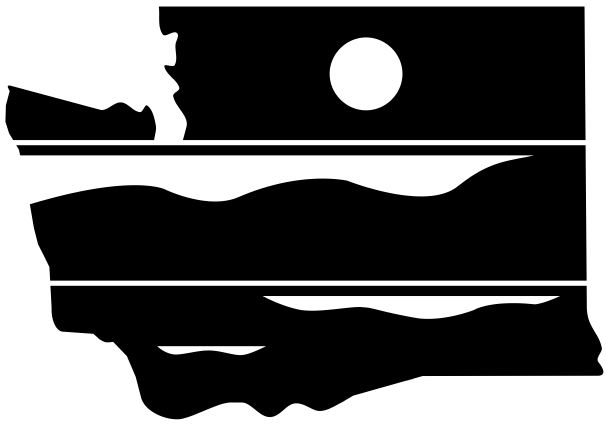

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

$PM_{2.5}$ Single Channel Sampler Procedure

Air Quality Program

February 2000

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State of Washington
Department of Ecology
Air Quality Program

$PM_{2.5}$ Single Channel Sampler Procedure

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February 2000

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1 INTRODUCTION

This document describes the procedures used to sample $PM_{2.5}$ (particulate matter that has an aerodynamic diameter of 2.5 micrometers or less) by the Washington State Department of Ecology Air Quality Program. A Partisol FRM® Model 2000 Single Channel Sampler draws a known volume of ambient air at a constant flow rate throu gh a size-selective inlet followed by a WINS Impactor (particle size separator). Particles in the $PM_{2.5}$ size range are then collected on a Teflon® filter during a specified 24 -hour sampling period. Each sample filter is weighed before and after sampling to determine the net weight (mass) gain of the collected $PM_{2.5}$ sample. This mass concentration is reported as micrograms per cubic meter at ambient conditions. The reference method for $PM_{2.5}$ sampling is given in the Code of Federal Regulations (40 CFR 50 , Appendix L).

This document is intended to be used together with the sampler -specific information and instructions provided by the manufacturer of the $PM_{2.5}$ sampler in the sampler's operation or instruction manual.

1.1 Principles of Operation.

Figure 1.1 is a schematic drawing showing the inlet head of the $PM_{2.5}$ sampler. The inlet is designed to remove particles with aerodynamic diameter greater than 10 μm and to send the remaining smaller particles to the next stage. Figure 1.2 depicts the WINS impactor that removes particles greater than 2.5 μm and allows 2.5 μm in diameter and smaller particles to be collected on a Teflon® filter surface. The design flow rate through the inlet is 16.7 liters per minute.

The Partisol FRM® Model 2000 Single channel A ir Sampler uses a filter cassette mounted in a single-filter tray for easy filter exchange and transport. The tray minimizes the chances of fingers coming into contact with the sample filter.

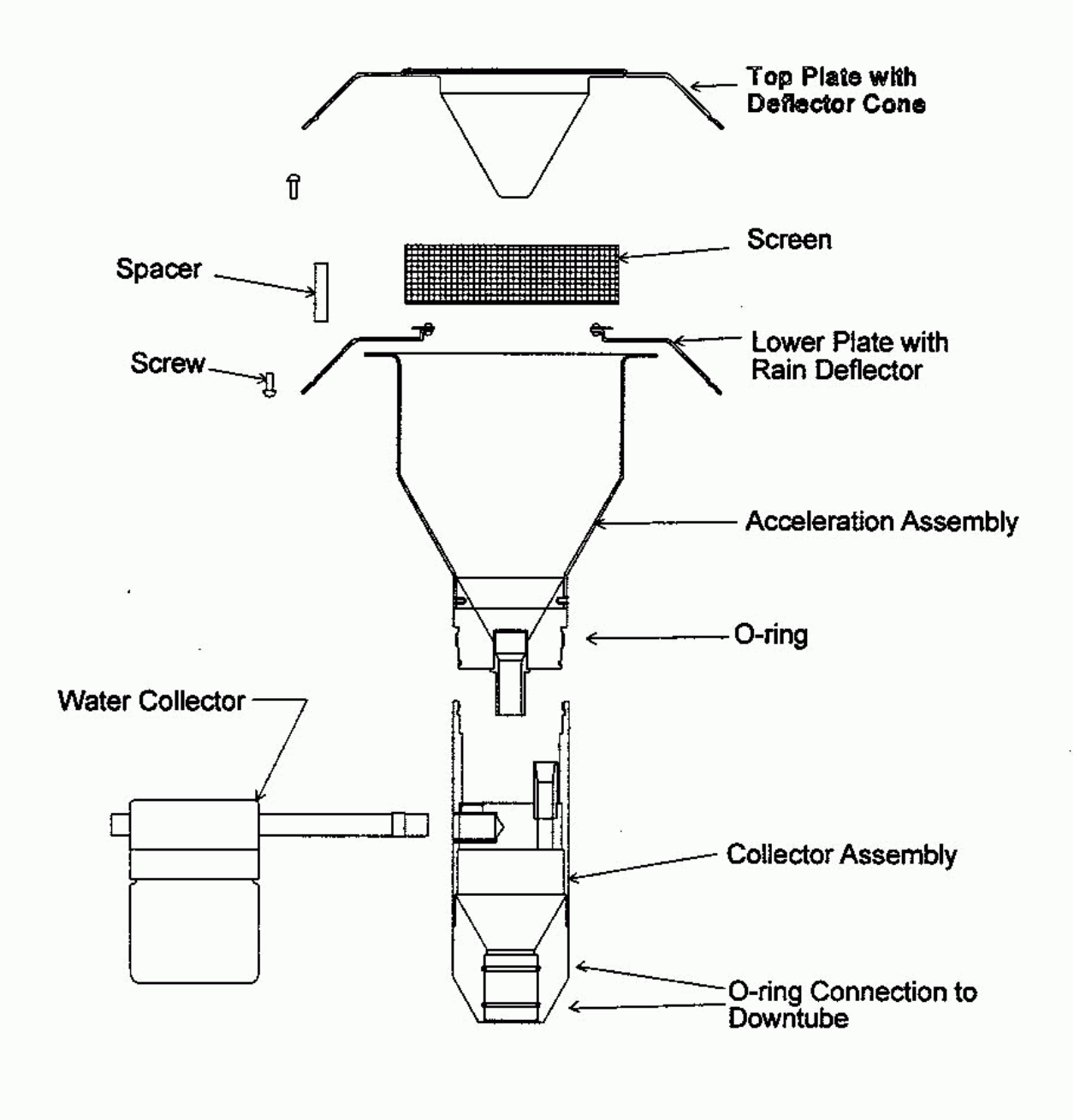

Figure 1-1 Exploded Cross-Sectional View of The $PM_{2.5}$ Sampler Inlet Head

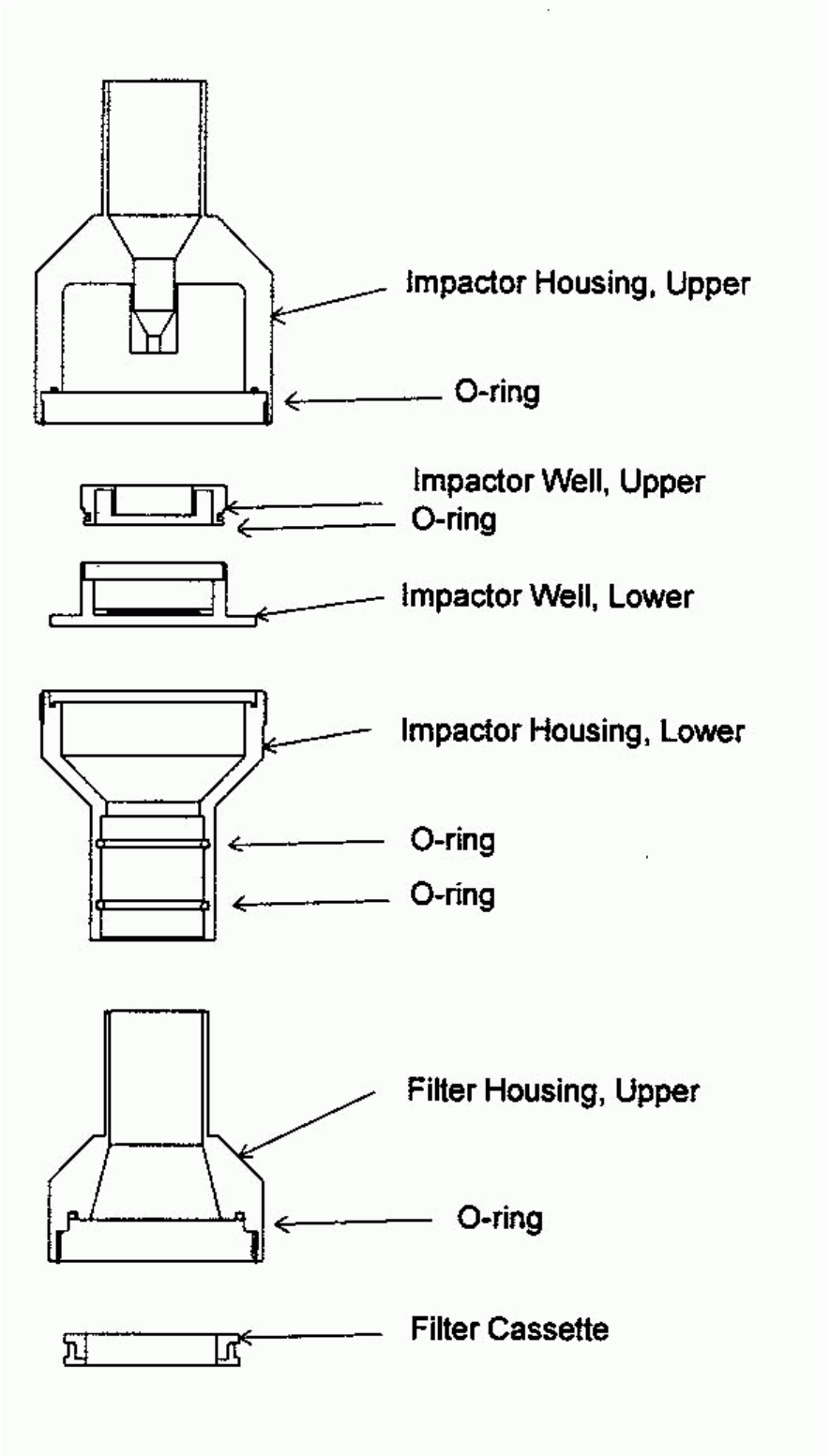

Figure 1-2 Exploded Cross-Sectional View of The $PM_{2.5}$ Impactor Well and Filter Holder

