Met One Instruments E-Sequential FRM Operating Procedure

By
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For the
Air Quality Program

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Olympia, Washington

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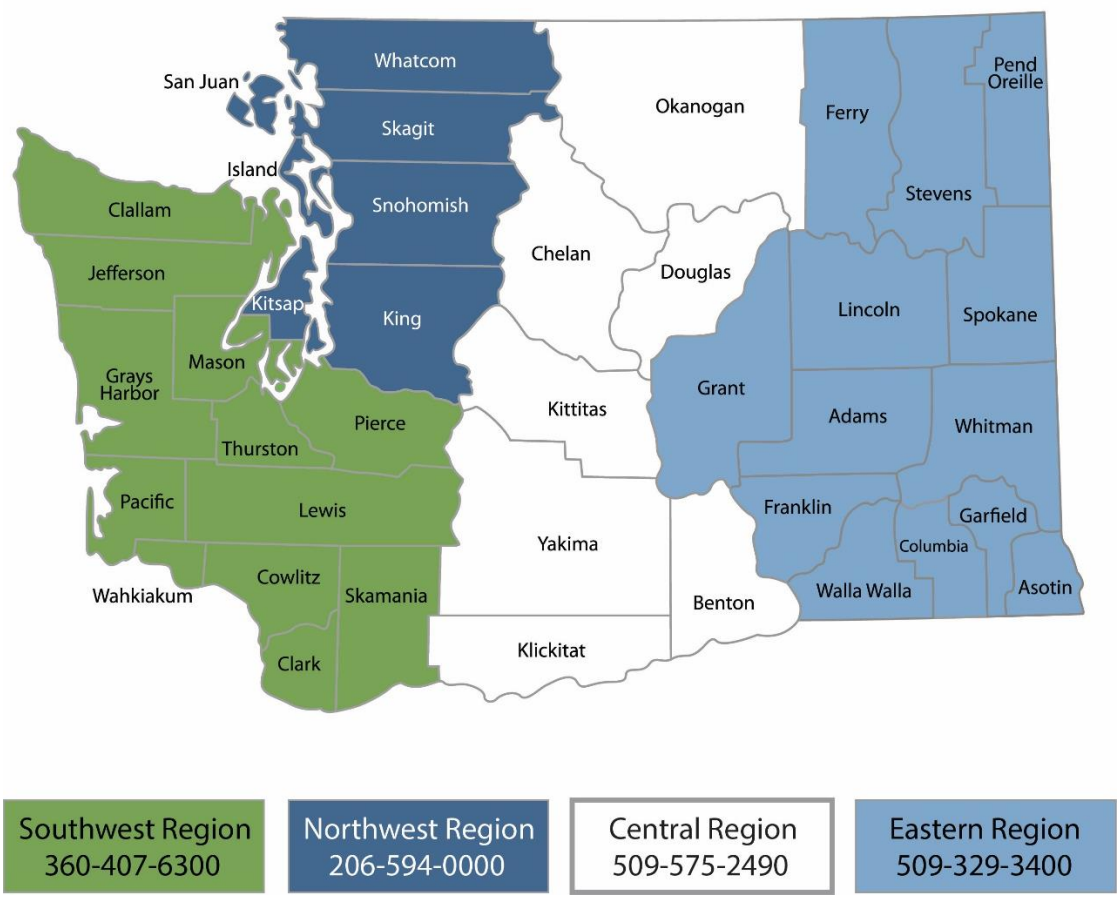

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Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	PO Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	PO Box 46700 Olympia, WA 98504	360-407-6000

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Air Quality Program
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Olympia, WA

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Revision History

Revision Date	Revision Number	Summary of Changes	Revised Sections	Revised by
05/12/2025	1.0	Initial publication.		Greg Crider and Wes Davis

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Definitions and Acronyms

AC	Alternating current
CFR	Code of Federal Regulations
Ecology	Washington State Department of Ecology
ERG	Eastern Research Group Inc.
EPA	Environmental Protection Agency
E-SEQ-FRM	Met One E-Sequential sampler
FRM	Federal Reference Method
mmHg	Millimeters of mercury
NATTS	National Air Toxics Trends Station
NIST	National Institute of Standards and Technology
Pace	Pace Analytical Services LLC
PM	Particulate matter
$PM_{2.5}$	PM less than 2.5 micrometers in diameter
PM_{10}	PM less than 10 micrometers in diameter
QC	Quality control
$\mu g/m^3$	Micrograms per cubic meter
µm	Micrometer
VAC	Volts alternating current
VDC	Volts direct current
VSCC	Very sharp cut cyclone

1. Introduction

This document describes the Washington State Department of Ecology's (Ecology) procedures for sampling ambient air for particulate matter (PM) with an aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$) or 10 µm or less (PM_{10}) using a Met One E-Sequential reference method sampler (E-SEQ-FRM). The E-SEQ-FRM is designed to meet the Federal Reference Method (FRM) requirements for $PM_{2.5}$ specified in 40 CFR Part 50 Appendix L when used with the model-specific information and instructions provided by the manufacturer.

For 24-hour accumulative $PM_{2.5}$ and PM_{10} mass concentration measurements in ambient conditions, the E-SEQ-FRM is configured for multi-event sampling and operated in accordance with the EPA's reference methods RFPS-0717-545 and RFPS-0717-246, respectively. Requirements of these methods include:

- Use of the US EPA PM_{10} inlet specified in 40 CFR 50 Appendix L, Figs. L-2 through L-19
- Operating flow rate of 16.67 L/min
- Use 47 mm PTFE membrane filter media

E-SEQ-FRM are operated in accordance with the Met One Instruments E-SEQ-FRM Particulate Sampler Operation Manual, with firmware version R1.1.0 and later.

If measuring $PM_{2.5}$, the sampler is equipped with a Met One Instruments BX-808 or Mesa Laboratories Very Sharp Cut Cyclone (VSCC) in the sample train.

The Pace Analytical Services LLC gravimetric laboratory (Pace) processes all $PM_{2.5}$ and PM_{10} samples from E-SEQ-FRM samplers operated within the Washington Ambient Air Monitoring Network (Washington Network). Following gravimetric analysis, PACE sends the PM_{10} samples collected on a 1:6 day sampling schedule at the Seattle-Beacon Hill monitoring station to Eastern Research Group Inc (ERG) for metals analysis with Inductively Coupled Plasma Mass Spectrometry as part of the National Air Toxics Stations (NATTS) network requirements. More on the metals analysis can be found in Ecology's Air Toxics Monitoring SOP.

2. Principle of Operation

The E-SEQ-FRM is a programmable multi-event filter sampler designed to meet FRM requirements for 24-hour measurements of $PM_{2.5}$ or PM_{10} concentrations in ambient air.

The E-SEQ-FRM employs a supply magazine containing up to 16 pre-weighed 47 mm sample filter discs of a known mass (pre-weighed) in individual EPA-standardized cassettes. These are automatically exchanged by the sampler prior to each sample period. The instrument runs according to an operator programmed schedule with defined start times and sampling durations.

A vacuum pump, controlled to 16.67 liters per minute (lpm), draws ambient air through a series of standardized inlets that provide the PM_{10} and $PM_{2.5}$ cut points. The sample then passes through the filter, where the airborne PM is deposited.

After the 24-hour sample period is complete, the sampled filter is automatically moved to the storage magazine which is later emptied. The filters are then sent to a lab where they are to be equilibrated and reweighed. Because volatile compounds can evaporate, the filters are weighed in a temperature-, humidity-, and static-controlled environment. The difference between pre- and post-sampling mass divided by the total air flow through the filter during the 24-hour duration provides a concentration in micrograms per cubic meter ($\mu g/m^3$).

In the Washington Network, the E-SEQ-FRM is configured as a FRM for $PM_{2.5}$ when equipped with a Met One Instruments BX-808 or Mesa Laboratories VSCC. The instrument and its components are shown in Figure 2-1. When paired with an E-SEQ-FRM configured as a $PM_{2.5}$ FRM, the E-SEQ-FRM is also operated without the $PM_{2.5}$ cyclone for measurement of $PM_{10\text{-}2.5}$.

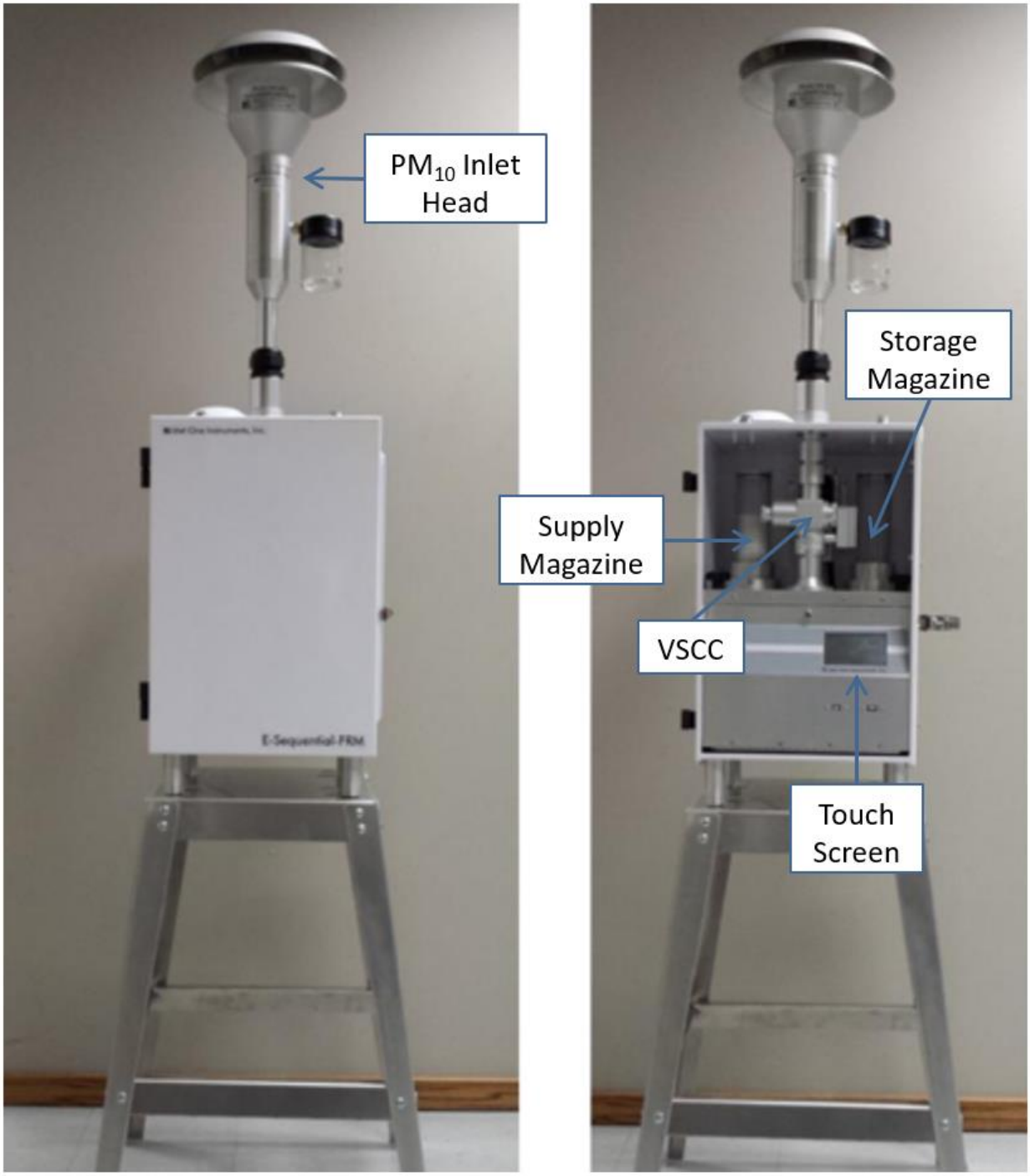

Figure 2-1: E-SEQ-FRM front views with and without the door

3. Safety

Repair of the E-SEQ-FRM should only be performed by properly trained service personnel. Contact Ecology's Calibration & Repair laboratory for help with troubleshooting and use established safety precautions when working with this instrument.

The E-SEQ-FRM is heavy, weighing over 50 lb. Follow proper lifting techniques, including using team lifts when moving or installing. The stand must be anchored when installed outdoors to prevent tipping of the sampler and/or stand in high winds. The stand is designed to be bolted or screwed down to a wooden platform or deck. Cement blocks can also be used if needed.

Monitoring stations may attract a wide array of spiders, insects, and other wildlife. Hornets, wasps, and bees may build nests around the area. It is also common to find spiders and other insects around and inside the monitor, especially underneath the rain hoods and around fan vents. Always check these areas before reaching into them. It is advisable to keep insecticide or wasp killer onsite.

4. Equipment and Supplies

This section details the equipment, consumables, and tools necessary to operate and maintain the E-SEQ-FRM in the field. Contact the Calibration and Repair lab for assistance in sourcing any of these materials.

