

# Audit Procedure for the URG 3000N Sampler



## Table of Contents

<u>Section</u>	<u>Page</u>
1.0 Background	3
2.0 Preparing the triCal Audit Reference Standard for Service	4
2.1 Equilibrating the triCal Audit Device	5
2.2 Assembling and Initiating the triCal	5
2.3 Installing the AUDIT Cartridge	6
3.0 Performing Audit Tests	7
3.1 Clock and Date Tests	7
3.2 Leak Test	8
3.3 Flow Test	12
3.4 Temperature Test	14
3.5 Barometric Pressure Test	16
4.0 Other	17
5.0 Follow-Up Actions	18

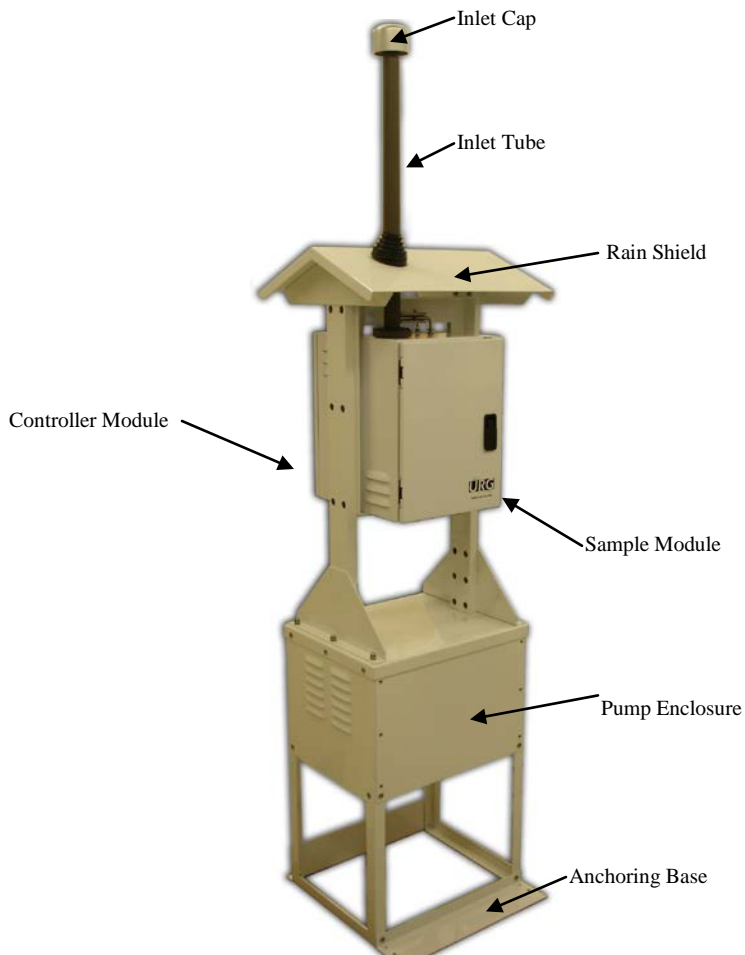
## Table of Exhibits

Exhibit 1:	URG 3000N Sampler	3
Exhibit 2:	triCal Multi calibrator Unit	4
Exhibit 3:	triCal Accessories	4
Exhibit 4:	Inserting the Temperature Probe	5
Exhibit 5:	Inserting the Venturi	5
Exhibit 6:	Coupling Venturi Hose Adapter with Flow Measurement Tubing	5
Exhibit 7:	Venturi Self-Calibration Screen	5
Exhibit 8:	Default Main Menu Screen	6
Exhibit 9:	Replacement of Sample Cartridge with AUDIT Cartridge	7
Exhibit 10:	Menu Tree and Keystrokes from AUTO Mode Screen to Audit Menu Screen	8
Exhibit 11:	Removal of Ambient Air Inlet Cap	9
Exhibit 12:	Place the Reducer and the Flow Adapter on the Downtube	9
Exhibit 13:	Vacuum (Air) Line Disconnect	9
Exhibit 14:	Pump Shutoff Valve Connection	9
Exhibit 15:	Connection of Air Line to Pump Shutoff Valve	9
Exhibit 16:	Flow Audit Adapter and Shutoff Pump Valve in the Closed Position	10
Exhibit 17:	Interior of the Sample Module	14
Exhibit 18:	Black Plastic Disc Supporting the Temperature Probe	14
Exhibit 19:	Temperature Probe and NIST-traceable Temperature Probe	15

## 1.0 Background

The URG 3000N Sequential Particulate Speciation System was developed to collect particulate matter smaller than 2.5  $\mu\text{m}$  in diameter ( $\text{PM}_{2.5}$ ) on a 25-mm quartz filter. These filters are analyzed in an analytical laboratory for organic and elemental carbon using thermal optical analysis (TOA).

