Approval of Standard Operating Procedures (SOP)

Title: Met One Instruments Speciation Air Sampling System 22 LPM (SASS 22 LPM)

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1.0 GENERAL INFORMATION

1.1 Purpose:

The purpose of this Standard Operating Procedure (SOP) is to supplement the Met One C-SASS Operation Manual, Model 82230 Addendum and Model SASS™ & SuperSASS™ PM2.5 Ambient Chemical Speciation Samplers Field Operation Manual by describing modifications in hardware or operating procedures which may have been implemented by the Monitoring and Laboratory Division of the Air Resources Board (ARB). These modifications are designed to assure compliance with the Federal Reference Method (FRM) for collection of particulate matter 2.5 microns or smaller (PM2.5) when using the Met One air sampler. The intent of this document is not to duplicate the Met One manual and Addendum, and where applicable, this SOP refers to the Met One manual.

1.2 General Description and Theory of Operation:

The Met One SASS 22 LPM is a five channel sampler designed to collect PM2.5 on various collection media for speciation. The sampler operates at volumetric flow rates of 6.7 liters per minute (LPM) on channels 1-3 & 5, and a volumetric flow rate of 22.0 LPM on channel 4. The PM2.5 cut-point is achieved by utilizing sharp cut cyclones. ARB utilizes three types of filter media for the speciation program; 47 mm Teflon, 47 mm Nylon, and 25 mm Quartz fiber filters. The particles collected on the 47 mm diameter Teflon filter will be used for mass and metals analysis or wood smoke (Levoglucosan). The particles collected on the 47 mm diameter nylon will be used for ion analysis. The particles collected on the 25 mm diameter quartz fiber filters will be used for carbon analysis. See Figure 1 for a schematic of the Met One SASS 22 LPM sampler.

Electronic systems in the sampler are designed to monitor and maintain the volumetric flow rate as well as record the elapsed sampling time enabling the SASS 22 LPM to calculate the total sample volume in cubic meters (m³). Using this information, the analyzing laboratory will calculate and report the average PM2.5 concentration for the sampling period in µg/m³.

The SASS 22 LPM monitors and regulates the flow rates for all the channels using the sampler’s microprocessor, software, mass flow controllers, ambient temperature sensor, and ambient pressure sensor. The valid sampling period must be between 23 and 25 hours. The flow rate of the sampler must be 6.7 LPM ±4%, except for the carbon channel (4) which will be 22.0 LPM ±4%. The sampler, along with the analytical analyses, can generate results for 58 different air quality parameters.

Data from a previous run can be downloaded to a laptop or PC via a RS232 cable and the SASSCom AQ software or the data can be accessed from the
screens on the instrument.
Figure 1. Schematic of Met One SASS 22 LPM Sampler.
1.3 **Safety Precautions:**

Installation, operation, maintenance, and calibration of the sampler should only be performed by properly trained personnel.

Think “safety first”. High voltages (120 volts AC) are used to power the unit. Unplug the sampler whenever possible while working around electrical components.

Due to typical rooftop installations, the risks of working outdoors at elevated heights should also be considered. To prevent injury from the sampler falling over, the sampler should be securely mounted to the stand using the included hex head bolt hardware and washers. The stand should be properly secured or anchored to the floor/platform.

Rooftop sampling creates a hazard from falling. Be careful climbing and descending to and from the rooftop platform. For additional safety information read Section 2.0 Unpacking, Siting, and Installation Section of the Met One SASS 22 LPM Operating Manual and the Air Quality Surveillance Branch Safety Manual.

Ensure that the green (and/or green/yellow) grounding cable is connected to an appropriate grounding substance. For maximum effectiveness the ground cable should be connected to a nearby earthed ground rod. In addition, it is recommended that one leg of the mounting tripod also be grounded to the same earth ground used to ground the pump box.

1.4 **Interferences:**

Precaution must be taken when handling the SASS filter cassettes. It is recommended that the instrument operator wear powderless nitrile gloves when handling the cassettes to prevent contamination. The internal filters are delicate. Any foreign object falling into the filter cassettes may result in pinholes and, subsequently, the invalidation of the sample.
2.0 INSTALLATION PROCEDURE

2.1 Physical Inspection:

Inspect equipment and accessories for completeness and check for any shipping damage upon receipt of a SASS 22 LPM sampler. If equipment is missing or damage is found, immediately notify your supervisor and/or your agency’s shipping department.

2.2 Siting:

Siting of the SASS 22 LPM will be dictated by the type of sampling to be conducted. An effort should be made to meet siting guidelines stated in the Code of Federal Regulations, Title 40 Part 58. Ensure the sampler inlet is separated by at least 1 meter, but not more than 4 meter, from other PM2.5 samplers and that the sampler has an unobstructed airflow of a minimum of 2 meters in all directions. Note, all other samplers should be at least 1 meter away. For collocated sampler studies, position the sampler inlets exactly 1 meter apart.

2.3 Tools:

The SASS 22 LPM sampler contains a tool kit that has the equipment necessary to assemble the sampler. A drill is required to bolt the tripod and pump box to the platform. Review the operator’s manual and the steps below completely before installing.

2.4 Tripod Assembly:

Remove the three pins holding the legs in the upright position. Lower the legs and reinsert the pins to lock the legs in the down position. The tripod must be anchored to the platform to ensure that it will not tip over in strong wind or inclement weather. If the platform is made of wood, 1/3” lag screws are advised.

2.5 Sampling Head Installation:

The bottom and top shields of the sampling head are attached when shipped. Detach the bottom shield and slide it past the hoses and cables that are attached to the upper sampling head. Remove the pin on the side of the bottom shield. Slide the shield down the tripod with the open side of the shield facing upwards.

Find the bag of three 8-32 x 3/16” socket head screws in the tool kit. The correct screws have been treated with a red thread locking compound. Install two screws into the two tapped holes in the mast.
Remove the gray PVC shipping tube from the center of the upper sampling head. Unwind the sampling lines attached to the sampling head. Feed the lines down the center of the mast and slide the head onto the mast. Aligning the notch in the sampling head with the upper socket head screw in the mast allows the head to slide completely downward. Tighten the two socket head screws in the sampling head to secure it to the mast. Raise the bottom shield and align the notch with the lower set screw in the mast. Put the pin in place to lock the shield in the raised position.

