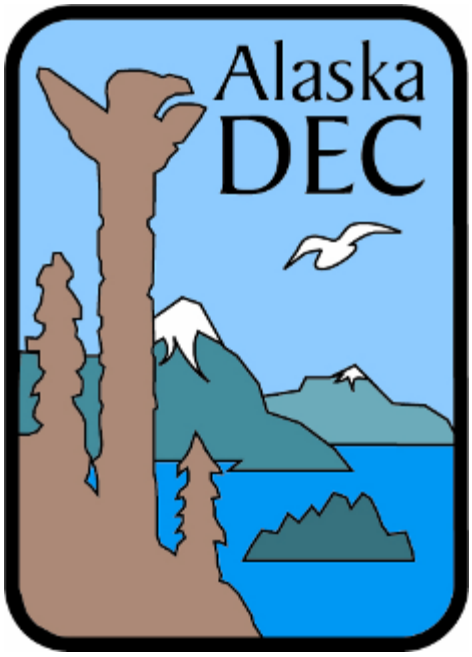
Standard Operating Procedure
for
Thermo Electron Partisol 2000-FRM



State of Alaska Department of Environmental Conservation
Division of Air Quality
Air Monitoring and Quality Assurance Section
619 E Ship Creek Ave. Suite 249
Anchorage, AK 99501

$PM_{2.5}$ Thermo Electron FRM MODEL 2000 SAMPLER

STANDARD OPERATING PROCEDURES

STANDARDS:

State:	Federal standards adopted by Alaska.
Federal:	Primary 35 µg/m^3, 24 (± 1 hr) hour block arithmetic mean (midnight-midnight local standard time). 15 µg/m^3 annual arithmetic mean concentration.
METHOD:	Thermo Electron Partisol-FRM with PM_{10} size-selective inlet and WINS $PM_{2.5}$ impactor and short cut cyclone (SCC)
FLOW CONTROL TYPE:	Microprocessor based volumetric flow control.
FLOW RANGE:	1 m^3/hr (16.7 L/min) (± 10%).
FILTER MEDIUM:	Teflon – 47 mm.
MANUFACTURER:	Thermo Electron (formerly Rupprecht & Patashnick)

1 General Information/Overview

This document describes the procedure used to sample $PM_{2.5}$, particulate matter that has a mean aerodynamic diameter of 2.5 micrometers or less, by the Alaska Department of Environmental Conservation Air Quality Program. The federal reference method for the measurement of $PM_{2.5}$ is presented in 40 CFR Part 50, Appendix L. Sampler siting, operation and quality assurance regulations are presented in 40 CFR Part 58. The operating procedures presented in this SOP are derived from the above cited regulations and the guidance presented in the manufacturer's instructions and the EPA *Quality Assurance Handbook for Air Pollution Measurement Systems* section 1.

1.1 Principles of Operation

An electrically powered air sampler draws ambient air at a constant volumetric flow rate maintained by a mass flow controller coupled to a microprocessor into specially designed inertial particle-size separator (i.e. cyclones or impactors) where the suspended particulate matter in the $PM_{2.5}$ or PM_{10} size ranges is separated for collection on a polytetrafluoroethylene (PTFE) filter over a specified sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the $PM_{2.5}$ or the PM_{10} size ranges divided by

the actual volume of air sampled, and is expressed in µg/m^3 at LTP (local temperature and pressure).

The microprocessor reads, averages and stores five-minute averages of ambient temperature, ambient pressure, filter temperature and volumetric flow rate. In addition, the microprocessor calculates the average temperatures and pressure, total volumetric flow for the entire sample run time and the coefficient of variation of the flow rate.

Clear, polystyrene plastic protective cases are used for sample retrieval, shipment and storage of the Partisol sampler samples. These hold individual filters within their sampling cassettes and are taped shut prior to sampling. Samples are collected from the samplers by field staff, at which time they are stored in either a cooler or an on-site refrigerator. Samples are retrieved from the samplers within 177 hours of the end of sampling for Partisol FRM $PM_{2.5}$ samples.

Any abnormalities that are observed on the filters, the sampler or the nearby environment are noted on the appropriate field sheet. During shipping or transport, the samples are kept at <4°C. Upon return to the laboratory, the samples are placed in a refrigerator maintained at < 4°C.

To equilibrate the filters, they are taken to the weighing room, removed from their protective cases and equilibrated in their cassettes for a minimum of 24 hours before post-sampling weighing.

The holding time for pre-sampling (tared) filters is 30 days, although the results are not downgraded if this holding time is exceeded. The holding time for post-sampling (loaded) filters is 10 days, unless they are maintained < 4°C during the entire time between retrieval and the start of conditioning, in which case the time period cannot be more than 30 days. After post-sampling (loaded) weighing, filters are stored in labeled Petri dishes and cataloged in closed cardboard boxes. They are stored in either a refrigerator or freezer for an archiving period of at least one year.

1.2 **Safety Precautions**

Only properly trained personnel should perform the FRM 2000 filter changes, installation, testing, operation, maintenance or calibration. As with all monitoring equipment, precautions should be taken when working around electricity, power tools and elevated platforms. Repair should be done by properly trained service personnel.

1.3 **Interferences/Limitations**

1.4 Partisol Display Screens

The Partisol employs a LCD screen with a menu system to activate sampler functions, program the sampler for operation and view stored data and errors. The brightness of the screen can be adjusted with the black knob below and to the left of the keypad. If no keys have been pressed for a prolonged period of time, the screen powers down to save energy. To restore the screen, press any key.

Upon initial power-up, the sampler displays the Title Screen that shows the manufacturer, model number and software version. In addition, this screen allows access to three functions for resetting hardware configurations to factory defaults. This screen is shown only momentarily, after which the Main Screen is displayed.

Each screen is named. The name of the screen appears in the middle of the top line of the screen. On the left of this row is the sampler status code. On the right side is the current operating mode. The bottom row of each screen, lists the functions associated with the function keys F1- F5. Not all screens have a function associated with each function key.

