

**MODEL SASS™ & SuperSASS™
PM_{2.5} AMBIENT CHEMICAL
SPECIATION SAMPLERS**

**FIELD OPERATION MANUAL
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MODEL SASS™ & SuperSASS™ PM_{2.5} AMBIENT CHEMICAL SPECIATION SAMPLERS

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**SASS/SuperSASS OPERATORS MANUAL
TABLE OF CONTENTS**

1.0	General Information.....	3
1.1	Introduction	3
1.2	Specifications	3
1.3	Technical Description	4
1.4	Sampler Configuration Options	18
1.5	Sampling Head	19
2.0	Siting and Installation.....	21
2.1	Siting	21
2.2	Tripod	21
2.3	Sampling Head Installation.....	22
2.4	Control unit & Mounting	23
2.5	Ambient Temperature Sensor Installation	24
2.6	Canister Installation	24
2.7	Pump Box Mounting.....	26
2.8	System Grounding	27
3.0	Setup and Operating Procedures.....	28
3.1	Operational Checkout of System	28
3.2	Programming of System	30
3.3	Preparation for Test Sequence	33
3.4	Sample QA/QC Procedures	39
4.0	Microprocessor Menus and Screens	41
4.1	Main Screen	41
4.2	Event Menu	42
4.3	Setup Menu	52
4.4	Calibration Menu	57
4.5	Transfer Data	61
4.6	Error and Warning Screens.....	62
5.0	Sampler Options	63
5.1	Hand-Held Data Transfer Module*	63
5.2	Flow Rate Transfer Standard.....	63
5.3	Accessory Communications Items.....	63
6.0	Maintenance, Calibration, Troubleshooting	64
6.1	Maintenance.....	64
6.2	System Leak Check.....	65
6.3	Calibration.....	67
6.4	Troubleshooting.....	72
7.0	References & Additional Reading	73

AMBIENT PM_{2.5} CHEMICAL SPECIATION SAMPLERS

MET ONE MODELS “SASS™ & SuperSASS™”

1.0 GENERAL INFORMATION

1.1 Introduction

The manual covers both the operation of the Met One Instruments, SASS™ (Speciation Air Sampling System) and the second generation of the SASS™ called SuperSASS™. SASS™ and SuperSASS™ are trademarks of Met One Instruments, Inc. The SuperSASS includes all of the operating benefits of the SASS plus expanded sampling canister stations, and the addition of sequential programming in groups of sample collection canisters. The SASS and SuperSASS have developed from the field tests performed by the US-EPA and the suggestions of our customers. The term SASS will be used in this manual to identify basic concepts used in the SASS and the SuperSASS. SuperSASS will be used to identify specific features or details of the SuperSASS.

The SASS (Speciation Air Sampler System) chemical sampler was developed under contract from the United States Environmental Protection Agency – US-EPA by Met One Instruments. The SASS collects samples for the chemical and gravimetric analysis of ambient air PM_{2.5} particles. PM_{2.5} 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 recently enacted fine particle standard for PM_{2.5}, the US-EPA has mandated a new sampling network for determining the concentration of each of these species. The SASS has been specifically designed to meet these needs.

The measurement techniques for the different chemical constituents, including semi-volatile components such as nitrates, have been developed through special sampling programs¹⁻³. These studies have shown that different sampling techniques are required for analyzing the different chemical constituents of PM_{2.5}. Met One Instruments has worked closely with the US-EPA and with potential end users to develop the SASS and the SuperSASS in order to comply with government regulations but to also incorporate features which the end user is likely to find desirable. These features include portability, and a design, which allows collection of samples without the user having to handle either the sample filter or the denuder.

1.2 Specifications

The basic SASS accommodates up to five (5) sampling canisters while the SuperSASS accommodates eight (8) sampling canisters used in groups of up to four. The SASS has active flow control on canisters 1 thru 3 with canisters 4 and 5 using a critical orifice for flow setting. The SuperSASS can operate in groups, each with active flow control. In both systems, each individual canister has its own PM_{2.5} sharp cutoff cyclone inlet; denuder ring and tandem 47 FRM filter holders. As such, each canister contains all necessary components for excluding particles above 2.5 µm, for removing interfering gases, and for collecting ambient fine particles.

The canisters are mounted in a wind aspirated radiation shield that maintains sampler temperature close to ambient. Inlets are approximately 72 inches above the ground. There are no transport lines or plenums ahead of the canisters. The sample flow rate is controlled at a flow

rate of 6.7 L/min per canister depending on filter media and denuder material pressures. The critical orifice channels are set for 6.9 L/min of the SASS.

The PM_{2.5} separation is produced by a sharp cut cyclone (SCC)⁴ 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_{2.5} cutoff curve of the WINS impactor as defined by the Environmental Protection Agency⁵. 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.

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 SuperSASS and at canister #1 of SASS.

The SASS makes use of three active volumetric flow controllers to provide precise flow control. The SuperSASS 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 filter 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. This approach eliminates the typical inlet line and plenum related contamination problems. Samplers employing sample lines and plenums upstream of the filter are prone to contamination and unreliable results.

1.3 Technical Description

The SASS sampler is shown in Figure 1.1. Ambient air enters each of the selected active canisters mounted within the solar radiation shield. Particles larger than 2.5 µm aerodynamic diameter are removed by the cyclonic inlet mounted with each canister. Remaining PM_{2.5} particles are collected on the filter media installed within each canister. Canisters may be equipped with a diffusion denuder ahead of the filter to remove selected gaseous compounds.

The SASS was designed with individual sharp cut cyclone inlets. This approach minimizes the chance for contamination and significantly reduces the required field maintenance of the unit.

Table 1.1. Specifications for the SuperSASS Ambient Chemical Speciation Aerosol Sampler

Analytes:	PM _{2.5} mass and trace metals PM _{2.5} organic and elemental carbon PM _{2.5} sulfate, nitrate and other ions PM _{2.5} elements
Number of Canisters:	SASS = Five (5), SuperSASS = Eight (8) maximum
Sample Flow Rate:	6.7 Liters/minute ± 2% per canister (active flow controlled channels) 6.9 Liters/minute per canister (critical orifice channels)
Inlet:	Sharp cut cyclone (SCC), (D ₅₀ 2.5µm AED) Detachable from Canister
Denuders:	Multicell, magnesium oxide, sodium carbonate, citric
Filter size:	47 mm OD typical FRM filter
Filters per canister	One or two in series
Plenum:	None
Transport Lines	None
Logged Parameters	Ambient temperature, °C (-30 to 50) Filter temperature, °C (-30 to 50) Sample start date and time, Sample stop date and time Status of Sampler, Flags Volumetric flow rates (L/m), and Volume (m ³ /hr)
Logging Interval	5 minute averaging
Support Stand	Tripod with mounting feet and mast.
Solar radiation	Shield, 20" Diameter. x 12"H, Wind Aspirated
Control Box	NEMA Environmental Enclosure 14"L x 14"W x 19.5"H including mounting base.
Pump	Two head diaphragm vacuum, 110/60AC
Power	110AC/60 Hz input to pump system and fan 12 VDC
Ambient Temp	(-30 to 50°C) Bead thermocouple in naturally aspirated radiation shield
Filter Temp	(-30 to 50°C) Bead thermocouple at inlet of each canister



Figure 1.1. SASS showing aspirated Solar radiation shield, Canister Inlets, Tripod, Control Box, and Vacuum Pump Box.

The SASS flow system is shown in Figure 1.2 with the SuperSASS flow system shown in Figure 1.3. Individual flow lines lead from each sampling canister through the support pole to the pump box mounted on the ground. The flow from each of the first 3 or 4 canisters enters a volumetric flow controller.

Note: *In the standard SASS, canister #4 and #5 flows are set by a precision critical orifice.*

The check valve fitting on the side of the pump box for each canister can be used to close sample lines not in use. In the SuperSASS, a set of 8 solenoid valves are used to select which of the canisters are used during each test sequence. Vacuum lines for each orifice or flow controller, leads to an electronic mass flow monitor. The lines are then connected to a common manifold. A vacuum line from the manifold leads to the pump, which is housed in a fan-ventilated box.

The electronic mass flow sensor measures the sample flow rate and the processor uses the filter temperature and barometric pressure reading to calculate and control actual volumetric flow at site conditions. These volumetric flow rates are shown instantaneously on the LCD display and logged on a five-minute average in the processor data logger.

Sample flow rates can be validated manually at the canister cyclone inlet before and after each sample event using an external NIST traceable device. Note: A low-pressure bubble meter, frictionless piston or venturi is recommended.

The physical configuration of the SASS is the similar to that of the Two-Week Sampler⁶⁻⁸. That sampler also uses a PM_{2.5} inlet (although of a different type than SASS) mounted directly in the sample canister are housed underneath a solar radiation shield with downward pointing flow inlets. It has operated continuously at twelve sites since 1994, with collocated sampling precision of 5% for most species⁹.

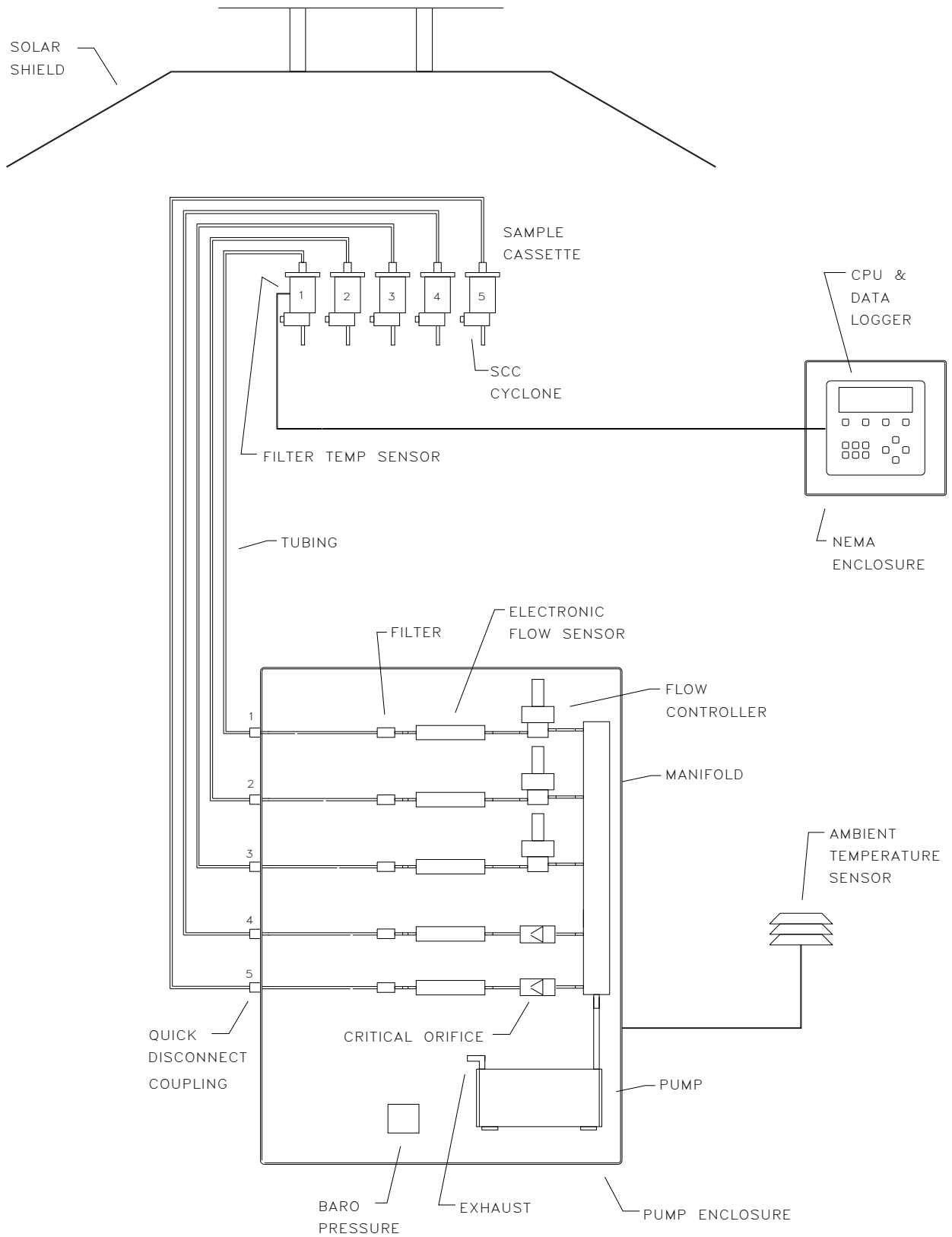


Figure 1.2. Flow Diagram for the SASS, showing solar radiation shield, sample canisters, ambient temperature sensor, control box, and pump box.

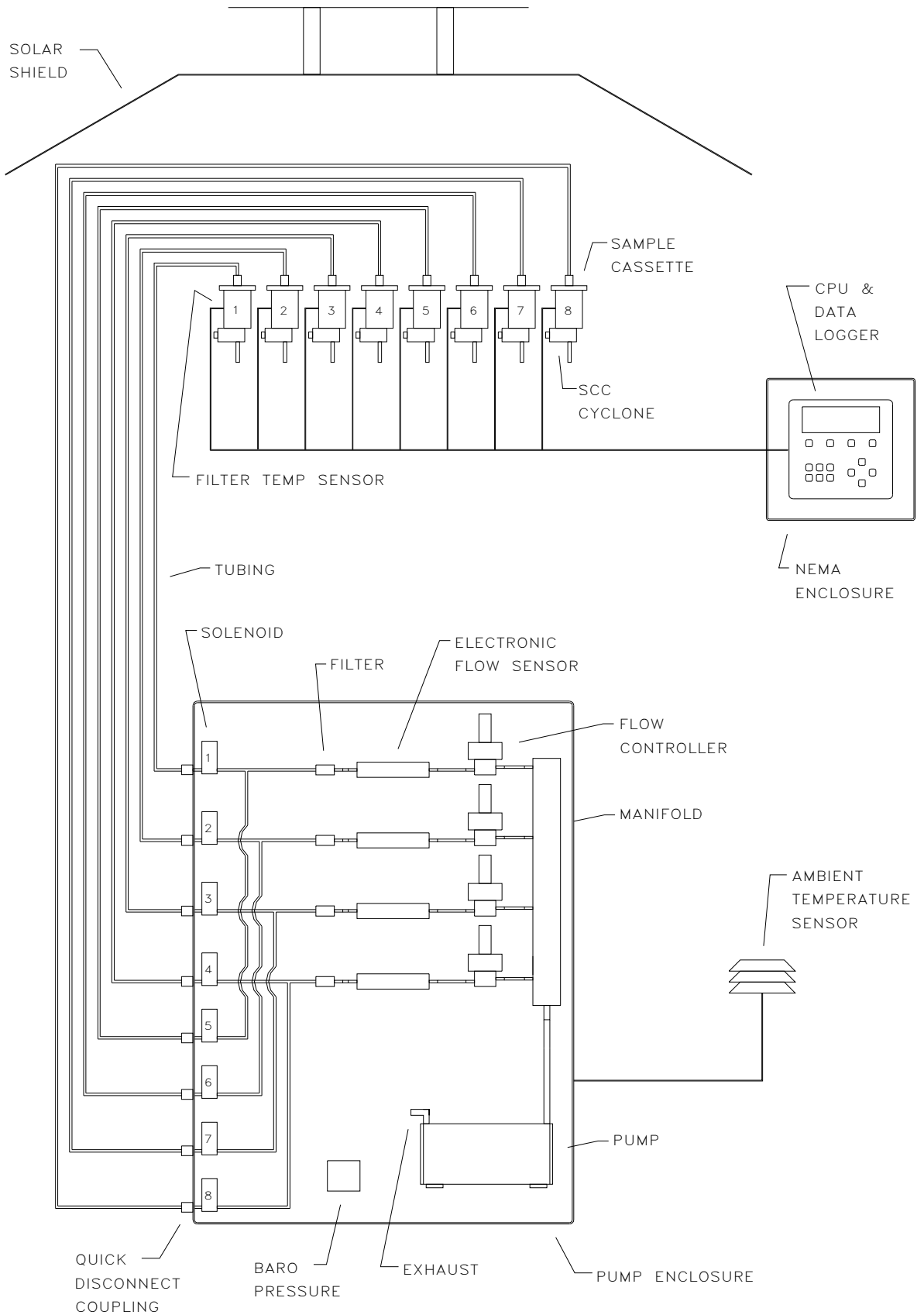


Figure 1.3. Flow Diagram for the SuperSASS, showing solar radiation shield, sample canisters, ambient temperature sensor, control box, and pump box.