2 EQUIPMENT & SUPPLIES

- Partisol FRM Model 2000 Single Channel Air Sampler.
- Additional sampler parts and supplies consisting of WINS impactors, impactor oil, 37mm glass impactor filters, filter cassettes, inlet O-rings, filter carrier/trays.
- 47mm Teflon filters.
- Filter carrier transportation cooler equipped with thermometer.
- Calibration equipment as defined in Section 3.0.
- Laboratory equipment as defined in Section 5.0.
- Miscellaneous hand tools, miscellaneous sampler spare parts including additional gaskets/seals, soft brushes and cotton swabs, calculator, Kimwipes, and worksheets.
- Logbook

3 CALIBRATION & VERIFICATION PROCEDURES

This section describes the procedures involved in verifying and calibrating the temperature, pressure and flow sensors incorporated in the Partisol FRM Model 2000 Sampler. In addition, this section describes the procedure for performing a leak check. Requirements for calibration of sampling network by U.S. EPA can be found in 2.12 Quality Assurance Handbook, Section 6.

Because $PM_{2.5}$ concentration standards are not available for determining calibration relationships, individual components of the sampling method must be calibrated to ensure integrity of reported data.

3.1 Discussion Of Flow-Rate Measurement And General Aspects Of The $PM_{2.5}$ Single Channel Air Sampler Calibration

The sampler's mass flow controller operates under the control of the sampler's microprocessor and maintains the sample air stream at a constant volumetric flow rate of 16.67 L/min. through the use of ambient temperature and pressure sensors.

The calibration of the mass flow controller is achieved by calibrating the flow rate with a NIST traceable flow device. The temperature sensor is calibrated with a NIST traceable thermometer while the pressure sensor is calibrated using a barometer traceable to a laboratory grade Fortin mercury barometer.

If there is a data logger on the site then it will be used to maintain and verify accurate time on the Partisol FRM Model 2000 samplers. Otherwise the time on the telemetry system time will be used to maintain and verify accurate time on the Partisol FRM samplers.

3.2 Basic Calibration Procedure For A Partisol FRM Model 2000 Single channel Air Sampler

3.2.1 Calibration Equipment

- A flow rate transfer standard (bubble meter, orifice) with proper calibration traceable to NIST. The flow rate transfer st andard must have an accuracy of ±2%.
- An associated manometer with a 0 to 10 inch range and minimum scale divisions of 0.1 inches.
- A thermometer capable of accurately measuring temperature over the range of -30 to 50°C (243 to 323°K) to the nearest ± 0.1°C and referenced to an NIST thermometer within ± 0.5 °C at least annually.
- A portable, aneroid barometer (e.g., a climber's or engineer's altimeter), capable of accurately measuring ambient barometric pressure within ± 1 mm Hg resolution and referenced within ±5 mm Hg to a barometer referenced to a NIST standard.
- Sampler Calibration Data Sheet, Table 4-2.
- A clean filter

3.2.2 Verification Procedures

The following describes the procedures involved in verifying the calib ration of the Partisol FRM Model 2000 Sampler.

Note: It is important that the verification described in this section be performed in the order presented.

The sampler allows access to the Audit Screen used in the verification procedures in this section only if it is in the "**Stop**" mode, as shown in the upper right-hand corner of the Main Screen on the sampler.

To verify any parameters while in the **Sampling** or **Wait** Modes, press <F4: Run/Stop> > to switch to **Stop** mode.

3.2.3 Verifying Ambient Air Temperature

Perform a verification of the ambient air temperature in the **Audit** mode in the following manner:

1) Press <F5: Audit> when in the Setup Screen to access the Audit Screen.

2) The ambient temperature sensor is located in the radiation shield mounted on the side of the unit. Determine the current temperature (°C) at the ambient temperature sensor positioned on the sample tube of the hub using an external thermometer

3) Verify that the value for temperature displayed for "Temperature" in the Audit Screen is within ±4°C of the measured temperature.

If this is not the case, perform the temperature calibration procedure described in Section 3.2.5.

3.2.4 Calibration Procedures

It is important that the procedures described in this section be performed in the order in which they appear.

To calibrate any parameter, the sampler must be in **Stop** mode, press <F4: Run/Stop> to switch to **Stop** mode.

3.2.5 Ambient Air Temperature Calibration

Calibration of the Partisol FRM is done only in the **Stop Operating** Mode.

Perform calibration of the ambient air temperature in the following manner:

1) Press ESC until the Main Screen appears.

2) The sampler must be in the "Stop" operating mode to perform a temperature calibration. If the sampler is currently in the "Run" operating mode, a s shown in the upper right-hand corner of the Main Screen, press <F4: Run/Stp> to enter the "Stop" operating mode.

3) Press <F5: Setup> and then press <F2: Calib> when in the Main Screen to access the Calibration Screen

4) The ambient temperature sensor is located in the radiation shield mounted on the side of the unit. Determine the current temperature (°C) at the ambient temperature sensor mounted on the sample tube of the sampler using an external thermometer.

5) Press <F1: Edit> to enter the Edit Mode, and move the cursor to the "Act" (actual) column in the row labeled "AmbT."

6) Enter the current ambient temperature (°C) and press <ENTER> to leave the Edit Mode. Use the <F6: +/-> (Shift F1) key to enter negative temperatures when in the Edit Mode.

7)When the actual temperature is entered, the system's microprocessor automatically computes "Span" for the ambient temperature. Note this number in the logbook for future reference.

NOTE: If the instrument has been reset and you have recorded the value of "Sp an" for the ambient temperature, you may enter it directly in the "Span" column when in the Edit Mode.

3.2.6 Verifying Filter Temperature

Perform the filter temperature verification in the following manner:

1) Press <F5: Audit> when in the Setup Screen to access the Audit Screen .

2) Determine the current temperature (°C) at the location of the sample filter in the Sampler using an external thermometer.

3) Verify that the value for temperature displayed for "Filt Temp" in the Audit Screen is within ±4 °C of the measured temperature.

If this is not the case, perform the filter temperature calibration procedure described in Section 3.2.7.

3.2.7 Filter Temperature Calibration

Perform filter temperature calibration in the following manner:

1) Press ESC until the Main Screen appears.

2) The sampler must be in the "Stop" operating mode to perform a temperature calibration. If the sampler is currently in the "Run" operating mode, as shown in the upper right-hand corner of the Main Screen, press <F4: Run/Stp> to enter the "Stop" operating mode.

3) Press <F5: Setup> and then press <F2: Calib> when in the Main Screen to access the Calibration Screen

4) Determine the current temperature (°C) at the location of the sample filter in the Sampler using an external thermometer.

5) Press <F1: Edit> to enter the Edit Mode, and move the cursor to the "Act" (actual) column in the row labeled "FltT."

6) Enter the current ambient temperature (°C) and press <ENTER> to leave the Edit Mode. Use the <F6: +/-> key to enter negative temperatures when in the Edit Mode.

7) When the actual temperature is entered, the system's microprocessor automatically computes "Span" for the filter temperature. Note this number in the log book for future reference.

NOTE: If the instrument has been reset and you have recorded the value of "Span" for the ambient temperature, you may enter it directly in the "Span" column when in the Edit Mode.

3.2.8 Verifying Ambient Pressure

Verify the ambient pressure in the following manner:

1) Press <F5: Audit> when in the Setup Screen to access the Audit Screen.

2) Determine the current ambient station pressure in mm Hg (absolute pressure, not corrected to sea level).

3) Verify that the value for "Amb Pres" in the Audit Screen is within ±10mm Hg of the measured ambient pressure.

If this is not the case, perform the pressure calibration procedure described in Section 3.2.9.

3.2.9 Ambient Pressure Calibration

Perform ambient pressure calibration in the following manner:

1) Press ESC until the Main Screen .

2) The sampler must be in the "Stop" operating mode to perform a temperature calibration. If the sampler is currently in the "Run" operating mode, as shown in the upper right-hand corner of the Main Screen, press <F4: Run/Stp> to enter the "Stop" operating mode.

3) Press <F5: Setup> and then press <F2: Calib> when in the Main Screen to access the Calibration Screen.

4) Determine the current ambient station pressure in mm Hg (absolute pressure, not corrected to sea level).

5) Press <F1: Edit> to enter the Edit Mode, and move the cursor to the "Act" (actual) column in the row labeled "Pres."

6) Enter the current ambient pressure (mm Hg) and press <ENTER> to leave the Edit Mode.

7) When the actual pressure is entered, the system's microprocessor automatically computes "Span" for the ambient pressure. Note this number in the logbook for future reference.

NOTE: If the instrument has been reset and you have recorded the value of "Span" for the ambient pressure, you may enter it directly in the "Span" column when in the Edit Mode.

3.2.10 External Leak Check

Perform a leak test on the sampler as described below. To ensure leak tightness, a filter cassette containing a new 47 mm filter must be installed. Press <F5: Audit> when in the Setup Screen to access the Audit Screen.

1) Carefully remove the 1st. stage size-selective inlet from the sampler.

2) Install a filter cassette containing a new 47 mm filter.

