

3.0 Audit Procedure for the Andersen RAAS Speciation Sampler



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3.1 Background

The Andersen RAAS (Reference Ambient Air Sampler) chemical speciation sampler was developed in order to collect samples for the chemical and gravimetric analysis of PM_{2.5} ambient air particulate matter. These particles are comprised of sulfates, nitrates, organic carbon, soot-like carbon and metals.

The RAAS2.5-400 series sampler inlet has essentially no cut point. The inlet provides primarily wind speed and direction independent sampling. The connecting tubing is a 12-inch length of anodized aluminum tubing with an inner sampling tube for the sample to follow. The size selective elements, 24 Liter per Minute (L/min) cyclones, reduce the passed particulate to exclude particles larger than 2.5µm. The cyclones remove particles larger than 2.5 micrometers aerodynamic diameter. Each of the two airstreams enters a manifold that directs the air into a maximum of three separate and distinct flow paths. The sum of the flow rates for each manifold must total 48 liters per minute.

The particulate is collected on a specified filter media such as a Teflon[®] membrane filter. Other components of the air stream are reacted or trapped on an appropriate absorbent media for additional chemical identification in a laboratory. A steady and exact flow must be maintained.

The system pulls ambient air through a protective inlet preventing water and wind distortions while sampling. The air sample is directed via the sample down tube to a primary sample Flow Splitter into two (2) streams. Each flow stream in turn moves through a fine particulate cyclone where particulate matter greater than 2.5microns is removed. Following one side after splitting, the remaining particulate and gases are split again through the Sample Manifold into one, two, or three outlet channels. Finally the flow streams are collected across filters or specified sample trains (Table 3-1). The other half of the primary flow stream duplicates the same pathway and secondary splits to final filters as well. A total of six channels are made available for various chemical speciation techniques.

Table 3-1: Sample filter type and sampled constituents.

Constituents	Filter Type	Flow	Color Code*	Single Channel	Sequential Channel	Flow Rate
Fine particulates	Teflon	1	Green	1	1A, 1B	16.67
Fine Particulate Nitrates	Nylon w/ denuder	2	Red	2	2A, 2B	7.3
Organics	Quartz	3	Yellow	5	3A, 3B	7.3*
Ionic Species	Cellulose/Paper Filter	4		4	N/A	16.67*

* When running the sequential channel sampler, the total flow rate for either 3A, or 4B (dependent on which set of channels is running, A or B) will be a total of 24L/min because only one channel on this leg is running.

If uncertainty exists regarding filter type, sampler and audit cassettes are also color-coded.

A typical EPA sampling train configuration utilizes four of the six available channels. Two channels from each side of the primary split, regardless if the sampler is a single channel or sequential channel sampler. An advantage to a sequential sampler enables the operator to load for Friday and Monday run times without visiting the site on Saturday or Sunday. It's important to remember that either valve A or B is running and never both

simultaneously or a combination of both. For example, channels 1A, 2A, and 3A will run simultaneously while 1B, 2B, and 3B will run simultaneously.

The field audit of this sampler includes the determination of the accuracy of the total flow rate reading under normal operating conditions ambient and filter temperature readings, and the barometric pressure reading as compared to those measured with a NIST traceable audit device (that must be recalibrated on an annual basis). Prior to performing an audit, verify that the annual calibration and maintenance procedures have been performed according to the required frequencies specified in Section 16 of the STN QAPP.

3.2 Calibration Equipment

A TriCAL Laboratory/Field Audit Calibrator (Figure 3-1), and three or four (dependent on sample) audit sample filter cassettes (see Table 3-1 for a list of filter types necessary to perform audit) are necessary for conducting audits of the Andersen RAAS2.5-400.

Figure 3-1: TriCAL calibration unit.