The Main Screen is at the top of the menu system. Screens beneath the Main Screen are accessed by pressing the appropriate function key. To return to the previous screen, press the ESC key.

Further descriptions of the operating software and menu system are presented in Sections 4 and 5 of the operating manual.

2 Installation

2.1 List of Tools and Supplies

Drill and bits
Wrench
Partisol stand, screws
Partisol 2000
Certified flow standard capable of measuring 16.7 L/min
Certified temperature and pressure standards
Rain hoods (2 small and 1 large)
WINS impactor
Partisol blanket (for cold climates)
Sample tube
PM_{10} head
Ambient temperature sensor
Filter cassettes
Extension cord

2.2 Physical inspection

Upon receipt of a FRM 2000, inspect equipment and accessories for completeness and/or damage. If shortage or damage is found, immediately notify your supervisor and the shipping department.

List of components:

Partisol 2000
Rain hoods (2 small and 1 large)
Sample tube
PM_{10} sampling head
WINS impactor, if $PM_{2.5}$ installation
Partisol blanket, if cold temperatures
Filter cassette

2.3 Siting Requirements

Samplers should be sited to meet the goals of the specific monitoring project. For routine sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler siting is described in the *Quality Assurance Project Plan for the State of Alaska $PM_{2.5}$ Ambient Air Quality Monitoring Program* and is regulated by 40 CFR Part 58.

Samplers should be mounted on a safe, suitable monitoring platform according to the following guidelines:

1. The $PM_{2.5}$ sampler must be exposed to unobstructed airflow in all directions for a minimum of 2 m horizontal distance.
2. The sampler inlet must be placed between 2 and 15 m above ground level.
3. If a sampler is collocated with other samplers, the minimum spacing between sampler inlets is as follows:
   a. If collocated with other $PM_{2.5}$ or other low-volume samplers (flow rate < 16.7 L/min), maintain a minimum distance between sampler inlets of 1 m.
   b. If collocated with total suspended particulate samplers (TSP) or other high-volume samplers (flow > 16.7 L/min), maintain a minimum distance between sampler inlets of 2 m.

2.4 Setting up the Sampler

Prior to first use, setup the sampler following the manufacturer's operating manual as follows:

1. Inspect the sampler to ensure that all transport restraints and tie wraps are removed from the sampler enclosure.

2. Install the one large and two small rain hoods over the appropriate openings in the sampler enclosure. Be sure to install the rubber gaskets on the rain hoods prior to installation.
3. If the temperature is below freezing, or will be below freezing, zip the blanket around the outside of the Partisol. Otherwise, keep in storage until cold weather.
4. The sample tube typically has two machined ends. On one end the machining extends 2 inches from the end. On the other end, the machining extends 1.25 inches. Insert the end of the sample tube with the 2-inch machined section into the top of the bulkhead fitting on the top of the sampler enclosure. Firmly push the tube into the fitting, through the final O-ring, until it stops. Gently tighten the nut on the bulkhead fitting.
5. Insert the PM_{10} sampling head onto the top of the sampling tube. Firmly push the sampling head onto the tube, past the inlet's two O-rings, until it stops.
6. Connect the Partisol to the electrical supply. Warning: The plug provided by the manufacturer is for indoor installation only. Be sure to install an appropriate plug for outdoor use.
7. Attach the ambient temperature sensor assembly (temperature probe and radiation shield) to the two holes provided toward the top of the left side of the enclosure. Install the unit so that the temperature probe extends up and to the left of the enclosure. If the unit was supplied with washers, place the washers between the temperature assembly and the enclosure, not under the head of the screws. This ensures a watertight assembly. If the unit was provided without washers, install the assembly with screws only.
8. Connect the ambient temperature cable to the connector on the back of the enclosure labeled "Temperature Sensor".
9. Following the procedures described in section 6.1 #2, prepare the WINS $PM_{2.5}$ impactor for use.
10. Follow the procedures in the next section (2.5) to setup the system software.
11. Conduct a sampler external and internal leak check (sections 3.2 and 3.3).
12. Perform a temperature calibration, a pressure calibration, and a multi-point flow calibration (sections 3.5, 3.6, 3.8, and 3.10, respectively).
13. Prepare the sampler for sample collection following the procedures in Sections 4.1 and 4.2.

2.5 **Sampler Software Setup**

Prior to initial operation, the sampler software needs to be reset and default values need to be entered as referenced in the operational manual. The following procedures should be followed for a direct connect using the RPCom program or Hyperterminal. Other connection types like a phone modem connection will require a different set-up:

1. If not already off, turn the sampler off using the power switch on the front panel.

[Note: The following steps will perform a complete hardware and software reset of the sampler. All calibration constants for temperature pressure and flow will be lost and the sampler will have to be recalibrated. Only perform these steps upon initial installation or when a major system reset is necessary.]

2. Turn the sampler power on. While the Title Screen is displayed, press <F3: HReset> twice. The sampler will beep 3 times after the Title Screen disappears to indicate that the sampler hardware and software have been reset.

3. From the Main Menu, press <F5: Setup>.
4. From the Setup Screen, press <F1: Edit Mode>.
5. Using the arrow keys, press <F5: Set Def>. From the keypad, enter the default start time for sample runs (for routine NAAQS monitoring, enter 00.00 for midnight). **Do not press Enter**.
6. Use the arrow keys to move to the Def Dur field. From the keypad, enter the default sampling duration in hours and minutes (for routine NAAQS monitoring, enter 24.00). **Do not press Enter**.
7. If the Set Flow field does not show 16.7 L/min, move the cursor to the Set Flow field, and enter 16.7 from the keypad. **Do not press Enter**.
8. Using the arrow keys, position the cursor on the Cur Time field. Using the keypad, enter the current time in 24-hour time (i.e. 1:00 pm is 13.00). Press Enter. The clock is now set and the sampling time defaults have been entered.
9. From the Setup Screen, press <F4: RS232>. Verify that the settings are as listed below or as needed to match the values set in the AKCOMM software on the computer that will access the sampler.