4.1. Transfer Standards

The following transfer standards are required during QC checks and audits:

- Certified NIST-traceable volumetric flow meter (e.g. Alicat FP-25 transfer standard or similar certified flow device)
- Certified NIST-traceable transfer standard for measuring ambient temperature, with an accuracy of ±2 ^{o}C over the range of -30 to 45 ^{o}C and a resolution of 0.1 ^{o}C
- Certified NIST-traceable barometer for measuring ambient barometric pressure with an accuracy of ±5 mmHg over a range of 600 to 800 mmHg and a resolution of 1 mmHg
- A clock displaying standard time. Official time may be referenced from a network datalogger, agency laptop, or agency phone

4.2 Consumables

The following consumables should be brought or stored onsite for replacement as necessary:

- O-ring kit for VSCC, PM_{10} inlet and E-SEQ-FRM Sampler Unit
- CR 1216 batteries
- Vent filters
- Spare pump assembly
- Silicone based O-ring grease
- 47 mm Teflon filters (supplied pre-tared and numbered by Pace)
- Filter cartridges and replacement cassette magazine

4.3 Tools

The following tools should be brought or stored onsite:

- Cotton swabs, paper towels, lint free cloths
- Small soft-bristle brush
- Distilled water
- Canned air
- General tool kit; including small screw drivers and wrenches
- Leak test inlet valve
- Transport cooler equipped with ice packs and a Nist-traceable min/max thermometer
- RS-232 communication cable (Serial to 5 Pin DIN)
- USB flash drive
- USB communication cable, Type A-B Male

5. Installation

The Calibration & Repair Lab will provide a calibrated E-SEQ-FRM.

1. Upon receipt of the E-SEQ-FRM, perform a visual inspection. Notify the Calibration & Repair Lab immediately of any missing or damaged equipment and if there are questions about the assembly.
2. Carefully transport the sampler to the field site. Level and secure the sampler and stand in its location. Install any parts separated for shipping as described in the manufacturer's manual.
3. Install the PM_{10} head on the downtube of the base unit and check all tubing and power cords for crimps, cracks or breaks.
4. Once the sampler has been completely assembled and secured, turn it on and allow it to equilibrate to ambient conditions for at least 15 minutes.

5.1. Siting Criteria

Proper siting is essential to ensure that data collected are representative at the appropriate scale for the monitoring project. The majority of $PM_{2.5}$ and PM_{10} monitoring in the Washington Network is conducted at the neighborhood scale. Siting criteria for neighborhood-scale PM monitoring sites are described in 40 CFR Part 58, Appendices D and E; the primary considerations are summarized in Table 5-1 below. For additional information regarding site selection, refer to Ecology's Site Selection and Installation procedure.

Table 5-1: Summary of PM Siting Criteria (adapted from Vaughn, 2009)

Parameter	Category	Siting Requirement
Inlet Height	General	2-15 m above ground
	On rooftop	2 m above roof
	Collocated sampler	Within 1 vertical m of each other
	Inlet tube length	≤16 ft (4.9m)
Inlet radius clearance	General	≥ 1 m radius clearance
	Collocated samplers	1-4 m between inlets
	Near small obstructions (fences, walls, etc)	≥ 2 m
	Near large obstructions (buildings, sound walls, billboards, etc)	Distance ≥ 2x height of obstruction
	Near overhanging trees	≥ 10 m from dripline; ≥20 m from dripline is recommended
	Arc of air flow	Unrestricted, continuous 270° arc that includes prevailing direction of high concentrations
Nearby air sources	General	As far away as possible from vents
Distance from roadways	< 3,000 vehicles per day	≥ 5 m from nearest traffic lane
	Elevated roadway (>25 m high)	≥ 25 m away
	Unpaved roads	As far away as possible

The sampler must be installed in a secure location that can be safely accessed by monitoring staff even during inclement weather. Ground-level sites with fences are common and advised. Rooftop sites may provide a secure alternative given that they meet the Air Quality Program's safety requirements (see the Air Quality Program Safety Plan). Additionally, the site must be equipped with adequate and stable power to support routine operation.

The E-SEQ-FRM sampler runs on 12 VDC power and includes a power supply to adapt from 115-230 VAC. The sample site needs to be equipped with AC power and a standard weatherproof outdoor electrical outlet. An earth-ground point near the unit is strongly recommended.

5.2. Inlet Configuration

Two inlet components are used in series to separate $PM_{2.5}$ from ambient air prior to sample collection; a PM_{10} inlet and $PM_{2.5}$ VSCC. Figure 2-1 shows the inlet head of the PM_{10} sampler situated on top of the instrument. This inlet is designed to remove particles with aerodynamic diameter greater than 10 µm and send the remaining smaller particles to the next stage. Figure 5-2 shows the VSCC impactor inside the enclosure, which removes particles greater than 2.5 µm in diameter. Smaller particles pass through to be collected on the Teflon filter. The size of particles sorted is dependent on flow rate; flow must be maintained at 16.67 LPM to properly sort particles.

5.2.1. PM_{10}

When sampling PM_{10}, a pass-through adapter is mounted on the sampling station receiver inside the enclosure in place of a VSCC. To install the pass-through adapter, insert one of the two coupler rings on top of the PM_{10} pass-through adapter and install the adapter over the receiver on the sampling station as shown in Figure 5-1.

Press down on the adapter to fully seat it on the receiver of the sampler. There should be a gap between the PM_{10} adapter and the upper receiver. Install the second coupler ring on the short inlet coupler. Place the coupler in the gap between the adapter and the upper receiver. Slide both connector rings up to seal the two gaps between the upper receiver, the inlet coupler, and the pass-through adapter.

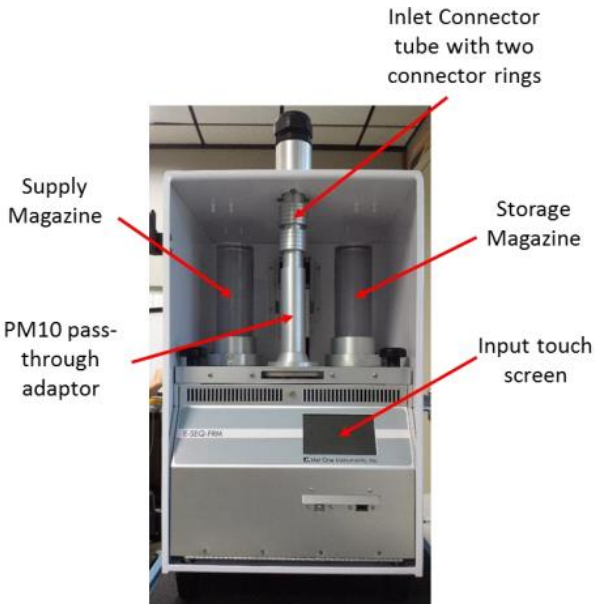

Figure 5-1: Installation Using the PM_{10} Pass Through Adapter (Met One, 2013)

5.2.2. $PM_{2.5}$

The $PM_{2.5}$ VSCC is installed inside the enclosure, as described in Section 3.3.5 of the Manual. To install, insert one of the two coupler rings on top of the VSCC and install the separator over the receiver on the sampling station as shown on the far left of Figure 5-2.

Press down on the VSCC to fully seat the separator on the receiver of the sampler. There should be a gap between the cyclone and the upper receiver at the top of the enclosure. Install the second coupler ring on the short inlet coupler. Place the coupler in the gap between the separator and the upper receiver as shown on the far right in Figure 5-2. Slide both connector rings up to seal the two gaps between the upper receiver, the inlet coupler, and the cyclonic separator as shown in the far-right image of Figure 5-2.

Figure 5-2: VSCC Installation (Met One, 2013)

6. Instrument Operation

6.1. Pre-Sampling

6.1.1. Scheduling Sample Events Using FSCOMMAQ

This section provides steps to schedule filter runs on the E-SEQ-FRM using Met One's desktop-based software, FSCOMMAQ. For additional software information, including installation, data viewing, and running reports, please refer to Met-One's FSCOMMAQ Operators Manual.

The FSCOMMAQ software package can be used to create a full event schedule on a computer. This schedule can then be saved to a USB flash drive and loaded into the E-SEQ-FRM sampler instead of manually configuring each event through the front panel display of the sampler. The event schedule must be configured to match the serial number of the sampler. See Section 9.1 in the FSCOMMAQ software manual for instructions on creating the event schedule and saving it to the USB flash drive.

Filter Blanks: One Filter Blank is deployed per month to ensure accuracy and reliability of the data being collected. By using filter blanks, trends can be tracked in blank mass-loadings and evaluate the performance of the laboratory and the field filter-handling practices. Check the current Pace sampling schedule to identify which set of filters to schedule the filter blank run within. When scheduling the filter blank, choose a date in between regularly scheduled run days and set the run time to 00:00. The filter will shuttle through the sampler but will not be sampled on. This filter is to be handled just like the rest of the lot but will have no run-time, flow, temperature, or pressure data associated with the filter, as it will not be sampled.

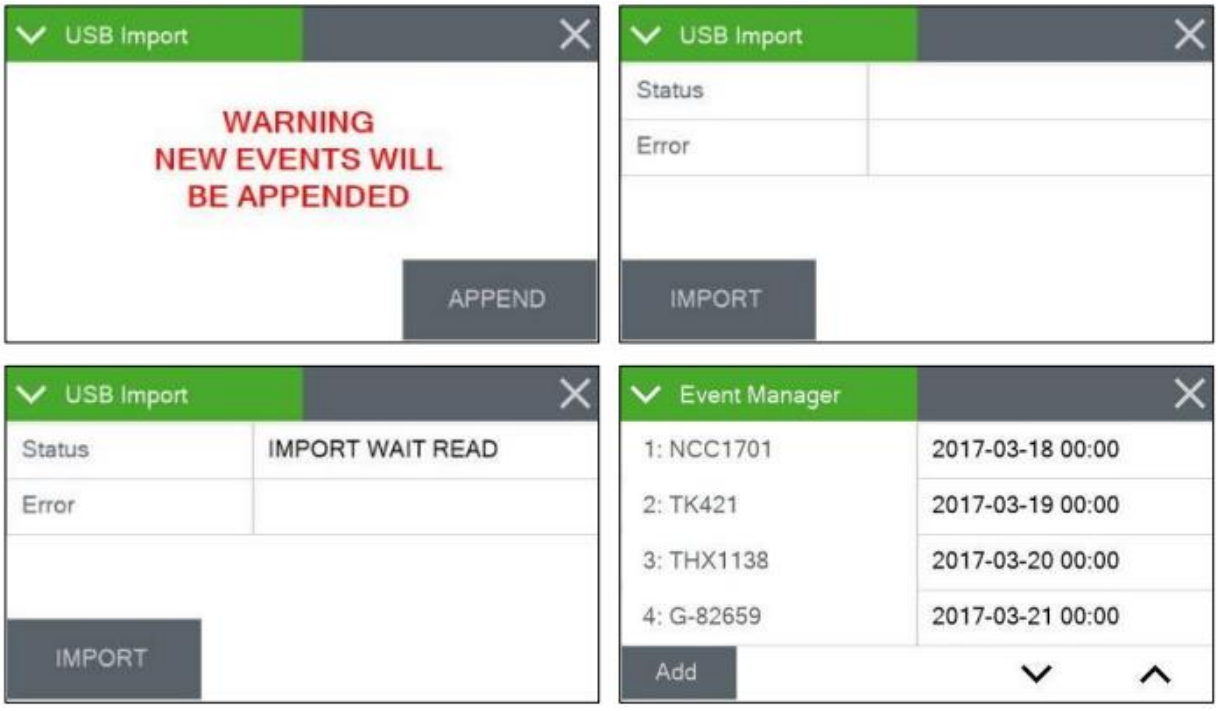

Figure 6-1: USB Import Sequence (Met One, 2013)

To upload a schedule via USB drive:

1. From the Operate Menu, select **USB Import**. You will be warned that added events will not replace currently scheduled events but will be added to the end of the list.
2. Press **APPEND** to proceed to the import screen. The Status and Error fields will be blank. Make sure the USB flash drive containing the event schedule is inserted below the display.
3. Press **IMPORT** and the sampler will import the pre-configured schedule, appending all events to the end of the sample queue.
4. Use the arrow keys to scroll through and review the list. To manually add additional samples, press **ADD** and follow the procedure listed in section 6.1.2
5. **Note:** because the magazine holds 16 filters, no more than 16 events may be scheduled.
6. Once the event schedule has been configured and the new filters are loaded in the supply magazine, press **X** to return to the Operate Menu.

6.1.2. Scheduling Sampler Events Using the Event Manager

The Operate Menu contains most functions used during normal operation. Note that the appearance of the menu changes slightly when a sample event is in progress, as shown in the right-hand image of Figure 6-2. Specifically, the Pause/Stop option appears to interrupt sampling, and the Advance Cassette option appears to allow filter shuttling.

