

# **E-SEQ-FRM SEQUENTIAL REFERENCE METHOD PARTICULATE SAMPLER OPERATION MANUAL**

**E-SEQ-FRM-9800 REV F**



**Met One Instruments, Inc.**

1600 NW Washington Blvd.

Grants Pass, OR 97526

Telephone: (541) 471-7111

Facsimile: (541) 471-7116

[www.metone.com](http://www.metone.com)

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# 1 INTRODUCTION

## 1.1 *About This Manual*

This document is organized with the most important information toward the front of the manual. All users should read and understand the sections on setup, operation, and field audits. Toward the back are sections that provide in-depth information on subjects such as diagnostics and accessories. These sections should be consulted as needed.

This manual is periodically revised for maximum accuracy and to incorporate new features or updates. User feedback is welcome. Electronic versions of this manual are available upon request.

## 1.2 *Technical Service*

Should support still be required after consulting the printed documentation, contact one of the expert Met One Instruments, Inc. Technical Service representatives during normal business hours of 7:00 a.m. to 4:00 p.m. Pacific Time, Monday through Friday. In addition, technical information and service bulletins are often posted on our website. Please contact us and obtain a Return Authorization (RA) number before sending any equipment back to the factory. This allows us to track and schedule service work and to expedite customer service.

**Contact Information:** Tel: + 541 471 7111  
Fax: + 541 471 7115  
Web: <http://www.metone.com>  
Email: [service@metone.com](mailto:service@metone.com)

**Address:** Met One Instruments, Inc.  
1600 Washington Blvd  
Grants Pass, Oregon  
97526 U.S.A.

Please have the instrument serial number available when contacting the manufacturer. On most models manufactured by Met One Instruments, it will be located on a silver product label on the unit, and printed on the calibration certificate. The serial number will begin with a letter and be followed by a unique five-digit number such as U15915.



### **1.3 E-SEQ-FRM: Environmental Sequential Federal Reference Method Sampler**



**Figure 1-1 E-SEQ-FRM Sequential Air Sampler**

The Met One Instruments, Inc. Model E-SEQ-FRM is a programmable multi-event filter sampler designed to meet US-EPA specifications as a reference method for the determination of daily PM<sub>2.5</sub> or PM<sub>10</sub> particulate concentrations in ambient air.

The E-SEQ-FRM employs a supply magazine containing up to 16 pre-weighed 47 mm sample filter discs in individual EPA-standardized cassettes which will be automatically exchanged by the sampler prior to each sample period. The instrument runs a series of samples based on an operator programmed schedule with defined start times and sampling durations.

A vacuum pump, controlled to 16.67 liters-per-minute, draws ambient air through a series of standardized inlets that provide the PM<sub>10</sub> and, if applicable, PM<sub>2.5</sub> cut points. The sample then passes through the filter, where the airborne particulate matter is deposited.

After the sample period is complete, the dust-laden filter is automatically moved to the storage magazine which is later emptied. The filters are then sent to a lab to be equilibrated and reweighed. The resulting clean and dirty mass values for the filter are then combined with the volume of air sampled to determine the concentration of particulate in micrograms-per-cubic-meter ( $\mu\text{g}/\text{m}^3$ )

The E-SEQ-FRM can easily be configured for US-EPA  $\text{PM}_{2.5}$  FRM operation using the Met One Instruments BX-808 very-sharp-cut cyclone, or the BX-804 WINS Impactor.

Alternately, other cyclonic separators may be used with the E-SEQ-FRM if operation as a US-EPA designated reference method is not required.

If  $\text{PM}_{10}$  sampling is desired, the  $\text{PM}_{2.5}$  cyclones can be omitted entirely and a pass-through adapter can be installed in its place.

### **1.3.1 E-SEQ-FRM U.S. EPA Configurations**

The E-SEQ-FRM is US-EPA designated under the following designation numbers:

- RFPS-0717-245:  $\text{PM}_{2.5}$  designation
- RFPS-0717-246:  $\text{PM}_{10}$  designation
- RFPS-0717-247:  $\text{PM}_{10-2.5}$  designation

US-EPA designated methods using the E-SEQ-FRM are modified from time to time in order to reflect hardware or software improvements. These modifications do not impact previously designated configurations of the E-SEQ-FRM but may provide the end user with a product upgrade path that will allow the monitor to continue to be operated as a US-EPA designated method. For further details, please contact our service department. Details concerning USEPA designated configurations of the E-SEQ-FRM may be found on the US-EPA website:

<http://www3.epa.gov/ttn/amtic/files/ambient/criteria/reference-equivalent-methods-list.pdf>

## 1.4 Model E-SEQ-FRM Specifications

PARAMETER	SPECIFICATION
<b>Measurement Principle:</b>	Programmable multiple-event filter sampler for determination of particulate matter concentrations
<b>Resulting Data Units:</b>	Micrograms per actual or standard cubic meter $\mu\text{g}/\text{m}^3$ . Calculated from lab filter weights and actual or standard sampled volumes
<b>Design Specifications:</b>	Title 40 CFR, Part 50 Appendix L.
<b>U.S. EPA Designations:</b>	RFPS-0717-245, RFPS-0717-246, RFPS-0717-247
<b>Main Inlet Type:</b>	EPA-pattern $\text{PM}_{10}$ size-selective louvered inlet standard (MOI part no. BX-802)
<b><math>\text{PM}_{2.5}</math> Separator Type:</b>	BX-808 Very Sharp Cut Cyclone (BX-804 WINS Impactor optional)
<b><math>\text{PM}_{10}</math> Sampling Config:</b>	Pass-through tube (used in place of cyclone) included for $\text{PM}_{10}$ sampling.
<b>Other Configurations:</b>	Compatible with $\text{PM}_{2.5}$ or $\text{PM}_1$ SCC cyclones. TSP inlet available.
<b>Filter Type:</b>	47mm PTFE disc filters standard. Other filter material types available.
<b>Filter Holder:</b>	Accommodates standard EPA-pattern white Delrin filter cassettes.
<b>Filter Temp Control:</b>	Within $5^\circ\text{C}$ of ambient, sampling and standby. Logged in data.
<b>Operating Temperature:</b>	$-30$ to $+50^\circ\text{C}$ , Ambient.
<b>Operating Pressure:</b>	400 to 800 mmHg, Ambient.
<b>Sample Events:</b>	24 hour samples standard. Programmable start date/time and duration.
<b>Flow Rate:</b>	16.67 L/min ( $1 \text{ m}^3/\text{hr}$ ). With flow sensor and real-time actual flow control.
<b>Flow Accuracy:</b>	$\pm 2\%$ ( $\pm 0.33 \text{ L/min}$ ).
<b>Flow Records:</b>	Flow rate, temperature, pressure logged in 5 minute intervals.
<b>Vacuum Pump:</b>	Single-head diaphragm 12 VDC pump
<b>Upper Concentration Limit:</b>	At least $200 \mu\text{g}/\text{m}^3$ estimated for daily average.*
<b>Data Collection:</b>	9-Pin RS-232 port. USB data port. USB flash drive port. Software supplied.
<b>Memory Capacity:</b>	24 sample events
<b>Compatible Software:</b>	FRMCommAq
<b>User Interface:</b>	4.3" graphical touch screen
<b>Enclosure Type:</b>	Active fan ventilation.
<b>Deployed Dimensions:</b>	2.0 meters (77") high, 37 cm (14.4") wide, 36 cm (14") deep.
<b>Footprint Dimensions</b>	23.5wide, 24.5deep
<b>Weight:</b>	Sampler 45lb(except $\text{PM}_{10}$ inlet head), Stand 10.5lb
<b>Power:</b>	100 to 240VAC, 50W,

