STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX AI

ANDERSEN
RAAS2.5-300 SEQUENTIAL AIR SAMPLER

MONITORING AND LABORATORY DIVISION

MAY 1999

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AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX AI.1

STATION OPERATOR'S PROCEDURES FOR ANDERSEN RAAS2.5-300 SEQUENTIAL AIR SAMPLER

MONITORING AND LABORATORY DIVISION

MAY 1999

AI.1.0 GENERAL INFORMATION

AI.1.0.1 PURPOSE

The purpose of these Standard Operating Procedures (SOP) is to supplement the manufacturer's (Andersen) Operator's Manual by describing modifications in hardware or 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) collection of particulate matter 2.5 microns or smaller (PM2.5) when using the Andersen Reference Ambient Air Sampler (RAAS).

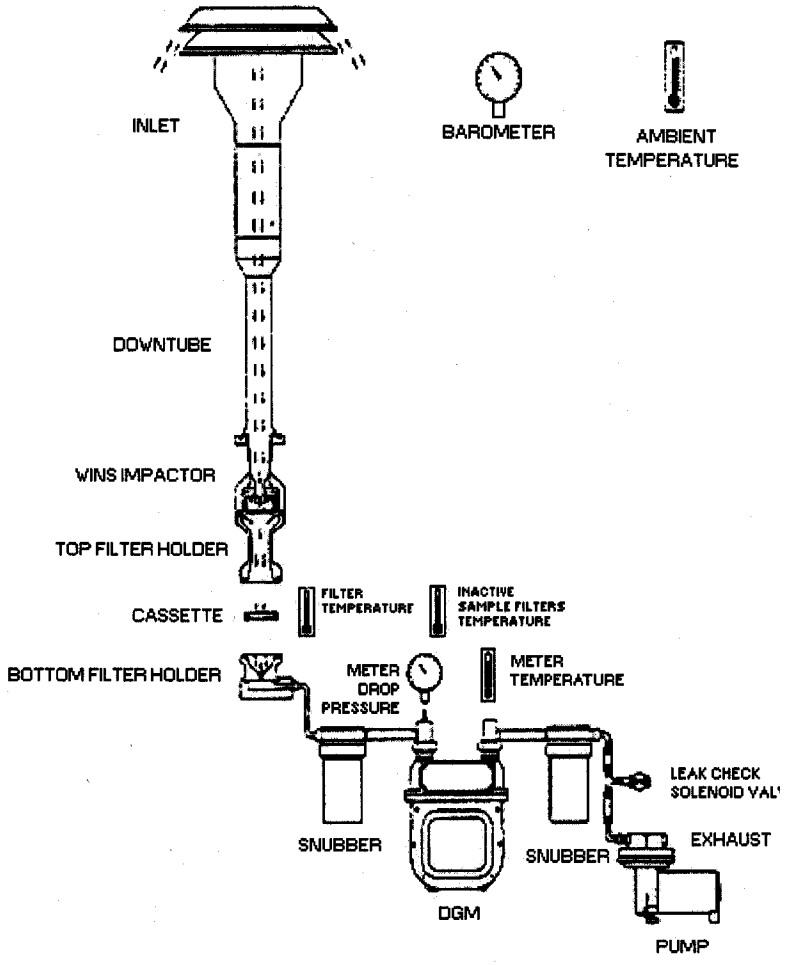
AI.1.0.2 GENERAL DESCRIPTION AND THEORY OF OPERATION

In June 1998, the Andersen RAAS2.5-300 (sequential sampler) was designated in the Federal Register as a FRM for collection of PM2.5. The sampler and its systems perform all the functions required or recommended in the instrument specification portion of the FRM PM2.5 standard. The standard requires a fixed flow rate of 16.67 liters per minute (LPM) using a specified PM10 inlet, tubing (downtube), secondary size-selective impactor, filter holder, and filter cassette. The sequential sampler uses a filter cassette tray (carousel) which can hold up to eight separate filters in their individual cassettes. Once programmed, this enables the sampler to sample up to eight separate events without operator intervention as well as continue a sampling event on one filter while installing or removing other sample filters (sample cassette exchange).

The sampler draws ambient air through its PM10 inlet, PM2.5 Well Impactor Ninety-Six (WINS), and a 46.2 millimeter (mm) diameter Teflon sample filter which traps the PM2.5 fraction. The sample filter is conditioned and weighed before and after sampling and the resulting difference is the collected PM-2.5 mass. Electronic systems in the sampler are designed to monitor and maintain the flow rate as well as record the elapsed sampling time enabling the sampler to calculate the total sample volume. With this information, the analyzing laboratory will calculate the average PM2.5 concentration of the sampling period.

The Andersen sequential sampler monitors and regulates the flow rate using a dry gas meter, a variable speed pump, and ambient temperature and pressure sensors, all controlled by the sampler's microprocessor and software.

For a more detailed explanation of the sampler's theory of operation, please read Section 2: Introduction, of the Operator's Manual and see Figure AI.1.0.1: Schematic Andersen RAAS2.5 Sequential Air Sampler and Figure AI.1.0.2: Schematic of the WINS Impactor.



The RAAS systems pull ambient air through an inlet, which removes particulate matter of about 10 microns and larger. The air sample is then directed via the downtube to the WINS Impactor, which removes particulate matter of greater than 2.5 mircrons. The remaining particulate is collected using a 47 mm Teflon filter.

