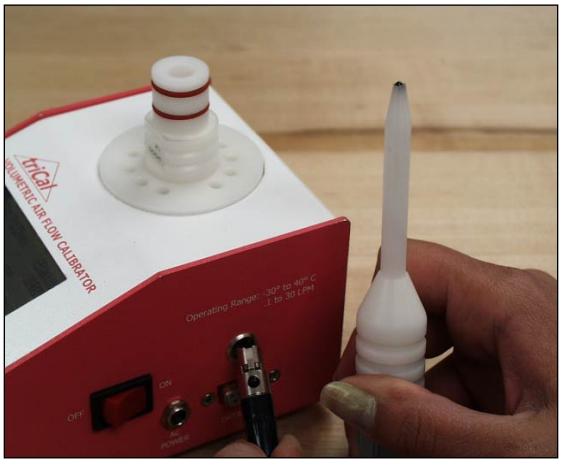


Figure 4-9: Coupling venturi hose adapter with flow measurement tubing

Troubleshooting: If the unit experiences temperature variances greater than 5°C during its use, the auditor should note the battery capacity. If battery capacity is greater than 90% at least one hour of power is available and rebooting the triCal should restore it to proper service. If batteries are at lower capacity than 90% the batteries should be replaced. Erratic values have been noted with batteries at 80% capacity and lower.

Figure 4-10: Venturi self-calibration screen.

Once the venturi has been calibrated to zero flow, the triCal or tetraCal will default to the Main Menu displaying barometric pressure, battery capacity, temperature, and flowrate (Figure 4-11).

Figure 4-11: Default Main Menu screen, of the legacy triCal upon self-calibration

A value for the Tfil will then be displayed. (Tamb is the internal temperature sensor of the audit reference standard, Tfil is the external temperature reading of the temperature probe.)

The Tfil is the only temperature reading used during speciation audits. To acquire a temperature value displayed as Tfil reading, the external temperature probe must be plugged in.

The earlier models of tricals and deltaCals displayed the flow rate (Q) that was measured and converted to "actual" or "local" ambient conditions with respect to barometric pressure and temperature. An important upgrade was instituted in later model triCals,deltaCals and the tetraCals. They were programmed to calculate and display flow rates based on both standard (Q_s) and actual (Q_a) ambient conditions, illustrated in Figure 4-12.

Figure 4-12: Menu screen upon self calibration of newer model deltaCal, triCals, and tetraCal

4.2.2.1 Assembling and initializing the deltaCal

Attach the external temperature probe (Figure 4-13). The tubing adapter should be affixed to or inserted into the deltaCal's downtube as illustrated in Figures 4-14 and 4-15. The size of the hose and therefore the size of the barbed hose connector, are dictated by the size of the sampler inlet. Both need to be a snug fit. For more information refer to the service and operation booklet supplied by BGI. Attach the Tygon or surgical rubber tubing to

the barbed hose adapter. With the flow channel of the audit reference standard closed off, turn on the instrument by pressing the on/off switch. It will perform a self-calibration of the venturi (Refer to Figure 4-6). Remember to keep the deltaCal's shielded inlet completely stationary and shielded from any breeze.

Figure 4-13: External temperature probe

Figures 4-14 and 4-15: Tubing adapters

4.2.3 Installing Audit Filter Canisters

Auditors should acquire three MetOne filter canisters, and have the Speciation Network service laboratory load them with filter media used by the network-

polytetrafluoroethylene, nylon and carbon. The canisters will be labeled PTFE or #1; Nylon or #2; and Quartz or #3. These will be mounted into Channels #1, #2 and #3, respectively, of the sampler undergoing the audit. Figure 4-16 illustrates canisters identified by filter media. Alternatively, the auditor could send three cassettes to the contract lab and request that the currently utilized filters be loaded in the appropriately labeled cassettes. The cassettes could then be installed into their respectively designated modules.