2.6 Control Unit and Temperature Sensor Mounting:

Using two U-bolts, four 7/16" nuts, and four washers, mount the control unit just above the tripod legs. The control unit will face upwards with the cable connections on the bottom when properly oriented.

The temperature sensor mounts to the tripod with a U-bolt, two 7/16" nuts, and washers. Align the top of the probe’s radiation shield with the top of the control box. Place the sensor so that it is oriented 180° in relation to the control box.

2.7 Pump Box Mounting:

Place the pump box close to the base of the tripod to ensure that all cable connections can be made. Anchor the pump box using lag bolts or other appropriate hardware. There are pre-drilled holes in the legs of the unit for this purpose.

Plug the pump box power cord into a 110V AC power source. Connect the sensor cable and the control box power cable into the control box. There are 5 quick-disconnect valve connectors on the pump box numbered 1-5. These numbers correspond to the channels on the SASS 22 LPM sampling head. Each pump line from the head is numbered; connect each line to the corresponding quick-disconnect valve. Channel five may be connected or the pump line and valve may be left disconnected. If channel five is disconnected, place the orange caps over the sample line connection points. Connect the green and yellow grounding cable to an appropriate ground source.

2.8 Sample Canister Mounting:

The sample canisters will contain the necessary filters and denuders when they arrive from the laboratory. The sharp-cut cyclone inlets (SCC) must be installed and the sample canisters must be placed onto the appropriate channels in the sampling head. Placing a very small amount of o-ring lubricant (silicone grease) on the o-rings will facilitate insertion of the cyclone and the canister. Remove the plugs on both ends of the sample canister. The SCC is inserted into the side of the canister with only one lock screw. Rotate the SCC until the metal plate on
the cyclone locks into the lock screw on the canister. From this point on ensure the canister is oriented SCC side down to keep the filters from being contaminated.

The two lock screws on the upper side of the canister are inserted into the guides on the sampling head. Align the lock screws with the wider portion of the guides, ensuring that the mark on the canister faces outward. Push the canister upward and rotate counterclockwise to lock it into place. A small amount of silicone grease on the o-rings will make it easier to install the canisters and avoid o-ring damage. Once all the canisters have been installed raise the radiation shield and lock it in place.
3.0  CONFIGURATION

3.1  Time and Date Setup:

Press the “SETUP” key in the main menu to set the date and time. Press “F3” to get to the clock menu. Use the left and right arrows to move the cursor. Use the up and down arrows to adjust values as necessary. Set sampler time to current Pacific Standard Time.

3.2  Event Setup:

Press the “SETUP” key to begin programming a sampling event. Press “F1” to activate the event manager. Set the start date and time using the up and down arrow keys to change values and the left and right arrow keys to move the cursor. Edit the event length time to the desired run interval. (The default run interval is 24 hours.) Choose the canister set to be activated (default is 1, 2, 3, 4). Press “SAVE” to store the event. The SASS 22 LPM allows up to four events to be preprogrammed. Press “F1” to review the event to ensure proper storage and setup, and then select “EXIT” to go to the main menu.

3.3  Sample Retrieval Time:

Sample canisters need to be removed within 48 hours after sampling. If the 48-hour retrieval time cannot be met due to logistical reasons (e.g. weekends/holidays/etc.), the field operator has two options (2nd option is preferable):

1. Retrieve the sample on the next available business day. For informational purposes, the sample will be flagged in Northern Laboratory Branch’s laboratory information management system for not meeting the 48-hour retrieval time. However, this flag will not carry over to US EPA’s Air Quality System database, or

2. Perform a make-up sample run per the guidance given below.

3.4  Make-up Guidelines

It is the decision of air monitoring field staff and their management on whether or not to perform a make-up run. If it is determined that a make-up run will occur, then the following make-up criteria need to be followed:

1. A sample make-up must be performed after the regularly scheduled sample run, preferably before the next required sampling day. The make-up sample should also occur within the same sampling month as the missed sample run.
2. If one or more sample is invalidated, then all four SASS (i.e. canisters) channel samples must be re-sampled (on new media).
4.0 DATA RETRIEVAL

4.1 General Information:

Field personnel will have the responsibility of ensuring the PM2.5 sampling information for each filter run is properly retrieved. The sampling information for the sample can be obtained either manually or electronically downloaded to a computer using SASSCom AQ Software.

For each sample, field personnel will complete a PM2.5 Speciation Custody and Field Data Form (Appendix C). Use the Previous Event Summary option on the event menu to retrieve necessary data to complete this form.

The event summary information can also be downloaded with the SASSCom AQ software. The SASS 22 LPM sampler can store the 5-minute data for one run. If 5-minute data is needed for a run it must be collected before the next run. If the 5 minute data is required, it must be downloaded via the SASSCom AQ software.

4.2 Viewing Sample Summaries:

1. Select “Event” option from the main screen, then “F2” button to retrieve the previous data record. It now displays the summary of the sample event, including start and stop dates and times, along with elapsed time of the sample.

2. Press the button under the >> to move to the next screen to finish recording all necessary values. This will include start and end date/time, sample retrieval date/time (using the current time and day), sampler collection information (temperatures, pressures, volumes, flow CV, flows, and note any flow or dT warnings).

4.3 SASSCom AQ Software:

To download run data from the SASS 22 LPM Control Box with a laptop use the SASSCom AQ software and the included RS-232 cable.

The included RS-232 Cable (Met One part # 3169) must be used for communication with the SASS 22 LPM. Place the round four pin connector into the appropriate connector on the SASS 22 LPM Control Box. Next place the nine-pin serial port connector onto the serial port of the laptop. Note the com port setting on the serial port.

Ensure that the cables are connected properly and start the software. Select the com port corresponding to the serial port used by the SASS 22 LPM, and click on the “Retrieve Data” button. If only the event data summary is needed,
choose yes at the “Would You Like To Only Download the Event Data” screen. If 5-minute data is desired choose no. Data can either be viewed within the program or exported as a comma-delimited text file for import into a spreadsheet. Two files are downloaded for each run. The .bin files are SASSCom AQ formatted. The .csv files are comma-delimited text files that can be viewed with most spreadsheet software.
5.0 SAMPLE CANISTER HANDLING AND RETRIEVAL

5.1 General Information

Federal regulations stipulate specific time frames and environmental conditions for PM2.5 sample filters at various stages in the sampling program. If these time frames and conditions are not met, sample filters may be flagged or invalidated by the receiving laboratory. In addition to these requirements, operators should practice the usual care to prevent or minimize contamination of the sample filter canisters, or anything else which may come in contact with the sample filters.