Figure AI.1.0.1
Schematic of Andersen RAAS2.5 Sequential Air Sampler

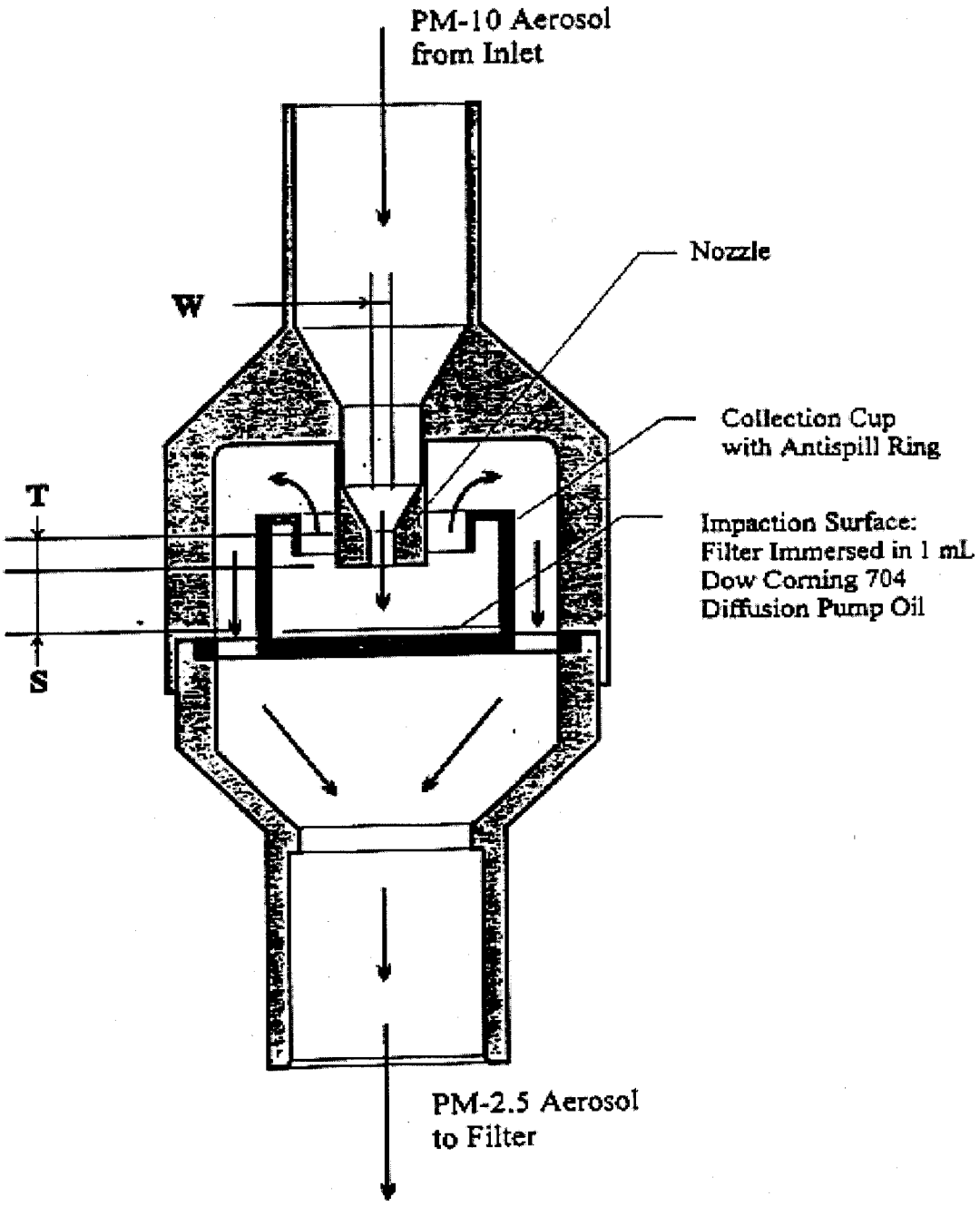


Figure AI.1.0.2
Schematic of the WINS Impactor

AI.1.0.3 SAFETY

Installation, operation, maintenance, or calibration of the sampler should only be performed by properly trained personnel. High (120 volts A.C.) voltages are used to power the unit and due to typical rooftop installations, the risks of working outdoors at elevation during ambient weather conditions should also be considered. Also read Section 1: Cautions and Notices, in the Operator's Manual.

AI.1.1 INSTALLATION PROCEDURE

AI.1.1.1 PHYSICAL INSPECTION

Each Andersen RAAS2.5-300 Sequential Sampler purchased through the National PM2.5 Sampler Procurement Contract should be supplied with the following supplies:

1 SA642 PM10 Inlet
1 inlet tube
1 stand kit
1 leak check adapter
1 filter bypass leak check disk
1 filter cassette tray
1 filter area cover
1 ambient temperature solar radiation shield
3 sets of impactor wells and anti-spill rings
8 sets of filter cassettes and backing screens
2 sets of inlet O-rings
100 milliliters (ml) of impactor oil
50 (count) of 37 millimeter (mm) diameter glass fiber impactor filters
4 accessories required for the collection, storage, and transport of filter samples
1 DataLink, docking station and power supply, and interconnect cable
8 accessories required for the collection, storage, and transport of filter samples. Each accessory consisting of a Styrofoam insulated cardboard shipping box, twelve (12) containers of Blue Ice or equivalent, and a metal cylinder capable of holding eight (8) sample filters in cassettes.
1 copy of the Operator's Manual

Upon receipt of the sampler(s), inspect sampler and accessories for shortage and for shipping damage. If shortage or damage is found, immediately notify your supervisor, and/or your agency's shipping department.

AI.1.1.2 INITIAL SAMPLER INSTALLATION

Follow directions found in Section 3 of the Andersen Operator's Manual for installation instructions and consult with your area specialist/engineer or supervisor to assure that installation site complies with Federal and State siting criteria for FRM PM2.5.

AI.1.1.3 INITIAL SAMPLER SET-UP

Follow directions found in Sections 4, 5, and 6 of the Andersen Operator's Manual.

AI.1.2 DATA RETRIEVAL

AI.1.2.1 INTRODUCTION

Field personnel will have the responsibility of ensuring PM2.5 sampling information for each filter run is properly retrieved. The sampling information from the Andersen sequential sampler can be obtained either manually or electronically.

The Andersen sequential sampler has a built-in serial communications port that can be used to interface with PC's, modems, and printers. The sampler's communications use N-8-1 protocol (8 stop bits, no parity, 1 stop bit). The sampler is capable of communications over a wide range of baud rates. There are two primary ways to download data from the sampler: Laptop PC or DataLink.

To manually record sample data, field personnel will complete a CARB 24-Hour Field Sample Report (see Figure AI.1.2.1). The 24-Hr sample report will contain all information required by 40 CFR Part 50, Appendix L, Table L-1.

To electronically record sample data, field personnel can download data via an RS-232 data output connection through which digital data will exported to a laptop PC or DataLink unit.

AI.1.2.2 DOWNLOAD APPARATUS USING LAPTOP PC

1. Laptop PC with communications software or terminal program.

2. Serial cable with D-9 male plug with female pins on one end and a D-9 female plug with male pins on the other.

AI.1.2.3 DOWNLOAD PROCEDURE USING LAPTOP PC

1. Connect the serial cable from the PC to the serial port on the sampler.

2. Open the communications software, configure to operate using the N-8-1 protocol and baud rate set on the Andersen sequential sampler. Enable the file capture capability of the software package. (For Procomm click capture icon or type "Alt F1").

3. Select the "Data Transfer" menu from the main menu of the Andersen sequential sampler. Select either "Summary", "Data Log", or "Pwr Fail Log" depending on the information that is desired to be transmitted. Typically only the summary information will be downloaded. Data Log (5-minute averages) should be downloaded if a problem was encountered during sampling.

CARB 24 Hour - FIELD SAMPLE REPORT
Feceral Reference Method PM2.5 Filter Samplers

Bar Code:
LIMS Sample ID:

Site Name: _____
AIRS Site Number: _____
Field Technician: _____
Agency: _____

Cassette I. D. Number: _____
Scheduled Sampling Date: _____
Sampler Property #: _____

SAMPLE SUMMARY

☐ Check if data electronically submitted to Laboratory

Start Date / Time: _____ / _____
Total Elapsed Time: _____ Hr:min
Volume: _____ M^3
Flow CV: _____ %

	MIN	AVG	MAX
Ambient Temp(°C):			
Filter Temp (°C):			
Pressure (mmHg):			
Flow :			

Local Condition Codes: _____

A.	No Unusual Conditions	E.	Fire Nearby
B.	Wind/Blown Sand/Dust	F.	Sampler Malfunction
C.	Construction Nearby	G.	Rain
D.	Farming Operation Nearby	H.	Other (See Comments)

Sampler Flag Codes: _____

OK	Good	T.	Filter Temp.
F.	Flow Rate	I.	Inst. Elec. Temp
X.	Flow Cutoff	V.	Power Outage
S.	Ambient Temp.	E.	Elapsed Sample Time
P.	Ambient Pressure	C.	Percent CV

Operator Comments: _____

Chain of Custody

ACTION	DATE	TIME	FILTER TEMP. °C	NAME
Sample Load				
Sample Removal				
Sample placed in cooler				
Sample shipped to Lab				
Sample received at Lab				
Start post-conditioning				

FOR LABORATORY USE ONLY

Postweigh by: _____

	Mass:	Dup Mass:	Date:	Analyst:
Preweight				
Postweight				

Lab Comments: _____

MLD-140 (3/99) ver. 1

Figure AI.1.2.1
CARB 24-Hour Field Sample Report

4. After a selection is made, the Andersen sequential sampler system will send the data over the serial connection to the PC. The terminal window of the communications software should show the data being transmitted.

5. After transmission is completed, disable the file capture capability of the communications software to close the capture file. (For Procomm click capture icon or type "Alt F1"). Disconnect serial cable from sampler and PC.

AI.1.2.4 DOWNLOAD APPARATUS USING DATALINK

1. DataLink unit

2. 9-pin Male to 9-pin female extension cable

3. AC to DC wall transformer for 115 V.

4. Docking station adapter

5. WinDataLink software package

AI.1.2.5 DOWNLOAD PROCEDURE USING DATALINK

1. The Andersen sequential sampler system must be properly configured in order to use the DataLink. The baud rate of both the DataLink and the Andersen sequential sampler system must be identical. The default setting is 19200 baud. See the Andersen Operator's Manual for instructions on setting sampler and DataLink baud rate.

2. Connect the DataLink to the serial port on the sampler. Each time the DataLink is attached to an Andersen sequential sampler system a new data file is created in the data link.

3. Select the "Data Transfer" menu from the main menu of the Andersen sequential sampler. Select either "Summary", "Data Log", or "Pwr Fail Log" depending on the information that is desired to be transmitted.

4. After making a selection, the Andersen sequential sampler system will send data to the DataLink. The green LED of the DataLink will flash while it is receiving data. When the green LED has stopped flashing it is safe to disconnect the DataLink. The DataLink will store this data for later retrieval. If additional data files are transferred they will be appended to the same data file. If a separate data file is desired for each data file then detach and reattach the DataLink.