The URG 3000N sampler, shown in Exhibit 1, consists of a sample module, a controller module, a stand, a pump enclosure, a rain shield, and a 36-inch inlet tube. A pump pulls air through the sampler, and the mass flow controller maintains that air flow at 22 L/min. The screened inlet cap removes bugs, debris, and air particles (aerosols and particulate matter) larger than 15  $\mu\text{m}$  as air passes through it. The air continues to pass through the inlet tube; at the base, a cyclone removes any remaining particles larger than 2.5  $\mu\text{m}$ . What remains is  $\text{PM}_{2.5}$ , which is collected on the quartz filter. These quartz filters are secured to one of four sample cassettes that are held in place by a sample cartridge.



**Exhibit 1: URG 3000N sampler.**

The field audit of this sampler includes determining the accuracy of (1) the total flow rate under normal operating conditions (nominally 22.0 L/min), (2) the temperature reading, and (3) the barometric pressure reading, as compared to those measured with a National

Institute of Standards and Technology (NIST)–traceable audit device (which must be recertified annually). The reference standard used to evaluate flow rate, temperature, and barometric pressure following audit procedures in this SOP is the BGI triCal multi calibrator. Before using the triCal audit device, the auditor must check the NIST-traceable standard certificate accompanying it. If the audit device’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 have been certified with a NIST-traceable standard within 365 days prior to the date that the audit is performed.

In addition to reference standards, an AUDIT cartridge with four sample cassettes and quartz filters in place are needed to conduct an audit of the URG 3000N. When conducting the leak check, a flow audit adapter, a reducer, and pump shutoff valve are also required. These three devices can be obtained from URG.

EPA will supply an Excel worksheet for conducting performance audits on the URG 3000N sampler. The first page contains general monitoring site information, such as

- Location of the monitoring site
- AQS (Air Quality System) Site ID number
- Date of the audit
- Auditor(s) and agency affiliation
- Operator(s) and agency affiliation
- Sampler model and serial number (S/N)
- Last calibration date
- Reference standard model, calibration date, and serial number.

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 Technical Systems Audit (TSA) form for the Chemical Speciation Network 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 the TSA Form before arriving at the monitoring site.

## 2.0 Preparing the triCal Audit Reference Standard for Service

Exhibit 2 shows the triCal audit device, and Exhibit 3 shows the accessories.



Exhibit 2: triCal multicalibrator unit.



Exhibit 3: triCal accessories.

## 2.1 Equilibrating the triCal Audit Device

The audit device must be in thermal equilibrium with the ambient environment of the sampler before conducting the audit. Upon arrival at the site location, place the triCal in a location where it can equilibrate with the local conditions; the shady side of a building or deck is suitable. Set the triCal out of its carrying case on a level surface and allow it to equilibrate for at least an hour (60 minutes) prior to conducting any measurements. During this time, you can assemble and initiate the triCal and install the AUDIT cartridge, as described in Sections 2.2 and 2.3.

## 2.2 Assembling and Initiating the triCal

To assemble and initiate the triCal, follow these steps:

1. Attach the external temperature probe (see Exhibit 4).
2. Insert venturi #1, which is designed to measure flows from 6–30 Lpm (see Exhibit 5); venturi #2 and #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.
3. Attach the tygon tubing to the venturi hose adapter, and then attach the hose adapter to the venturi (see Exhibit 6). Note that the correct venturi hose adapter is determined by the size of the sampler inlet adapter to which the triCal attaches.
4. Turn on the triCal by pressing the on/off switch. The triCal will perform a self-calibration of the venturi (see Exhibit 7).



Exhibit 4: Inserting the temperature probe.



Exhibit 5: Inserting the Venturi



Exhibit 6: Coupling venturi hose adapter with flow measurement tubing.

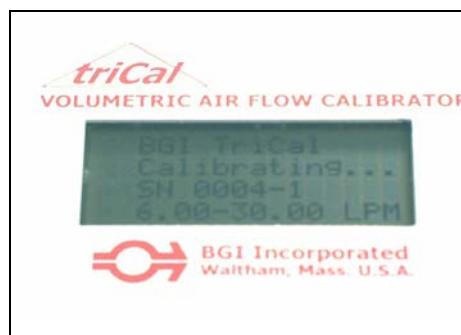


Exhibit 7: Venturi self-calibration screen.

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

Once the venturi has been calibrated, the triCal will default to the Main Menu, displaying barometric pressure, battery capacity, temperature, and flowrate (see Exhibit 8). On this display, Tfil is the external temperature reading of the temperature probe, and Tamb is the internal temperature sensor of the triCal. 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.



