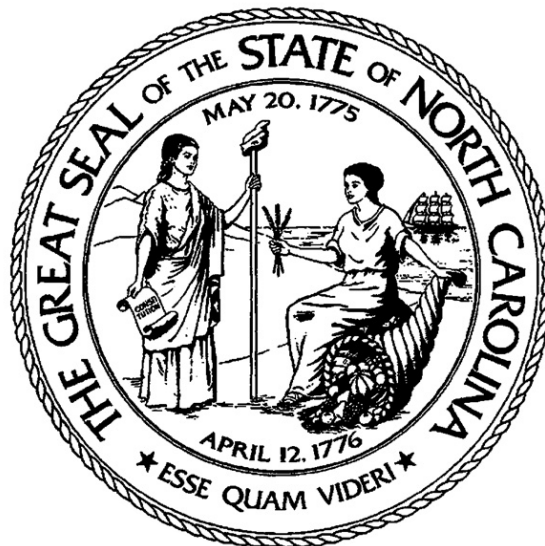


**Standard Operating Procedure 2.45**  
**Section 2:**  
**Met One Super Speciation Air Sampling System (Super SASS) Standard**  
**Procedures for Operators**

**Revision 2020**





## Standard Operating Procedure Approval

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## 1.0 SCOPE AND PURPOSE

In accordance with Federal requirements outlined in 40 CFR Part 58, “Ambient Air Quality Surveillance for Particulate Matter”, the State of North Carolina is conducting chemical speciation monitoring.

PM<sub>2.5</sub> chemical speciation is considered a *Non-Criteria* parameter, along with Toxics, Carbonyls, Ozone precursors and Meteorological data; however, chemical speciation sites help:

- Provide more specific data to define the correlation between particle concentration/composition and public health concerns
- Recognize national trends
- Identify source/receptor relationships and determine the effectiveness of emission control strategies
- Access air quality models and emission inventories
- Support future revisions to the NAAQS

The Super Speciation Air Sample System (Super SASS) chemical sampler was developed under contract from the United States Environmental Protection Agency – US-EPA by Met One Instruments. The Super SASS collects samples for the chemical and gravimetric analysis of ambient air PM<sub>2.5</sub> particles. PM<sub>2.5</sub> refers to those airborne particles with diameters smaller than 2.5 µm. These particles are comprised of sulfates, nitrates, organic carbon, soot-like carbon and metals. With the 1997 fine particle standard for PM<sub>2.5</sub>, the US-EPA established a sampling network for determining the concentration of each of these species. The SUPER SASS has been specifically designed to meet these needs.

The following document describes the operation and field technician responsibilities for the Met One Super SASS. The objective of this Standard Operating Procedure (SOP) is to familiarize the station operator with the activities used in the collection of air monitoring data. The accuracy of data obtained from any instrument depends upon the instrument's performance and the operator's skill. It is important that the station operator become familiar with both this SOP as well as the manufacturer's operation manual in order to achieve a high level of data quality.

## **2.0 SAMPLER DESCRIPTION AND ASSEMBLY**

### **2.1 Description of the Super SASS Monitor**

When analyzed, most PM<sub>2.5</sub> can be expected to contain the following or a combination of the following components:

- Geological Material: airborne PM<sub>2.5</sub> consists of approximately 5-15% of oxides of aluminum, silicon, calcium, titanium, iron, and other metal oxides.
- Sulfate: the most common forms of sulfate found in mass PM<sub>2.5</sub> samples are: ammonium sulfate, ammonium bisulfate and sulfuric acid.
- Nitrate: ammonium nitrate, ammonium bisulfate and ammonium nitrate.
- Organic Carbon: particulate organic carbon consists of hundreds of separate compounds that contain more than 20 carbon atoms.
- Elemental Carbon: most often called 'soot' contains pure, graphic carbon.

The Super SASS uses two separate filter media to collect the PM<sub>2.5</sub> samples. Each medium is analyzed separately for different components:

- Teflon filter for gravimetric mass thirty-three trace metals, using Energy Dispersive X-ray Fluorescence.
- Nylon filter for sulfates, nitrates, and three cations (ammonium, potassium, and sodium), using Chromatography.

The PM<sub>2.5</sub> separations are 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. Particle penetration through the SCC mimics the PM<sub>2.5</sub> cutoff curve of the WINS impactor as defined by the Environmental Protection Agency.

The denuders are of a multi-cell configuration. They are 25 mm in length, and are housed in a 47-mm O.D. aluminum sleeve. The nitric acid denuder is made of aluminum with 350 parallel, hexagonal channels, and is coated with Magnesium oxide. Empty sleeves are provided for use in canisters and flow channels operated without a denuder.

The filter size (media) used in the sample canister is 47 mm O.D. Each canister can hold either one or two 47-mm filters in tandem. The collection media used for each cassette can be varied as needed for the types of analyses to be performed. The filter holders are FRM design specified and interchangeable with all commercially available FRM samplers.

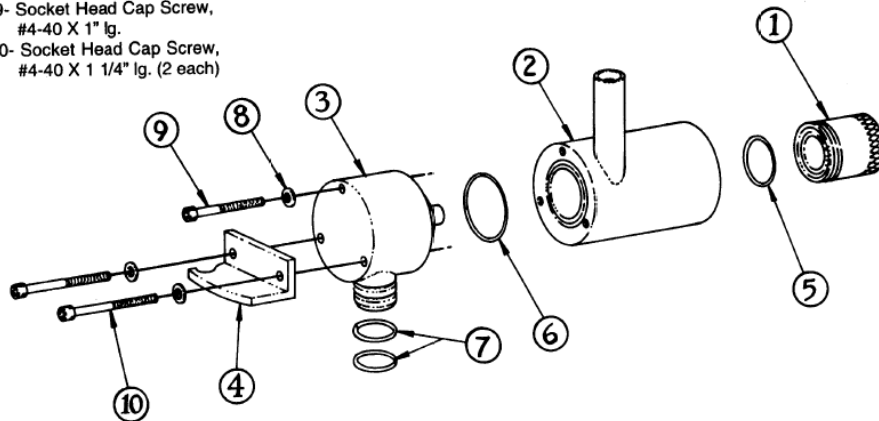


**Figure 1. Met One SASS.**



**Figure 2. Disassembled SASS Canister.**

- 1- Grit Pot #8664
- 2- Body #8662
- 3- Outlet Head #8666
- 4- Bracket #8665
- 5- Viton O-Ring, #2-016
- 6- Viton O-Ring, #2-020
- 7- Viton O-Ring, #2-015 (2 each)
- 8- Flat Washer, #4 (3 each)
- 9- Socket Head Cap Screw, #4-40 X 1" lg.
- 10- Socket Head Cap Screw, #4-40 X 1 1/4" lg. (2 each)



**Figure 3. Short Cut Cyclone (SCC) Exploded View.**

The solar and heat radiation shield is of the design used for the maintenance of the samples at near ambient temperature. Both the sample filter and ambient temperatures are logged throughout the sampling period. The filter temperature is measured immediately downstream of the filter media in each canister of the Super SASS. The Super SASS is standard with four active volumetric flow controllers. Additionally, each sampling line has a check valve to shut off the flow if the sampling line

is not used, or for performing a dynamic field leak check. Volumetric flow rate measurement is made independently for each of the active flow channels, displayed instantaneously and logged with five-minute averages.

Flow rate errors are flagged both on the display and in the data logger. Volumetric flows are measured and recorded with four independent electronic mass flow sensors. The mass flow sensors in conjunction with ambient temperature, and the barometric pressure readings, are used by the control unit microprocessor to calculate the actual volumetric flow. This provides site-specific flow measurements so no correction is needed in the field or for data reporting at true volumetric readings.

All routine maintenance can be done in the field. Sample canisters are transported to the laboratory for inspection, cleaning and changing of sampling substrates. Every element of the sampler that is contacted by the sampled air stream ahead of the filter, including the inlet can be cleaned with each sample change.

## **2.2 Assembly**

### **2.2.1 Tripod**

The SASS tripod comes as an assembled item. Upon removal from the shipping container, the operator simply removes the 3 ringed pins from the tripod leg bracket and folds down the three legs of the tripod. The 3 pins are then re-inserted to hold the three legs in position.

**CAUTION: Note the tripod and sampling system operate at approximately 72 inches above ground or sampling deck level. It is very important to anchor the tripod with use of commercial hardware to the sampling deck to prevent damage in strong winds or weather.**

Holes are provided in the tripod feet and commercial hardware can be used to anchor the tripod to the sampling site. Use of ¼" Lag Screw mounting is advised, to attach the tripod feet to the sampling platform. If the sampling site is on the ground, it is recommended to use spikes driven through the tripod mounting feet. If cement or other hard material makes up the sampling site surface, commercial hardware must be selected to properly secure the tripod.

### **2.2.2 Sampling Head**

**Note: It is advisable for installation of sampling head to use a short three-step ladder and/or the help of a second person makes assembly easier. The bottom shield must be set in place before any of the socket head cap screws are set in place.**

Locate bottom shield. It can easily be identified by the 8 holes in the flat portion. Lift it up off the rest of the sampling head, letting the hose and cable slide through the hub at the center of the shield. It is of mostly sheet metal construction with a hub and tethered pin. Pull the pin from the hub, letting it hang by its chain. Slide the shield down onto top of mast and allow it to rest on the leg weldment.

Next, install the socket head screws. Use the Allen wrench and install them into the two tapped holes in the top area of the mast. These screws provide upper and lower shield orientation. Stretch out and unwind the cable with connector and tubing bundle coming from the hub of the upper sampling head. While supporting the sampling head, feed the bundle into the top of the mast and mount the hub onto the mast. Engage the notch in the hub with the topmost screw head to properly align unit. Tighten two Setscrews to secure sampling head to mast.

### **2.2.3 Control Unit**

The SASS control unit is an all-weather & environmental NEMA rated cabinet. The control unit houses the microprocessor, LCD display, and keypad. The SASS control unit is designed for angle mounting on the tripod so that it can be easily read and operated.

There is no AC power in the control unit. The AC 110VAC 60 Hz enters the vacuum pump box and a DC power supply is used to operate the control unit. The control unit is provided with two metal mounting brackets and two sets of U-bolt hardware clamps. It is the first item to be mounted to the mast.

Proper orientation of the control box is with the hinged side of the box facing the left (from the front) and all cable connections are facing the ground or platform in the middle of two legs of the tripod. Once the unit is positioned, tighten the U-bolt hardware clamps.

### **2.2.4 Ambient Temperature Sensor**

The SASS includes a passive ambient temperature sensor using a thermistor protected by several round plates. The shield is naturally aspirated by the wind to provide an accurate temperature measurement. This is identical to EPA PM2.5 FRM sampler. The ambient temperature sensor includes the Model 5980 temperature shield, Model 064-1 temperature Sensor, tripod mounting hardware and the connecting cable with connectors.

After the control unit is secured to the tripod, the next item is to mount the ambient temperature sensor and shield assembly. Attach the shield and temperature sensor assembly using one U-bolt hardware clamp. The temperature shield is mounted above the lower mounting bracket of the control unit. Place the ambient temperature sensor on the mast with the flat top plate facing up and the cable connector

facing the ground. Lower the sensor until the mounting bracket hits the top of the bottom bracket of the control unit. Position the ambient temperature sensor so the shields face the back of tripod. When positioned secure the sensor by tightening the U-bolt hardware clamp. Typically, it would be about 3 inches above the lower control unit U-bolt. The top of the shield should be about the same level as the top of the control unit box. This will allow the lower shield of the sampling head to be lowered without hitting the top of the temperature shield. Attach the cable and connector to the ambient temperature sensor from the pump control box. It is impossible to misconnect the cable since the connections are keyed.