5.2 Pre-Sampling Canister Handling Procedures

Sample canisters must be used within 30 days from the pre-weighing date for the mass filter (sampled on channel 1). If 30 days have elapsed before the canister set is to be used, do not use this set of canisters. Note the reason for not using them on the sample form, return the set to the laboratory, and ask for a replacement set.

The sample canister temperature must be within 5°C of the ambient temperature while installed on the sampler.

5.3 Canister Handling:

It is suggested that the instrument operator wear powderless nitrile gloves when handling the cassettes to prevent contamination.

The sampling canisters and leak check canisters must be capped when not on the SASS 22 LPM. Remove the sampling canisters within 48 hours after sampling and place in cold storage immediately. To remove the canister, rotate the canister clockwise until it stops and pull down. While keeping the SCC end pointed downwards, twist the SCC until the metal plate disengages from the locking screw and remove. Cap the ends of each canister and store them in a refrigerator. The canisters may be stored in a freezer if a refrigerator is not available. Sampled canisters must be kept at a temperature ≤4°C during storage and shipping.

Ship the canisters within 96 hours after sample retrieval. Canisters are to be shipped under cold conditions because it is important the samples are received in the laboratory ≤ 4°C. If the samples arrive with temperatures above 4°C they may be invalidated, and make-ups will need to be completed. If the samples will be temporarily stored, it is important to continue to store the samples in a refrigerator set at ≤ 4°C (or freezer if a refrigerator is not available).
5.4 **SCC Inlets:**

Use each SCC inlet on the same channel for every sampling event, leak and flow checks. SCC inlets should be cleaned monthly, or more frequently if needed.

5.5 **PM2.5 Speciation Custody and Field Data Form:**

After retrieving the sampled canisters, the PM2.5 Speciation Custody and Field Data Form (CFD, see Appendix C) will need to be completed.

1. Select “Event” option from the main screen, then “F2” button to retrieve the pervious data record. It now displays the summary of the sample event, including start and stop dates and times, along with elapsed time of the sample. Record these values on the CFD form.

2. Press the button under the >> to move to the next screen to finish recording all necessary values. This will include start and end date/time, sample retrieval date/time, sampler collection information (temperatures, pressures, volumes, flow CV, flows, and note any flow warnings).

3. If the CV > 2% or if there are any Filter dT Warnings or Flow Warnings, these must be noted, and the field operator should write INVALID on the CFD form. A make-up sample should be scheduled (see Section 3.4 Make-up Guidelines). If more sampling canisters sets will be needed, contact lab personnel to request additional sample media.

4. Field personnel should also note any unusual local conditions they may have observed during the sample run by circling the appropriate condition code. “No Unusual Conditions” may be used if no unusual conditions were observed during the sample run. Remember to include any post-sampling information and comments. Please double-check entries and write clearly.

5. It is suggested that the site operator make a copy of the form if possible. These documents would be kept in accordance to the standard ARB Documentation Policy, currently located in section 5.3 of the Quality Assurance Manual, Vol. 1.

5.6 **Post-Sampling Canister Handling Procedures**

Sampled canisters must be removed from the sampler within 48 hours after the end of sampling and placed in cold storage immediately. Sampled filters must be kept at a temperature ≤4°C during storage and shipping.

Ship the canisters within 96 hours after sample retrieval.
Sampled canisters and the PM2.5 Speciation Custody and Field Data Form are to be shipped in an insulated shipping container containing sufficient Blue Ice or other chilled media to assure that sample filters arrive at the laboratory with a temperature no greater than 4°C. Other cold storage methods may also be employed if they comply with these temperature requirements. This requirement also applies when sampled filters are being transported from remote or satellite sites to central or main locations. Samples received at the laboratory at temperatures greater than 4°C may be invalidated, will be noted on the field sample report form, and entered into LIMS. The lab personnel will immediately notify the field operators if the samples arrive greater than 4°C, or if any other invalidations occur so that field operators know to perform a make-up (see Section 3.4 Make-up Guidelines).

Sampled filters should be shipped to the laboratory weekly on Monday, Tuesday, or Wednesday to avoid Saturday, Sunday, or holiday arrivals when staff may not be present to receive the samples.

More information about the laboratory documentation and handling procedures can be found in the Standard Operating Procedure for the Filter and Canister Preparation for PM2.5 Speciation Samples (SOP MLD 062, http://www.arb.ca.gov/aaqm/sop/mld062.pdf).

5.7 Field Blanks:

One set of field blanks will be shipped from the laboratory every quarter. They will have a separate PM2.5 Speciation Custody and Field Data Form (Appendix C). The field blanks will be labeled with channel numbers and colored dots. Install the field blanks prior to installing normal run canisters. Install the field blanks in channels 1-4 as labeled with SCC. The canisters should be installed for approximately 3-5 minutes. Remove the canisters and the cyclones, cap the ends of the field blank canisters, and return to the shipping bin. As with field samples, ship the canisters within 96 hours after sample retrieval. Install routine sampling canisters according to schedule.

5.8 Field Quality Control Criteria:

Field operator invalidation criteria for the SASS filter samples collected on the SASS 22 LPM samplers are listed below. All samples collected in the field will be validated using these criteria. If a sample does not meet these criteria, the sample will be invalidated by the field operator (record the error in the comments section and clearly write "INVALID" on the PM2.5 Speciation Custody and Field Data Form). A make-up sample should be scheduled (see Section 3.4 Make-up Guidelines). If more sampling canisters sets are needed, contact lab personnel to request additional sample media.

1. CV - If the CV > 2%, these must be noted and the samples are invalid.
2. **Warnings** - If there are any Filter dT Warnings or Flow Warnings, these must be noted and the samples are invalid.

3. **Start/Stop Times** – The sampler start and stop time must be midnight ± 30 minutes. Please note, that if the SASS indicates the sample began and stopped before 2330 hours or after 0030 hours, the samples are invalid.

