

STANDARD OPERATING PROCEDURES

Andersen Instruments Federal Reference Method (FRM) Ambient Particulate (PM₁₀/PM_{2.5}) Sampler (RAAS)

AMBIENT AIR MONITORING PROGRAM for the 130 LIBERTY STREET DECONSTRUCTION PROJECT



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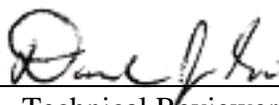
Standard Operating Procedures

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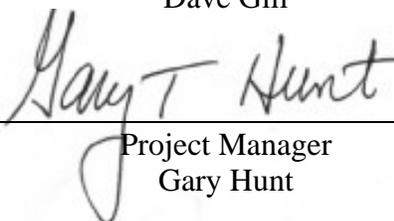
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TABLE OF CONTENTS

<i>Section</i>	<i>Page</i>
1.0 PURPOSE OF SOP	1
2.0 EQUIPMENT DESCRIPTION	1
2.1 OPERATING PRINCIPLE	1
3.0 EQUIPMENT OPERATION	1
3.1 EQUIPMENT FOR RAAS 2.5	1
3.2 EQUIPMENT FOR RAAS 10	1
3.3 ASSEMBLING OF THE WINS IMPACTOR (FOR PM _{2.5})	2
3.4 ASSEMBLING RAAS SAMPLER	2
4.0 SAMPLING	3
4.1 SAMPLE HANDLING	3
5.0 DATA LOGGING	4
6.0 CALIBRATION	4
6.1 CALIBRATION MENU	4
6.2 TEMPERATURE CALIBRATION PROCEDURE USING A THERMOCOUPLE CALIBRATOR	4
6.3 PRESSURE CALIBRATION	6
6.3.1 Meter Drop Pressure	6
6.3.2 Barometric Pressure	7
6.4 FLOW CALIBRATION	7
7.0 SYSTEM AUDIT	9
7.1 INTERNAL LEAK CHECK (LEAKAGE AROUND THE FILTER)	9
7.2 FLOW VERIFICATION	10
8.0 MAINTENANCE	10
9.0 ADDITIONAL INFORMATION	10

1.0 PURPOSE OF SOP

This SOP was designed to describe the procedures used for PM_{2.5} or PM₁₀ particulate matter measurements in ambient air.

2.0 EQUIPMENT DESCRIPTION

The RAAS-100 is a standalone sampling system meeting the Federal Reference Method (FRM) standards for single day sampling of PM_{2.5} or PM₁₀. The operator will refer to the manufacturer's operation manual for pictorials and additional information to aid in performing maintenance and operations. (Document No. RAAS Operator's Manual)

2.1 Operating Principle

The RAAS systems pull ambient air through an inlet, which removes particulate matter larger than 10 micrometers. The air sample is then directed via the downtube to the WINS impactor in the RAAS2.5 systems, which removes particulate matter greater than 2.5 micrometers. In the RAAS10 systems the WINS impactor is replaced with an equivalent length of section of tubing with no size selective characteristics. The particulate is collected using a 47 mm Teflon filter. The flow rate of the system is maintained at 16.67 L/min by a digitally encoded dry gas meter and a diaphragm pump. Temperature and pressure corrections are made to correct for temperature and pressure differences between ambient and dry gas meter conditions.

3.0 EQUIPMENT OPERATION

In order to operate the RAAS Sampler, it is necessary to assemble the instrument.

3.1 Equipment for RAAS 2.5

- . RAAS PM_{2.5} FRM
- . 1 Inlet Tube
- . 1 RAAS – 2.5 Inlet
- . 1 WINS Impactor Assembly
- . 1 Stand
- . 1 Leak Check Adapter
- . 1 Filter Bypass Leak Check Disk
- . 1 Filter Cassette
- . 1 Ambient Temperature Solar Radiation Shield
- . 1 RAAS Accessories Kit

3.2 Equipment for RAAS 10

- . RAAS PM_{2.5} FRM
- . 1 Inlet Tube
- . 1 RAAS – 10 Inlet
- . 1 Inlet Tube Extension

- 1 Stand
- 1 Leak Check Adapter
- 1 Filter Bypass Leak Check Disk
- 1 Filter Cassette
- 1 Ambient Temperature Solar Radiation Shield
- 1 RAAS Accessories Kit

3.3 Assembling of the WINS Impactor (for PM_{2.5})

The procedure for assembling the WINS Impactor is given below.