3) Install the Flow Audit Adapter on the end of the sample tube.

4) Turn on the flow valve by pressing <F2: Valve> when in the Audit Screen

5) Turn on the pump by pressing <F3: Pump>.

6) Shut off the valve on the Flow Audit Adapter.

7) Shut off the flow to the flow controller assembly by turning the manual shut off valve attached to the large air filter on the left side of the manifold in the hub.

8) Record the reading on the vacuum gauge once it is stable. This should read at least 15" (381 mm Hg).

NOTE: To convert from inches Hg to mm Hg, multiply by2.54.

9) Shut off the flow to the pump by turning the other manual shut off valve (pump manual valve) located on the bottom of the manifold in the hub.

10) Record the reading on the vacuum gauge 30 seconds after the pump valve is closed. This reading should not drop more than 8.5 inches of Hg during this 30 second period. This corresponds to a leak of 80 ml/min. If this is not the case, trace the internal (and external) flow paths to identify problems in tubing or connections.

11) Open the flow controller manual valve and pump manual valve that were closed in steps 7 and 9 above.

12) Open the valve of the Flow Audit Adapter, and remove this hardware from the sampler being checked. Replace the size-selective inlet.

3.2.11 Internal Leak Check

Perform an internal leak test of the Partisol FRM Sampler in the manner described below.

NOTE: To ensure that there are no leaks a filter cassette containing a 47mm Leak Check metal disk must be installed in the hardware.

1) Clean the leak check disk with cloth and alcohol to remove any oil or other material. Reassemble the cassette and place the metal disk in it and then insert the filter cassette containing a leak check disk into the sampling position.

2) Turn on the flow valve by pressing <F2: Valve> when in the Audit Screen.

3) Turn on the pump by pressing <F3: Pump>.

4) Shut off the flow to the flow controller assembly by turning the manual shut off valve attached to the large air filter on the left side of the manifold in the hub.

5) Shut off the flow to the pump by turning the other manual shut off valve (pump manual valve) located on the bottom of the manifold in the hub. Turn off the pump by pressing <F3: Pump>.

6) This reading on the vacuum gauge 30 seconds after the pump valve is closed must be recorded in the Table 4-4 This reading should not drop more than 8.5 inches of Hg during this 30 second period.

7) Press <F2: Valve> and open the flow control manual valve and the pump manual valve.

8) Remove the leak check disk from the filter cassette.

3.2.12 Flow Verification

Flow verification must be done after the temperature verification, pressure verification and external leak check has been performed. Perform the flow verification procedure below in the following manner:

1) Press <F5: Audit> when in the Setup Screen to access the Audit Screen.

2) Install a filter cassette containing a new 47 mm filter into the filter holder of the sampler. This filter will be thrown away at the end of this flow audit.

3) Carefully remove the size-selective inlet from the sampler.

4) Install the Flow Transfer Standard to the end of the sample tube of the sampler, with its valve open.

5) If using the FTS confirm that the FTS calibration constants m and b are entered in the Setup Screen. Press <ESC> to display the Setup Screen and press <F1 : EDIT>. Scroll down to the FTS CONST m field and enter the m and b constant from the FTS Calibration sheet and press Enter.

6) Press <F5:Audit> to return to the Audit Screen.

7) Turn on the pump by pressing <F3: Pump>, and then press <F2:Valve>.

8) If using the Flow Transfer Standard, press <F1: Edit>, then enter the pressure drop (inches H_2O), press Enter. The sampler will automatically calculate the flow in l/min.

7) Determine the flow in units of actual (volumetric) l/min using the external flow meter and verify that it matches the value displayed for flow in the "Calc" column of the Calibration Screen to within ±4%. Record in the Table 4-4 $PM_{2.5}$ 2000 Sampler QC Check Data Sheet. If this is not the case, perform the flow calibration procedure described in Section 3.2.13.

8) Return to the Main Screen by pressing <ESC> twice.

9) Restore the sampler to its original state by removing the flow metering hardware and re-installing the size selective inlet on the sample tube of the hub. Remove the filter cassette, and throw away the filter installed in it.

3.2.13 Flow Calibration

Perform the temperature calibration, pressure calibration and leak checks described above before executing the flow calibration procedure below. Flow calibration is required whenever the sampler has been transported or any electormechanical maintenance has been performed or if the flow deviates from the set flow by ± 4%. The sampler must be calibrated once per calendar year.

3.2.13.2 Five Point Flow Calibration

Perform the five-point flow calibration in the following manner:

1) Return the sampler to the Main Screen.

2) The device must be in the "Stop" operating mode to perform a five point flow calibration. If the sampler is currently in the "Run" operating mode, as shown in the upper right-hand corner of the Main Screen, press <F4: Run/Stp> to enter the "Stop" operating mode.

3) Carefully remove the size-selective inlet from the sampler.

4) Install a filter cassette containing a 47 mm filter into the filter holder of the sampler. This filter will be thrown away at the end of this flow calibration.

5) Display the Flow Calibration Screen by pressing <F5: Setup> and then press <F2: Calib> and then press <F2: FlowCal> when in the Main Screen.

6) If using the Flow Transfer Standard install the FTS to the end of the sample tube of the sampler, with its valve open.

7) Confirm that the FTS calibration constants m and b are entered in the Setup Screen. Press <ESC> to display the Setup Screen and press <F1 : EDIT>. Scroll down to the FTS CONST m field and enter the m and b constant from the FTS Calibration sheet and press Enter.

8) Press <F2:Calib> to begin the five-point flow calibration.

9) With the pump turned off, the sampler first computes the Flow Offset value before automatically starting the span calibration using five flow rates around the default sample flow rate of 16.7 l/min.

10) Determine the flow in actual l/min using the external flow meter. If using the Streamline FTS Flow Transfer Standard, enter the pressure (inches H_2O) in the FTS Pres field by pressing <F1:Edit>, input the value using the keypad, press Enter. The sampler will calculate the volumetric flow in l/min.

11) The unit then operates at flow rates of 16.7, 17.5, 15.8, 18.3 and 15.0 l/min. in succession. If using the Streamline FTS Flow Transfer Standard, the sampler will automatically enter the calculated flow into the ACT field and compute "Span" which is the span offset for the mass flow controller. Note the span in the logbook for future reference.

12) If using another flow measurement device the operator must manually enter the volumetric flow in the ACT field by pressing <F1: Edit> to enter the Edit Mode, and move the cursor to the "Act" (actual) column in the row labeled "Flow."

13) Enter the flow determined by the external flow meter and press <ENTER> to leave the Edit Mode. This causes the microprocessor to compute "Span ," which is the span offset for the mass flow sensor. Note this number in the log book for future reference.

NOTE: If the instrument has been reset and the value of "Span" for the ambient pressure has been recorded, it can be directly entered in the "Span" column when in the Edit Mode.

14) Return to the Main Screen by pressing <ESC> three times.

15) Restore the sampler to its original state. Remove the filter cassette from the sampler and discard the installed filter.

3.3 Sampler Calibration Frequency

To ensure accurate measurement of the $PM_{2.5}$ concentrations, calibrate $PM_{2.5}$ samplers upon receipt. Table 3.1, Table 3.2 and Table 3.3 below summarize the calibration, verification and maintenance frequencies. Table 3.2 and 3.3 are to be used for quality control purpose and kept on site.

Table 3-1 Calibration And Verification Check Intervals

Parameter	Recommended interval
Single point flow rate verification	Every 4 weeks
Flow rate multi-point verification	On installation, then annually or when one point failure
Flow rate Calibration	If multi-point verification failure

Temperature verification (Ambient air inlet sensor and filter temperature sensor	Every 4 Weeks
Temperature Calibration	On installation, If verification failure and annually
Pressure verification	Every 4 weeks
Pressure calibration	On installation, then annually or if out of specs.

The sampler also needs to be calibrated after any electromechanical repairs that might affect sampler calibration and if the sample r is transported.

Table 3-2 $PM_{2.5}$ 2000 Sampler Annual Performance And Maintenance Check Sheet

	Frequency	Jan		Feb		Mar		April		May		June		July		Aug		Sept		Oct		Nov		Dec		Acceptance Criteria
One Point Flow Rate Verification	Once in 4 Weeks																									± 4% of the Transfer Standard
Flow Rate multi-point Verification	1/Year Or if One Point Failure																									± 4% of the Transfer Standard
Flow Rate Calibration	If Multi-Point Failure																									± 4% of the Transfer Standard
Temperature Multi-point Verification	1/Year																									± 2°C of Standard
Temperature Calibration	If Multi-Point Failure																									± 2°C of Standard
Pressure Verification	Once in 4 Weeks																									± 10 mm Hg
Pressure Calibration	1/Year																									± 10 mm Hg
Clock/timer Verification	Once in 4 Weeks																									1 min/month
Disassemble, Inspect and Clean Sample Inlet	Once in 4 Weeks																									
Clean Interior of Sample Case	Once in 4 Weeks																									

Table 3-3 $PM_{2.5}$ 2000 Sampler Quarterly Performance And Maintenance Check Sheet

Parameter	**Frequency**	**Initial and date boxes after each check is completed**																		**Nominal Value**
External Leak Check	Every 5 Sampling Events																			80 ml/min 8.5” Hg/ 30 seconds
Internal Leak Check	Annually & after major maintenance																			80 ml/min 8.5” Hg/ 30 seconds
One-point Temperature Verification	Once in 4 Weeks																			± 4°C of Standard
Water Collector Bottle Inspection	Every 5 Sampling Events																			
Impactor Well Cleaning and Oiling	Every 5 Sampling Events																			

4 FIELD OPERATIONS

This section presents information pertinent to the routine operation of a $PM_{2.5}$ sampling site. It covers an array of topics, ranging from initial site selection to final data documentation.

4.1 Siting Requirements

4.1.1 Probe Height

4.1.1.1 Microscale

The sampler inlet for microscale $PM_{2.5}$ samplers must be 2-7 meters above ground level.