4. **Sample Run Duration** – Sample run duration shall be at least 23 hours and no more than 25 hours. Filter samples collected on samplers which operated for less than 23 hours or more than 25 hours, as documented the by elapsed time meter of the SASS, are invalid.

5. **Power Failure** – If a power failure during a sample run causes the stop time or sample run duration requirements (3 and 4 above) to be violated, the sample is invalid.

6. **Sample Flow Rate** – If during the monthly quality control flow verification, the samplers flow rate exceeds the acceptable flow range, field operators need to initiate a Corrective Action Notification [CAN] to invalidate all filters sampled on the channel(s) that fails this verification.

All samples are to be returned to the laboratory with the completed PM2.5 Speciation Custody and Field Data Form. If a sample(s) is invalid, the data form needs to indicate why the sample(s) is invalid.

5.9 **Laboratory Quality Control Criteria:**

Laboratory invalidation criteria for the SASS filter samples collected on the SASS 22 LPM samplers are listed below. All samples collected returned from the field will be validated using these criteria. If a sample does not meet these criteria, the sample will be invalidated by the laboratory staff. In addition, laboratory staff will inform the field operator immediately of this invalidation, so they are able to perform a makeup sample.

1. **Filter Contamination** – Filters are torn, damaged, or have become contaminated by any foreign matter (e.g., dirt, ink, liquids, etc.) are invalid.

2. **Shipping** - If sampling canisters are not shipped within 96 hours after sample retrieval, or return to the laboratory above 4°C, the samples may be invalid.

3. **Report Form** – The filter is considered invalid if a PM2.5 Speciation Custody and Field Data Form is not included with the samples or the form is not completed. The laboratory staff need to thoroughly check the box for the form before it is deemed missing.
Laboratory staff will inform the field operator immediately of any invalidations, allowing the field operator to perform a makeup sample.
6.0 CALIBRATION PROCEDURES

6.1 General Information:

This section of the SOP covers the calibration procedures for the Met One SASS 22 LPM. This document is intended to supplement the manufacturers operating manual and should not be used as a substitute. Read the procedures outlined in this document and examine the user’s manual before attempting to calibrate a SASS 22 LPM unit.

The SASS 22 LPM sampler requires calibration of the ambient temperature sensor, barometric pressure sensor and each flow controller. Perform the SASS 22 LPM sampler calibration using the following steps:

1. Time Verification/Adjustment
2. Leak Check
3. Temperature Sensor Calibration
4. Pressure Calibration
5. Flow Calibration

6.2 Apparatus for Met One SASS 22 LPM Calibration:

- NIST traceable Flow Transfer Standard for 6.7 LPM
- NIST traceable Flow Transfer Standard for 22.0 LPM
- NIST traceable time standard
- NIST traceable pressure (P) standard
- NIST traceable temperature (T) standard

- 4 PM2.5 Sharp Cut Cyclones (SCC) (3 for 6.7 LPM, 1 for 22.0 LPM)
- 4 Calibration Canisters with appropriate filters and denuders in place
- Calibration worksheet
- Two 1 to 2 liter vessels to hold water for temperature calibrations
- A hot plate
- A bag of ice
- A gas-tight syringe (@ 60 cc capacity), tubing with a “tee”
- Fittings to connect to the P standard and the sampler’s pressure transducer inlet
- Met One SASS Field Operations Manual
- Access to the SASS 22 LPM sampler tool kit, and other basic tools (screwdrivers, wrenches, zip ties, etc.)

6.3 Pre-Calibration Preparations:

Install the correct filters in each calibration canister to simulate flow conditions during sampling. Use a 47 mm diameter Teflon filter on channel one, a nylon 47
mm diameter filter on channel two, a 47 mm diameter Teflon filter on channel three, and a 25 mm diameter quartz filter on channel four. Use these canisters only for calibrations, verifications, and leak tests.

Plug in and turn on the flow, pressure and temperature standards to let them warm up for about ½ hour. Place the flow, P and T standards in the shade if possible.

Prepare the SASS 22 LPM calibration worksheet while waiting for the standards to acclimate.

6.4 **Time Adjustment:**

Press the “Setup” Key from the main menu. Press “F3” to choose clock menu. Compare the clock setting on the sampler with a time standard. Enter the date and time in the laptop calibration spreadsheet for both the sampler and the NIST time standard. If the sampler clock is not within 2 minutes of “true” use the left and right arrow keys to move the cursor and the up or down arrow keys to adjust the time. Press “Save” before exiting. Record the values in the calibration worksheet.

6.5 **Leak Test:**

To perform a leak check, install calibration canisters and SCC with appropriate filters on each channel to be checked. A canister with a Teflon filter must be installed in channel one. A canister with a nylon filter must be installed for channel two. A canister with a Teflon filter must be installed in channel three. A canister with a quartz fiber filter must be installed in channel four. Appropriate sharp cut cyclones must be installed on all of the canisters.

Press the “Calibrate” key in the main menu. Press “F1” to enter the “System Test” screen. Select “Calibrate Flows”. Press “Pump On” the turn on the pump. Let the sampler operate for about 5 minutes to warm up.

Observe the flows on the first four channels. The displayed flow rate should be 6.7 LPM on channels 1-3 and 22.0 LPM on channel 4. Press the "Leak" key. Cover the inlet of the sharp cut cyclone on channel one. Observe the flow rate displayed for channel one. The flow rate should drop to 0.1 LPM or less. Ensure that the flow remains at or below 0.1 LPM for at least 30 seconds. If the display remains at or below 0.1 LPM that channel passes the leak test. Slowly remove the cover from the inlet to keep the filter from breaking. Record the results in the laptop calibration spreadsheet. Repeat this procedure for channels two, three, and four. Record the values on the calibration worksheet.

If the leak check fails, troubleshoot the error and redo the leak check. Refer to section 10.2 for more information.
6.6 Ambient Temperature Sensor Calibration:

The ambient temperature sensor must be accurate to ±2°C because the SASS 22 LPM sampler flow rates are calculated in volumetric flow. Calibrate the ambient temperature sensor upon installation. The ambient temperature sensor must be removed from the ambient temperature sensor shield before beginning the calibration. Once the sensor has been removed from its housing, follow the steps described below to complete the calibration.