    Baud: 9600
    Config: 8-N-1
    Xon/Xoff Cont: ON AK Station: 52 AK Channel: 75048
    AK Append: 13010

    If the values do not match the above, press <F1: Edit>. Use the arrow keys to move to the correct field. Enter the correct value from the keypad and press Enter.
10. Return to the Main Screen by pressing ESC twice.
11. From the Main Screen, press <F1: FiltSet>.
12. Press <F1: Edit>.
13. Use the arrow keys to move the cursor to the ID1 field.
14. Using the keypad, enter the unique AIRS code and sampler ID number that will identify all samples collected by this sampler and press Enter.
15. Perform all necessary sampler calibrations.

3 Sampler Calibration

Calibrations are to be performed as follows: when the monitor is initially installed at its sampling location prior to operation, whenever the monitor fails any monthly operational check (temperature, pressure or flow), after any software updates are

installed, and annually. Sections 3.5, 3.6, 3.8 and 3.10, respectively, describe calibration procedures for ambient temperature, ambient pressure, single point flow and multipoint flows.

3.1 Calibration of Transfer Standards

Following established EPA methods and procedures, all calibration transfer standards (i.e. temperature, pressure and flow) must be certified against NIST-traceable standards at least once per year. Calibration of these transfer standards will be conducted by the transfer standard manufacturer.

3.2 External Leak Check Procedure

Upon initial installation of the sampler, following sampler repair or maintenance and at least monthly, perform a sampler external leak check according to the following procedure:

1. Ensure that the sampler is in the STOP mode by pressing <F4: Run/Stp> in the Main Screen.
2. Open the pump access door on the lower half of the sampler. Inside are a vacuum gauge and two valves (one to the left of the gauge and one below the gauge).
3. From the Main Screen, press <F5: Setup>.
4. From the Setup Screen, press <F5: Audit>.
5. Carefully lift straight up on the PM_{10} inlet (and $PM_{2.5}$ SCC if installed) to remove it from the sampling tube.
6. Install a filter cassette containing a Teflon filter (designated for calibrations/leak checks) in the filter holder. **Do not use a filter that is to be used for sampling**.
7. Install the supplied Flow Audit Adapter onto the end of the sampling tube (ensure the adapter is open).
8. Turn on the flow valve by pressing <F2: Valve>.
9. Turn on the pump by pressing <F3: Pump>.
10. Close the valve on the Flow Audit Adapter (valve fins horizontal).
11. Shut off the flow to the flow controller by shutting the valve to the left of the vacuum gauge (valve fins perpendicular to the tubing).
12. Allow the vacuum gauge to stabilize and record reading. The vacuum should be at least 15“ Hg.
13. Shut off the flow to the pump by shutting the valve below the vacuum gauge (valve fins perpendicular to the tubing).
14. Turn off the pump by pressing <F3: Pump>.
16. Read and record the vacuum gauge reading.
17. Wait 30 seconds and record the new vacuum gauge reading. The reading should not have dropped by more than 8.5“ Hg in one minute (corresponds to a leak rate of 80mL/min).
18. If the decrease in vacuum is greater than 8.5“Hg, initiate corrective action to locate and repair the leak.

19. Slowly Open the flow controller valve and pump valve (left and below the vacuum gauge).
20. Slowly Open the Flow Audit Adapter valve and remove the adapter from the sampler.
21. Reinstall the PM_{10} inlet. (and $PM_{2.5}$ SCC if installed)

3.3 Internal Leak Check Procedure

Upon initial installation of the sampler, following sampler repair or maintenance, and at least monthly, perform a sampler internal leak check according to the following procedure:

1. Ensure that the sampler is in the STOP mode by pressing <F4: Run/Stp> in the Main Screen.
2. Open the pump access door on the lower half of the sampler. Inside are a vacuum gauge and two valves (one to the left of the gauge and one below the gauge).
3. From the Main Screen, press <F5: Setup>.
4. From the Setup Screen, press <F5: Audit>.
5. Carefully lift straight up on the PM_{10} inlet to remove it from the sampling tube.
6. Install a leak check disc (designated for calibrations/leak checks) in the filter holder.
7. Turn on the flow valve by pressing <F2: Valve>.
8. Turn on the pump by pressing <F3: Pump>.
9. Shut off the flow to the flow controller by shutting the valve to the left of the vacuum gauge (valve fins perpendicular to the tubing).
10. Read and record the vacuum gauge reading.
11. Shut off the flow to the pump by shutting the valve below the vacuum gauge (valve fins perpendicular to the tubing).
12. Wait 30 seconds, and then record the reading on the vacuum gauge. If the reading dropped less than 8.5” Hg from the initial reading, the sampler has passed the leak check. If the pressure dropped more than 8.5” Hg, take corrective action to locate and repair the leak.
13. Press <F2: Valve>, Open the valves from steps 9 and 11.
14. Remove the Leak Check Disc from the filter cassette.

3.4 Single-point Ambient Temperature and Filter Temperature Verification Check

A single-point temperature verification check of both the ambient temperature and filter temperature sensors must be performed at least once every month. The temperature check is performed as follows:

1. Perform any required sample recovery from a previous sample run, if necessary.
2. Ensure that the sampler is in the STOP mode by pressing <F4: Run/Stp> in the Main Screen.
3. From the Main Screen, press <F5: Setup>.
4. From the Setup Screen, press <F5: Audit>.

5. Record the as found calibration data.
6. Place the temperature transfer standard in close proximity to the ambient temperature sensor. Be sure that both sensors are shaded from direct sunlight.
7. Read the temperature transfer standard reading and the ambient temperature reading (from the sampler display) and record these values on the Single-point Verification Worksheet.
8. Calculate the difference between the temperature readings. If the ambient temperature is within ± 4 °C of the temperature transfer standard, the sampler's temperature is verified. If the temperature difference exceeds ± 4 °C, conduct a temperature calibration.
9. Repeat steps 5-7 above for the filter temperature sensor.

*A check of the current data downloads should be made to see if the ambient temperature and the filter temperature are well within the +/- 5 ^{o}C factor. If it is getting close to exceeding the +/- 5 ^{o}C tolerance, the inlet filters should be cleaned and the temperature sensors recalibrated as needed.