### 2.2.5 Sampling Canisters

It will be necessary to install the 2.5-micron sharp cut cyclone (SCC) to the bottom of each filter canisters. A very light coating of silicone grease can be applied to the two O-rings on the cyclone. Use just enough to “wet” the O-rings. The short fitting with the two O-rings is inserted into the hole on the bottom of each canister. It is then rotated until the notched corner of the SCC mount is under the lock screw of the canister.

**Note: Do not loosen or remove the fixed shoulder bolts that are mounted in the canister. These are locked in place and are necessary for the proper installations of both the canister and the SCC inlet assembly.**

The sampling head assembly has mountings for up to eight filter sampling canisters. Around the outside of the upper shield are labels indicating the location of the sampling canisters (Note: In some instances during operation, only three or six of the canisters will be installed). Each canister has a pair of mounting shoulder bolt posts and a vacuum connection with O-rings. The posts are slipped into the inlet assembly and the O-ring seal provides an airtight seal to the airflow system. The canister’s alignment posts are inserted into the larger holes in the mounting fixture of the inlet head. Apply a very light coating of silicone grease to the O-rings on the top of the canister. Use only enough to “wet” the O-rings; any additional or excess grease may contaminate other parts in the air path. Push up the canister, and then rotate clockwise (looking up) to the stop and it will lock into place.

Each canister has a mark that should be pointing out and away from the center of the support tripod. Once all the canisters are installed in the sampling head, the lower shield can then be up raised up and locked into place. When raising the lower shield, be sure that the slot in the shield must be aligned with the socket head screw. Once in the correct position, the locking pin on the chain can be inserted in place to hold the lower shield assembly in the operating position.

**Note: When removing the canisters, keep them in their normal operating position and remove the Sharp cut cyclone. Do not invert the canister when removing the SCC, as any loose material in the cyclone might fall into the canister and contaminate the collection filter.**

Once removed, cap both ends of the canister with the supplied yellow stoppers. Removing the grit cup, and dumping it out, and then a quick blow of clean air through the cyclone to remove any collected dust can then clean the cyclone.

**Note: As part of the EPA project to monitor PM<sub>2.5</sub> particulate, canisters, denuders, and canister spare parts are sent to the EPA contractor in charge of filter analysis. They will be cycled around on a regular basis to collect filter data. If the SASS owner chooses, some canisters can be retained for their own use and analysis of collected samples. Typically, in the EPA project, only two canisters are used in each test, at one time in the SASS. All materials for collection of samples, chain of custody, and transport cooler will be provided by the EPA contractor.**

### **2.2.6 Pump Housing**

The dual diaphragm AC vacuum pump is contained in its own environmental shelter isolated from the SASS to prevent vibration, noise, heat and any potential of exhaust contamination. The vacuum pump is a dual head Thomas Co.<sup>TM</sup> diaphragm vacuum pump mounted with four bolts through the bottom of the cabinet. The vacuum pump box contains a filter screen under the pump and an aspiration fan on the side. Heat is exhausted from the box by pulling ambient air in the base and through the fan and exhausting on the right. The pump box is mounted on an aluminum framework stand with four ¼” anchoring holes provided in the base. The pump box will be located in a position that is close to the base of the tripod. The pump box is made to sit on the floor or deck of the sampling platform and the pre-drilled holes for securing to the platform. The base can be mounted using ¼” bolts or lag screws. The holes are located on a hole pattern that is set on 10” x 16” dimensions.

AC power supplied to a DC converter powers the entire SASS system. The vacuum pump box contains three cables. One is the 110VAC 60HZ power cable, which is connected to the AC grounded service. The second is a signal cable with a screw type connector that attaches to the ambient temperature sensor. The third cable from the bottom of the pump box connects to the center connector on the bottom of the control unit. Be sure that this cable connection is pushed securely into the mating connector on the control unit. Once inserted rotate the outer ring on the front of the connector to lock it in place on the control unit. A multi-pin connector on the side of the pump box connects to a multi-conductor cable that runs down from the sampling head assembly.



With the inlet head in place, it is then necessary to make the sample line connections. There will be either five or eight labeled sample lines, visible below the mast-mounting tube. Pull each individual sample tube out and attach #1 tube to #1 quick disconnect valve connector on the side of the Pump Box. If only two canisters are used with SASS, lines 3, 4 and 5 can be left disconnected and capped. Now, attach the filter canister temperature sensor cable if not already done.

Once all the cables have been connected, some tie wraps can be used to secure the various cables to the support tripod. Be sure that the tie wraps used are the black colored type. The natural or nylon type will degrade in the sunshine, and break after only a short time in the sun.

### **3.0 SUMMARY INFORMATION SPECIFIC TO THE INSTRUMENT**

#### **3.1 AC Power Warning**

##### **WARNING!**

To avoid damage to the monitor, ensure that the AC power voltage matches the voltage indicated on the monitor's model/specifications label located on the rear panel before plugging the Super SASS into line power. High voltages are present inside the instrument. Ensure that the power cord being used is capable of carrying the power rating of the instrument (see rear panel label). Note:

- Power connection must have functioning ground connection.
- Do not defeat the ground wire on power plug.
- Turn off instrument power before disconnecting or connecting electrical subassemblies.
- Do not operate with cover off.

Some repair and troubleshooting operations need to be carried out with the monitor open and running. Use common sense when operating inside a running monitor. Exercise caution to avoid electrical shocks and electrostatic or mechanical damage to the monitor. Do not drop tools into the monitor or leave those after your procedures. Do not short or touch electric connections with metallic tools while operating inside the monitor. Beware of external elements (i.e., weather conditions) when performing maintenance exposing the monitor.

As in any monitoring program, it is recommended that site operators and support personnel, follow all manufactures' recommended procedures for sampler set up and operation.

#### **3.2 Siting Criteria**

The installation of the URG should follow the siting criteria requirements in 40 CFR Part 58, Appendix E in order for the sampled filters to be considered valid. General siting criteria include:

1. Being >20 meters from a tree, and at least 10 meters from a tree drip line,
2. Being >1 meter horizontally away from another probe,
3. Having the probe inlet located 2-15 meters above ground,
4. And being twice the distance from a structure or tree that acts as an obstruction, as the structure or tree protrudes above the inlet.

## 4.0 LOGBOOK SETUP, SITE VISIT PROCEDURES AND CHECKS

### 4.1 Initial Setup of the Electronic Logbook

An electronic logbook (e-log) must be created for each site at the beginning of the calendar year or upon setup. The SASS e-log consists of the spreadsheets listed in Table 1. The most current e-log version can be obtained from the Internet Based Enterprise Application Management (IBEAM) documents module, the Ambient/Documents/PM Monitoring SharePoint folder or by contacting the RCO particulate matter lead.

**Table 1. Description of E-Log Spreadsheets.**

<b>E-Log Spreadsheet</b>	<b>Description</b>
Instructions	Setup of site information (Site Name, AQS ID, SiteID2). Provides a summary of operational evaluations and sampler maintenance for users.
Event Summary	Table for users to track dates of verifications, audits, and maintenance.
Calibration	Table for documenting sampler calibrations.
Verification Audit	Table for documenting all verifications and audits.
Maintenance Log	Table for documenting monthly, quarterly, and annual maintenance activities, as well as, leak checks, clock verifications, etc.

Initial setup of the e-log requires selecting the site name from a pull down menu on the “Instructions” tab of the e-log. The AQS ID, pollutant, and SASS type field will automatically populate based on the site name.

#### 4.1.1 Guidance for Useful Logbook Documentation

EPA has been providing guidance on record keeping requirements for QA/QC programs. In particular, EPA has discussed the role that logbooks play in providing proof that QAPPs and SOPs are being followed. According to EPA, logbooks should, at a minimum, provide the following to be a useful tool for documenting the operations conducted at a monitoring site:

1. Purpose – Define the purpose of this site visit. Tell why you are there. Is it to replace a filter? Did you note something in the previous data download that is indicating a problem? Are you experiencing data drops and want to see if anything is wrong? In a couple of sentences, tell

what you intend to do. Don't say routine maintenance, say instead: "noted fluctuations in flow while reviewing the 5-minute average data". Be specific.

2. Appearance – Tell how you found the site. If the site was secure, say so. If you noted a problem, or a changed condition, then document it in a couple of sentences: "construction has taken place in the vacant lot next to the site since my last visit".
3. Action – Tell what you did. In a few short sentences describe the actions you took at the site: "cleaned the inlet head and replaced one of the two gaskets". In particular, you might want to document any site computer updates that were run. Just things like that.
4. Results – Were you successful? Did you accomplish your goals? If so, then say so: "completed the monthly and quarterly maintenance and returned the monitor to "Wait" mode". If not, then say so: "failed as-left leak check, contacted ECB".
5. Response – Is the equipment operating within specifications set in SOP? If so, then great, note that fact in the logbook and you are done. If not, then what did you do? If something is wrong then reach out for help and document it: "contacted Scott at ECB, he will be here presently with a new FRM."
6. Reviewers should add their comments: "reviewed above, approved operator action." Or: "upon review noted deviation from SOP".

## **4.2 Site Visit Procedures and Checks**

### **4.2.1 Site Inspection**

Before entering the station, the perimeter should be inspected for damage. Extreme weather conditions, neglect of station maintenance or vandalism that may have resulted in damage to the site since the operator's last visit. Once the operator has approached the site, she/he should first:

1. Check for any obvious sampler malfunctions. For example, check to see that the equipment is running, the pumps are operating and the instrument is cycling properly.
2. Note any unusual odors or noise. An unusual odor may indicate a point source of a pollutant or a strange new noise can indicate a malfunction in the equipment.

These observations should be recorded in the station log book and may prove to be invaluable if the data is challenged. The station operator is responsible for making several observations during the

station inspection. Any of the above described observation must be thoroughly detailed in the site log book.

It is the operator's responsibility to maintain the monitoring site. Routine maintenance includes keeping the site clean and being observant of potential problems. Examples of potential problems include:

1. Accumulation of dirt and debris.
2. Infestation by rodents or insects.
3. Overgrowth of vegetation around the site.

#### **4.2.2 Site Logbook**

A station log book must be maintained at each monitoring site and should accurately reflect site operations. The log book will be identified with the station name and station number. All entries shall include the date, time, operator, maintenance on equipment and equipment changes. Additional information should include: maintenance performed on the station, abnormal traffic patterns or nearby construction. If the data is challenged, the information recorded in the logbook is invaluable. A written record of observations concerning abnormal operations or localized occurrences is critical if a violation of ambient air standards were recorded during this period.

#### **4.2.3 Equipment Inspection**

There are several routine duties that must be performed each time an air monitoring station is inspected. These duties include equipment inspection, performing calibrations, assisting during audits, documentation, and making necessary adjustments or repairs to the instruments.

It is suggested that each station operator consult the SASS Operation Manual and compile personal notes on troubleshooting as they gain experience with the instruments. The operator is encouraged to contact ECB or the manufacturer when attempting any repairs.