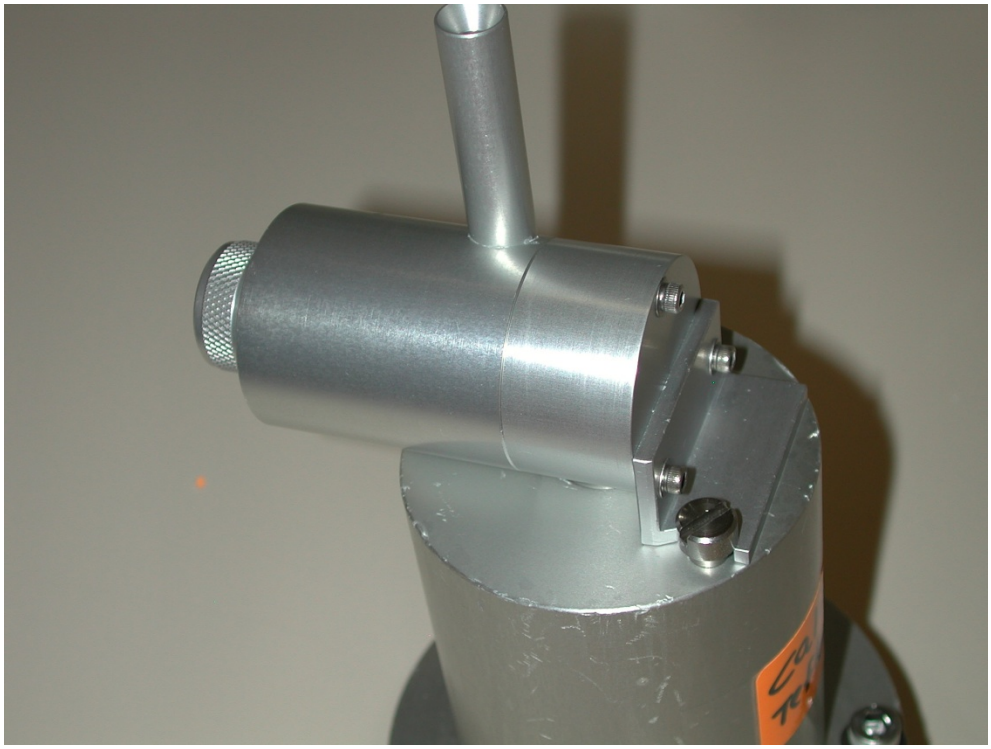
Figure 4.16 Canisters labeled #1, #2, #3, or Teflon®, nylon, and quartz.

Figures 4-17 through 4-19 illustrate how the sharp cut cyclones are attached to the canisters.

Figure 4-17. Canister Ready to Receive Sharp Cut Cyclone

Figure 4-18. Sharp Cut Cyclone Being Inserted into Canister Orifice

Figure 4-19. Sharp Cut Cyclone fully Inserted into canister orifice and locked in position