\* The approximate upper concentration limit is based on the sampler's ability to maintain 16.67 L/min sample flow over the entire 24 hour period, despite PTFE filter loading with typical urban  $\text{PM}_{2.5}$  particulate. Actual concentration limits will vary depending on ambient conditions, altitude, and particulate type.

Specifications may be subject to change without notice.

## 2 SITE SELECTION and POSITIONING CRITERIA

Selection of a proper site for the sampler is critical for accurate measurements. These items must be correctly addressed in order for the collected data to be acceptable for regulatory requirements, such as US-EPA PM<sub>10</sub> or PM<sub>2.5</sub> data reporting.

Specifications for site selection and inlet positioning for samplers operated as US-EPA designated reference methods for PM<sub>2.5</sub> or PM<sub>10</sub> can be found in United States regulation 40 CFR, Part 58, Appendix D and E. There are also a variety of EPA guidance documents and quality assurance documents which describe site criteria in detail. In any case, the Code of Federal Regulations takes precedence. The operator is encouraged to contact local environmental authorities for information concerning local regulations if the E-SEQ-FRM is to be operated outside of the United States.

**Note:** The sampler location may consist of an elevated site such as a flat rooftop, the top of a walk-in lab shelter, or an elevated platform. The location may also be at or near ground level on a concrete pad or a simple wooden platform. In any case, the location must be level and easily accessible for routine service and filter replacement. Locating the sampler stand directly on the soil is not usually recommended, due to possible intrusion of dirt, insects, and vegetative growth.

### **Inlet Height Criteria:**

- The sampler total inlet height must be located in the “breathing zone”, between 2 and 15 meters above ground level for neighborhood scale sites. Middle scale or microscale sites require a total inlet height of between 2 and 7 meters.
- If the unit is to be installed on ground level, then the inlet height must be at least two meters above the ground. The sampler stand and enclosure are designed to locate the inlet two meters above whatever surface the unit is placed on.
- If the unit is located on the roof of a building, the inlet height must be no less than two meters above roof surface of the building. The total height must be no more than 15 meters above ground level.
- If the sampler is to be collocated with other particulate instruments, such as BAM units or other samplers or monitors, then the air inlets must all be the same height within one meter vertically. Met One Instruments recommends a tighter tolerance of within 30cm (1 foot).
- If the sampler inlet is the highest metallic point on a building, then a lightning rod must be installed to prevent destruction of the sampler during electrical storms.

### **Inlet Spacing and Clearance Criteria:**

- If the sampler is to be collocated with another instrument, such as a BAM-1020 or other sampler or monitor, then the inlets must be spaced between one and four meters apart.
- If installed near a PM<sub>10</sub> high-volume sampler, then the distance between the inlet of the sampler and the Hi-Vol should be no less than three meters.
- The sampler inlet must be unobstructed for two meters in all directions from any object that may influence airflow characteristics, such as walls, parapets, or structures on a rooftop.
- If located beside a major obstruction (such as a building), then the distance between the inlet and the building should be equal to twice the height of the building.

- There must be at least a 180-degree arc of completely unrestricted airflow around the sampler inlet. The predominant wind direction during the highest concentration season must be included in the 180-degree arc.
- The sampler inlet must be at least 10 meters from the drip line of any trees.

#### **Artificial Particulate Sources:**

To avoid possible errors in the concentration measurements, the inlet must be located as far as possible from any artificial sources of particulate, such as blowers or vents on a rooftop. Even sources of filtered air must not blow across the sampler inlet.

#### **Spacing from Roadways:**

Except for microscale studies or purposeful near-road studies, the sampler should usually not be located directly next to a major highway or arterial roadway, as vehicle exhaust will dominate the concentration measurement. Criteria for roadway spacing of particulate monitors can be complicated. See 40 CFR Part 58 - Appendix E, section 6.3 (July 2009).

- For general neighborhood scale monitoring, the sampler should be at least 10 meters away from a road with a daily traffic volume of less than 1,000 vehicles, at least 30 meters from a road with a volume of 20,000 vehicles, at least 100 meters from a road with a volume of 70,000 vehicles, and at least 250 meters from a road with a volume of greater than 110,000 vehicles.
- The unit should be located as far as possible from unpaved roadways, as these also cause artificial measurements from temporarily suspended fugitive dust.
- The unit should usually not be installed in unpaved areas unless year-round vegetative ground cover is present, to avoid the effects of re-entrained fugitive dust.

## 3 SETUP

Use the following information to correctly assemble, configure, and deploy the E-SEQ-FRM sampler. Installation of the sampler should ideally be performed by personnel familiar with environmental monitoring equipment. There are no special precautions or handling concerns except for the normal level of care required for handling scientific equipment. Refer to the instructions and diagrams on the following pages.

### 3.1 Unpacking

Unpack the mass monitor and accessories and compare them to the packing list to make sure all items are present.