AI.1.2.6 DATA UPLOAD FROM DATALINK TO PC

1. To view data stored on the DataLink, data will need to be uploaded to a desktop PC via the docking station and viewed with the winDataLink software.

2. Locate an available COM port on the desktop PC. Attach the appropriate end of the 9-pin extension cable to the selected COM port. Attach the docking station adapter to the other end of the 9-pin extension cable. Connect the docking station to a 110-120 VAC outlet via the AC to DC wall transformer.

3. Start winDataLink software and attach DataLink to the docking station. The WinDataLink software will initiate communications with the DataLink. After the software has initialized, users will see a preview screen and a directory pane. The preview pane provides a preview of this.

AI.1.3 DATA SUBMITTAL (FIELD TO LABORATORY)

AI.1.3.1 INTRODUCTION

Once field personnel have retrieved sampling information either manually or electronically, the sample run information must be forwarded to the laboratory. If the sampling information was recorded manually, a 24-Hr sample report (see Figure AI.1.0.3) will accompany the sampled filter(s) to the laboratory. If the sampling information was recorded electronically, the sampling information will be sent to the lab via file transfer protocol. An abbreviated 24-Hr sample report will still accompany the sampled filter(s) to document chain-of-custody and additional sampling information.

AI.1.3.2 ELECTRONIC DATA SUBMITTAL TO LABORATORY

Various procedures can be used to electronically submit the sampling data to the laboratory. Refer to Appendix B for the specific procedures that will be followed.

AI.1.3.3 SAMPLE CHAIN-OF-CUSTODY

The chain-of-custody process begins once the filter is pre-conditioned and inspected by laboratory personnel. After pre-conditioning is complete, filters will be preweighed, placed in cassette filter rings and prepared for shipping to the field. Each filter will be assigned a bar code number, which will be attached to the filter's 24-Hr sample report. Laboratory personnel will annotate the preweight of the filter, date and initials on the 24-Hr sample report. The 24-Hr sample report and filter(s) will then be shipped to the field. Within 30 days of preweighing, the filter must be used for sampling. When the filter is loaded into the sampler, field personnel will document the date, time and name of person loading the sampler. After sampling, field personnel will document date, time and name of personnel removing the sample from the sampler. If the filter is not being shipped to the laboratory right away, the filter must be placed in a refrigerator for storage until shipping. Field personnel will document date, time and filter temperature when the filter is placed in refrigerator. When the filter is shipped to the laboratory, the date, time, filter temperature, and personnel shipping the filter will be documented on the 24-Hr sample report. When the filter arrives at the laboratory, the date, time, filter temperature, and person receiving the filter will be noted on the 24-Hr sample report. Laboratory personnel will then enter the filter information into the Laboratory Information Management System (LIMS). LIMS will generate a LIMS sample identification number, which will be documented on the 24-Hr sample report. The filter will then be prepared for postconditioning or placed in a refrigerator for storage until postconditioning. The date, time, filter temperature, and name of analyst will be documented once postconditioning begins.

AI.1.4 QUALITY CONTROL MAINTENANCE PROCEDURES

AI.1.4.1 GENERAL INFORMATION

Quality Control (QC) maintenance procedures (checks) are designed to help assure that valid data is produced as a result of proper sampler operation and maintenance in accordance with its federal designation and the manufacturer's operating manual. The maintenance frequency presented in these standard operating procedures should be considered the minimum required even though the actual frequency of performing some of these checks may vary from site to site due to different environmental factors. These may include the sampling schedule, particulate concentrations, or seasonal factors, which may require an increase in maintenance frequency. In the event that these checks cannot be performed on schedule, the deferred maintenance should be performed as soon as practical. The QC procedures schedule is presented in Table AI.1.4.1.

When QC checks are performed, the date, results, and any pertinent comments should be recorded onto the Monthly Quality Control Maintenance Checksheet for the FRM PM2.5 Filter Sampler (QC checksheet) presented in Figure AI.1.4.1. This document will be forwarded to the supervisor on a monthly basis for subsequent review and filing. It is recommended that a copy be made by the operator and kept at the field site for later reference by the operator or a site visitor.

AI.1.4.2 DAILY CHECKS

Prior to removing the filter from the sampler, use a slightly damp Kimwipe tissue (or other lint-free equivalent) to wipe the interior of the sampler, especially that portion in which the sample filter(s) reside. During unloading of the sample cassettes from the sampler, record the sample summary data onto the sample cassette's matching 24-Hr sample report or download the data electronically. Also record the run date on the QC checksheet.

Review the summary data for reasonableness and for compliance with Measurement Quality Objectives for FRM PM2.5 presented in Table AI.1.4.2. If questionable summary data is seen, download the five (5) minute data averages using the Andersen DataLink or personal computer (PC) and examine these averages for anomalies. Procedures for downloading these data are presented in Section AI.1.2 (Data Retrieval) of this SOP as well as Section 7: Data Logging, in the Operator's Manual. In the event that anomalies are present in the 5-minute averages, troubleshoot the sampler according to instructions in Section 12, Troubleshooting, of the Operator's Manual, then notify your supervisor or area calibrator. Also, visually inspect the PM10 inlet's water collector jar and drain it if water is present.

Table AI.1.4.1
QC Procedures Schedule for FRM PM2.5 Sampling

Quality Control Procedure Schedule for
Federal Reference Method PM2.5 Sampling

	*Daily	Every 5 Samples	Every 25 Samples	Every Month	Every 6 Months	Every 12 Months
Record and Review Run Summary	X					
Inspect or Drain Inlet Water Jar	X					
Clean Interior of Sampler	X					
Service WINS Impactor Well		X				
Perform Leak Check		X				
Disassemble and Clean PM10 Inlet, Downtube and Entire WINS			X	X		
Inspect O-rings and Gaskets			X	X		
Perform Single Point Flow Rate Check			X	X		
Clean Air Intake Filter and Fan				X		
Perform Single Point Check of Ambient Temp and Press Sensors				X		
Verify Sampler Clock Time				X		
Transport Samples with Temp-logger				X		
Run a Field Blank (minimum 10% of runs)				X		
Perform as-is Three Point Calibration Verification of Flow Rate, Pressure and Temperature Sensors					X	
Verify as-is Condition of Sampler's Interior, Inlet, and WINS Impactor					X	
Perform Multipoint Calibration of Flow Rate, Pressure & Temperature Sensors					X	
Measure Temp of Station Freezer					X	
Calibrate or Re-certify Flowrate, Press and Temp QC Check Standards						X

*or each time sample cassettes are exchanged

CARB MONTHLY QUALITY CONTROL MAINTENANCE CHECKSHEET
FRM PM2.5 FILTER SAMPLER

Site Name: _____ Month/Year: _____
Site Number: _____ Sampler Make & Model: _____
Operator/Agency: _____/_____ Sampler ID Number: _____

Operator Instructions:

At Each Sample Unload: Record and review sample run data; inspect/drain inlet water jar.
Run Days: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____
(if sampling daily, then indicate by 1-10, 21-25, etc.)
Every 5 Runs: Clean or change-out WINS impactor well.
Days WINS Serviced: _____ _____ _____ _____ _____ _____ _____ _____
Perform leak check - Results: _____ _____ _____ _____ _____ _____
(<80mL/min for 10 min).
Every 10 Runs: Run a field blank. Date Performed: _____ _____ _____
Monthly or Every 25 Runs: Clean inlet, downtube, entire WINS, interior of sampler, air intake filter and fan.
Inspect o-rings and gaskets; check sampler clock time (<+/-10min).
Perform single point QC check of flow rate, ambient temperature and pressure, and record results below.
Date Performed: _____ Include temp-logger with samples during transport.
Semiannually: Perform as-is calibration check. Inspect sampler's inlet, WINS, and interior condition.
Perform maintenance or repair wiring and connectors, tubing and connections, pumps and fans.
Perform multipoint calibration of flow rate, temperature and pressure sensors.
Perform leak check and measure temperature of station freezer. Date Last Performed: _____
Annually: Re-certify QC check standards - Certification Date: _____ _____ _____
(flow std) (temp std) (press std)