4.1.1.2 Middle or larger scale

The required height of the air intake for middle or larger scales is 2-15 meters.

4.1.2 Horizontal Spacing for Obstructions

4.1.2.1 Microscale

- A minimum of 2 meters separation from walls, parapets, penthouses etc. No furnaces or flues should be nearby.
- The sampler must be at least 10 meters from the dripline of trees and if possible it is recommended that the sampler be placed 20 meters from the dripline.
- The sampler must be located away from obstacles such as buildings and trees that act as an obstruction, so that the horizontal distance between the obstacles and the sampler is at least twice the height that the obstacle protrudes above the sampler. For example, if the obstacle protrudes 15 meters above the sampler then the distance between the obstacle and the sampler must be at least 30 meters.
- There must be an unrestricted airflow in an arc of at least 270-degree around the sampler except for street canyon sites.

4.1.2.2 Middle or larger scale

Stations not meeting these criteria may be classified as **micro** or **middle** scale.

4.1.3 Spacing from Roads

4.1.3.1 Microscale: For microscale station, the sampler must be between 5 and 15 meters from the major roadway. For a street canyon site the location must be between 2 and 10 meters from the roadway.

4.1.3.2 Middle scale and Neighborhood scale: Figure 4.1 provides guidance on the recommended sampling distances from the paved roads with different levels of average daily traffic.

4.1.4 Spacing from nearby sources and other Considerations

- Stations should not be located in an unpaved area unless there is vegetative ground cover year - round.
- In case of emissions from a chimney resulting from natural gas combustion, the sampler should be placed at least 5 meters from the chimney.
- Samplers should not be located within 100 meters of residential wood burning appliances.

4.1.5 Other Requirements

Table 4-1 presents basic siting criteria for the placement of the $PM_{2.5}$ sampler. This is not a complete listing of siting requirements. Instead, it should be used as an outline to determine a sampler's optimum location. Complete siting criteria are presented in 40 CFR 58, Appendix E.

Several additional factors must also be considered in determining where the sampler will be deployed. These include accessibility under all weather conditions, availability of adequate and stable power, and security of the sampling personnel and equipment. The site should be able to provide sufficient power for the primary sampler, a collocated sampler and an FRM performance evaluation sampler.

The sampler must be situated where the operator can reach it safely despite adverse weather conditions. If the sampler is located on a rooftop, care should be taken that the operator's personal safety is not jeopardized by a slippery roof surface during inclement weather. Consideration also should be given to the fact that routine operation (i.e., calibrations, filter installation and recovery, flow checks, and audits) involves transporting supplies and equipment to and from the sampling site.

The security of the sampler itself depends mostly on its location. Rooftop sites with locked access and ground-level sites with fences are common. The security of the operating personnel, as well as that of the sampler must always be considered.

Table 4-1 Minimum $PM_{2.5}$ Sampler Siting Criteria

Scale	Height Above Ground (Meters)	Vertical and Horizontal Distance from supporting structure (Meters)	Other Spacing Criteria
Micro	2 to 7	>2	Should be >20 meters from trees.
Middle, neighborhood, urban, and regional scale.	2 to 15	>2	Distance from sampler to obstacle, such as buildings, must be twice the height that the obstacle protrudes above the sampler.
			Must have unrestricted airflow 270 degrees around the sampler inlet.
			Sampler is maintained in a horizontal plane and is 2.0+/-0.2 meters above the floor or horizontal surface.
			Sampler inlet is at least 2 m but not greater than 4 m from any collocated PM_{10} sampler. (See 40 CFR 58, Appendix A.)

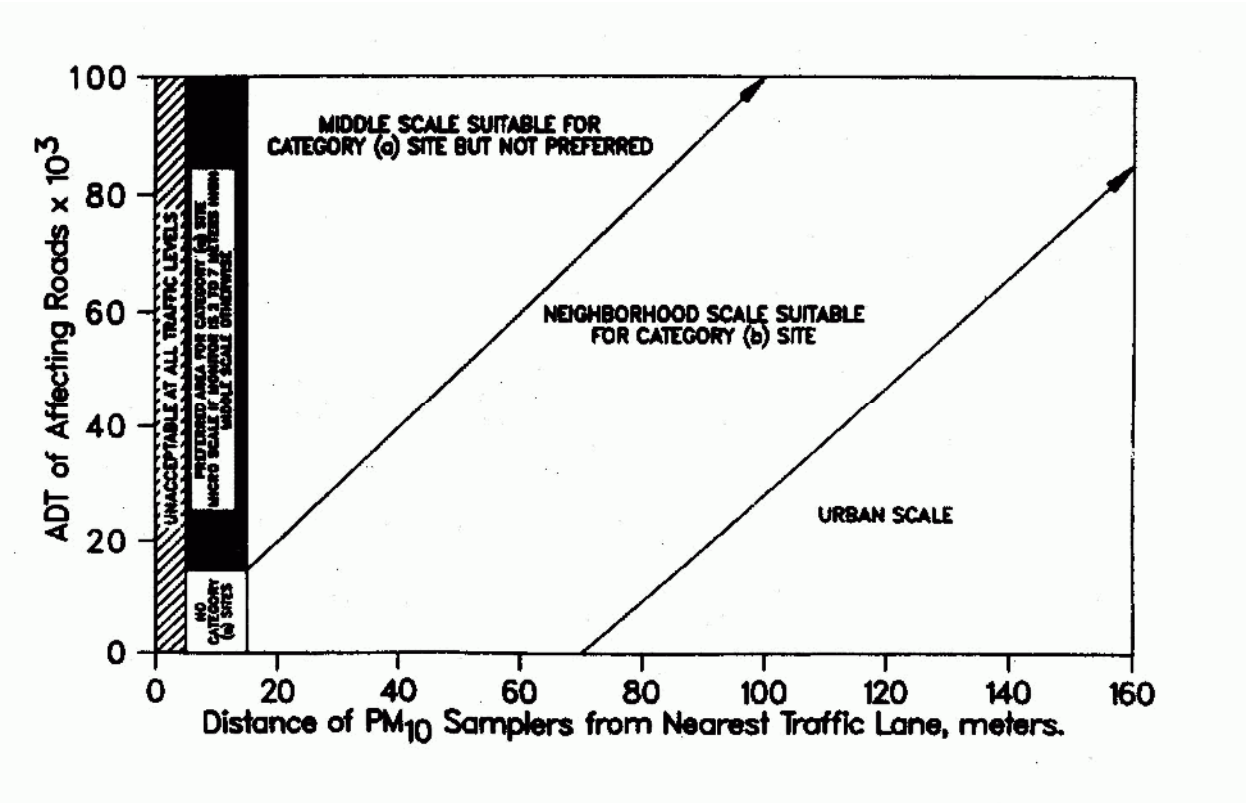

Figure 4-1 Acceptable areas for Micro, Middle, Neighborhood and urban samplers except for micro scale street canyon sites

4.2 Sampler Installation

1) On receipt of a $PM_{2.5}$ sampler, visually inspect it to ensure that all components are accounted for. Notify the laboratory immediately of any missing or damaged equipment.

2) Carefully transport the sampler to the field site. Secure the $PM_{2.5}$ sampler in its location keeping it level.

3) Install the sampler inlet on the base unit and check all tubing and power cords for crimps, cracks or breaks

4) Turn on the sampler and perform a leak test with a filter in the filter cassette.

5) Allow the sampler to run and equilibrate with ambient conditions for about 15 minutes and calibrate the sampler as discussed in the section on Calibration Procedures.

6) Fill out the initial Calibration form.

4.3 Sampling Operations and Programming Sampler Setup

This section discusses the steps for programming the sampler for a sampling run.

1) Fill out top portion of run data sheet with information related to the sample collection such as site location or identification number, date and time of sampler setup visit, sample st art date, filter ID (ID1) and Station ID (ID2) number. The run data sheet is shown in Table 4-3 and the operator will receive it with the filter cassette and this will be the chain of custody sheet.

2) Ensure that the sampler is not operating and that there is enough time available to complete setup procedures before its automatic start. If the sampler is not in the Stop Mode, press <F4:Run/Stop> in the Main Screen.

3) Inspect the records of the sampler and the Sampler Annual Perform ance, Quarterly Performance and Maintenance Check Sheet in Tables 3.1, 3.2, 3.3 and 7.1. Perform the scheduled maintenance, verification and calibration activities. The verification and calibration procedures are described in Section 3. Keep a record of t he activities performed in the logbook.

4) After the performance verification is complete, return to the Main Screen by pressing <ESC> twice. Press Run/Stop in the Main Screen to enter the Stop Mode. The sampler must be in a STOP mode to enter a sampling pro gram.

5) Select a sample filter from the lot provided by the laboratory and use filters in sequential order and ensure that the sample date for the specified filter will occur within 30 days of the filter tare weighing. In addition, take at least one spare fi lter. To install a clean, unused 47 mm filter, lift the handle of the filter exchange mechanism in the Sampler into its upward position to expose the area in which the filter cassette is installed. If a filter is currently installed in the sampling unit, remove the filter cassette with its filter installed, and place it immediately into its box. A groove in the filter holding mechanism allows the operator to gain better access to the filter cassette for removal. Take the new filter cassette with its unus ed filter installed out of its box,

and place it carefully into the lower part of the filter holding well of the filter exchange mechanism. The carrier contains a slot and hole that fit into the appropriate locations of the lower part of the filter exchange mechanism. The enclosure of the sampling station serves as a good storage location for the box of the filter currently in use. Close the filter exchange mechanism.

NOTE: Make sure that the filter installed and the filter ID # entered on the Field data sheet correspond.

6) To program the sampler for midnight to midnight sampling In Press <F5: SETUP> to access the Setup Screen. and then confirm that the correct time, date and set flow rate are displayed on the Setup Screen. If not, reset the sampler by pressing <F1:Edit>, then enter the correct data using the keypad. Press ENTER.