3.5 **Ambient Temperature Calibration**

The ambient temperature calibration is to be performed upon initial installation, yearly after site installation after any major maintenance that might affect the temperature reading, and at any time thereafter when the sampler fails a verification check. To perform the ambient temperature calibration:

1. Ensure that the sampler is in the STOP mode by pressing <F4: Run/Stp> in the Main Screen.
2. From the Main Screen, press <F5: Setup>.
3. From the Setup Screen, press <F2: Cailb>.
4. Record the as found calibration data.
5. Place the temperature transfer standard in proximity to the ambient temperature sensor. Be sure that both sensors are shaded from direct sunlight.
6. Read the temperature transfer standard reading in °C.
7. Press <F1: Edit> to enter the Edit Mode.
8. Using the arrow keys, move the cursor to the "Act" column in the row labeled "AmbT".
9. Enter the actual ambient temperature on the sampler's keypad and press Enter. To enter a negative number, first press the Shift key, and then press F1 (+/-). This will enter the negative sign. Next, press the Shift key and then enter the remainder of the number.
10. Record the new "Span" value for the ambient temperature.

3.6 **Filter Temperature Calibration**

The filter temperature calibration is to be performed upon initial installation, yearly after site installation, and at any time thereafter when the sampler fails either a

single-point or multi-point temperature verification check. To perform the filter temperature calibration:

1. Ensure that the sampler is in the STOP mode by pressing the <F4: Run/Stp> key in the Main Screen.
2. From the Main Screen, press <F5: Setup>.
3. From the Setup Screen, press <F2: Cailb>.
4. Record the as found calibration data.
5. Place the temperature transfer standard in proximity to the filter temperature sensor. Be sure that both sensors are shaded from direct sunlight.
6. Read the temperature transfer standard reading in °C.
7. Press <F1: Edit> to enter the Edit Mode.
8. Using the arrow keys, move the cursor to the "Act" column in the row labeled "FltT".
9. Enter the actual filter temperature on the sampler's keypad and press Enter. To enter a negative number, first press the Shift key, and then press F1 (+/-). This will enter the negative sign. Next, press the Shift key and then enter the remainder of the number.
10. Record the new "Span" value for the ambient temperature.

3.7 **Pressure Verification Check**

A single-point pressure verification must be performed at least once every month. The pressure check is performed as follows:

1. Perform any required sample recovery from a previous sample run, if necessary.
2. Ensure that the sampler is in the STOP mode by pressing the F4 key in the Main Screen.
3. From the Main Screen, press <F5: Setup>.
4. From the Setup Screen, press <F5: Audit>.
5. Record the as found calibration data.
6. Place the pressure transfer standard in proximity to the sampler. Be sure that the pressure transfer standard is shaded from direct sunlight.
7. Read the pressure transfer standard reading (in mm Hg) and the sampler pressure reading (from the sampler display) and record these values on the Single-point Verification Worksheet. Make sure that the pressure transfer standard is reading in actual station pressure. *Not sea-level adjusted pressure*.
8. Calculate the difference between the pressure readings. If the sampler pressure is within ±10 mm Hg of the pressure transfer standard, the sampler's pressure is verified. If the pressure difference exceeds ±10 mm Hg, conduct a pressure calibration followed by another pressure verification check.

3.8 **Pressure Calibration Procedures**

The pressure calibration is to be performed upon initial installation, yearly after site installation, and at any time thereafter when the sampler fails a single-point pressure verification check. To perform the pressure calibration:

1. Ensure that the sampler is in the STOP mode by pressing the F4 key in the Main Screen.
2. From the Main Screen, press <F5: Setup>.
3. From the Setup Screen, press <F2: Cailb>.
4. Record the as found calibration data.
5. Place the pressure transfer standard in proximity to the sampler. Be sure that the pressure transfer standard is shaded from direct sunlight.
6. Read the pressure transfer standard reading in mm Hg.
7. Press <F1: Edit> to enter the Edit Mode.
8. Using the arrow keys, move the cursor to the "Act" column in the row labeled "Pres".
9. Enter the actual pressure on the sampler's keypad and press Enter.
10. Record the new "Span" value for the ambient pressure.

3.9 **Single-point Flow Verification Check**

A single-point flow verification check must be performed at least every month. The flow check is performed as follows:

1. Perform any required sample recovery from a previous sample run, if necessary.
2. If necessary, turn on the power to the flow transfer standard to allow it time to warm-up. Expose the flow transfer standard to ambient temperature, but keep the unit out of direct sunlight.
3. If not already completed, perform a single-point temperature check, a single-point pressure check, an external leak check and an internal leak check.
4. Ensure that the sampler is in the STOP mode by pressing the F4 key in the Main Screen.
5. Install a filter cassette containing a 47mm Teflon filter (designated for calibrations/leak checks) in the filter holder. Do not use a filter that is to be used for sampling.
6. Carefully lift straight up on the PM_{10} inlet head to remove it from the sampling tube.
7. Install the flow transfer standard onto the end of the sampling tube. If necessary, first install the supplied Flow Audit Adapter and open its valve (valve fins vertical).
8. From the Main Screen, press <F5: Setup>.
9. From the Setup Screen, press <F5: Audit>
10. Turn on the pump, press <F3: Pump>.
11. Turn on the sample flow valve, press <F2: Valve>.