Any damage incurred to the equipment during shipping are the responsibility of the carrier. If any damage to the shipment is noticed before unpacking, **a claim must be filed with the commercial carrier immediately**. Follow any special unpacking instructions provided by the carrier as all items are carefully removed from the containers and each component inspected. It is recommended to document and photograph all damaged packages and items before, during, and after unpacking them. Contact Met One Instruments (see section 1.2 of this manual) to arrange for any replacement items needed.

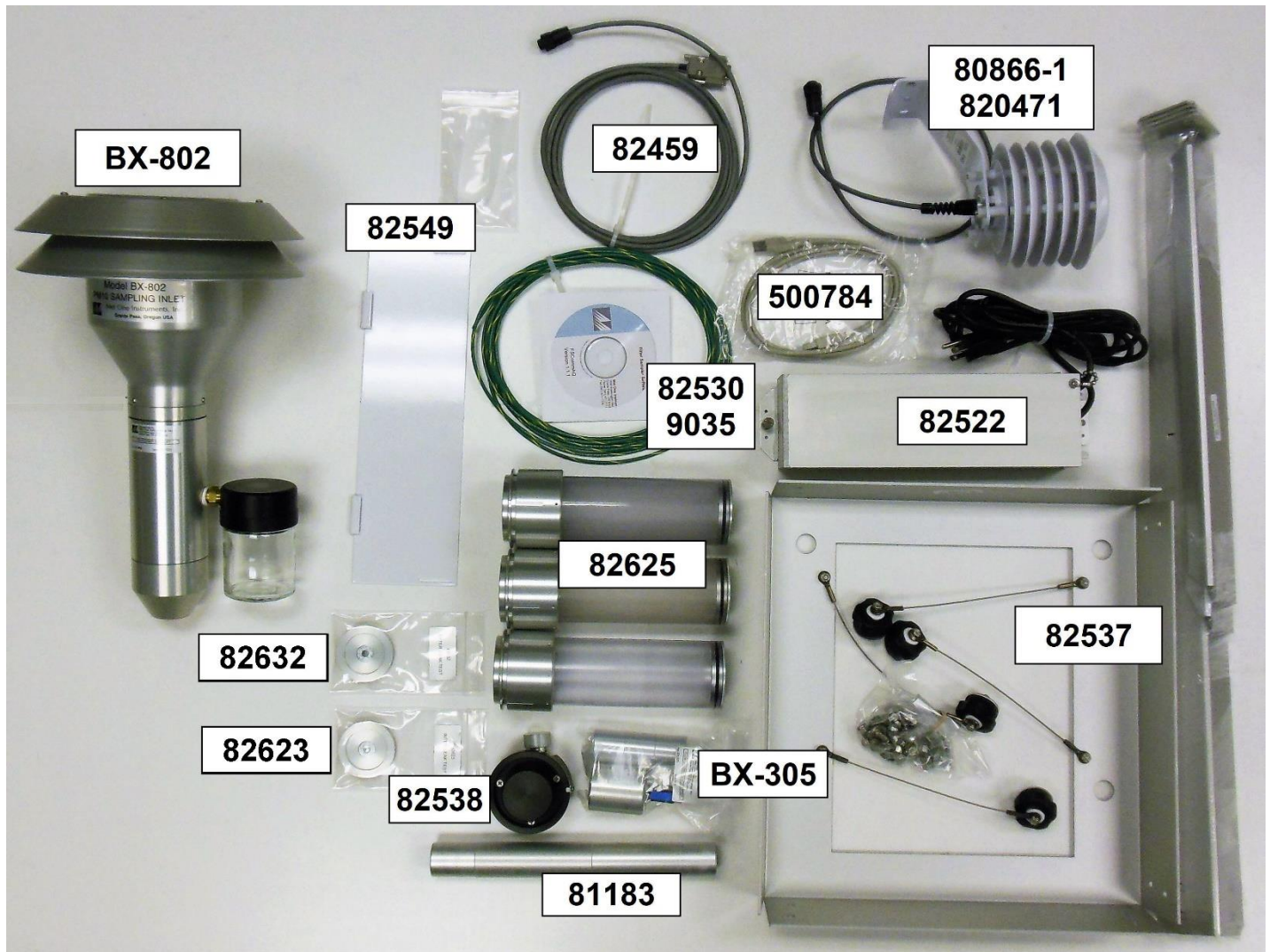
The normal PM<sub>10</sub> configuration of the instrument is supplied with the following standard accessories:

#### PM<sub>10</sub> E-SEQ-FRM sampler includes

- One (1) PM<sub>10</sub> Inlet (BX-802)
- One (1) 12 VDC Power Supply Adapter (with Standard U.S.A. Type Power Cord 82522)
- Three (3) Filter Cassette Magazines (82625)
- One (1) Adjustable Magazine Lid (82538)
- One (1) Ground Cable (9035)
- One (1) Sample Inlet Down Tube (81183)
- One (1) PM<sub>10</sub> Measurement Pass-Through Adapter Tube (81210)
- One (1) E-SEQ-FRM Stand (82537)
- One (1) Ambient Temperature Sensor (80866-1) With Solar Gill Shield (820471)
- One (1) Internal Leak Test Filter Assembly (82623)
- One (1) External Leak Test Filter Assembly (82632)
- One (1) Flow Audit Adapter (Leak Test Valve BX-305)
- One (1) Rain Protector Plate (82549) With Two Velcro Straps
- One (1) Dust Filters
- One (1) Operating Manual

The standard components for the PM<sub>10</sub> configuration of the E-SEQ-FRM are shown in Figure 3-1. Note that the PM<sub>10</sub> pass-through adapter tube (81210) and the dust filters are already installed inside the E-SEQ-FRM Sampler when purchased in this configuration.





**Figure 3-1 Standard Components for the E-SEQ-FRM**

The following optional accessories may be purchased separately:

- BX-808 Very Sharp Cut PM<sub>2.5</sub> cyclone.
- BX-804 WINS Impactor
- Non-reference cyclones for PM<sub>2.5</sub> or PM<sub>1</sub> cut-points.
- BX-803 TSP Sampling Inlet
- 47 mm filter holders or filters.

Please keep all of the special shipping items (box, foam packing material, etc.) used to ship the E-SEQ-FRM. They should be re-used if the sampler is to be transported (changing site locations, returning to the factory, etc.). Contact Met One Instruments (see section 1.2 of this manual) for replacement packing materials if necessary.