7) Press <ESC> to return to the Main Screen, then <F1:Setup> to enter the Filter Setup Screen.

8) Press <F1:EDIT>, then enter the sample run start time and start date, ID1 is filter I D #'s and ID2 is Station ID# and press ENTER. Press <ESC> to return to the Main Screen.

9) If the filter cassette magazine has a blank filter, then after entering the filter ID#,

10) The sampler is now ready to sample

4.4 Post Sampling Verification

1) Return to the sampling site within 96 hours (4 days) of the end of the sample collection period and carefully remove the filter cassette in the carrier from the sampler by pulling on the handle of the filter exchange mechanism. Place the filter cassette with the carrier in the metal box for transportation.

2) Place the metal box in a protective covering (polyethene bag) such that the cover does not come off. Cover the box with blue ice and place it in the cooler box. After retrieval from the sampler, care must be taken to maintain the filter box as cool as possible in an ice-box and protect it from exposure to temperatures above 4 ^{0}C.

3) Check the sampling run status on the Main Screen and note if the status is other than OK. Press <F3:Data> to view the filter data from the run. Record the Total sample Time, Sampler Volume, Sample removal date/time, Sampler's indicated ambient temperature and barometric pressure, final flow rate, average flow rate, coefficient of variation of the flow rate, on the Sampler Run Data Sheet. If the status codes is other than OK, then verify the validity of the sampling run from the output of the Filter Data Screen . Press <F4:Pwr Dat> to view Power Outage Data Screen, until the filter Data Status Codes Screen appear.

4) Also record, if the flow rate, filter temperature or elapsed sample time were out of spec and if any flags triggered by the sampler. Record unusual conditions that may have affected the sample. Press <ESC> to return to the Filter Data Screen.

5) Record any comments or unusual conditions such as sampler tampering or malfunctions, construction activities, fires or dust storms on the form.

6) Install a new filter cassette with carrier and repeat steps 1 through 9 of Section 4.3 for the next sampling run.

7) Transport the metal box and store it in the refrigerator/freezer. Ship the box and the Sampler Run Data Sheet(s), in protective bag with the filter magazine, to the lab. The mailing should be done as soon as possible Monday, Tuesday, or Wednesday, using Federal Express Priority Overnight.

4.5 Data Retrieval From The Single Channel Sampler

This section discusses how to use the software RPCOMM with handheld personal computer to retrieve data from the Partisol FRM 2000 Model sampler. This section is intended to be used together with the instructions provided by the manufacturer of the $PM_{2.5}$ Single Channel sampler on their Internet site (www.rpco.com). The RPCOMM can also be downloaded from the internet.

1) Ensure communication is set up between the hand held PC and the desktop computer. Refer to the hand held PC's operating manual for additional guidance to set up a communications link between the hand held PC and desktop computer. Ensure that the communication parameter between the handheld personal computer and the sampler must agree.

2) Set up the desktop computer with Microsoft Windows CE Services software from the CD -ROM that was enclosed with the hand held PC. Follow the documentation included with the hand held PC for setting up the desktop computer.

3) Install service pack SP for Windows CE onto the hand held PC.

4) Install RPCOMM and RPData for Windows CE onto the hand held PC. When all the files have been copied, the hand held PC will display an icon for RPComm for Windows CE. RPComm for Windows CE is a program designed by R&P to download data from the Partisol FRM 2000 Model sampler.

5) To download data from the Main screen select "File" and then "Download Data". At this point, the hand held PC will ask if you would like to use the serial number of the R&P instrument for the file name. Choose "No" and then select a file name to use for storing the data. The operator should assign a name to the downloaded file that is reflective of the city and the date the download was conducted. For example, data from the Port Angeles Stevens Middle Scho ol site was downloaded on December 9th, 1999, then the file name would be "pa120999.txt". The "pa" stands for Port Angeles and the date is mm/dd/yy. For any site that has two words in its name this would be the case, such as Mt. Vernon "mv". For sites with one word in the name, the operator could simply use the first two letters so, for example, Colfax would be "co" and Ellensburg would be "el". RPComm uses .txt as a default file extension. The Download Data screen will be displayed.

6) Select "Download all records" to download all available records from the storage pointer to the end of all data records. Press "start Download" to start downloading process.

7) View the data that has been downloaded. From the Main screen, select "File" and then "Open File…". Select the file and the hand held PC will display the Data File Format screen . Select Model 2000 and the type of format of data file. Press "OK".

8) View the raw data in the format that it was downloaded from the monitor, from the Main screen press the "View Raw Data" button on the toolbar at the top of the screen. Use the scrollbar at the right side of the screen and go through the data..

9) When the operator gets back to the office, transfer all the files collected that day to the desktop computer. Storing the data permanently on the hand held PC is not recommended because of its storage limitations and the potential for losing data due to battery failure.

10) Email the data files to Sean Lundblad weekly.

4.5 QC Flow-Check Procedure

A flow rate verification check of the sampler flow rate is required every four weeks. The Sampler QC Check Data Sheet provided in Table 4.3. These check data will provide an indication of when flow limits of ±4% have been exceeded. The procedure for flow -rate verification check is described in Section 3.

Deviation of 4% or greater from the design value in flow rate during sampling require that the sample data be flagged for potential invalidation.

Changes in flow rate calibration of more than 4% as determined by a monthly f ield flow rate verification check may cause invalidation of all samples collected since the last acceptable flow rate check.

1) Record the **actual** flow rate measured by the flow verification check device and the flow rate **indicated** by the sampler.

2) Using the above information, calculate the percentage difference as:

$$\text{QC \% Difference} = \left[\frac{Ind - Act}{Act}\right] \times 100$$

3) If the sampler flow rate is within 96 to 104 percent of the measured flow rate at actual conditions and if the sampler flow rate is within 96 to 104 percent o f the design flow rate of 16.67 L/min, the sampler is operating properly.

4) If either limit is exceeded, repeat leak check procedure, as described in Section 3. Investigate and correct any malfunction and recheck the flow. If necessary, recalibrate before sampling again.

Table 4-2 Initial Calibration Form

Partisol FRM Model 2000 Single channel Air Sampler Calibration Sheet

Station ID Number	Operator Name and Initials
53	
Sampler Serial Number/State ID	Impactor Serial Number
2025A2_____/	200FA4

Instrument Calibration Constant Values:

Screen	**Assignment**	**Offset**	**Span**
Sensor Calibration	Amb Temp: Amb Pres:		
Filter Temp Calibration	Filter:		
Filter Compartment Calibration	Filter Comp:		
Flow Calibration	Flow Calib:		

Software Version: _____ Software Update _____
Signature _____ Date _____

Table 4-3 $PM_{2.5}$ 2000 Sampler Run Data Sheet

AIRS Number			
Station Name		Filter ID Number	
Station Location			
Sampler Serial #		State ID #	
Sample Date		Cassette ID Number	
Sample Removal (Date/Time)		Sample Ship Date (Date/Time)	
Operator		Operators Initials	
Ambient temp.	°C	Ambient press.	mm Hg
Start Time		Start Date	
Stop Time		Stop Date	
Total Sample Time			
Sampled Volume	m^3	Flow Rate, CV	%
Status Codes			
Average Flow Rate	l/minute		
Min. Ambient temp.	°C	Min Ambient press.	mm Hg
Avg. Ambient temp.	°C	Avg. Ambient press.	mm Hg
Max Ambient temp.	°C	Max Ambient press	mm Hg

Comments by instrument operator (Unusual conditions, weather etc.)

Area below for lab use only

Sample temp. upon receipt	°C	Sample Receipt Date	
		Time	
Gross Weight (M_f)	µg	Calculated Concentration	$\mu g / m^3$
Tare Weight (M_i)	µg		

$$\mu g / m^3 = \frac{(Mf - Mi)}{Total\ \ Volume} \times 10^3$$

Comments by laboratory analyst

Table 4-4 $PM_{2.5}$ 2000 Sampler QC Check Data Sheet

Station # _____ Date: _____

Location: _____ Time: _____

State ID # _____ Operator: _____

Thermometer Serial # _____

- Certification Date: _____

Barometer Serial # _____

- Certification Date _____

Flow Standard Serial # _____

- Certification Date: _____

QC Check

Temperature Check

Ambient

Actual _____ °C Indicated _____ °C Difference _____ °C

Filter

Actual _____ °C Indicated _____ °C Difference _____ °C

Pressure Check

Actual _____ mm Hg Indicated _____ mm Hg Difference _____ mm Hg

Flow Check

Actual _____ L/min Indicated _____ L/min % Difference _____ %

Leak Check

External Leak Check				Internal Leak Check			
Pass ☐	In. Hg _____	Fail ☐	In. Hg _____	Pass ☐	In. Hg _____	Fail ☐	In. Hg _____

$$\text{QC \% Difference} = \left[\frac{Ind - Act}{Act}\right] \times 100$$

Mail to the Quality Assurance Unit

5 LABORATORY ACTIVITIES

Precision, accuracy, and calibration procedures for the laboratory apparatus along with filter preparation and analysis are described in this section.

The microbalance will be located away from potential sources of drafts such as doors, windows, aisles with frequent traffic, ventilation ducts and equipment with fans.

47mm Teflon filters meeting the requirements specified in 40 CFR 50, Appendix L are used in the collection of $PM_{2.5}$.

5.1 Equipment And Supplies

1) Mettler MT5 Microbalance.

2) Smooth non metal forceps for filter handling

3) Petri slide dishes

4) Petri dishes (Optional)

5) Primary weight standards (NIST traceable weights with forceps)

6) Working weight standards

7) Static Deionizer

8) Cassette rings

9) Magazines

5.2 Filter Procedures

5.2.1 Filter Handling

47mm Teflon filters meeting the requirements specified in 40 CFR 50, Appendix L are used in the collection of $PM_{2.5}$.