1. Remove the upper portion of the well.
2. If WINS well is not clean, clean it.
3. Place a new filter in the lower portion of the well.
4. Add 1 ml of impactor oil to the lower portion of well so it completely “wets” the filter.
5. Assemble the WINS Impactor in the following order, starting from bottom up:
 - a. Impactor, Lower
 - b. Well, Lower
 - c. WINS Filter
 - d. Well, Upper
 - e. Impactor, Upper
6. Install the WINS Impactor into the RAAS System.

3.4 Assembling RAAS Sampler

The RAAS system is shipped partially assembled; follow the steps below for final assembly.

1. Turn the RAAS sampler over so that it is sitting on the top cover.
2. Align the stand on the bottom of the unit and attach using the ¼ 20 nuts and washer provided with the unit.
3. Return the sampler to the upright sampling position.
4. Remove the back panel from the system by removing the 6 screws located on the back of the unit.
5. Remove the top of the system by the 4 screws located underneath the top.
6. Remove the piece of shipping foam from the top.
7. Select one of the three possible locations for the Ambient Temperature radiation shield and run the ambient thermocouple through the middle hole.
8. Reinstall the top.
9. Reinstall the back panel.
10. Install the Inlet tube by screwing it into the threads located at the top of the unit.
11. Open the door to the system and install the WINS Impactor (for RAAS2.5) or Inlet Tube Extension (for RAAS10), by pushing it into the bottom of the Inlet tube.
12. Install the Ambient Temperature radiation shield at the selected position and screw it in using the provided screws.
13. System set up is complete.

4.0 SAMPLING

Prior to sampling, the RAAS system must be leak checked and a flow audit performed. See calibration section for the procedures to be followed:

1. Select the Setup Run menu item from the main menu. This will display the event setup screen.
2. Select the filter position to be programmed by using the “Up Arrow” and “Down Arrow” keys. Press the “Enter” key to setup the sampling event for the selected filter.
3. Enter the Filter ID number for the sampling position. This entry is provided to help the user track the filter.
4. Enter the sample Start Date.
5. Enter the duration for the sampling event in hours.
6. The display will now change to show the set start date and duration of the programmed event.

To remove the filter from the RAAS system, the following procedures must be followed to ensure proper data logging of the system.

1. Select the filter position that is to be removed and press “Clear” key.
2. The system will prompt for confirmation of the filter being removed. Select “Yes” and press the “Enter” key if the filter being removed is at the position being displayed. Otherwise, select “No” and press the “Enter” key.

4.1 Sample Handling

The following step should be followed for installing and removing the filter cassettes from the RAAS system. NOTE: 47 mm diameter Teflon filters will be supplied and pre-weighed by the analytical laboratory.

1. The filter cassette should only be removed from the system when a sampling event is not in progress.
2. Lower the filter stage by turning the hand crank in the counter-clockwise direction until the filter cassette is accessible.
3. Install a RAAS-CAP to cover the top of the filter cassette. This will help prevent contamination.
4. Remove the filter from the RAAS and attach a second RAAS-CAP to cover the bottom of the filter cassette.
5. When filters are removed from the system, the user needs to inform the system so that it will stop logging data about that filter. This is done by using the “Clear” function in the Setup Run Display.
6. Install a new filter cassette. Be sure that the RAAS-CAPs have been removed prior to installation.
7. When raising the filter stage, rotate the crank clockwise until the filter cassette is inside the bottom of the top filter holder/WINS Impactor and significant resistance to turning occurs.

NOTE: Collect any data associated with the filter being removed at this time.

5.0 DATA LOGGING

The RAAS system has built in data logging capabilities. The RAAS stores 4 different types of data: summaries, interval average, power failure, and calibration. The summary data contains information on each sampling event including average flow rate, sampled volume, min/max/avg sensor data, and other important values. The interval average data log contains averaged values for the different measurements made by the system at the interval set. The power fail data log records the time and duration of power failures. The calibration data log contains the calibration values, and the date and time of calibration.

NOTE: Please refer to owners' manual for a detailed explanation of the contents of these logs.

6.0 CALIBRATION

The RAAS system requires periodic calibration. This section outlines the recommended calibration procedures for the RAAS samplers and as defined by the project specific QAPP, during the sampling event.

6.1 Calibration Menu

Calibration is controlled from the "Calibrate" menu of the Maintenance menu. The following steps describe how to access this menu.