1.3.1 The Integrated SASS Canister

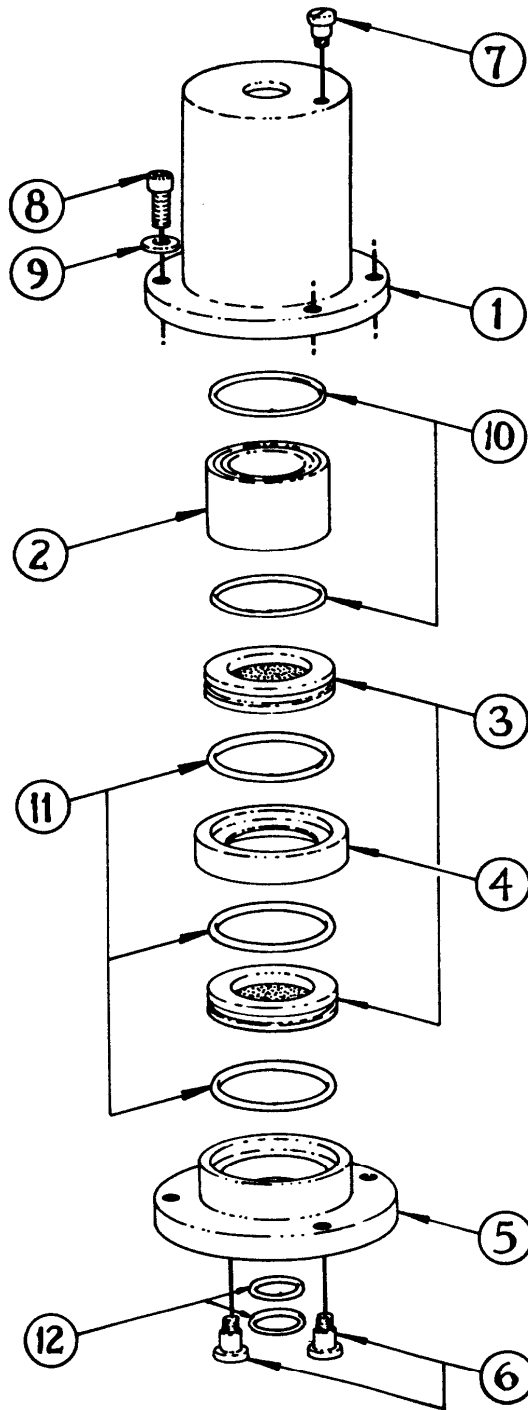
The integrated sampler canister is shown in Figure 1.4. It contains the following components:

- Sharp cut cyclone at 6.7 L/M to remove particles larger than 2.5 μm aerodynamic diameter.
- Denuder to remove nitric acid or other interfering gases, or an empty denuder ring.
- 47mm Front filter for particle capture.
- 47mm Tandem or Backup filter, as needed.
- Cover to hold and protect the components

An empty denuder sleeve is used when no denuder is needed. If only one filter is used, it is placed in the front filter position, with the second filter holder being empty. Assembly details can be seen in Figure 1.5.



Figure 1.4 Photograph of the disassembled SASS Canister, showing the SCC Inlet, the MgO denuder, the front and back filters and the protective canister.



- 1- Cover #8379
- 2- Denuder Sleeve #8380
- 3- Filter Cassette, FRM #460128 (2 each)
- 4- Filter Spacer #8652
- 5- Outlet Plate #8378
- 6- Shoulder Screw #860024 (2 each)
- 7- Shoulder Screw #860029
- 8- Socket Head Cap Screw,
1/4"-20 X 5/8" lg. (3 each)
- 9- Flat Washer, 1/4" (3 each)
- 10- Viton O-Ring, #2-030 (2 each)
- 11- Viton O-Ring, #2-135 (3 each)
- 12- Viton O-Ring, #2-115 (2 each)

Figure 1.5 Speciation Sample Canister (PN 8370) Exploded View

1.3.2 The Sharp cut cyclone (SCC) Inlet: Description and Performance

The SASS inlet selectively transmits airborne particles according to the EPA's PM_{2.5} criteria⁵. After exiting the inlet tube (Figure 1.6), the aerosol moves cyclonically within the body of the cyclone where the larger particles are transported due to their inertia against the outer wall. It is the unique design of this computer-modeled cyclone¹⁰, which produces the desired sampling efficiency⁴. The curvatures of the cyclone body causes particles to inertially move towards the outside wall and migrate into the collection or grip cup to be disposed. Because the drift velocity is small compared to the velocity along the channel, deposition of particles is relatively gentle and at a tangential angle, which accounts for the observed lack of particle bounce, even without greased surfaces. The grit cup should be cleaned periodically.



Figure 1.6. View of the Sharp cut cyclone Inlet that provides the PM_{2.5} cut-point. Canister is shown Inverted in Canister Assembly Block

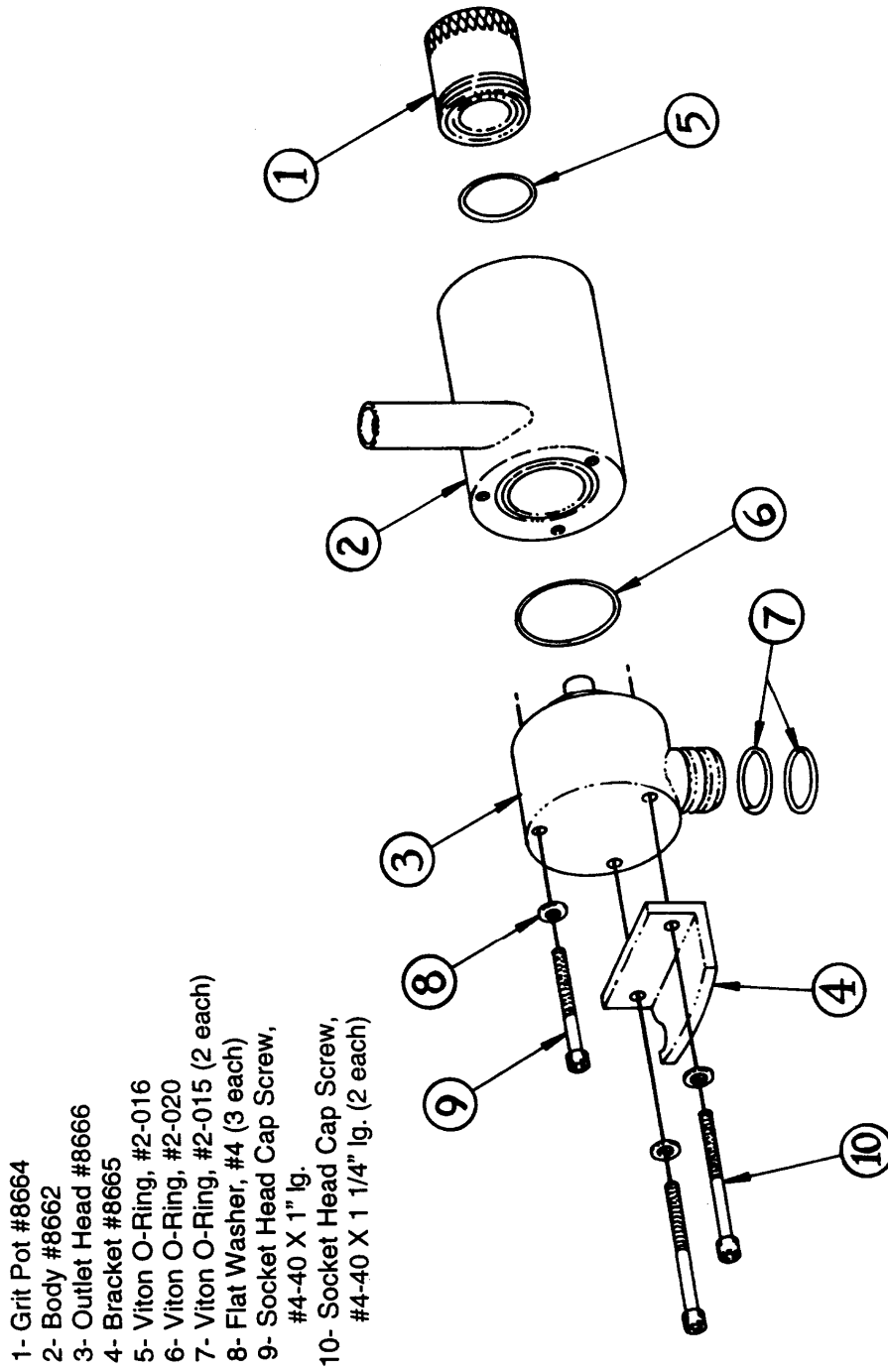


Figure 1.7 SCC Cyclone (PN 8670) Exploded View

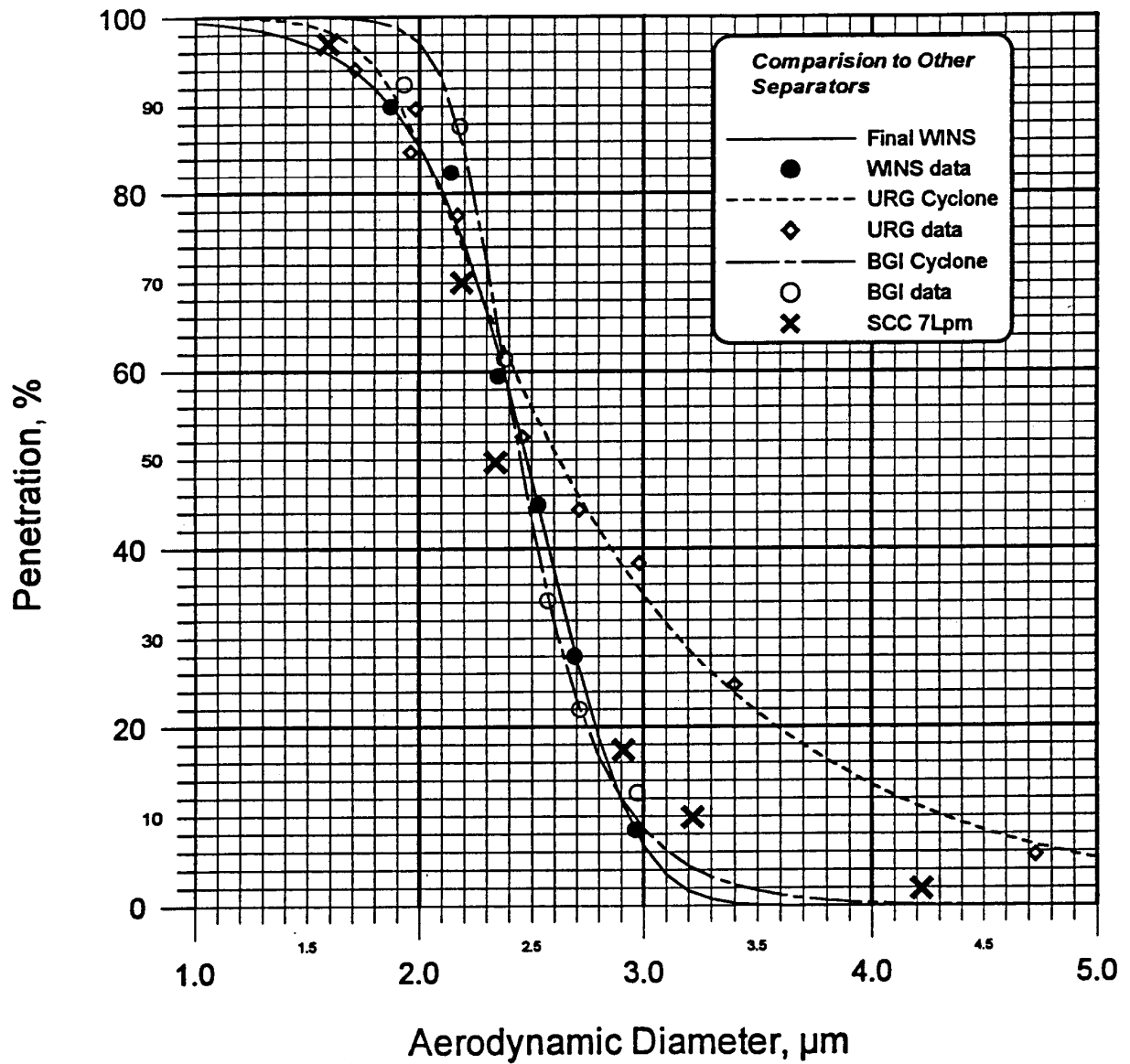


Figure 1.8. Penetration curve of the Sharp cut cyclone (Diameter 2.141mm) compared to the U.S. EPA WINS Impactor curve for PM_{2.5}.

1.3.3 The Multicell Denuder

Denuders consist of tubes or annular spaces that capture reactive gases while allowing the particles to penetrate. Gases have a large diffusion coefficient, and their random motion brings them into contact with the walls of the denuder. With appropriate coatings or selection of the denuder material, semi-volatile vapors are captured by the denuder walls. In contrast, the particles follow the airflow stream lines, and pass through the denuder without contacting the walls. The particles penetrate the denuder and are captured by a filter placed downstream of the denuder. The filter medium is selected so that it adsorbs vapor from any subsequent volatilization of the collected particles.

The SASS nitric acid denuder is an aluminum hexagonal cell material, coated with Magnesium oxide. There are approximately 350 hexagonal channels, each approximately 1.6-mm diameter. The denuder is 25 long. Calculations based on the Gormely-Kennedy relations show 100% collection for depositing vapors, with 99% to 100% penetration of particles greater than 0.08 μm in diameter.

Particle penetration through the denuder was measured in the laboratory using the aerodynamic particle sizer described above. These tests were conducted for both liquid and solid particles in the size range from 0.5 μm to 1.5 μm . First, tests with filtered air confirmed that there is no shedding of MgO particles from the denuder. Second, tests confirm 100% penetration of both liquid and solid particles in the size range tested.

The nitric acid collection efficiency of the SASS denuder was measured in the laboratory using a permeation tube source diluted with purified (ammonia free) laboratory air, and a catalyst equipped chemiluminescent nitrogen oxides analyzer detector. The measured nitric acid efficiency at the design flow rate of 6 L/min is 95%. Denuder performance results are summarized in Table 1.2.

Table 1.2. Results of SASS Denuder Performance Tests

Denuder	Parameter Tested	Test	Result
Multicell Aluminum. coated with MgO Length: 25 mm # of channels:~350	Liquid particle penetration	Penetration of oleic acid particles with diameters in the range from 0.5 µm to 1.5 µm	100% penetration for all particle sizes tested
“	Solid particle penetration	Penetration of solid particles with diameters in the range from 0.5 µm to 1.5 µm	100% penetration for all particle sizes tested
“	Collection efficiency for nitric acid	Measured the penetration of nitric acid through the denuder at concentrations of 50 ppb and 100 ppb	95-99% collection efficiency

1.3.4 Filter Media and Detection Limits

Several types of filter media are needed for assaying the different chemical constituents of ambient particles. The filter media must be suitable for the type of analysis to be done. For example, Teflon™ filters are used for gravimetric mass and trace metal determinations. Quartz filters are used for analysis of total organic carbon because, unlike other filter media, they contain very small amounts of carbon.

Detection limits for 24-hr samples collected on 47 mm filters at the standard SASS flow rate of 6 L/min are listed in Table 1.3. Values are based on analytical detection limits and filter blank variability, as reported by Chow and Watson¹¹.

Some analyses, such as ion chromatography involve extraction of the filter media. However other analyses such as x-ray fluorescence directly analyze the filter without extraction. These analyses require a uniform filter deposit. Similarly, the analysis of organic and elemental carbon is most often done using a small section, or punch from the filter. Again, it is necessary that the filter deposit be uniform.

The SASS sampler is designed to give a uniform filter deposit. The SASS filter support screens are manufactured to the same specifications as those for the Federal Reference Method PM_{2.5} sampler. The FRM screens are specifically designed to avoid the grid patterns that can arise on Teflon™ filters when using coarse support screens.

Table 1.3.