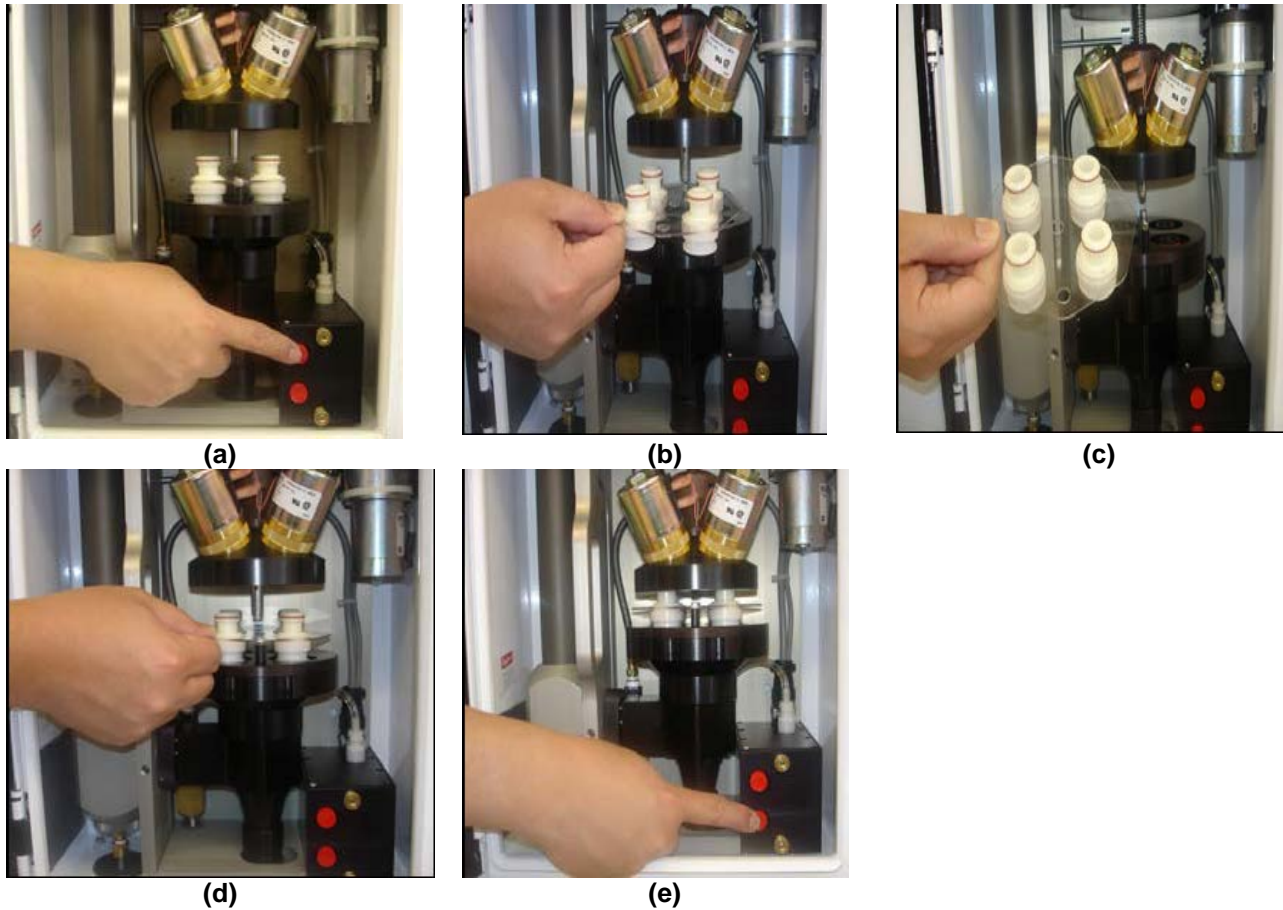
Exhibit 8: Default Main Menu screen.

### 2.3 Installing the AUDIT Cartridge

The steps required to remove the existing cartridge and inserting the AUDIT cartridge are illustrated in Exhibit 9:

- Open the Sample Module door and raise the solenoid manifold by pressing the red “up” button on the electronic box **(a)**
- Remove any filter cartridge on the cassette manifold, place red caps on the bottom of the four filter cassette inlets, and place in plastic bag for safety **(b,c)**
- Remove the red caps from the AUDIT cartridge and place the cartridge on the cassette manifold **(d)**
- Lower the solenoid manifold by pressing and holding the red “down” button. Release the “down” button when the solenoid manifold has stopped moving to close the filter cassettes against the cassette manifold **(e)**.





**Exhibit 9: Replacement of sample cartridge with AUDIT cartridge.**

### 3.0 Performing Audit Tests

Open the Controller Module door and the display screen will be in the AUTO Mode. The Clock and Date Test, Leak Test, Flow Test, Temperature, and Barometric Pressure Test are all accessed from the Audit Menu, as described in the subsections that follow. You will enter the data you obtain on the Performance Audit Worksheet for the URG 3000N sampler. The Performance Audit Worksheet is an Excel Spreadsheet that performs all calculations for passing or failing the respective tests.