12. If using the Streamline FTS flow transfer standard, enter the calibration constants m and b into the FRM Setup Screen as follows:
    a) Press the Esc key to return to the Setup Screen.
    b) Press <F1: Edit>.
    c) Using the arrow keys, move the cursor to the FTS CONST m field.
    d) Using the keyboard, enter the m constant for the Streamline FTS flow transfer standard.
    e) Using the keyboard, enter the b constant for the Streamline FTS flow transfer standard.
    f) Press the Enter key.
    g) Press <F5: Setup>.
13. Allow the sampler to warm-up for 10 minutes before continuing.
14. Read and record the flow rate (actual L/min) from the flow transfer standard on the Single Point Verification Worksheet. If using the Streamline FTS flow transfer standard, enter the pressure drop (inches H_2O) in the Audit Screen as follows:
    a) Press <F1: Edit>.
    b) Using the keyboard, enter the FTS pressure drop and press the Enter key.
    c) Read and record the actual flow rate displayed on the FRM screen.
15. Read and record the sampler flow rate (actual L/min) from the sampler display on the Single Point Verification Worksheet.
16 Turn off the pump, press <F3: Pump>.
17. Calculate the flow rate percent difference as:

$$d = \frac{(Audit\,Flow\,Rate - Sampler\,Flow\,Rate)}{Audit\,Flow\,Rate} * 100\%$$

18. If the flow rate percent difference (d) is greater than ± 4%, conduct a full multi-point calibration of the sampler flow. If the difference is less than or equal to ± 4%, the sampler's flow rate is within specifications.
19. Remove the flow transfer standard and reinstall the PM_{10} inlet.
20. Remove the filter cassette from the sampler.

3.10 **Multi-Point Flow Calibration Procedure**

A multi-point flow calibration must be performed upon initial installation and once per year thereafter. In addition, the multi-point calibration must be performed whenever a single-point flow verification check indicates that the sampler flow deviates from the flow transfer standard by more than ± 4%. The multi-point calibration is performed as follows:

1. Record all as found calibration data and perform any required sample recovery from a previous sample run prior to making any adjustments.
2. If necessary, turn on the power to the flow transfer standard to allow it time to warm-up. Expose the flow transfer standard to ambient temperature but keep the unit out of direct sunlight.

3. If not already completed, perform a single-point temperature check, a single-point pressure check, an external leak check and an internal leak check.
4. Ensure that the sampler is in the STOP mode by pressing the F4 key in the Main Screen.
5. Install a filter cassette containing a 47mm Teflon filter (designated for calibrations/leak checks) in the filter holder. Do not use a filter that is to be used for sampling.
6. Carefully lift straight up on the PM_{10} inlet to remove it from the sampling tube.
7. Install the flow transfer standard onto the end of the sampling tube. If necessary, first install the supplied Flow Audit Adapter and open its valve (valve fins vertical).
8. From the Main Screen, press <F5: Setup>.
9. From the Setup Screen, press <F2: Cailb>.
10. If using the Streamline FTS flow transfer standard, enter the calibration constants m and b into the FRM Setup Screen as follows:
    a) Press the Esc key to return to the Setup Screen.
    b) Press <F1: Edit>.
    c) Using the arrow keys, move the cursor to the FTS CONST m field.
    d) Using the keyboard, enter the m constant for the Streamline FTS flow transfer standard.
    e) Using the keyboard, enter the b constant for the Streamline FTS flow transfer standard.
    f) Press the Enter key.
    g) Press <F2: Cali>.
11. From the Calibration Screen, press F2 to access the Flow Calibration Screen.
12. Press F2 to start the calibration. The sampler display will indicate that it is computing the Flow Offset. Following this, the sampler will cycle through five different flow rates (16.7, 17.5, 15.8, 18.3, and 15.0 L/min). At each flow rate, the sampler will ask the user to enter the flow rate indicated by the flow transfer standard. If using the Streamline FTS flow transfer standard, use the following steps to enter the values:
    a) Wait for the flow readings on both the sampler and the Streamline FTS flow transfer standard to stabilize.
    b) Read the pressure from the Streamline FTS flow transfer standard.
    c) Press <F1: Edit>.
    d) Using the sampler keyboard, enter the pressure from the Streamline FTS flow transfer standard into the FTS Pres field and press the Enter key. The sampler will initiate the next flow rate.
    e) Repeat steps a-d for all five flow rates. After the fifth flow rate, the sampler will indicate “Calibration Complete”.

    If not using the Streamline FTS flow transfer standard, use the following steps to enter the values:
    a) Wait for the flow readings on both the sampler and the flow transfer standard to stabilize.

b) Read the flow rate from the flow transfer standard to the nearest 0.1 L/min.
c) Press <F1: Edit>.
d) Enter the flow rate from the flow transfer standard on the sampler keypad and press the Enter key. The sampler will initiate the next flow rate.
e) Repeat steps a-d for all five flow rates. After the fifth flow rate, the sampler will indicate “Calibration Complete”.

14. Remove the flow transfer standard and reinstall the PM_{10} inlet.
15. Remove the filter cassette from the sampler.

4 Operational Procedures

4.1 Office Preparatory Procedure for Filter Changes

1. Select a sample filter from the lot provided by the laboratory. 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. Post-weighing must occur within 30 days of run date. This includes shipping time and at least 24 hrs for equilibration time. *In addition, take at least one spare sample filter.?*
2. Prepare work area by clearing an area that allows room for filters and cassette holder. Once area has been designated, wipe surface with isopropyl alcohol.
3. Inspect both filters for pinholes, chaff or flashing, loose material, discoloration, and non-uniformity. Replace any defective filters.
4. Using specified tweezers for Partisol samples, place the filter into an open filter cassette ensuring that the filter ID number is facing up. Close the filter cassette by completely snapping its top part onto the bottom section.
5. Place the filter cassette into the filter cassette carrier and place the entire assembly into the appropriately labeled metal transport container.
6. On the Field Data Log, fill in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

4.2 Installing a New Filter and Setup for a New Sample

1. Perform all necessary pre-sampling procedures as described above.
2. Determine from the Main Screen if the monitor is sampling; it will be in WAIT mode. If it is sampling, let it continue till the sampling program has completed; it will read DONE.
3. Perform any required sample recovery from a previous sample run, if necessary.
4. Put the sampler in the STOP mode by pressing <F4: Run/Stp>.
5. Perform QA/QC checks or maintenance, if required. Record **all** maintenance activities in the field log book; include time, date, and any concerns that might affect the quality of the sample. This includes, but is not limited to, all

activities like WINS impactor cleaning/replacement, inlet head cleaning, air filter replacement and inlet filter cleaning.