1. Select the "Offline" menu item from the main menu and press the Enter key.
2. Select the "Maintenance" menu item from the main menu and press the Enter key.
3. Select the "Calibrate" menu item from the Maintenance menu and press the "Enter" key.

6.2 Temperature Calibration Procedure Using a Thermocouple Calibrator

The procedure for using a digital thermocouple calibrator is outlined below. This procedure is applicable to all temperature sensors in the RAAS system. This procedure should be repeated for each temperature sensor once a year.

MENU SELECTION	CALIBRATION PANEL LABEL
Ambient	Ambient
Meter	DGM
Filter	Sample Filter
Inactive	Non-Sampling Filter

Perform the following steps to perform a temperature calibration.

1. Unplug the yellow, mini, type-K thermocouple plug that corresponds with the temperature sensor that is to be calibrated from the calibration panel. Refer to the owner's manual for the location of the thermocouple on the calibration panel.
2. Attach the thermocouple calibrator to the calibration panel using the calibration cable. Ensure that the remaining thermocouples are plugged into the calibration panel. An unplugged thermocouple connection can cause the system to be incorrectly calibrated.
3. If the thermocouple calibrator is not already on, then turn it on at this point.
4. Select the menu selection for the appropriate sensor from the "Calibrate" menu. Press the "Enter" key to begin the calibration process.
5. The system will prompt for the low temperature calibration point. The display on the left will vary slightly depending on which temperature sensor is being calibrated. The low value defaults to the recommended value of -20°C. Other values can be entered, by using the numeric keypad on the RAAS. Set the thermocouple calibrator to match the entered value. Press the "Enter" key on the RAAS to start calibrating the low point of the two-point calibration.
6. The system will wait for the signal from the thermocouple calibrator to stabilize. After the signal has stabilized the RAAS will take the average of the next 100 measurements. This average will be used for the low end point of the two point calibration. If the text "Sat" is displayed on the screen, then the thermocouple is saturated. The second line contains a number representing the stability of the input. The third line represents the A/D converter value.
7. The system will prompt for the high temperature calibration point. The display on the left will vary slightly depending on which temperature sensor is being calibrated. The high value defaults to a recommended value of 40°C. Other values can be entered, by using the numeric keypad on the RAAS. Set the thermocouple calibrator to match the entered value. Press the "Enter" key on the RAAS to start calibrating the high point of the two-point calibration.
8. The system will wait for the signal from the thermocouple calibrator to stabilize. After the signal has stabilized the RAAS will take the average of the next 100 measurements. This average will be used for the low end point of the two point calibration. If the text "Sat" is displayed on the screen, then the thermocouple is saturated. The second line contains a number representing the stability of the input. The third line represents the A/D converter value.
9. The system will now display a status window containing the Gain, Offset, and the current temperature of the sensor being calibrated. The Gain and the Offset are the calibration values used by the system and the displayed reference. The current temperature reading should match the value displayed on the thermocouple calibrator. Change the calibrator to 0°C, the RAAS will track the temperature change and the value displayed on the screen should match within $\pm 2^\circ\text{C}$.
10. Detach the thermocouple calibrator and calibration cable and reconnect the thermocouple.
11. Co-locate a thermometer with the calibrated thermocouple.

12. Allow time for the thermometer and thermocouple to stabilize. The value displayed in the window should agree with the thermometer within $\pm 2^{\circ}\text{C}$.
13. Press the "Cancel" key to complete the calibration process. The system will prompt the operator to save the calibration. Select "Yes" if the calibration is satisfactory. The system will use the new values in calculating Ambient Temperature. Selecting "No" will void this calibration and restore the previous calibration.

6.3 Pressure Calibration

The RAAS contains two pressure transducers that are used to measure the ambient pressure and the meter drop pressure. The procedure for calibrating each of these sensors is given below.

6.3.1 Meter Drop Pressure

To calibrate the meter drop pressure, attach the pressure measurement and pressure changing devices to the Ambient/Calibration port located on the calibration panel. The device should be attached so that the same pressure is applied to both the Calibration port and the pressure measurement device.