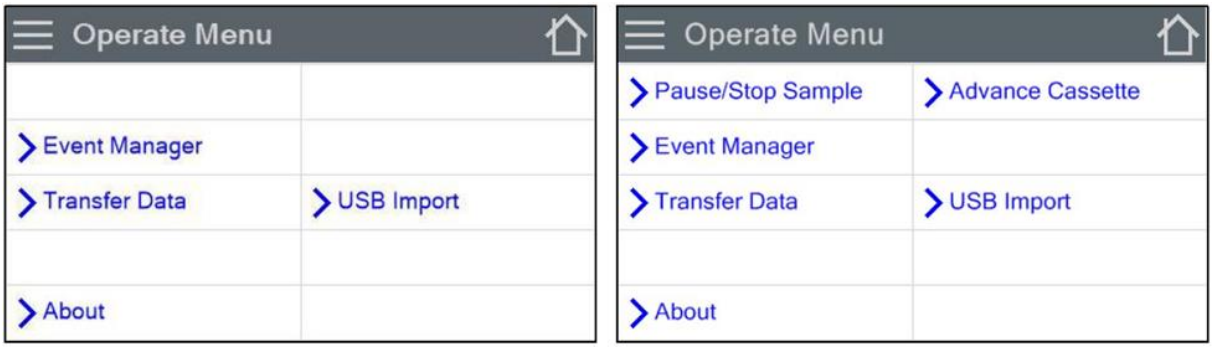

Figure 6-2: Operate Menu and Event Manager Selection (Met One, 2013)

From either the Main Operating Screen or the Operate Menu, select Event Manager. If any events are scheduled, they will be listed on this screen (Figure 6-3).

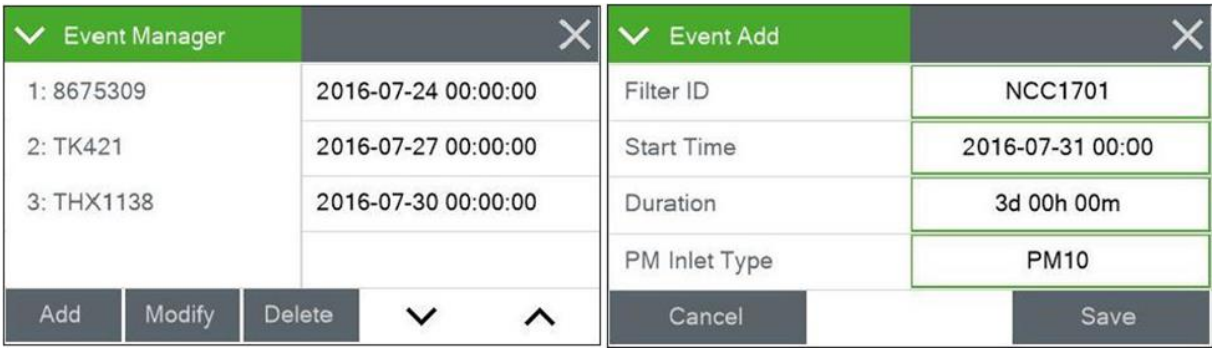

Figure 6-3: Event Manager and Event Add Screens (Met One, 2013)

The filter cassette ID list for the supply magazine should be available when setting up new events. Sampling events must be configured in the order they will be run.

1. Press **Add** to bring up the Event Add interface (right of Figure 6-3). Enter the ID number or name of the filter cassette in the Filter ID field.
2. Set the Start Time: Press Start Time and change this field to the correct start date, year/month/day and time of day. The defaults should be set for a Start Time of 00:00 and a Duration of 1 day (see Section 4.6.1 in the Operations Manual for adjusting Event Default settings).
3. Verify the sample duration is set to 1d 00h 00m
4. Choose the PM Inlet Type: $PM_{2.5}$ If using a VSCC, otherwise PM_{10}.
5. Press **Save**.

If additional sample events still need to be configured, press **Add** again and repeat the above sequence. When adding additional sample events, the start time will be calculated by adding the amount of time set in the Repeat Time field of the Event Defaults screen to the Start Time of the last programmed sample event.

Warning: After all Sampler Event entries or modifications have been entered, exit the Event Manager and return to the Home Screen. The unit will not begin sampling while Event Manager is active.

6.1.3. Loading the Sampler

The E-SEQ-FRM sampler uses 47 mm Teflon filters.

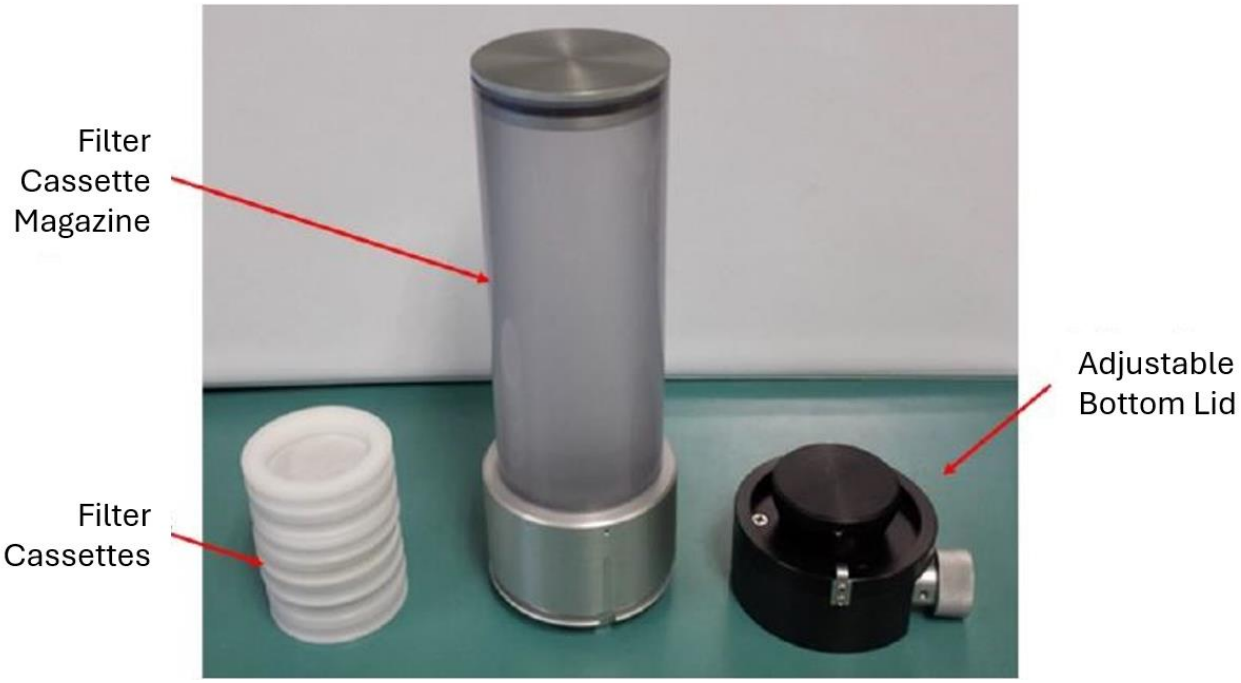

Figure 6-4: Filter Cassettes, Magazine and Adjustable Bottom Lid (Met One, 2013)

The magazine's adjustable bottom lid includes a plunger mounted on a steel ribbon which can be moved up and down by rotating a knob in the base (Figure 6-5). This is used to load or unload filter cassette magazines and secures the internal stack of filter cassettes.

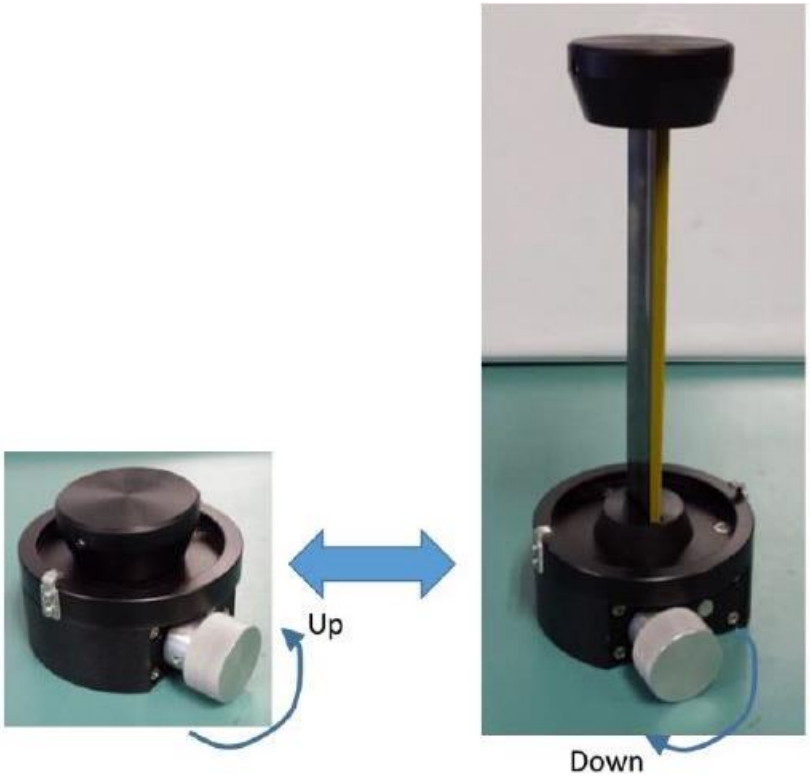

Figure 6-5: Adjustable Bottom Lid Operation (Met One, 2013)

Figure 6-6: Loading New Filter Cassettes into the Magazine (Met One, 2013)

To load the magazine with filters:

1. Remove top magazine lid and install the adjustable bottom lid into the base of the magazine. Rotate the bottom lid to secure it in place.
2. Turn the knob of the bottom lid counterclockwise until the plunger is positioned near the top of the magazine.

3. Record the ID of the first filter cassette and set it on top of the plunger. It should be resting nearly level with the top of the magazine.
4. Record the ID of the next filter cassette. Be certain to indicate this cassette's position in the magazine stack. It will be necessary to know the exact order of the filters later when programming the sequential sampling events.
5. Rotate the knob in the bottom lid clockwise to lower the plunger just far enough to set the next filter cassette holder in place so that it is level with the top of the magazine.
6. Repeat steps four and five as needed until all the desired filter cassette holders are loaded and then install the top lid.
7. The bottom lid remains in place. Raise the plunger just enough to secure the filter stack in place so that it does not wobble or shake during transit.
8. Keep a copy of the filter ID sequence with the magazine. It will be needed when the magazine is installed in the sampler.

6.1.5 Installing a Supply Filter Cassette Magazine.

1. Remove the current supply magazine (if installed) and set it aside.
2. On the new supply magazine, slowly lower the plunger until the filter stack is supported on the stops.
3. Gently rotate and remove the bottom lid from the magazine.
4. Carefully align the magazine's mount slot with the supply mounting index inside the sampler (see Figure 6-7).
5. Insert the supply magazine into the mounting index and rotate as shown by the arrows in Figure 6-7. The magazine can be rotated in either direction. Rotate until the magnets catch. An audible clicking sound should be heard and the filters should drop down into place.
   Warning: If the filters don't drop into place, it is very likely they will not cycle properly during sampling. It is surprising how far the supply stack will drop (3 filters will drop into the sampler).

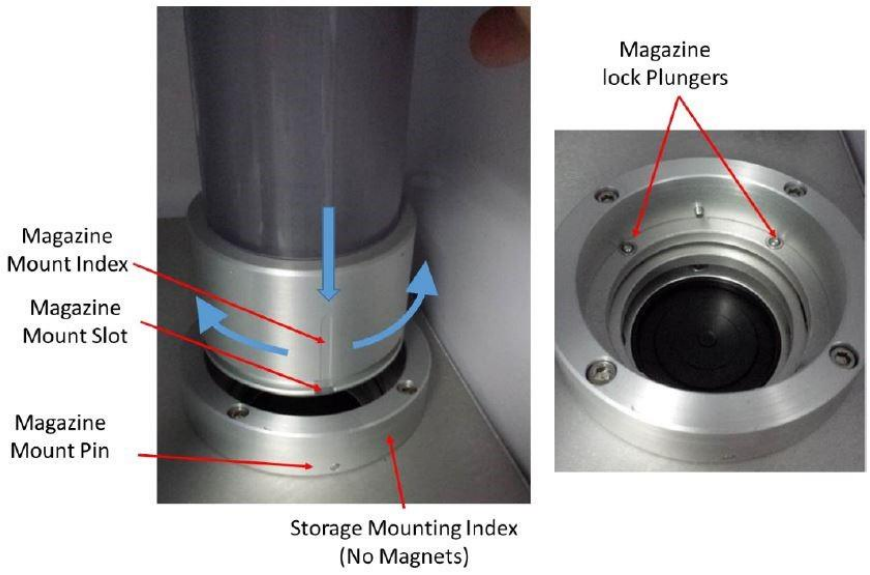

Figure 6-7: Mounting the Storage Magazine (Met One, 2013)

6.1.6 Installing a Storage Filter Cassette Magazine

The storage magazine houses used filters until they are removed. The storage mounting index is slightly different than the supply mounting index shown in Figure 6-7. The storage magazine should always be empty when it is loaded into the sampler. Never load a storage magazine that already contains used filters. Instead, ship these to the lab.

To install the storage magazine:

- Align the storage magazine's mount slot with the storage mount index pin.
- Insert storage magazine into storage mounting index, push down, and then turn the magazine as shown by the arrows in Figure 6-7. The magazine can be rotated in either direction. Rotate it until the magnets catch and it clicks in place.

6.2. Post-Sampling

6.2.1. Sample Pickup

Filters must be picked up within 177 hours (7 days, 9 hours) of the end of the filter's run date. Return to the sample site and carefully remove the right-side filter magazine (storage magazine) from the sampler. The storage magazine is designed to hold the filters during transport from the field. Additional or replacement magazines are available. When filters are removed from the magazine, individual filters must be returned to their individual protective coverings (polyethylene or polypropylene bag) and packaged carefully to avoid damage or contamination. Note the removal date and time on each baggy.