***We recommend that you key in the data in the field and also write it on a printed form for cross verification.***

#### 3.1 Clock and Date Tests

1. From the AUTO Mode screen (see below), record the air sampler's displayed time and date as the URG time and date on the URG 3000N Performance Audit Worksheet.

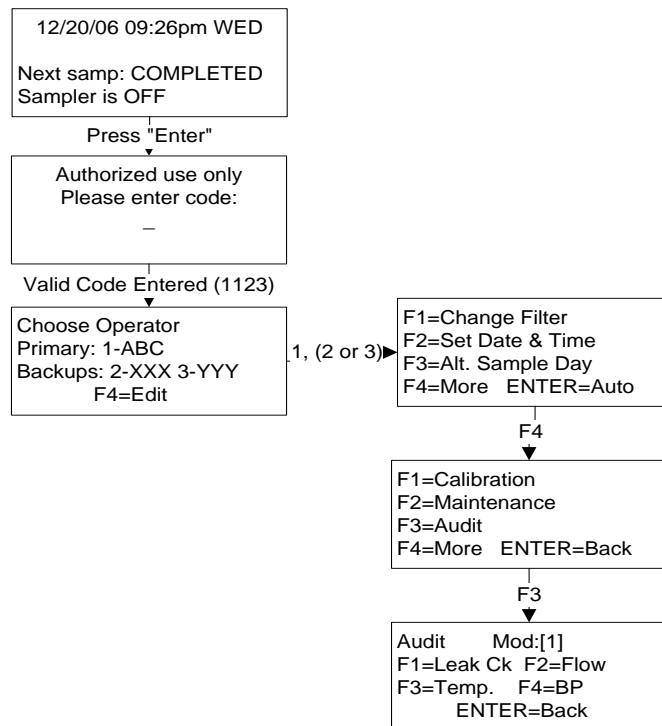
<p>12/20/06 09:26pm WED</p> <p>Next samp: COMPLETED Sampler is OFF</p>
--

- Record the NIST-traceable reference clock time and date from another external device such as a cell phone or an atomic wristwatch/clock.
- The time and date difference will be calculated on the worksheet and determined to be either a Pass/Fail status.

*Recall that the Chemical Speciation Network samples on the same schedule as the National PM<sub>2.5</sub> FRM network, which is constrained to Local Standard Time all year long.*

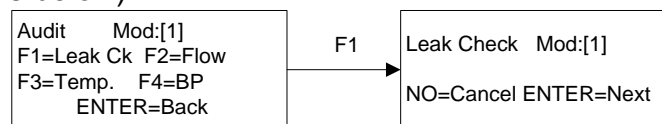
### 3.2 Leak Test

- Follow the menu tree and key strokes in Exhibit 10 to move from the **AUTO Mode** Menu to the **AUDIT** Menu.



**Exhibit 10: Menu tree and keystrokes from AUTO Mode screen to Audit Menu screen.**

- At the **Audit** Menu, press the “**F1**” key to proceed to the leak check (see screens below).



- Press the “**ENTER**” key to begin the leak check. The screen below requests the operator install the flow audit adapter in the open position.

```

Leak Check Mod:[1]
Install flow audit
adapter(valve open)!
NO=Cancel ENTER=Next
  
```



4. Ensure that the flow audit adapter is in the open position. If not, open it, and then remove the inlet cap at the top of the downtube (see Exhibit 11). Place the reducer on the downtube and then the flow audit adapter on the reducer (see Exhibit 12).



**Exhibit 11: Removal of ambient air inlet cap.**



**Exhibit 12: Place the reducer and the flow audit adapter on the downtube.**



5. Press the “**ENTER**” key to continue with the leak check. The screen below requests that the operator install the pump shutoff valve in the open position.

```
Leak Check Mod:[1]
Install pump shutoff
valve (valve open)!
NO=Cancel ENTER=Next
```

*Post-2006 models of the URG 3000N sampler may have the pump shut-off valve plumbed into the pump box.*

6. Inspect the pump shutoff valve to ensure it is in the open position. Disconnect the vacuum line from the side of the pump enclosure (see Exhibit 13). Connect the pump shutoff valve to the vacuum (air) line and reconnect to the side of the pump enclosure (see Exhibits 14 and 15).