1. Select the "Meter Drop" from the "Calibrate" menu. Press the "Enter" key to begin the calibration process.
2. The system will prompt for the low meter drop pressure. Disconnect the pressure changing source from the calibration port and the pressure measurement device. This will result in a zero differential pressure on the Meter Drop pressure sensor. Enter 0 using the numeric keypad on the RAAS. Press the "Enter" key. The system will now wait for the applied pressure to stabilize.
3. The system will take the average of the next 100 measurements. This value will be used for the low end point of the two-point calibration. If the text "Sat" is displayed in this window, the pressure channel is saturated. The second line contains a number representing the stability of the input. The third line represents the A/D converter value.
4. The system will prompt for the high meter drop pressure. Re-attach the pressure changing device. Enter 200 using the numeric keypad on the RAAS. Press the "Enter" key. Change the pressure so that it is 200 mmHg above the ambient pressure. The system will now wait for the applied pressure to stabilize.
5. The system will take the average of the next 100 measurements. This value will be used for the high end point of the two-point calibration. If the text "Sat" is displayed in this window, the pressure channel is saturated. The second line contains a number representing the stability of the input. The third line represents the A/D converter value.
6. The system will now display a status screen that contains the Gain, Offset and the current meter drop pressure. The Gain and Offset are displayed for reference purposes only. The current pressure reading should match the value displayed on the pressure gauge minus atmospheric pressure within ± 5 mmHg. Press the "Cancel" key to continue the calibration process.

7. The system will now ask the operator to accept the calibration. Select “Yes” if the calibration is satisfactory. The system will use the new values in calculating the Meter Drop Pressure. Selecting “No” will void this calibration and the prior calibration values will be restored.

6.3.2 Barometric Pressure

To calibrate the barometric pressure, attach the pressure measurement and pressure changing devices to the Ambient/Calibration port located on the calibration panel. The device should be attached so that the same pressure is applied to both the Calibration port and the pressure measurement device.

1. Select the “Barometer” from the “Calibrate” menu and press the “Enter” key. This will begin the calibration of the barometric pressure sensor.
2. The system will prompt for the low barometric pressure. Enter 600 using the numeric keypad on the RAAS. Press the “Enter” key. Adjust the pressure so that the pressure measurement device reads 600 mmHg. The system will now wait for the applied pressure to stabilize.
3. The system will take the average of the next 100 measurements. This value will be used for the low end point of the two-point calibration. If the text “Sat” is displayed in this window, the pressure channel is saturated. The second line contains a number representing the stability of the input. The third line represents the A/D converter value.
4. The system will prompt for the high barometric pressure. Enter 800 using the numeric keypad on the RAAS. Press the “Enter” key. Adjust the pressure so that the pressure measurement device reads 800 mmHg. The system will now wait for the applied pressure to stabilize.
5. The system will take the average of the next 100 measurements. This value will be used for the high end point of the two-point calibration. If the text “Sat” is displayed in this window, the pressure channel is saturated. The second line contains a number representing the stability of the input. The third line represents the A/D converter value.
6. The system will now display a status screen that contains the Gain, Offset and the current meter drop pressure. The Gain and Offset are displayed for reference purposes only. The current pressure reading should match the value displayed on the pressure gauge. Press the “Cancel” key to continue the calibration process.
7. The system will now ask the operator to accept the calibration. Select “Yes” if the calibration is satisfactory. The system will use the new values in calculating the Barometric Pressure. Selecting “No” will void this calibration and the prior calibration values will be restored. Remove the pressure calibration equipment.

6.4 Flow Calibration

The procedure below outlines the steps in calibrating the flow system of the RAAS system. The temperature and pressure sensors of the RAAS should be calibrated and/or checked before calibrating the flow (DGM). A flow calibration is performed once a

month or at any time that a flow verification check is found to be outside preset criteria (see Section 7.2).