- New filters will be placed in the conditioning environment upon arrival and stored there until the pre-sampling weighing. The filters will be handled using smooth nonmetal forceps.
- Do not fold or crease clean filters prior to weighing or use.
- Place filters in petri dish in a controlled humidity/temperature room or conditioning chamber to equilibrate for at least 24 hours before weighing. Relative humidity (RH) must be held constant with a mean value between 30 and 40%, with a variability of not more than ±5%.
- Temperature must be held constant with a mean value between 20 and 23 °C, with a variability of not more than ±2 °C. RH and temperature must be checked and recorded on equilibration days (either manually or by a hygrothermograph) to assure compliance with these guidelines.

- Record equilibration chamber malfunctions, discrepancies, and maintenance activities in the laboratory log book or database.

5.2.2 Visual Filter Inspection

Visually inspect filters for the following defects before their initial weighing. Defective filters must be rejected and returned to the manufacturer. Those defects include:

- **Pinhole** - A small hole appearing as a distinct and obvious bright point of light when examined over a light table or screen, or as a dark spot when viewed over a black surface.
- **Loose material** – If there is any loose material or dirt particles on the filter then the filter must be discarded.
- **Discoloration** - Any obvious visible discoloration that might be evidence of a contaminant.
- **Non-uniformity** - Any obvious visible non-uniformity in the appearance of the filter when viewed over a light table or black surface that might indicate gradations in porosity across the face of the filter.
- **Other** - A filter with any imperfection not described above, such as irregular surfaces or other results of poor workmanship.

5.2.3 Filter Conditioning Procedure

Filters must be conditioned prior to weighing. The lab is temperature and humidity controlled, with temperature maintained at 20 - 23 °C ±2 °C and humidity maintained at 30 – 40% RH ±5%.

- Petri dishes containing filters are left open for at least a 24-hour conditioning time period.
- A unique filter identification number will be assigned to each filter. The first two digits represent the year and the next two digits denote the week in which the filter is tare weighed. For example: A filter number 9912XXXX signifies that the filter was tare weighed in the 12 th week of the year 1999.
- Record the filter identification numbers of the filters being conditioned into the Filter Conditioning Log book or database. Record the date and time.
- After 24 hours record the end date and time. Record the minimum, maximum and average (mean) humidity and temperature readings for the 24-hour time period.

5.2.4 Initial Weighing Procedures (Tare Weight)

Filters must be weighed on an analytical balance with a minimum resolution of 0.001 mg (1 µg) and a repeatability of 1µg. Each balance must be identified by a balance number and calibrated annually.

All QC data should be recorded on the Internal Quality Control Log Sheet (Figure 5.1), a laboratory log book or database encompassing all elements of the Internal Quality Control Log Sheet.

1) Zero the balance according to manufacturer's directions.

2) Perform a QC "Standard Weight" check on the analytical balance. Two sets of Class 1 mass reference standards (100 mg and 200 mg), traceable to National Institute of Standards and

Technology, will be used for microbalance verification. One set, the "Primary Standards", will be re-certified annually; the second set, the "Working Standards", will be used during routine operations, checked quarterly against the Primary Standards, and re-calibrated as necessary. Following verification of the microbalance using the Primary Standards to within tolerances of ±3µg, weigh each Working Standard 7 times. The difference between each set of values must be ±3µg; a mean value will then be determined to be the "true" value and all subsequent weighing must be within ±3µg of the true weight.

3) Using a smooth nonmetal forceps select a conditioned filter. Place the filter over the ^{210}Po deionizing unit for 30-60 seconds to reduce static electricity. Be careful not to bump the filter against the chamber opening. Place the filter in centered on the weighing pan to avoid corner load errors.

4) Allow the microbalance to stabilize. Once the stability detector goes off, record the pre-sampling weight with the filter identification number in the Weight Log book or a computer database. Each filter will be weighed at least twice until the weights agree within 15 µg; if not, troubleshooting and reweighing are in order.

5) Carefully return the filter to the appropriate petrislide dish with the filter ID Barcode on the petri slide dish.

6) For the filters to be used at the sites, each filter will be installed in a filter cassette, marked with an assigned number and put in the filter magazine. The filters can be delivered / picked up by a field operator with the Field data sheet /Chain of Custody form. This form will have a bar-code indicating the filter identification number.

7) The pre-sampling (tare) weighing shall be within 30 days of the sampling period.

NOTE: Filters have been tare weighed in numerical sequence, with lower numbers first. Operators will use the filters in the correct numerical sequence, thereby maintaining relative consistency in time between tare and final weights for all filters. Operators will use the filter magazine with an earlier week number prior to the filter magazine with a later week number on it. For example: Use the magazine with the number 99113705 (tared in 11th week) before 99133701 (tared in 13th week)

5.2.5 Quality Control Checks During Weighing

During the filter weighing process, the following QC checks are recommended.

5.2.5.1 Laboratory Temperature and Humidity Checks

Prior to each weighing session record that the previous 24-hour mean and peak temperature and humidity values meet specifications (see section 5.1). After every 10 filters are weighed the lab conditions will be checked. If the lab conditions vary beyond the acceptance criteria for temperature or humidity a Corrective Action Report form must be completed. All the filters will be reweighed once the specified lab conditions have been re-established.

All pre-sampling filters will be weighed twice. At the end of a 10 post sampling filter weighing session, one of the filters must be selected to be reweighed. Weight should be within 10 μg of the original weight; if not, troubleshooting and reweighing are in order.

5.2.5.2 Lot Blanks, Laboratory Blanks and Field Blanks

Three types of filter blanks are used for QC checks:

- Lot blanks are used to determine filter weight stability over a long period of time. Three unsampled filters from each new filter lot will be lot blanks. After an initial 24 - hour conditioning, these three lot blanks will be reweighed periodicall y. These measurements will be recorded in a QC notebook or database. The weightings will continue until the 24 -hour weight change is less than 15 μg. This will determine the pre-conditioning period for that entire lot.
- Lab blanks go through the same pro cesses as regular filters. The filters are pre-conditioned, weighed, refrigerated, post-conditioned and reweighed. Lab blanks do not leave the lab environment. If the weight change exceeds 15 μg, it indicates contamination in the conditioning chamber. Corrective actions will be performed to prevent this contamination from re -occurring.
- Field blanks are sent with regular filters to the field and go through the environmental exposure to standard field operations without actually using the filter to take a sample. The field blank is returned along with the regular filters for analysis.

The suggested frequency for the field blanks is 12 -18 blanks in a year for a sampler operating at a 1 in 3 day schedule and for a sampler operating every day would have 36 to 54 blanks. The schedule of field blanks will be such that at least one blank will be weighed during each post sampling session. The pre and post sampling weights will be recorded in the QC lab data form or equivalent database. If the weight change exceeds 30 μg, contamination during transportation or at the sampling site may be occurring. Corrective steps must be taken to prevent this from happening again.

5.2.6 Receipt of Sampled Filters:

Upon receipt of the sample from the field, the sample custo dian should follow these steps:

1) Verify that the temperature of the cooler's interior was maintained at or below 4°C from the time of shipment until receipt at the laboratory. Remove the filter cassette from its metal box and examine the container. If deb ris is found in the metal box after the filter has been removed, record that the sample has been flagged as questionable.

2) Examine the field data sheet and determine whether all data needed to verify sample validity and to calculate mass concentration are provided. Void the sample if data are missing or unobtainable from a field operator or if a sampler malfunction is evident.

3) Match the filter identification number with the correct Field Data Sheet. Remove the filter from the filter cassette and transfer the filter to a filter-handling container labeled with the corresponding filter number. The filter will be handled with clean, smooth nonmetal forceps and inspected for any damage that may have occurred during sampling. If damaged, note the sample has been flagged as questionable.

4) Transfer the filter to its bar-code labeled petrislide dish then to the conditioning chamber and allow the filter to condition for at least 24 hours.

5.2.7 Storage of Exposed filters

If the post sampling weighing session is not scheduled immediately the filters will be stored in a refrigerator. After the filters have been weighed they will be returned to the refrigerator.

5.2.8 Filter Conditioning Procedure

Filters must be conditioned prior to post-weighing. The exposed filters will be conditioned similar to an unexposed filter.

5.2.9 Post Sampling Filter Weighing (Gross Weight)

The following steps should be followed during post sampling filter weighing.

1) Place the defect-free filter(s) in a conditioning environment and allow them to be equilibrated for a minimum 24 hours.

2) The post-sampling conditioning and weighing shall be completed within 240 hours (10 days) after the end of the sample period. However, if the filter is maintained at 4°C or less during the entire time between retrieval from the sampler and the start of the conditioning, the weighing shall be completed within 30 days of the end of the sample period.

3) Repeat the steps 1 through 4 described in the Initial Weighing Procedure Section.

4) At least one lab blank should be weighed during each weighing session. If the pre- and post sampling weights for the lab blanks disagree by more than 15 µg, repeat the measurements. If the pre and post sampling weights for the field blanks disagree by more than 30 µg, repeat the measurements. If the two measurements still disagree, troubleshoot and take appropriate corrective step.

5) One routine filter should be reweighed at the end each post weighing session. Record this replicate measurement. If this replicate measurement differs from the original weight by more than 15 µg, reweigh the filter. If the measurement still disagrees, trouble shoot and take appropriate corrective action, such as reweighing all or some of the previously weighed filters, re-weighing the working standards or servicing the microbalance.

5.2.10 Filter Voiding Criteria and Procedures

Each filter will be inspected for damage. If the damage on a filter causes a negative net weight, the filter will be voided. Filters will also be voided if during the weighing process the filter integrity is compromised; the filter is dropped, damaged or contaminated.

5.2.11 Internal QC

During the filter weighing session, the following QC checks are recommended. Record QC data, including the actual and measured weights, the date and the operator's initials, on the internal Quality Control Log sheet, laboratory log book or database.