To install the canisters, the bottom weather shield should be lowered from its ready position to a sampler servicing position, as illustrated in Figures 4-20 and 4-21. This is done by removing the pin, which is located at the base of the sample head.

Figures 4-20 and 4-21: Lowering Weather Shield.

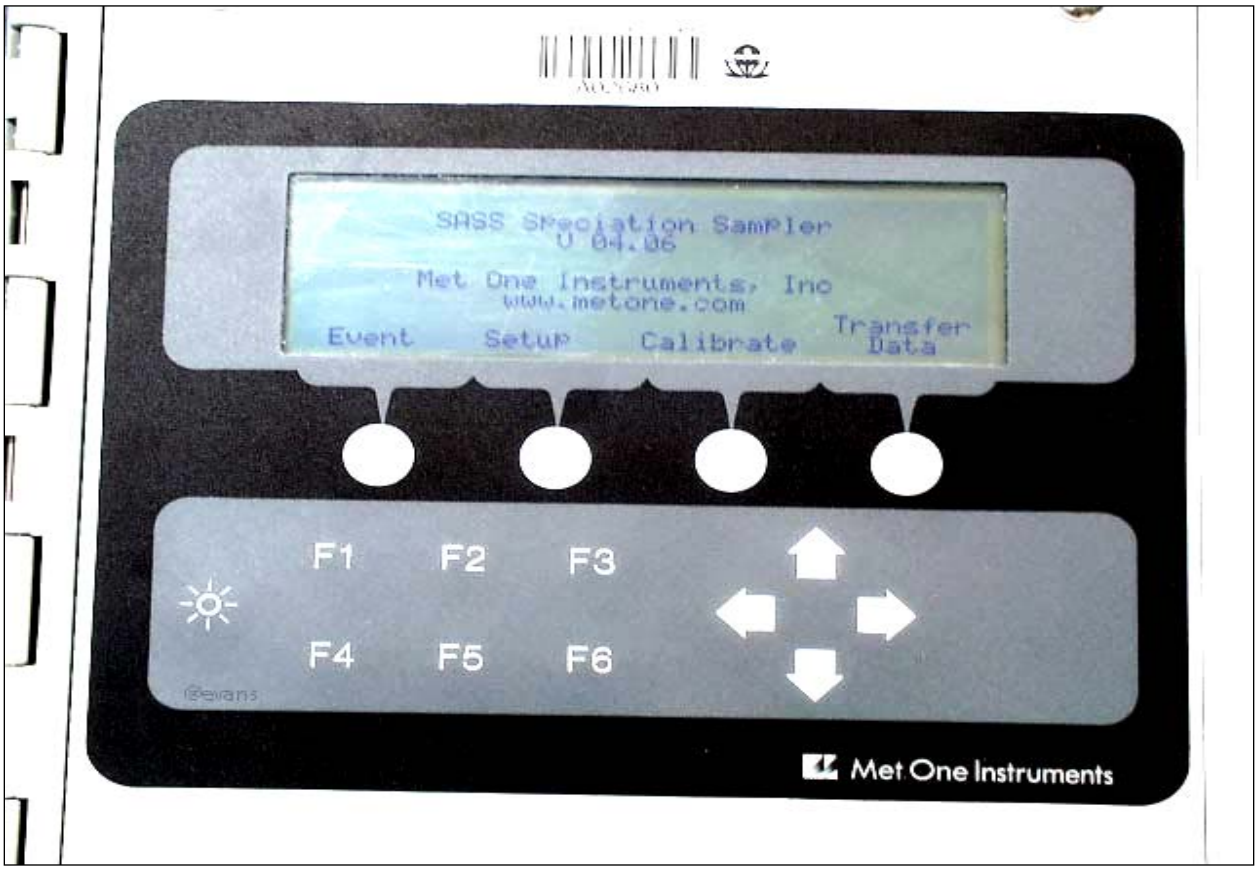
The two studs on the top of the canister are inserted into keyhole slots on the underside of the head of the sampler, and given a twist to lock into place. Figure 4-22 illustrates this process.