After all filters in the current batch have been sampled and removed, install a loaded supply magazine and empty storage magazine and set up the next sampling run. Sample setup of the E-SEQ-FRM can take place any day after the previous sample has been recovered. Pre-sampling hold times for filters is 30 days. If more than 30 days has expired or will expire prior to sampling, contact Pace for replacement filters.

Place the filters in their corresponding plastic baggy, along with a min/max NIST-traceable temperature probe, in a cooler and surround them with blue ice to keep them cool during transport. Plastic gloves must be worn whenever handling filters.

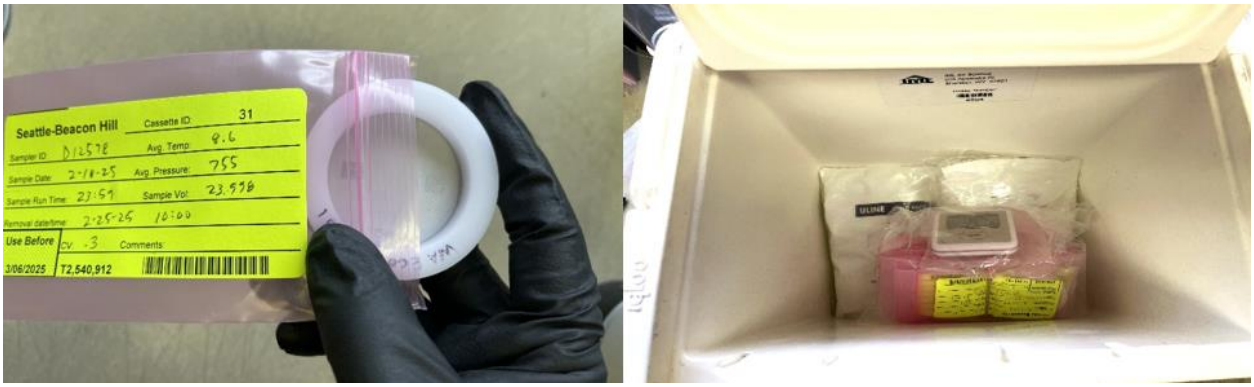

Figure 6-8: Proper Sample Handling

After retrieval, the filters must stay under 4 °C. The min/max temperature probe must accompany the filters from the moment they enter the cooler until they are opened at Pace. Pace will qualify samples whose temperature exceeded 4 °C during transit. Pace will provide custody seals to seal the ice chest during shipping. The seals should be placed on the lid as shown in the left of Figure 6-9. The ice chest is then taped closed and the shipping label, provided by Pace, is placed as shown on the right of Figure 6-9.

Figure 6-9: Shipping Container with Custody Seal

6.2.2. Filter Handling and Preservation

During transit to the site, filters must be protected from physical damage and excessive heat (e.g., direct sunlight, hot vehicles). No specific temperature control is required during transport to the sampling location.

During sampling, the temperature difference between ambient air and the filter must not exceed 5 °C for more than 30 consecutive minutes.

Samples must be used within 30 days of the initial tare date. Following the scheduled sampling period, filter cartridges must be retrieved from the monitoring location within 177 hours. Storage temperature and recovery times must be documented on the FRM Chain of Custody form. Upon retrieval, filters should be removed from the magazine (if not done in the field) and placed in appropriate laboratory bags, then stored in a refrigerator maintained at 4 °C. Minimize filter handling to mitigate the potential for condensation on the filters or their bags. Finally, all exposed filters must be shipped or delivered to the laboratory within 23 days of the oldest sample run date, accompanied by a completed Chain of Custody form. For detailed information regarding acceptable filter holding times, please refer to Appendix D.

6.2.3. Filter Quality

FRM monitoring of $PM_{2.5}$ requires a 47 mm diameter, 2 µm pore-size Teflon® filter. Filters must be obtained from EPA and are sent directly to the laboratory for initial weighing (taring).

Filters and cartridges should be checked at each step of the monitoring process – upon receiving filters from the lab, after transporting filters to the site, prior to installing filters in the FRM monitor, after transporting the collected samples back to the office, and prior to shipping

the filters back to the lab for analysis and weighing. It is important to note the integrity and condition of the filters at each step of the process so that it is possible to track what may be leading to filters being damaged and what corrective action may be needed. Important things to look for are pinholes, loose material, discoloration, or non-uniformity of color or shading across the filter. Filters with holes or tears prior to sampling must not be used. If replacement filters are not available the sampling run(s) will be missed. Work with the lab to ensure an adequate supply of extra filters is on hand. If a damaged filter is replaced, note the new filter's ID on the Chain of Custody form so that the correct ID is associated with the correct run day.

If filter imperfections (discoloration, scrapes, and marks other than holes and tears) are noted, the data reviewer should determine whether the resulting concentrations were impacted.

6.2.4. Handling Sample Data

After the filters have been collected, the data for each sample must be sent to Pace, as well Ecology's Quality Assurance team, via email. For sites that have connected the analyzers to data loggers, the data can be uploaded through FSCOMMAQ. This process is described in section 3 of the FSCOMMAQ operators manual.

For sites without an ethernet or RS-232 connection to the analyzer, the data can be downloaded onto a flash drive using the USB port on the front of the instrument. This data also must be transcribed onto each individual filter baggy, as well as the Chain of Custody form that will accompany the filters to Pace Labs.

USB Data Transfer Instructions (from section 4.4.3 of the E-SEQ-FRM Manual):

1. Enter the **Operate** > **Transfer Data** menu
    a. The Days field determines how many records will be downloaded. If it is necessary to change the number of days being copied, press the green bordered value box and the numerical entry keypad will be displayed. Enter the number of days between 0 and 999. Selecting 0 will download all data.
    b. The FILES field determines whether all of the stored record types will be downloaded or only the user selected records. The USER files are ones which are used for all routine data collection purposes. The ALL option includes additional factory diagnostics files which are only used if data is being sent to Met One Instruments for factory support. The default setting is USER. If this field needs to be changed, press the green bordered value box and a list of the options available will be displayed. Tap the one required, and it will be applied.
2. Locate the USB slot below the display and insert a USB memory stick into it.
3. Press the **COPY** button to copy the selected data to the USB memory stick. (See Figure 6-10).
4. When the COPY COMPLETE message is displayed, remove the USB memory stick and close the front door of the sampler.
5. Access the USB files on a computer and transcribe the pertinent data onto each individual filter baggy (see Figure 6-11).

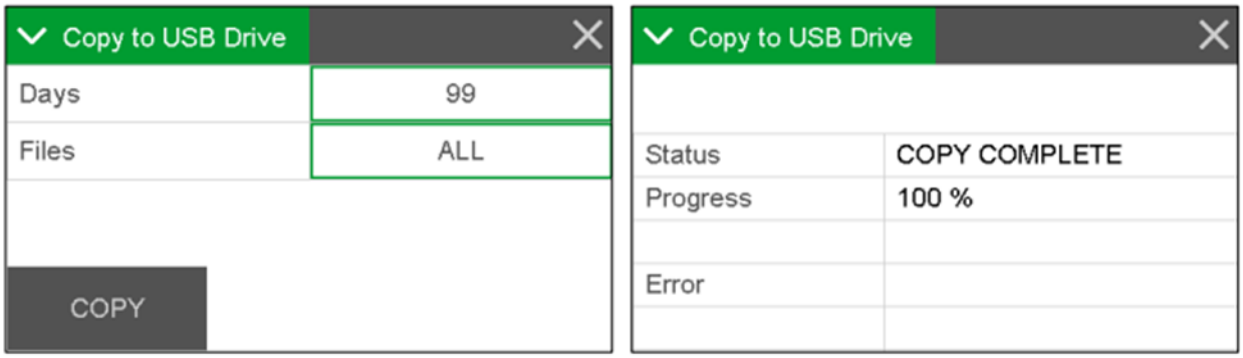

Figure 6-10: Data Transfer Screens (Met One, 2013)

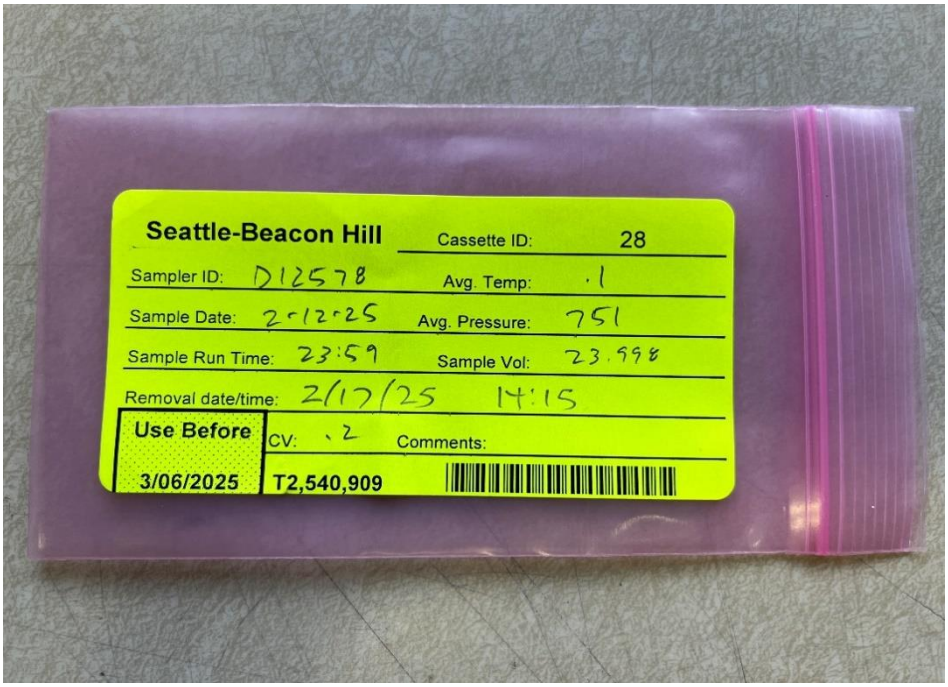

Figure 6-11: Pace filter baggy

7. Quality Control and Calibration

To ensure proper operation of the instrument, QC checks, calibrations, and maintenance must be conducted at regular intervals. QC requirements and acceptance criteria from EPA's $PM_{2.5}$ Validation Template are summarized in Table 7-1.

Table 7-1: QC Requirements and Acceptance Criteria

Criteria	Frequency	Tolerance Limits	Invalid?
Filter holding time	All Filters	Pre-sampling: ≤ 30 days Sample recovery: ≤ 177 hours from sample end date	Yes
Sampling duration	All Filters	1380-1500 minutes, unless <1380 and PM result exceeds NAAQS (must be flagged)	Yes
Average Flow Rate	24 hours of operation (midnight to midnight)	± 5.1 % of design flow (16.67 lpm)	Yes
Variability in flow rate	24 hours of operation (midnight to midnight)	Coefficient of variation (CV) ≤ 2 %	Yes
Flow Verification	QC: Monthly Audit: Semi-annual	± 4.1 % of actual flow; ± 5.1 % of design flow	Yes
External leak check	QC: Monthly Audit: Semi-annual	>5 mmHg after 3.4 min	Yes
Internal leak check	If External Leak check fails	>5 mmHg after 3.4 min	Yes
Clock verification	QC: Monthly Audit: Semi-annual	± 1 min. of data logger	Weight of evidence
Temperature verification	QC: Monthly Audit: Semi-annual	± 2.1 °C	Weight of evidence
Pressure verification	QC: Monthly Audit: Semi-annual	± 10.1 mmHg	Weight of evidence

7.1. Field QC Procedures

This section describes the QC and calibration procedures for verifying and ensuring proper operation of the E-SEQ-FRM.

Because $PM_{2.5}$ concentration standards are not available for establishing calibration relationships, individual components of the sampling method, such as the sample flow rate, ambient temperature, and pressure must be periodically checked and calibrated as needed to ensure integrity of the reported data. It is also critical that the sampler's clock be accurate to ensure that daily samples are comparable across the state and national $PM_{2.5}$ and PM_{10} networks.

Only NIST-traceable devices with current certification can be used to verify and calibrate the sampler's flow, temperature, and pressure. These devices are referred to as transfer standards and must be recertified annually. The Calibration & Repair Lab will recertify these field standards for operators on an annual basis. Operators should coordinate with the Calibration & Repair Laboratory and build in sufficient lead-time to ensure that their transfer standards' certifications do not expire.

Operators are required to use the current electronic $PM_{2.5}$ and PM_{10} QC form provided in Appendix A and available upon request from the Quality Assurance team.

7.1.1. Beginning the QC Check

To ensure proper operation of the E-SEQ-FRM sequential sampler, a full QC check must be conducted every 30 days and following any instrument calibration.

Note: Scheduling QC checks between batches of filters is highly recommended.

An as-found QC must be conducted prior to any instrument adjustments or calibration and an as-left QC must be conducted following any calibration, repair, or major maintenance. As-found and as-left QCs must be documented on two separate forms.