1) Zero and Calibration Checks - After each weighing, the operator will re-zero the balance. The calibration of the balance must be checked every 10 filters. A set of standard Class-S Weights (these weights may be the same set used for the initial "standard weight" check) should be used at levels bracketing the filter weights. These weights must also agree within ±0.5 mg. Larger discrepancies should be corrected immediately. When calibration checks exceed acceptable limits, all previously weighed filters must be rechecked.

2) Tare and Gross Weight Checks - On each day of operation, the operator should reweigh 5 to 10% of the exposed per batch. All the unexposed filters will be re-weighed. Weights of clean filters should be within ±15 µg of original values; if not, troubleshooting and re-weighing are in order. However, if the difference exceeds ±15 µg, the laboratory QC supervisor should investigate immediately.

3) QC Officer Duties - The QC officer should keep a bound laboratory logbook or database. These logbooks or database should contain all QC data, including balance calibration and maintenance information, internal routine QC checks, and independent audits.

5.2.12 Calculation of $PM_{2.5}$ Net Filter Loading

The gross weight minus the tare weight of a $PM_{2.5}$ filter is the net weight of $PM_{2.5}$ for that filter. Each calculation of this process must be independently validated. Section 6 presents information regarding the calculation of $PM_{2.5}$ mass concentration.

Table 5-1 Internal Quality Control Log Sheet

Balance ID Number E110110										
Balance Operator S. Davis							**Quality Control Supervisor** C. Minish			
Date	**Standard Weight Checks**		**Zero Check (±3 μg)**		**Calibration Check (±3 μg)**		**Tare and Gross Weight Checks**			
	Original Value	**Observed Value**	**Original Value**	**Observed Value**	**Original Value**	**Observed Value**	**Filter ID**	**Original Value**	**Observed Value**	**T/G[a]**
9/30	100.000	99.999	0.000	0.000	100.000	99.999	99123546	140.740	140.730	T
9/30	200.000	199.999			200.000	199.997	99234701	141.707	141.717	G

[a] Tare or Gross Measurement

6 CALCULATIONS, VALIDATIONS, AND REPORTING OF $PM_{2.5}$ DATA

This section discusses calculations, validations and reporting of $PM_{2.5}$ data.

6.1 Calculations

6.1.1 $PM_{2.5}$ Concentration

1) Calculate the total volume of air sampled:

$$V = Q_a \times t \times 10^{-3}$$

where:

V = total volume of air sampled, m^3;
Q_a = average sampler flow rate, l/minute;
t = total elapsed sampling time, minutes; and
10^{-3} = Conversion factor, m^3/L

2) Calculate total $PM_{2.5}$ mass concentration in $\mu g/m^3$:

$$PM_{2.5} = \frac{(M_{gross} - M_{tare})}{V} \times 10^3$$

Where:

$PM_{2.5}$ = $PM_{2.5}$ mass concentration, $\mu g/m^3$
M_{gross} = gross (final) weight of filter, mg;
M_{tare} = tare (initial) weight of filter, mg;
V = total sample volume, m^3; and
10^3 = conversion factor, $\mu g/mg$

6.2 Calculation Validation

Data that are needed to compute the mass concentration of $PM_{2.5}$ originate from two main sources: field operations and laboratory operations. Data must be validated to ensure that all reported $PM_{2.5}$ measurements are accurate relative to the overall scope of the quality assurance program. When the final mass concentration of $PM_{2.5}$ in a sample has been computed, the validation procedure not only will check on these computations, but also will aid in the flagging of questionable mass concentrations (i.e., extremely high or low values). Therefore, should a mass concentration approach the primary or secondary ambient air quality standard, this validation procedure will provide checks for all preliminary field and laboratory operations. The steps of the calculation validation procedure are as follows:

1) Gather the following data for each sample.

- Total sampling time (minutes)
- Average actual volumetric flow rate, Qa (l/minute)
- Tare and gross weights, Wt and Wg, of the $PM_{2.5}$ filter (mg)

2) Recalculate the total mass concentration of $PM_{2.5}$ for 7 samples per 100 (minimum of 4 per lot). These suggested frequencies may be adjusted based on accumulated experience and level of data quality. Decrease the frequency if experience indicates that data are of good quality, or increase it if data are of marginal or poor quality.

3) Compare each validated $PM_{2.5}$ concentration with the originally reported value. Correct any errors that are found, initial them and indicate the date of correction. If a high percentage of errors is found, check additional calculated values. If consistent errors are found, check all values in the block of data and investigate and correct the cause.

4) Scan all total mass concentration values; note those that appear excessively high or low and investigate. Repeat Steps 2 and 3 for those samples.

5) If all mass concentration computations appear correct and questionably high or low values still exist, review all raw data (i.e., sample time, average actual volumetric flow rate) for completeness and correctness.

6.3 Final Data Validation

Data that has been reviewed by the Quality Assurance Unit and found to satisfy the requirements of this procedure and the criteria defined in the Washington State Department of Ecology Air Monitoring Quality Assurance Plan will be certified as valid. The Critical Data Criteria Table is used to validate the data.

6.4 Data Reporting

Data is coded into telemetry system database from the laboratory reports. After the data is logged and edited the Data Management Unit will prepare quarterly and annual summary reports and transmit the data to EPA.

7 MAINTENANCE PROCEDURES

This section presents the regular maintenance schedule that allows the sampling network to operate for longer periods of time without system failure. The operator may find that increases of the routine maintenance frequencies are necessary due to the operational demands on the samplers. All maintenance activities are to be documented in the sampler logbook. Table 7.1 is a summary of required maintenance procedures and frequencies.

The EPA Reference Method for $PM_{2.5}$ specifies a large number of maintenance items to ensure that the collected samples meet the $PM_{2.5}$ monitoring program Data Quality Objectives. These maintenance items are listed below, grouped by the frequency of required maintenance.

7.1 Supplies And Tools Recommended For Maintenance:

1) Ammonia based general purpose cleaner

2) Cotton swabs

3) Small soft-bristle brush

4) Paper towels

5) Distilled water

6) Silicone-based stopcock grease

7) Small screwdriver

8) Small crescent wrench

9) Pocket knife

7.2 Spare Parts

1) Spare gaskets

2) O-rings

3) Batteries

4) Anything else that might wear out

7.3 Five Day Maintenance

The following maintenance items are to be serviced every 5 sample days:

1) Service Water Collection Jar:

   Inspect the water collection jar on the PM_{10} inlet and empty if necessary. To empty the jar, unscrew the glass collector jar from the black metal top, empty the jar, and replace. Ensure that a tight seal is made between the jar and the metal top.

2) Clean the WINS Impactor Well:

   i) Clean the WINS impactor well according to the following instruct ions:

   ii) Perform any required sample recovery from a previous sample run, if necessary.

   iii) Ensure that the sampler is in the STOP mode by pressing the F4 key in the Main Screen. Open the filter exchange mechanism by pulling out on the black handle.

   iv) Push back on the filter exchange mechanism slightly and lift the metal rollers through the slots on the guides. Let the filter holder settle downward, away from the WINS impactor. With a downward motion, remove the WINS impactor.

v) Separate the WINS impactor from the adapter (below the impactor). Grasp the top and bottom halves of the WINS impactor and unscrew the two halves.

vi) Remove the impactor well assembly from the bottom half of the WINS impactor. Remove the top of the impactor well assembly by lifting upward.

vii) Remove any previously-installed filter from the impactor and discard. Clean the top and bottom using a dry paper towel. If necessary, use a general-purpose cleaner.

viii) Inspect the O-ring in the top of the impactor well assembly. Replace or lubricate with O-ring lubricant, if necessary. Place a new 37 mm borosilicate glass filter into the impactor well. Lubricate the filter with 42 to 44 drops (1 ml) of impactor oil.

ix) Reassemble the impactor well and the WINS impactor. Be sure to keep the unit upright during reassembly to prevent spillage of the impactor oil.

x) Reinsert the WINS impactor into the adapter. Insert the WINS impactor and adapter back into the sampler.

xi) Pass the rollers on the filter exchange mechanism through the slots on the guides. Pull on the black handle to fully open the filter exchange mechanism.

xii) To reduce field service time, spare impactor wells can be prepared. Field servicing would then involve only the exchange of the impactor wells.

3) Perform external leak check as described in section 3. 2.10.

7.4 Monthly Maintenance

The following maintenance items are to be serviced every month.

1) Clean PM_{10} Inlet.

i) Remove the sampler inlet by gently lifting the complete inlet upward off the aluminum sample tube. Disassemble the upper and lower inlet halves by unscrewing the top acceleration assembly from the lower collector assembly.

ii) Clean the top acceleration assembly: Mark the top plate deflector cone and lower plate with a pencil to facilitate proper orientation in reassembly. Remove the four phillips-head screws from the top and lift the top plate off. Clean the insect screen with general-purpose cleaner and a brush. Clean also the top plate deflector cone and internal surface of the acceleration assembly. Check the O-rings. Reassemble the acceleration assembly.

iii) Clean the lower collector assembly: Clean the threads on the lower collector assembly. Using a general-purpose cleaner, clean the collector assembly walls and bottom side as well as the three vent tubes. Clean the drain hole and rain collection jar. Be sure to inspect the brass nipple to the water collection jar for blockage. Clean if necessary.

iv) Apply a light coating of silicone vacuum grease on the cork gasket inside the cap to the collection jar. Grease the two inlet-to-male-inlet tube sealing O-rings.

v) Reassemble the two halves of the PM10 inlet. Hand tighten only. Reinstall the PM10 inlet onto the sample tube.