6. Remove the filter to be installed from its protective filter cassette carrier.
7. Place the filter carrier onto the lower filter holder making sure that the slot in the back of the filter carrier fits around the pin on the back edge of the filter holder, and that the hole in the front of the filter carrier rests over the short pin at the front of the filter holder.
8. Push forward (into the sampler) on the black handle of the filter mechanism, raising the filter into place against the bottom of the WINS impactor.
9. Gently push forward on the bottom half of the WINS impactor to ensure that the rubber lip seal on the bottom of the WINS impactor is seated squarely against the filter.
10. From the Main Screen, press <F1: FiltSet>.
11. Check the system clock and make sure it is within 1 min of NIST time.
12. The Filter Setup Screen shows the start date and time and the end date and time for the next sample. To change the sampling parameters follow the steps below:
    a) Press <F1: Edit>.
    b) Using the arrow keys to move the cursor, position the cursor in the date or time field to be changed.
    c) Using the sampler keypad, enter the start date and time and the end date and time for the next sample. Note that midnight is entered as a time of 00.00 and that all other times are entered using a 24-hour clock (e.g. 1:00 pm would be entered as 13.00). Also note that the midnight time is associated with the date of the day that is just starting. For instance, if a sample is desired on July 15, 2006 from midnight to midnight, the start and stop times should both be 00.00. The start date should be 06/07/15 and the stop date should be 06/07/16.
    d) Use the arrow keys to move the cursor to the ID2 field.
    e) On the sampler keypad, enter the 7-digit filter ID number of the filter placed onto the sampler and press the Enter key.
13. Press the ESC key to return to the Main Screen.
14. Verify that the sample start and stop dates and times are correct.
15. Press <F4: Run/Stp> to place the sampler in the WAIT mode.

4.3 **Recovering the Sample and Data from a Completed Sample Run**

1. From the Main Screen, note the current sampler operating mode (top line, right side of display). If the sampler is in the WAIT mode or the SAMP (sampling) mode, the sampler has not completed the previously scheduled sampling run. Do not disturb the sampler unless absolutely necessary.
2. If the sampler is in the DONE mode or the ERR mode, press <F4: Run/Stp>. This allows the sampler to write the final information into storage for the current sample run and *must* be performed prior to filter exchange. The sampler mode should now indicate STOP.
3. Open the filter exchange mechanism by pulling straight back on the black handle. The filter holder will lower away from the WINS impactor.

4. Remove the filter carrier from the filter holder.
5. Place the filter carrier in the filter cassette case.
6. From the Main Screen, press F3 to access the Filter Data screen.
7. Using the information displayed on the Filter Data screen, complete the Field Data Log with the following information from the completed sample run:
    a) Total Sample Volume – from the Vol field
    b) Average Flow Rate – from the AveFlow field
    c) Coefficient of Variation – from the %CV field
    d) Total Run Time – from the Tot field
    e) Maximum Temperature Difference – from the Temp Diff field
    f) Minimum, Average and Maximum Ambient Temperatures – from the AmbT fields
    g) Minimum, Average and Maximum Filter Temperatures – from the FltT fields
    h) Minimum, Average and Maximum Pressures – from the Pres fields
8. Prepare the sampler for its next sample run.
9. If the sampler indicated there was an error, note the error in the field log book and make any repairs as needed. Any fixes should be done prior to the next run date.

4.4 **Downloading stored data using data transfer programs**

There are various data transfer programs available for the Partisol. Verify with the program operating manual and the Partisol operating manual for data retrieval instructions.

To retrieve the interval data from the Partisol, attach a laptop to the Partisol.

1. Use the RP 232 cable to connect the port and the front of the Partisol to a laptop.
2. Turn on the computer and check that the Partisol is On and in WAIT or DONE mode.
3. On the computer open RPcomm.
4. Open up file “frm2000” or another appropriate file. The connections list should read “New connection” “2000frm” “inactive”.
5. Connect using the telephone icon. Then wait for the RPComm program to put up the New Connections screen.
6. Be sure to select the filter data and the interval data in order to get one text file for each.
7. Press the Select all icon (circle) and download selected icon (=over the v). This will download all the data from the last pointer to the present.
8. Open the text files in WordPad to check that you have downloaded all the current filter and interval data.
9. Disconnect from the Partisol by pressing the ‘telephone hanging up’ icon.
10. Close RPComm and disconnect the cord.

5 Data Calculations and Validation

The following subsections describe the routine procedures used to calculate 24-hour $PM_{2.5}$ concentrations and to validate individual samples.

5.1 Data Calculations

1. From the Field Data Log or the electronic filter data (downloaded from the sampler), determine the total sample volume (V_a) for the sample run. If the total sample volume is not available it can be alternatively calculated from the average volumetric flow rate (Q_{avg}) and the total sample duration (t) as follows:

   $V_a = (Q_{avg})(t)(10^3)$

   where:

   V_a = total sample volume (actual m^3)
   Q_{avg} = average sample flow rate (L/min)
   t = total sample duration (min)
   10^3 = units conversion (m^3/L)

2. Using the final weight and tare weight of the sample filter, determine the total filter mass gain ($M_{2.5}$) as:

   $M_{2.5} = (M_f - M_I)(10^3)$

   where:

   $M_{2.5}$ = total mass gain (µg)
   M_f = final filter weight (mg)
   M_I = initial (tare) filter weight (mg)
   10^3 = units conversion (µg/mg)

3. Calculate the $PM_{2.5}$ concentration as:

   $PM_{2.5} = M_{2.5} / V_a$

5.2 Data Validation

The following steps apply to the validation of single $PM_{2.5}$ concentrations based upon the field and laboratory data. Additional validation techniques (i.e. statistical techniques) may be specified in the Quality Assurance Project Plan (QAPP). Invalidated data should be flagged for quality assurance review and an explanation should be noted in the free-form notes section on the field data sheet.