Figure 4-22: Canister installation.

4.3 Performing Audits

When the audit canisters are in place, raise the weather shield and power up the sampler. The control module display will become illuminated. Through a series of keystrokes listed later in this section, the Clock Test, Leak Test, Flow Test, Temperature, Pressure Test can be obtained from the Main Menu (Figure 4-23) of the control box. The data that is obtained will be entered on the Performance Audit Worksheet in Appendix 1. The Performance Audit Worksheet is an Excel Spreadsheet that performs all calculations for passing or failing the respective tests. ***It is recommended that the auditor key in the data in the field as well as write it on a printed form for cross verification.***

Figure 4-23 MetOne Control Box Displaying Main Menu



4.3.1 Clock Test

1) From the Main Menu screen (Figure 4-23), select the Setup menu (Figure 4-24); press F3 to select “Clock”.
2) From the clock screen (Figure 4-25), record the sampler’s displayed time as the SASS time on the Performance Audit Worksheet.
3) Record the NIST traceable reference clock time; this is another external device such as a cell phone or an atomic wristwatch/clock.
4) The time difference shall be calculated, on the worksheet, and determined to be either a Pass/Fail status.

Recall that the Speciation Network samples on the same schedule as the National PM2.5 FRM network which is constrained to Local Standard Time all year long.

Dates for Daylight savings time _____

Figure 4-24: Setup Menu

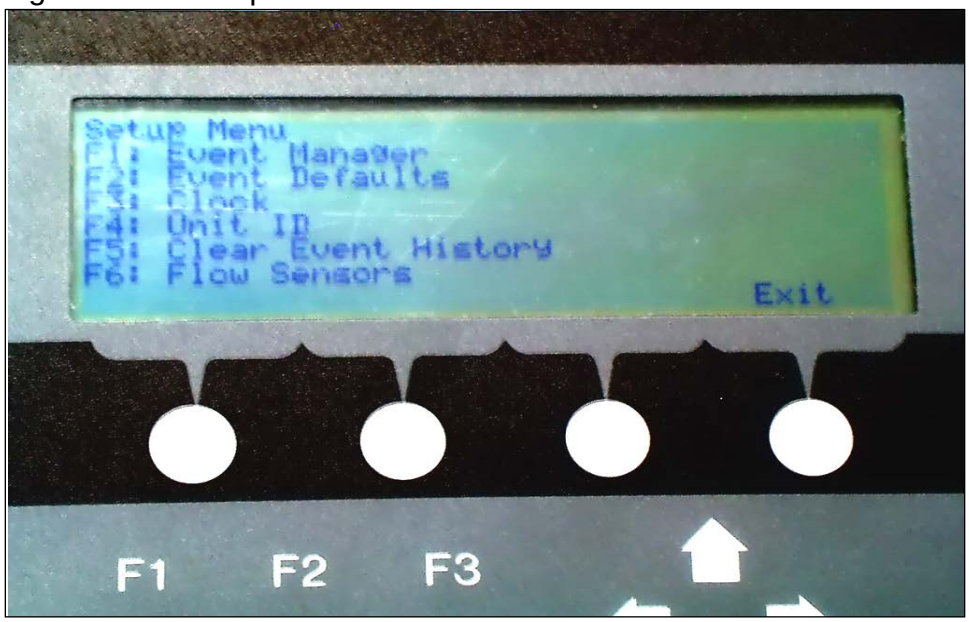
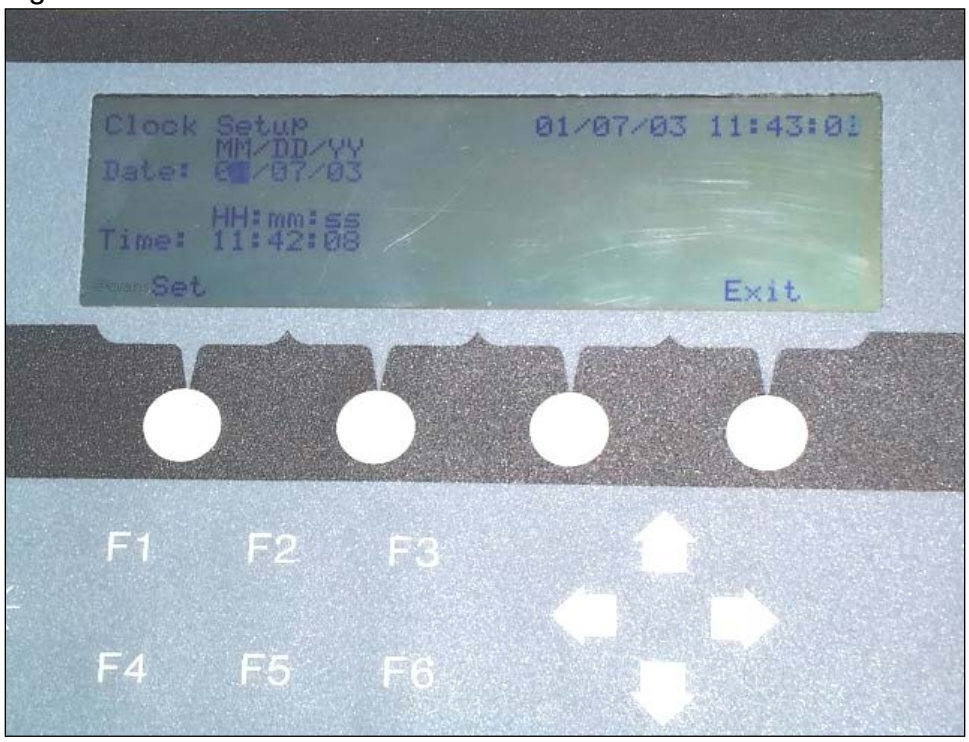