Sampler Flow Rate, Ambient Temp and Pressure Check Results:

	Flow Rate Standard	Temperature Standard	Pressure Standard
Standard Name/Type:			
Identification Number:			
Correction Factor:			
Std's Indicated Reading:			
Std'sCorrected Reading:			
Sampler's Reading:			
Percent Difference:			
Acceptance Criteria:	≤+/-4% of standard	≤+/-2°C of standard	≤+/-10 mm Hg of std

Operator
Comments:_____
_____
_____

Reviewed By/Date: _____/_____ MLD-999 (10/98)

Figure AI.1.4.1
CARB Monthly Quality Control Maintenance Checksheet
FRM PM2.5 Filter Sample

Table AI.1.4.2
Measurement Quality Objectives for FRM PM2.5

Requirement	Frequency	Acceptance Criteria
Filter Holding Times:	all sample filters	
Pre-sampling		<30 days from preweighing
Post-sampling (in sampler)		<96 hrs from end of sampling
Post-sampling (during storage and transport)		<10 days at 25°C from end of sampling or <30 days at 4°C from end of sampling
Sampling Period:	all data	1380 to 1500 minutes or MC if <1380 and exceedance of NAAQS
Sampler:	every 24 hrs of operation	
Flow rate		≤5% of 16.67 LPM
Flow rate variability		≤2% CV
		measured ≤5% average for 5 min
Filter temp sensor		≤5°C of amb temp for <30 min
Data Completeness:	quarterly	75%
Filter:	all filters	Visual defect check
Monthly QC Check:	monthly	
Flow rate		+/-4% of standard
Leak check		<0.08L/min for 10 minutes
Ambient temp sensor		+/-2°C of standard
Ambient press sensor		+/-10 mm Hg of standard
Clock/timer		+/-10 min of corrected clock time
Multipoint Calibration:	semiannually or	
Flow rate	when failed monthly check,	+/-2% of transfer (xfer) standard
Leak check	following major repair,	<0.08L/min for 10 minutes
Temperature sensors	or after sampler transport	+/-2°C of xfer standard
Pressure sensors		+/-10 mm Hg of xfer standard
Monthly QC Standards:	annually	
Flow rate standard		+/-2% of Full Scale (20LPM)
		NIST-traceable standard
Temperature standard		+/-0.1°C resolution
		+/-0.5°C accuracy
Pressure standard		+/-1 mm Hg resolution
		+/-5 mm Hg accuracy
Calib. Xfer Standards:		
Flow rate xfer standard	dry gas meter annually	+/-2% of NIST-traceable standard
	mass flow meter quarterly	
Temperature xfer standard	annually	+/-0.1°C resolution
		+/-0.5°C accuracy
Pressure xfer standard	annually	+/-1 mm Hg resolution
		+/-5 mm Hg accuracy

AI.1.4.3 EVERY 5 SAMPLING RUNS CHECKS

Remove the WINS impactor from the sampler and inspect impaction well to determine size of particulate cone, which may have formed in the center of the well. A cone taller than two (2) millimeters or a cone with its top broken off indicates a need for more frequent well cleaning to minimize the possibility of particle bounce and re-entrainment of particles larger than 2.5 microns.

Clean or replace impactor well with a newly serviced well according to instructions in Section 11.4 of the Operator's Manual. Record performance of this procedure and pertinent comments onto the sampler's QC checksheet.

After servicing the WINS impactor and reassembling perform a leak test and record the results on the sampler's QC checksheet. If the results of the leak check do not meet the criteria, troubleshoot the sampler according to Section 12: Troubleshooting, of the Operator's Manual to determine the cause and if a cause cannot be found, notify your supervisor or area calibrator.

AI.1.4.4 EVERY 25 SAMPLING RUNS CHECKS

Disassemble and clean the PM10 inlet, sampler downtube, and the entire WINS impactor assembly. Inspect o-rings for abrasions, breaks, tears, deformations or other damage. If necessary, replace o-rings and lubricate them with a light coating of halocarbon or silicone vacuum grease prior to reassembly. Using the same lubricant, also lightly lubricate any aluminum threads and take extra care that the fine threads are not cross-threaded during assembly. After reassembly, perform a leak check according to instructions in Section 9.3 of the Operator's Manual and record the results on the QC checksheet. If the results of the leak check meet the acceptance criteria found in Table AI.1.4.2, perform a single point flow check according to instructions presented in Section 9.4 of the Operator's Manual. If the results of the leak check do not meet the criteria, troubleshoot the sampler according to Section 12: Troubleshooting, of the Operator's Manual, to determine and resolve the cause. If the problem cannot be resolved, notify your supervisor or area calibrator.

Before conducting the flow check, a single-point check of the ambient pressure and temperature sensors should be performed. Perform the flow check using an actual flow rate or volume measuring device having an accuracy of at least +/-2 percent (%) of full scale (0-20 LPM Vol-o-Flow, mass flow meter, etc.) and which is calibrated or certified annually against a NIST-traceable standard. If using a vol-0-flow or other volumetric measuring device, in addition to correcting the indicated reading by the meter's calibration factors, also correct for the ambient temperature and pressure to obtain the actual flow rate (AFR). First, correct the Vol-o-Flow's indicated meter

reading by the calibration's slope and intercept to obtain a corrected meter reading (CMR). Then, apply the ambient temperature and pressure correction according to the following formula:

$$AFR = CMR \times \frac{Ta}{298.15K} \times \frac{760mmHg}{Pa}$$

Where AFR = actual flowrate
CMR = corrected meter reading
Ta = ambient temperature in Kelvin, and
Pa = ambient pressure in mmHg

If the sampler's flow rate measurement is not within +/-4 percent of the standard's measurement, investigate the cause. If a cause for the flow discrepancy cannot be found, notify your supervisor or area calibrator. Record the date that these procedures were performed and results of the flow check onto the sampler's QC checksheet.

AI.1.4.5 MONTHLY CHECKS

Clean the interior of the sampler chassis with a damp cloth. Remove the air intake filter and clean it with soap and water following instructions found in Section 11.3 of the Operator's Manual. Clean air intake fan blades with a damp cloth or brush if necessary.

Perform both a leak check and a flow check, as previously described in Every 25 Sampling Runs Checks, if it has been more than a month since these procedures were last performed. Perform a single point check of ambient pressure and temperature sensors using a temperature and pressure standard, which is calibrated or certified annually against a NIST-traceable standard. If the sampler's measurements are not within the acceptance criteria (+/-4% for flow rate, <80 mL/min for leak check, $\pm$10 mm Hg for pressure, and $\pm$2°C for temperature) of the standard's measurements, examine the sampler for obvious causes as well as following instructions in Section 12: Troubleshooting, found in the Operator's Manual. If the cause of the discrepancy cannot be found, notify your supervisor or area calibrator.

Verify that the sampler's clock time is within ten (10) minutes of standard time as If there is a difference of more than 10 minutes, reset the sampler's clock to within one (1) minute of the Operator's Manual. Record the date that these procedures were performed and the results obtained onto the sampler's QC checksheet.

Field blanks will be implemented at 10% of sampling frequency. This procedure will be initiated by the laboratory and will consist of the laboratory sending or designating a sample cassette as a field blank. The operator will treat this sample cassette in the same manner as a regular sample cassette used for sampling with the sole exception that it will not be used to collect sample. The field blank sample cassette is to be loaded and unloaded from the sampler, transported, stored and shipped as usual, but the sampler will not be programmed for a sampling event using this sample cassette. In order for the field blank to be as meaningful as possible in checking for passive contamination, leave the field blank in the sampler for at least as long as a regular filter cassette stays in the sampler, both before and after the sampling event. Fill-in the appropriate sections of the field blank's 24-Hr sample report and ship blank cassettes alongside valid samples to the laboratory.

A trip blank is handled similarly except that the filter cassette is not installed in the sampler and the sample cassette covers are not removed. The trip blank is used to check for possible contamination during shipping or transport only.