1. Remove the sample inlet and install the leak check adapter.
2. Attach the reference dry gas meter to the leak check adapter. Ensure that the valve on the leak check adapter is in the open position.
3. Select the Dry Gas Meter option from the Calibrate menu and press the “Enter” key. This will begin the calibration of the Dry Gas Meter.
4. The system will prompt for the reference meter calibration coefficient. This value is also commonly known as the Y factor of the dry gas meter. This value is determined by comparing the dry gas meter to a calibration standard. This value should be supplied with the dry gas meter. The RAAS multiplies the volume numbers entered by the operator by the Y factor to obtain the actual value.
5. The system will prompt for the initial volume of the reference meter. Enter the number and press the “Enter” key.
6. The system will now prompt for the temperature of the reference dry gas meter. Enter the current temperature of the reference dry gas meter and press the “Enter” key. The system will now pull air through system at the nominal rate of 16.67 L/min.
7. The system will pull air through the reference meter until the “Cancel” key is pressed. (Note: It is recommended that at least 0.5 cubic meters be allowed to pass through the reference meter before the “Cancel” key pressed.)
8. The system will prompt for the final volume of the reference dry gas meter. Enter the number and press the “Enter” key.
9. The system will now prompt for the temperature of the reference dry gas meter. Enter the current temperature of the reference dry gas meter and press the “Enter” key.
10. The system will prompt for the initial volume of the reference meter. Enter the number and press the “Enter” key.
11. The system will now prompt for the temperature of the reference dry gas meter. Enter the current temperature of the reference dry gas meter and press the “Enter” key. The system will now pull air through system at the nominal rate of 18.33 L/min.
12. The system will pull air through reference meter until the “Cancel” key is pressed. It is recommended that at least 0.5 cubic meters be allowed to pass through the reference meter before the “Cancel” key is pressed.
13. The system will prompt for the final volume of the reference dry gas meter. Enter the number and press the “Enter” key.
14. The system will now prompt for the temperature of the reference dry gas meter. Enter the current temperature of the reference dry gas meter and press the “Enter” key.
15. The system will prompt for the initial volume of the reference meter. Enter the number and press the “Enter” key.
16. The system will now prompt for the temperature of the reference dry gas meter. Enter the current temperature of the reference dry gas meter and press the “Enter”

- key. The system will now pull air through system at the nominal rate of 15.00 L/min.
17. The system will pull air through the reference meter until the “Cancel” key is pressed. (Note: It is recommended that at least 0.5 cubic meters be allowed to pass through the reference meter before the “Cancel” key is pressed.)
 18. The system will prompt for the final volume of the reference dry gas meter. Enter the number and press the “Enter” key.
 19. The system will now prompt for the Temperature of the reference dry gas meter. Enter the current temperature of the reference dry gas meter and press the “Enter” key.
 20. The system will now display a status screen that contains the calibration factors for each flow rate and the average calibration factor. The individual factors for each run should agree within 0.1 cc/tick. The average value should be between 5.5 and 6.8 cc/tick. The pump should be running and the flow rate should read 16.67 (± 0.2) liters per minute. Press the “Cancel” key to continue the calibration process.
 21. The system will now ask the user to accept the calibration. Select “Yes” if the calibration is satisfactory. The system will use the new values in calculating the flow rate. Selecting “No” will void this calibration and the prior values will be restored.

7.0 SYSTEM AUDIT

The RAAS sampler should be checked periodically to ensure the proper operation.

7.1 Internal Leak Check (Leakage around the filter)

The system leak check option can be accessed through the “Leak Check” menu selection of the main menu. This leak check should be performed daily.

1. Remove the Leak Check Adapter and install the impermeable plastic disk in place of the filter in the filter cassette. Select the “Leak Check” menu item from the main menu and press the “Enter” key. This will start the leak check process.
2. The RAAS system will now evacuate the air from the system. After evacuation the pump will continue to run. The system will monitor the dry gas meter of the RAAS for changes in flow and report them on the screen. The flow should be below 0.08 L/min for 10 minutes to pass the leak check procedure. Press the “Cancel” key when finished.

7.2 Flow Verification

The method to verify that the RAAS sampler is controlling flow at the proper rate is a general method, which can be used with a variety of flow measurement devices. The system can verify the flow through the system using the “Verify Flow” menu item in the main menu. A flow check is performed monthly.

1. Remove the sample inlet and install the leak check adapter. Connect the flow measurement device to the leak check adapter. Select the “Verify Flow” menu item and press “Enter” key. This will start the flow verification process.
2. The RAAS system will control the flow at the 16.67 L/min set point. The Average Flow and FlowCV will appear after 60 seconds. Allow sufficient time for the flow to stabilize (5 minutes). Compare the reading from the flow measurement device with the Flow and AvgFlow value displayed on the RAAS screen. The values displayed on the RAAS and the flow measurement device should be within $\pm 10\%$ of the 16.67 L/min set point. Press “Cancel” key when finished.

8.0 MAINTENANCE

Maintenance on the RAAS consists primarily on cleaning the air intake filter and WINS Impactor. Refer to the manual for cleaning procedures.

9.0 ADDITIONAL INFORMATION

A more detailed equipment manual is available from Andersen Instruments, Inc. and is located in the site office for any other questions about the RAAS Operator’s Manual.