The calibration procedure requires water, a hot plate, ice, and containers to hold the water baths. Two points are necessary for a calibration. An ice bath is used to provide a 0°C reference point, and the second should be a water bath of a high temperature (50°C is a common point). Use the following steps to calibrate the temperature sensor:

1. Enter the Calibration menu. Press “F3” to select the “Temperature Calibration” screen. Press the up and down arrows until the display reads "(0)" in the upper left corner. The "0" indicates the ambient temperature sensor calibration screen.

2. Prepare an ice bath. Place the temperature standard and the ambient temperature probe into the bath in close proximity to each other. Allow the probes to equilibrate for at least 5 minutes.

3. Enter the reading from the temperature standard into the reference column for point 1.

4. Press “F1” to save this reference point.

5. Repeat step 2 with a 50°C water bath.

6. Enter the reading from the temperature standard into the reference column for point 2. Press “F4” to save this reference point. When points one and two have been saved, press the “Calibrate” button to save the settings.

7. Perform a temperature verification on the SASS 22 LPM sensor. If the ambient sensor is in excess of ±2°C from the standard, perform another calibration. If the sensor is still not within acceptable parameters the SASS 22 LPM will need repair.

8. Record results on the calibration worksheet.

6.7 Filter Temperature Sensor Calibration:

The filter temperature sensor must be accurate to ±2°C because the SASS 22 LPM sampler flow rates are calculated in volumetric flow. Calibrate the filter
temperature sensor upon installation.

A similar procedure to the ambient temperature will be used for the filter temperature, except that for the filter temperature calibration, use the local ambient temperature as a single high reference point.

Use the following steps to calibrate the filter temperature sensor:

1. Enter the Calibration menu. Press “F3” to select the “Temperature Calibration” screen. Press the up and down arrow keys until the display shows "(1)" in the upper left corner. The "1" indicates the filter temperature sensor calibration screen.

2. 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.

3. Enter the reading from the temperature standard into the reference column for point 2 (upper temperature).

4. Press “F4” to save this reference point. Once the point has been saved, press the “Calibrate” button to save the settings.

5. Perform temperature verification on the SASS 22 LPM sensor. If the filter sensor is in excess of ±2°C from the standard, perform another calibration. If the sensor is still not within acceptable parameters the SASS 22 LPM will need repair.

6. Record results on the calibration worksheet.

6.8 Pressure Sensor Calibration:

Since the SASS 22 LPM sampler uses volumetric flow the pressure sensor must be accurate to ±10 mm Hg. Open the pressure port on the P standard to ambient. (Sometimes there are plugs at the inlet of the sensor to keep dust out.) Allow the pressure standard to warm up for at least ½ hour before performing a verification/calibration.

The barometric pressure sensor is located in the pump box housing. To access the sensor, unscrew the four (4) screws along the bottom of the housing and remove the cover. The pressure test port is next to the power supply housing. This procedure will require a gas tight syringe, tubing and a tee. This is a 2-point calibration at 600 and 800 mm Hg. The following steps outline the pressure sensor calibration procedure.

1. In the “Calibrate” menu press “F4” to reach the “Pressure Calibration” Menu.
2. Connect the SASS 22 LPM pressure test port, the syringe, and P standard test port together with tubing and the tee.

3. Adjust the syringe plunger until the P standard reads 600 mm Hg. Enter the value on the P standard into the reference column on point 1. Press “F1” to save the setting.

4. Adjust the syringe until the P standard reads 800 mm Hg. Enter the value on the pressure standard into the reference column on point 2 in the control panel display. Press “F4” to save the setting.

5. Press the “Calibrate” button to save the calibration points. Remove the syringe and tubing and re-check both the 600 and 800 mm Hg points. If the sensor still exceeds ±10 mm Hg of the standard, perform another calibration. If it still exceeds the ±10 mm Hg limit, the sampler must be repaired.

6.9 Flow Calibration Setup:

The current version of the SASS 22 LPM sampler has 5 channels. The first three channels are designed to operate at 6.7 LPM, channel four is designed to operate at 22.0 LPM, and channel five is designed to operate at 6.9 LPM. Since channel five isn’t utilized in standard operating conditions, it will not need to be checked or calibrated. Channels one, two, three, and four have active flow control. Mass flow controllers on the channels actively maintain a constant flow. Channel five has a critical orifice to maintain the flow. Flow through these orifices can vary significantly if there is a large amount of filter loading. Therefore, channels one, two, three, and four are the only channels that should be used for sampling.

The SASS 22 LPM samplers are operated in the “volumetric” flow mode. Therefore it is necessary to ensure that the temperature and pressure sensors are within acceptable limits before performing flow calibrations. In addition, a leak check should be performed on all channels prior to a flow calibration.

If the calibrations canisters are not already installed (from leak check), please install the calibration canisters with SCCs. A canister with a Teflon filter must be installed in channel one. A canister with a nylon filter must be installed for channel two. A canister with a Teflon filter must be installed in channel three. A canister with a quartz fiber filter must be installed in channel four. Appropriate sharp cut cyclones must be installed on all of the canisters.

6.10 Flow Calibration:

If the flow rate verification for channels 1-3 is greater than ±2% of the 6.7 LPM (±0.268 LPM) or channel 4 is greater than ±2% of the 22.0 LPM (±0.88 LPM), that channel must be calibrated. Use the following procedure for calibration.
Note a passing Leak Test should be performed before a Flow Calibration.

1. Press “F2” in the Calibration menu to reach the “Flow Calibration” screen. Press “Pump” to turn the pump on. Allow the pump to warm up for 5 minutes, and then connect the flow standard to the channel to be calibrated.

2. Place the cursor on the “Channel” column and use the up and down arrows to scroll to the correct channel. Read or calculate the volumetric flow rate on the transfer standard. Equations for converting standard flow to volumetric flow can be found in the Section 7.5 if needed. Enter the volumetric flow rate in the “Ref” column and press the “Calibrate” key. Within 20 seconds the system will update with the new displayed flow rate on the SASS 22 LPM display. Exiting out of the calibration screen and returning will ensure that the SASS 22 LPM software has updated the calibration.