Table 7-1 summarizes QC acceptance criteria. The operator should adjust or investigate the cause of potential leak when the QC results exceed the action limits to avoid data loss. In addition to calibrating when a parameter falls outside the acceptance limits, the sampler must be calibrated after any repairs and after the sampler is transported.

7.1.2. Filter Shuttling

Scheduling QC checks between filter runs eliminates the need to shuttle filters and avoids potential for filters being swapped. If a QC check must be done while filters are still in the supply magazine (left side), follow these instructions to remove the filters in an organized manner.

A video demonstrating the proper method for shuttling filters is available upon request from the Ecology Calibration and Repair lab.

Operators should have either a cooler with ice and a NIST-traceable thermometer, or a refrigerator on-hand to store any filters that have already been sampled. If not, you must keep sampled filters in the same order and avoid handling them manually.

1. Open the sampler and check the supply (left) and storage (right) magazines for filters.
2. Seal the supply magazine with a spare plunger and store it in the back of the instrument.
3. Check if there is a filter in the sampler window. If there isn't, you can simply remove both magazines without shuttling.
    a. If there is a filter in the sampler window, pause the sample (**Transport** > **Move Down**). The sampler will not allow movement if it is not paused.
    b. The following screen will prompt you to **Pause** or Stop. **Do not select "Stop"**, as this will erase the sampler's memory. Instead, **Pause** the sample before proceeding.
4. The screen will prompt you to remove the storage magazine.
    a. Remove it and seal the bottom with an extra plunger.
    b. Keep the magazine upright to prevent filters from flipping.
5. Replace the storage magazine with an empty magazine.
6. Move all unsampled filters from the supply (left) to the new storage (right) magazine. They will now be in reverse order.

7. Move the magazine containing all filters back to the supply position and the empty magazine to the storage position.
8. Transport all filters back to their original magazine by shuttling them back through the sampler. Ensure they are in the correct order by noting the top cassette number at the beginning and end of the two shuttles.
9. Seal the storage magazine and store it in the back of the sampler. Remember to install the supply and storage magazines back in their original positions once your work on the instrument is complete.

7.1.3. External Leak Check

1. Remove the PM_{10} inlet head.
2. Open the Test Menu and select **Leak Test**. You will then be prompted to Pause or Stop sampling. Select **Pause** if more filters are left to be sampled or **Stop** if all sampling events have finished.
3. **TEST** > **Leak Test** > **EXTERNAL** (Figure 7-1).

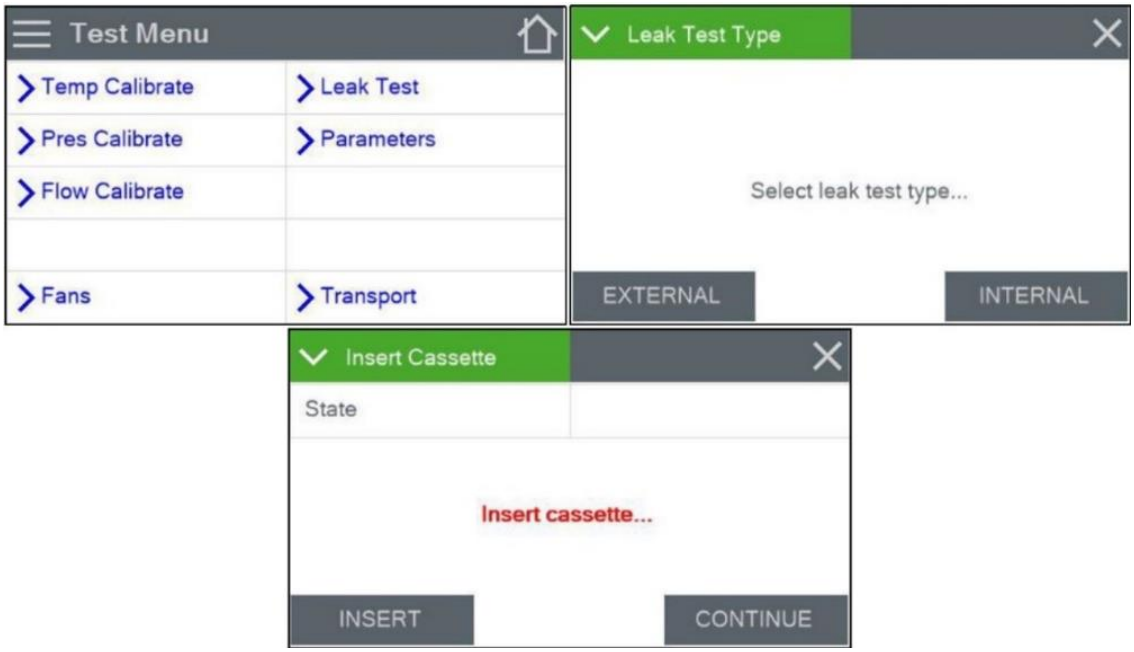

Figure 7-1: External Leak Test Cassette Insertion Screen (Met One, 2013)

4. Place the External Leak Test Cassette (with small hole in the center) in the supply side magazine receiver.

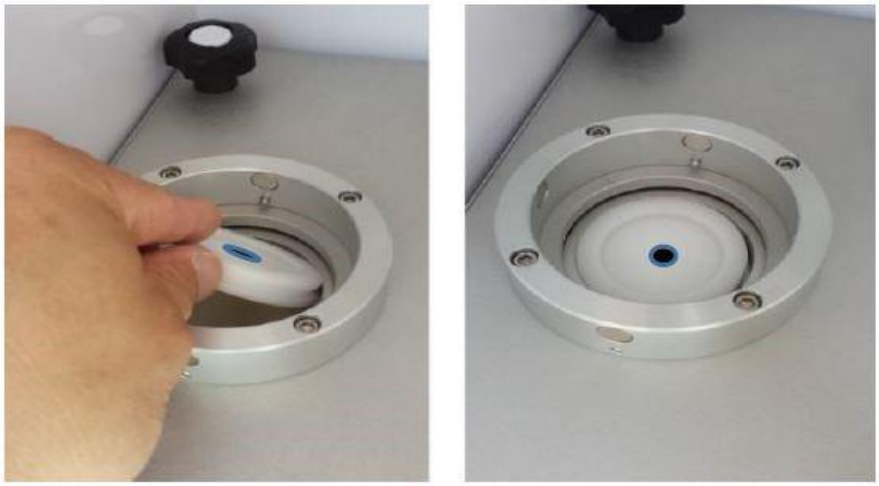

Figure 7-2: Inserting the External Leak Test Cassette (Met One, 2013)

5. Once the test cassette is in position, press **INSERT**.
6. The sampler should advance the test cassette to the sample position and display the Leak Test screen.
7. Press **START**. The pump will turn on for a couple seconds to draw a vacuum. When the pump turns off the change in pressure is measured over time. This leak rate must not exceed the factory set reference leak rate over 3.4 minutes.

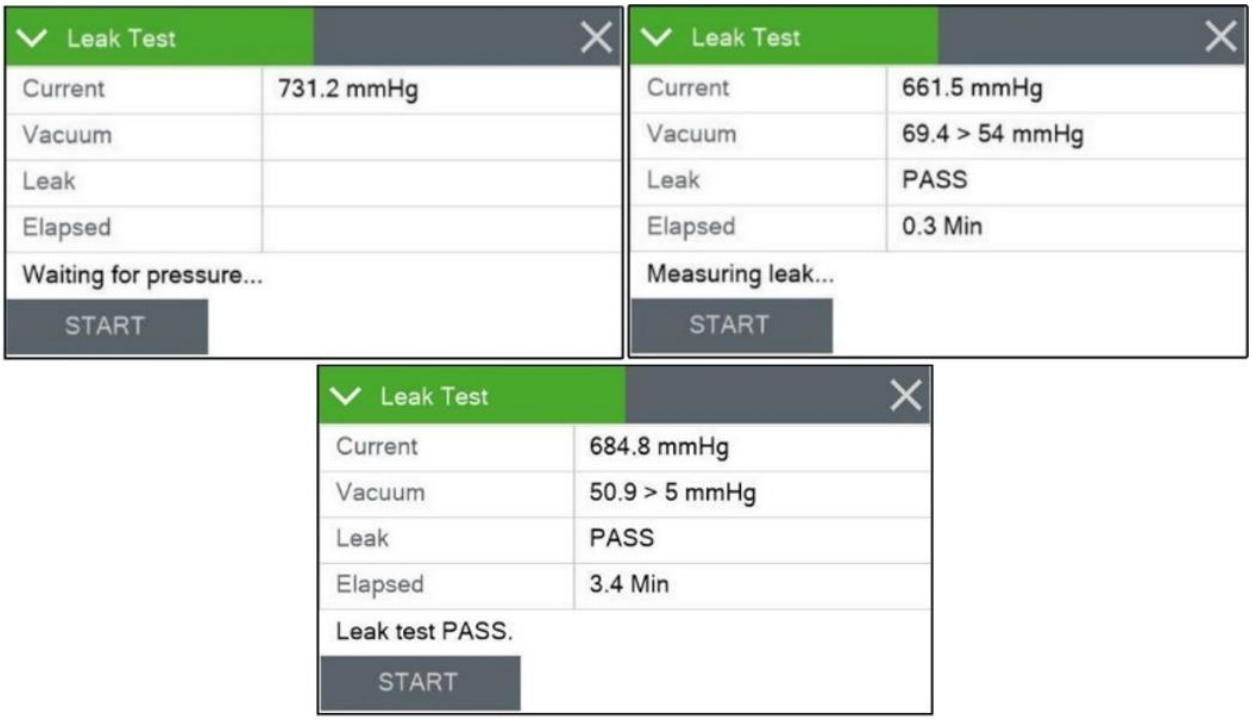

Figure 7-3: Leak Test Result Screen (Met One, 2013)

Figure 7-3 shows the absolute internal pressure, the vacuum rate vs. the reference vacuum decline rate, whether the test is passing or failing, and how much time has

elapsed since the start of the test. The current stage of the test procedure is shown just above the START button.

8. Check the results of the leak test. If it fails, go to section 7.1.3 and perform an internal leak test. If it passes, proceed to step 9.
9. Slowly open the valve on the inlet adapter to relieve the vacuum inside the sampler.
10. Remove the leak check adapter and reinstall the PM_{10} head.
11. Press **X** to exit.

Figure 7-4: Leak Test Cassette Removal Screen (Met One, 2013)

12. Press **REMOVE** to advance the leak test cassette to the storage magazine position.
13. Remove the cassette.

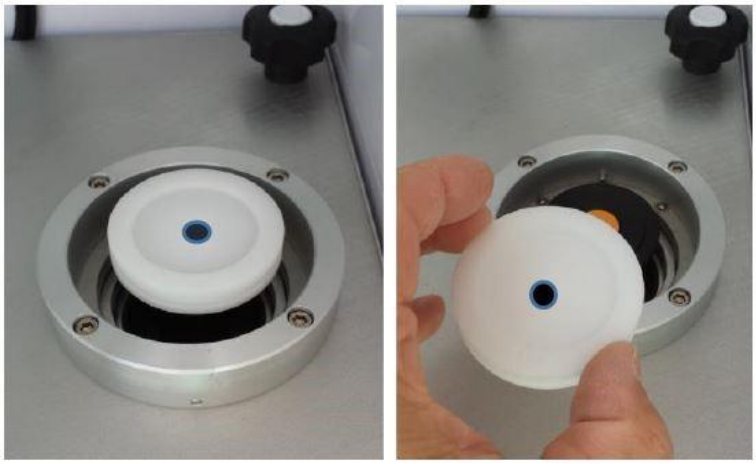

Figure 7-5: Removing the External Leak Test Cassette (Met One, 2013)

14. Press **EXIT** to return to the Test Menu.

7.1.4. Internal Leak Check

If an external leak test failed, an internal leak test must be performed. This test follows the same procedure as the External except the use of the solid cassette to isolate the internal flow system from the external inlet components. If the internal leak test fails, the leak is downstream of the filter cassette location; if it passes, the leak is before the filter cassette location.

To perform the internal leak test, perform the following procedure, as described in section 7.3.2 of the Met One manual.

1. **Test** > **Leak Test** > **INTERNAL**.
2. Place the solid Internal Leak Test Cassette in the supply side magazine receiver.

Figure 7-6: Inserting the Internal Leak Test Cassette (Met One, 2013)

3. Once the test cassette is in position, press **INSERT** on the Insert Cassette screen.
4. The sampler should advance the test cassette to the sample position and display the Leak Test screen.
5. Press **START**. The pump will turn on for a couple seconds to draw a vacuum. When the pump turns off the change in pressure is measured over time. This leak rate must not exceed the factory set reference leak rate over 3.4 minutes.
6. Check the results of the leak test. Refer to the operations manual for additional troubleshooting steps.
    a. If the test passes, there is a leak above the cassette.
    b. If the test fails, there is a leak below the cassette.
7. Slowly open the valve on the inlet adapter to relieve the vacuum inside the sampler.
8. Press **X** to exit the test.
9. Press **REMOVE** to advance the leak test cassette to the storage magazine position and remove it (Figure 7-7).