1. Verify that the run data from the Partisol are within the following limits:

Average volumetric flow rate	= 16.67 L/min ± 5%
Flow rate coefficient of variation	= < ± 4%
Total sample duration	= 24 hours ± 1 hour

Temperature difference (filter-ambient) = < 5°C

2. Verify that the post-run sampler status code was OK and that the sampler mode was no ERR.
3. Verify that the site technician did not flag the sample as “questionable” on the Field Data Log.
4. Verify that free-form notes on the Field Data Log do not indicate an invalid sample.
5. Verify that the sample was recovered from the Partisol within 96 hours of the completion of the sample run.
6. Verify that the sample cooler temperature did not exceed 25°C during transportation to holding facility. If sample is going to the laboratory please ensure that the cooler temperature did not exceed 4°C.
7. Verify that the sample holding times were not exceeded (30 days if the filter temperature prior to conditioning was maintained less than 4°C, 10 days otherwise).
8. Verify that the sample was not invalidated by lab personnel.

6 Sampler Maintenance

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.

6.1 **Five-Day Maintenance**

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

Note: all maintenance must be documented in the field log book. Information logged should include date, time, operator ID and a description of what was done.

1. Service Water Collection Jar:
   a) 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 according to the following instructions:
   a) Perform any required sample recovery from a previous sample run, if necessary.
   b) Ensure that the sampler is in the STOP mode by pressing the F4 key in the Main Screen.
   c) Open the filter exchange mechanism by pulling out on the black handle.
   d) Push back on the filter exchange mechanism slightly and lift the metal rollers through the slots on the guides.
   e) Let the filter holder settle downward, away from the WINS impactor.
   f) With a downward motion, remove the WINS impactor.

g) Separate the WINS impactor from the adapter (below the impactor).
h) Grasp the top and bottom halves of the WINS impactor and unscrew the two halves.
i) Remove the impactor well assembly from the bottom half of the WINS impactor.
j) Remove the top of the impactor well assembly by lifting upward.
k) 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.
l) Inspect the O-ring in the top of the impactor well assembly. Replace or lubricate with O-ring lubricant, if necessary.
m) Place a new 37 mm borosilicate glass filter into the impactor well.
n) Lubricate the filter with 42 to 44 drops (1 mL) of impactor oil.
o) Reassemble the impactor well and the WINS impactor. Be sure to keep the unit upright during reassembly to prevent spillage of the impactor oil.
p) Reinsert the WINS impactor into the adapter.
q) Insert the WINS impactor and adapter back into the sampler.
r) Pass the rollers on the filter exchange mechanism through the slots on the guides.
s) Pull on the black handle to fully open the filter exchange mechanism.

3. Clean WINS Impactor Housing and Impactor Jets:
a) Perform any required sample recovery from a previous sample run, if necessary.
b) Ensure that the sampler is in the STOP mode by pressing the F4 key in the Main Screen.
c) Open the filter exchange mechanism by pulling out on the black handle.
d) Push back on the filter exchange mechanism slightly and lift the metal rollers through the slots on the guides.
e) Let the filter holder settle downward, away from the WINS impactor.
f) With a downward motion, remove the WINS impactor.
g) Separate the WINS impactor from the adapter (below the impactor).
h) Grasp the top and bottom halves of the WINS impactor and unscrew the two halves.
i) Service the WINS impactor well, if necessary.
j) 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.
k) Reassemble the impactor well and the WINS impactor. Be sure to keep the unit upright during reassembly to prevent spillage of the impactor oil.
l) Reinsert the WINS impactor into the adapter.
m) Insert the WINS impactor and adapter back into the sampler.
n) Pass the rollers on the filter exchange mechanism through the slots on the guides.

o) Pull on the black handle to fully open the filter exchange mechanism.

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

4. Perform a sampler external and internal leak check.

6.2 **Fourteen-Day Maintenance**

The following maintenance items are to be serviced every 14 sample days:

1. Clean PM_{10} Inlet:
   a) 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.
   b) 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 the top plate deflector cone and internal surface of the acceleration assembly. Check the O-rings. Reassemble the acceleration assembly.
   c) 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 and clean if necessary.
   d) 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.
   e) Reassemble the two halves of the PM_{10} inlet. Hand tighten only.
   f) Reinstall the PM_{10} inlet onto the sample tube.

6.3 **Quarterly Maintenance**

1. Inspect and grease PM_{10} inlet O-rings:
   Remove the PM_{10} inlet and inspect the O-rings that seat against the sample tube. Replace or lubricate the O-rings as necessary.
2. Clean Sample Tube and Inspect Bulkhead Fitting O-rings:
   a) Remove the PM_{10} inlet from the sample tube by pulling straight up.
   b) Loosen the nut on the bulkhead fitting at the top of the FRM enclosure.
   c) 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.
   d) Clean the inside of the sample tube using a dry paper towel or a suitable brush. Use a general-purpose cleaner, if necessary.

e) Inspect the bulkhead fitting O-rings. Replace or lubricate the O-rings, as necessary.
f) Insert the correct end of the sample tube into the bulkhead fitting and gently push until the tube stops.
g) Tighten the nut on the bulkhead fitting to ensure a watertight fit.
h) Reinstall the PM_{10} inlet on top of the sample tube.
i) Perform a sampler leak-check.

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

6.4 **Six-Month Maintenance**

1. Replace In-line Air Filter:
   a) Open the Partisol 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.
   b) Locate the large in-line filter in the top of the pump compartment.
   c) 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
   d) Install the replacement filter.
   e) Perform a sampler external leak check and internal leak check.
   f) Reattach the pump, compartment cover. Be sure to secure the electrical grounding wire to the lower right-hand screw.
2. Clean Air Screens:
   a) Remove the three rain hoods that cover the vents on the side of the FRM enclosure.
   b) Each vent is covered with a removable air screen.
   c) Remove the air screens and clean with water. Dry thoroughly before reassembling.
   d) Reassemble the air screens and reattach the rain hoods.
3. Check System Board Battery Voltage
   a) Turn off the sampler and disconnect the Partisol from the power source.
   b) Open the door to the electronics compartment (behind the sampler display).
   c) The sampler uses two batteries on the circuit board at the back of the electronics compartment. Each needs to be tested.
   d) 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.
   e) 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.