**Exhibit 13: Vacuum (air) line disconnect.**

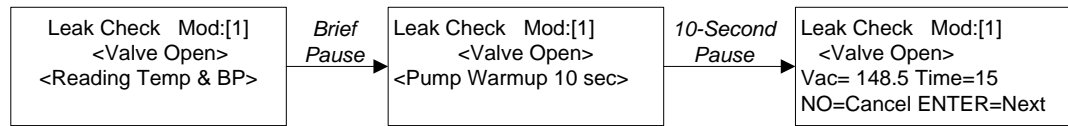


**Exhibit 14: Pump shutoff valve connection.**



**Exhibit 15: Connection of air line to pump shutoff valve.**

7. Press the “**ENTER**” key to continue with the leak check. The software screen will now display that both valves are open, the pump is warming up, and a vacuum and time value, which will count down from 15 to 0 seconds. (See screens below).



8. Press the “**ENTER**” key to continue to the next screen. This screen below requests the operator close the flow audit adapter at the top of the downtube.

```

    Leak Check Mod:[1]
    Close valve on flow audit
    adapter!
    NO=Cancel ENTER=Next
  
```

9. Rotate the lever on the flow audit adapter 90° to close the **flow audit adapter** (see Exhibit 16 below). This will begin creating a vacuum in the downtube, through the sampler, to the pump. The pump should begin to sound a little louder, representing more stress on the pump.

10. Press the “**ENTER**” key to continue to the next screen. The vacuum will begin to increase and at a point near 680 mm Hg, the time will begin to count down from 15 to 0.

```

    Leak Check Mod:[1]
    <Valve Closed>
    Vac=655 Time=15
    NO=Cancel ENTER=Next
  
```

11. After countdown reaches zero, press the “**ENTER**” key to continue to the next screen.

```

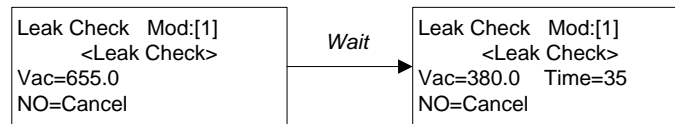
    Leak Check Mod:[1]
    Close pump
    shutoff valve!
    NO=Cancel ENTER=Next
  
```

12. Promptly rotate the lever on the pump shutoff valve 90° to close the valve (see Exhibit 16 below).



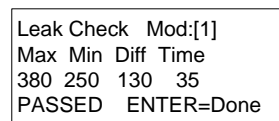
**Exhibit 16: Flow audit adapter and shutoff pump valve in the closed position.**

13. Press the “**ENTER**” key to begin the leak check. The pump will stop automatically. The vacuum will begin to drop, and when it reaches 380 mm Hg, a timer will count for a maximum of 35 seconds.

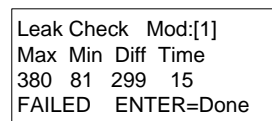


14. After the countdown from 35 seconds, the results will be displayed as either PASSED or FAILED. **The acceptance criterion is a vacuum drop of less than 225 mm Hg in 35 seconds.** The timer will stop if the leak is large enough for the vacuum pressure to drop more than 225 mm Hg within 35 seconds.

**PASSED**



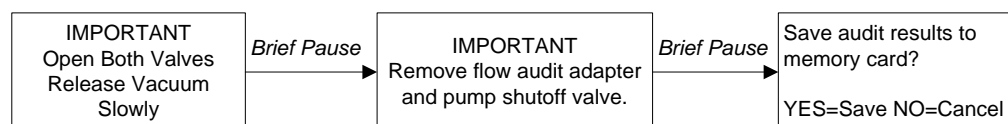
**FAILED**



15. Record the pressure drop in mm Hg in Initial Audit column of the Leak Test on the URG Performance Audit Worksheet. If the sampler fails the leak check, attempt another leak check and report pressure drop value in the After Correction column of the Leak Test. If the sampler fails both times, report results on the URG Performance Audit Worksheet and discontinue with the audit.
16. Press the “**ENTER**” key to advance to the next screen (shown below in Step 17). Slowly release the pressure in the sampler by **FIRST** slowly turning the lever on the flow audit adapter.

*Releasing the vacuum quickly may rupture the filter or pop it loose from the cassette.*

17. The next screen will instruct you to remove the flow audit adapter and pump shutoff valve. If you are going to perform a flow rate verification or calibration, leave the flow audit adapter in place. If you are not going to perform a flow rate check, remove the flow audit adapter and then the pump shutoff valve. Reconnect the vacuum (air) line and store the flow audit adapter and pump shutoff valve in a safe place for further service.