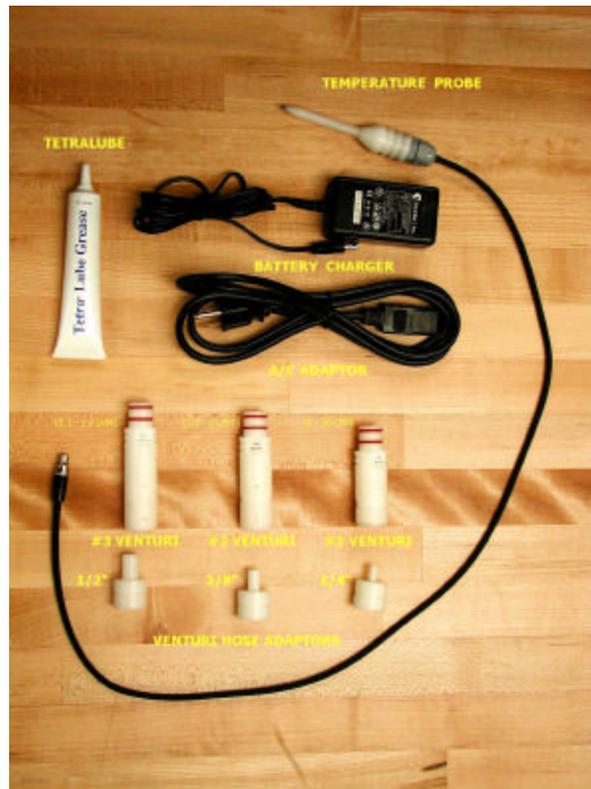


The TriCAL's ancillary equipment is illustrated in Figure 3-2. The audit sample filter cartridge, and the leak and flow check audit adapters are illustrated in Figure 3-3, and Figure 3-4. (The denuder is used to remove nitric acid or other interfering gases.)

It is important to ensure that the equipment is in thermal equilibrium with the ambient environment of the sampler. It is recommended that the TriCAL be set out (of its carrying case) for an hour prior to any tests being conducted. If the unit experiences temperature variances greater than 5° during its use, it should be rebooted.

Battery capacity should be in excess of 10% (this ensures that at least one hour of power is available). If this is not the case, the battery in the TriCAL unit shall be charged prior to use. Before using the TriCAL audit device, the auditor must check the calibration tag on the instrument. If the instrument is out of calibration, **do not use**. Use one that is in calibration.

Figure 3 -2: Calibration equipment.



Figures 3-3 and 3-4: Audit cartridges and leak and flow check adapters.



3.3 Audit Procedure for Andersen RAAS 2.5-400 Series

Upon arrival at the site location, the auditor must fill in all information listed below on the Performance Audit Worksheet. This worksheet will also be used to record other required information throughout the audit procedure/process.

1. location of the sampler;
2. date of audit;
3. auditor (s) and agency affiliation;
4. operator (s) and agency affiliation;

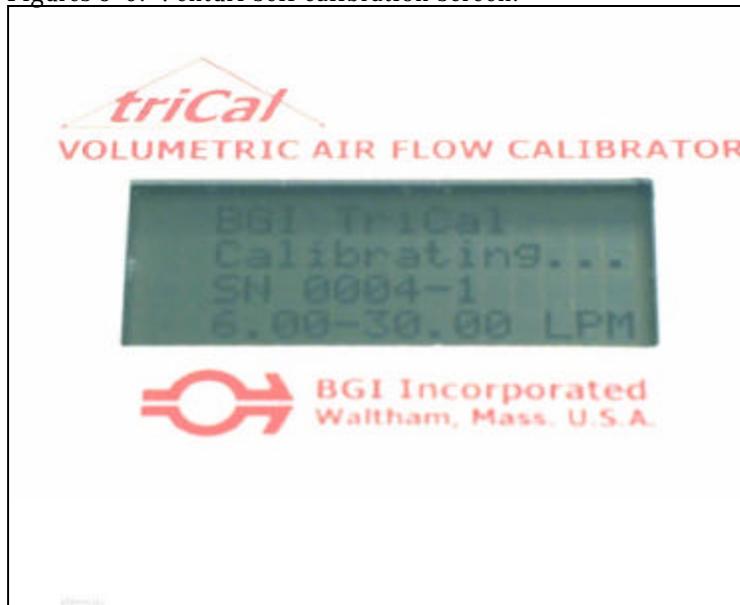
5. sampler model and serial number (SN);
6. SASS or sampler calibration due date;
7. reference model, calibration date, and serial number.
8. location sampler operating agency, sampler operator's name, auditor's name.

Unpack the TriCAL and turn it on by pressing the on/off switch. The menu will prompt the user to insert venturi #1, #2, or #3. This audit requires the use of venturi #1 (flow rate range of 6-30 L/min). The venturi that will be used is determined by the flow rate of the air sampler being audited. After a venturi has been inserted the TriCAL will perform a self-calibration of the venturi (Figure 3-5 and 3-6).