AI.1.4.6 SEMIANNUAL CHECKS

Every six (6) months, the area calibrator will inspect the sampler's interior, PM10 inlet, and WINS impactor for cleanliness and condition after an as-is single-point calibration verification check has been performed. If any of the sampler's calibrated systems fail to meet the acceptance criteria presented in Table AI.1.4.2, the calibrator must perform a final multipoint calibration of all systems. The operator may assist the area calibrator in performing all necessary repairs and maintenance prior to the calibrator performing a final multipoint calibration of flow rate and all temperature and pressure sensors. After the multipoint calibration, the area calibrator will perform a leak check. Using the temperature standard, the area calibrator will also measure the temperature of the site's freezer (if so equipped) and record the results onto the sampler's calibration worksheet or report. The operator will record all maintenance performed and date of calibration onto the sampler's QC checksheet.

AI.1.4.7 ANNUAL CHECKS

The operator will have their flow rate, temperature, and pressure QC verification check measurement standards re-certified or calibrated against a NIST-traceable standard. The date these procedures are performed will be recorded onto the sampler's QC checksheet.

The calibrator will have their flow rate/volume, temperature, and pressure calibration transfer standards re-certified or calibrated against a NIST-traceable standard at least annually.

AI.1.5 SAMPLE FILTER HANDLING AND SHIPPING PROCEDURE

AI.1.5.1 GENERAL INFORMATION

The major differences between collection of PM2.5 using the Federal Reference Method (FRM) and current filter sampling for particulates are the additional time and temperature requirements (see *Filter Holding Requirements* presented in Table AI.1.0.2). FRM PM 2.5 filters must be used for sampling within 30 days of the date of preweighing by the laboratory. Also, postweighing by the laboratory must be performed within ten (10) days of the end sampling date if the sampled filters have been continuously stored at no more than 25°C since removal from the sampler. If the sampled filters have been continuously stored at 4°C or less since removal from the sampler, the laboratory must conduct postweighing within 30 days of the end sampling date.

Since this latter (30 days at $\leq$4°C) requirement is preferred in order to give sufficient time for field, transport, and laboratory procedures, additional equipment such as a freezer, insulated shipping containers, and chilled medium ("Blue Ice" or equivalent) will be provided to the field operators. In addition, various means and devices to monitor the storage and transport temperatures of the sampled filters will also be provided. This equipment and the following operating procedures are designed to assure compliance with these time and temperature requirements.

AI.1.5.2 PRESAMPLING FILTER HANDLING PROCEDURES

The laboratory will supply preweighed sample filters, installed in filter cassettes, to the field/site operator. These sample cassettes, along with their respective 24-Hour sample report, will be shipped inside an insulated shipping container. This container should have external markings which designate that the container is assigned to the site operator as well as that it contains preweighed filters which are available for sampling. These markings are necessary to insure that the correct amount of filters are delivered to the proper site since different sites will be operating under different sampling schedules. Also, additional markings will alert the operator that the shipment contains sample filters since not all shipments of insulated containers being returned to the field will contain sample filters.

Inside the shipping container, the sample cassettes will be further contained inside the Andersen metal cylinder which is designed to hold up to eight cassettes and which unscrews apart. Open the metal cylinder and confirm that each sample cassette has a cassette ID number written on its side and that this number corresponds to the cassette ID number written in a matching 24-Hr sample report. If it is necessary to take a

sample cassette out of the cylinder in order to see its ID number, do not remove the metal cassette covers in order to minimize the possibility of contamination. If either a cassette or a 24-Hr sample report is received that does not have its matching cassette or 24-Hr sample report, notify the laboratory for further instructions.

Examine the 24-Hr sample report for the date that the sample filter was preweighed. The sample filter must be used within 30 days of this date. Notify the laboratory if this requirement cannot be met, as the sample cassettes may still be able to be used as field blanks. Return expired filters and their respective sample report forms to the laboratory noting on the 24-Hr sample report the reason for their return.

Close the metal cylinder leaving the sample cassettes inside, attach the sample report forms and store the cylinder under office environmental conditions until ready for loading into the sampler. If the cylinder will be stored with previously received cylinders, store them in such a way that the first received is the first sampled. When ready for sampling, remove the sample cassette(s) from the cylinder and load the filters into the sampler according to instructions in Section 6: Sampling, and Section 10: PM2.5 Measurement Procedure, of the Operator's Manual. At this time, also fill-in appropriate sections of the sample cassette's matching 24-Hr sample report.

To minimize the possibility of contaminating the sample filter prior to the sampling event, load the sample filter(s) at a time as close as practical to the start of the sampling event. Also, if it appears probable that the surface of the sample filter may be touched during handling, then laboratory grade (non-dusted) latex gloves should be worn.

AI.1.5.3 POSTSAMPLING FILTER HANDLING PROCEDURES

Remove sample cassette(s) from the sampler according to instructions in Sections 6 and 10 of the Operator's Manual. Before removing the filter from the sampler, use a slightly damp Kimwipe tissue (or other lint-free equivalent) to wipe the interior of the sampler, especially that portion in which the sample filter(s) reside. Install metal cassette covers onto cassette and place cassette into metal cylinder with the cassette ID number visible. After completing 24-Hr sample report(s), review sample summary data for compliance with Measurement Quality Objectives presented in Table AI.1.0.2. If objectives are not met, download and review the 5-minute average data, investigate the cause, and if a cause cannot be found and remedied, notify your supervisor or area calibrator. Note problem in comments section of the 24-Hr sample report as well as on the QC checksheet. After filling in the 24-Hr sample report(s), place report(s) inside a zip-lock plastic bag to avoid condensation damage and attach bag to the exterior of the cylinder with a rubber band. Store cylinder containing sampled cassettes in cold storage (less than 4°C) until shipment to the laboratory. Use

a method of storage which assures that the oldest samples will be the first shipped to the laboratory.

As previously noted, although the sample cassette(s) may remain in the sampler up to 96 hours (4 days) after the end of the sampling event, remove them from the sampler as soon as practical. This practice will lessen the possibility of postsampling contamination as well as minimize volatilization of the collected sample.

AI.1.5.4 SHIPPING AND TRANSPORT PROCEDURES

When traveling to a satellite PM2.5 site, the operator should bring an insulated shipping container or cooler having chilled medium inside. The container will be used to chill the sampled filters to less than 4°C during the transportation period to the operator's office or shipping location. The average ambient temperature encountered as well as the amount of time spent during the transport period will determine the amount of chilled medium necessary to maintain sample temperatures within limits. It is recommended that the sampled filters also be contained in a chilled metal cylinder, both to provide additional chilled mass as well as to minimize contamination. If the metal cylinder is not used, the sampled filters should at least be placed inside of a ziplock, static-resistant plastic bag before being put into the insulated container. The 24-Hr sample report(s) should also be placed inside a ziplock bag to avoid condensation damage if they are transported in the container.

If the elapsed time between removal of the sample cassette(s) from the sampler and placing the cassettes into the home office/main station freezer is more than 2 hours, activate both 5°C and 25°C temperature ranges of irreversible temperature indicators and place them in close proximity to the sampled filters during transport. Follow the directions included with the indicators for their proper storage and activation. If the indicators' temperature threshold is not exceeded, they may continue to accompany the samples during shipment to the laboratory. If the temperature threshold is exceeded, note this information in the affected sample filter's 24-Hr sample report and attempt to determine the cause of why this temperature was exceeded.

If the elapsed time between removal of the sample cassette(s) from the sampler and placing the cassettes into the home office/main station freezer is less than one hour, the sample cassettes do not need to be chilled during this period.

Upon arrival at the operator's office, the operator will fill-in the portion of each 24-Hr sample report's chain of custody section which asks for time, date, and filter temperature. Next, put the 24-Hr sample reports into a ziplock bag and attach the bag to the cylinder containing the samples and place the cylinder into the freezer for storage until ready for shipment to the laboratory.

Shipments to the laboratory will be made on a weekly basis using UPS Ground Service or other suitable service or carrier. Determine beforehand how long the transit time is between pick-up and arrival at the laboratory. Schedule the pick-up early enough in the week to avoid arrival on weekend or holiday dates.

To prepare the samples for shipment, remove the cylinder containing the oldest (earliest sample date) sample cassettes and attached 24-Hr sample reports from the freezer. Open the cylinder and confirm that each sample cassette has a matching 24-Hr sample report having the same cassette ID number. Fill-in the portion of each 24-Hr sample report's chain of custody which asks for date, time and temperature of the samples. If correct, close the cylinder, attach the 24-Hr sample report(s) and electronic data storage media (diskettes if appropriate), and place the cylinder in an insulated shipping container having enough chilled medium to assure that the samples arrive at the laboratory at a temperature not exceeding 4°C. The type of insulated shipping container needed and the amount of chilled medium used will depend on the transit time of shipping as well as the expected ambient temperatures during shipment.