### **3.2 Electrical Service**

The E-SEQ-FRM sampler uses 12 VDC power supply which can be used 115-230 VAC input power. The sampler is rated at 40 Watt max continuous with the pump running.

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 recommended.

For critical applications where possible sample invalidations due to power failures are unacceptable, the sampler should be equipped with a backup uninterruptable power supply (UPS). The supply must be rated for the electrical load and must be appropriately configured for an outdoor application. Consult a qualified electrical contractor.

### **3.3 Instrument Assembly and Deployment**

The E-SEQ-FRM sampler is designed for easy setup and deployment. This allows it to be used for either permanent long-term sampling at a fixed site or for portable audit sampling for temporary applications.



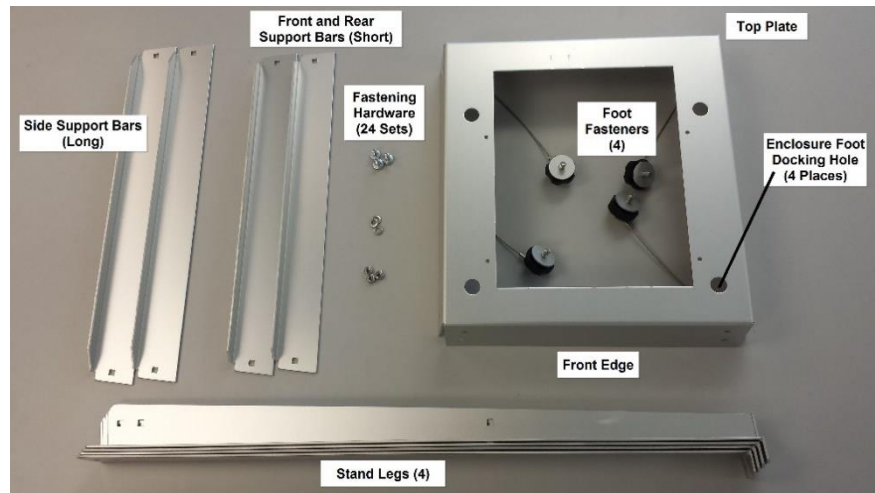
**Figure 3-2 E-SEQ-FRM front views with and without door**

Once the E-SEQ-FRM is placed in the desired sample location the following steps should be performed to properly configure the unit.



### 3.3.1 Assemble the E-SEQ-FRM Stand

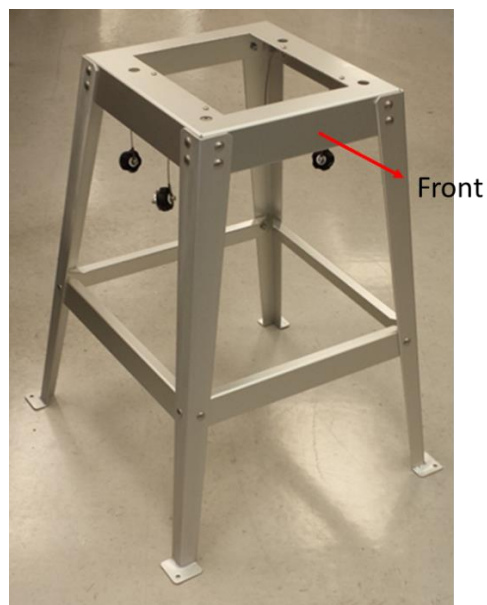
The sampler stand consists of nine primary components and the associated fasteners. There is one top plate, four legs, and two each long and short support bars. It has an overall height of 29 inches when assembled. This is the same approximate height of a typical table or desk.



**Figure 3-3 E-SEQ-FRM Sampler Stand Components**

Assemble the stand as follows:

1. Place the top plate upside down (flat edges down) on a flat surface.
2. Place one leg on the outside of each corner (see Figure 3-4) and secure with the provided fasteners.
3. Place the short front and back support bars in position and fasten to the legs. Note the sampler mounting holes are offset toward the front of the stand (see Figure 3-4).
4. Place the long side support bars in position and fasten to the legs (see Figure 3-4).
5. Turn the stand over to the upright position. Verify all fasteners are fully secured and tight. Confirm all four of the captive foot fasteners are present (see Figure 3-3).



**Figure 3-4 E-SEQ-FRM Sampler Stand Final Assembly**

### 3.3.2 Install E-SEQ-FRM sampler on top of Stand

Place the E-SEQ-FRM sampler onto the stand. The feet on the bottom of the sampler should line up with the holes in the top of the stand. Use the four captive foot fasteners to secure the sampler to the stand by screwing them in to the sampler feet as shown in Figure 3-5.

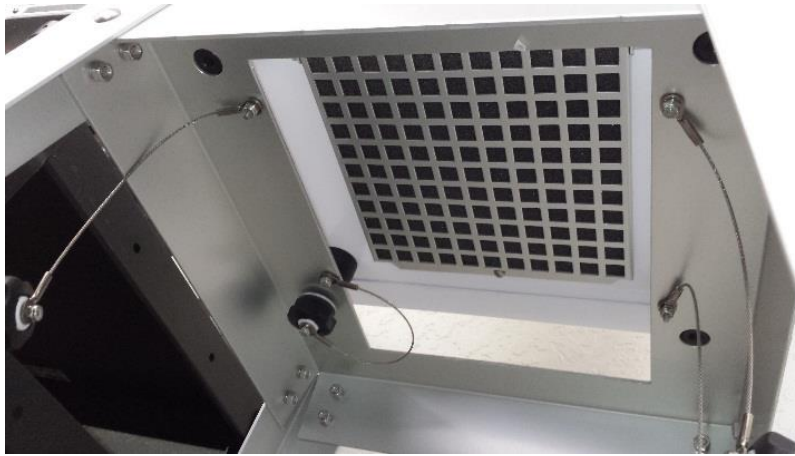


Figure 3-5 Securing the E-SEQ-FRM Sampler to the Stand

### 3.3.3 Installing the Ambient Temperature Sensor

On the rear wall of the sampler enclosure, remove the two sets screws and washers in the upper right hand corner. Align the ambient temperature (AT) sensor mounting holes with the mounting holes in the enclosure (see Figure 3-6) and reinstall the screws and washers to secure the probe in place. See section 3.3.7 for cable connection details.