3. Check the updated flow rate on the SASS 22 LPM against the transfer standard. If the actual flow is not within ±2% of the displayed flow, repeat step 2. The displayed flow must also be within ±2% of 6.7 LPM (±0.134 LPM) for channels 1-3 and within ±2% of 22.0 LPM (±0.44 LPM) for channel 4. Repeat the calibration procedure if the SASS 22 LPM does not meet the ±2% requirement. Once the calibration is complete, record the displayed and actual flow values into the calibration sheet.

4. Repeat the previous steps for the other channels. When complete, ensure that the calibration sheet has been completely filled out. Turn off the sampler and remove the calibration canisters. Plug the ends of the calibration canisters to preserve them for the next flow test. Exit the calibration screen and return to the main menu.

A copy of the laptop calibration form is illustrated in Appendix B.
7.0 VERIFICATION PROCEDURES

7.1 General Information:

The SASS 22 LPM sampler requires verification of the ambient temperature sensor, barometric pressure sensor and each flow controller. Perform the SASS 22 LPM sampler verification using the following steps:

1. Time Verification
2. Leak Check
3. Temperature Verification
4. Pressure Verification
5. Flow Verification

7.2 Time Verification:

Press the “Setup” Key from the main menu. Press “F3” to choose clock menu. Observe the clock time setting on the sampler. Record the date and time from both sampler and NIST time standard on the maintenance check sheet. If the sampler clock is not within 2 minutes of “true,” the clock setting fails and must be calibrated. The calibration procedures are detailed in section 6.0, Calibration Procedures.

7.3 Leak Check:

To perform a leak check, install canisters with appropriate filters and SSCs to each channel to be checked. A canister with a Teflon filter must be installed on channel one. A canister with a nylon filter must be installed for channel two. A canister with a Teflon filter must be installed on channel three. A canister with a quartz fiber filter must be installed on channel four. Appropriate sharp cut cyclones must be installed on all canisters.

Press the “Calibrate” key in the main menu. Press “F1” to enter the “System Test” screen. Select “Calibrate Flows”. Press “Pump On” the turn on the pump. Let the sampler operate for about 5 minutes to warm up.

Observe the flows on the first four channels. The displayed flow rate should be 6.7 LPM on channels 1-3, and 22.0 LPM on channel 4. Press the “Leak” key. Cover the inlet of the sharp cut cyclone on channel one. Observe the flow rate displayed for channel one. The flow rate should drop to 0.1 LPM or less. Ensure that the flow remains at or below 0.1 LPM for at least 30 seconds. If the display remains at or below 0.1 LPM that channel passes the leak test. Slowly remove the cover from the inlet to keep the filter from breaking. Record the results in the laptop calibration spreadsheet. Repeat this procedure for channels two, three, and four. Record the values on the maintenance check sheet.
7.4 Ambient Temperature Sensor Verification:

Place temperature probe of the T standard within the radiation shield of the ambient temperature sensor. If using the BGI DeltaCal, use the external temperature probe. Avoid exposing the sensor to direct sunlight. The temperature probe must be within the radiation shield for at least 5 minutes. If the temperature standard was in a different environment (i.e. in a colder or warmer building/car than ambient temperature), make sure the temperature standard is stable before comparing values.

1. Press the “Calibrate” key. Press “F1” to reach the “System Test” screen.

2. Observe and record the ambient temperature value on the system test screen on the maintenance check sheet.

3. Read or calculate the true temperature with the transfer standard’s slope and intercept and determine the difference of the sampler from true. Record the value on the worksheet. If the difference from true is less than ±2°C, the ambient temperature sensor passes. If the difference from true is greater than ±2°C, the ambient temperature sensor fails and must be calibrated. The calibration procedures are detailed in section 6.0, Calibration Procedures.

7.5 Filter Temperature Sensor Verification:

Place temperature probe of the T standard into the port of channel 1 on the sampling head. If using the BGI DeltaCal, use the external temperature probe. Avoid exposing the sensor to direct sunlight. The temperature probe must be within the port for at least 5 minutes.

1. Press the “Calibrate” key. Press “F1” to reach the “System Test” screen.

2. Observe and record the filter temperature value on the system test screen on the maintenance check sheet.

3. Read or calculate the true temperature with the transfer standard’s slope and intercept and determine the difference of the sampler from true. Record the value on the worksheet. If the difference from true is less than ±2°C, the filter temperature sensor passes. If the difference from true is greater than ±2°C, the filter temperature sensor fails and must be calibrated. The calibration procedures are detailed in section 6.0, Calibration Procedures.

7.6 Pressure Sensor Verification:

Since the SASS 22 LPM sampler uses volumetric flow the pressure sensor must be accurate to ±10 mm Hg. The pressure port on the P standard needs to be
open to ambient. (Sometimes there are plugs at the inlet of the sensor to keep dust out.) Allow the pressure standard to warm up for at least ½ hour before performing a verification.

1. Press the “Calibrate” key in the main menu. Press “F1” to reach the “System Test” screen.

2. Observe and record the values of the sampler’s ambient pressure sensor in the laptop calibration sheet. Read or calculate the pressure value from the pressure standard and enter it into the maintenance check sheet.

3. If the difference from true is less than ±10 mm Hg, the ambient pressure sensor passes. If the difference from true pressure is greater than ±10 mm Hg, the ambient pressure sensor fails and the pressure sensor must be calibrated. The calibration procedure is outlined in the section 6.0, Calibration Procedures.

7.7 Flow Verification:

1. Press the “Calibrate” key. Press “F1” to get to the “System Test” screen.

2. Press the “Pump” key. Allow the pump to run for 5 minutes.

3. Connect the flow transfer standard to the channel 1 inlet. If using a transfer standard that gives standard flow you must convert it to volumetric flow. Use the following equation:

   $\text{Volumetric flow} = \frac{(\text{std. flow} \times 760 \text{ mm Hg})(\text{ambient temp in K})}{(\text{ambient pressure in mm Hg})(298 \text{ K})}$

   *Note: the equation for standard flow used above is:

   \[
   \text{std. flow} = \left[\text{(MFM disp)}(\text{MFM cert. slope})\right] + (\text{MFM cert. intercept})
   \]

   The above calculations are not necessary if your transfer standard reports volumetric flow directly. The SASS 22 LPM should display a flow within ±4% of 6.7 LPM (6.43-6.97 LPM) for channels 1-3, and within ±4% of 22.0 LPM (21.12-22.88 LPM) for channel 4. Record the SASS 22 LPM displayed flow and the transfer standard flow on the maintenance check sheet.