In order to monitor whether the 4°C or the 25°C temperature specifications of the samples are exceeded during shipment, activate and insert both a 5°C and a 25°C irreversible temperature indicator into the cylinder. Place the chilled cylinder into an insulated shipping container and fill the remaining space with chilled medium. Close the shipping container and secure the lid or opening to prevent opening during shipment. Address the container to the analyzing laboratory and store the container in a cool place until pickup.

Periodically (every one to three months depending on need), a miniature temperature sensor with a built-in data logger (temp-logger) will be provided to field operators. The temp-logger will be used to monitor and record the sample temperature from the time the cassettes are removed from the sampler to the start of postweighing conditioning by the laboratory. This practice will provide added assurance that the sample temperatures are within specifications. The temp-logger may also be used to determine at what point the specifications are being exceeded, as perhaps indicated by the irreversible temperature indicators. Initiating this procedure and analyzing the recorded data are the responsibility of the area calibrator. Results of this procedure will be forwarded to the area supervisor, station operator, and filed in the station's site files.

AI.1.6 TROUBLESHOOTING

AI.1.6.1 GENERAL INFORMATION

If a problem is encountered as a result of the review of the sample summary data which may affect the validity of the sample, download and store the five (5) minute averages. Review the five-minute averages for operational parameters which may exceed limits f measurement quality objectives defined in Table AI.1.4.2 of these procedures. Also refer to Section 12: Troubleshooting, of the Operator's Manual for a probable cause and remedy. Notify your supervisor or area calibrator if the problem cannot be resolved. If the perceived problem does not affect sample validity, refer to Section 12: Troubleshooting of the Operator's Manual and continue to monitor the problem or correct it. If the problem persists, contact your area calibrator or shop repair specialist.

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX AI.2

CALIBRATION PROCEDURES FOR ANDERSEN MODEL RAAS2.5 - 300 SEQUENTIAL FRM AIR SAMPLER

MONITORING AND LABORATORY DIVISION

MAY 1999

AI.2.0 BACKGROUND AND GENERAL INFORMATION

AI.2.0.1 OVERVIEW

The calibration of the fine particulate matter samplers that collects mass with an aerometric diameter of less than 2.5 micron (PM2.5) must be performed on a six-month basis. There are several parameters that must be calibrated with this new generation of fine particulate matter samplers. These parameters include temperature, pressure, flow and volume. Generally, the calibration procedure in Section 8 of the Andersen manual is fairly complete, accurate, and easy to follow. The primary purpose of the calibration is to determine and/or verify that the volumetric flow of the PM2.5 sampler is at 16.7 liters per minute (LPM), or that the sampler collects a volume of 1 cubic meter of air per hour. Refer to Appendix L, Part 50, 40 CFR for additional information.

AI.2.0.2 GENERAL INFORMATION

The calibration of the Andersen sampler should be performed in the following set of steps:

1. flow rate verification
2. leak test
3. temperature verification/calibration
4. pressure verification/calibration
5. flow rate calibration
6. post calibration flow rate verification
7. clock/timer verification

All calibration information and data will be recorded on the Andersen Sequential PM2.5 Calibration Datasheet (Figure AI.2.0.1).

California Air Resources Board
Andersen Sequential PM2.5 Calibration Datasheet
Page 1 of 2

Site Name _____ Site Elevation _____
Site Number_____ Ambient Temperature _____
Property Number _____ Ambient Pressure _____

Temperature Sensor Calibration

Tegam ID Number _____ Certification Date_____
Ambient Temperature Sensor Gain _____ Offset _____ Zero Reading _____
Filter Temperature Sensor Gain_____ Offset _____ Zero Reading _____
Meter Temperature Sensor Gain _____ Offset _____ Zero Reading _____
Inactive Filter Temp. Sensor Gain _____ Offset _____ Zero Reading _____

Pressure Sensor Calibration

Pressure Standard ID Number _____ Certification Date_____
Pressure Slope _____ Pressure Intercept_____
Meter Pressure Drop _____ Gain _____ Offset _____
Barometric Pressure _____ Gain _____ Offset _____

Leak Test

Channel Number	Leak Flow	Time	Channel Number	Leak Flow	Time
1	_____	_____	5	_____	_____
2	_____	_____	6	_____	_____
3	_____	_____	7	_____	_____
4	_____	_____	8	_____	_____

Flow Calibration

DGM ID Number _____ Calibration Coefficient _____ Calibration Date _____

Nominal Flow	Initial Volume	Final Volume	Initial Temp	Final Temp	Time (min)
16.7	_____	_____	_____	_____	_____
18.3	_____	_____	_____	_____	_____
15.0	_____	_____	_____	_____	_____

Sampler DGM Gain_____ Offset_____ Ticks/cc _____
Calibrated by_____ Checked by _____

Figure AI.2.0.1
Andersen Sequential PM2.5 Calibration Datasheet

California Air Resources Board
Andersen Sequential PM2.5 Calibration Datasheet
Page 2 of 2

Site_____ Date_____

Temperature Calibration Verification

Temperature Standard ID Number _____ Certification Date _____
Certification Slope _____ Certification Intercept_____

	DGM Temperature Sensor			Avg	Temperature Standard			Avg
Cold	_____	_____	_____	_____	_____	_____	_____	_____
Ambient	_____	_____	_____	_____	_____	_____	_____	_____
Hot	_____	_____	_____	_____	_____	_____	_____	_____

Pressure Verification

Sampler Pressure_____ Pressure Standard _____

Flow Verification

Initial DGM Volume _____ Initial DGM Temperature _____
Final DGM Volume _____ Final DGM Temperature _____
Sampler L/MIN _____
Percent Difference _____

Time Verification

Time Standard Make _____ Model_____ Cal Date _____ Bias _____
Andersen Sampler Time _____ Time Standard Time_____ Difference _____

Final Time Set

Andersen Sampler Time _____ Time Standard Time _____ Difference _____

Calibrated by _____ Checked by _____

Figure AI.2.0.1 (cont.)
Andersen Sequential PM2.5 Calibration Datasheet

AI.2.1 VERIFICATIONS AND CALIBRATIONS

AI.2.1.1 CALIBRATION TRANSFER STANDARDS AND EQUIPMENT

The calibration transfer standards and equipment will be as follows:

1. NIST-traceable dry gas meter (DGM)
2. Tegam temperature calibrator and associated "K" type connector
3. NIST-traceable thermometer
4. NIST-traceable pressure meter
5. Andersen flow adapter
6. Tubings: 1/2 inch OD, thick walled, surgical rubber, @ 1 meter in length
   1/8 inch OD, surgical rubber, 3 pieces, @ 1 ft in length, plus a plastic 1/8 inch "tee"
7. Blank filter (s)
8. Source of vacuum/pressure
9. Calibration forms or laptop computer

AI.2.1.2 CERTIFICATION OF TRANSFER STANDARDS

All transfer standards used for calibrations will be re-certified every 12 months by the ARB standards laboratory.

AI.2.1.3 FLOW RATE VERIFICATION:

In the flow rate verification procedure, a volume of air is sampled for 30 minutes at 16.67 LPM. The Andersen volume is tested by placing the leak test adapter at the inlet of the sampler, opening the valve, and attaching the leak test adapter to the reference DGM with a thick walled 1/2" OD surgical rubber tubing.

From the main menu, select '**Maintenance**', press <**ENTER**>, then select '**Automation Control**', press <**ENTER**>, then select '**Unload Filter**' and press <**ENTER**>.

Remove the filter cover and place a filter cassette in the number 1 position.

Select '**Initialize**' and press <**ENTER**> to load the cassette.

Press <**CANCEL**> until back in the main menu.

To verify flow rate with a reference DGM, select '**Maintenance**' from the main menu and press <**ENTER**>, then select '**Verify Flow (DGM)**' and press <**ENTER**>.

When prompted, enter the reference DGM meter calibration coefficient. This value can be found on the calibration report that accompanies the reference DGM.