Figure 3-6 Ambient Temperature Sensor Assembly Mounted on the Enclosure

### 3.3.4 Installing Inlet Down Tube and BX-802 PM<sub>10</sub> Inlet Head

Loosen the black watertight fitting on the inlet tube receiver located on top of the E-SEQ-FRM sampler. Slide the sample inlet down tube through the fitting and down into the inlet tube receiver. Press down firmly and be certain the tube snaps into the O-ring socket securely, then tighten the black plastic fitting.

Place the BX-802 PM<sub>10</sub> inlet on top of the inlet down tube. Press or pull down on the BX-802 and ensure it is fully seated on the tube.



Figure 3-7 Installation of the PM<sub>10</sub> Inlet

**Note:** The PM<sub>10</sub> inlet is used in almost all configurations of the E-SEQ-FRM sampler. It serves as a pre-separator for subsequent PM<sub>2.5</sub> stages when using either one of the PM<sub>2.5</sub> cyclone separators or the WINS impactor. It is not used when the E-SEQ-FRM is configured for TSP sampling.

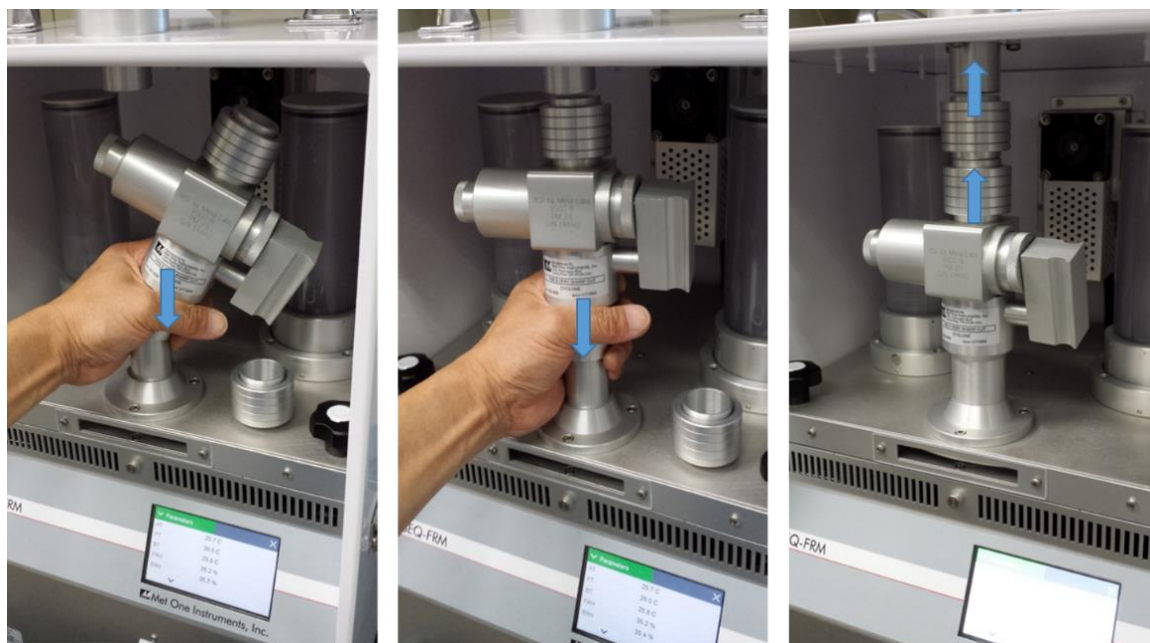
### 3.3.5 Configure the Internal Size Selection Hardware

Since all samples enter the E-SEQ-FRM Sampler through the PM<sub>10</sub> inlet head (see section 3.3.4) other than when the sampler is being used to sample TSP, in order monitor PM<sub>2.5</sub> particulate (or other non-designated or indicative PM<sub>2.5</sub> or PM<sub>1</sub> sampling) the sample air must pass through an additional separator.

#### 3.3.5.1 Configuration for PM<sub>2.5</sub> Particulate

To configure sampler for PM<sub>10</sub> particulate collection, see section 3.3.5.2.

When using the sampler to monitor PM<sub>2.5</sub>, the PM<sub>2.5</sub> cyclone is mounted on top of the sampling station inside the enclosure. The sampler is usually supplied with a BX-808 cyclonic separator. Normally, the cyclone should already be installed inside the upper enclosure as shown in Figure 3-8. If it has been removed, it should be installed now by performing the following steps:



**Figure 3-8 Installation of the PM<sub>2.5</sub> Cyclonic Separator**

1. Insert one of the two coupler rings on top of the cyclonic separator and install the separator over the receiver on the sampling station as shown in Figure 3-8 on the far left.
2. Press down on the BX-808 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.
3. 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 3-8.
4. 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 3-8.

**Note:** The WINS Impactor may be exchanged for a PM<sub>2.5</sub> cyclone when configuring the sampler for PM<sub>2.5</sub> sampling. See Figure 3-9.