**The operator's manual is the best resource the station operator has for the information on the operation and maintenance of the SASS monitor.**

## 5.0 SAMPLER SETUP

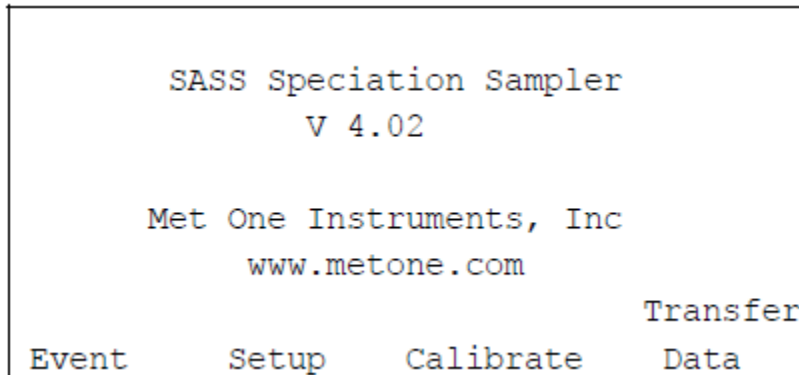
### 5.1 User Interface and Menus

The SASS system is powered by plugging the male AC power cord into a 115 VAC supply. There is no on/off switch. The pump fan in the pump box should be detected operating and the LCD display of the Control unit should illuminate. The SASS uses a LCD display with menu driven push buttons located below the main screen. Selections made here can access all other necessary screens.

**Note: Due to ambient temperature, the LCD display may be weak or saturated. Adjust the screen contrast using the ☀ key on the Control Box keypad. Continued pressure on the key will lighten or darken the LCD display accordingly.**



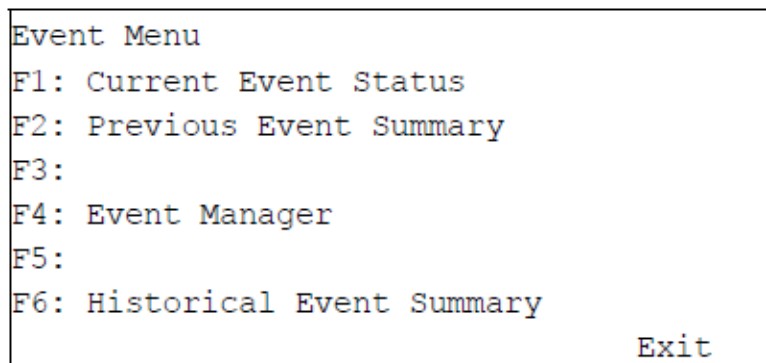
**Figure 4. Control Box.**



**Figure 5. Home Screen View.**

### 5.1.1 Event Menu

From the main screen, press <Event>. The event menu provides the user with current operating conditions and post event summaries. The event menu screens are arranged in a closed circle. Select the major section of choice using the function keys and then scroll to other screens listed in the event menu using the << and >> arrow keys. Select your choice by pressing the associated function key. The event menu provides selections for viewing the results of current and post events.



**Figure 6. Event Menu.**

#### 5.1.1.1 Current and Previous Event Screens

By pressing <F1> or <F2> from the event menu, this particular status screen provides the user with the current event status or the most recently sampled event status. During operation there are two

variations of the screen label that will appear depending upon the current operational sequence in the event. They are identified in the status line as “Finished” and “Sampling” (Figure 7).

From this screen only, the >> and << arrow keys can be used to navigate through the various status and summary screens, such as event averages for volume, % CV, ambient min/max and 5 minute averages and warnings/power failures. The current event number appears under the status label at the left hand top corner of the display screen.

```
Status: Finished      MM/DD/YY HH:mm:ss
06      Canister Set: (1,2,3)
        Event Start: MM/DD/YY HH:mm:ss
        Event Stop:  MM/DD/YY HH:mm:ss
        Event Length:      HH:mm:ss

        <<      >>      Exit
```

**Figure 7. Finished Status Screen.**

### 5.1.1.2 Event Manager Screen

Pressing <F4> will direct the user to the event manager that is part of the setup menu. This shortcut can be used to view the events currently programmed in the SASS, or to add, modify or delete events from the system. Exiting the event manager will return to the setup screen and does not return to the event menus.

### 5.1.1.3 Historical Event Summary Screen

The historical event summary screen allows for viewing of past events. A maximum of 24 past events can be stored in memory before they are over written by a new event. The menu is identical to that of the previous event summary screen. The key difference is that the event number can be selected from the historical event summary; while in the previous event summary shows only the most recently completed event. The event number is displayed below the status label in the upper left hand corner of the screen.



## 5.1.2 Setup Menu

The setup menu is used to setup the various event, defaults, date and time, the unit ID as well as provide a way to clear from the SASS memory all event history. The setup menu screen shown in figure 8 is displayed, when the setup key from the main menu is selected. Use the function keys to access the various menu selections. To return to the main menu, the exit key can be selected.

```
Setup Menu
F1: Event Manager
F2: Event Defaults
F3: Clock
F4: Unit ID
F5: Clear Event History
F6: Flow Sensors

Exit
```

**Figure 8. Setup Menu Screen.**

### 5.1.2.1 Event Manager Screen

The event manager allows for the programming of the events or test sequences that will be processed by the SASS unit. Up to four events can be programmed to occur at the prescribed date and time. In addition to the date, time and length of the event, the set of canisters that will be used during each event can also be programmed. The SASS allows for sequential sampling, so that a new sample event can begin using an alternate set of canisters while the original canisters are still in place.

Only active pre-events are listed. They are ordered (top to bottom) by the earliest date and time. Up to four pre-events can be listed. Use the up and down arrows to select an event for modification or deletion. Then use the modify or delete action keys to perform the function on the selected event. If there are less than four pre-programmed events, then the add key will bring up the add event screen.

```
Event Manager          MM/DD/YY HH:mm:ss
Start Date/Time      Length  Canisters
MM/DD/YY HH:mm:ss   HH:mm   {1,2,3}
MM/DD/YY HH:mm:ss   HH:mm   {5,6,7}

Add      Modify      Delete      Exit
```

**Figure 9. Event Manager Screen.**

### 5.1.2.2 Event Defaults Screen

This menu allows the operator to set default values into the system. These values will be used whenever the default is selected from the add or modify event screens. Defaults are selected for event length and canister set. A list of canister sets can be found in the add events section. Use the arrow keys to select the value to change. Use Save key to save the default values or the Exit key to leave them as they are.

```
Sample Event Defaults
                               HH:mm
Event Length:  24:00
Canister Set:  {1,2,3}

Save                               Exit
```

**Figure 10. Event Defaults Screen.**

### 5.1.2.3 Clock Setup Screen

The clock screen shows the current date and time setting of the SASS at the upper right of the screen. Using the left and right arrow keys scroll to the settings to be changed, change using the up and down arrows. After setting to the correct date and time press the SET key. Notice that the SASS time is changed to the current settings. It is best to set the new clock time to a future time, and then hit the set key when the new set time has been reached.

```
Clock Setup          12/24/00 11:10:35
      MM/DD/YY
Date: 12/24/00
      HH:mm:ss
Time: 11:30:22
Set                               Exit
```

**Figure 11. Clock Setup Screen.**

#### 5.1.2.4 Unit ID Screen

The SASS is identified by a station number (ID). This is set by the factory to match the last four digits of the SASS serial number. The ID number marks the retrieved data from the SASS. Data retrieved from multiple samplers are identified by a unique ID number.

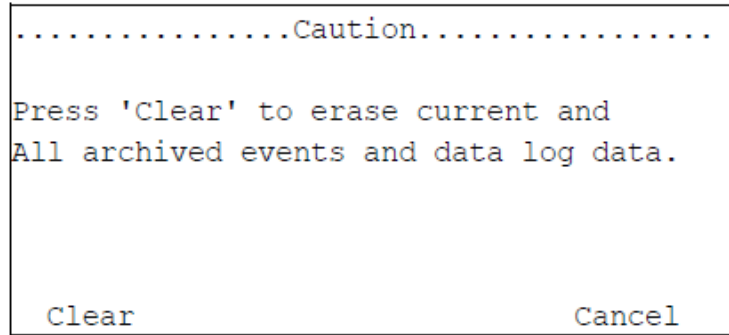
```
Unit ID
Unit ID: 4585
Save                               Exit
```

**Figure 12. Unit ID Screen.**

#### 5.1.2.5 Clear Event History Screen

The clear event history screen can be used to remove all archived events as well as all logged data that has been collected during the archived events. This function should only be used when all data in the

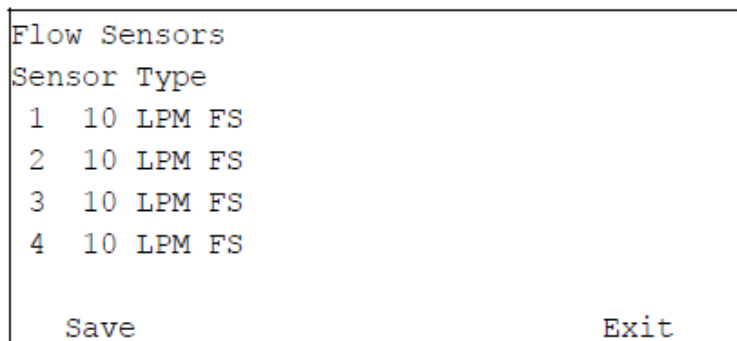
SASS has been collected and archived on other media such as a PC Computer. The clear will delete any current test in progress as well as any events in the event queue. Use this command with caution to prevent the loss of data.



**Figure 13. Clear Event History Screen.**

#### 5.1.2.6 Flow Sensors Screen

Flow sensor types are only changed if a flow sensor must be replaced. Instructions are provided with the flow sensor that provide correct configuration. The SASS can use two types of mass flow meters (10 or 20 lpm full scale). Edit to select the appropriate type. This configuration is normally done at the factory, but it may become necessary to make a change if a field replacement is of a different type than the original.