Next, enter the initial volume on the reference DGM in $M^{3.}$. Press the <**ENTER**> key.

The Andersen sampler will ask for the reference DGM temperature. Read the temperature from the thermometer located on top of the reference DGM, and enter that value into the display. Press the <**ENTER**> key to continue. The pump will start and draw air through the sampler. The sampler must run until it collects a volume of at least 0.5 M^3.

After at least 30 minutes press the <**CANCEL**> key, the pump will stop, and the display will prompt you for the reference DGM reading. Enter the volume reading in M^3 into the sampler and press <**ENTER**>.

The system will now prompt you for the reference DGM temperature. Enter this temperature data into the sampler display and press <**ENTER**>.

Enter the final reference DGM volume '**Vol**' and reference DGM temperature '**Tr**' on the calibration worksheet, or onto the laptop calibration computer program.

The flow rate should be 16.67 LPM +/- 2 % to pass the flow verification test. If the sampler flow rate is greater than +/- 2 %, the sampler must be recalibrated.

AI.2.1.4 LEAK CHECK

Before calibrating the flow rate (volume) of the sampler, it is important to ensure that the sampling train does not have a leak. The Andersen sampler was designed to perform automatic leak checks.

1. Confirm that the leak check pressure setting is at 200 mm Hg by selecting '**Maintenance**' and pressing <**ENTER**>, then selecting '**Configure**'and pressing <**ENTER**>, and then selecting '**Set Leak Pressure**' and pressing <**ENTER**>.

2. With the sampler inlet removed, install the leak check adaptor to the sampler inlet, and place the valve in the closed position. Insert 47 mm Teflon filter(s) into each position of the sampling carousel. Each position in the carousel should be tested for leaks.

3. The leak check procedure is accessed from the Main Menu. Select 'Leak Check', press <**ENTER**>, select the channel that you wish to leak check. Press <**ENTER**>. The carousel will move to the appropriate filter channel and begin the leak test.

4. The sampler will pump the system pressure down to 200 mm Hg and display the flow through the dry gas meter. When the flow drops below 0.08 LPM and stabilizes for 30 seconds, record the channel, leak check flow rate, and the leak check time on the calibration worksheet.

5. After recording the leak check information, press <**CANCEL**>.

6. Continue the leak test procedure until all 8 channels have been tested and proven leak tight. If a leak has been located, proceed to the troubleshooting section of the sampler manual.

AI.2.1.5 TEMPERATURE

The Andersen samplers employ epoxy coated bead thermocouples to measure temperature at several locations throughout the sampler. The locations are the outside ambient air, the filter holder assembly, the sampling carousel (inactive) and within the DGM. A two-point Tegam calibration will be performed for each of these sensors. The ambient and DGM thermocouples are used to determine the volumetric flow rate of the sampler and therefore it is essential that these two sensors are tested for accuracy.

Also, due to the short length of the filter and inactive thermocouple leads, the ambient and DGM sensors will be the only temperature probes to receive a full three-point calibration. (Subject to discussion and change).

1. AMBIENT TEMPERATURE SENSOR VERIFICATION:

   To verify the ambient temperature sensor, only a one-point ambient comparison to an external thermometer will be performed.

   a. Remove the ambient temperature sensor from the shield. Place the ambient temperature sensor next to the external certified thermometer (a medium such as packing material may help to acquire steady, consistent readings). Record the Make, Model, ID Number, Certification Date, and Certification Factors onto the calibration worksheet, or into the laptop calibration program.

   b. From the main menu, select the '**Maintenance**' option. Next, select the '**Monitor**' option. This screen will display the values for the Ambient, Meter, Filter and Inactive temperature sensors.

   c. When the temperature readings are stable, read and record the temperature from both the sampler display for the "ambient" and calibration thermometer onto the calibration worksheet.

   d. Determine the difference from true. Record the information on the calibration sheet. The temperature of the ambient thermometer must be +/- 2 ^{o}C of true. If not, the sensor requires calibration.

2. AMBIENT TEMPERATURE SENSOR CALIBRATION:

   a. To calibrate the ambient temperature sensor, unplug the thermocouple marked 'ambient' inside the sampler cabinet. Connect one end of the "K" type connector to the Tegam temperature calibrator, and the other end into the 'ambient' thermocouple connection.

   b. From the main menu of the Andersen Sampler, arrow down until the '**Maintenance**' item is highlighted and press <**ENTER**>. Next, select the 'Calibrate' option and press <**ENTER**>.

c. Record the Tegam ID number and calibration date on the calibration work sheet or in the laptop calibration procedure. Enter the Sampler ID number, date, and analyst name on the calibration worksheet or in the laptop computer program.

d. Turn on the Tegam calibrator. Select the 'CALIB' mode (by pressing **<CALIB/METER**> Tegam key), the "K" thermocouple, the degrees C scale, and enter -20.0 by pressing '**CHANGE**', -20.0 and then '**ENTER**'. The display flashes while setting, and stops flashing when the temperature is entered.

e. Next, from the Andersen sampler display select the '**Ambient**' option, and press the <**ENTER>** key. The sampler will prompt you for the low temperature value. Enter a low temperature value of -20.0°C. Press the <**ENTER**> key. (If -20.0 is already on the display, press the <**ENTER**> key). The sampler will now measure the voltage associated with -20.0°C. It takes 100 readings and determines the average for that temperature.

f. The sampler will now prompt for the high temperature value. Enter 40.0º on the Tegam and 40.0º on the PM2.5 sampler display. Press the <**CANCEL**> key. The sampler will now measure the voltage associated with 40.0°C. It takes 100 readings and determines the average voltage for that temperature. When completed, record the Gain, Offset, and current temperature. Change the Tegam to read 0.0°C. The reading on the sampler should drop to 0º. Enter the Gain, Offset and Tegam reading on the calibration worksheet or in the laptop computer program.

g. Pull the "K" lead out of the sampler and replace the thermocouple.

h. Verify the calibration with the method described in Ambient Temperature Sensor Verification (AI.2.1.5.1)

i. If the verification is okay, press <**CANCEL**> to continue.

j. The next screen asks if you want to save the calibration. Use the arrow keys to select 'Yes', if you want to save the calibration, and press <**ENTER**>.

3. FILTER TEMPERATURE SENSOR VERIFICATION AND CALIBRATION:

To verify the response of the filter temperature sensor, only a one-point ambient comparison to an external thermometer will be performed. Follow the procedures listed in Ambient Temperature Sensor Verification (AI.2.1.5.1), using the 'Filter' option when applicable.

To calibrate the filter temperature sensor, refer to the Ambient Temperature Sensor Calibration procedure (AI.2.1.5.2).

4. INACTIVE FILTER TEMPERATURE SENSOR VERIFICATION AND CALIBRATION:

To verify the inactive filter temperature sensor response, only a one-point ambient comparison to an external thermometer will be performed. Pull out the knurled brass knob located on the top left-hand side of the aluminum shelf by the filter carousel (the brown thermocouple lead is fixed through the center of the brass knob). Follow the procedures listed in the Ambient Temperature Sensor Verification (AI.2.1.5.1), using the 'Inactive' option when applicable.

To calibrate the inactive filter temperature sensor, refer to the Ambient Temperature Sensor Calibration procedure (AI.2.1.5.2).

5. METER TEMPERATURE SENSOR CALIBRATION:

To calibrate the meter temperature sensor, unplug the thermocouple marked "DGM" inside the sampler cabinet. Connect one end of the "K" type connector to the Tegam temperature calibrator, and the other end into the "DGM" thermocouple connection. Refer to the Ambient Temperature Sensor Calibration procedure (AI.2.1.5.2), using the 'Meter' option when applicable to calibrate the meter temperature sensor.

AI.2.1.6 PRESSURE DROP

1. PRESSURE DROP VERIFICATION:

The Andersen Sampler has the capability to determine the pressure drop between the filter and the dry gas meter. This provides useful information about particulate loading and sample validation.

a. To verify the meter pressure drop, select '**Maintenance**' and press <**ENTER**>, then select 'Monitor'and press <**ENTER**>.

b. Connect one end of the 1/8" surgical rubber tubing to the Ambient/Calibrate port, and the other end to the calibration syringe with the plunger removed. At this point no pressure is applied to the system.

c. The '**MtrDrp**' display must read 0.0 mm Hg +/- 5 mm Hg. If not, then calibrate using the Pressure Drop Calibration below.

d. Next, insert the plunger into the syringe and apply force to the plunger until the pressure gauges reads 200 mm Hg above ambient.

e. The '**MtrDrp**' display must read 200 mm Hg +/- 5 mm Hg. If not, then calibrate using the Pressure Drop Calibration below.