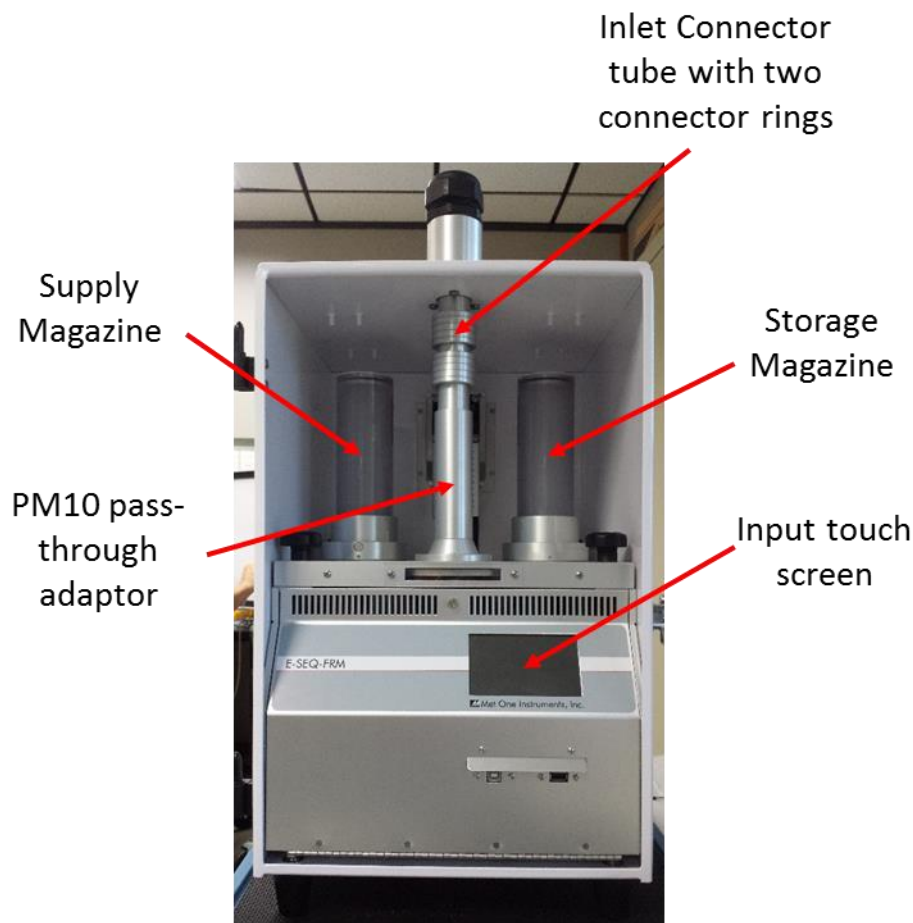


**Figure 3-9 Installation of the PM<sub>2.5</sub> WINS Impactor**

### 3.3.5.2 Configuration for PM<sub>10</sub> Sampling

To configure sampler for PM<sub>2.5</sub> particulate collection, see section 3.3.5.1.

When sampling PM<sub>10</sub>, the PM<sub>10</sub> pass-through adapter is mounted on the sampling station receiver inside the enclosure. The pass-through adapter can be installed by performing the following steps:



**Figure 3-10 Installation of the PM<sub>10</sub> Pass-Through Adapter**

1. If installed, remove the PM<sub>2.5</sub> accessories by reversing the installation steps found in section 3.3.5.1.
2. Insert one of the two coupler rings on top of the PM<sub>10</sub> pass-through adapter and install the adapter over the receiver on the sampling station as shown in Figure 3-10.
3. Press down on the adapter to fully seat it on the receiver of the sampler. There should be a gap between the PM<sub>10</sub> adapter and the upper receiver at the top of the enclosure.
4. Install the second coupler ring on the short inlet coupler. Place the coupler in the gap between the adapter and the upper receiver as shown in Figure 3-10.
5. Slide both connector rings up to seal the two gaps between the upper receiver, the inlet coupler, and the pass-through adapter as shown in Figure 3-10.



### 3.3.6 Power Supply Installation

The E-SEQ-FRM sampler is powered by a 12 VDC power supply mounted on the back of the enclosure. Before the supply can be mounted, it must be installed inside the protective metal power supply case. Slide the power supply into the case and secure it in place with attached plate as shown Figure 3-11

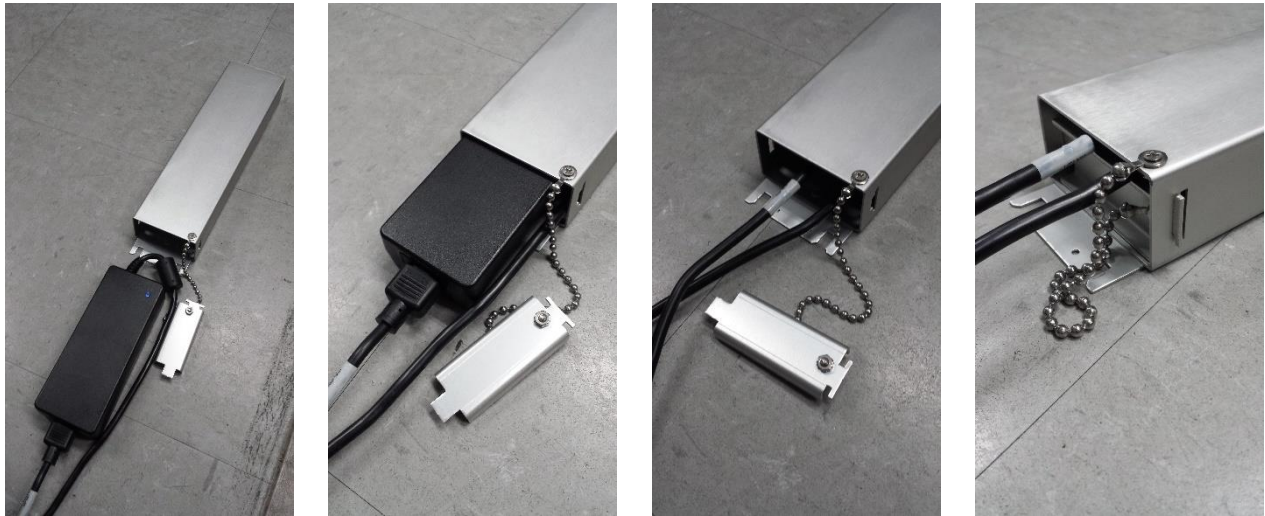


Figure 3-11 Installing the Power Supply into the Power Supply Case



*Caution: Cabling should be inspected before deployment to verify the cable integrity. Replace the power supply or the AC power cable if the cable is damaged. Failure to do so is unsafe and may result in electric shock and equipment damage!*

On the rear wall of the enclosure, remove the three sets of screws and washers located on the left hand side. Align the power supply case mounting slots and hole with the mounting holes in the enclosure (see Figure 3-12) and reinstall the screws and washers to secure the case in place. See section 3.3.7 for cable connection details.



Figure 3-12 Securing the Power Supply Case

### 3.3.7 Rear Panel Connections

The rear panel cable connections are shielded with a rain protector plate as shown below in Figure 3-14.