**Figure 14. Flow Sensors Screen.**

### 5.1.3 Calibration Menu

This menu contains the calibration and test screen selection. Using the functions keys F1 to F4, the various types of test and calibration sub menus can be found. The system test selection allows for the viewing of physical parameters temperature, and flow on all system channels.

```

Calibrate Menu
F1: System Test
F2: Flow Calibration
F3: Temperature Calibration
F4: Pressure Calibration
F5:
F6:
Exit
  
```

**Figure 15. Calibration Menu Screen.**

#### 5.1.3.1 System Test Screen

The system test screen shows all of the measured parameters in real time. Its primary function is to allow testing of the system as part of the preliminary check of the SASS. It is also useful for troubleshooting when problems may have been detected or for general maintenance of the unit.

```

System Test          MM/DD/YY HH:MM:SS
Ambient P   xxx mmHg  Ambient T  -xx.x C
  Flow 5   xx.x Lpm   Filter 5   -xx.x C
  Flow 6   xx.x Lpm   Filter 6   -xx.x C
  Flow 7   xx.x Lpm   Filter 7   -xx.x C
  Flow 8   xx.x Lpm   Filter 8   -xx.x C
                                Pump:   ON
Cans                Pump      Exit
  
```

**Figure 16. System Test Screen.**

### 5.1.3.2 Flow Calibration Screen

This menu is the first of the calibration screens that allow for the actual calibration of the SASS system. To perform a calibration of volumetric flow, a reference standard is required. This single point check is made on each individual flow channel. Selection of flow channel is done using the up and down arrow keys to select the number of the channel listed under “Chan”.

```
Volumetric Flow Calibration

Chan  SASS  Ref      Type
(1)   .0    6.7 LPM  10 LPM FS

      Pump: OFF

Calibrate  Pump  Default  Exit
```

**Figure 17. Flow Calibration Screen.**

### 5.1.3.3 Temperature Calibration Screen

This screen provides the calibration screen for the calibration of the temperature monitoring system of SASS. To perform a calibration of temperature, a single reference standard is required. The up/down keys are used to select the temperature sensor that is to be calibrated. The name in the upper left corner will either be listed as “ambient” for the outside temperature and “filter” for the specific canister temperature (1 through 8).

```
(x) xxxxxxxx Temperature Calibration

SASS  Pt  Save  Reference
21.9  1  -30.0  -30.0 C    Save (F1)
      2   50.0  050.0 C    Save (F4)

Calibrate                Default  Exit
```

**Figure 18. Temperature Calibration Screen.**

### 5.1.3.4 Pressure Calibration Screen

This screen provides the calibration screen for the calibration of the pressure sensor in the SASS unit. The pressure is used by the flow monitoring system to determine the volumetric flow from the measured mass flow sensors. To perform a calibration of pressure, only a single reference standard is required.

```
Pressure Calibration

SASS  Pt  Save  Reference
 730   1   735   600 mmHg   Save (F1)
       2   735   735 mmHg   Save (F4)

Calibrate                Default  Exit
```

**Figure 19. Pressure Calibration Screen.**

### 5.1.3.5 Transfer Data Menu

This menu once selected from the main screen allows for the transfer of the SASS memory contents into the optional UX-961 Transfer Module. During direct connection to PC data transfers, the status of the transfer can be viewed when the transfer data screen is selected.

```
XMODEM File Transfer
      Status:
      Received:
      File Size:
      Packet:

Transfer Transfer
History    All          Exit
```

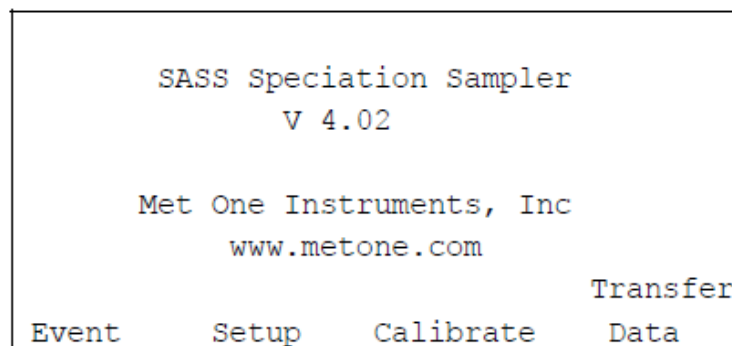
**Figure 20. Transfer Data Screen.**

## 5.2 Monitor Setup

The SASS user interface is a touchscreen display. All of the features and functions for monitor setup are accessed using the control box and menu driven screens.

### 5.2.1 Power Up and Warm Up Period

Upon initial startup, allow the instrument to run for at least 10 minutes to reach stable operating conditions. This applies any time the unit is powered up after being off for more than one minute or power outage. When powering up the sampler, the home menu screen should appear as in Figure 21.



**Figure 21. Home Menu Screen.**

**Note: Due to ambient temperature, the LCD display may be weak or saturated. Adjust the screen contrast using the ☼ key on the Control Box keypad. Continued pressure on the key will lighten or darken the LCD display accordingly.**

After warm-up, navigate to the system test screen to verify that the monitor is functioning within allowable operating parameters. These readings can also be used as diagnostic tools for troubleshooting a performance problem.

### 5.2.2 Time and Date Setup

The SASS clock time must agree with NIST time to within  $\pm 1$  minute, Eastern Standard Time. The clock setup screen allows changes to the hour, minute, second and date.

1. From the home menu screen press <Setup>. Then press <F3>.



2. Use the left and right arrow keys to move to the values of MM/DD/YY or HH:mm:ss that need to be entered or changed.
3. Use the up and down arrow keys to change the current values to the proper date and time.
4. Press <Set> and the values will be entered as the new default values. Press <Exit> to return to the setup menu screen.

```
Clock Setup          12/24/00 11:10:35
      MM/DD/YY
Date: 12/24/00

      HH:mm:ss
Time: 11:30:22

Set                               Exit
```

**Figure 22. Clock Setup Screen.**

### 5.2.3 Default Event Setup

1. From the home menu screen press <Setup>. Then press <F2> to view the event default screen (Figure 24).
2. Use the left and right arrow keys to move to the values of HH or mm that need to be entered or changed.
3. Use the up and down arrow keys to change the current values to the typical values used for all sampling collections.
4. Press <Save> and the values will be entered as the new default values. Press <Exit> to return to the setup menu screen.

```
Sample Event Defaults
                                     HH:mm
Event Length: 24:00
Canister Set: {1,2,3}

Save                                     Exit
```

**Figure 23. Event Default Screen.**

#### **5.2.4 Sampler ID Setup**

1. From the home menu screen press <Setup>. Then press <F4> to view the sampler ID screen (Figure 25).
2. Use the up and down arrow keys to change the current values to the new ID value.
3. Press <Save> and the values will be entered as the new default values. Press <Exit> to return to the setup menu screen. Press <Exit> again to return to the home menu screen.

```
Unit ID
Unit ID: 4585

Save                                     Exit
```

**Figure 24. Sampler ID Screen.**

## 5.3 Sample Setup and Retrieval

### 5.3.1 Pre-Sampling

During shipment from the support laboratory to the sampling locations, there are no requirements for temperature control. However, the sampling canisters should remain in their protective transport containers. Avoid exposure to excessive heat (avoid storing transport containers in direct sunlight or enclosed vehicles during the summer months).

Upon receipt at the field office:

- The site operator should notate the date the sample arrives at the field office on the enclosed custody and field data form (CAFDF).
- Inspect the exterior of the shipment container notating any evident damage or contamination on the CAFDF.
- Ensure that each identifying number printed on the CAFDF corresponds to an enclosed sample canister. Do not use any unidentified component and notify the support laboratory should there be discrepancies.
- Sign and date the custody portion of the CAFDF.
- Keep all sample components together in an air conditioned, secure area until transport to the sampling site.
- Freeze the enclosed ice packs for use in transport back to the support laboratory. It is recommended that ice packs be frozen for at least three days at a temperature of  $-32\text{ }^{\circ}\text{C}$  to ensure filters arrive at the support laboratory at or under  $4\text{ }^{\circ}\text{C}$ .

Once a canister is removed from its transport container, extreme care should be taken to avoid potential contamination. It should remain capped until installation in the sampler and protected from exposure to dust, gases, or abrasion. Along with the preloaded filter canisters, the operator should take the following along for sample set up:

- The PM 2.5 STN CAFDF, provided by the support laboratory.
- Equipment for independent verification of routine sampler operation (date, time, temperature, pressure).
- Operations manual.

- Sharp cut cyclone (SCC) for each sampling canister(s) if they are not currently on site or if they are scheduled to be replaced.
- Shipping coolers and frozen ice substitutes.

### 5.3.2 Sample Setup

1. Lower the radiation shield.
2. Insert the SCC into the bottom of the sample canister and rotate it until the plate on the cyclone locks into the lock screw on the canister. A small amount of silicone grease or similar lubricant on the O-rings will make the cyclone insertion easier. *Note: From this point forward always keep the canister SCC side down to avoid contamination of the filter media.*
3. Remove the protective plug from the canister and install it onto the matching channel on the sampling head. Align the lock screws on the canister with the wider portion of the guides on the sample head. Push the canister upwards and rotate counterclockwise to secure the canister in place.
4. Once all of the canisters have been installed, raise the radiation shield and lock it in place.

### 5.3.3 Sample Event Setup

1. Open the control box and press any key to waken the screen.
2. Press <Setup> and <F1> soft key to activate the event manager.
3. Press <Add>. Using the arrow keys, enter the desired sample date in the MM/DD/YY format.
4. Press <Add> to save the information and <Exit> to return to the main screen. The SASS is now programmed and ready for the next sample run.

### 5.3.4 Data Retrieval

For consistency, it is recommended that data from the previous run be collected prior to canister pick-up or setup. To complete the data retrieval, follow the steps described below:

1. Open the sampler control box and press any key to waken the screen. Press <Event> and <F1>.
2. Record the run time information on the CAFDF.

3. Press >> to proceed to the volume summary screen. This screen displays the volume data as well as the average values over the previous sampling event. Record all required information on the CAFDF.
4. Press >> to proceed to the CV summary screen. This screen displays the CV values, mean values, and the standard deviation of the flow measurements taken during the previous sampling event. Record all required information on the CAFDF.
5. Press >> to proceed to the min/max summary screen. This screen displays the various min/max values, for temperature and pressure that were recorded during the previous sampling event. Record all required information on the CAFDF.
6. Press >> to proceed to the flow warnings summary screen. This screen indicates if there were any alarms or warnings during the previous sampling event related to flow measurement. A “Yes” value indicates an alarm occurred, the date and the time is stored on the screen. Record any flow warnings on the CAFDF.
7. Press >> to proceed to the power interruptions screen. This screen displays information on power interruptions that may have occurred during the previous sampling event. Record any power interruptions on the CAFDF.
8. Press <Exit> to return to the event menu.

### 5.3.5 Sample Retrieval

Upon retrieval, through shipment to the support laboratory, the sample canisters must be refrigerated or stored in coolers with ice packs. In addition to the sample canisters for the next run, the operator should take the following into the field:

- The PM 2.5 STN CAFDF, provided by the support laboratory.
- Equipment for independent verification of routine sampler operation (date, time, temperature, pressure, flow).
- Operations manual.
- Shipping coolers and frozen ice substitutes.

Once all the required information has been recorded on the CAFDF, and downloaded to your PC:

1. Lower the radiation shield.

2. Disengage the spent sample canister(s) by rotating it clockwise until it is free from the locking screws on the sampler head.
3. Cap the sample port. Keeping the canister SCC side down, carefully remove the SCC and cap the inlet port.
4. Place the canister upright into the shipping cooler supplied by the support laboratory.
5. Repeat this procedure until all canisters have been collected.

#### **5.4 Sample Shipment**

Spent sampling canisters must be stored in a protective transport container and transported to the support laboratory/field office within 48 hours of the sample run. Situations that cause this time frame to be extended (Friday runs, Holidays, staff issues, extreme weather conditions, etc.) must be noted on the CAFDF. The operator should retain the second page of the three page CAFDF and package the top copy in the shipping container. Package the canisters and ice packs, then contact the shipping agent. Chain-of-custody seals on the shipping coolers or containers are not required.

## 6.0 CALIBRATION

It is a good practice to complete all outstanding maintenance activities prior to initiating a full calibration. *Note: A flow verification must be completed prior to a calibration if the sampler was previously operating at the site.* New samplers installed at a site do not need a flow verification prior to a calibration because there is no collected data to envelope. Annual calibrations are required within 365 days of the prior calibration.