2. PRESSURE DROP CALIBRATION:

a. To calibrate the meter pressure drop, select the '**Meter Drop**' prompt in the sampler calibration menu and press <**ENTER**>. Connect one end of the 1/8" surgical rubber tubing to the Ambient/Calibrate port and the other end to the calibration syringe with the plunger removed (no pressure applied to the system).

b. Make sure the display reads 0.0 mm Hg and press <**ENTER**>. The system will measure and record this point as 0.0 mm HG.

c. Next, the system will ask for an ambient pressure that is 200 mm Hg above ambient pressure. If the ambient pressure reading is 762 mm Hg, insert the plunger into the syringe and apply force to the plunger until the pressure gauges reads 962 mm Hg. When the pressure gauge reading stabilizes, press the <**ENTER**> key while keeping constant pressure on the syringe plunger. The system will now read and record the high filter pressure.

d. When the pressure testing is complete the display will show the gain and the offset. Enter the Gain and Offset values into the calibration report

form. Press the <**CANCEL**> key to continue the calibration. The display will now ask you to accept the meter calibration. Select '**Yes**' and press <**ENTER**> to save the calibration.

AI.2.1.7 BAROMETRIC PRESSURE

1. BAROMETRIC PRESSURE VERIFICATION:

   a. From the Main Menu, select 'Maintenance' and press <**ENTER**>, then select "Monitor" and press <**ENTER**>. This screen will display the values for the Ambient, Meter, Filter, and Inactive thermometers, and Barometer.

   b. Record the Make, Model, ID Number, Certification Date and Certification Factors for the pressure standard on the calibration datasheet, or laptop calibration program.

   c. Read and record the pressure reading from the pressure transfer standard and from the sampler in mm Hg. If the difference between the sampler barometer and the calibration barometer is greater than +/- 5 mm Hg, the sampler barometer must be recalibrated.

   d. Repeat step 3, using the syringe apparatus as described in Pressure Drop Verification (AI.2.1.6.1.1), to produce a pressure 30 mm Hg above and again 30 mm Hg below ambient as indicated on the pressure gauge (+/- 5 mm Hg).

2. BAROMETRIC PRESSURE CALIBRATION:

   a. Select '**Barometer**' from the '**Calibrate**' menu and press <**ENTER**>. Connect one end of the 1/8" surgical rubber tubing to the Ambient/Calibrate port and the other end to the calibration syringe. The analyzer will ask for a pressure of 600 mm Hg. Pull the stem of the syringe until vacuum of 600 mm Hg is indicated on the pressure gauge. When the pressure value is stable on the pressure gauge, Press the <**ENTER**> key. The system will read 100 pressure measurements.

   b. Next the sampler will ask for a pressure of 800 mm Hg. Push the plunger of the syringe in until the pressure in the sampler is increased to

800 mm Hg. When the value on the pressure gauge stabilizes press the <**ENTER**> key. The system will collect 100 pressure measurements.

c. The calibration screen will now display the Gain, Offset and current barometric pressure. Record the Gain, Offset, and current pressure on the calibration worksheet. Press the <**CANCEL**> key to continue.

Select '**Yes**' if you want to save the pressure calibration, and press <**ENTER**>.

d. Perform the three-point procedure described in Barometric Pressure Verification (AI.2.1.6.2) to verify the barometer calibration.

AI.2.1.8 FLOW RATE

If any temperature or pressure sensors required calibration in the procedures described above, it is recommended to proceed with the three-point calibration outlined below due to the time required to verify and calibrate this sampler using the DGM.

The flow rate of the Andersen Sequential sampler must be 16.7 LPM in order to correctly select particulate matter smaller than 2.5 microns in diameter. The purpose of the flow rate calibration is to ensure that the sampler draws the correct volumetric air flow rate. Section 8.5 of the Andersen manual discusses the sampler flow calibration. The Andersen sequential sampler is flow calibrated by testing the volume of air at three points using a NIST-traceable DGM. The relationship between flow and volume is:

Volume = Flow x Time.

Volume is reported in cubic meters (M^3). The relationship between cubic meters and liters is:

$1\ M^3 = 1000$ liters.

1. FLOW RATE CALIBRATION

In this calibration procedure, it is recommended to pull a volume of 0.5 M^3 through the sampler for each point of the calibration. At 16.67 LPM, the sampler should run for 30 minutes. The flow rate for the second calibration point is

18.3 LPM for at least 27 minutes, and the flow rate for the third point is 15.0 LPM for at least 33 minutes.

a. The Andersen flow is tested by placing the leak test adapter at the inlet of the sampler, opening the valve, and attaching the leak test adapter to the reference DGM with thick walled 1/2" OD surgical rubber tubing. Place a filter in the filter holder, select filter position, and make sure the filter has been properly engaged by the automated sampling system. Choose the '**Dry Gas Meter**' selection from the '**Calibrate**' Menu. Press <**ENTER**>.

b. Record the reference DGM ID number, calibration date, calibration coefficient, initial reading, and temperature on the calibration worksheet.

c. When prompted, enter the reference DGM meter calibration coefficient. This value can be found on the calibration report that accompanies the reference DGM and on the reference DGM itself.

d. Next, enter the initial volume on the reference DGM in M^3. Press the <**ENTER**> key.

e. The Andersen sampler will ask for the DGM temperature. Read the temperature from the thermometer located on top of the DGM, and enter that value into the display. Press the <**ENTER**> key to continue. The pump will start and draw air through the sampler. The sampler should be run for at least 30 minutes. If the sampler is operated for 30 minutes at 16.67 LPM, it will draw the recommended 0.5 M^3 for this calibration point.

f. After 30 minutes press <**CANCEL**>, the pump will stop, and the display will prompt you for the reference DGM reading. Enter the volume reading into the sampler and press <**ENTER**>. Enter the final volume and temperature on the calibration worksheet, or onto the laptop calibration computer program.

g. Finally, the sampler will ask you for the ending temperature of the reference DGM in ^oC. Type this value into the sampler display, and press <**ENTER**>.

h. The sampler calibration procedure will prompt you to repeat steps 4 through 7 for flow rates of 18.3 and 15.0 LPM. In each case, operate the pump until greater than 0.5 M^3 of air are drawn through the sampler.

i. After the three calibration volumes have been entered, the system will display a screen that shows the calibration factor for the DGM. The display will show the number of cc/tick, the system flow rate, and the Reference Coefficient. Enter this data at the appropriate location on the calibration report form. Press <**CANCEL**> to continue.

j. The system will ask if you want to save the calibration. Select 'Yes' to save the calibration, and press <**ENTER**>.

k. The flow calibration is now complete.

2. POST CALIBRATION FLOW RATE VERIFICATION

Refer to the Flow Rate Verification procedure listed in AI.2.1.3 to check the post calibration flow rate.

AI.2.1.9 CLOCK/TIMER VERIFICATION

Units of time are used in several aspects of sampler operation. Examples are the start and stop times, volume/flow calculations, run dates, etc. Therefore, it is necessary to document the time setting of the sampler.

Observe the sampler time from the Main Menu, choose 'View Run', then 'Current Sample'. Press <**ENTER**> until you reach the last of 3 screens. The last screen will contain the current sampler time. Enter this value onto the calibration datasheet. At the same time, enter the value of your time keeping device. Identify your time-keeping device on the calibration datasheet.

Include the make, model, ID number, date last certified, and bias of your clock.

The requirement in 40 CFR Part 50, Appendix L, Section 7.4 states that the sampler must not lose more than one minute per month.

If the sampler is greater than 10 minutes from true time, reset the system clock.

To reset the clock, from the Main Menu select 'Configure', then "Set Clock" and press <**ENTER**>. Enter the correct time to $\pm$1 minute from true. Enter the corrected time on your calibration datasheet.