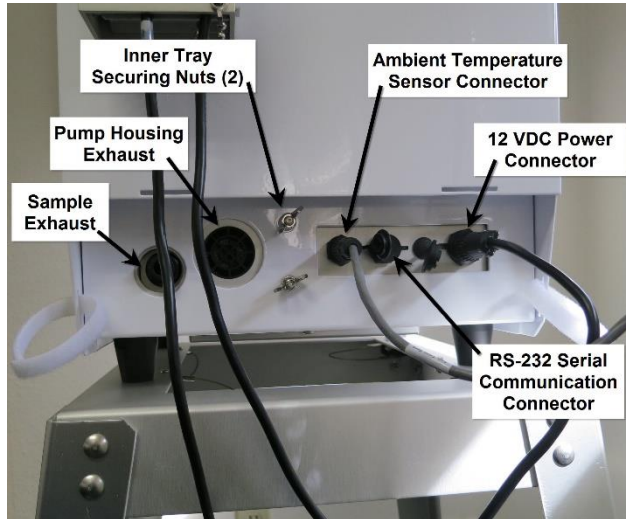


Figure 3-13 Rear Panel Connections

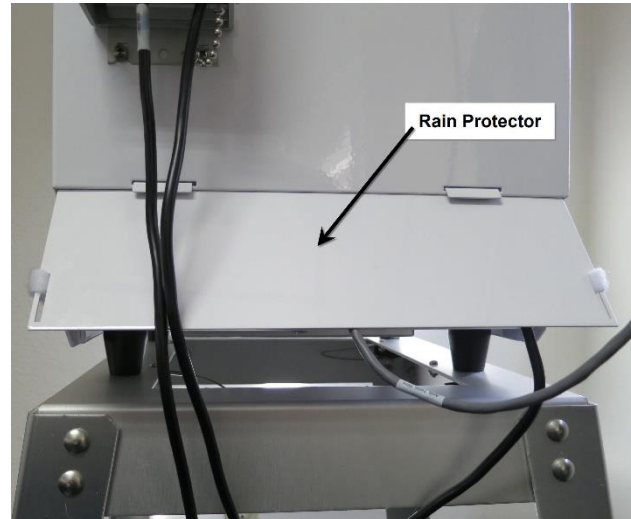


Figure 3-14 Rear Panel Rain Protector

Attach the rear panel connections by performing the following steps:



**Caution:** Connect the 12 VDC Power Connector before connecting the AC power cable to a live electrical source!

1. Connect the DC output voltage cable from this supply to the rear panel connector (far right connector) as shown in Figure 3-13.
2. Connect the Ambient temperature sensor cable (far left connector) also as shown in Figure 3-13.
3. If needed, connect the RS-232 communication cable (see Figure 3-13).
4. Verify all connectors are secure and all exhaust vents are clear of obstructions.
5. If it is desired to reduce noise from the pump, insert a 1m length of flexible 10mm O.D. tubing into the sample flow exit port (see Figure 3-13 for port location)
6. Attach rain protector as shown in Figure 3-14.

The sampler is now ready to be connected to a reliable AC power source using the provided AC power connector on the 82522 power supply.



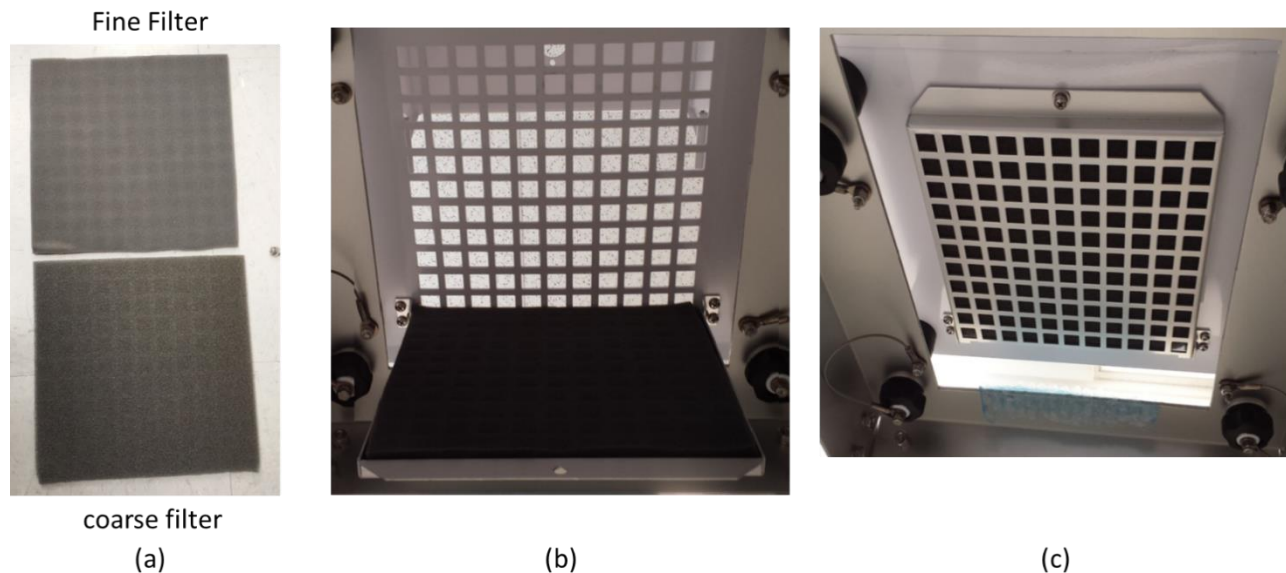
**Warning!** Electrical service must be properly configured for outdoor use with the correct voltage and frequency in accordance with local electrical codes. Consult a qualified electrician if unsure.

### 3.3.8 Installing Dust Filters

The E-SEQ-FRM Sampler enclosure is cooled by pulling ambient air up through the bottom of the enclosure. This cool air passes over the internal components and is then exhausted out of the rear wall near the top of the enclosure. This circulation is accomplished by mounting a fan inside the sampler on the rear wall to push the warm air out of the exhaust vent.

To keep the interior as clean as possible, the incoming air passes through two filters located in the bottom of the enclosure. Instead of one coarse filter that lets in too much small dust or one fine filter that clogs quickly with large particles, the sampler uses both a coarse *and* a fine filter in tandem. The air passes through a 45 PPI coarse filter first to remove the larger dirt particles and then through a fine 80 PPI filter to remove the smaller dust particles.

Both filters can be cleaned with water and reused a maximum of five times. Filters should be verified to be completely dry before being installed in the sampler.



**Figure 3-15 Dust Filters Installation**

To install new or cleaned dust filter, refer to Figure 3-15 and follow these steps:

1. The filter holder is hinged. Open by unscrewing the captive fastener and allowing the holder to swing down.
2. Remove the dirty filters and wipe off any residual dust on both the outside and inside of the filter holder.
3. Place a clean coarse filter (45 PPI) on the bottom of the filter holder.
4. Place a clean fine filter (80 PPI) on top of the coarse filter.
5. Close the filter holder and secure with the captive fastener.