18. Press the “**YES**” key to save audit results to the memory card. When reviewing the memory card, all files beginning with an “a” are audit files. By selecting “**YES**”, the next screen appears.

```

Audit results saved to
memory card.

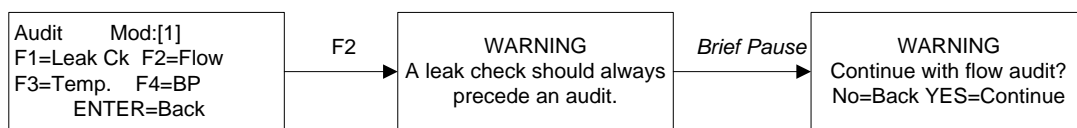
ENTER=Next
  
```

19. Press the “**ENTER**” key to return to the Audit Menu.
20. If you wish to return to the AUTO MODE, press the “**ENTER**” key twice.

### 3.3 Flow Test

Prior to conducting flow rate audit, you must complete a successful leak check. To conduct the flow rate audit, you must use a NIST-traceable flow rate calibration standard that has been equilibrated to ambient conditions (such as the triCal device). Follow the procedures provided by standard’s manufacturer regarding the length of time for the standard to obtain stable conditions. The flow rate audit must be conducted with the AUDIT cartridge installed in the sampler.

1. Connect tubing from the reference standard to the flow audit adapter that you left on the downtube after performing the leak test and begin the flow rate audit.
2. At the Audit Menu, press the “**F2**” key to proceed to the flow rate audit screen (see screens below).



3. Press the “**YES**” key to continue with the flow verification (audit). The values for the Gain and Offset should be near 6.00 and 0.00, respectively.

```

Audit Flow Mod:[1]
Gain=6.000 Off= 0.00
Connect Flowmeter!
ENTER=Next
  
```

4. Check connections to reference flow meter, and press the “**ENTER**” key to continue.

```

Audit Flow Mod:[1]
Raw Flow Vacuum
<Setting Flow>
  
```

5. The Mass Flow Controller (MCF) initiates after a brief pause, and the following screen appears.

```
Audit Flow Mod:[1]
Raw Flow Vacuum
<Pump Warmup 300sec>
```

6. The MCF will run for 5 minutes (300 seconds) at the sampler's design flow rate of 22.0 L/min. At the end of the 5-minute warm up period, the screen below will appear showing the sampler's flow rate and vacuum at that time.

```
Audit Flow Mod:[1]
Raw Flow Vacuum
3052 21.95 147.9
ET=5 ENTER=Done
```

7. Press the “**ENTER**” key to continue to the next screen. In the screen below, you are prompted to enter the reference standard's flow rate in L/min. Use the keypad to enter the reference standard's flow rate value. The decimal place is fixed at two decimal places, so for a flow rate of 21.95 L/min., enter “**2195**”. Enter the reference flow rate on the URG Performance Audit Worksheet in the Reference Standard column under Flow Test.

```
Audit Flow Mod:[1]
Raw Flow Vacuum
3052 21.95 147.9
Ref. Flow(LPM):?
```

*Note that the pump will not shutdown until all the reference flow rates have been recorded.*

8. The screen below will appear, showing the sampler's flow rate, the reference standard's flow rate, and the difference between the two values (sampler – reference standard), all in L/min. Confirm the difference from the sampler display screen to the calculation on the URG Performance Audit Worksheet. **The agreement should be within  $\pm 10\%$ .**

```
Samp. Ref. Diff.
21.95 22.00 -0.05

ENTER=Next
```

9. Press the “**ENTER**” key to proceed to the next screen (see below).

```
Save audit results to
memory card?

YES=Save NO=Cancel
```

- Press the **“YES”** key to save audit results to memory card. If the operator selects **“NO”**, no data will be saved and the sampler software will return to the Audit Menu screen.

*When reviewing the memory card, all files beginning with an “a” are audit files.*

After you select **“YES”**, the next screen appears. (This screen could take a couple of minutes to appear.)

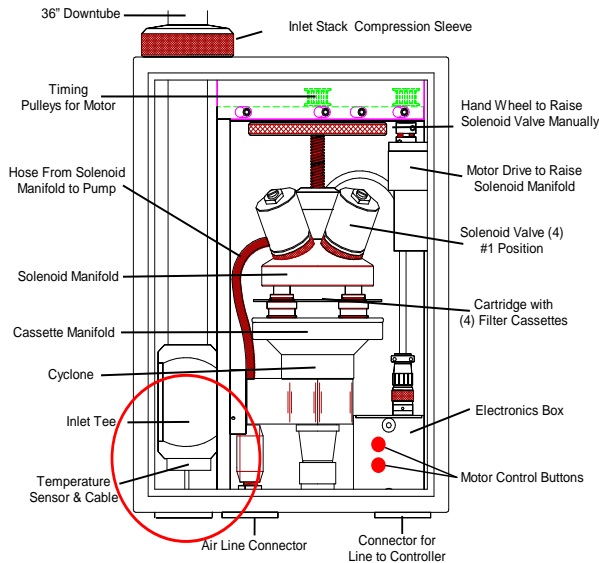
Audit results saved to memory card.  
  