*Note: If the monitor is being turned on for the first time, or being restarted after a period of stoppage, it is recommended that the user allow the SASS to warm-up for 10 minutes prior to performing any calibration.*

### 6.1 Calibration Requirements

A calibration is required under the following circumstances:

- Upon initial sampler set up.
- Annually (no more than 365 days from the last calibration).
- After a sampler is replaced.
- After a sampler is moved or relocated, no matter the distance.
- After the pump or flow controller is replaced.
- If flow check or a flow audit are not within specifications.
- If the device once used for flow calibration needs to be used as the audit device.
- If the sampler is without power for longer than 72 hours and the flow verification fails.

## 6.2 Calibration Equipment



**Figure 25. BGI Tetra Cal with Optional Temperature Probe.**

All device certifications must be current within 365 days of use. Listed below is the necessary equipment needed for completing a calibration:

- Audit SASS canisters.
- A certified Tetra Cal unit or Streamline Flow Transfer Standard (FTS).
- If using a FTS, a digital, water or oil manometer, capable of measuring to a tenth of an inch of water.
- If using a FTS, a 12-18" piece of 1/4" diameter Tygon® tubing to connect the FTS to the manometer.
- If using a FTS, a SCC flow audit adapter.
- A glass thermometer capable of measuring to the nearest half a degree Celsius, that is traceable to a National Institute of Standards and Technology (NIST) standard, or the thermistor probe included with a certified Tetra Cal unit.
- A digital barometer, that is NIST traceable, or the barometer that is part of a certified Tetra Cal unit.
- The most recent revision of the SASS electronic logbook.



*Note: If using a glass thermometer, hang the thermometer from the shaded side of the ambient temperature probe's solar shield or sampling inlet. Allow all devices, whether a Tetra Cal or digital barometer, to equilibrate for approximately 10 minutes, making sure to keep them out of direct sunlight.*

### **6.3 Calibration: E-Log Setup**

1. Open the most recent scrolling e-log for the site. If this is a new site or the first visit of the calendar year, obtain the proper e-log from the IBEAM documents module, the Ambient/Documents/PM Monitoring SharePoint folder or by contacting the RCO particulate matter lead.
2. Select the "Calibration" tab of the e-log.
3. Enter in the information for all of the white boxes under the Visit Information, Thermometer information, Manometer Information, Barometer Information, Tetra Cal or FTS information sections.
4. Do not proceed if any of the devices fail the certification requirement (certified within 365 days of use).

### **6.4 Calibration: Leak Check**

Prior to conducting a flow rate calibration, a successful leak check must be performed. The system can easily be checked for air leaks. Take the following steps to perform an "as found" leak check:

1. Lower the radiation shield. Remove the sample canisters and SCCs from the SASS channels. Cap the canister's sample port and set aside.
2. Attach the audit canisters to channels one through three and use the unit's respective SCCs.
3. Press <Calibrate>, <System Test>, <Pump> and then <Continue> to engage the pump. The screen should return to the system test menu.
4. Allow pump to run for 5 to 10 minutes.
5. Press <Leak>. This will allow the flow controller valves to be disengaged, and therefore not adjust the flow.
6. Tightly seal the inlet of the SCC using a cap or a non-gloved thumb.

7. Allow for stabilization and record the leak flow rate for channel #1 from the system test menu screen in the leak check field on the calibration tab of the electronic logbook. *Note: the flow rate for Channel #1 should drop to  $\leq 0.0$  l/min.*
8. Without making changes to the operating status of the SASS (i.e. it is not necessary to turn the pump or leak check mode off when switching channels) repeat the leak check on the remaining in service channels using the audit canister and the respective channel's SCC. If all remaining channels pass the leak check, move on to step 13. If not, continue with step 9 for the failing channel.
9. Disconnect the vacuum line from the sample head at the side of the pump box. The flow for that channel should drop to 0.0 L/Min. This indicates that the leakage path is between the pump and the sample head.
10. Reconnect the vacuum line to the pump box. Remove the canister from the sample head, and block off the vacuum line connection that would have inserted into the canister. One of the yellow cap plugs supplied on the canisters can be used for this. If the flow value drops to 0.0 L/Min, then the leakage is either in the connection between the canister and the head, the canister and SCC, or both.
11. Remove the SCC from the canister and plug the bottom of the canister with one of the yellow cap plugs. Install the canister on the sample head and examine the flow value. It should drop to 0.0 L/Min. If it indicates a leak then the seal between the sample head and the canister is at fault (check to see if the O-rings are in good condition). The other possibility is that the canister is not correctly assembled and a leakage path around the two sections of the canister exists. A 0.0 L/Min reading would indicate the problem is in the SCC.
12. Replace the SCC on the canister; if the flow channel indicates a leak, then the problem is with the SCC. Verify that the O-ring seals on the SCC are intact and have not been damaged. If they are cut or have any other type of damage, they must be replaced. If the flow reads 0.0 L/Min then the problem is fixed, and there is no leakage in the system. The original indication was probably caused by a poor initial connection when the canister or SCC was installed in the sample head.
13. When the leak check values for all channels has been recorded, press <Leak>. This will turn off the leak check mode.

## 6.5 Calibration: Ambient Pressure Sensor

The ambient pressure must be calibrated prior to the flow because the actual flow is calculated using both ambient temperature and pressure. *Note: A sensor calibration always requires a flow calibration afterwards.* Take the following steps to perform a pressure sensor calibration:

1. With a NIST traceable pressure device measuring the ambient pressure, from the main menu screen, press <Calibrate> and then <F4>. This will display the pressure calibration screen (Figure 26).

Pressure Calibration				
SASS	Pt	Save	Reference	Save (F1)
730	1	0	000 mmHg	Save (F2)
	2	730	730	
Calibrate			Default	Exit

**Figure 26. Pressure Calibration Screen.**

2. Compare the current SASS pressure measurement with a reference barometer. If the two values differ, then enter the reference value in the top window for point one. Use the left and right arrow keys to move through the input fields, and use the up and down arrow keys to change the current value to the NIST pressure reading.
3. Press “F2” to save this value
4. Now press “Calibrate” and the new values will be stored into the memory control unit. This calibrates the pressure sensor in the pump box to the reference barometer
5. Record all information in the applicable fields of the climate calibration section of the calibration tab.
6. If calibration cannot meet the needed tolerance, contact the ECB and the RCO lead.

## 6.6 Calibration: Ambient Temperature Sensor

The ambient temperature must be calibrated prior to the flow because the actual flow is calculated using both ambient temperature and pressure. *Note: A sensor calibration always requires a flow calibration afterwards.* Take the following steps to perform a temperature sensor calibration:

1. From the main menu screen press <Calibrate> and then <F3>. This will display the temperature calibration screen (Figure 27).

```
(x) xxxxxxxx Temperature Calibration

SASS  Pt  Save  Reference
21.9  1    .0   -30.0 C    Save (F1)
      2   22.0 050.0 C    Save (F4)

Calibrate          Default  Exit
```

**Figure 27. Temperature Calibration Screen.**

2. If the menu is not already in the “ambient” temperature measurement mode, use the arrow keys to move the cursor to the upper left hand selection and choose the “ambient” measurement (0). *Note: The value under the SASS on the screen; this is the ambient temperature.*
3. Hold the temperature probe of the NIST device in close proximity to the gill screen holding the ambient temperature probe of the SASS. *Note: If there is direct sun, ensure the NIST probe is held behind the gill screen relative to the sun so that the gill screen casts a shadow on the NIST device temperature probe (Figure 28).*



**Figure 28. Proper Shaded Location.**

4. Wait at least ten minutes for the NIST device and SASS temperatures to stabilize. When the probes are stable, enter the value measured from the reference thermometer into the top reference window using the arrow keys. When completed, press <F1> to save.
5. Now press <F4> and the new values will be saved in memory of the control unit.
6. Record the final NIST device ambient temperature and SASS ambient temperature to the calibration tab of the E-log.
7. Compare NIST temperature to SASS ambient temperature and if off by more than  $\pm 2^{\circ}\text{C}$ , troubleshoot and repeat. *Note: Temperature probes that do not meet the expected tolerance of  $\pm 2^{\circ}\text{C}$  of NIST should be inspected and cleaned. Cleaning of the gill screen may also help to ensure air can pass freely to the probe.*
8. If calibration cannot meet the needed tolerance, contact the ECB and the RCO lead.

## 6.7 Calibration: Filter Temperature Sensor

This same procedure can also be used for the calibration of the filter temperature sensors.

1. From the main menu screen press <Calibrate> and then <F3>. This will display the temperature calibration screen.
2. Use the arrow keys to move the cursor to the upper left hand selection and change the value from 0 to 1. This will now indicate the channel one filter temperature.
3. Insert a temperature probe into the open hole after canister number one has been removed. Wait at least ten minutes for the NIST device and SASS temperatures to stabilize. When the probes are stable, enter the value measured from the NIST thermometer into the top reference window using the arrow keys. When completed, press <F>1 to save.
4. Now press <F4> and the new values for the channel one temperature probe will be saved in memory of the control unit.
5. Record the final NIST device temperature and SASS filter temperature to the calibration tab of the E-log.
6. Compare NIST temperature to SASS ambient temperature and if off by more than +/- 2°C, troubleshoot and repeat. *Note: Temperature probes that do not meet the expected tolerance of +/- 2°C of NIST should be inspected and cleaned. Cleaning of the gill screen may also help to ensure air can pass freely to the probe.* Repeat this process for channels two through eight.
9. If calibration cannot meet the needed tolerance, contact the ECB and the RCO lead.

## 6.8 Calibration: Flow

Flow rate calibrations are done on installation, annually, or if a verification fails. This applies to all channels individually. Flow calibrations are conducted on channels one through four only. Channels five through eight use the same flow controllers as one through four. *Note: Flow calibrations should be conducted after all verifications and a pressure calibration have been performed, as necessary.* Conduct the flow calibrations and post calibration flow evaluations of the flows in the following order:

1. From the main menu press <Calibrate> and then <F2>. This will display the volumetric flow calibration screen.
2. Insert the audit canister and the sampler's SCC onto sample channel number one.

3. Attach the reference device to the inlet of the SCC. If using a FTS, a SCC flow audit adapter will be needed.
4. Using the arrow keys to select the channel number to be calibrated.
5. Press <Pump>. Allow time for flow rate stabilization.
6. Once stable, use the arrow keys to enter the NIST flow rate in the “Ref” field. Press <Calibrate>. This will enter in the correctly measured flow rate value for that channel into the memory of the control unit.
7. Record the final NIST device flow and SASS flow to the calibration tab of the E-log.
8. Compare NIST flow to the SASS flow. If is off by more than +/- 10%, troubleshoot and repeat the calibration process.
9. Repeat this process for channels two through four, using the arrow keys to change channel number.
10. If calibration cannot meet the needed tolerance, contact the ECB and the RCO lead.

## 7.0 QUALITY CONTROL

A **Flow Verification** must be performed once every thirty days (a.k.a. Monthly Verification). It is a test of the monitor's sensors against certified standards. It is preferred, **but not required**, that the verification be completed with devices that are different from the devices used for the calibration. A flow verification is also required before any action that requires the operator to envelope the data (e.g. moving the monitor, performing maintenance that will break the sampling pathway or shutdown). A flow verification is also required after a power outage lasting more than 48 hours. A monthly flow verification cannot be completed on the same day as a calibration unless it is the final day of the calendar month.