Analytical Detection Limits for Ambient Aerosols Collected with the SASS

Species	Analytical Method	Method Detection Limit ¹	SASS Detection Limit ² ($\mu\text{g}/\text{m}^3$)
Mass	Gravimetry	15 $\mu\text{g}/\text{filter}$	1.7
Chloride	Ion chromatography	0.05 $\mu\text{g}/\text{mL}$	0.06
Nitrate	"	0.05 $\mu\text{g}/\text{mL}$	0.06
Sulfate	"	0.05 $\mu\text{g}/\text{mL}$	0.06
Ammonium ion	Auto. Colorimetry	0.05 $\mu\text{g}/\text{mL}$	0.06
Soluble potassium	Atomic Adsorption	0.07 $\mu\text{g}/\text{mL}$	0.08
Organic carbon	Thermal Optical Anal.	0.82 $\mu\text{g}/\text{cm}^2$	1.07
Elemental carbon	"	0.19 $\mu\text{g}/\text{cm}^2$	0.25
Al	X-ray fluorescence	0.0025 $\mu\text{g}/\text{cm}^2$	0.0033
Si	"	0.0014 $\mu\text{g}/\text{cm}^2$	0.0018
P	"	0.0014 $\mu\text{g}/\text{cm}^2$	0.0018
Cl	"	0.0012 $\mu\text{g}/\text{cm}^2$	0.0016
K	"	0.0026 $\mu\text{g}/\text{cm}^2$	0.0034
Ca	"	0.0015 $\mu\text{g}/\text{cm}^2$	0.0020
Ti	"	0.0011 $\mu\text{g}/\text{cm}^2$	0.0014
V	"	0.00073 $\mu\text{g}/\text{cm}^2$	0.00096
Cr	"	0.00048 $\mu\text{g}/\text{cm}^2$	0.00063
Mn	"	0.0004 $\mu\text{g}/\text{cm}^2$	0.00053
Fe	"	0.00038 $\mu\text{g}/\text{cm}^2$	0.00050
Co	"	0.00022 $\mu\text{g}/\text{cm}^2$	0.00029
Ni	"	0.00022 $\mu\text{g}/\text{cm}^2$	0.00029
Cu	"	0.00027 $\mu\text{g}/\text{cm}^2$	0.00035
Zn	"	0.00027 $\mu\text{g}/\text{cm}^2$	0.00035
Ga	"	0.00048 $\mu\text{g}/\text{cm}^2$	0.00063
As	"	0.00039 $\mu\text{g}/\text{cm}^2$	0.00051
Se	"	0.00031 $\mu\text{g}/\text{cm}^2$	0.00041
Br	"	0.00025 $\mu\text{g}/\text{cm}^2$	0.00033
Rb	"	0.00024 $\mu\text{g}/\text{cm}^2$	0.00032
Sr	"	0.00028 $\mu\text{g}/\text{cm}^2$	0.00037
Y	"	0.00033 $\mu\text{g}/\text{cm}^2$	0.00043
Zr	"	0.00042 $\mu\text{g}/\text{cm}^2$	0.00055
Mo	"	0.00067 $\mu\text{g}/\text{cm}^2$	0.00088
Ag	"	0.003 $\mu\text{g}/\text{cm}^2$	0.0039
Cd	"	0.003 $\mu\text{g}/\text{cm}^2$	0.0039
In	"	0.0034 $\mu\text{g}/\text{cm}^2$	0.0045
Sn	"	0.0044 $\mu\text{g}/\text{cm}^2$	0.0058
Sb	"	0.0045 $\mu\text{g}/\text{cm}^2$	0.0059
Ba	"	0.013 $\mu\text{g}/\text{cm}^2$	0.017
Hg	"	0.00065 $\mu\text{g}/\text{cm}^2$	0.00085
Pb	"	0.00076 $\mu\text{g}/\text{cm}^2$	0.00100

¹ from Chow and Watson (1998)

² Assumes 24 hour collection at 6L/min with deposit diameter of 38 mm (11.4 cm^2) or extraction of entire filter in a volume of 10 mL

1.4 Sampler Configuration Options

The SASS is designed to be flexible. Any canister can be configured with just one filter, with two filters, with a denuder and one filter or with a denuder and two filters. The type of denuder and the filter media can be tailored to meet the needs and desires of the sampling program. In this way, it can accommodate new denuder filter methods as they become established.

For sampling nonvolatile particle constituents, denuders are not needed. Non-volatile components are readily collected by selection of a filter media appropriate to the analysis to be performed, and which does not adsorb gaseous species that could interfere with the measurement. For nonvolatile inorganic species, Teflon™ and quartz filters are usually used.

Semi-volatile constituents are collected using a denuded, adsorbing filter. This is because more volatile particle constituents can be lost during sampling due to evaporation from the filter substrate. Denuder – filter systems use a denuder that removes semi-volatile vapors followed by an adsorbing filter that retains both particle and vapor compounds.

Denuded filter methods have traditionally been used for measuring particle nitrates¹²⁻¹⁹. One method is to pass the air sample through a MgO coated denuder followed by a nylon filter²⁰. The MgO coated denuder removes the gas phase nitric acid and other gaseous nitrogen species that can collect on the nylon filter. The particles pass through the denuder and are collected by the nylon filters. The nylon filter adsorbs nitric acid that is formed from the vaporization of the particle nitrate, and thus the nylon filter is able to retain the particle nitrate without vaporization losses. It is also possible to use tandem Teflon™ and nylon filters behind a nitric acid denuder to give inorganic ions and nitrate in the same cassette. However, if samples cannot be retrieved quickly after the end of the sampling period, a separate nylon filter downstream of the denuder may be preferred because of possible losses from the Teflon™ filter after the conclusion of sampling. (Note that the backup nylon filter will capture nitrate lost during sampling, but once sampling stops further volatilization will result in loss in nitrate to the sampler walls.)

For some constituents such as total organic carbon there is no accepted accurate sampling method. The organic compounds in the atmosphere include gaseous organic compounds that are readily adsorbed by the quartz fiber filters required for total carbon analysis^{21, 22}. The particle phase also includes semi-volatile compounds that are lost by evaporation from the filter during sampling²³. The magnitude of these two artifacts appears to be variable. Correction for positive artifacts has been done by sampling with two quartz filters in series, or by sampling with a quartz filter behind the Teflon™ filter. This backup filter is used to correct for the adsorption of gaseous organic compounds on the front quartz filters. However, some have argued that the volatilization of organic compounds during sampling is a larger source of error. Denuder-filter methods²³ for organic carbon, analogous to that described above for nitrate, is a current area of research. The SASS can be used for organic sampling in any of the configurations described here.

The SASS is provided with one type of denuder, the MgO coated aluminum. The expected configuration for the SASS for most applications is shown in Figure 1.9. This has two Teflon™ filters, one for mass and metals analysis, and one for inorganic ion analysis. The third leg is a MgO-denuded nylon filter is provided for fine particle nitrate measurement and the fourth leg is double quartz for organic and elemental carbon analysis.

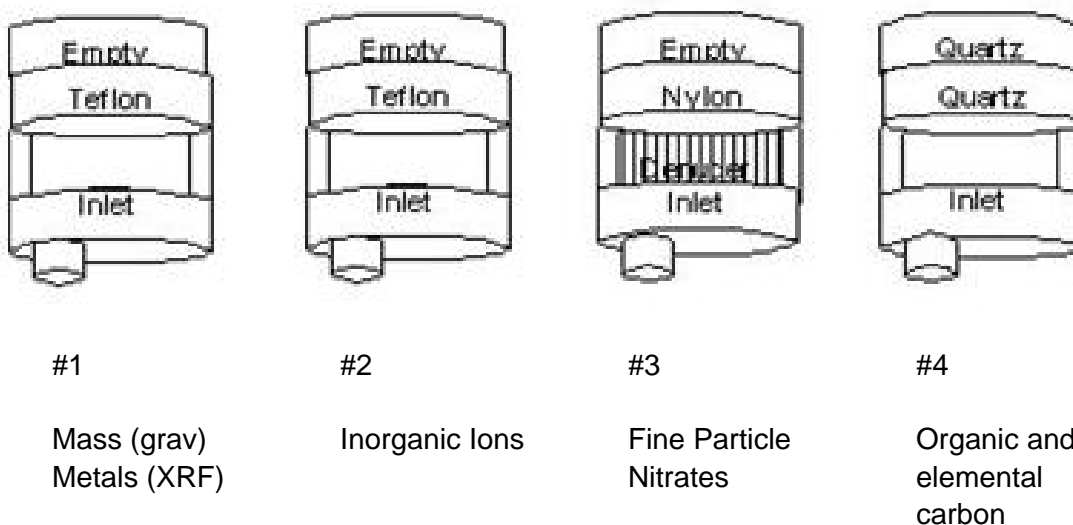


Figure 1.9. The expected configuration for the SASS canisters, including the use of an MgO denuder for removal of gaseous nitrates.

For EPA test configuration, the canisters are configured with canister 1 containing a Teflon filter, with canister 2 containing the MgO denuder and a nylon filter, and the third canister supplied with a quartz filter.

1.5 Sampling Head

The requirement to minimize the temperature differential between ambient temperature and filter (sample) temperature in the sample canister is a prime consideration in the design of the SASS. The solar radiation shield is one of three unique designs with the SASS. The second is the Sharp cut cyclone Inlet (Section 1) and third is the design incorporated features from the field tested “Two Week Sampler” of Aerosol Dynamics used over the past four years in California for the Children’s Epidemiology Study. Additionally, the SASS microprocessor firmware and SASS Comm AQ™ Software meets the requirements of the 40CFR Part50 Appendix L. The sampler operates with a clean exhaust diaphragm vacuum pump.

The SASS solar radiation shield has been designed to maintain the sample canisters and filter temperatures to the EPA FRM design requirement of < 5°C above the ambient temperature during and after a sampling event. This temperature control is designed to minimize the loss of semi-volatile materials from the aerosol sample. The SASS is designed to maintain the temperature differential between ambient and sample to within 3° C. The sampling head / solar radiation shield is physically separate from the sampling control and vacuum systems. The shield manufactured from aluminum for low mass. High reflectivity coatings are used on all surfaces. Isolation is included to minimize direct conductive paths upstream of the filters.

The Solar radiation shield is composed of an upper shield, lower shield and terrestrial shield. All three are uniquely designed from Met One’s years of experience in measuring ambient temperatures using fan aspirated radiation shields. The large upper shields, flat top plate and second round plate provide primary solar radiation shielding. At the maximum solar input, between mid-morning and late afternoon, the lower shields are almost completely shaded by the primary shielding.

The requirement to minimize the temperature differential between ambient temperature and filter (sample) temperature in the canisters is a prime consideration in the design of the SASS. The solar radiation shield that is provided by the inlet head assembly is one of three unique designs with the SASS. This temperature control is designed to minimize the loss of semi-volatile materials from the aerosol sample.

The terrestrial radiation shield (the bottom flat part of the solar radiation shield assembly) cannot have air circulation across the outside surface as that could impact the ambient particulate sample going into the nozzle and sharp cut cyclone inlet. However, this flat shield prevents bounced radiated heat and light off the sampling deck or ground surface to heat the sampling canisters.

The sample canisters are housed inside the lower shields, mounted from above with a single point of thermal contact located after the filters. The design consists of two concentric shields separated by an air passage to allow the air to flow between the shields and this airflow “scrubs” the surfaces and effectively cools the cassette surfaces. The SASS has a thermistor temperature measurement at the first of the canister locations, as all canisters are used in a common test. For maximum flexibility with the SuperSASS, a thermistor temperature measurement is provided in each of the canister connections immediately after the hardware connection.

To insure the solar radiation shield is operating correctly, ambient air temperature and filter temperature are measured continuously and the logger records data. The air temperature is measured using a passive multi-plate radiation shield and thermistor temperature sensor that is mounted on the sampling pole.

Met One, EPA contractor, and state and local agencies to determine the effects of solar conducted numerous ambient field tests and terrestrial radiation and the temperature difference between ambient and filter temperatures. One site was chosen in a typical North West SLAMS monitoring site in Grants Pass, Oregon. Five days of 24-hour measurements were collected in May of 1998. The maximum solar radiation measured during these tests was 1250 W/m^2 , measured with a NIST traceable Eppley™ meter. All data points are averaged over five minutes, built on a second sample. The temperature difference indicated over the five-day test was a maximum of -0.7°C . Arid desert sites like Phoenix indicate the SASS can maintain filter temperatures over a 24 hour sample event to within $<2^\circ\text{C}$ above ambient.

2.0 SITING AND INSTALLATION

2.1 Siting

40 CFR Part 58 Regulations and promulgated PM_{2.5} National Ambient Air Quality Standard (NAAQS) were revised in 1997. A Chemical Speciation network of fifty (50) PM_{2.5} sites was required to be operational by end of year 1998.

Note: Use of co-located instruments with carbon vanes, i.e., Hi-Vol, Anderson RAAS, etc can be a source of contamination and steps should be taken to isolate these instruments.

At the time of writing this operating manual two government documents are in draft form, which give specific details to guidance regarding siting, operation and analysis.

DRAFT "Particulate Matter PM_{2.5} Speciation Guidance Document" May 4, 1998 Monitoring and Quality Assurance Group, Emissions, Monitoring, and Analysis Division, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711

DRAFT "Guideline on Speciated Particulate Monitoring" February 9, 1998 Prepared for Neil Frank & Jim Homolya, Office of Air Quality Planning & Standards (MD-44). U.S. Environmental Protection Agency, Research Triangle Park, NC 27711 Prepared By Judith C. Chow & John G. Watson, Desert Research Institute, P.O. Box 60220, Reno, NV 99506

The USA EPA Web site for more current information can be found at <http://www.epa.gov/ttn/amtic>

2.2 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 (3) legs of the tripod. The 3 pins are then re-inserted to hold the three legs in position.

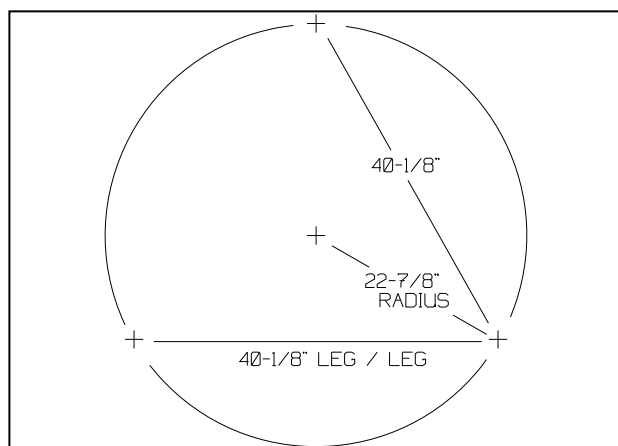


Figure 2.1 Mounting Hole Pattern

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.

(Note: Installation Instructions Are Additionally Supplied on Outside of Each Tripod Shipping Carton)

Holes are provided in the tripod feet and commercial hardware can be used to anchor the tripod to the sampling site. Typically, AMS and SLAMS operating sites are made of wood. 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.

2.3 Sampling Head Installation

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.

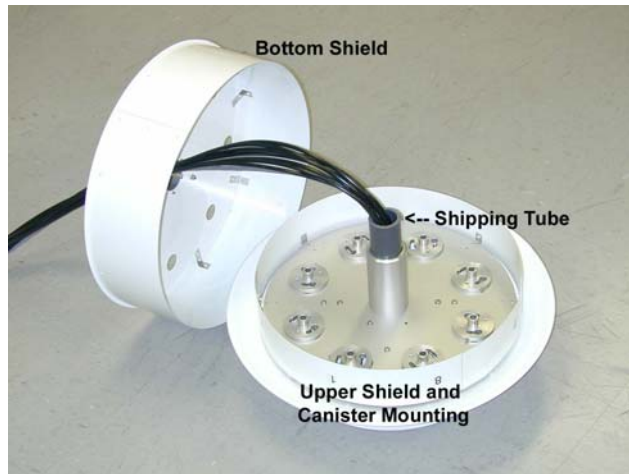


Figure 2.2 Sample Head (Upside Down)

weldment. There is a gray PVC shipping tube that will need to be removed from the center of the sampling head assembly. It is used only for aligning the two sections during shipment and is no longer required as part of the installation of the sample head.

Next, install the socket head screws as shown in figure 2.3. Locate the tool kit and plastic bag containing three (3) each 8-32 x 3/16" long socket head cap screws. (An extra screw is provided.)



Figure 2.4 Assembled Sample Head

Locate bottom shield. It is in the top portion of the sampling head that is found in the box containing the complete head assembly. (See Figure 2.2) 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

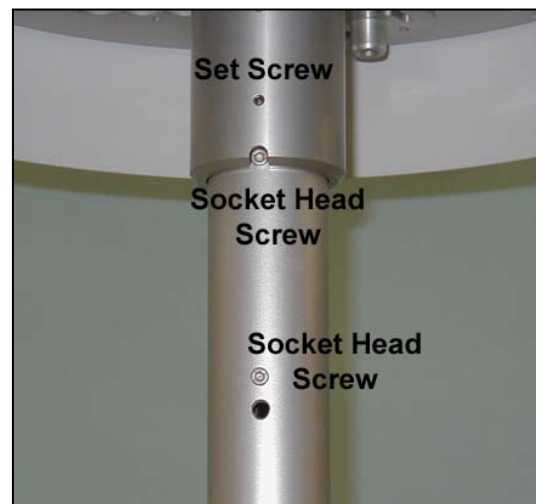


Figure 2.3 Screw Locations

Screws have been treated with thread-locking compound. 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 (2) setscrews (factory installed in sampling head hub) to secure sampling head to mast.

Note: A bundle of sample flow lines and one (1) electrical cable should be coming out bottom of tripod tube.

Raise bottom shield to stop position, aligning the slot with screw head in mast and pin in place, while installing the next portion of the SASS Unit.

2.4 Control unit & Mounting

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.



Figure 2.6 Mounting Detail



Figure 2.5 Control Unit Mounting

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. Use the supplied wrench or a 7/16" Nut Driver

A set of mounting brackets holds the control unit to the mast just above the top of the tripod legs. Use the two U-Bolts supplied in the hardware package and secure the control unit 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 using the supplied wrench or by using a 7/16" nut driver.