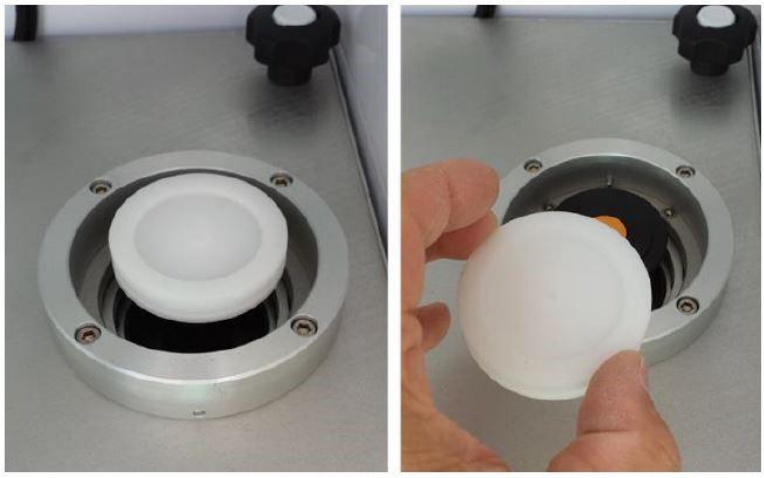

Figure 7-7: Removing the Internal Leak Test Cassette (Met One, 2013)

10. Press **EXIT** (Figure 15) to return to the Test Menu.

7.1.5. Ambient Temperature Verification

1. Place the reference temperature sensor near the ambient temperature sensor radiation shield (shroud) mounted on the rear wall of the sampler. The sensors should be placed as close together as possible (Figure 7-8).

Figure 7-8: Ambient Temperature Sensor Audit

2. Wait 2 minutes to allow the sensors to equilibrate.
3. Read the current ambient temperature (AT) on the Parameters screen (**Temp** > **Temp Calibrate**) and compare it to the reference temperature. The two should be within 2 °C. If they are not, ensure an As Found Leak check was documented, perform an As Found flow check, and then proceed to Section 7.4.2 to calibrate the temperature probe.

7.1.6. Ambient Pressure Verification

1. Place the reference pressure sensor near the instrument
2. Wait 2 minutes to allow the sensors to equilibrate
3. Read the current temperature (BP) on the Parameters screen (**Test** > **Pres Calibrate**) and compare it to the reference pressure.

7.1.7. Filter Temperature Verification

The filter temperature sensor is located about a half an inch below the filter cassette sample location.

Figure 7-9: Filter Temperature Sensor Audit

1. Remove the VSCC or PM_{10} pass through adapter.
2. Insert the reference temperature sensor near the filter temperature sensor, as shown in Figure 7-9. Do not let the reference temperature sensor touch any of the components within the sampling chamber.
3. Wait 2 minutes to allow the sensors to equilibrate.

4. Read the current filter temperature (FT) on the Parameters screen and compare it to the reference temperature. The reference and FT readings should be within 2 °C . If they are not, ensure an As Found Leak check was documented, perform an As Found flow check, and then proceed to Section 7.4.2 to calibrate the filter temperature probe.
5. Remove the reference temperature sensor.
6. Re-install the VSCC or PM_{10} pass through adapter.

7.1.8. Flow Rate Verification

An accurate flow rate is critical to the proper operation of the PM_{10} inlet head and $PM_{2.5}$ particle size selectors. The system must pass an external leak test (section 7.1.2), ambient temperature check, and pressure check (section 7.1.5) before flow rate verification.

Figure 7-10: Flow Check

In addition to a reference flow standard (Alicat), a clean 47 mm filter cassette (with filter) is required to complete the flow check. This filter must not be used for sample collection.

1. Remove the PM_{10} inlet head but leave the VSCC, SCC, or PM_{10} pass through adapter in place.
2. Install the flow standard on the top of the inlet tube.
3. **Test** > **Flow Calibrate**. The Insert Cassette screen shown on the right of Figure 7-11 should appear:

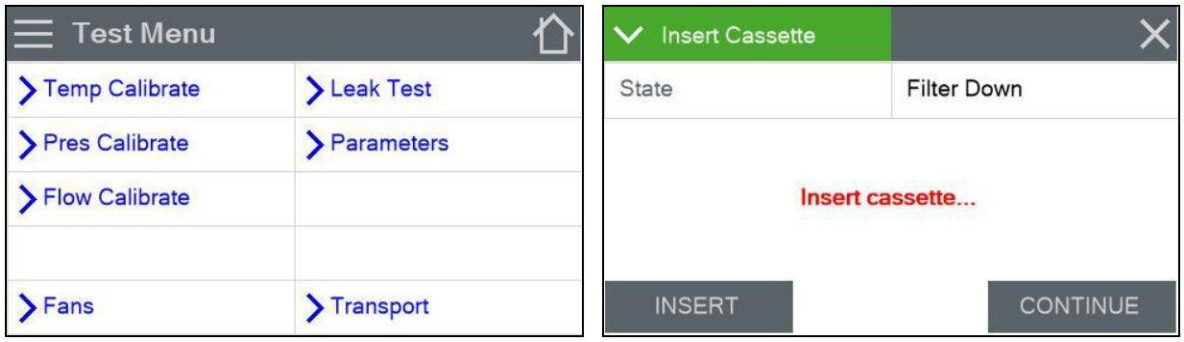

Figure 7-11: Insert Cassette Screen (Met One, 2013)

4. Place the test cassette in the supply side magazine receiver.
5. Press **INSERT**. The sampler should advance the test cassette to the sample position and display the Flow Calibrate screen (Figure 7-12). The pump will start automatically and adjust flow to the 16.67 lpm test point.

Figure 7-12: Flow Calibration Flow Rate Selection Screen (Met One, 2013)

6. Compare the E-SEQ-FRM flow rate to the reference standard and design value of 16.67 lpm.
7. If the flow standard reports a flow ± 4.1% of the reference standard, the flow rate needs to be calibrated according to section 7.2.1.
8. Press **X** to exit the test.
9. Press **REMOVE** to advance the filter cassette to the storage magazine position and remove by hand.
10. Press **EXIT** to return to the Test Menu.
11. Remove flow standard from inlet tube and install the PM_{10} sample head.
12. Navigate back to the Operate Menu and press the Resume Sample option. Be sure to reinstall filter magazines in their correct locations.

7.1.9. PM_{10} Head and VSCC Inspection

To inspect and clean the PM_{10} head:

1. Remove the PM_{10} inlet head from the down tube.

2. Unscrew the bottom portion of the inlet from the cap and inspect it for cleanliness.
3. Inspect the O-ring that seals the top and bottom of the inlet head. If it's broken, replace the O-ring.
4. Clean the collector plate with a cloth and cotton swab.
5. Carefully put the PM_{10} head back together and set it on the ground such that it's out of the way and contaminants (rain, dust and insects) cannot enter the collector assembly.

The PM_{10} head can be completely disassembled, including the two metal shields and metal mesh screen, and thoroughly cleaned with warm water, when necessary. Allow to dry completely before use

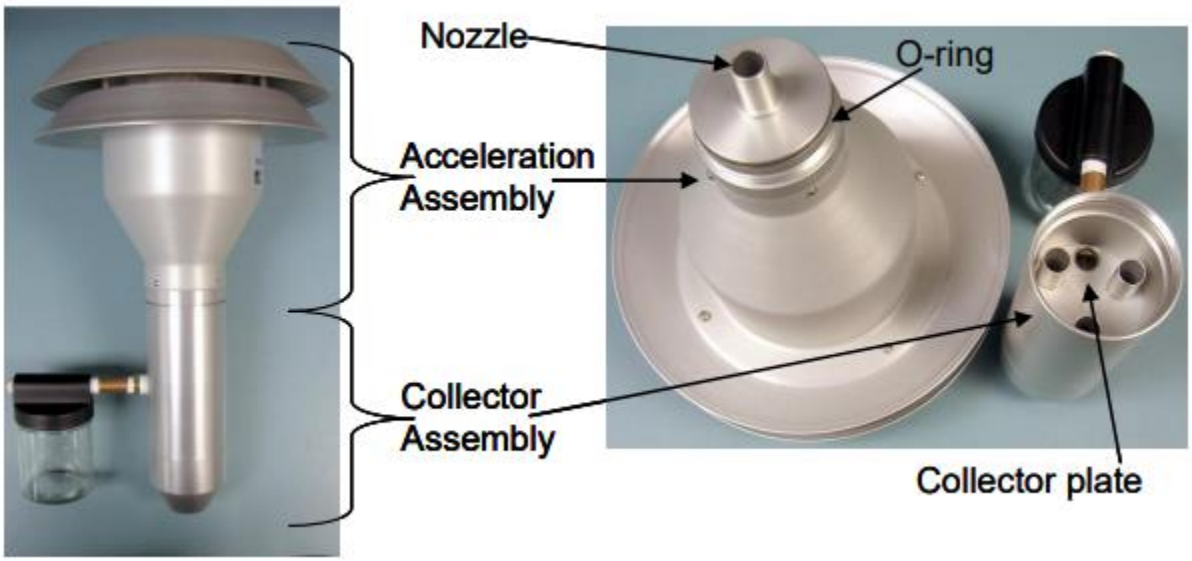

Figure 7-13: Diagram of PM_{10} head inlet components (Vaughn, 2009)

To inspect and clean the VSCC™, remove it from the upper part of the sampler enclosure and inspect and clean the transfer tube and emptying cup. Inspect the O-rings for tear and/or damage.

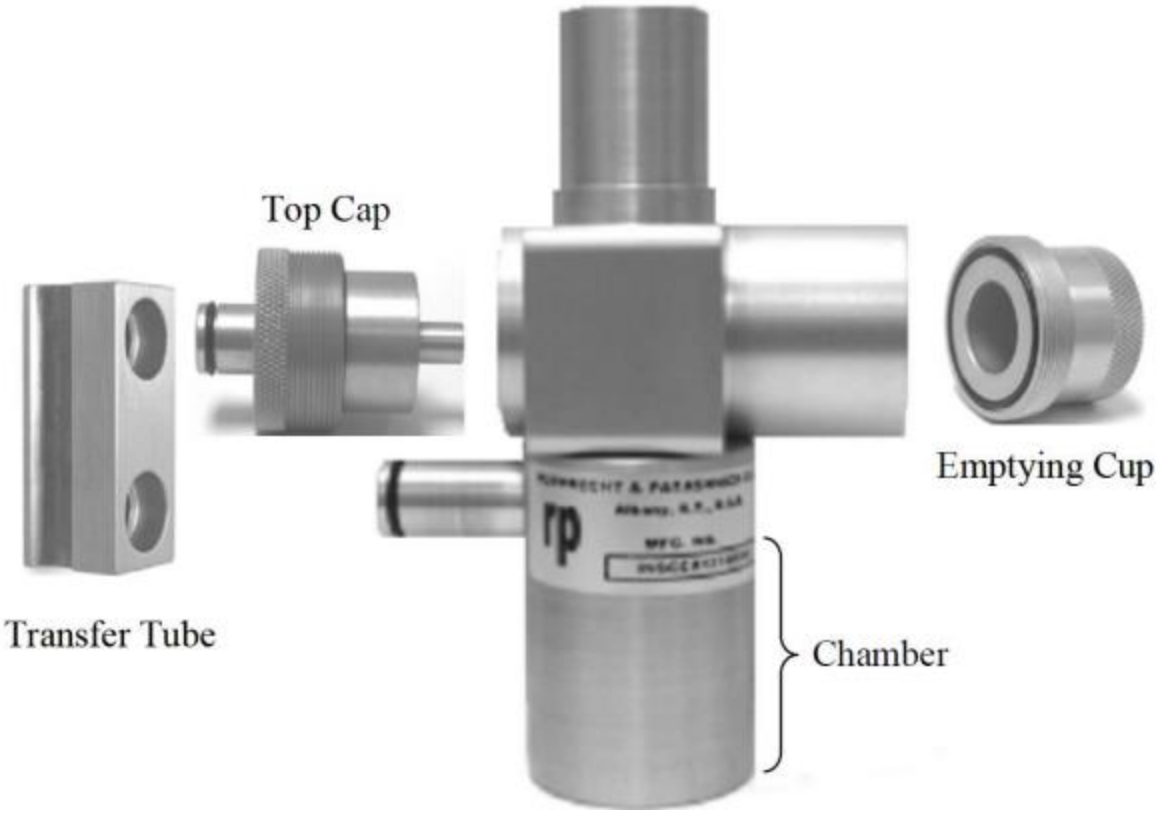

Figure 7-14: Exploded view of VSCC components (Vaughn, 2009)

7.1.8. Finishing the Quality Control Check

After the QC check is completed, perform an "As Left" leak test according to section 7.1.3. Once completed, mount the VSCC and PM_{10} head to the inlet tube. The filter magazines, along with any remaining filters yet to be sampled, can now be placed back in the instrument, making sure the appropriate sequence matches the programmed event schedule.

To resume operations, return to the Operate Menu and press **Resume Sample**.

7.2. Calibrations

7.2.1. Flow Calibration

In addition to a reference flow standard (Alicat), a clean 47 mm filter cassette (with filter) is required for a flow calibration. This filter must not be used for sample collection.