4. Repeat step 3 with channels 2, 3, and 4. If a channel does not pass the flow verification that channel must be calibrated. The calibration procedure is outlined in the section 6.0, Calibration Procedures. In addition, field operators need to investigate when this problem started, and initiate a Corrective Action Notification [CAN] to invalidate all filters sampled on the channel(s) that fails this verification.
Record displayed and actual flow rates on the monthly check sheet or calibration sheet as required.
8.0 ROUTINE SERVICE CHECKS

8.1 General Information:

Perform the following checks on the SASS 22 LPM Sampler at the intervals specified in the service schedule. The checks may be performed more frequently but should be performed at least at the prescribed intervals. Document all results and maintenance on the SASS 22 LPM Monthly Quality Control Maintenance Check Sheet. Maintain a set of loaded test canisters solely for the purpose of leak and flow checks. Do not use actual sample canisters to perform leak and flow checks.

8.2 Daily Checks or after each sampling event:

Review event logs after each run to ensure proper operation of the SASS 22 LPM sampler. Complete Custody and Field Sample Data sheet, and return to lab with sampled cartridges.

8.3 Monthly Checks:

Complete the SASS 22 LPM Monthly Quality Control Maintenance Check Sheet and include a hardcopy in the monthly data submittal packet. A time/date check must be done monthly. Compare SASS 22 LPM date and time against an accurately set clock and adjust accordingly.

Perform a leak check monthly. Use loaded leak/flow test canisters and SCC inlets during flow checks. The sampler display must read 0.1 LPM or less to pass. Refer to Section 7.7 for the leak check procedure.

Perform a flow rate verification for all channels in use. The flow rate must be 6.7 LPM ±4% (6.43-6.97 LPM) for channels 1-3 and 22.0 LPM ±4% (21.12-22.88 LPM) for channel 4. The flow checks must be done with loaded test canisters and SCC inlets in place. Refer to Section 7.6 for the flow verification procedure.

If a channel does not pass the flow verification that channel must be calibrated. The calibration procedure is outlined in the section 6.0, Calibration Procedures. In addition, field operators need to investigate when this problem started, and initiate a Corrective Action Notification (CAN) to invalidate all filters sampled on the channel(s) that fails this verification.

The temperature and pressure sensors must be checked monthly. The temperature sensors must be within ±2°C of the temperature standard. The pressure sensor must be within ±10 mm Hg of the pressure standard. Refer to Sections 7.3-7.5 for the procedures. If any sensor is out of tolerance, perform a multi-point calibration or replace the faulty sensor.
Clean all SSC inlets monthly (Section 9.3).

The original Monthly Quality Control Maintenance Check Sheet must be retained onsite at the monitoring station in accordance to the standard ARB Documentation Policy, currently located in section 5.3 of the Quality Assurance Manual, Vol. 1.

8.4 **Semi-Annual Checks:**

Perform semi-annual verification/calibration of the external ambient temperature sensor, filter temperature sensor, pressure sensor, and volumetric flow controller, along with verifying the date and time are correct and it passes leak tests on all channels.
9.0 MAINTENANCE PROCEDURES

9.1 General Information:

Routine SASS 22 LPM maintenance requires keeping the SASS 22 LPM sampling head, pump box, inlet, and control unit dust free and clean.

9.2 Sampler Maintenance:

The control box, OT sensor shield, and pump box should be cleaned when required with a clean wet cloth. The sampling shield should be cleaned whenever canisters are changed to minimize chances for contamination and to maximize effectiveness of the radiation shield.

9.3 PM2.5 Sharp Cut Cyclone (SCC) Maintenance:

Clean the SCC inlet monthly. Remove the inlet from the sampling canister before cleaning. Remove the grit cup and clean with compressed air or a lint-free cloth. Disassemble the SCC and clean the inner chamber of the SCC with a lint-free cloth. Check all o-rings (grit cup, inlet head and body) for damage and replace if necessary. Use a small amount of silicon grease on o-rings if needed. Reassemble cyclone.

9.4 Pump Box Maintenance:

Clean and inspect the pump box once a quarter. Remove the four screws on the corners and lift the cover off the assembly. Clean the inside of the pump box with a brush or compressed air. Pay special attention to the screen located below the pump assembly. Replace the cover by first tightening the two screws on the fan exhaust side first, then tighten the screws on the opposite end of the enclosure.
10.0 TROUBLESHOOTING

10.1 General Information:

The SASS 22 LPM manual contains a table of symptoms and common solutions. Examining the event log data can be an important source of information when troubleshooting the SASS 22 LPM unit.

10.2 Leak Check Failure:

Ensure that the canister and SSC are securely installed, along with confirming that the device used to block the flow works appropriately. If that channel still won’t pass leak check criteria, try the following suggestions:

1. Check pump box quick-connect and o-rings.

2. Exchange SCC. If still failing, trade canisters.

3. Visually check SCC, canister, head o-rings and lines for degradation.

4. Isolate components backwards – leak check with canister only. If still failing, leak check on head if possible. If still failing leak check at pump box. Should be able to roughly isolate component responsible for the leak.
11.0 REFERENCES


Standard Operating Procedure for the Filter and Canister Preparation for PM2.5 Speciation Samples (SOP MLD 062, http://www.arb.ca.gov/aaqm/sop/mld062.pdf)


### Operator Instructions:

1. **Each Run:** Review event logs to ensure proper SASS 22 LPM operation. Run field blanks as directed by the laboratory. Wipe down, with wet cloth, control box, OT sensor shield and pump box.
3. **Quarterly Checks:** Clean and inspect pump box with brush or compressed air, especially the fan covers. Date last performed:
4. **Semi-Annual Checks:** Perform verification/calibration of the leak check, external ambient temperature sensor, filter temperature sensor, pressure sensor, and volumetric flow controllers. Date last performed:

### Transfer Standard Used

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<thead>
<tr>
<th>Make/Model</th>
<th>Serial Number/Bar Code</th>
<th>Component (T, P, Flow)</th>
<th>Date Certified</th>
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### Date and Time Verification

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<th>Sampler Display (PST) Date/Time</th>
<th>Transfer Standard (PST) Date/Time</th>
<th>Does Date Agree? Does Time Agree ± 2 min?</th>
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### Leak Verification