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

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

7 Performance Audits

Performance audits are designed to evaluate the accuracy of the sampler in measuring the key parameters involved in collecting a valid $PM_{2.5}$ sample. The parameters are the volumetric flow rate, ambient air temperature, filter temperature, barometric pressure and time. Performance audits should be conducted in accordance with the frequency and personnel requirements specified in the QAPP. In general, however, performance audits are to be conducted by personnel not directly involved in the routine operation, data processing or reporting of the $PM_{2.5}$ monitoring network. Furthermore, performance audits are to be conducted using transfer standards different from those used in the routine calibration and operation of the sampler. It is acceptable for the audit transfer standards to be certified against the same local primary standard as the routine transfer standards.

There are three distinct components to the performance audit – a temperature audit, a pressure audit and a flow rate audit. Each of these components is described separately below.

7.1 **Audit Criteria Table**

Criteria	Instrument Flags	EPA Table	Range (and frequency if not every sample)	Current Documentation	Checked By	Current Tracking	Comment if data is qualified
Precision							
Precision: Collocated Samples	NA	operational	CV <=10% for samples > 6 ug/m3 checked at 25% of sites every 6 days	Duplicate site sampler comparison report, generated monthly	AQM and LAB	Lab review during report validation	Primary versus duplicate results CV >10% for >6 ug/m3 samples: verified
Accuracy							
Sampler Temperature Audit (filter T and ambient T)	NA	operational	<=±2°C checked each sampler 4 times per year	QA section documentation	QA	QA to AQM	NA

Sampler Pressure Audit	NA	operational	<= ±10 mm Hg checked each sampler 4 times per year	QA section documentation	QA	QA to AQM	NA
Sampler Flow Rate Audit	NA	operational	<= ± 4% of audit standard <= ± 5% of design flow rate 4/year	QA section documentation	QA	QA to AQM	NA
Balance Audit	NA	operational	manufacturer specifications 1 time per year	Yearly balance maintenance/service	Contracted Maintenance	Label on balance and notice from service company	NA
Audit Criteria							
Audit Thermometer (QA and AQM)	NA	operational	± 0.1° C resolution, ± 0.5° C accuracy, check once per month (AQM)	Manufacturer specs, comparison to traceable thermometer	AQM and QA	To be developed	NA
Audit Barometer (QA and AQM)	NA	operational	± 1 mm Hg resolution, ± 5 mm Hg accuracy, check once per month (AQM)	Manufacturer specs, comparison to traceable barometer	AQM and QA	To be developed	NA
Audit Orifice (QA and AQM)		systematic	± 0.08 Plum resolution, ± ?? Plum accuracy, calibrated to primary standard every 6 months (AQM)	Manufacturer specs, comparison to traceable flow measurement device	AQM and QA	To be developed	NA

7.2 **Performance Audit Reporting**

Upon completion of the performance audit, immediately inform the site operator of the audit results so that corrective action may be taken, if necessary. An audit report should be prepared for submittal to the ADEC-AQI Section Chief within 30 days of the completion of the audit.

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Air Quality — Monitoring & Quality Assurance Program

$PM_{2.5}$ Flow Rate, Temperature & Pressure Audit

Network Agency:	ADEC, AM&QA								
Site Name:		**GPS:**	North		West		**Elevation:**		
Location:				**Date:**			**Time:**		
Auditor:				**Observer:**					

SAMPLER INFORMATION

Sampler:	FRM-A	**Sampler Manufacturer:**	R&P Inc.	**M/N:**		**S/N:**		**Last QC Check:**	
Calibration Factors	**flow offset:**		**flow span:**	**T_a offset:**			**T_f offset:**	**pressure offset:**	
Calibration standard make:	BGI	**model:**		**S/N:**			**cert. date:**	**exp. date:**	

AUDIT INFORMATION

Flow Audit Device	**Manufacturer:**			**M/N:**		**S/N:**	
cert. by:	BGI	**cert date:**	**exp. date:**		T_a units in ^oC	P_a units in mb and mmHg	Flow units in L/min

Audit Results

Audit Data						**Sampler FRM-A Data**				**Δ** Sampler - Audit			Flow Rate % Δ	
				Flow Rate										Design
Temperature		Pressure		delta H_2O		Flow Rate	Temperature		Pressure	Temperature		Pressure	Accuracy	(A -16.7)/
Inlet (^oC)	Filter (^oC)	(mbHg)	(mmHg)	(inches)	Q_a (L/min)	Q_a (L/min)	Inlet (^oC)	Filter (^oC)	(mmHg)	Inlet (^oC)	Filter (^oC)	(mmHg)	(S-A)/A*100	16.7*100
Internal Leak check			initial vacuum (in. Hg):			vacuum after 30 sec. (in. Hg):				diff. (in.Hg)=		<=-8.5in. Hg/30 seconds, acceptable		
External Leak check			initial vacuum (in. Hg):	-23.7		vacuum after 30 sec. (in. Hg):	-22.6			diff. (in.Hg)=	-1.1	<=-8.5in. Hg/30 seconds, acceptable		

Sampler ID	**QC Time (AST)**		**Sampler Time (AST)**		**AST Time Δ**		**Acceptance Δ Criteria**	
	Date	hour:minute:second	Date	hour:minute:second	Date	hour:minute:second	min.	Pass/Fail
						0:00:00	≤ ± 1	

Audit Criteria

Flow Audit	Audit % Δ = [(Q_a,sampler - Q_a,orifice)/Q_a,orifice]*100	Audit % Δ ≤± 4%
	Design Condition % Δ = [(Q_a, sampler - 16.7)/16.7]*100	Design Condition % Δ ≤± 5%
	Internal, External Leak Check	≤ 8.5 inHg/30 seconds
Temperature Audit	Audit Δ = Temperature (inlet) - Audit temperature (measured at inlet)	Audit Δ ≤± 4^{o}C
	Audit Δ = Temperature (filter) - Audit temperature (measured at filter)	Audit Δ ≤± 4^{o}C
Pressure Audit	Audit Δ = Sampler Pressure - Audit Pressure	Audit Δ ≤± 10 mmHg.
Time Check	QC Δ = Sampler Time - QC Std. Time	Time Δ ≤± 1 minute