Figure 3 -5: Inserting venturi into TriCAL.

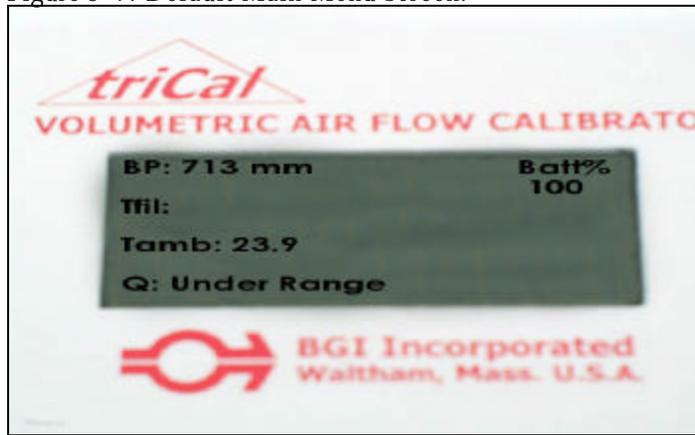


Figure 3 -6: Venturi self-calibration screen.



Once the venturi has been calibrated, the TriCAL will default to the Main Menu displaying barometric pressure, battery capacity, temperature, and flowrate (Figure 3-7).

Figure 3-7: Default Main Menu screen.



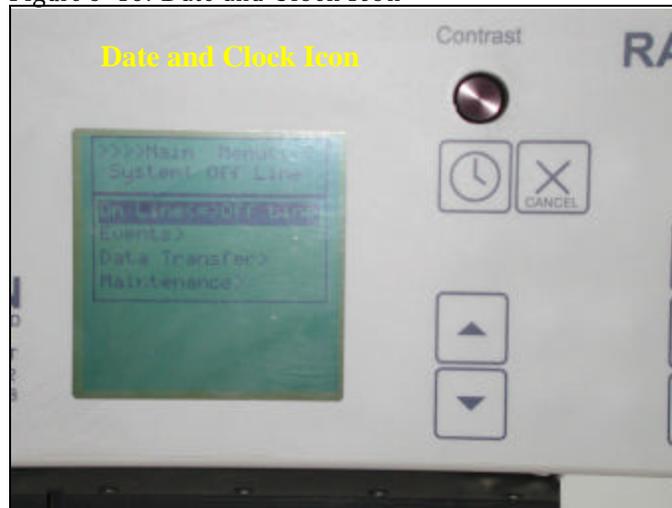
Attach the temperature probe to the TriCAL (Figure 3-8). A value for the T_{fil} will then be displayed. (T_{amb} is the internal temperature sensor of the TriCAL, T_{fil} is the external temperature reading of the temperature probe.) Next, attach the tygon tubing to the venturi hose adapter, then attach the hose adapter to the venturi. (Figure 3-9) (**Note: The correct venturi hose adapter is determined by the size of the venturi that was inserted into the TriCAL.**)

Figures 3-8 & 3-9: Inserting temperature probe and venturi hose adapter.



The data required for the next five sections (*Clock Test*, *Leak Test*, *Flow Test*, *Temperature*, *Pressure Test*) can be obtained from the Main Menu (Figure 3-10) of the Andersen RAAS2.5-400 Sampler through a series of keystrokes listed later in this section.

Figure 3 -10: Date and Clock Icon



3.3.1 Clock Test

From the main panel, press the button (Figure 3-10) with the clock icon to display the date and time. Record this information on the audit worksheet. Record the date and time from the auditors clock reference.

3.3.2 Leak Test

Place the audit cassette that contains filter at the channels to be leak checked. The cassettes must contain the type of filter normally used at this sampling channel location (see Table 3-1). A denuder must also be installed if called for in the sampling protocol. The audit cassette must be installed *below* the denuder. (Figure 3-11)

Figure 3 -11: Audit cartridge including denuder.



Note: Use these cassette assemblies for leak checks and flow rate audits only.

Remove the sampler inlet assembly from the down tube (Figure 3-12) on the top of the RAAS sampler cabinet box. Attach an Andersen leak check adapter to the down tube (Figure 3-13) and close the adapter intake by rotating the valve lever 90° so that it is in the horizontal position (Figure 3-14).