See Figures 2.5 and 2.6 for mounting details.

2.5 Ambient Temperature Sensor Installation

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 PM_{2.5} FRM sampler. The ambient temperature sensor includes the Model 074 temperature shield, Model 065 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 (1) U-Bolt and the two 7/16" nuts with washers. 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 two 7/16" hardware nuts and Washers using the supplied wrench or a nut driver. Typically, it would be about 3 inch 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. See Figures 2.5 and 2.6 for details.

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.

2.6 Canister Installation

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.



Figure 2.7 Inserting Canisters

Details on the canisters can be found in Section 1.0 of this manual. The Sampling Head Assembly has mountings for up to eight filter sampling canisters. Around the outside of

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

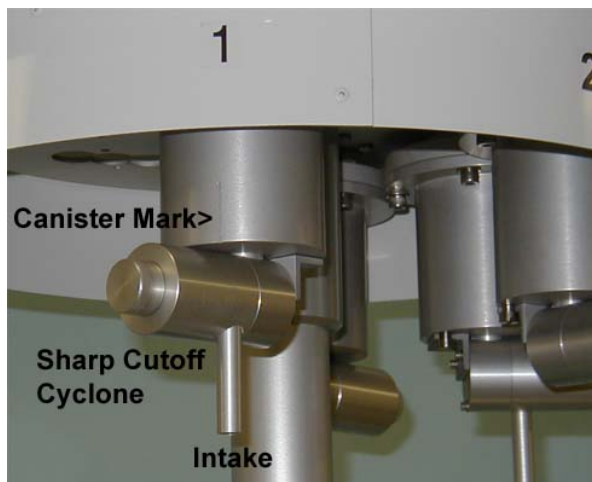


Figure 2.8 Canister Mark

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. This can be seen in Figure 2.8. 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.



Figure 2.9 Installed Canisters

Note: As part of the EPA project to monitor PM_{2.5} 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 three 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.

2.7 Pump Box Mounting

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.TM 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 (5) or Eight (8) 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 three canisters are used with SASS, lines 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.



Figure 2.10 Tubing Installation (SuperSASS)

2.8 System Grounding

To provide electrical hazard protection, a heavy green/yellow ground cable, is attached to the bottom of the pump box. This ground cable provides an electrical hazard ground, and static discharge path. It also provides some protection to the equipment from induced electrical currents that may occur during nearby lightning strikes.

NOTE: Because of the potential for injury and possible loss of life, the operator should not work around the SASS unit during lightning storms or whenever there is the possibility of nearby lightning strikes. In general, the location of the SASS and its association with other similar equipment, accentuates the potential hazard to the user.

For maximum effectiveness the ground cable should be connected to a nearby earthed ground rod. If a ground rod is not available, a cold water pipe can be used as an alternative. If a water pipe must be used, be sure that a suitable type of compression grounding clamp is attached to the water pipe.

NOTE: If a water pipe is used as a ground, be sure that it is a cold water pipe, and not a gas pipe, or hot water pipe. They do not provide a suitable ground, or have the potential for explosion.

In addition, it is recommend that one leg of the mounting tripod also be grounded to the same earth ground used to ground the pump box. For maximum effectiveness, a copper cable of AWG # 6 or larger should be used to ground the tripod.

3.0 SETUP AND OPERATING PROCEDURES

3.1 Operational Checkout of System

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 screen of the control unit will start up in the Main Screen as displayed below in Figure 3.1. From this point pressing the push buttons located below the four main screen menu selections can access all other necessary screens.

Note: For a detailed list of all menu selections, see Section 4.0 of this manual.

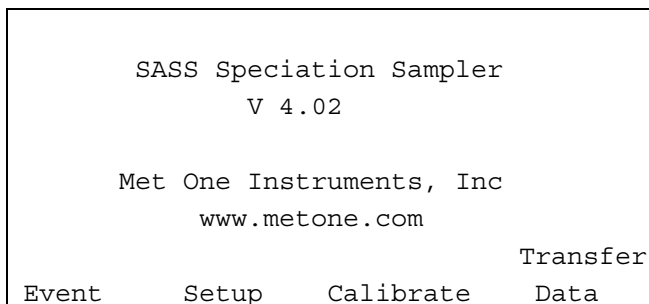


Figure 3.1 Example of Main Screen

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

As part of the preliminary setup and checkout of the SASS or SuperSASS, the following process can be used to verify the operation of the unit. Differences between the two units will be indicated. It will also cover the programming of the unit to begin the first test sequence and any additional sequences following the first test. To insure that the system has been correctly assembled, there are no leaks, and that there has been no damage to the SASS use the following procedure.

3.1.1 Temperature, Pressure and Flow Test

From the main screen menu, select the “Calibrate” function. This will take you to the next menu selection identified as the Calibrate Menu. From this menu select the “System Test” item by pressing the F1 key as indicated in the menu. Once the F1 key has been selected the following screen shown in Figure 3.2, with the following options will appear.

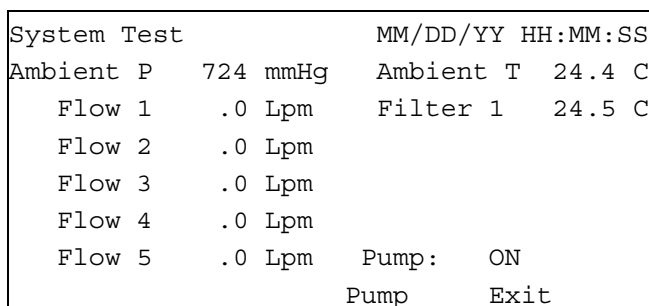


Figure 3.2a System Test Screen (SASS)

System Test		MM/DD/YY HH:MM:SS	
Ambient P	724 mmHg	Ambient T	24.4 C
Flow 1	.0 Lpm	Filter 1	24.5 C
Flow 2	.0 Lpm	Filter 2	24.3 C
Flow 3	.0 Lpm	Filter 3	24.3 C
Flow 4	.0 Lpm	Filter 4	-xx.x C
		Pump:	ON
Cans		Pump	Exit

Figure 3.2b System Test Screen (SuperSASS)

At this point the current ambient temperature, the current temperature of the filters in the sample head, and the current absolute barometric pressure in mm/Hg will be displayed. The SASS provides a single filter temperature while the SuperSASS includes filter temperatures for each group of four canisters. In addition, the SASS provides flow values for all five canisters with the SuperSASS having flow for a maximum of four canisters. The values for flow on all channels should be at 0.0 LPM. If the values displayed for temperature or barometric pressure are obviously incorrect, check to verify that all connections have been made and the connectors from the pump box are installed. If any problems are found, consult Section 6.0 of this manual for assistance in trouble shooting problems.

If all looks correct, then the button under the menu selection “pump” can be pressed. This will bring up the following caution screen. This is displayed to prevent stopping an event in progress to activate the pump.

```

.....Caution.....

Press 'Continue' to STOP the sample
event and control the pump.

Cancel                               Continue

```

Figure 3.3 Test Caution Screen

Pressing the “Continue” will activate the pump and you should immediately hear the pump start inside the pump enclosure. The pump should not have been running prior to pressing the “pump” button on the keyboard of the control unit, unless a test event was already in progress. The only exception to this would be if the temperature inside the pump box were below 35 degrees F. Under these conditions, the pump is automatically turned on so that there is no possibility of the pump not starting correctly in cold weather. If the pump was running, pressing the “pump” button will cause the bypass valve in the pump box to de-activate and flow values should now appear on the screen of the control unit. The values for all canisters should be between 6.6 and 6.8 LPM of flow.

If the flow value is far outside this range, then check use the trouble shooting information contained in Section 6.0 of this manual.

3.1.2 Leak Check of System

Use the following procedure described in the revised section 6.2 for System Leak Check .

3.1.3 Calibration of System

When supplied from the factory, the system has been setup and calibrated using NIST traceable standards for measurement of flow, pressure and temperature. It should be ready for operation as supplied, and the operator using this procedure as described in Section 3.1 has verified operation. If a complete calibration is required, see Section 6.0 of this manual for procedures.

3.2 Programming of System

As delivered, either type of SASS will need to be set with the current date and time, as well as some default values for typical operation. This can be done, by selecting the “Setup” button from the Main Screen as shown in Figure 3.1. One selected, the Setup Menu Screen as shown below in Figure 3.4 will appear.

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

Figure 3.4 Setup Menu

3.2.1 Setting Date and Time

Pressing the keyboard key “**F3**” will take you to the Clock Setup Screen (See Section 4.3.3) and time at the installed location of the SASS. From the screen menu use the left and right arrow keys to move to the values of MM/DD/YY or HH:mm:ss that need to be changed. Then use the up and down arrow keys at each digit, to change the current values to the current date and time. Once completed, press the “Set” key and the newly entered values will be entered as the new default values. At the point the “Set” key is entered, the new time will be entered. It’s best to set the time to a future time or at the top of the minute, and then enter “Set” when that time occurs.

3.2.2 Setting Default Elapsed Time for Tests

Pressing the keyboard key “**F2**” will take you to the default setup screen, this is used to set up the default value that is used for the total elapsed time for each run of the SASS during the operation and collection of sample material in the installed canisters. This also allows for the selection of a default set of canisters. See section 3.2.3 for a listing of the defined sets of canisters. Factory default set is {1,2, & 3}.

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



Figure 3.5 Default Values Menu

From the Sample Event Defaults Screen (See Section 4.3.2) use the left and right arrow keys to move to the values of HH or mm that need to be changed. Then use the up and down arrow keys to change the current values to the typical value used for all sample collection. Once completed, press the “Save” key and the newly entered values will be entered as the new default values.

3.2.3 Event Manager

SASS includes an Event Manager for the most flexible operation. It is used to program the start time and duration of all test sequences. Each test event or sequence must be pre-programmed into the Event Manager. The Event Manager will maintain a pre-event list, up to four (4) pre-events are allowed. When working with SASS, the events are entered, but the canisters cannot be sequenced, all of them 1 to 5 will be operating at the same time. Unused vacuum lines can be disconnected at the pump box. The SuperSASS allows for sequential programming of the groups of canisters that will be used for each sample event. Twenty-four (24) post events are archived in a circular manner where the oldest is overwritten by the newest addition.

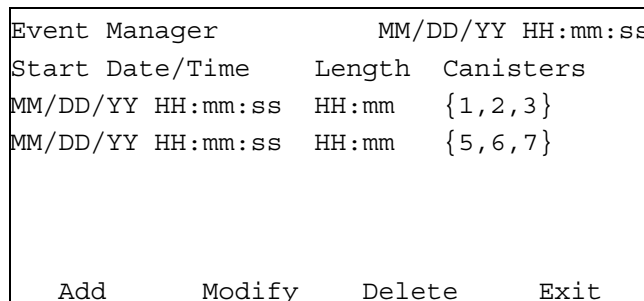


Figure 3.6 Event Manager

Only active pre-events are listed. They are ordered (top to bottom) by the earliest date and time. Up to four (4) pre-events can be listed. Use the up and down arrows to select an event for modification or deletion. If there are less than 4 pre-programmed events then the Add key will bring up the Add Event screen. Typically as delivered from the factory, there are no pre-programmed events programmed into the Event Manager. The Add key is also used to begin the first event sequence. See Figure 3.6

Add Event	MM/DD/YY	HH:mm:ss
	MM/DD/YY	HH:mm
Event Start:	MM/DD/YY	HH:mm
Event Length:		HH:mm
Canister Set:	{1,2,3}	
Add	Default	Cancel

Figure 3.7 Add Event Screen

Edit the Event Start date and time, Event Length time, and the Canister Set. The canister set is a pick list of defined sets. Use the up down keys to select the specific canister set or use the Default key to select the default set and event length. Even though the canisters cannot be sequenced in the SASS unit, it is necessary to indicate to the control box which canisters are installed and used as part of the sample event. Doing this insures that the correct data is recorded for each flow sensor and canister set. All of the control box screens are dynamically updated; they only show the active canisters as part of the reported data. Typically as part of the EPA test plan, SASS canister set {1,2, & 3} will be used. This is also the default set.

- Defined set for SASS consists of {1}, {1,2}, {1,2,3}, {1,2,3,4} and {1,2,3,4,5}
- Defined sets for SUPER SASS are {1}, {2}, {3}, {4}, {1,2}, {3,4}, {5,6}, {7,8}, {1,2,3}, {5,6,7}, {1,2,3,4}, and {5,6,7,8}.

Press the Add button to add this event to the pre-event list. A successful add will return the user to the Event Manager screen. Edit keys are available to modify or delete the events.

Press the Modify button to view the Modify Event screen.

Press the Delete button to view the Delete Event screen.

3.2.4 Setting ID Value of SASS System

Pressing the keyboard key “F4” will take you to the ID Setup Screen (See Section 4.3.4). This screen allows the entry of an ID value for this particular site. Normally site number that was entered at the factory is the serial number of the control unit. If a different ID value is to be used then use the up and down arrow keys at each digit, to change the current values to the new ID value. Once completed, press the “Save” key and the newly entered values will be entered as the new ID.

3.2.5 Clear all Event History

Pressing the keyboard key “F5” will clear all event history. This would typically be used to clear all events, or to start up the SASS at a new location. It will bring up a warning screen before allowing the clearing of all event history. (See Section 4.3.5)

Note: This completes the initial setup of required preset values in the unit. The last menu entry for flow sensors is factory set and should not be changed unless there has been a replacement of the flow sensor from a 20 LPM to a 10 LPM Sensor.

3.3 Preparation for Test Sequence

Once the system setup values and the sequence have been entered, the first test sample sequence can begin. Each test sequence will require a new set of canisters properly configured with filters and identified. If the SASS is used as part of the EPA Trends Network Speciation Project, then the pre-loaded canisters will have been loaded with filters and supplied in a protective cooler. Each canister supplied as part of the data collection project, from the EPA will have a specific serial number identified by a bar code; along with a colored dot indicating which position, the canisters are to be installed. (See Table 3.1) Specific information on the setup and installation location of the canisters will be supplied from the third party contractor that is doing the actual filter evaluation and testing. The colored dots are typically supplied from the EPA or the third party contractor. The canisters are supplied less the Sharp Cut Cyclones and they will need to be installed on the canisters before they are installed in the sample head. Typically, only three canisters are used as part of the EPA Trends Network.

The next step is to install the canisters in the appropriate locations, install the lower shield, and setup of the control unit for the correct operating sequence.

Canister Number	Color Code
Canister #1	Green
Canister #2	Red
Canister #3	Orange
Canister #4	Blue

Table 3.1 Canister Color Codes

Note: At the time of printing of this manual, specific color configuration has yet to be determined by the EPA for any changes in color codes for canisters used in sequential sampling systems.

3.3.1 Starting Sample Event

If the sequence has been programmed into the Event Manger in section 3.2.3, the system is ready to start the next test sequence when the start time has been reached. From the main menu on the menu screen, select the Event key selection. This will take you to the menu screen identified as Event Menu as shown below.

```
Event Menu
F1: Current Event Status
F2: Previous Event Summary
F3:
F4: Event Manager
F5:
F6: Historical Event Summary
Exit
```

Figure 3.8 Operate Menu

From this screen, select the **F1** Menu Item. This will advance to the Status Menu as shown below.

```
Status: Finished          MM/DD/YY HH:mm:ss
00          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 3.9 Status Menu (Finished)

The next test will begin at the date and time programmed into the event sequence menu. Once the test has been completed, the status menu will display Finished as the status on the screen. If a sample event is in progress then the Status will be indicated as Sampling as shown in Figure 3.10.