Figure 4-25: Clock screen



4.3.2 Leak Test

1) From the Main Menu, select the Calibration Menu (Figure 4-26);
2) At the Calibration menu, press F1 to select the System Test Menu (Figure 4-27). ***Do not press "Flow Calibration."*** From the System Test Menu the user is able to turn on the pump by selecting the Pump key.
3) When the pump key has been chosen, a warning will come up and ask if you want to continue or cancel the run; push "Continue" and the pump will start (Figure 4-28).
4) The user must press "Continue" to perform the leak test and flow checks. Once this is done, the screen reverts back to the System Test Menu that allows the user to view the flow rates for each channel.
5) Ensure that the leak option is on by pressing the "Leak" key, from the System Test Menu.

The user is now ready to perform the leak test.

Figure 4-26: Calibration Menu.

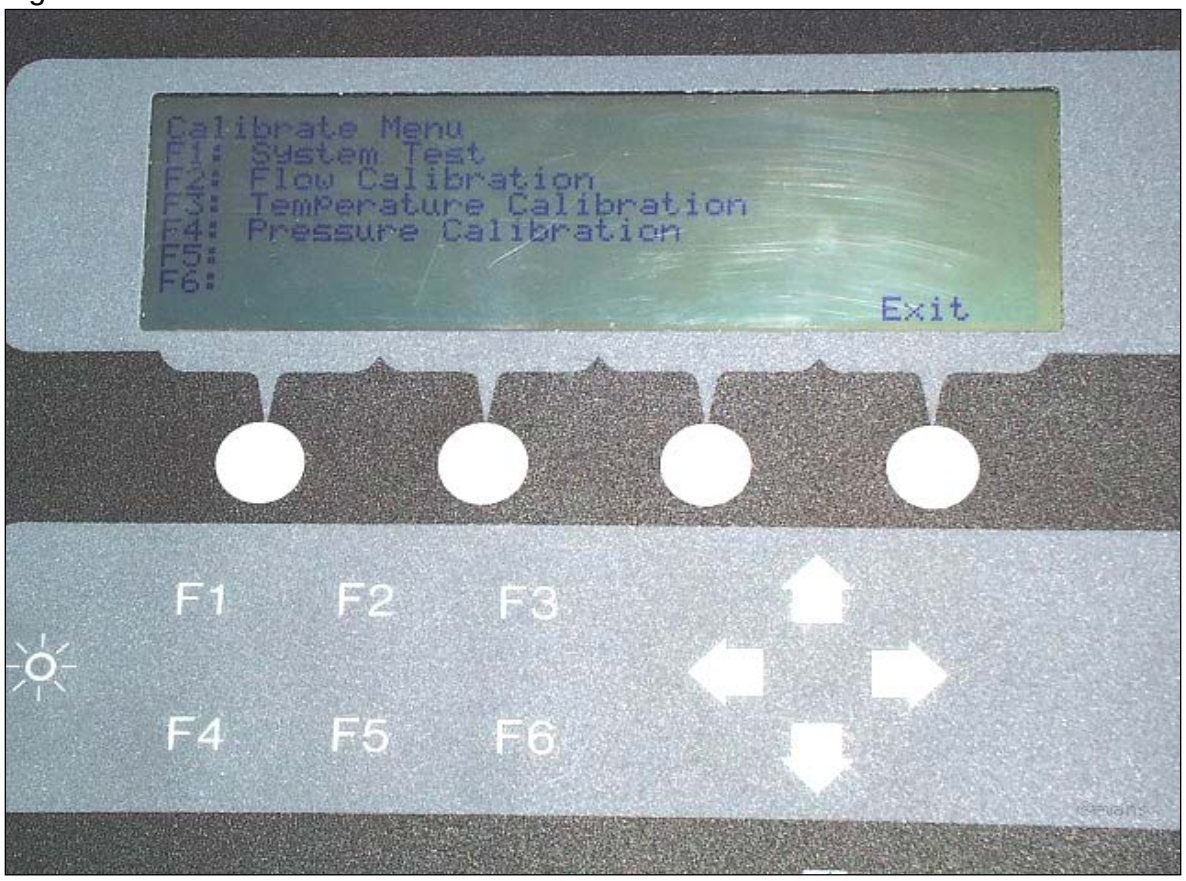


Figure 4-27: System Test Menu.

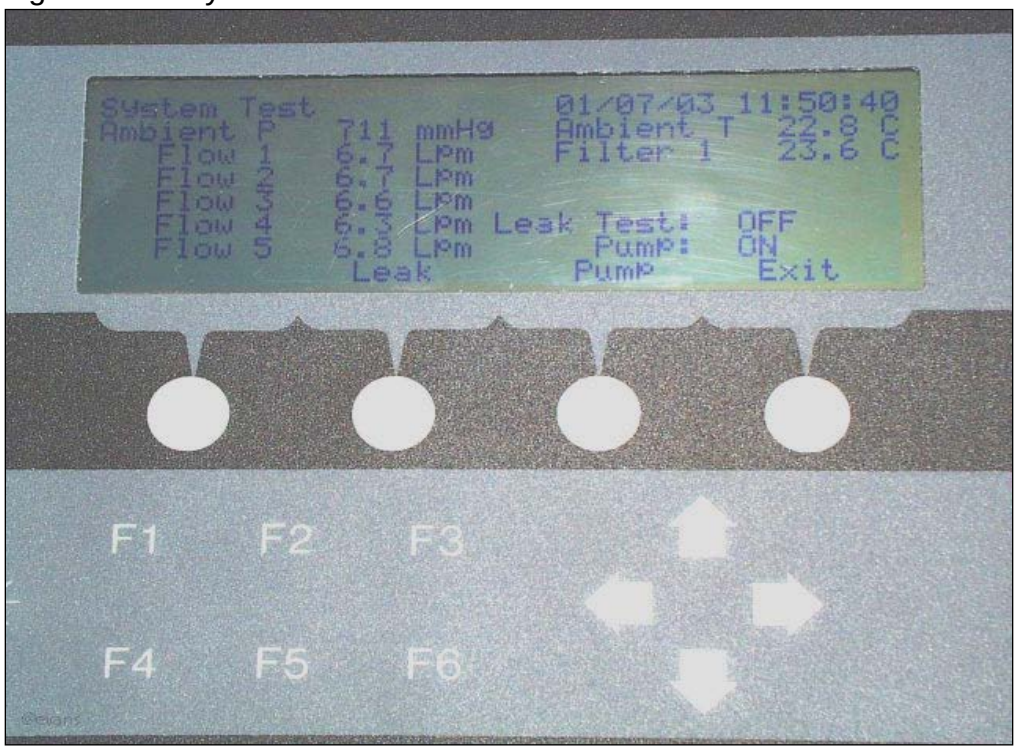


Figure 4-28: Pump Screen.