Figure 3 -12: Removal of sampler inlet assembly from down tube.



Figure 3 -13: Leak check adapter.

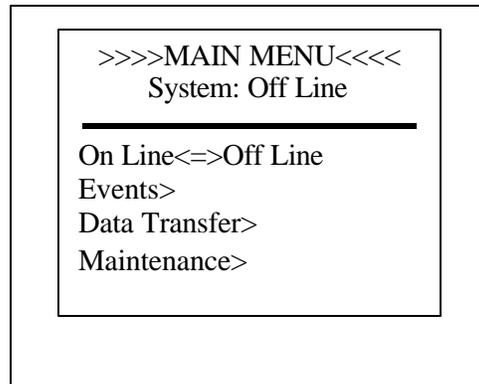


Figure 3 -14: Close valve lever for leak check.



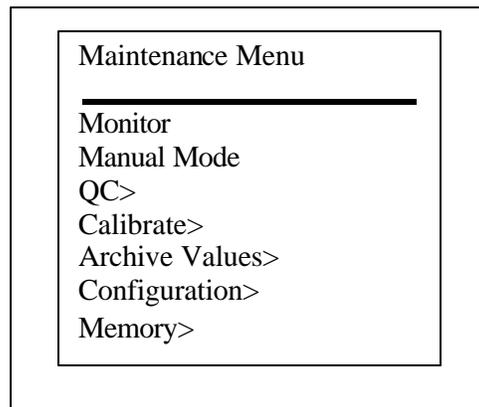
System leak checks are performed by blocking off incoming air flow using the Leak Check Adapter and pulling a vacuum on the system using the oil-less, rotary vane pump and isolation valve. The “Maintenance” menu contains options to calibrate the system, configure various aspects of operation, and other functions useful in locating problems with the unit. The “Maintenance” menu is only available when the unit is Off Line. If the “Maintenance” item is not already displayed, do so by selecting the “On Line <=> Off Line” option from the Main Menu, press the [Enter] key, this displays four menu items displayed in Figure 3-15.

Figure 3 -15: Main Menu



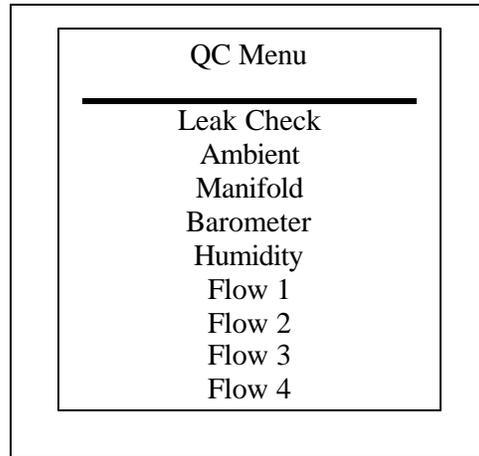
Using the Up and Down arrows, scroll to the Maintenance Menu (Figure 3-16) and press the [Enter] key.

Figure 3 -16: Maintenance Menu



Next, scroll down to the QC item and press [Enter]. The QC menu is then displayed (Figure 3-17). There are two types of leak checks that need to be performed. The first leak check is designed to detect a leak from the outside of the system and is called “External Leak Check”. It is designed to detect leaks that could occur around a filter that is installed in a filter cassette. This is the leak check we re interested in.

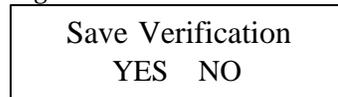
Figure 3 -17: QC Menu.



Scroll to “Leak Check” and press [Enter]. The system evacuates air and the pump continues to run. The screen will display 4 channel readings. The sum of the readings must indicate a total flow of less than 0.08 L/min for a period of at least 3 minutes. If the system fails this criterion, check for leaks in the system and repeat the leak check until it is passed successfully. If the channel’s flow rate error is greater than 10%, the channel requires flow calibration using a reference dry gas meter (consult operator’s manual), or maintenance of pump, or maintenance of the critical orifice flow controller.

Press the “Cancel” key when finished. You will be prompted to “Save Verification” (Figure 3-18). No is automatically the default setting. Press [Enter] to return to the QC Menu.

Figure 3 -18: Verification



Remove the flow audit adapter and ensure that the vacuum is released slowly so that filter damage does not occur. Replace the inlet assembly on the down tube.