```

Status: Sampling           MM/DD/YY HH:mm:ss
00      Canister Set: (1,2,3)
        Event Start: MM/DD/YY HH:mm:ss
        Event Stop: MM/DD/YY HH:mm:ss
        Elapsed:           HH:mm:ss
        Remaining:        HH:mm:ss

      <<           >>           Exit

```

Figure 3.10 Status Menu (Sampling)

3.3.2 Collecting Data After Sample Event

Following the sampling event, the data required for documentation of the results can be done manually or via the RS-232 port on the Control Box. Both methods can be used to provide immediate and archival storage of information. See typical form in Appendix B of this manual.

Using the RS-232 Connection and PC

Located under the control box, the most left hand circular connection is for the RS-232 cable supplied with the SASS Unit (Part Nr 3159). It is a four pin circular connector with a 9-pin RS-232 female (DE-9F) type connection at the other end. Connect the circular connection to the control box, and the 9-pin connector to the laptop PC or to an RS-232 extension cable to a PC Computer. In most applications, RS-232 connections are typically, limited to 50 ft. unless special low loss cables are used. Longer lengths of cable made from some types of wire can cause errors in the data collection process.

Use the SASSComm AQ Software version 4.0.1 (or higher), supplied with the system, to collect the data from either type of SASS. Consult the SASSComm AQ Manual for specific information on data collection via the RS-232 port, or via telephone dial-up modem.

Using the Transfer Module

A small transfer module UX-961 can be used to collect data from the SASS. This is a useful accessory item that is described in Section 6 of this manual. It simply plugs into the SASS Control Box. Using the special RS-232 Cable part nr 3169 supplied with the transfer module. Connect the 9-pin end to the transfer module and the circular 4-pin connector to the RS-232 connection on the control box. **NOTE: The standard RS-232 cable nr 3159 will not work.**

```

Super SASS Speciation Sampler
V 4.02

Met One Instruments, Inc

```

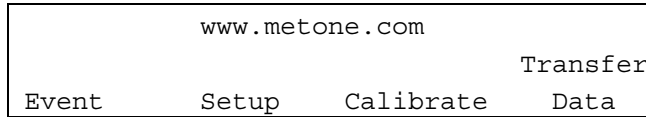


Figure 3.11 Main Screen

Once connected, select the Transfer Data button from the main control box screen as seen in figure 3.11. This will activate the data transfer of information from the control box to the transfer module. The screen will appear with download information as the data is copied from the control unit to the transfer module. Note: Only one SASS sampler data set can be stored in the transfer module at any one time. Once the data has been removed, the same transfer module can be used to collect data from another SASS System.

Take the transfer module to the PC computer using the SASS Com Software, and follow the procedure for extraction of data from the transfer module. Collected data will be stored in the PC computer where reports can be generated on the results of this sample run. This method will also collect all of the 5-minute data from the data logger of the SASS.

Manual Collection of Data

To fill out the transfer of custody / field data form provided from the vendor that is doing the analysis of the collected canisters; it will be necessary to record the data from the various screens. Select from the main menu the Event screen as shown in Figure 3.8 in this section of the manual. Next, Select the key “F2” for Previous Event Summary. This will display the data from the previous event that was most recently completed. Note: When all programmed events are completed, the current event status and the previous event summary will be the same.

Using the << and >> arrow keys under the menu, the remaining status menus can be viewed, to find the additional information required for filling out the forms. Using the right arrow key >>, the first screen is “Current” it displays current values, press the key again and it comes to the screen “5 Min Values” it shows the last 5 minute values that were collected. Now press the >> key once more and it goes to the first of the screens containing the information for the custody/field data form. This is the “Volume Summary” Screen.

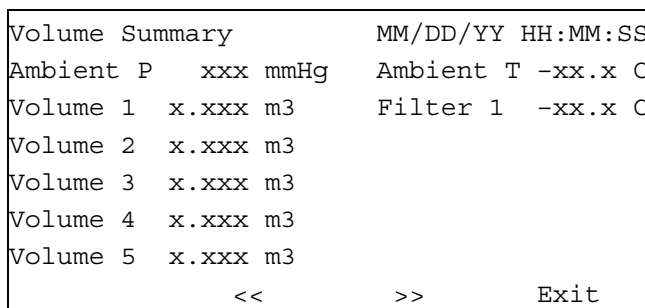
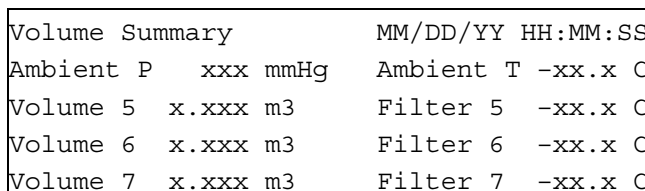


Figure 3.12a Volume Summary Screen (SASS)

In the SASS unit, up to 5 of the recorded volumes will be displayed. The total number will be based on the number of canisters selected for the sample event.



```

Volume 8  x.xxx m3      Filter 8  -xx.x C
                                     <<      >>      Exit

```

Figure 3.12b Volume Summary Screen (Super SASS)

From this screen the volume, data as well as the average values over the previous event can be examined and transferred to the field data form. In the SASS unit, there can be up to 5 flow channels displayed. Press the >> Key again and this will bring up the “CV Summary” Screen as shown below.

```

CV Summary                               MM/DD/YY HH:MM:SS
      CV      Mean      Std Dev
Flow 1      %      Lpm      Lpm
Flow 2      %      Lpm      Lpm
Flow 3      %      Lpm      Lpm
Flow 4      %      Lpm      Lpm
                                     <<      >>      Exit

```

Figure 3.13 CV Summary Screen

From this screen the CV values, Mean Values as well as the Standard Deviation of the flow measurements taken during the previous event can be examined and transferred to the field data form. Press the >> key again and this will bring up the “Min/Max” Summary Screen as shown below.

```

Min/Max Summary                          MM/DD/YY HH:MM:SS
Ambient T Max      C
      Min      C
Filter 1 T Max      C
      Min      C
Ambient P Max      mmHg
      Min      mmHg
                                     <<      >>      Exit

```

Figure 3.14 Min/Max Summary Screen

On SuperSASS, use the Up and Down arrow keys to scroll through the filter canister numbers to select the desired filter temperature. The SASS unit provides only a single filter temperature from canister #1. From this screen the various min/max values, for temperature and pressure that were recorded during the previous event can be examined and transferred to the field data form.

Press the >> key again and this will bring up the “Filter DT Summary” Screen as shown on the next page.

```

Filter dT Summary                          MM/DD/YY HH:MM:SS
Max dT
5 -xx.x C      MM/DD/YY HH:mm:ss
6 -xx.x C      MM/DD/YY HH:mm:ss
7 -xx.x C      MM/DD/YY HH:mm:ss

```

```

<<          >>          Exit

```

Figure 3.15 Filter Temperature Summary Screen (Super SASS)

This screen indicates the maximum temperature recorded between the ambient temperature and the filter temperature. The SASS screen, provides only a single MAX dT value for filter canister #1 and the ambient temperature. It also includes the date and time of the maximum value. This value will continue to record even after the event has been completed, so that the value includes any differences that occur before the sample canister is removed.

Press the >> key again and this will bring up the “Warnings” Summary Screen as shown below.

```

Warnings                MM/DD/YY HH:MM:SS
Elapsed Time: YES      HH:mm:ss < 23:00:00
Filter dT
5   YES      -xx.x C    MM/DD/YY HH:mm:ss
6   YES      -xx.x C    MM/DD/YY HH:mm:ss
7   YES      -xx.x C    MM/DD/YY HH:mm:ss

<<          >>          Exit

```

Figure 3.16 Warnings Screen (Super SASS)

This screen indicates if there were any alarms or warnings, which occurred during the previous test. A “Yes” value indicates that an alarm occurred, the date and time of the event is stored on the screen. These alarm results can be examined and transferred to the field data form. As before, the SASS version of this screen will show only a single filter temperature warning.

Press the >> key again and this will bring up the “Flow Warnings” Summary Screen as shown below.

```

Flow Warnings          MM/DD/YY HH:mm:ss
                        Lpm
Flow 1: Yes          xx.x MM/DD/YY HH:mm:ss
Flow 2:  No
Flow 3:  No
Flow 4:  No
Flow 5:  No

<<          >>          Exit

```

Figure 3.17 Flow Warnings Summary Screen (SASS)

This screen indicates if there were any alarms or warnings, which occurred during the previous test, related to flow measurement. A “Yes” value indicates that an alarm occurred, the date and time of the event is stored on the screen. The SASS screen can display up to 5 separate flow warnings, while the SuperSASS would have a maximum of 4 flow warning channels. These alarm results can be examined and then are transferred to the field data form. This completes the collection of data results required by the field data form.

Pressing the >> Key again brings up the “Power Interruptions” screen. This screen provides information on power interruptions that may have occurred during the sampling event.

Power Interruptions		MM/DD/YY	HH:MM:SS
1	MM/DD/YY	HH:MM:SS	6 MM/DD/YY HH:MM:SS
2	MM/DD/YY	HH:MM:SS	7 MM/DD/YY HH:MM:SS
3	MM/DD/YY	HH:MM:SS	8 MM/DD/YY HH:MM:SS
4	MM/DD/YY	HH:MM:SS	9 MM/DD/YY HH:MM:SS
5	MM/DD/YY	HH:MM:SS	0 MM/DD/YY HH:MM:SS
		<<	>> Exit

Figure 3.18 Power Interruptions Screen

A power interruption event is logged when it lasted for more than 1 minute. A maximum of ten events are logged. If more than ten events occur, the tenth (0) is over written with the most recent.

3.4 Sample QA/QC Procedures

Certain quality control checks must be conducted at the time of sample setup and at monthly or quarterly intervals thereafter. Carry out these checks before making any adjustments to the sampler. Record information about the site, the sampler and the results of scheduled or special (unscheduled) quality control checks on a QA/QC Report Form. This report form originates at the field site, and the site operator should keep the original on file and copies to others. Any actions taken to service or calibrate the SASS sampler, after the check should be recorded in brief on the form and in detail in the field operators notebook.

3.4.1 Date and Time Checks

Conduct these checks monthly or whenever daylight savings time changes occur. Compare the date and time displayed on the sample to the known data and to an accurately set watch. Record date and time check information on the QA/QC data form.

3.4.2 Monthly Leak Check

Performed upon startup, and then monthly, see procedure in Section 6.0 of this manual

3.4.3 Monthly Temperature Check

Performed upon startup and then monthly, check the ambient and filter temperature sensors of the sample by positioning the probe of a certified transfer standard digital thermometer in close proximity to the sample sensors. Allow time to achieve stable readings and record the results in the field notebook and the QA/QC report form. If the sample and control check temperature readings differ by more the $\pm 2^{\circ}\text{C}$, trouble shoot the system and recheck. If still out of tolerance, conduct a two-point calibration as described in Section 6.0, or replace the faulty sensor.

3.4.4 Quarterly Temperature Check

Performed each calendar quarter, follow the procedure for the calibration of the temperature probe as described in Section 6.0 of this manual. It should be compared against a certified NIST calibrated standard. Should a temperature sensor not maintain its calibration after the monthly or quarterly checks, maintenance and/or replacement of the faulty parts must occur.

3.4.5 Monthly Pressure Check

Compare the ambient barometric pressure readout from the sampler display screen with the reading from a certified transfer standard barometer. If the pressure readings differ by more than ± 10 mm Hg, perform a calibration of the pressure sensor as described in Section 6.0 of this manual or if necessary replace the faulty sensor.

3.4.6 Quarterly Pressure Check

Performed each calendar quarter, follow the procedure for calibration of the pressure sensor as described in Section 6.0 of this manual. It should be compared to a certified NIST calibrated pressure standard. Should the pressure sensor not maintain its calibration after the monthly or quarterly checks, maintenance and/or replacement of the faulty parts must occur.

3.4.7 Monthly Flow Rate Check

Performed upon startup, and then monthly, see procedure in Section 6.0 of this manual. If the flow deviation exceeds +/- 10% (+/- 0.67 LPM) ²⁴ then troubleshoot the problem to determine the cause of the change.

3.4.8 Quarterly Flow Rate Check

Performed each calendar quarter, follow the procedure for calibration of the flow sensor as described in Section 6.0 of this manual. It should be compared to a certified NIST calibrated flow reference standard. Should the flow sensor not maintain its calibration after the monthly or quarterly checks, maintenance and/or replacement of the faulty parts must occur.

4.0 MICROPROCESSOR MENUS AND SCREENS

Super SASS uses a series of intuitive menus to lead the operator through the setup, calibration, operation and data recall. Review the following section for a complete overview of the menu system.

Super SASS includes an Event Manager for the most flexible operation. An Event Manager will maintain a pre-event list, up to four (4) pre-events are allowed. Twenty-four (24) post events are archived in a circular manner where the oldest is overwritten by the newest addition. User selectable menus are designed to allow automatic timed sample events or manual on and off settings for calibration. Many menus and windows give current sampler information of ambient temperature, filter canister temperature, barometric pressure, sample flow rates and any error messages.

4.1 Main Screen

When the SASS or SuperSASS, is first powered up the user will see the MAIN SCREEN. The version number and system identification, as well as the choices Operate, Setup, Calibrate and Transfer Data are displayed.

Keys directly below the screen are associated with the screen text; these keys are called “soft keys”, because their function changes as the software changes. Keys F1 to F6 are called function keys.

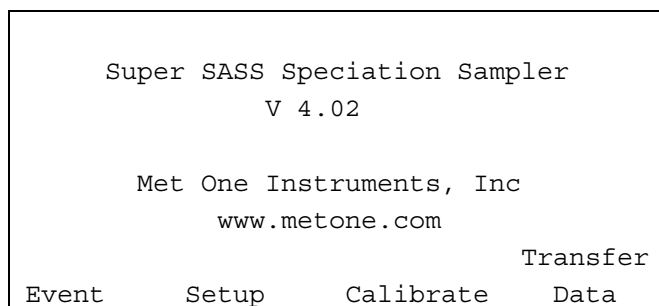


Figure 4.1 Main Screen

Event Menu Screen:

The Event menu is used to view all previous data and event results that have occurred. Up to 24 previous events can be stored in the memory of the SASS control box. From the Event menu, either current or previous sample event data can be viewed.

Setup Menu Screen:

Setup Menu is used to program into the control box the time and date of events, set the clock, customize the default menu, set the identification number and clear all event memory.

Calibration Menu Screen:

This menu contains the various calibration screens and test functions.

Transfer Data:

Provides data save menu using the accessory transfer module. It can also be used to verify the transfer of data via the RS-232 port. When communications is active, the transfer information is displayed in this screen.

4.2 Event Menu

From the Main Screen, press the EVENT key. The Event section 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.

```
Event Menu
F1: Current Event Status
F2: Previous Event Summary
F3:
F4: Event Manager
F5:
F6: Historical Event Summary
Exit
```

Figure 4.2 Event Menu

The event menu provides selections for viewing the results of current and post events.

4.2.1 Current Event Status

By pressing the “F1” This particular status screen provides the user with the current operating conditions of the SASS sampler. When a sampling event is in progress, the data available for viewing is the current event data.

From this screen, the operator can access the current event that was most recently completed or the current event that is in progress. During operation of the SASS, 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**. The Status line values are shown in reverse video on the screens.

```
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 4.3 Finished Status Screen

From this screen only, the >> and << arrow hot keys can be used to navigate through the various status and summary screens. The current event number appears under the status label at the left hand top corner of the display screen.

If there is a test in progress, the sampling screen will appear indicating the current status of the event that is currently in progress.

```

Status: Sampling          09/11/00 11:43:22
07          Canister Set: (1,2,3)
          Event Start: 09/11/00 00:00:00
          Event Stop: 09/11/00 24:00:00
          Elapsed:          11:42:22
          Remaining:        12:17:38

          <<          >>          Exit
  
```

Figure 4.4 Sampling Status Screen

Menu Item Descriptions:

Soft Key	Description
Exit	The Exit key when pressed will exit the current menu and return to the event menu screen as seen in Figure 4.2
<< And >>	Selection of these keys step through the various status and summary screens for the current event, or when there are no running events, the just finished event will be displayed.
Status	Description
Sampling	During this state the line 6 display is: Remaining: HH:mm:ss Where the time displayed is the Event Stop time minus the current time. In other words, the time remaining until the pump is turned OFF and sampling stops. Stays in this state until the current time is greater or equal to the Event Stop time, and then the status is set to the Stopping state.
Finished	During this state Data logging continues.

To view the current data relating to the test that is in progress, the >> key can be used to go to the next status screen

Current Data Screen

This screen shows the current operating conditions of flow, temperature, filter temperature and pressure. The pump status is shown in the lower right of the screen. It will display only those canisters that are installed for the current event. Use the >> key to advance to the next screen.

```

Current          MM/DD/YY HH:MM:SS
Ambient P   xxx mmHg   Ambient T  -xx.x C
  Flow 1   xx.x Lpm   Filter 1  -xx.x C
  Flow 2   xx.x Lpm
  Flow 3   xx.x Lpm
  Flow 4   xx.x Lpm
  Flow 5   xx.x Lpm   Pump:    ON
          <<          >>          Exit
  
```

Figure 4.5a Current Data Screen (SASS)

```

Current                MM/DD/YY HH:MM:SS
Ambient P    724 mmHg  Ambient T    24.4 C
  Flow 1    xx.x Lpm   Filter 1    24.5 C
  Flow 2    xx.x Lpm   Filter 2    24.3 C
  Flow 3    xx.x Lpm   Filter 3    24.3 C
  Flow 4    xx.x Lpm   Filter 4    24.2 C
                          Pump:    ON
                          <<      >>      Exit

```

Figure 4.5b Current Data Screen (SuperSASS)

Average Screen

The Super SASS logs data at the U.S. EPA setting of 5 minutes. In the Average screen, the user can view the last calculated average. Included are the last average time and all data values for the sample: flow, temperature, filter temperature and barometric pressure. These are displayed for the current configuration of canisters being used.

```

5 Min. Values          MM/DD/YY HH:MM:SS
Ambient P    xxx mmHg  Ambient T   -xx.x C
  Flow 1    xx.x Lpm   Filter 1   -xx.x C
  Flow 2    xx.x Lpm
  Flow 3    xx.x Lpm
  Flow 4    xx.x Lpm
  Flow 5    xx.x Lpm   Pump:    ON
                          <<      >>      Exit

```

Figure 4.6a Average Screen (SASS)

```

5 Min. Values          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
                          <<      >>      Exit

```

Figure 4.6b Average Screen (SuperSASS)

This screen always displays the 5-minute values from the current event in progress or when there is no event in progress, it is the data for the previous event. This data is not applicable for recording on the post event data report. Be careful that these screens are not confused with the event summary data that should be recorded on the transfer of custody or data result forms.