2) Clean WINS Impactor Housing and Impactor Jets.

i) Perform any required sample recovery from a previous sample run, if necessary. Ensure that the sampler is in the STOP mode by pressing the F4 key in the Main Screen.

ii) Open the filter exchange mechanism by pulling out on the black handle. Push back on the filter exchange mechanism slightly and lift the metal rollers through the slots on the guides. Let the filter holder settle downward, away from the WINS impactor.

iii) With a downward motion, remove the WINS impactor. Separate the WINS impactor from the adapter (below the impactor). Grasp the top and bottom halves of the WINS impactor and unscrew the two halves.

iv) Service the WINS impactor well, if necessary. Using a dry paper towel and/or cotton swabs, clean the inside of the WINS impactor housing and impactor jets. Use an all-purpose cleaner, if necessary.

v) Reassemble the impactor well and the WINS impactor. Be sure to keep the unit upright during reassembly to prevent spillage of the impactor oil.

vi) Reinsert the WINS impactor into the adapter. Insert the WINS impactor and adapter back into the sampler.

vii) Pass the rollers on the filter exchange mechanism through the slots on the guides. Pull on the black handle to fully open the filter exchange mechanism.

7.5 Quarterly Maintenance

3) Inspect and Grease PM_{10} Inlet O-rings:
   i) Remove the PM10 inlet and inspect the O-rings that seat against the sample tube. Replace or lubricate the O-rings as necessary.

4) Clean Sample Tube and Inspect Bulkhead Fitting O-rings:
   i) Remove the PM10 inlet from the sample tube by pulling straight up.

   ii) Loosen the nut on the bulkhead fitting at the top of the enclosure. Slide the sample tube up and out of the bulkhead fitting. Be sure to note which end of the sample tube goes into the bulkhead fitting.

   iii) Clean the inside of the sample tube using dry paper towel or a suitable brush. Use a general-purpose cleaner, if necessary.

   iv) Inspect the bulkhead fitting O-rings. Replace or lubricate the O-rings, as necessary.

   v) Insert the correct end of the sample tube into the bulkhead fitting and gently push until the tube stops. Tighten the nut on the bulkhead fitting to ensure a watertight fit.

   vi) Reinstall the PM10 inlet on top of the sample tube.

   vii) Perform a sampler leak-check.

5) Inspect and Service Vacuum Tubing, Fittings, Electrical Connections.
   i) Inspect all vacuum tubing, pneumatic connections, fittings, and electrical connections for excessive wear. Replace as necessary.

7.6 Six Month Maintenance

1) Replace In-line Air Filter:
   i) Open the sampler door and remove the four screws holding the bottom access cover to the pump compartment. Be careful not to lose the lock washer holding the electrical grounding connection to the lower right-hand screw.

   ii) Locate the large in-line filter in the top of the pump compartment.

   iii) Remove the filter. Be careful to note the direction of flow as indicated on the side of the filter. Be sure to install the replacement filter in the same direction.

   iv) Install the replacement filter.

   v) Perform a sampler external leak check.

vi) Reattach the pump compartment cover. Be sure to secure the electrical grounding wire to the lower right-hand screw.

2) Clean Air Screens

i) Remove the three rain hoods that cover the vents on the side of the sampler enclosure.

ii) Each vent is covered with a removable air screen.

iii) Remove the air screens and clean with water. Dry thoroughly before reassembling.

iv) Reassemble the air screens and reattach the rain hoods.

3) Check System Board Battery Voltage

i) Turn off the sampler and disconnect the sampler from the power source.

ii) Open the door to the electronics compartment (behind the sampler display).

iii) The sampler uses two batteries on the circuit board at the back of the electronics compartment. Each need to be tested.

iv) To test the round battery on the circuit board, measure the voltage across the ground ("GND") test point in the center of the interface board and the top of the round battery. This voltage should be at least 2.5 VDC. Replace if necessary.

v) To test the socket battery, measure the voltage across pins 14 and 28 on U4. This voltage should be at least 2.5 VDC. Replace if necessary.

vi) Close the electronics compartment door. Reconnect the sampler to the power source and turn the sampler on.

vii) If either battery was replaced, follow the installation procedures in this Procedure to ensure that the sampler clock is set, the default sampling times are entered and the sampler is calibrated.

7.6 Other Maintenance

Wipe down the interior of the sampler's case to remove bugs, dirt, and/or water deposits that may have collected inside the case. This may be required more frequently during summer months. Inspect the cooling air intake filter during the summer months and clean if necessary.

7.7 Software Update

For Software Update contact the Calibration and Repair Unit.

Table 7-1 Routine Maintenance Activities

EQUIPMENT	FREQUENCY	ACTION
WINS Impactor	Every 5 sampling days	Replace with clean WINS impactor
Water Collector Jar	Every 5 sampling days	Clean
Tubing and fittings	Every 5 sampling days	Replace as necessary
Upper and Lower Collector Assembly	Monthly	Clean
Inlet O-rings	Monthly	Inspect, replace if damaged
Inlet O-rings	Quarterly	Remove, inspect, and lightly coat with vacuum grease
Sampler down tube	Quarterly	Clean
Down tube water seal gasket	Quarterly	Inspect and replace if necessary
WINS impactor gasket and O-rings	Quarterly	Inspect, lubricate and replace if necessary
Air intake and fan	Quarterly	Clean
Vacuum motor	As needed	Replace if needed
Power lines	Inspect on sample-recovery days	Replace as necessary

8 DATA FORMS

Blank data forms are provided on the following pages for the convenience of the manual user.

Table 8-1 $PM_{2.5}$ 2000 Sampler QC Check Data Sheet

Station # _____ Date: _____

Location: _____ Time: _____

State ID # _____ Operator: _____

Thermometer Serial # _____

- Certification Date: _____

Barometer Serial # _____

- Certification Date _____

Flow Standard Serial # _____

- Certification Date: _____

QC Check

Temperature Check

Ambient

Actual _____ °C Indicated _____ °C Difference _____ °C

Filter

Actual _____ °C Indicated _____ °C Difference _____ °C

Pressure Check

Actual _____ mm Hg Indicated _____ mm Hg Difference _____ mm Hg

Flow Check

Actual _____ L/min Indicated _____ L/min % Difference _____ %

Leak Check

External Leak Check				Internal Leak Check			
Pass ☐	In. Hg	Fail ☐	In. Hg	Pass ☐	In. Hg	Fail ☐	In. Hg

$$\text{QC \% Difference} = \left[\frac{Ind - Act}{Act}\right] \times 100$$

Mail to the Quality Assurance Unit

Table 8-1 $PM_{2.5}$ 2000 Sampler Run Data Sheet

AIRS Number			
Station Name		Filter ID Number	
Station Location			
State ID #			
Sample Date		Cassette ID Number	
Sample Removal (Date/Time)		Sample Ship Date (Date/Time)	
Operator		Operators Initials	
Ambient temp.	°C	Ambient press.	mm Hg
Start Time		Start Date	
Stop Time		Stop Date	
Total Sample Time			
Sampled Volume	M^3	Flow Rate, CV	%

Status Codes			
Average Flow Rate	L/min		
Min. Ambient temp.	°C	Min Ambient press.	mm Hg
Avg. Ambient temp.	°C	Avg. Ambient press.	mm Hg
Max Ambient temp.	°C	Max Ambient press	mm Hg

Comments (Unusual conditions, weather etc.)

Area below for lab use only

Sample temp. upon receipt	°C	Sample Receipt Date	
		Time	
Gross Weight (M_f)	μg	Calculated Concentration	$\mu g / m^3$
Tare Weight (M_i)	μg		

$\frac{(Mf - Mi)}{TotalVolume} 10^3 =$ $\mu g / m^3$ Comments

Comments by lab analyst

Table 8-2 $PM_{2.5}$ 2000 Sampler Annual Performance and Maintenance Check Sheet

	Frequency	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Acceptance Criteria
One Point Flow Rate Verification	Once in 4 Weeks													± 4% of the Transfer Standard
Flow Rate multi-point Verification	1/Year Or if One Point Failure													± 4% of the Transfer Standard
Flow Rate Calibration	If Multi-Point Failure													± 4% of the Transfer Standard
Temperature Multi-point Verification	1/Year													± 2°C of Standard
Temperature Calibration	If Multi-Point Failure													± 2°C of Standard
Pressure Verification	Once in 4 Weeks													± 10 mm Hg.
Pressure Calibration	1/Year													± 10 mm Hg.
Clock/timer Verification	Once in 4 Weeks													1 min/month
Disassemble, Inspect and Clean Sample Inlet	Once in 4 Weeks													
Clean Interior of Sample Case	Once in 4 Weeks													

Table 8-3 $PM_{2.5}$ 2000 Sampler Quarterly Performance and Maintenance Check Sheet

External Leak Check	Every 5 Sampling Events																			80 ml/min 8.5”Hg/30 sec
Internal Leak Check	Every 5 Sampling Events																			80 ml/min 8.5”Hg/30 sec
One-point Temperature Verification	Once in 4 Weeks																			± 4^{o}C of Standard
Water Collector Bottle Inspection	Every 5 Sampling Events																			
Impactor Well Cleaning and Oiling	Every 5 Sampling Events																			

Table 8-4 Internal Quality Control Log Sheet

Balance ID Number										
Balance Operator						**Quality Control Supervisor**				
Date	**Standard Weight Checks**		**Zero Check (±3 μg)**		**Calibration Check (±3 μg)**		**Tare and Gross Weight Checks**			
	Original Value	**Observed Value**	**Original Value**	**Observed Value**	**Original Value**	**Observed Value**	**Filter ID**	**Original Value**	**Observed Value**	**T/G[a]**

Table 8-5 Initial Calibration Form

Partisol FRM Model 2000 Single channel Air Sampler Calibration Sheet

Sampler Data	Impactor Data
State ID Number:	Serial Number: 200FA4

Instrument Calibration Constant Values:

Screen	**Assignment**	**Offset**	**Span**
Sensor Calibration	Amb Temp: Amb Pres:		
Filter Temp Calibration	Filter:		
Filter Compartment Calibration	Filter Comp:		
Flow Calibration	Flow Calib:		

Software Version: _____ Software Update _____
Signature _____ Date _____