3.3.3 Flow Test

If not already done, detach the sampling cartridge, if one is installed, from the fractionator on the first channel (Figure 3-19). Attach the assembled flow rate audit cartridge to the bottom tube assembly for the first channel leading to the manifold in the bottom of the sampler cabinet (Figure 3-20). Attach the adapter and flow rate digital meter to the top of the audit cartridge (Figure 3-21).

Figure 3 -19: Detachment of sampling cartridge.

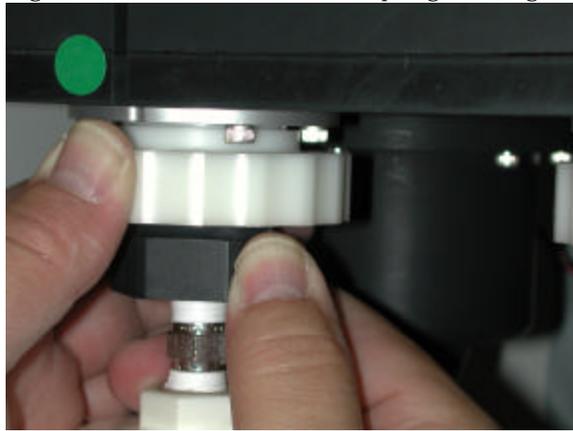
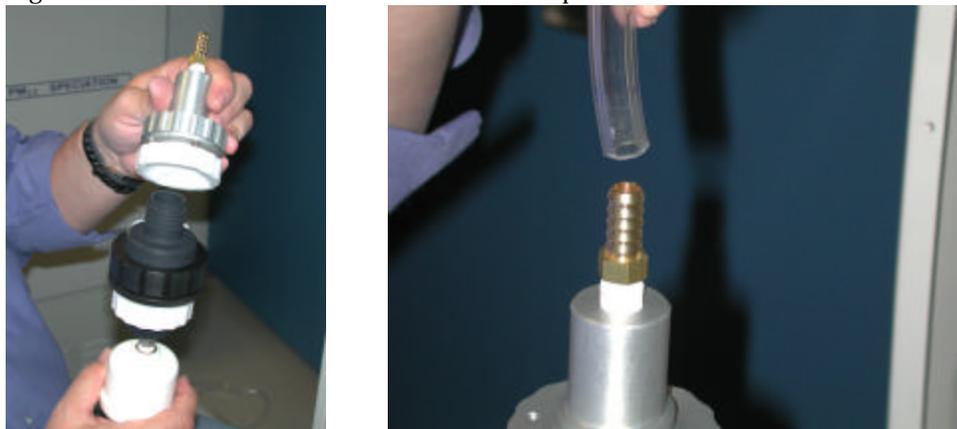


Figure 3 -20: Attach assembled flow rate audit cartridge.



Figure 3 -21: Attach the TriCAL to the audit adapter.



Prior to flow verification, temperature and barometric pressure are necessary and can be obtained from the TriCal display screen. The following paragraphs will provide step-by-step instructions on how to conduct a flow test for each channel.

Andersen

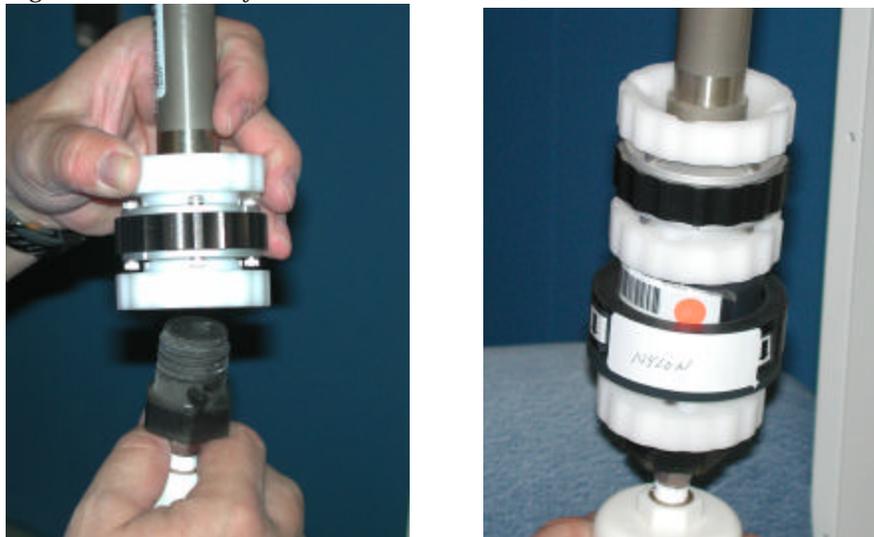
Enter the QC menu through the Maintenance menu. Dependent on the channel that is being audited, the user will select one of the following: “Flow 1”, “Flow 2”, “Flow 3”, or “Flow 4”. After the appropriate one has been selected, press [Enter]. Window will come up and prompt the user to verify barometric pressure and temperature. If these parameters are operating properly, press the ‘Cancel’ key to proceed with the flow verification process. The next window will prompt the user for the verification flowrate. Enter appropriate flowrate (see Table 1) and press [Enter] to continue. Dependent on the channels that are being audited, select, either Valve A or B. Press [Enter]. The last window will prompt the user to select the appropriate flow device. Select “Ambient Flow Device” and press [Enter]. The pump will start running.