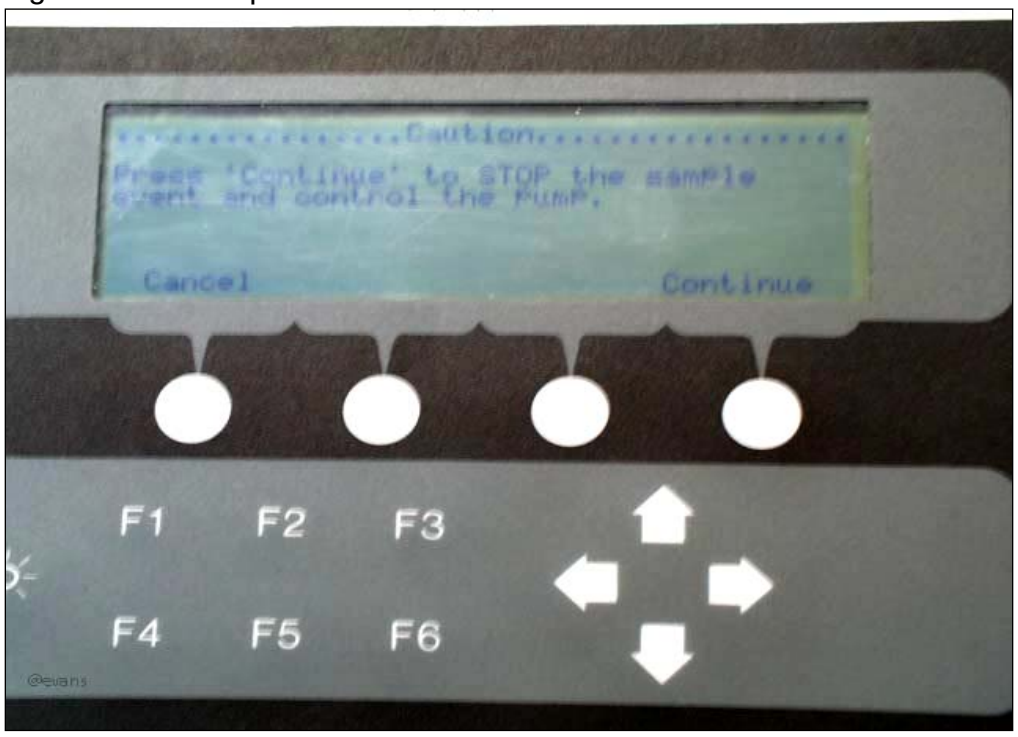


Figure 4-29: Leak check by capping inlet.

1) Use either a finger or a cap to tightly seal the inlet of the SCC so that no air can pass up through the nozzle (Figure 4-29).
2) Allow the system to stabilize at a constant flow rate for several minutes.
3) The flow rate indicated should be 0.0 L/min, which indicates that there is no leak in the flow system.
4) Record the leak flow rate for channel #1, from the System Test Menu, on the Performance Audit Worksheet. A leak of up to 0.10 Lpm will pass the acceptance criteria.
5) **Slowly** release the vacuum on the Channel #1 inlet, and move to the next two channel positions (channels 2 and 3) in succession to perform leak checks.
6) Record the leak flow rate for each channel on the Performance Audit Worksheet.
7) Channels 4 and 5 should be capped to prevent flow while not in service.

Note: It is not necessary to stop the pump or change the menus to conduct leak and flow checks between each channel.

4.3.3. Flow Test

Following the leak test, with the pump still running, begin the flow checks. Remember, the triCal requires 60 minutes to equilibrate prior to use.

1) Attach the opposite end of the hose that is connect to the triCal via the venturi #1 tube adapter to the filter canister SCC inlet (Figure 4-30).
2) Allow the flow to stabilize. Record both the displayed MetOne sample flow rate for channel #1, and the flow rate displayed on the triCal, onto the Performance Audit Worksheet.
3) Without stopping the pump, audit positions 2 and 3 as described above. It's important to note that positions 4 and 5 are not part of normal audit procedures. However, under certain circumstances, channels 4 and 5 may be used for special studies and, therefore, would require an audit. This is also true of the Super SASS; which has eight channels.

Figure 4-30: Flow audit device connected to SCC inlet.

4) When the flow audit is completed, select Exit from the System Test menu to shut off the pump. The screen will then default back to the Calibration Menu.
5) At the Calibration Menu, press the Exit key the screen defaults back to the Main Menu.
6) Remove the canister assembly from the air sampler, stow and repack for the next audit.

4.3.4. Filter Temperature

5) Ensure that the temperature probe is attached to the triCal, and that it has equilibrated (Figure 4-3).
6) From the Main Menu, press the “Event” key; this will take the user into the Event Menu (Figure 4-31).
7) At the Event Menu, press F1 for the Current Event Status; this takes the user into the Current Event Menu (Figure 4-32).
8) Insert the triCal temperature probe into the open sample orifice of channel #1, and allow the temperature reading on the triCal display to stabilize (Figure 4-33).
9) Record the filter temperature for channel #1 (located in the upper right hand corner of the screen), and the displayed temperature reading,”Tfil,” from the triCal.

Note: For the MetOne SASS, the filter temperature audit only requires temperature readings for channel #1. The SuperSASS has a temperature sensor in each channel, so each sensor should be audited.