An **Audit** must be performed every quarter. It should be performed in the second month of each calendar quarter if possible. It is a test of the monitor's sensors against certified standards **that were not used** for the previous calibration, monthly verifications or mid-month verifications. Standards that have been recently recertified (having been used for calibrations/verifications and not used since) are candidates for becoming audit equipment. Audits are also to be performed by personnel other than the normal site operator. If the audit cannot be performed during the second month due to abnormal circumstances (such as the monitor being inoperable or extreme weather events), the mid-month verification must be completed instead. The audit should then be performed in place of the mid-month verification during the third month, before the quarter ends.

All device certifications must be current within 365 days of use. Listed below is the necessary equipment needed for completing a calibration:

- Audit SASS canisters.
- A certified Tetra Cal unit or Streamline Flow Transfer Standard (FTS).
- If using a FTS, a digital, water or oil manometer, capable of measuring to a tenth of an inch of water.
- If using a FTS, a 12-18" piece of 1/4" diameter Tygon® tubing to connect the FTS to the manometer.
- If using a FTS, a SCC flow audit adapter.
- A glass mineral thermometer capable of measuring to the nearest half a degree Celsius, that is traceable to a National Institute of Standards and Technology (NIST) standard, or the thermistor probe included with a certified Tetra Cal unit.
- A digital barometer, that is NIST traceable, or the barometer that is part of a certified Tetra Cal unit.

*Note: If using a glass thermometer, hang the thermometer from the shaded side of the ambient temperature probe's solar shield or sampling inlet. Allow all devices, whether a Tetra Cal or digital barometer, to equilibrate for approximately 10 minutes, making sure to keep them out of direct sunlight.*



## 7.1 Tolerances and Corrective Actions for Verifications, Checks, and Audits

If any parameter fails the tolerance listed in Table 2, corrective action is required as indicated. *Note: Do not perform a calibration until after you have verified, checked, or audited all of the parameters.*

**Table 2. Operation Evaluations.**

CRITERIA	TOLERANCE	FREQUENCY	CORRECTIVE ACTION
External Leak Check	$\leq 0.1$ lpm	<ol style="list-style-type: none"> <li>Before and after any flow verification.</li> <li>During each quarterly audit.</li> </ol>	Make sure all hoses are well connected. If unit fails to pass, call ECB and Particulate Lead.
Ambient Temperature Verification or Audit	$\pm 2$ °C of NIST Thermometer	<ol style="list-style-type: none"> <li>During each monthly check.</li> <li>During each quarterly audit.</li> </ol>	Perform a flow verification prior to an ambient pressure adjustment. Follow with complete calibration. If unit fails to pass, call ECB and Particulate Lead.
Ambient Pressure Verification or Audit	$\pm 10$ mm Hg of NIST Barometer	<ol style="list-style-type: none"> <li>During each monthly check.</li> <li>During each quarterly audit.</li> </ol>	Perform a flow verification prior to an ambient pressure adjustment. Follow with complete calibration. If unit fails to pass, call ECB and Particulate Lead.
Monthly Verification	$6.7$ lpm $\pm 10\%$	<ol style="list-style-type: none"> <li>Each calendar month.</li> <li>Power outage <math>&gt; 72</math> hours</li> </ol>	Investigate the cause for the failure. If no other cause is identified other than monitor drift, perform a calibration. If unit fails to pass, call ECB and Particulate Lead.
Mid-Month Verification	$6.7$ lpm $\pm 10\%$	14-18 Days after Flow Rate Verification (in non-audit months)	Investigate the cause for the failure. If no other cause is identified other than monitor drift, perform a calibration. If unit fails to pass, call ECB and Particulate Lead.
Quarterly Audit	$6.7$ lpm $\pm 10\%$	Quarterly (preferably the second month)	Investigate the cause for the failure. If no other cause is identified other than monitor drift, perform a calibration. If unit fails to pass, call ECB and Particulate Lead.

## 7.2 Verification or Audit: E-Log Setup

1. Open the most recent scrolling e-log for the site. If this is a new site or the first visit of the calendar year, obtain the proper e-log from the IBEAM documents module, the Ambient/Documents/PM Monitoring SharePoint folder or contact the RCO PM lead.
2. Select the “Verification Audit” tab of the e-log.
3. Enter in the information for all of the white boxes under the Visit Information, Thermometer information, Manometer Information, Barometer Information, Tetra Cal or FTS information sections.
4. Do not proceed if any of the devices fail the certification requirement (certified within 365 days of use).

## 7.3 Verification or Audit: Leak Check

Prior to conducting a flow rate calibration, a successful leak check must be performed. The system can easily be checked for air leaks. Take the following steps to perform a leak check:

1. Lower the radiation shield. Remove the sample canisters and SCCs from the SASS channels. Cap the canister’s sample port and set aside.
2. Attach the audit canisters to channels one through three and use the unit’s respective SCCs.
3. Press <Calibrate>, <System Test>, <Pump> and then <Continue> to engage the pump. The screen should return to the system test menu.
4. Allow pump to run for 5 to 10 minutes.
5. Press <Leak>. This will allow the flow controller valves to be disabled, and therefore not adjust the flow.
6. Tightly seal the inlet of the SCC using a cap or a non-gloved thumb.
7. Allow for stabilization and record the leak flow rate for channel #1 from the system test menu screen in the Leak Check field on the “Verification Audit” tab of the electronic logbook. *Note: the flow rate for Channel #1 should drop to  $\leq 0.0$  l/min.*
8. Without making changes to the operating status of the SASS (i.e. it is not necessary to turn the pump or leak check mode off when switching channels) repeat the leak check on the remaining in service channels using the audit canister and the respective channel’s SCC. If all remaining

channels pass the leak check, move on to step 9. If not, continue with the rest of the verification or audit and then consult section 11.0 for guidance on determining the cause of the leak.

9. When the leak check values for all channels has been recorded, press <Leak>. This will turn off the leak check mode.

#### **7.4 Verification or Audit: Ambient Pressure**

Take the following steps to perform a pressure sensor verification or audit:

1. With a NIST traceable pressure device operating and measuring the ambient pressure, from the main menu screen, press <Calibrate> and then <System Test>.
2. Compare the current SASS pressure measurement with a reference barometer and record the information in the applicable fields of the climate calibration section of the “Verification Audit” tab.
3. If the ambient pressure does not pass, continue with the rest of the verification or audit and then troubleshoot afterwards.

#### **7.5 Verification or Audit: Ambient Temperature and Filter Temperatures**

Take the following steps to perform a pressure sensor verification or audit:

1. With a NIST traceable temperature device measuring the ambient temperature, from the main menu screen, press <Calibrate> and then <System Test>.
2. Hold the temperature probe of the NIST device in close proximity to the gill screen holding the ambient temperature probe of the SASS. *Note: If there is direct sun, ensure the NIST probe is held behind the gill screen relative to the sun so that the gill screen casts a shadow on the NIST device temperature probe.*
3. Wait at least ten minutes for the NIST device and SASS temperatures to stabilize. When the probes are stable, enter the information in the applicable fields of the “Verification Audit” tab.
4. Next, insert a temperature probe into the open hole after canister number one has been removed. Wait at least ten minutes for the NIST device and SASS temperatures to stabilize. When the probes are stable, enter the information in the applicable fields of the “Verification Audit” tab.
5. Repeat this process for channels two through eight.

6. Compare the current SASS ambient temperature measurement with the NIST temperature. Record the information in the applicable fields of the climate calibration section of the “Verification Audit” tab.
7. If any temperatures do not pass, continue with the rest of the verification or audit and then troubleshoot afterwards.

#### **7.6 Verification or Audit: Flow**

Conduct the flow verification or audit in the following order:

1. From the main menu press <Calibrate> and then <System Test>.
2. Insert the audit canister and the sampler’s SCC onto sample channel number one.
3. Attach the reference device to the inlet of the SCC. If using a FTS, a SCC flow audit adapter will be needed.
4. Press <Pump>. Allow time for flow rate stabilization.
5. Once stable, record the NIST device flow and SASS flow to the “Verification Audit” tab of the E-log.
6. Compare NIST flow to the SASS flow. If it is off by more than +/- 10%, continue with the rest of the verification or audit and then troubleshoot afterwards.
7. Repeat this process for channels two through four.

## 8.0 MAINTENANCE

Very little maintenance is required for the operation of the SASS Sampler System. The following procedures should be followed for reliable continuous operation of the system. Most maintenance involves inspection of components for damage or wear, as well as performing regular checks and calibrations of the system. All sampler maintenance must be recorded on the “Maintenance Log” tab of the e-log.

The SASS system contains both electronic and pneumatic components. Historically the vacuum pumps of most ambient air sampling systems require at least annual maintenance. The dual headed Thomas™ diaphragm pump used in the SASS can be removed by the operator from the field and new diaphragms and valves placed into the pump insuring another year of operation without failure.

The O-rings used in the SASS are made from Viton™ rubber. These O-rings should continue to provide a leak free system for several years. However, if leaks are detected during operation or during leak checking, these O-rings could be leaking. It is recommended to replace O-rings every two to three years depending on use and wear. However, they should be inspected on a regular basis.

It is recommended that operators carry the following items in their field maintenance kit:

- Can of compressed air with tube
- Cotton Tipped Applicators
- Phillips Head Screwdriver
- Vacuum grease (silicone based)
- 91% Isopropyl Alcohol for cleaning the SCCs
- Distilled water
- Cotton cloth or Shop Towels

- Kimwipes
- O-rings for the SCCs
- Flashlight

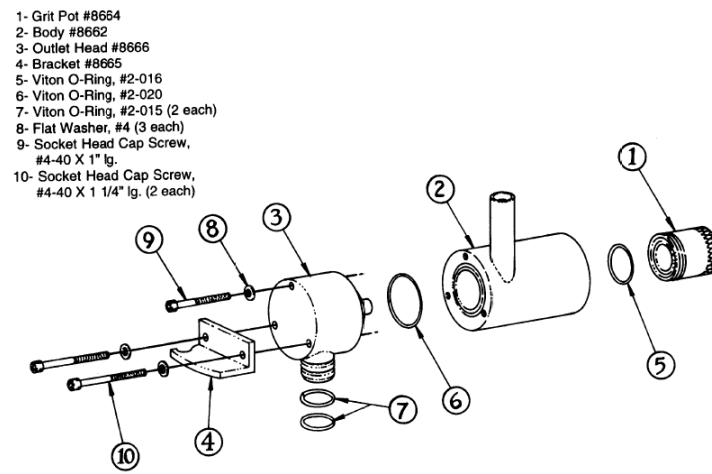
**Table 3. Summary of Sampler Maintenance.**

<b>Maintenance Activity</b>	<b>Frequency</b>
<ul style="list-style-type: none"> <li>• Download data, settings, and alarm files</li> </ul>	Every 14 – 18 days
<ul style="list-style-type: none"> <li>• Disassemble and clean the SCCs</li> <li>• Clean the head assembly</li> <li>• Clean solar radiation assembly</li> <li>• Wipe down interior/exterior of sampler</li> <li>• Check clock time against NIST</li> </ul>	Every 30 days
<ul style="list-style-type: none"> <li>• Inspect and clean pump housing</li> <li>• Inspect O-rings</li> <li>• Inspect and clean control box, cables and sampling lines</li> <li>• Inspect and clean pump box filter screen and aspiration fan</li> <li>• Ensure sampler is connected to grounding rod.</li> </ul>	Every 91 days
<ul style="list-style-type: none"> <li>• Purge the data from the internal memory</li> </ul>	Every 181 days
<ul style="list-style-type: none"> <li>• Inspect electrical connections</li> <li>• Change filters in audit canisters</li> </ul>	Every 365 days

### **8.1 Cleaning the SASS SCC**

1. Having removed the SCC from the sampling canister, unscrew the grit pot from the main body of the SCC and set aside.
2. Using a cotton tipped applicator and Isopropyl Alcohol, clean the grit pot, the outlet and the inlet of the SCC body.
3. Using a new applicator with Isopropyl Alcohol, clean the internals of the SCC with downward strokes, taking time to completely move around the inside of the orifice.
4. Use a Kimwipe to remove any remaining dust or debris from the body of the SCC.