1. Remove the PM_{10} inlet head.
2. Inside the sampler, remove both the supply and storage magazines along with all filters, if installed.
3. Install the flow standard on top of the inlet tube.
4. Go to **Test** > **Flow Calibrate** screen. The Insert Cassette screen should appear:

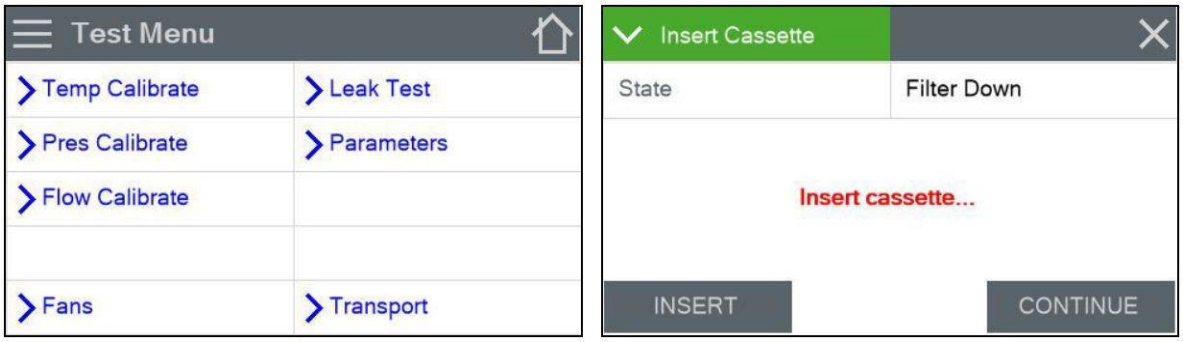

Figure 7-15: Flow Calibrate Cassette Insertion Screen (Met One, 2013)

5. Place the test cassette in the supply side magazine receiver.
6. Press **INSERT**. The sampler will advance the test cassette to the sample position and display the Flow Calibrate screen. The pump will start automatically and adjust flow to the 16.67 lpm test point.
7. Press the green bordered Set Point field and the Set Point flow rate selection screen shown on the right of Figure 7-16 will appear.

Figure 7-16: Flow Calibration Flow Rate Selection Screen (Met One, 2013)

8. Select 15.00 and press **OK**. The display will return to the Flow Calibrate screen and adjust the flow to the new test point.
9. Wait at least one minute for flow to stabilize then compare the sampler flow and the standard flow reading.
10. If the flow rate is within 4% of the standard, record the results and proceed to step 11.
    a. If the difference exceeds ±4%, press **DEFAULT** to remove the current offset. Select the remaining two set points and reset them with **DEFAULT**.
    b. If the flow rate still does not pass, it needs to be adjusted. Press the green bordered Reference field. Enter the flow standard's value and press **OK** to return to the Flow Calibrate screen. Press **SET** to apply the change.
    c. When setting the 16.67 lpm flow rate, the **SET** option will change to read **CALIBRATE** (as shown in the image on the left of Figure 7-16).
11. Repeat steps 7 through 11 above for the 18.34 lpm flow rate.

12. Repeat steps 7 through 11 above for the 16.67 lpm flow rate.
13. Press **X** to exit the test.
14. Press **REMOVE** to advance the filter cassette to the storage magazine.
15. Remove the cassette from the storage magazine by hand.
16. Press **EXIT** to return to the Test Menu.
17. Remove the flow standard from the inlet tube and install the PM_{10} head.
18. Resume normal operation of the sampler.

7.2.2. Temperature Calibration

To perform a multi-point temperature calibration test temperature sensors are exposed to a hot and cold water bath, and ambient air.

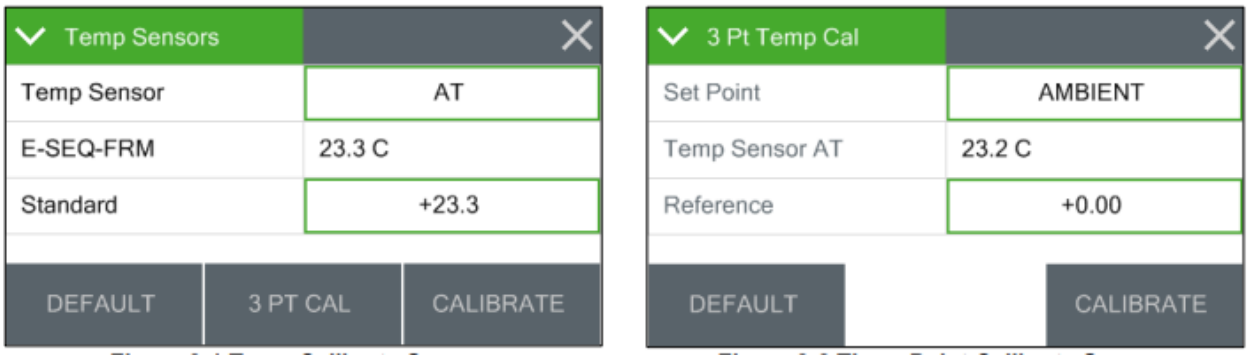

Figure 7-17: Temperature Calibration Screens (Met One, 2013)

1. Navigate to the **Test** > **Temp Calibrate** menu.
2. The green bordered Temp Sensor field will show AT (ambient temperature). If a different sensor is to be tested, tap the green bordered Temp Sensor field and select either the FT (filter temp) or BT (box temp) sensor.
3. Press **3 PT CAL.**
4. Place the reference temperature sensor near the ambient temperature sensor in the radiation shield on the rear wall of the sampler. The sensors should be placed close together as shown in Figure 7-8.
5. Allow the sensors at least 2 minutes to equilibrate.
6. The Set Point field will read AMBIENT.
7. Read the current temperature (AT) in the Temp Sensor field and compare it to the reference temperature. The reference and AT readings should be within 2 °C.
    a. If the sensors are outside ±2 °C, press the green bordered Reference value field. The numeric entry keypad will be displayed.
    b. Enter the value reported by the reference and press **OK** to return to the 3 Point Temperature Calibrate screen.

c. Press **CALIBRATE** to set the calibration point.

8. Press the green bordered Set Point button and select **HOT**.
9. Remove the ambient temperature sensor from its radiation shield.
10. Place the two probes in the hot water bath close together. Repeat step 7.
    a. **Note:** Stirring gently with the temperature probes will help ensure a uniform temperature in the water bath and improve agreement.
11. Remove the sensors and allow them to cool down.
12. Press the green bordered Set Point button and select **COLD**.
13. Place the two probes in the cold-water bath close together. Repeat step 7.
14. Remove the sensors, allow them to warm up and reinstall the temperature probe into the radiation shield.
15. Press **X** to return to the Temperature Calibration screen.

Calibration of the filter and box temperature probes is done via a similar procedure. These probes are difficult to access, and should only be calibrated in a lab setting.

7.2.3. Barometric Pressure Calibration

A reference pressure standard will be needed to perform the filter and ambient (box) barometric pressure sensor calibration procedures.

1. Select **TEST** > **Pres Calibrate** to access the Ambient Pressure Sensor (BP) test interface.
2. Place the reference pressure sensor anywhere near the sampler and allow at least 1 minute for the sensors to equilibrate.
3. Verify the pump is off and there is no sample filter cassette holder installed in the sample position.
4. Read the current ambient pressure (BP) in the field and compare it to the reference pressure. The values should be within 10.1 mmHg.
    a. If the sensors do not match within specification, press the green bordered Standard Value field. The numeric entry keypad will be displayed.
    b. Enter the value reported by the standard and press **OK** to return to the Pres Calibrate screen.
    c. Press **CALIBRATE** to set the new calibration.
5. Remove the reference sensor.

8. Laboratory Activities

The Pace $PM_{2.5}$/PM_{10} gravimetric laboratory processes all Washington Network $PM_{2.5}$ and PM_{10} samples from Sequential Samplers operated within the Washington Network. This work is performed in accordance with all requirements described in:

- 40 CFR Part 50, Appendix J and L
- EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II
- EPA Quality Assurance Guidance Document 2.12
- EPA Technical Note (Oct 2015) on Holding Time Requirements for $PM_{2.5}$ Filter Samples

The personnel responsible for the laboratory activities will perform tasks including, but not limited to:

- Ship and receive the samples to and from the operators.
- Verify the integrity of the samples upon receipt, including visual inspection of the filter samples and storage/cooler conditions and verify that the Nist-traceable thermometer has stayed at or below 4°C.
- Perform gravimetric analysis, including pre-weighing and post-weighing.
- Record any noticeable aspects of the filter sample and/or weighing conditions.
- Generate summary reports based on information gathered from the Sequential Sampler Data and gravimetric analysis.

A more detailed description of the laboratory activities can be found in Pace's $PM_{2.5}$/PM_{10} Gravimetric Laboratory Standard Operating Procedure. Contact the Pace technician for the most recent version.

Following gravimetric analysis, the Pace technician sends the PM_{10} samples collected on a 1:6 day sampling schedule at the Seattle-Beacon Hill monitoring station to Eastern Research Group Inc (ERG) for metals analysis with Inductively Coupled Plasma Mass Spectrometry (ICP-MS) as part of the National Air Toxics Stations (NATTS) network requirements. PM_{10} Metals sample filters should be analyzed for metals with ICP-MS within 180 days of sampling collection and retrieval. More details on PM_{10} Metals can be found in Ecology's Air Toxics SOP.

9. References

Met One Instruments, Inc. *E-SEQ-FRM Particulate Sampler Operation Manual*. Rev. G, Met One Instruments, 2013.

United States Environmental Protection Agency. *Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring*. *Code of Federal Regulations*, Title 40, Parts 50, 53, and 58, 2013 ed.

"PM2.5 Validation Template." *Ambient Monitoring Technology Information Center*, United States Environmental Protection Agency.

"Filter Hold Time Flow Chart." *Ambient Monitoring Technology Information Center*, United States Environmental Protection Agency.

Met One Instruments, Inc. *FSCommAQ Operator's Manual*. Met One Instruments, 2013.

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Code of Federal Regulations, Title 40, Part 50, Appendices J and L.

United States Environmental Protection Agency. *EPA Quality Assurance Handbook for Air Pollution Measurement Systems*. Vol. II.

United States Environmental Protection Agency. *EPA Quality Assurance Guidance Document 2.12*.

United States Environmental Protection Agency. *Technical Note on Holding Time Requirements for PM2.5 Filter Samples*. Oct. 2015.

PACE Laboratory. *PM2.5/PM10 Gravimetric Laboratory Standard Operating Procedure*.

Appendices

Appendix A: QC Form

Washington State Department of Ecology
Federal Reference Method $PM_{2.5}$ Quality Control Check Form

AQS ID		Date	
Location		Operator	
Sampler Serial No.		QC Start Time	
State Tag No.		QC Stop Time	
Firmware Version			
Flow/Temp/BP Std. Model			
Flow/Temp/BP Std. Serial No.			
Flow/Temp/BP Std. Cert. Date			

Temperature and Pressure QC

Ambient Temperature (< ±2.1 °C)	Act:	°C	Filter Temperature (< ±2.1 °C)	Act:	°C
	Ind:	°C		Ind:	°C
	Diff:	°C		Diff:	°C
Barometric Pressure (< ±10.1 mmHg)	Act:	mmHg	Time ± 1 minute of data logger?		
	Ind:	mmHg	Is the inlet head clean?		
	Diff:	mmHg			

Flow QC

Indicated Flow lpm	Actual Flow lpm	Flow Difference < ±4.1%	Design Flow Difference < ±5.1%