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<th>Action Taken And Recheck Results</th>
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<td>1) Mass</td>
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</tr>
<tr>
<td>2) NOx/SOx</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3) Wood Smoke</td>
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<td></td>
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</tr>
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<td>4) Carbon</td>
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### Temperature Verification

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<th>Transfer Standard (°C)</th>
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<th>Action Taken And Recheck Results</th>
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<th>Transfer Standard (mm Hg)</th>
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<th>Action Taken And Recheck Results</th>
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### Flow Rate Verification

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<th>Transfer Standard Display (L/min)</th>
<th>Design Flow Rate (L/min)</th>
<th>Agreement ±4%</th>
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<td></td>
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<td>4) Carbon</td>
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### Comments:

Reviewed By: [Signature]
Date: [Date]

APPENDIX A
## APPENDIX B

### ARB Calibration Report - Met One SASS 22 LPM Sampler (Deltacal)

#### ID Information:
- **Station Name:** Chico-East
- **Make:** Met One
- **AIRS #:** 06-007-0008
- **Model #:** SASS 22 LPM
- **Station Address:** 984 East Ave, Ste4
- **Property #:** 20102613
- **Station Number:** 04-625
- **Serial #:** M2818
- **Operator:** Simoni
- **Agency:** ARB
- **Calibration Date:** 4/7/16
- **Report Date:** 4/7/16
- **Prev. Cal. Date:** 1/27/16

#### Time:
- **Date:** 4/7/16
- **Time:** 10:23:45 AM

#### Flow Standard:
- **Make & Model:** DeltaCal
- **Cert. Date:** 12/31/15
- **Cert. Exp.:** 12/31/16

#### Leak Test: (LPM)
- Channel 1: 0.0
- Channel 2: 0.0
- Channel 3: 0.0
- Channel 4: 0.0

#### Temperature: (deg. C)
- Ambient: 27.7
- Filter: 28.7

#### Pressure: (mm Hg)
- Ambient: 751

### Raw Calibration Data

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Channel 1 (Teflon)</td>
<td>6.7</td>
<td>6.70</td>
<td>0.4</td>
<td>0.35</td>
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<tr>
<td>Channel 2 (Nylon)</td>
<td>6.7</td>
<td>6.67</td>
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<tr>
<td>Channel 3 (Teflon)</td>
<td>6.7</td>
<td>6.68</td>
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<tr>
<td>Channel 4 (Quartz)</td>
<td>22.0</td>
<td>22.10</td>
<td>0.5</td>
<td>0.45</td>
</tr>
</tbody>
</table>

#### Comments:
- **Calibrated by:** McKay
- **Checked by:**

---

**ARB Calibration Form 402 (Deltacal)**

**AQSB SOP 402**
**Met One SASS 22 LPM**
**First Edition, September 2017**
PM$_{2.5}$ SPECIATION CUSTODY AND FIELD DATA FORM

<table>
<thead>
<tr>
<th>LIMS #</th>
<th>Bar Code</th>
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CHAIN OF CUSTODY RECORD (INITIALS, DATE, TIME)

<table>
<thead>
<tr>
<th>Lab Out</th>
<th>Site Out</th>
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</thead>
<tbody>
<tr>
<td>Site In</td>
<td>Lab In</td>
</tr>
<tr>
<td>Bin ID</td>
<td>Temperature at receipt (°C)</td>
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SITE INFORMATION

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Date Sampler Loaded</th>
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<tr>
<td>Scheduled Sampling Day</td>
<td>Operator’s Name</td>
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SAMPLER CHANNEL / CANISTER ASSIGNMENTS

<table>
<thead>
<tr>
<th>Channel #</th>
<th>Canister #</th>
<th>Canister Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Green</td>
<td>Teflon Filter - Mass / Metals</td>
</tr>
<tr>
<td>2</td>
<td>Red</td>
<td>Nylon Filter - Ions</td>
</tr>
<tr>
<td>3</td>
<td>Orange</td>
<td>Teflon Filter - Wood Smoke</td>
</tr>
<tr>
<td>4</td>
<td>Blue</td>
<td>Quartz Filter - Carbon</td>
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</table>

START AND END INFORMATION

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Start Time</th>
<th>End Date</th>
<th>End Time</th>
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RETRIEVAL INFORMATION

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<tr>
<th>Retrieval Date</th>
<th>Retrieval Time</th>
<th>Event Length</th>
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SAMPLE COLLECTING INFORMATION

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<tr>
<th>Channel #</th>
<th>Average Ambient P (mm Hg)</th>
<th>Sample Volume (M$^3$)</th>
<th>Average Ambient Temp (°C)</th>
<th>Flow CV (%)</th>
<th>Is CV Below 2%?</th>
<th>Mean Flow (L/min)</th>
<th>Flow Warning</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td></td>
<td></td>
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<td>Yes / No</td>
<td>Yes / No</td>
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</tr>
<tr>
<td>2</td>
<td></td>
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<td>Yes / No</td>
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<tr>
<td>3</td>
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<td>Yes / No</td>
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<tr>
<td>4</td>
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<td></td>
<td></td>
<td></td>
<td>Yes / No</td>
<td>Yes / No</td>
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Ambient Temp (°C) | Ambient P (mm Hg) | Elapsed Time Warning | Filter dT Warning

<table>
<thead>
<tr>
<th>Maximum</th>
<th>No</th>
<th>Yes</th>
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<tbody>
<tr>
<td>Minimum</td>
<td>No</td>
<td>No</td>
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Local Condition Codes (Circle One):  Construction - Demolition nearby / Wildfire-Mexico / Fireworks / Farming-Highway Construction-Roofing Operations / High Pollen Count / High Winds / Infrequent Large Gathering / Prescribed Burn / Structural Fire / Seismic Activity / Wildfire - USA / NO UNUSUAL CONDITIONS

Comments

MASS ANALYSIS

<table>
<thead>
<tr>
<th>Weight</th>
<th>Mass (mg)</th>
<th>Duplicate Mass (mg)</th>
<th>Date</th>
<th>Analyst</th>
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<tbody>
<tr>
<td>Pre</td>
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<tr>
<td>Post</td>
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Start Post-Conditioning ___________________________ 4/12/16

Appendix C