Menu Item Descriptions

Soft Key	Description
Exit	The Exit key when pressed will exit the current menu and return to the event menu screen as seen in Figure 4.2

<< And >>	Selection of these keys step through the various status and summary screens for the current event, or when there are no running events, the just finished event will be displayed.
Status	Description
Ambient P	Displays the 5-minute average of barometric pressure for the current event.
Ambient T	Displays the 5-minute average of ambient temperature for the current event.
Flow n-n	Displays the 5-minute average of the flow in Lpm for the current event, the number of flows values displayed will depend upon the number of installed canisters.
Filter n-n	Displays the 5-minute average of the filter temperatures for the current event. There is only a single temperature for the SASS unit, canister #1

The screens shown in figures 4.5 and 4.6 are the two key screens that display data being collected for the event that is in progress. Additional screens that can be viewed are described in section 4.2.2

4.2.2 Previous Event Summary Screen

This screen is selected from the event menu in figure 4.2 by using the “F2” key. It is used to show the recorded results of the previous event that has just finished. In some test sequences, the displayed previous event is the same as the current event. This can occur when there is not another event in progress and there is not one scheduled. It should also be noted that only the data results for the number of installed canisters would be displayed in the various screens.

The previous event summary is the primary source of information for the collection of data that is transcribed to the transfer of custody form or other documentation related to the recent event.

The sequence number of the event is listed in the upper left hand corner, just below the status label. The << and >> arrow hot keys are used to sequence through the various screens containing the status, summary and warnings data. The following status screen “finished” is the home display.

```

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 4.7 Status Screen

The remainder of the screens that display data results can be viewed by selecting the >> key from the status screen. The first two screens were previously shown in figures 4.5 and 4.6. They are only relevant for the display of current data that is being collected during an event that is in progress. Skip past them to the summary screen, which contains the information that needs to be transcribed to the transfer of custody form as seen in appendix B.

Volume Summary Screen

The volume summary screen has the information about the average pressure, volumes, the ambient temperature as well as filter temperature summary. This screen and the following screens provide information that may be required for chain of custody forms, or other documents used to document the results of the previous sample event. The number of individual items will vary depending upon the number of installed canisters used during each test sequence. Use the >> key to advance to the next screen.

```

Volume Summary          MM/DD/YY HH:MM:SS
Ambient P   xxx mmHg   Ambient T  -xx.x C
Volume 1   x.xxx m3    Filter 1  -xx.x C
Volume 2   x.xxx m3
Volume 3   x.xxx m3
Volume 4   x.xxx m3
Volume 5   x.xxx m3
                <<          >>          Exit
    
```

Figure 4.8a Volume Summary Screen (SASS)

```

Volume Summary          MM/DD/YY HH:MM:SS
Ambient P   xxx mmHg   Ambient T  -xx.x C
Volume 5   x.xxx m3    Filter 5  -xx.x C
Volume 6   x.xxx m3    Filter 6  -xx.x C
Volume 7   x.xxx m3    Filter 7  -xx.x C
Volume 8   x.xxx m3    Filter 8  -xx.x C
                <<          >>          Exit
    
```

Figure 4.8b Volume Summary Screen (SuperSASS)

Menu Item Descriptions

Soft Key	Description
Exit	The Exit key when pressed will exit the current menu and return to the event menu screen as seen in Figure 4.2
<< And >>	Selection of these keys step through the various status and summary screens for the current event, or when there are no running events, the just finished event will be displayed.
Status	Description
Ambient P	Displays the average barometric pressure for the event.
Ambient T	Displays the average of ambient temperature for the event.
Volume n-n	Displays the total volume in cubic meters for the event. The number of displayed channels will depend upon the number of installed canisters.
Filter n-n	Displays the average filter temperatures for the event, only a single filter temperature for the SASS unit.

CV Summary Screen

CV is the Coefficient of Variance is equal to the Standard Deviation divided by the Mean times 100. The units are in percent. The number of displayed flow values will vary with the number of installed canisters. To advance to the next screen, use the >> key.

CV Summary		MM/DD/YY HH:MM:SS	
	CV	Mean	Std Dev
Flow 1	%	Lpm	Lpm
Flow 2	%	Lpm	Lpm
Flow 3	%	Lpm	Lpm
		<<	>> Exit

Figure 4.9 CV Summary Screen

Menu Item Descriptions

Soft Key	Description
Exit	The Exit key when pressed will exit the current menu and return to the event menu screen as seen in Figure 4.2
<< And >>	Selection of these keys step through the various status and summary screens for the current event, or when there are no running events, the just finished event will be displayed.
Status	Description
Flow n-n	Displays the coefficient of variance, the mean and the standard deviation of the flow for the entire event. Only the flows for the installed canisters will be displayed in both SASS and SuperSASS.

Min/Max Summary Screen

The Min/Max Summary screen provides the maximum and minimum values recorded during the previous event. Each indicates the date and time of the occurrence of the maximum and minimum values. In the SASS unit, there is only a single filter temperature max/min value available. Use the >> key to advance to the next screen.

Min/Max Summary		MM/DD/YY HH:MM:SS	
Ambient T Max	22.4 C	MM/DD/YY	HH:MM:SS
Min	19.5 C	MM/DD/YY	HH:MM:SS
Filter 1T Max	23.3 C	MM/DD/YY	HH:MM:SS
Min	19.3 C	MM/DD/YY	HH:MM:SS
Ambient P Max	730 mmHg	MM/DD/YY	HH:MM:SS
Min	630 mmHg	MM/DD/YY	HH:MM:SS
		<<	>> Exit

Figure 4.10 Min/Max Summary Screen

Use the up/down keys to select the SuperSASS filter canister number to display max/min data.

Menu Item Descriptions

Soft Key	Description
Exit	The Exit key when pressed will exit the current menu and return to the event menu screen as seen in Figure 4.2
<< And >>	Selection of these keys step through the various status and summary screens for the current event, or when there are no running events, the just finished event will be displayed.
Up / Down	Use to select the specific canister filter temperature to display. This is only active in the SuperSASS. SASS provides a single temperature max/min value.
Status	Description
Ambient T Max/Min	Displays the maximum and minimum values for the ambient temperature and the time and date of occurrence since the beginning of the event.
Filter x T Max/Min	Displays the maximum and minimum values for the filter temperature and the time and date of occurrence since the beginning of the event. Use the up and down arrow keys to select individual canisters.
Ambient P Max/Min	Displays the maximum and minimum values for the barometric pressure and the time and date of occurrence since the beginning of the event.

Filter dT Summary Screen

The filter dT summary screen displays the maximum temperature difference between the ambient temperature and the filter temperature. In addition to recording the maximum temperature difference, it also indicates the date and time of the maximum value. These values will continue to change and will be an indication of the values up to the time the canisters are removed from the SASS. The SASS unit provides a single Max dT value for canister #1, while the SuperSASS provides a Max dT value for each canister used in the sample event.

Use the >> key to advance to the next screen.

Filter dT Summary	MM/DD/YY HH:MM:SS
Max dT	
1 -xx.x C	MM/DD/YY HH:mm:ss
2 -xx.x C	MM/DD/YY HH:mm:ss
3 -xx.x C	MM/DD/YY HH:mm:ss
<<	>> Exit

Figure 4.11 Filter dT Summary Screen

Menu Item Descriptions

Soft Key	Description
Exit	The Exit key when pressed will exit the current menu and return to the event menu screen as seen in Figure 4.2

<< And >>	Selection of these keys step through the various status and summary screens for the current event, or when there are no running events, the just finished event will be displayed.
Status	Description
Max dT	Displays the maximum difference between the ambient temperature and the filter temperature. Includes time and date of occurrence since the beginning of the event.

Warnings Screen

This screen displays any warnings that indicate that the length of the test was out of tolerance or the difference temperature between the ambient and the filter exceeded the preset limit.

A Filter Error display of NO indicates no flow errors. A Filter Error display of YES indicates a filter temperature error that is greater than 5 degrees Celsius from the ambient temperature. On the SASS only a single dT warning would be displayed, for SuperSASS a dT warning can be displayed for each canister used in the sample event.

```
Warnings                               MM/DD/YY HH:MM:SS
Elapsed Time: YES  HH:mm:ss < 23:00:00
Filter dT
1  YES  -xx.x C   MM/DD/YY HH:mm:ss
2  YES  -xx.x C   MM/DD/YY HH:mm:ss
3  YES  -xx.x C   MM/DD/YY HH:mm:ss

<<      >>      Exit
```

Figure 4.12 Warnings Screen

Menu Item Descriptions

Soft Key	Description
Exit	The Exit key when pressed will exit the current menu and return to the event menu screen as seen in Figure 4.2
<< And >>	Selection of these keys step through the various status and summary screens for the current event, or when there are no running events, the just finished event will be displayed.
Status	Description
YES - NO	NO indicates that there were no errors, a YES indicates that an error occurred or the dT was exceeded.
Elapsed Time	The elapsed sample time is out of range – less than 23 hours or greater than 25 hours.
Filter dT	Filter temperature differential is out of specifications and it's time and data of occurrence. The filter temperature exceeded the ambient temperature by more than 5° C for more than 30 minutes during either the sampling or post sampling period of operation.

Flow Warnings Screen

The displayed flows for each sample canister are constantly adjusted to the required “actual” volumetric flow based on actual site conditions using the filter temperature and the barometric pressure. In SASS there can be a maximum of 5 flows, while there are 4 for the SuperSASS. The actual number of channels displayed will depend upon the number of canisters used for the sample event.

```

Flow Warnings                MM/DD/YY HH:mm:ss
                               Lpm
Flow 1: Yes   xx.x MM/DD/YY HH:mm:ss
Flow 2:  No
Flow 3:  No
Flow 4:  No

                               <<   >>   Exit
    
```

Figure 4.13 Flow Warnings Screen

Menu Item Descriptions

Soft Key	Description
Exit	The Exit key when pressed will exit the current menu and return to the event menu screen as seen in Figure 4.2
<< And >>	Selection of these keys step through the various status and summary screens for the current event, or when there are no running events, the just finished event will be displayed.
Status	Description
YES - NO	NO indicates that there were no errors, a YES indicates that there was a error in flow rate.
Flow 1-8	Sample flow rate out of spec, its value, and its time and date of occurrence. The flow rate exceeded a range of +/- 10 percent of the average flow rate for the sample period for more than 5 minutes.

Power Interruptions Screen

A power interruption event is logged when it lasted for more than 1 minute. A maximum of ten events are logged. If more than ten events occur, the tenth (0) is over written with the most recent. The time and date of each event is logged as part of the power interruptions summary.

```

Power Interruptions          MM/DD/YY HH:MM:SS

1 MM/DD/YY HH:MM:SS   6 MM/DD/YY HH:MM:SS
2 MM/DD/YY HH:MM:SS   7 MM/DD/YY HH:MM:SS
3 MM/DD/YY HH:MM:SS   8 MM/DD/YY HH:MM:SS
4 MM/DD/YY HH:MM:SS   9 MM/DD/YY HH:MM:SS
5 MM/DD/YY HH:MM:SS   0 MM/DD/YY HH:MM:SS

                               <<   >>   Exit
    
```

Figure 4.14 Power Interruptions Screen

This is the last summary screen, pressing the >> key will return to the finished status screen as seen in figure 4.3.

4.2.3 Event Manager Screen

Selecting the event manager screen using the “F4” key will go directly to the event manager that is part of the setup menu. This shortcut can be used to view the events currently programmed into 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. See Section 4.3 for details on the using the event manager.

4.2.4 Historical Event Summary Screen

The historical event summary screen allows for viewing of post events. A maximum of 24 post 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 as seen in figure 4.7. The key difference is that the event number can be selected from the historical event summary; while in the previous event summary it only shows the most recently completed event. The event number is displayed below the Status label in the upper left hand corner of the screen. The various screens available are the same as described in section 4.2.2, except they are for the selected post event.

```

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 4.15 Status Screen

Menu Item Descriptions:

Soft Key	Description
Exit	The Exit key when pressed will exit the current menu and return to the event menu screen as seen in Figure 4.2
<< And >>	Selection of these keys step through the various status and summary screens for the current event, or when there are no running events, the just finished event will be displayed.
Up / Down	Use the Up and Down arrow keys to select the event summary to view, the most recent event will always be the starting point. Use the up arrow to go to the next older event.
Status	Description
Finished	Indicates that this is a completed event.

4.3 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 4.16 is displayed, when the setup key from the main menu is selected.

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

Figure 4.16 Setup Menu Screen

Use the function keys to access the various menu selections. To return to the main menu, the exit key can be selected.

4.3.1 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 be programmed. The SASS unit provides only a single set of canisters, typically (1,2, & 3) that can be programmed for future sample events. The SuperSASS 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.

```
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 4.17 Event Manager Screen

Only active pre-events are listed. They are ordered (top to bottom) by the earliest date and time. Up to four (4) 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 4 pre-programmed events then the Add key will bring up the Add Event screen.

Menu Item Descriptions

Soft Key	Description
Add	This key is used to add an event to the system
Modify	Once selected an event can be modified using this key selection.

Delete	This key allows for the deletion of an event from the event queue.
Exit	Used to exit the menu to the event manger screen (Figure 4.16)
Up / Down	The arrow keys are used to select an event for modification or deletion.

Add Event Screen

The add event screen is used to add an event to the pre-event list or to enter the first event into the SASS unit. This menu is used to edit the Event Start date and time, Event Length time, and the Canister Set. Current date and time are shown in the upper right hand corner of the screen. While the canister set of the SASS cannot be sequenced, the configuration of the installed canisters for the sample event needs to be indicated. The dynamic nature of the various screens requires that the configuration be defined for the test, so that it can be properly displayed on the screens. Typically as part of the EPA test plan, SASS canister set {1,2 & 3} will be used. This is also the default set. The Canister Set is a pick list of defined sets as shown below.

Defined sets for SASS are:

{1}, {1,2}, {1,2,3}, {1,2,3,4}, {1,2,3,4,5}

Defined sets for Super SASS are:

{1}, {2}, {3}, {4}, {1,2}, {3,4}, {5,6}, {7,8}, {1,2,3}, {5,6,7}, {1,2,3,4}, and {5,6,7,8}.

Press the Add button to add this event to the pre-event list. A successful add will return the user to the Event Manager screen.

Add Event	12/14/00	08:34:09
	MM/DD/YY	HH:mm
Event Start:	12/15/00	00:00
Event Length:		24:00
Canister Set:	{1,2,3}	
Add	Default	Cancel

Figure 4.18 Add Event Screen

Menu Item Descriptions

Soft Key	Description
Add	This key is used to add this event to the pre-event list.
Default	Selection will automatically enter the preset default values as described in figure listed in the section "Event Defaults"
Cancel	This key allows the user to cancel the add function and returns to the event manager screen.
Term	Description
Event Start	This is the start date and time for the event. Use arrow keys to move and edit values. Selection of default will automatically enter the default value

	for this event.
Event Length	This is the length of the event in hours and minutes. Use arrow keys to move and edit the values. Selection of default will automatically enter the default value for this event.
Canister Set	This is the set of canisters to be used during this event. Using the up and down arrow keys to select the set of canisters. See listing above for choices of canisters grouped in sets.

Modify Event Screen

The modify event screen is used to modify an event in the pre-event of the SASS unit. This menu is used to modify the Event Start date and time, Event Length time, and the Canister Set. Current date and time are shown in the upper right hand corner of the screen. The Canister Set is a pick list of defined sets as previously described.

Press the Save button to commit changes to the event. A successful save will return the user to the Event Manager screen.

Modify Event	12/14/00	18:23:05
	MM/DD/YY	HH:mm
Event Start:	12/15/00	00:00
Event Length:		24:00
Canister Set:	{1,2,3}	
Save	Default	Cancel

Figure 4.19 Modify Event Screen

Menu Item Descriptions

Soft Key	Description
Save	This key is used save the modified event to the pre-event list.
Default	Selection will automatically enter the preset default values as described in figure listed in the section "Event Defaults"
Cancel	This key allows the user to cancel the add function and returns to the event manager screen.
Term	Description
Event Start	This is the start date and time for the event. Use arrow keys to move and edit values. Selection of default will automatically enter the default value for this event.
Event Length	This is the length of the event in hours and minutes. Use arrow keys to move and edit the values. Selection of default will automatically enter the default value for this event.
Canister Set	This is the set of canisters to be used during this event. Using the up and down arrow keys to select the set of canisters. See listing above for choices of canisters grouped in sets.

Delete Event Screen

If the delete event from the event manager screen is selected, the following caution screen will appear. It is used to warn the operator that they are about to remove an existing sample event. Select the appropriate key to delete the event or the cancel key to return to the events manager screen.