5. Reassemble, taking time to inspect the O-rings for excessive wear or breaks.
6. The operator may also choose to disassemble the SCC for further cleaning (removing the outlet head) at intervals of their choosing.



**Figure 29. Exploded View of SCC.**

## 8.2 Cleaning the System

Each time the system canisters are replaced, or as deemed necessary, the solar radiation shield of the sampler head should be cleaned with a wet cloth or, if required, a dilute soap and water solution. Dirt buildup on the shield can reduce the effectiveness of the reflective surface and cause the temperature to rise inside the shield.

The pump housing should be inspected and cleaned at least every quarter by removing the four screws on the corners and lifting the cover up and out of the way. Using a brush or a compressed air source, clean the insides of the enclosure and in particular the screen located below the pump assembly. When completed, replace the cover by tightening down the two screws located on the fan exhaust side first, and then snug the two screws on the opposite end of the enclosure.

The control box and cables should be inspected for damage or dirt and dust accumulation. The control box can be cleaned with a wet cloth or if required a dilute soap and water solution. The screen of the

control box electronics should only be cleaned with a damp cloth, and no liquids should be allowed to enter the electronics package.

### **8.3 Inspecting the System**

As part of the normal maintenance and operation, the various components of the system should be inspected for wear, damage, and changes in previous operation. Most inspections rely on visual checks during normal operation of the system. These should be performed each time anything is done to the system.



## **9.0 DATA HANDLING**

The operator should retain the second page of the three page CAFDF and package the top copy in the shipping container. This second page of the CAFDF serves as a record of the sampling run data and a chain of custody. A download or copy is warranted of the compact flash memory card that is shipped along with the samples. Data will also be accessible, if needed, in DART (Data Analysis and Reporting Tool, see section 10.0 Quality Assurance) at a later date.

## **10.0 QUALITY ASSURANCE**

### **10.1 Data Review**

The downloaded SASS data must be reviewed by the regional office staff. The SASS concentrations should be reviewed. It is at the discretion of the regional ambient monitoring coordinator (RAMC) as to how this process should be executed. At a minimum, each operator should review their site data and report abnormalities to either the RAMC or the RCO PM Chemist.

### **10.2 Field Operator Quality Assurance**

Upon arriving at the site, the field operator is responsible for ensuring that the monitor has collected what appears to be valid data since the previous site visit. This includes reviewing the alarms and collected data. Below is a suggested list of items that operators should be verifying during each site visit:

- Possible changes near the site that could bias the data (fires, construction, etc.)
- Encroachment of wildlife or vegetation
- Vandalism
- Obstructions of the inlet
- Alarms on the screen of the SASS
- Abnormalities in the Super SASS downloads.
  - Ensuring that there are no gaps in the data
  - Investigating repetitive patterns of numbers
  - Checking the ambient temperature data (no abnormal trends, repeating values)

### **10.3 Regional Ambient Monitoring Coordinator Quality Assurance**

The RAMC is responsible for reviewing all raw data and logbooks prior to submitting the data to RCO. The specific QA duties for the regional ambient monitoring coordinator are described in the following sections.

### 10.3.1 URG Download Review

The RAMC is responsible for reviewing the SASS download data, alarms, and settings to ensure that there are no abnormalities:

- Ensuring that there are no gaps in the data
- Ensuring that repetitive patterns of numbers have been addressed
- Checking the ambient temperature data (no abnormal trends, repeating values)

### 10.3.2 Electronic Logbook Review

The e-logs are an additive yearly scrolling document. The RAMC must review the e-log for each site on a monthly basis. E-log reviews are recommended, but not required, to be conducted every 15 days to ensure the operators and the monitors are meeting the necessary requirements.

1. The RAMC must review all e-logs for completeness, verifications, audits, calibrations, and monitor problems. Specifically, the RAMC must verify that:
  - There is a monthly and mid-month verification (or audit) for each calendar month.
  - All devices used were within certification dates.
  - Audit devices were different from the monthly verification devices.
  - All leak checks passed.
  - All monitor issues and missing data are clearly documented in the comments.
  - Monthly, and quarterly maintenance items were completed.
  - There is downloaded data (alarms, data, and settings) for all collected data.
2. The RAMC and the operator should discuss any discrepancies, errors, concerns, or questions before the e-log is submitted to RCO.
3. The RAMC must sign and date each e-log record before submission to the RCO. There are RAMC review spaces on the “Maintenance”, “Calibration”, “Site Visit”, and “Verification Audit” pages. The RAMC should only make corrections in the comments section of the e-log to preserve the initial documentation of the operator.
4. The RAMC must bring any problem or suspect problem that affects the validity of the data to the attention of the RCO particulate matter lead by e-mail or telephone within 2 business days of discovery. It is recommended that the RAMC alert the RCO particulate lead as soon as possible to discuss corrective actions.

5. After e-log approval, the RAMC must post the reviewed e-logs at P:\Ambient\Incoming\RegOffices.NC\your region within fifteen days from the start of each month.

## **10.4 DART**

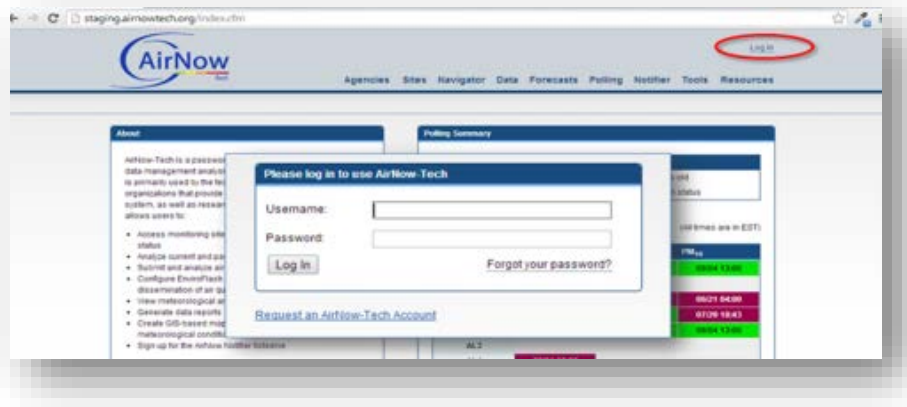
In the mid-1990s, Sonoma Technology, Inc. (STI) developed a software program, VOCDat, for validating and analyzing PAMS data. Many monitoring agencies have used VOCDat to validate and analyze PAMS data and other large sets of speciated ambient data (e.g., carbonyls, air toxics, or speciated PM<sub>2.5</sub>).

Along the same lines as VOCDat, DART (Data Analysis and Reporting Tool) is a STI web-based data validation and analysis system that is integrated with AirNow Tech. It not only provides a framework for validating and analyzing air quality data, but it will also eventually enable access to complementary data sets from different sources and web services.

In its current form, DART contains many key features for validating and analyzing data collected, such as routine air quality measurements (e.g., PM, O<sub>3</sub>, NO<sub>x</sub>), routine meteorological measurements, and VOC measurements.

### **10.4.1 Opening Dart**

1. To get started with DART, use an Internet browser to navigate to AirNow Tech (<http://airnowtech.org>). Google Chrome is the preferred Internet browser; however, Firefox and Internet Explorer version 10 or above are also supported.
2. Next, log in with a new or existing account. Choose to login at the upper right corner of the main page.



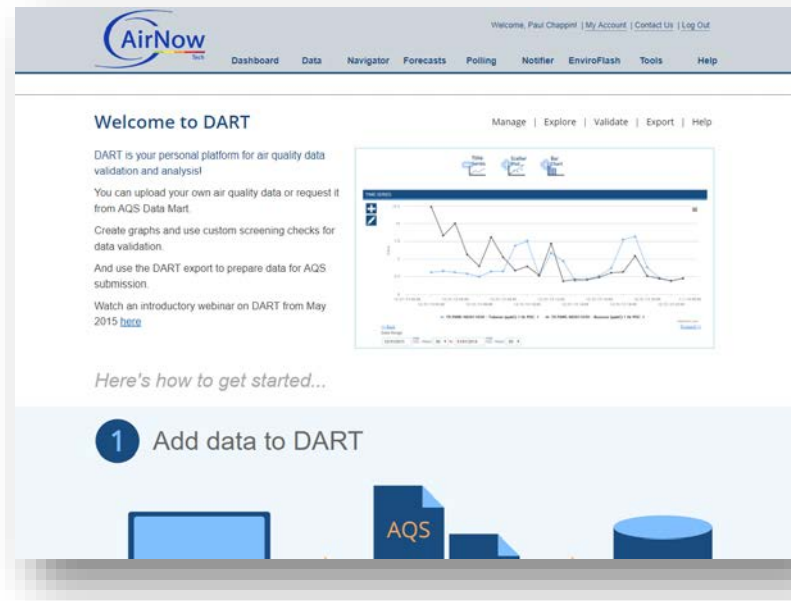
**Figure 30. DART Login Page.**

3. Find DART under the tools tab on the AirNow Tech home page.



**Figure 31. DART Tool Tab.**

4. Next, you will see the DART welcome page, which explains the three basic steps to using DART. You can return to this page at any time by clicking the DART link at the top left of the screen.



**Figure 32. DART Welcome Page.**

5. DART is organized into three general areas:

- Data Manager – upload and manage your data sets.
- Data Explorer – screen, validate, and explore your data using time series graphs, scatter plots, and bar charts.
- Data Validator – build and run automated screening checks and interactively explore results and your data using linked tables and time-series graphs.
- Data Exporter – export your data files and prepare them for submission to AQS.

6. You can access each area by clicking on the manage, explore, validate, and export links at the top right of every screen. The help link at the top right of the screen opens the DART help guide in a separate window.

#### **10.4.2 Validating CSN Data within DART**

On the manage page, you can begin to run screening checks to automatically identify problematic data, in order to make data validation more efficient.

1. To begin, click on the approval status icon.



The screenshot shows the DART Data Manage Screen. At the top, there is an AirNow logo and a navigation menu with items: Dashboard, Data, Navigator, Forecasts, Polling, Notifier, EnviroFlash, Tools, and Help. Below the navigation, the page title is "DART" with sub-links: Manage, Explore, Validate, Export, and Help. The main content area is titled "North Carolina DENR - Division of Air Quality Data Sets". It features a table with the following data:

Date Received	Type	Data Set Name	Date Range (LST)	Data Status	Download	Approval Status
04/12/2018	Lab - CSN	371830014 CSN Data	01/01/2013 - 09/28/2017	Ready for use		

Below the table, there is a "Show 10 entries" dropdown, "Showing 1 to 1 of 1 entries", and "Previous 1 Next" navigation.