ENTER=Next

- Press the **“ENTER”** key will return to the Audit Menu.

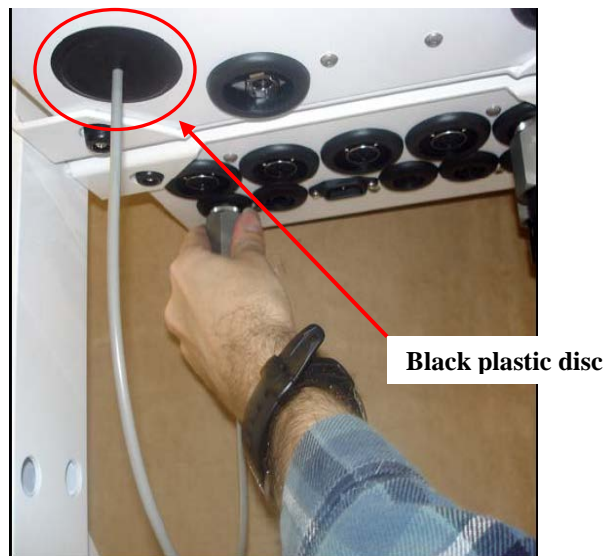
### 3.4 Temperature Test

*Note that even though you are taking the temperature from the URG Sampler, you must use the “Tfil” probe to make the measurement; therefore, you must record the “Tfil” reading as the measurement reading for the triCal.*

- At the base of the inlet tee, locate the temperature probe (see Exhibit 17).
- While holding the temperature probe cable, gently push the black plastic disc through the bottom of the sample module (see Exhibit 18).

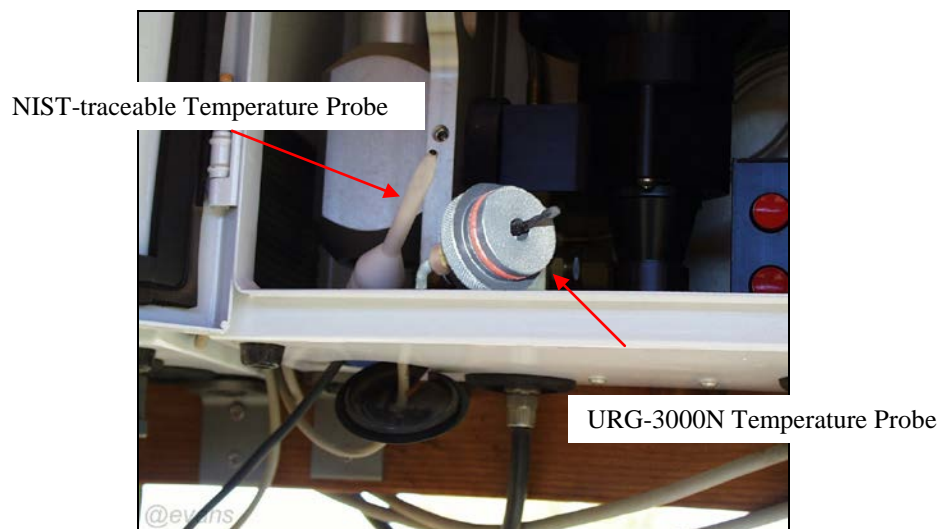


**Exhibit 17: Interior of the sample module.**



**Exhibit 18: Black plastic disc supporting the temperature probe.**

3. With one hand, reach into the sample module box. Carefully wiggle the probe plug free with your thumb and forefinger while holding the temperature probe cable on the bottom side of the sample module box with your other hand. Glide the probe through the opening at the bottom of the sample module. Set the temperature probe plug inside the sample module away from direct sunlight (exposing the probe to ambient conditions).
4. Place the reference temperature probe of the triCal (or other NIST-traceable device) ½ inch from the sampler's temperature probe and allow both temperature probes to equilibrate (see Exhibit 19). If it is windy, place the probes in the module for reading to minimize interference from wind effects.



**Exhibit 19: Temperature probe and NIST-traceable temperature probe.**

5. At the Audit Menu, press the “F3” key to proceed to the temperature audit screen (see screen below).

Audit Temperature Temperature(C)= 25.4 F1: +/-    F2: C/F Ref. Temp(C): ?
--

6. After the two probes equilibrate, enter the reference standard temperature value in degrees Celsius. The decimal place is fixed for a tenth degree (so for 25.2 °C; enter “252”). Press the “F1” key to toggle between positive and negative values; press the “F2” key to toggle between Celsius and Fahrenheit.
7. Record the sampler and reference standard values in degrees Celsius on the URG Performance Audit Worksheet. **The agreement should be within ±2 °C.**
8. After entering the reference standard's temperature, the next screen shows the sampler's temperature, the reference standard's temperature, and the



difference between the two values in Fahrenheit and Celsius (see screen below). Confirm the difference from the sampler display screen to the calculation on the URG Performance Audit Worksheet.

```
C/F Samp. Ref. Diff.
C 25.4 25.0 0.4
F 77.7 77.0 0.7
ENTER=Next
```

- Press the “**ENTER**” key to proceed to the next screen (see below).

```
Save audit results to
memory card?

YES=Save NO=Cancel
```

- Press the “**YES**” key to save audit results to the memory card. If you select “**NO**”, no data will be saved and the sampler software will return to the Audit Menu screen.