```
.....Caution.....  
  
Press 'Delete' to remove the selected  
sample event.  
  
Delete                               Cancel
```

Figure 4.20 Delete Event Screen

4.3.2 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 shown in figures 4.18 and 4.19. Defaults are selected for event length and canister set. A list of canister sets can be found in the add events section of figure 4.18. 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 4.21 Sample Event Defaults Screen

4.3.3 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 4.22 Clock Setup Screen

4.3.4 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. Every SASS unit has its own ID number, from 0 to 9999. Press the SAVE key to save changes to the Unit ID.

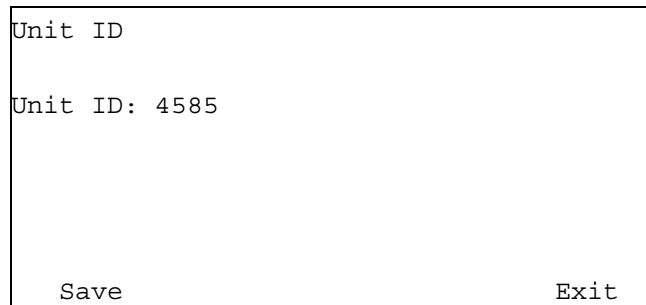


Figure 4.23 Unit ID Screen

4.3.5 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.

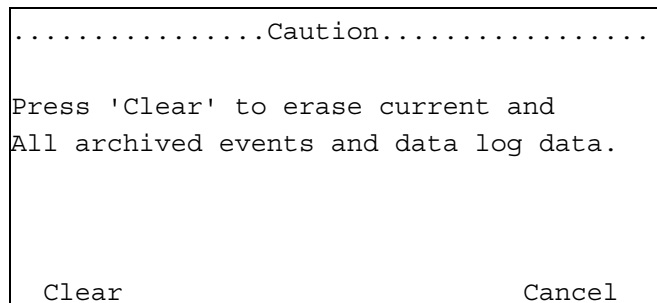


Figure 4.24 Clear Event History Caution Screen

4.3.6 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 2 types of mass flow meters—10 or 20 LPM full scale. Edit to select the appropriate type. This configuration 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. The SASS will have 5 sensors compared to SuperSASS 4 sensor channels. Press Save to save or Exit to leave the menu.

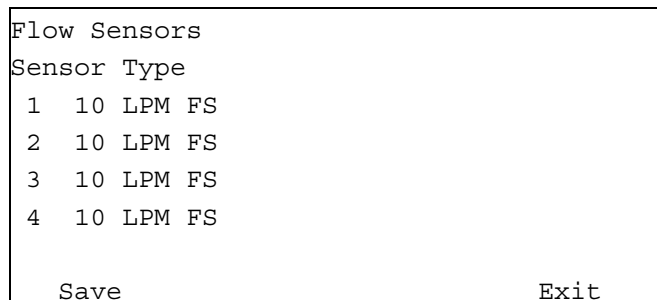


Figure 4.25 Flow Sensors Screen

4.4 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 4.26 Calibrate Menu

4.4.1 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 checkout of the SASS. It is also useful for the troubleshooting of the SASS 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 1   xx.x Lpm   Filter 1  -xx.x C
  Flow 2   xx.x Lpm
  Flow 3   xx.x Lpm
  Flow 4   xx.x Lpm
  Flow 5   xx.x Lpm   Pump:    ON
                                Pump    Exit
    
```

Figure 4.27a System Test Screen (SASS)

```

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 4.27b System Test Screen (SuperSASS)

Menu Item Descriptions:

Soft Key	Description
Cans	This key allows the toggling of canister group {1,2,3,4} and group {5,6,7,8} for display on the screen. (SuperSASS Only)
Pump	This key allows the toggling of the pump from OFF to ON
Exit	Exits this menu to the calibrate menu screen

Status	Description
Ambient P	The current ambient barometric pressure in mm of Mercury
Ambient T	The current ambient temperature in degrees centigrade.
Flow x	Displays the current numbered canister flow in liters per minute, use Cans to view the alternate canister group.
Filter x	Displays the current numbered canister temperature in degrees centigrade, use Cans to view the alternate canister group. There is only a single filter temperature in the SASS unit.
Pump	Displays the current status of the pump.

4.4.2 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 in label Chan.

Volumetric Flow Calibration			
Chan	SASS	Ref	Type
(1)	.0	6.7 LPM	10 LPM FS
Pump: OFF			
Calibrate	Pump	Default	Exit

Figure 4.28 Volumetric Flow Calibration Screen

Menu Item Descriptions:

Soft Key	Description
Calibrate	Set new calibration coefficients into memory. Before pressing this key, the pump should be ON and the desired SASS calibration reference reading entered in Ref.
Pump	This key allows the toggling of the pump from OFF to ON
Default	Restore factory default calibration values.
Exit	Return to the calibrate menu, see figure 4.26.
Term	Description
Chan	Flow sensor channel number, use up / down arrow keys to select 1 to 4 or 5
SASS	The current volumetric flow rate of the SASS unit.
Ref	This is the reference reading from the calibration standard being used to calibrate flow for the selected channel. This should be the volumetric flow value or the corrected value to volumetric flow.
Type	Flow sensor type either 10 LPM or 20 LPM full scale value
Pump	Indicates the current pump status, either ON or OFF

4.4.3 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 reference standard for a low value and a high value is required. Typically, the two points consist of a zero centigrade reading using an ice bath, and a high temperature using a high temperature bath with reference thermometer. 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 to 8). The SASS unit has only a single canister temperature (1) while the SuperSASS has (8). Because this is typically a two-point test, a separate save function key is provided for the low and high temperature values.

```
(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 4.29 Temperature Calibration Screen

Menu Item Descriptions:

Soft Key	Description
Calibrate	Set new calibration coefficients into memory. Before pressing this key, the desired SASS calibration reference reading for points 1 and 2 has been entered in Reference using the F1 and F4 keys.
Default	Restore factory default calibration values.
Exit	Return to the calibrate menu, see figure 4.26.
Save (F1)	Store the current low temperature reference reading to the Pt 1 entry.
Save (F4)	Store the current high temperature reference reading to the Pt 2 entry.
Term	Description
(x) xxxxxxxx	Used to select the desired temperature channel. (0) Ambient or (1 to 8) for filter temperatures of individual canisters. SASS unit has (0 & 1) only.
SASS	The current measured temperature of the selected SASS temperature channel.
Pt	One point of a two-point calibration. Generally point 1 = low calibration value and point 2= high calibration.
Save	Saved un-scaled SASS temperature device reading associated with the corresponding reference value. Use F1 to save calibration value 1 and F4 to save calibration value 2.
Reference	Enter the low or high calibration value that the temperature probe is currently measuring. Allow sufficient time for the temperature probe and the reference to stabilize.

4.4.4 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, a reference standard for a low value and a high value is required. Typically, the two points consist of a low reading of 600 mm of Hg and a high reading of 800 mm of Hg.

Pressure Calibration				
SASS	Pt	Save	Reference	
730	1	735	600 mmHg	Save (F1)
	2	735	735 mmHg	Save (F4)
Calibrate		Default		Exit

Figure 4.30 Pressure Calibration Screen

Menu Item Descriptions:

Soft Key	Description
Calibrate	Set new calibration coefficients into memory. Before pressing this key, the desired SASS calibration references reading for points 1 and 2 have been entered in Reference using the F1 and F4 keys.
Default	Restore factory default calibration values.
Exit	Return to the calibrate menu, see figure 4.26.
Save (F1)	Store the current un-scaled pressure reading to the Pt 1. Save variable associated with the corresponding reference value.
Save (F4)	Store the current un-scaled pressure reading to the Pt2. Save variable associated with the corresponding reference value.
Term	Description
SASS	The current pressure reading of the SASS unit.
Pt	One point of a two-point calibration. Generally point 1 = low calibration value and point 2= high calibration.
Reference	Measured pressure reading of reference device, enter value in range 000 to 999 mm of mercury.
Save	Saved un-scaled SASS pressure device reading associated with the corresponding reference value. Use F1 to save calibration value 1 and F4 to save calibration value 2.

4.5 Transfer Data

This menu once selected from the main screen allows for the transfer of the SASS memory contents into the optional UX-961 Transfer Module. See Figure 5.1 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 4.31 Xmodem File Transfer Screen

Menu Item Descriptions:

Soft Key	Description
Transfer History	Transfers all post event sample summaries to the transfer module. This file is approximately 16K bytes in size and transfers in XXX minutes.
Transfer All	Transfers all post event sample summaries as well as 5 minute logger data to the transfer module. This file is approximately 112K bytes in size and transfers in XXX minutes.
Exit	Exits this menu to the main menu screen
Status	Description
Status	Indicates status of either "Transmitting" or "Finished"
Received	Indicates the number of xmodem packets that have been received
File Size:	Indicates the files size transferred. (i.e. 114,688 bytes for All Transfer)
Packet	Packet number currently being transferred.

4.6 Error and Warning Screens

There are various screens used to indicate cautions and warnings to the user. These are used to prevent actions that might cause loss of data, or provide warning when an error condition occurs in the SASS unit. The following is a list of the common caution and warnings screens.

Link Down Warning Screen

This screen is displayed when communication has failed between the control box and the pump box. A failure is defined as no communication for more than 10 seconds. This screen will remain on the screen until the continue key is pressed. This error is caused by a number of conditions that can occur during the normal operation of the SASS System. It should be considered a problem when it has a duration that exceeds more than 5 minutes.

Link down warning: displays the date and time the event occurred.

Duration: displays the duration of the event. Press Continue to return to the Home screen.

```
.....Warning.....  
  
Communication link down to pump box!  
  
Link down: MM\DD\YY  HH:mm:ss  
Duration: HH:mm:ss  
  
Continue
```

Figure 4.32 Link Down Warning Screen

Test Caution Screen

This caution screen occurs whenever the operator requests that the pump be turned on, when an event is scheduled in the system. It also appears when the pump is running and an event and a stop request is made.

```
.....Caution.....  
  
Press 'Continue' to STOP the sample  
event and control the pump.  
  
Cancel                               Continue
```

Figure 4.33 Test Caution Screen

5.0 SAMPLER OPTIONS

5.1 Hand-Held Data Transfer Module*

Met One Instruments Model UX-961 is a 12 volt DC self contained RS232 compatible data transfer module that can be carried to the field site by an operator to down-load the data that has been logged from the SASS. The device eliminates the requirement to carry a laptop computer to the field or manually transcribing data to a data sheet. The Module measures 6"L x 3"W x 1"H.



Figure 5.1 Transfer Module

The Data Transfer Module includes all RS-232 Interface cables and connections to interface with the RS-232 connection on the Control Unit. By selecting "Transfer Data" from the main screen menu, the transfer of information from the SASS to the transfer module will start. As data is transferred, the screen will indicate the progress of the transfer.

Once the data has been transferred to the module, it can then be taken to a PC computer where the special power supply and cable connects to the communications port on the computer. The SASSComm AQ Software is used on the PC to prepare reports in a format similar to that used by the EPA FRM Samplers.

*Note: The UX-961 is no longer available for purchase. These instructions are included for customers that own existing modules.

5.2 Flow Rate Transfer Standard

Presently there are a number of commercial flow rate calibrators available from commercial manufacturers. Several use a patented "frictionless piston" and others a wet soap-bubble meter device. At present time, Met One believes the wet soap-bubble meter to be most reproducible and accurate, in laboratory conditions. For field use, the BGI, Model Delta Cal provides a single reference device for flow, temperature and pressure. In addition, several companies manufacture other types of transfer standard venturi flow devices. These are very accurate and can be used to calibrate the SASS. Please contact the factory for discussion of an accurate flow measurement device to use to calibrate the SASS. Adjustment of flow rates in the SASS should be consulted with the factory before made in the field.

5.3 Accessory Communications Items

Various accessory communications accessory items such as dial-up auto answer telephone modems, radio modems and cellular devices are available for the SASS. These are all designed to make the collection of data from the control unit easier. Additional information and details can be obtained from Met One Instruments, Inc.

6.0 MAINTENANCE, CALIBRATION, TROUBLESHOOTING

6.1 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. It is recommended that all maintenance and trouble shooting activities be recorded in the site notebook.

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

6.1.1 System Cleaning

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.

6.1.2 Denuder Replacement

Following the normal test sequence of the EPA Trends network, the MgO denuder will need replacement approximately every three months of operation or as required by the US-EPA. Under the EPA Trends program, the denuders are replaced by the third party vendor performing the analysis of the filters. The third party vendor is replacing filters and denuders in each canister; sufficient denuders should be supplied based on the three months of operation being typical. Details on the coating of the denuder can be found in the Appendix of this manual.

6.1.3 System Inspection

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.

Each time the canisters are removed, check the O-rings of the canisters and those on the Sharp Cut Cyclone. Each time the cyclones are removed, unscrew the grit cap and dump out any dirt that may have collected as part of a routine maintenance program.

6.2 System Leak Check

The system can easily be checked for air leaks. Leak checks are done from the System Test screen.

System Test		01/19/01 15:30:00	
Ambient P	735 mmHg	Ambient T	22.5 C
Flow 1	6.7 Lpm	Filter 1	22.5 C
Flow 2	6.7 Lpm		
Flow 3	6.7 Lpm		
Flow 4	6.7 Lpm	Leak Test:	OFF
Flow 5	6.7 Lpm	Pump:	ON
	Leak	Pump	Exit

System Test Screen (SASS)

System Test		01/19/01 15:30:00	
Ambient P	735 mmHg	Ambient T	22.5 C
Flow 1	6.7 Lpm	Filter 1	22.5 C
Flow 2	6.7 Lpm	Filter 1	22.5 C
Flow 3	6.7 Lpm	Filter 1	22.5 C
Flow 4	6.7 Lpm	Filter 1	22.5 C
Leak Test:	OFF	Pump:	ON
Cans	Leak	Pump	Exit

System Test Screen (Super SASS)

Before a leak test can be done the flow control valves must be operating at 6.7 LPM (+/- 0.2). Check for this operating point by turning the pump ON and waiting at least 5 to 10 minutes for the 6.7 LPM operating point to be reached (Note: SASS units do not have flow control on channels 4 and 5). Once this operating point has been reached press the **Leak** button to put the unit in leak test mode (Note: The leak test mode turns OFF motor control to the flow control valves).

While the pump is operating and flow values are being displayed on the screen of the control unit, block off the inlet tube of the SCC (Sharp Cut Cyclone) of canister #1 mounted in the sample head. The flow value for Flow 1 should drop to a 0.0 or 0.1 SLM, indicating that there are no detected leaks in the components of the first canister. Continue this procedure for the remaining canisters and make sure the flow drops to a 0.0 or 0.1 SLM. If you are using a SuperSASS, next select the **CAN** key to switch to the other canister set if they are installed in positions 5 to 8. A flow reading greater than this, on any of the canister channels, indicates that there is a leak in that portion of the system. Testing individual sections of the system can identify the location of the leak.

- 1.0 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 SLM. This indicates that the leakage path is between the pump and the sample head.
- 2.0 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 SLM, then the leakage is either in the connection between this point and the canister or the SCC.
- 3.0 Remove the SCC from the canister and plug the bottom of the canister with one of the yellow cap plugs. Install the canister in the sample head and examine the flow value. It should drop to 0.0 SLM. 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 SLM reading would indicate the problem is in the SCC.
- 4.0 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 SLM 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.

This now verifies that the vacuum system is intact and everything is working correctly.

6.3 Calibration

The calibration procedure performed in the field for the SASS is flow rate measurement, filter temperature, ambient temperature and barometric pressure measurement. Calibration procedures being adopted by the U.S. Environmental Protection Agency in the Draft document for Quality Assurance of PM_{2.5} samplers should be adopted and used for the SASS.

Using a set of NIST traceable standards, for volumetric flow, barometric pressure and temperature, the SASS Unit can be easily calibrated using the calibration screens in the SASS Control Unit. From the main screen menu select the “Calibrate” key. This action will display the following Utility Menu Screen.