Figure 4-31: Event Menu

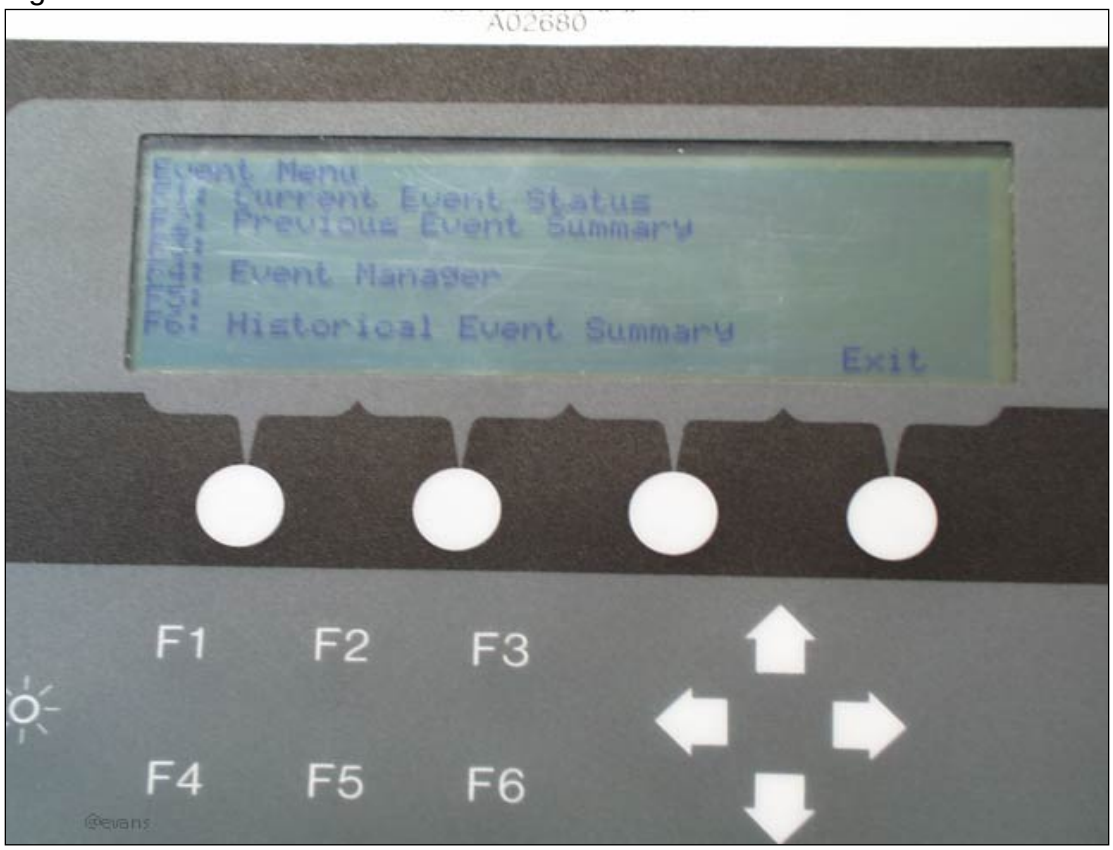


Figure 4-32: Current Event Menu

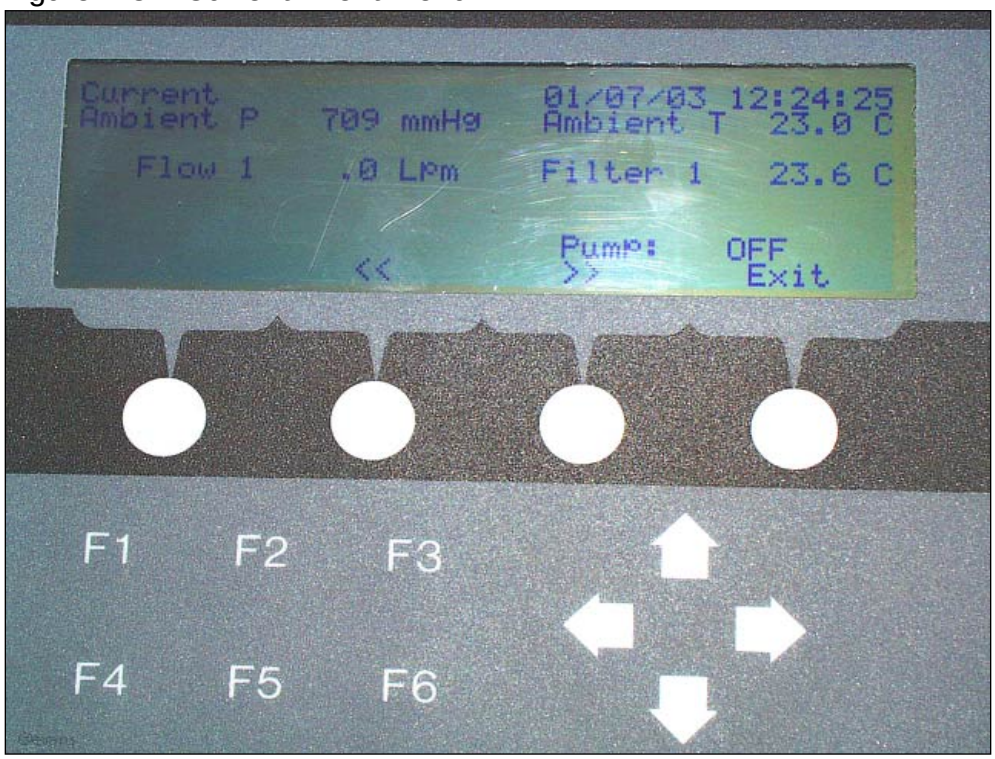


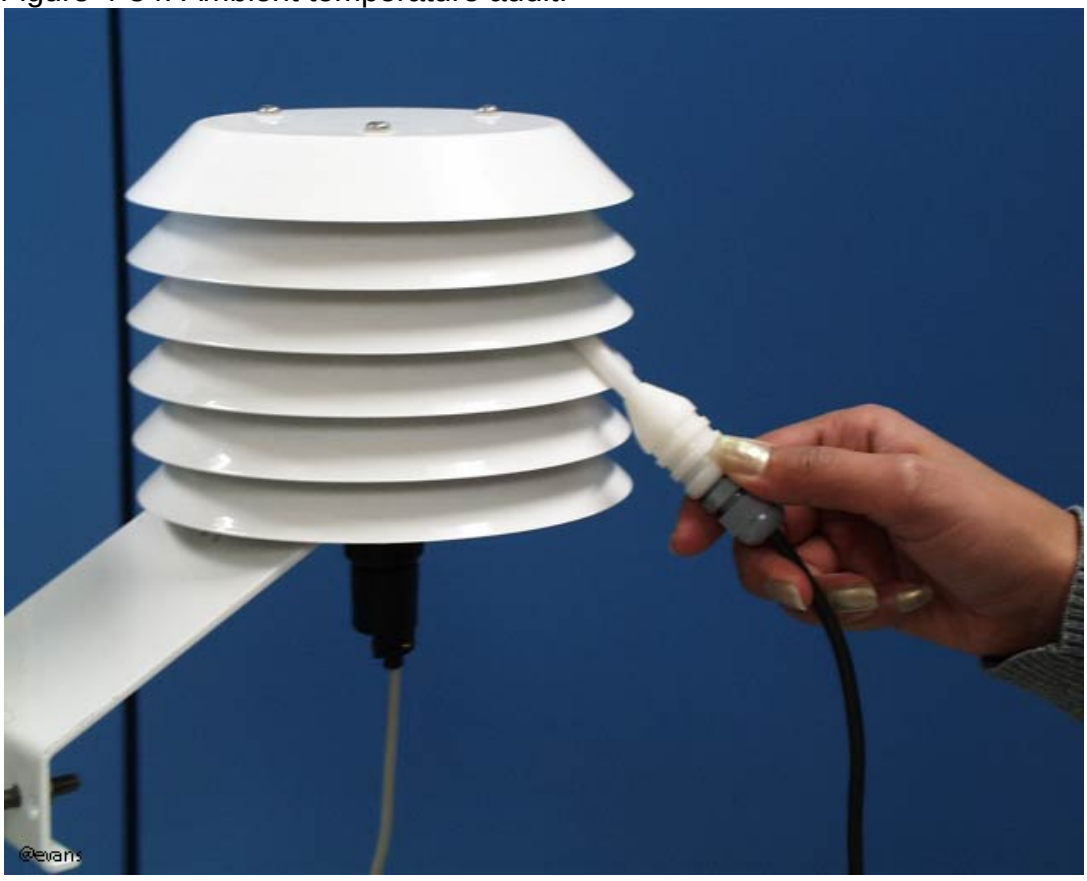
Figure 4-33: Filter temperature audit.

4.3.5 Ambient Temperature

Note that even though we are taking the ambient temperature from the SASS Sampler, we use the "Tfil" probe to make the measurement; therefore we must record the "Tfil" reading as our ambient measurement reading for the triCal.

1) Carefully insert the temperature probe into the gill screen of the SASS's ambient temperature sensor, avoiding contact with the sides of the gill screen, and direct sunlight (Figure 4-34). *Note: Contact with a gill screen that has been exposed to direct sunlight may result in non-representative/erroneous readings due to possible elevated temperatures of the gill screen*.
2) Allow the triCAL temperature reading to stabilize.
3) Record the air sampler's ambient temperature (from the Current Event Menu). The triCal's ambient temperature reading is taken using the external temperature probe listed on the triCal's menu screen as Tfil.

Figure 4-34: Ambient temperature audit.



4.3.6 Ambient Pressure Test

1) Record the ambient barometric pressures from the triCal and the SASS (which is found in the upper right hand corner of the Current Event screen).
2) Once the ambient pressures have been recorded the audit procedure is completed, restore the air sampler to its original condition ensuring that the Control Box is returned to the Main Menu.
3) Have the site operator replace any routine filter canisters to their original positions.
4) Return all the audit instrumentation to their cases.
5) Have the site operator fill out the site visit sheet and verify that the site is left in the same condition that it was found and it is ready for its next sample.

4.4 Other

Record any applicable observations on the comments section of the Performance Audit Worksheet or on the TSA form. This may include information such as the following:

obvious vandalism;
known power outages/failures;
any interrupted sample events;
inclement weather conditions;
and any other pertinent information that might have adverse impacts on data generation/collection.

4.5 Close-out

Follow the close-out checklist and be sure to get a signature from the site operator or attendant that all is in proper order before you leave.

4.5 Follow-up actions

Refer to Section 3 of the PM2.5 CHEMICAL SPECIATION/IMPROVE FIELD AUDITORS COURSE HANDBOOK.