Allow the pump to run for several minutes to reach a stable flow rate. Record the sampler flow rate and the audit meter flow rate of the channel on the Performance Audit Worksheet.

Press the “Cancel” key to stop the test. Continue to press the “Cancel” key until you return to the Main Menu. Remove the adapter, flow rate meter, and audit cartridge and replace the sample cartridge as in the sampler’s original state.

Repeat the same procedure for the remaining channels. Continue to attach the adapter and flow meter to the audit cartridge even if a denuder tube is present. (Figure 3-22) Record all results on the Performance Audit Worksheet.

Figure 3 -22: Audit system with denuder.



Note: Always ensure that the denuder is included as part of the audit system (Figure 3-23).

Figure 3 -23: Denuder in-line with audit system.



3.3.4 Filter Temperature

Ensure that the temperature probe is attached to the TriCAL and that it has been allowed to equilibrate (Figure 3-8). From the Main Menu, select the Maintenance menu item and press [Enter], select Monitor and press [Enter].

Move the temperature probe to the location of the cabinet temperature sensor (Figure 3-24) and allow the reading to stabilize. Record the audit temperature and sampler manifold temperature on the Performance Audit Worksheet.

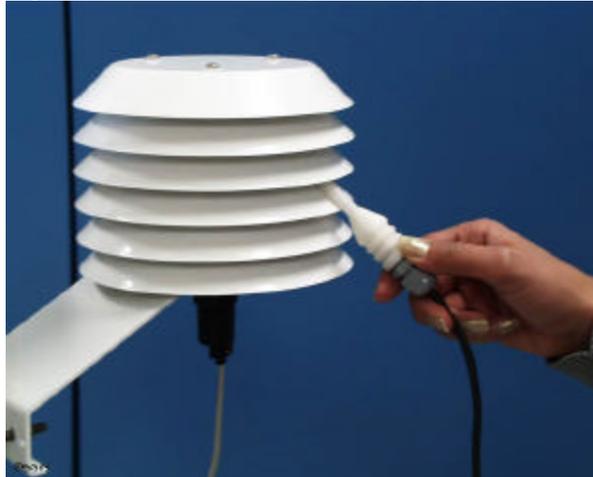
Figure 3 -24: Cabinet temperature sensor and Audit device probe.



3.3.5 Ambient Temperature

Carefully insert the temperature probe into the gill screen of the RASS ambient temperature sensor, avoiding contact with the sides of the gill screen, and direct sunlight (Figure 3-25). **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.** Allow the TriCAL temperature reading to stabilize for several minutes and record the system ambient temperature and the audit thermometer ambient temperature (from the Monitor menu from section 3.3.4) on the Performance Audit Worksheet.

Figure 3 -25: Ambient temperature probe.



3.3.6 Ambient Pressure Test

Record the ambient barometric pressures (from the Monitor menu from section 3.3.4) from the TriCAL and from the sampler. Record these readings on the Performance Audit Worksheet.

Once the ambient pressures have been recorded the audit procedure is completed. Restore the air sampler to its original condition ensuring that the screen is returned to the Main Menu. Replace any routine samples to their original positions. Return all the audit instrumentation to their cases.

3.4 Other

Record any applicable observations on the back of the Performance Audit Worksheet. This may include information such as the following:

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