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

Figure 6.1 Calibrate Menu Screen

6.3.1 Temperature Calibration

From the Utility Menu Screen shown in Figure 6.1, select the **F3** key on the control unit keyboard. This will bring up the Temperature Calibration Screen as shown below. Additional details on the various menu selections can be found in Section 4.4 of this manual.

```
(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 6.2 Temperature Calibration Menu

Before beginning it will be necessary to have a reference temperature measurement device that has a calibration traceable to NIST or other approved calibration authority.

One good reference point for the ambient temperature sensor measurement is “ice point” (0°C / 32°F) the second being some elevated temperature above 20° C. During the summer, the local ambient may provide a suitable second temperature for calibration. The ice bath consists of a slurry of distilled water and ice chips that has been stirred to produce a 0°C temperature bath as measured with the reference thermometer. A wide mouth thermos bottle works well for the temperature tests.

From the menu of Figure 6.2, 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.

The indication under the SASS menu item indicates the current ambient temperature, and this will be used to determine if the system needs to have the calibration changed.

Remove the ambient temperature probe from the shield by removing the three hexagonal nuts that hold the ring in place under the shield.

Now using the ice point bath with the reference thermometer, immerse the sensor portion of the ambient temperature probe 065 into the ice mixture. After about 1 minute of time to allow for stabilization, the measured value of SASS Ambient Temperature. The temperature should be within $\pm 2^{\circ}\text{C}$ of the reference thermometer.

Next using a second thermos bottle with a warm water mixture of approximately 30°C immerse the temperature probe and compare the reference thermometer in the bath with the measured value indicated for SASS Ambient Temperature. The temperature should be within $\pm 2^{\circ}\text{C}$ of the reference thermometer.

If both measurements are within the temperature tolerance then it is not necessary to calibrate the ambient temperature probe. If the temperature is in excess of the tolerance then use the following procedure to reset the calibration of the ambient temperature probe.

1. Insert the probe in the ice bath with the reference thermometer, and allow several minutes for the measurements to stabilize. It is best to try and stir the bath while both probes are in the ice mixture. When the probes are stable, enter the value measured from the reference thermometer in the top reference window. When completed press **F1** to save this value.
2. Now insert the probe in the heated water mixture and allow time for the probe and the reference thermometer to stabilize. When the probes are stable, enter the value measured from the reference thermometer in the second reference window. When completed press **F4** to save this value.
3. Now press the “Calibrate” key and the new values will be saved in memory of the control unit.
4. This calibrated the temperature probe to the reference thermometer. Re-run the temperature checks previously outlined and verify that at the two measurement points the temperatures are within the $\pm 2^{\circ}\text{C}$ tolerance. If they are not, then rerun the calibration test one more time.
5. If it fails the test a second, time, there is the possibility that the temperature probe is damaged, and will need to be replaced. If a new probe is installed, be sure to set the replacement probe using the “Default” menu selection. This will return to the original measurement factors.

This same procedure can also be used for the filter temperature measurement, except that for the temperature check, use the local ambient as a single reference point. From the temperature menu, use the arrow keys to change the value from 0 to 1 which will now indicated “Filter” Temperature. Insert a temperature probe into the open hole after canister #1 has been removed. Allow 10 minutes for the temperatures to stabilize, and then compare the reference thermometer with the filter temperature screen. They should be within $\pm 2^{\circ}\text{C}$ of each other. If the error is greater, then use the procedure outlined in steps 2-5 for this temperature probe. Except that the upper temperature is based on a reference thermometer placed near the filter temperature probe located above the canister. If this is a SuperSASS, continue this same procedure for the remaining 7 filter temperature probes.

6.3.2 Pressure Calibration

From the Utility Menu Screen shown in Figure 6.1, select the **F4** key on the control unit keyboard. This will bring up the Volumetric Flow Calibration Screen as shown below. Additional details on the various menu selections can be found in Section 4.4 of this manual.

Pressure Calibration				
SASS	Pt	Save	Reference	
730	1	0	000 mmHg	Save (F1)
	2	730	730 mmHg	Save (F4)
Calibrate			Default	Exit

Figure 6.3 Pressure Calibration Screen

Comparing the current SASS pressure measurement with a reference barometer can make a preliminary check. The pressure indicated for the SASS should be within ± 10 mm Hg of the

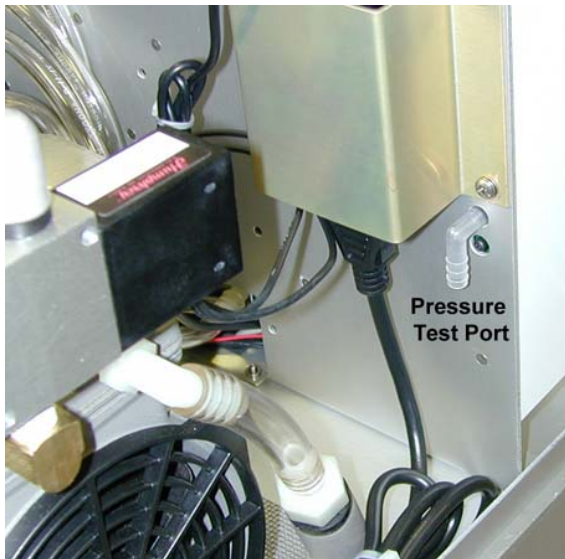


Figure 6.4 Pressure Test Port

reference pressure device. If the measurement is in excess of this value, then it may be necessary to re-calibrate the sensor in the SASS using a two-point barometric pressure measurement.

To perform a pressure calibration, a few items will be required. This includes a precision barometer or other pressure-monitoring device that has a range of 600 to 800 mm Hg with accuracy in excess of 0.1mm Hg. Located inside the pump enclosure just under the power supply on the center wall on the pump side is a nylon right angle connection that attaches to the pressure transducer. This can be seen in Figure 6.4.

To perform a calibration, two measurement points will be necessary. This can be accomplished by using a syringe, some tubing, a tee, and the precision reference pressure device. See Figure 6.5 for detail of pressure test setup. Connect from the pressure test point to a tee connector using some tubing, one side of the tee goes to the pressure measurement device and the other to the syringe. The size syringe required is dependent upon the length (total air volume) of tubing used to make this test apparatus. The syringe is used to change the pressure inside the tubing from below ambient to above ambient. Adjust the syringe in and out to change the simulated test pressure measured by the reference device and transferred to the sensor inside the SASS. Two typical readings would be 600 and 760 mmHg. First verify that the syringe is able to adjust the simulated barometric pressure to 600 mmHg and 800 mmHg. Adjust the size of the syringe or the lengths of tubing to provide the necessary adjustments.

Once set begin the following sequence to calibrate the internal barometer to the reference standard.

1. Set the simulated pressure value to 600 mmHg as measured from the reference pressure sensor. When the measurement is stable, enter the value measured from the reference in the top reference window. When completed press **F1** to save this value.

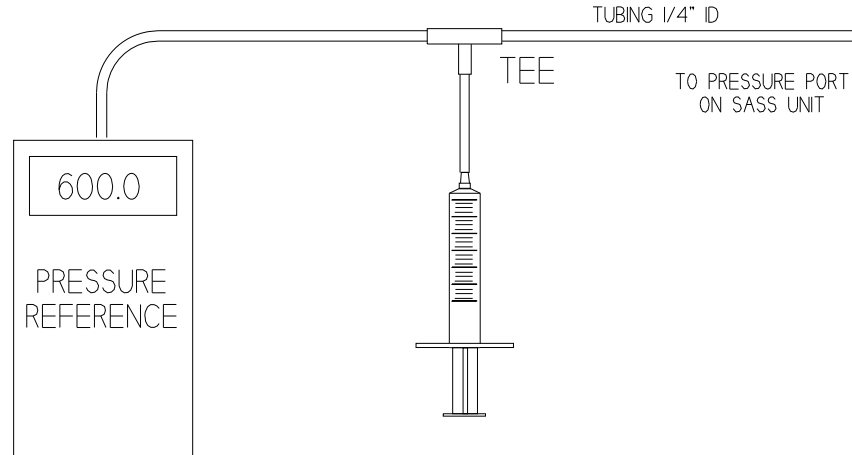


Figure 6.5 Pressure Test Setup

2. Now set the simulated pressure value to 800 mmHg as measured from the reference sensor. When the measurement is stable, enter the value measured from the reference in the second reference window. When completed press **F4** to save this value.
3. Now press the "Calibrate" key and the new values will be saved in memory of the control unit.
4. This calibrated the pressure sensor in the pump box to the reference barometer. Re-run the pressure checks previously outlined and verify that the new measurement is within the ± 10 mmHg tolerance. If they are not, then rerun the calibration test one more time.
5. If it fails the test a second, time, there is the possibility that the pressure sensor is damaged, and will need to be replaced. If a new sensor is installed, be sure to set the replacement sensor using the "Default" menu selection. This will return to the original measurement factors.

Remove the test apparatus and log the results in the on site maintenance log.

6.2.3 Flow Calibration

From the Utility Menu Screen shown in Figure 6.1, select the **F2** key on the control unit keyboard. This will bring up the Volumetric Flow Calibration Screen as shown below. Additional details on the various menu selections can be found in Section 4.4 of this manual.

Note: There are only 4 flow channels in the Super SASS

Volumetric Flow Calibration			
Chan	SASS	Ref	Type
(1)	.0	6.9 LPM	10 LPM FS
Pump: OFF			
Calibrate	Pump	Default	Exit

Figure 6.6 Volumetric Flow Calibration Screen

Before beginning the calibration, it will be necessary to have some type of reference flow device that has a calibration that is traceable to NIST, or some other approved calibration authority. The best type of flow unit to use is one that is a direct reading device that has minimal inline flow restriction. Some of the flow measurement devices can restrict the flow, to a point that it is difficult to measure at the operating flow rate of the system.

It is recommended that the SASS pump be run for approximately 20 minutes to allow the flow system to reach operating temperature before performing a flow calibration.

Using a flow test device, and any adapter that might be necessary to adapt to the input tube of the SCC, measure the flow at each of the canisters. The SCC inlet adapter part number 8959 can be used. Using the Up/Down key select each of the flow line positions. The SASS has 5 flow monitors while the SuperSASS has 4 flow lines. In the SuperSASS these same four lines are also used by the second set of 4 sample canisters. These keys are used to change the channel being monitored. All measured flows, should be within ± 0.67 LPM or $\pm 10\%^{24}$ of the reference standard. The channels 4&5 of the SASS are set to ± 0.69 LPM or $\pm 10\%^{24}$. If any value is in excess of this tolerance, entering the value of the reference in the Reference position and then hitting the "Calibrate" key can calibrate the channel. This will enter in the correctly measured value for that channel. Use this same procedure for any other channels that may require recalibration. Record all changes to the system in the onsite logbook.

6.4 Troubleshooting

Since this is a new instrument, Met One Instruments will revise the operation manual to include additional troubleshooting steps and operator information as it becomes available. If your problem is not listed, please contact the Met One factory and ask for SASS Technical Service (541) 471-7111.

PROBLEM(S)	ACTION
Torn or suspect filter catch	<ol style="list-style-type: none"> 1. Inspect filter holder and connections 2. Check sampler pneumatics
Out of specification (+/- 10% of transfer standard)	<ol style="list-style-type: none"> 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
Leak outside acceptable tolerance	<ol style="list-style-type: none"> 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.
Consistently low flows during sample runs	<ol style="list-style-type: none"> 1. Check programming of sampler flow rate. 2. Check flow with a flow rate verification filter and determine if actual flow is low.
Out of specification (+/- 4°C of standard)	<ol style="list-style-type: none"> 1. Recalibrate sensor; replace sensor.
Out of specification (+/- 10 mm Hg of standard)	<ol style="list-style-type: none"> 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.
Out of specification (+/- 5 min)	<ol style="list-style-type: none"> 1. Check programming; verify power outages 2. Reset
Sample did not run	<ol style="list-style-type: none"> 1. Check programming 2. Try programming sample run to start while operator is at site; ensure the transport filter is in the unit.
Power Interruptions	<ol style="list-style-type: none"> 1. Check line voltage
Liquid-crystal display pen on, but sample not working.	<ol style="list-style-type: none"> 1. Check to see that plugs are in place and there are no loose connections
Data did not transfer to laptop computer	<ol style="list-style-type: none"> 1. Document key information on sample data sheet. Make sure problem is resolved before data may be overwritten.

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Appendix A

Consumables, Spare Parts, and Maintenance Items.

Description	Met One Part Number
Accessory and Replacement Parts:	
Sharp Cutoff Cyclone, 2.5 Micron, Complete	8670
Filter Canister, includes filter holders, less SCC	8370
47 mm Filter Holder	460142
SCC Intake Tube to Flow Unit Adaptor	8959
Ambient Temperature Probe (Sensor)	065
Temperature. Solar Radiation Shield w/mount	074
Consumables:	
47mm 2 micron Pore Size Teflon Filters (50/pkg)	460137
47mm Glass Fiber Filters (100/pkg)	460138
47mm Quartz Fiber Filters (50/pkg)	460139
47mm 1 micron Pore Size Nylon Filters (100/pkg)	460141
Coated, MgO Denuder with Mounting Ring	8382
Maintenance:	
Canister O-Ring Kit	8657
Sharp Cutoff Cyclone O-Ring Kit	8658
Replaceable Spare Parts:	
Muffler, pump by-pass	580293
Muffler, main exhaust	580297
Flow Sensor Unit	8424
AC/DC Power Supply	510645
In-Line Filter Unit (4 per Unit)	580299
Female Quick Connection (Pump Box)	580012
Female Quick Connection SuperSASS (Pump Box)	580010
Male Quick Connection (Tubing End)	580011
¼" OD Black Polyethylene Tubing	960020
3/8" OD Black Tubing	960205
3/8" OD Clear Tygon Tubing	960200
Replacement Pump 110 VAC	680832
Replacement Pump 220 VAC	82936
Flow Control Module	9053
Line Select Solenoid Valve	8893
Pump By-Pass Solenoid	8894
SCC Grit Cap	8664
Fan, Pump Box	590052
15 Amp AC Fuse	590816

**Appendix B
Typical Transfer of Custody Form**

 Q10013M	PM 2.5 STN CUSTODY AND FIELD DATA FORM TRAINING DB FOR TRAINING USE ONLY	c. White (return to lab) c. Yellow (site retains) c. Pink (lab)						
A. CUSTODY RECORD (Name, Date) Bin ID: B1043Y								
1. Laboratory, Out <u>Jim O'Rourke 11/1/99</u>		3. Site, Out _____						
2. Site, In _____		4. Lab, In _____						
B. SITE AND SAMPLER INFORMATION								
1. Site AIRS Code <u>199901</u>		5. Site Name <u>EPA/RTP-SASS</u>						
2. Sampler S/N <u>100-3</u>		6. Intended date of use <u>Thursday, November 04, 1999</u>						
3. Sampler Type <u>SASS</u>		7. Date of Sampler set-up _____						
4. Sampler POC <u>3</u>		8. Operator's name _____						
C. SAMPLER CHANNEL COMPONENT								
Channel No.	Component ID No.	Component Description						
1	Kept at Site	SASS cyclone						
1	I1006S	SASS cassette (Teflon filter) (GREEN)						
2	Kept at Site	SASS cyclone						
2	I1007T	SASS cassette (MgO denuded nylon filter) (RED)						
3	Kept at Site	SASS cyclone						
3	I1008U	SASS cassette (quartz filter) (ORANGE)						
D. START, END, AND RETRIEVAL TIMES								
Channel No.	Start date	Start time	End date	End time	Retrieval date	Retrieval time		
1								
2								
3								
E. SAMPLER CHANNEL INFORMATION (Post-Sampling)								
Channel No.	Run Time	Run Time, Flag	Sample Volume (m ³)	Avg. flow (L/min)	Avg. flow CV (L/min)	Avg. ambient T (°C)	Max. ambient T (°C)	Min. ambient T (°C)
1								
2								
3								
Channel No.	Δ T Flag	Avg. Filter T (°C)	Max. Filter T (°C)	Min. Filter T (°C)	Avg. BP (mm Hg)	Max. BP (mm Hg)	Min. BP (mm Hg)	
1								
2								
3								
F. Comments _____ _____ _____								

Appendix C Denuder Maintenance

Coated Denuder

Coating:

Met One Instruments recommends to SASS users that the MgO coated aluminum multicell material and coated be provided by Met One. The multicell aluminum material is a sole source manufacturing company and when received in a bulk form it must be cleaned and made ready to coat.

Customers who wish to do their own coating can contact Met One for cut and cleaned multicell material which is pushed into the Denuder sleeve aluminum ring for use in the sampling canister.

Operational life expectancy of the MgO coated aluminum Denuder is six months in an urban airshed like Los Angeles. Re-coating of the material is not practical and therefore not recommended.

The Met One MgO Coating Procedure Follows, however users should consult the factory for improved or updated process.

Note: Laboratory Safety and Personal Protection Procedures Shall be applied. Use of gloves and a respirator is required.

1. The aluminum multicell material is washed in an ultrasonic bath under an explosive proof fume hood for five minutes using Methanol.
2. Air dry to complete dryness. Use of filtered laboratory air is necessary for quick drying.
3. Pour approximately 150ml of CH₃OH into a clean glass beaker
4. Place a #150 mesh Stainless Steel screen over the top opening of the beaker.
5. Using gloves, place MgO power reagent on top of the screen and using a clean spatula press the MgO through the screen into the CH₃OH.
6. Mix thoroughly
7. Using gloves, hand dip the multicell material into the slurry by dipping both one side and then the other to thoroughly coat the internal surfaces of the hexagonal cells.
8. Using filtered laboratory air in a hood, rotate the coated multicell material and blow-filtered air over the surface until the MgO starts to dry to the touch. Approximately 1 minute is necessary before it can be set down.
9. Set coated denuder in clean area and let dry 24 hours before packaging or use.