External Leak Check

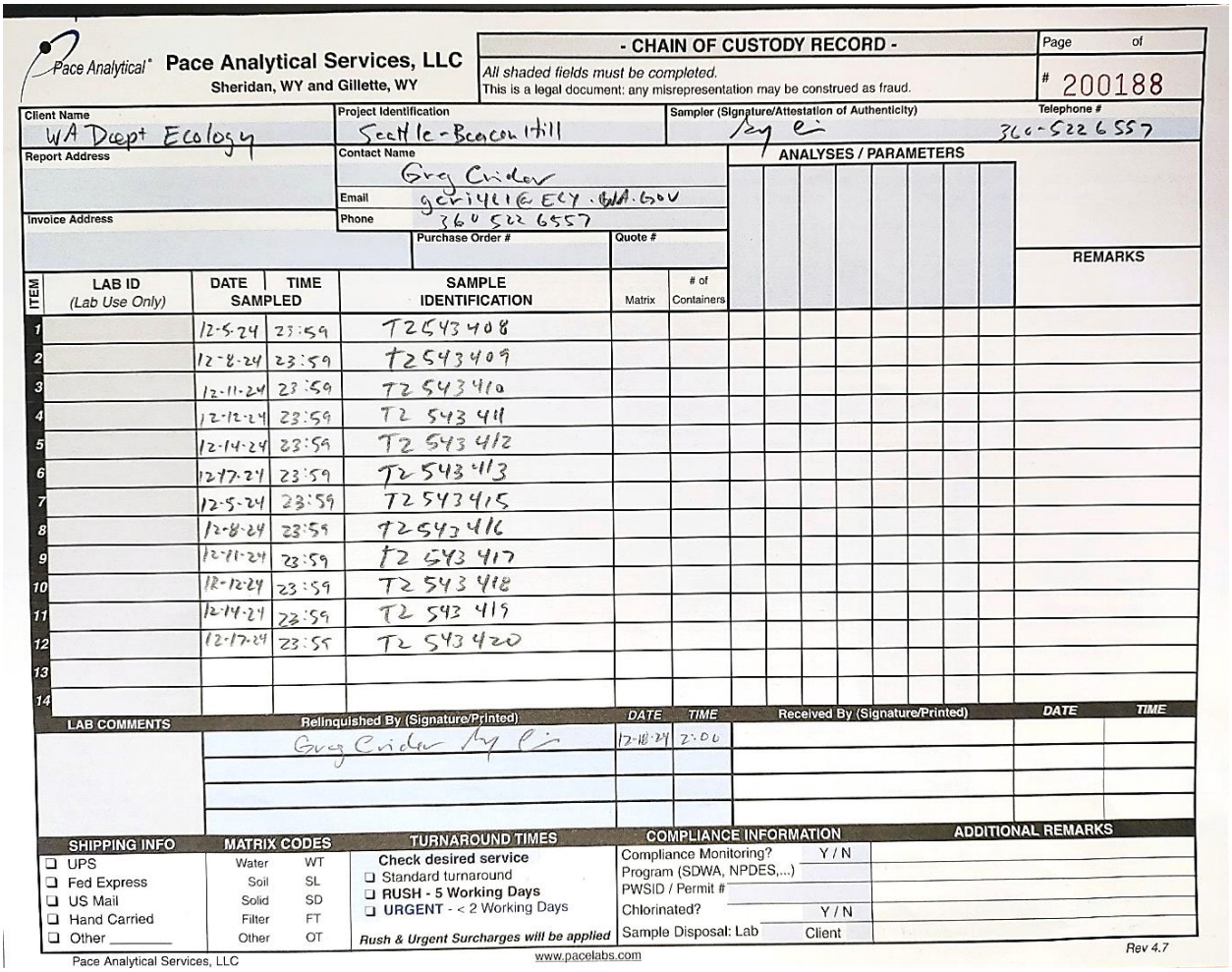
	Vacuum Pressure Loss mmHg	Pass/Fail
As-Found Leak Check (> 5 mmHg)		
As-Left Leak Check (> 5 mmHg)		

*Internal leak check only needed if external leak check failed.

Comments:

QC Result:

Appendix B: Chain of Custody Records



Pace Analytical® Pace Analytical Services, LLC
Sheridan, WY and Gillette, WY

- CHAIN OF CUSTODY RECORD -

Page of

All shaded fields must be completed.
This is a legal document: any misrepresentation may be construed as fraud.

200188

Client Name: WA Dept Ecology	Project Identification: Seattle - Beacon Hill	Sampler (Signature/Attestation of Authenticity): Greg Cridler	Telephone #: 360-522 6557
Report Address:	Contact Name: Greg Cridler		
	Email: gcri461@ECY.WA.GOV		
Invoice Address:	Phone: 360 522 6557		
	Purchase Order #	Quote #	

ANALYSES / PARAMETERS

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME	SAMPLE IDENTIFICATION	Matrix	# of Containers	REMARKS
1		12-5-24	23:59	T2543408			
2		12-8-24	23:59	T2543409			
3		12-11-24	23:59	T2543410			
4		12-12-24	23:59	T2 543 411			
5		12-14-24	23:59	T2 543 412			
6		1217-24	23:59	T2543413			
7		12-5-24	23:59	T2543415			
8		12-8-24	23:59	T2543416			
9		12-11-24	23:59	T2 543 417			
10		12-12-24	23:59	T2 543 418			
11		12-14-24	23:59	T2 543 419			
12		12-17-24	23:55	T2 543 420			
13							
14							

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
	Greg Cridler	12-18-24	2:00			

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
❑ UPS	Water	WT	Check desired service	Compliance Monitoring? Y / N	
❑ Fed Express	Soil	SL	❑ Standard turnaround	Program (SDWA, NPDES,...)	
❑ US Mail	Solid	SD	❑ RUSH - 5 Working Days	PWSID / Permit #	
❑ Hand Carried	Filter	FT	❑ URGENT - < 2 Working Days	Chlorinated? Y / N	
❑ Other _____	Other	OT	Rush & Urgent Surcharges will be applied	Sample Disposal: Lab Client	

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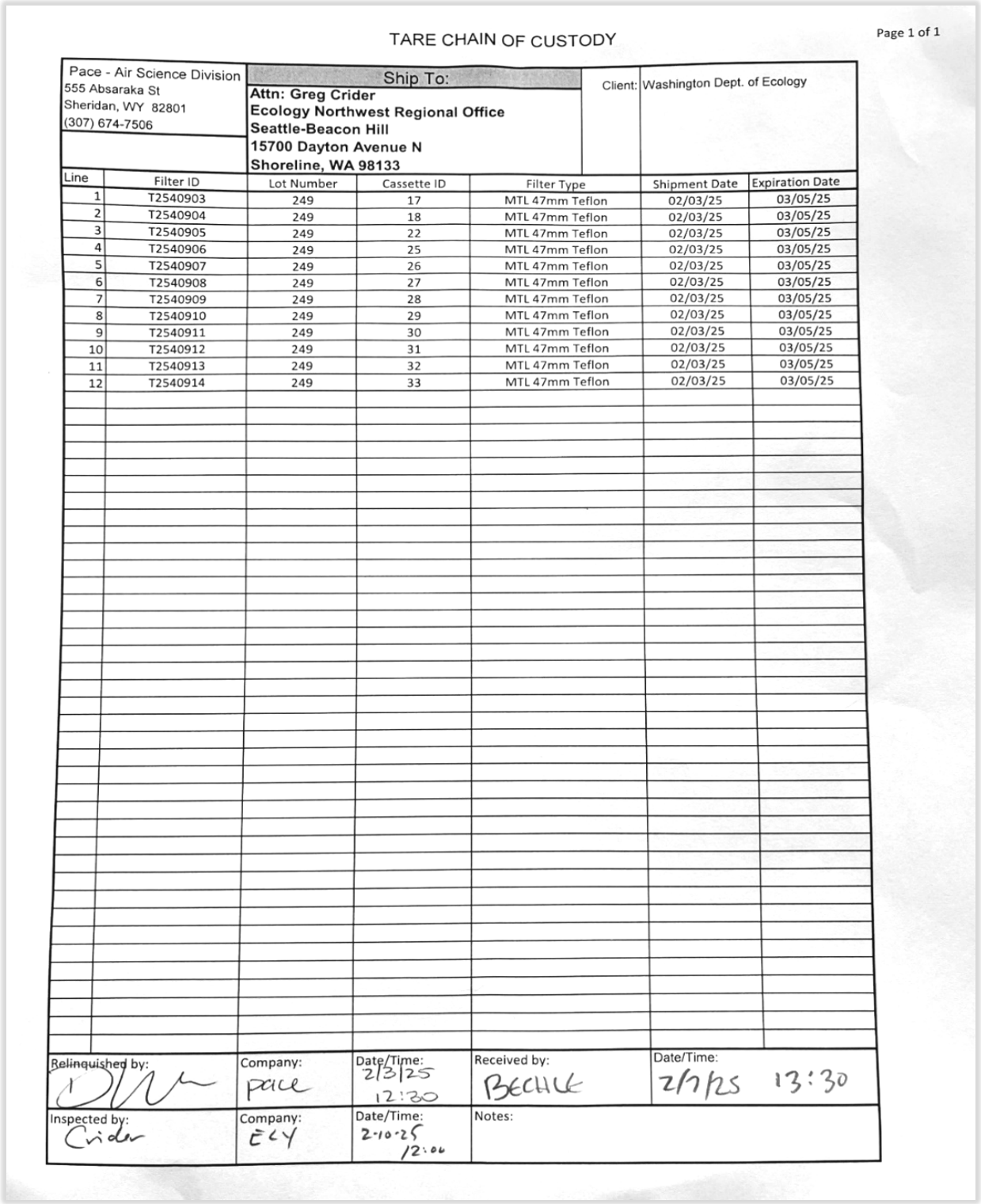
Appendix C: Tare Chain of Custody



TARE CHAIN OF CUSTODY

Page 1 of 1

Pace - Air Science Division
555 Absaraka St
Sheridan, WY 82801
(307) 674-7506

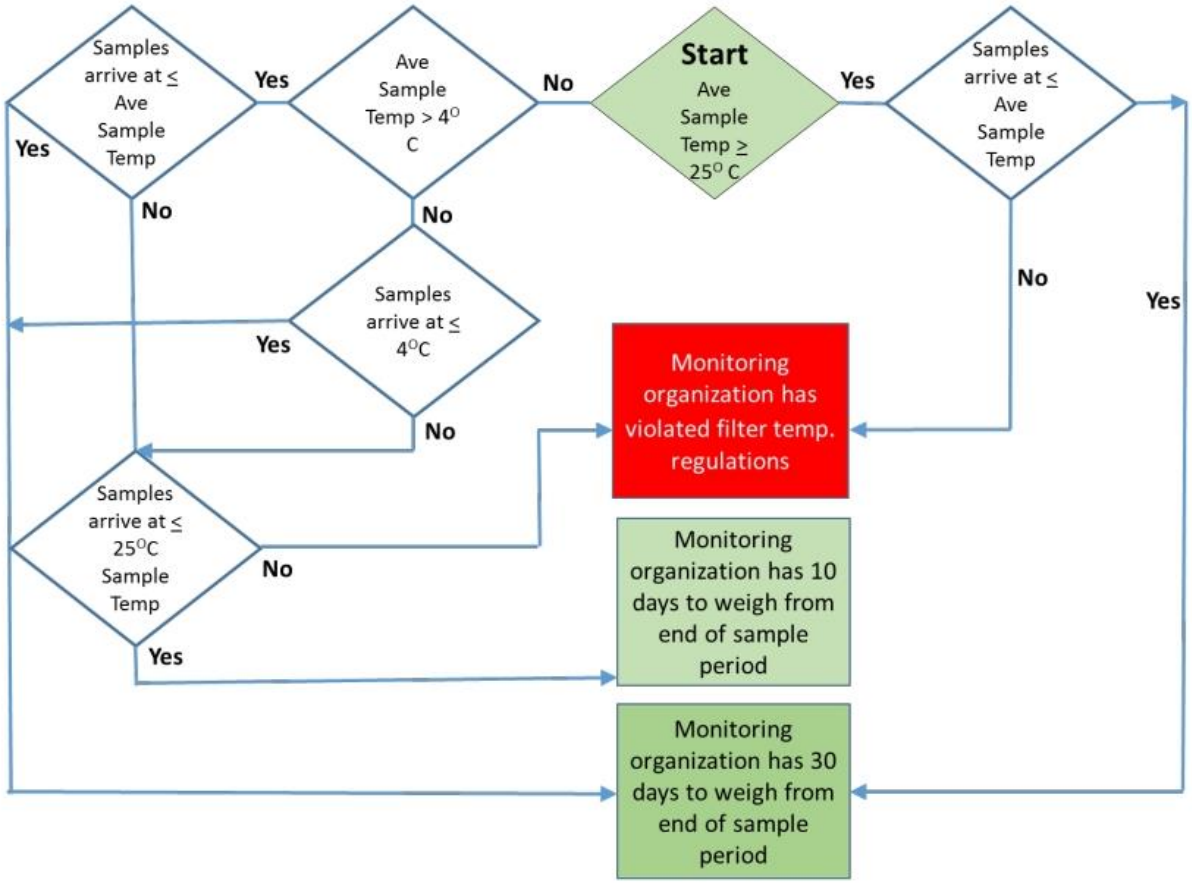
Ship To:
Attn: Greg Crider
Ecology Northwest Regional Office
Seattle-Beacon Hill
15700 Dayton Avenue N
Shoreline, WA 98133

Client: Washington Dept. of Ecology

Line	Filter ID	Lot Number	Cassette ID	Filter Type	Shipment Date	Expiration Date
1	T2540903	249	17	MTL 47mm Teflon	02/03/25	03/05/25
2	T2540904	249	18	MTL 47mm Teflon	02/03/25	03/05/25
3	T2540905	249	22	MTL 47mm Teflon	02/03/25	03/05/25
4	T2540906	249	25	MTL 47mm Teflon	02/03/25	03/05/25
5	T2540907	249	26	MTL 47mm Teflon	02/03/25	03/05/25
6	T2540908	249	27	MTL 47mm Teflon	02/03/25	03/05/25
7	T2540909	249	28	MTL 47mm Teflon	02/03/25	03/05/25
8	T2540910	249	29	MTL 47mm Teflon	02/03/25	03/05/25
9	T2540911	249	30	MTL 47mm Teflon	02/03/25	03/05/25
10	T2540912	249	31	MTL 47mm Teflon	02/03/25	03/05/25
11	T2540913	249	32	MTL 47mm Teflon	02/03/25	03/05/25
12	T2540914	249	33	MTL 47mm Teflon	02/03/25	03/05/25

Relinquished by:	Company:	Date/Time:	Received by:	Date/Time:
[signature]	pace	2/3/25 12:30	BECHLE	2/7/25 13:30
Inspected by:	**Company:**	**Date/Time:**	**Notes:**	
Crider	ECY	2-10-25 12:06		

Appendix D: Filter Hold Time Flowchart



(Technical Note from EPA's Ambient Monitoring Technology Information Center)