*When reviewing the memory card, all files beginning with an “a” are audit files.*

- After you select “**YES**”, the next screen appears. (This screen could take a couple of minutes to appear.)

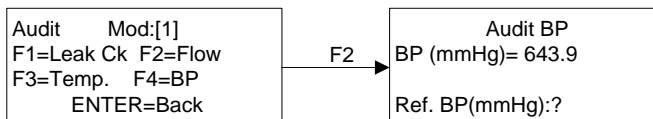
```
Audit results saved to
memory card.

ENTER=Next
```

- Press the “**ENTER**” key to return to the Audit Menu.
- Remove the temperature reference standard and securely replace the sampler’s temperature probe in the bottom of the inlet tee. Replace the black plastic disc.

### 3.5 Barometric Pressure Test

- At the Audit Menu, press the “**F4**” key to proceed to the barometric pressure verification (audit) screen (see screens below).



- Enter the barometric pressure (in mm Hg) of an equilibrated NIST-traceable reference standard using the keypad. The decimal place is fixed for a tenth degree, so for 754 mm Hg, enter 7540 (the display screen will show 754.0 mm Hg). If you enter “**754**”, the display screen will show 75.4 mm Hg, which is incorrect.

- Record the sampler and reference standard values in mm Hg on the URG Performance Audit Worksheet. **The agreement should be within  $\pm 10$  mm Hg.**
- After entering the reference standard's barometric pressure, the next screen shows the sampler's barometric pressure, the reference standard's barometric pressure, and the difference between the two values in mm Hg (see screen below). Confirm the difference from the sampler display screen to the calculation on the URG Performance Audit Worksheet.

Samp.	Ref.	Diff.
643.9	645.0	-1.1
ENTER=Next		

- Press the **"ENTER"** key to proceed to the next screen (see below).

Save audit results to memory card?
YES=Save NO=Cancel

- Press the **"YES"** key to save audit results to the memory card. If you select **"NO"**, no data will be saved and the sampler software will return to the Audit Menu screen.

*When reviewing the memory card, all files beginning with an "a" are audit files.*

After you select **"YES"**, the next screen appears. (This screen could take a couple of minutes to appear.)

Audit results saved to memory card.
ENTER=Next

- Press the **"ENTER"** key to return to the Audit Menu.
- To return to the **AUTO Mode** screen, press the **"ENTER"** key twice.

#### 4.0 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

- Any other pertinent information that might have adverse impacts on data generation/collection.

## 5.0 Follow-Up Actions

You should prepare a completed URG Performance Audit Worksheet including any findings recorded during the TSA interview and inspection in the “Findings” text box. The findings should be divided into “Significant” and “General.”

- 1) Within two weeks following a site audit, submit a draft audit report to the site operator and the EPA OAQPS PM<sub>2.5</sub> Speciation Network QA Lead.
- 2) The site operator will be given two weeks to respond for the purpose of ensuring there are no erroneously recorded data that led to a false significant finding. Erroneous data entry should be corrected if there is a high level of confidence that accurate audit data can be recovered from the written versions of the Performance Audit Worksheet and TSA form.
- 3) Disputed findings of any parameter or condition that were not the result of erroneous data entry should be identified for the interim final report.
- 4) Within 6 weeks after an audit has concluded and two weeks after the operator's response period, an Interim final report will be prepared and forwarded to the Site operator, the SLT's monitoring program manager, the EPA Speciation Network National Program Manager, the EPA Regional Delivery Order Project Officer, and the appropriate Regional Monitoring Program contact and QA Contact. Interim final reports will be posted on EPA's AMTIC on the Speciation Monitoring QA Web page.
- 5) Monitoring site owners are expected to correct significant findings within 60 days following issuance of the interim final report. **Safety findings should be corrected immediately.** Remedies for significant findings should be patterned after those stated in the National PM<sub>2.5</sub> Chemical Speciation Network guidance document and Field QAPP. (Note this document is being revised in late 2007.)
- 6) If necessary, a final actions update will be added to the interim final 90 days following the 60 day remediation period, and the resulting report will stand as the “Final Audit Report.”
- 7) Audit Reports for the Speciation Network will be summarized in a National QA Audit report at the end of the calendar year.