**Figure 33. DART Data Manage Screen.**

2. DART's approval mode includes the following tools to aid in data review:
  - Description of the number of samples, date range, and "Review by" deadline for the data batch.
  - Sample summary table for each sample in the batch, describing the number of species, number of qualifier and/or null codes applied to the data, data completeness, and percent of data above the method detection limit (MDL).
  - Batch data table displaying the parameter concentration value, MDL, data uncertainty, and null or qualifier codes, for all the data in the batch.
  - Time series and fingerprint plots for visually reviewing the data.
3. After the 30-day review period, CSN data are automatically sent back to the laboratory; data that were not marked as reviewed are assumed to be approved by the agency.
4. The laboratory reviews any null or qualifier code changes and the comments provided by the data validators; the laboratory then prepares the final data for submission to AQS.
5. Watch a [webinar](#) from March 2016 for more information about using approval mode for the CSN review process.

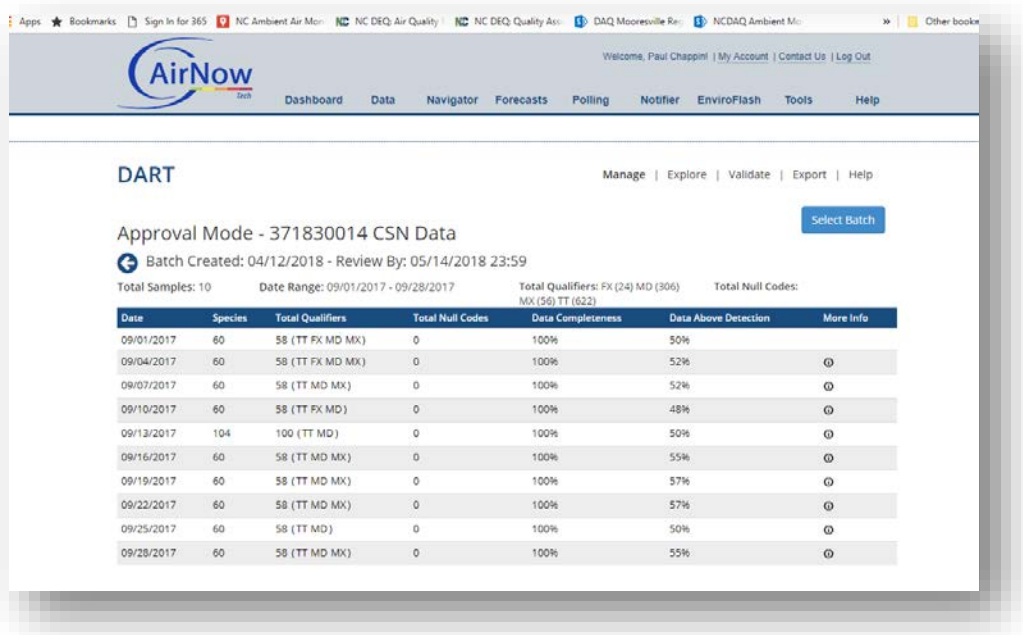


Figure 34. DART Approval Window.

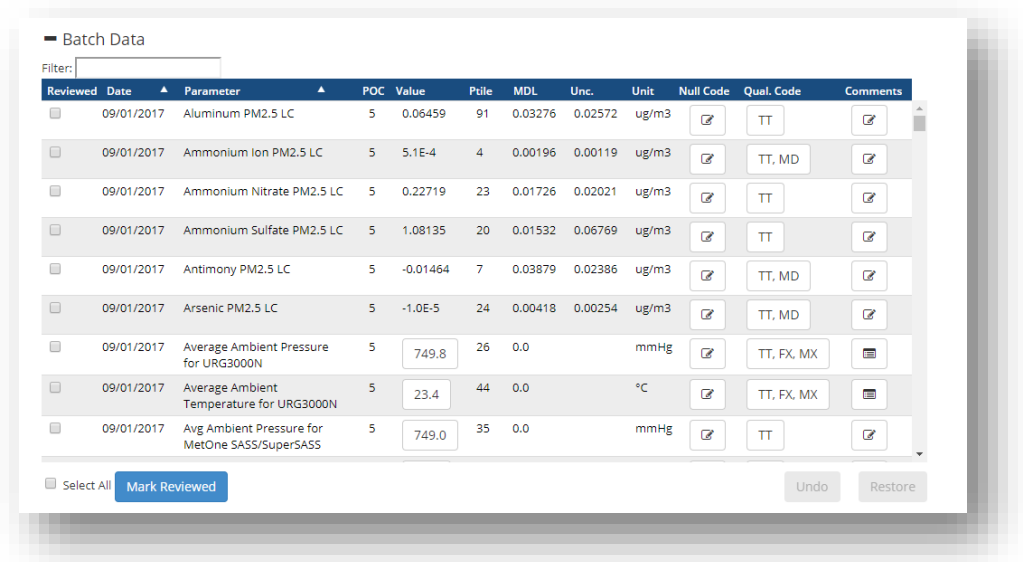
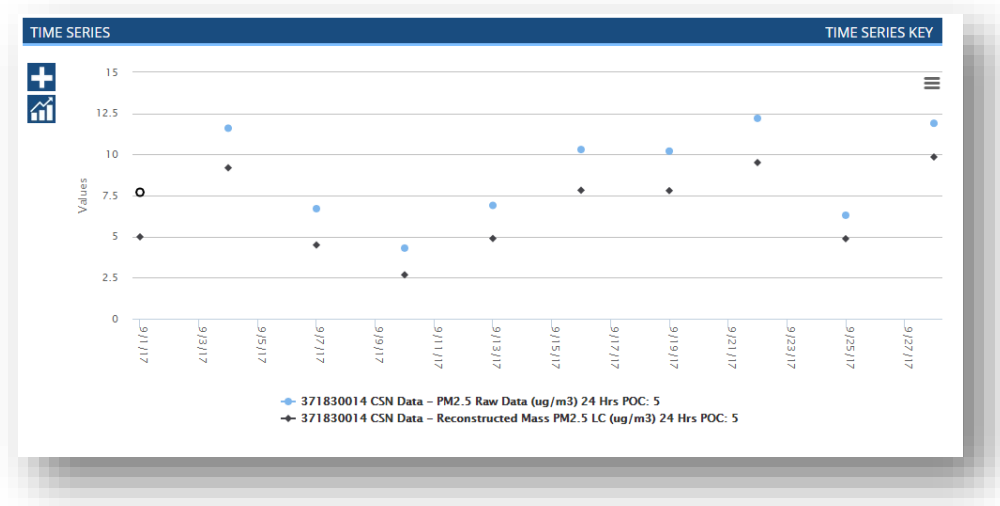


Figure 35. DART Batch Window.





**Figure 36. Time Series Window.**

6. In approval mode, null and/or qualifier codes can be edited using the edit batch window.
7. To access the edit batch window, click on the icon in the null code or qualifier code column in the row of the batch data table for the species that you would like to edit.
8. Choose the species or group of species that you would like to edit. A listing of the groups of 39 species for CSN, organized by sampling filter type, is provided in the table below. The options include:
  - Selected Species: Only the species selected in the batch data table will be changed. The row for the selected species in the batch data table will be highlighted in blue.
  - Entire Sample: All of the species for the selected sample date will be changed. For example, if the row for the Potassium ion concentration is selected and “Apply to Entire Sample” is chosen from the drop-down menu, the null and/or qualifier code(s) for all of the species measured in the sample will be changed.
  - Metal Species in Selected Sample: All of the metal species for the selected sample date will be changed. For example, if the row for the Aluminum concentration is selected and “Apply to Metal Species” is chosen from the drop-down menu, the null and/or qualifier code(s) for all of the metal species measured in the sample will be changed.
  - Ions Species in Selected Sample: All of the ion species for the selected sample date will be changed. For example, if the row for the Ammonium ion concentration is selected and

“Apply to Ions Species” is chosen from the drop-down menu, the null and/or qualifier code(s) for all of the ion species measured in the sample will be changed.

- Carbon Species in Selected Sample: All of the carbon species for the selected sample date will be changed. For example, if the row in the batch data table for the Elemental Carbon (EC) concentration is selected and “Apply to Carbon Species” is chosen from the drop-down menu, the null and/or qualifier code(s) for all of the carbon species measured in the sample will be changed.

9. Choose the null code or qualifier code(s) that you would like to add or remove from the selected species by using the drop-down menus. A species measured in a sample can have either a null code or qualifier code(s), but not both.
10. Therefore, if the selected species already has a qualifier code(s) and you would like to apply a null code, you must first remove the existing qualifier code(s) by clicking the “x” next to the code in the qualifier drop-down menu.
11. Similarly, if the selected species already has a null code and you would like to apply a qualifier code or codes, you must first remove the existing null code by selecting “No null code” from the null code drop-down. If a species concentration is missing, which displays as the value -999 in DART, a null code is required.
12. Add a comment to describe the changes you are making to the null code and/or qualifier code(s). Comments provide helpful information that is shared with other data validators in your agency. All comments and associated null or qualifier code changes are also provided to the laboratory at the end of the data review period.
13. Click “Save” to apply your changes or click “Cancel” to exit the window. By default, only specific null and qualifier code(s) will be appended or removed based on the user’s selections in the Edit Batch window. All other existing null and qualifier code(s) that are currently applied to the species or a group of species (e.g., metals, ions, entire sample) will be retained. DART also has an option to overwrite all existing null and qualifier code(s) prior to applying the new null or qualifier code(s) specified by the user in the Edit Batch window. This option can be invoked by checking the “Overwrite Codes” box next to the “Apply to” drop-down menu.

## **11.0 TROUBLESHOOTING**

This section is a description of commonly occurring problems.

### **11.1 Flow Out (Greater than +/- 10% of NIST)**

1. Completely remove flow rate measurement adapter; reconnect and perform flow rate check again.
2. Perform leak test.
3. Check flow rate at three points to determine if flow rate problem with slope.
4. Recalibrate flow rate.

### **11.2 Sample Did Not Run**

1. Check programming.
2. Try programming sample run to start while operator is at site; ensure the transport filter is in the unit.

### **11.3 Leak Check Failed**

1. Completely remove flow rate measurement adapter; reconnect and perform leak test again.
2. Inspect all seals and o-rings; replace as necessary and perform leak test again.
3. Check sampler with different leak test device.

If damaged O-rings have been found, or none of these steps have resolved the failed leak check, please contact ECB for further assistance.

### **11.4 Low Flows During Sample Runs**

1. Check programming of sampler flow rate.
2. Check flow with a flow rate verification filter and determine if actual flow is low.

### **11.5 Pressure Out (Greater than +/- 10 mmHg of NIST)**

1. Make certain pressure sensors are exposed to the ambient air and are not in direct sunlight.
2. Call local airport or other source of ambient pressure data and compare that pressure to pressure data from monitors sensor; pressure correction may be required.
3. Connect new pressure sensor.

### **12.0 REVISION HISTORY**

### **13.0 REFERENCES**

Met One Instruments, Inc., (2001) SASS Particulate Monitor Operation Manual. Prepared by Met One Instruments, Inc., Grants Pass, OR

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