### 3.4 Configurations for PM<sub>2.5</sub> or Other Particulate Cut-Points

***It is critical for the user to understand and keep track of the exact inlet hardware configuration, in order to ensure that the resulting concentration data is identified for the correct PM classification! The sampler cannot automatically identify the inlet cut-point configuration.*** The inlet configuration type should be selected to match the physical setup hardware by the operator through the user interface. This setting will appear in the data files for quality assurance purposes. See section 6

All standard configurations of the sampler use a standard louvered PM<sub>10</sub> size-selective inlet (Met One Instruments part number BX-802) as the main air inlet for the system. This inlet separates out and traps water, debris, and particles larger than 10 microns in size, while allowing smaller particles through to the sampler. For PM<sub>2.5</sub> sampling, the PM<sub>10</sub> inlet serves as a particulate pre-separator for the secondary cyclone or impactor stage inside the sampler. For PM<sub>10</sub> sampling, a pass-through adapter (Met One Instruments part number 81210) is installed in place of a PM<sub>2.5</sub> separator to allow the particulate directly through to the filter.

The sampler is configured for PM<sub>2.5</sub> sampling by using an internal VSCC™ (Very-Sharp-Cut Cyclone, Met One Instruments part number BX-808) to further separate out and trap particles larger than 2.5 microns in size, while allowing smaller particles through to the sample filter. The particle performance of these cyclones closely matches that of the classic WINS Impactor, but with simpler maintenance requirements. The VSCC™ cyclone is manufactured by BGI, Inc. as a condition of the EPA designated status of the cyclones. See [www.bgiusa.com](http://www.bgiusa.com) for details.

The classic WINS Impactor, built to 40 CFR Part 50L specifications, is the predecessor to the BGI cyclones for designated PM<sub>2.5</sub> sampling, and is available from Met One Instruments (part number BX-804) upon request. It fits into the same position as the BX-808 inside the sampler.

The cyclone position can accommodate an older style SCC (Sharp-Cut-Cyclone, Met One Instruments part number BX-807) for less common PM<sub>2.5</sub> sampling applications where a lower cost system is needed, and EPA designation is not required for the resulting data. The SCC cyclone is very similar to the VSCC™ cyclone, but is not designated as a Federal Reference Method for PM<sub>2.5</sub>.

The cyclone position can also accommodate a version of the SCC Sharp-Cut-Cyclone for PM<sub>1</sub> sampling (Met One Instruments part number BX-811). This separates out particles larger than 1 micron in size. This configuration is not very common because PM<sub>1</sub> sampling is not currently regulated or designated by the EPA.

### 3.5 Loading and Unloading the Filter Cassette Magazines

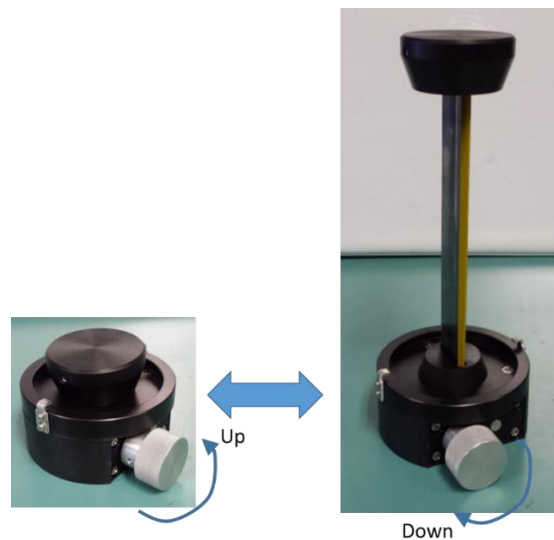
The E-SEQ-FRM Sampler comes with three filter cassette magazines and one adjustable bottom lid. Filter cassettes (as shown in Figure 3-16) may be purchased separately. The sampler uses industry standard filter size of 47 mm for collecting particulate.



**Figure 3-16 Filter Cassettes, Magazine and Adjustable Bottom Lid**

The filter cassette magazines hold a maximum of 16 filter cassettes.

An adjustable bottom lid is used whenever loading or unloading the filter cassette magazines. It also secures the internal stack of filter cassettes and prevents them shaking whenever the filter cassette magazine is transferred from one place to another. A plunger is mounted on a steel ribbon which allows it to be moved up and down by rotating a knob in the base. Rotating the knob in the clockwise direction lowers the plunger while rotating the knob counter-clockwise raises it (see Figure 3-17).



**Figure 3-17 Adjustable Bottom Lid Operation**

### 3.5.1 Loading New Filter Cassettes into the Filter Cassette Magazine

The adjustable bottom lid is used whenever loading (or unloading) filter cassette holders into the filter cassette magazine. It seals the bottom of the magazine so the holders cannot fall out of the bottom while also providing a controlled means of lowering them in to place to ensure proper positioning. The following procedure assumes pre-weighed filters are already loaded into properly identified filter cassette holders. This procedure can be done either in the lab or at the sampling site.



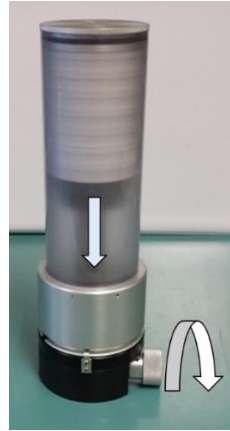
**Figure 3-18 Loading New Filter Cassettes into the Magazine**

1. Remove top magazine lid and install the adjustable bottom lid into the base of the filter cassette magazine:
2. Rotate the adjustable bottom lid to secure it in place.
3. Turn the knob of the bottom lid counter-clockwise until the plunger is positioned near the top of the magazine (see Figure 3-18).
4. Record the ID of the first filter cassette and then set it on top of the plunger. It should be resting nearly level with the top of the magazine.
5. 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 (see section 6.1).
6. 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.
7. Repeat steps five and six as needed until all of the desired filter cassette holders are loaded and then install the top lid.
8. The adjustable bottom lid should remain in place. Raise the plunger just enough to secure the filter stack in place so that it does not wobble or shake during transit to the site.
9. Keep a copy of the filter ID sequence with this magazine. It will be needed when the magazine is installed in the sampler.

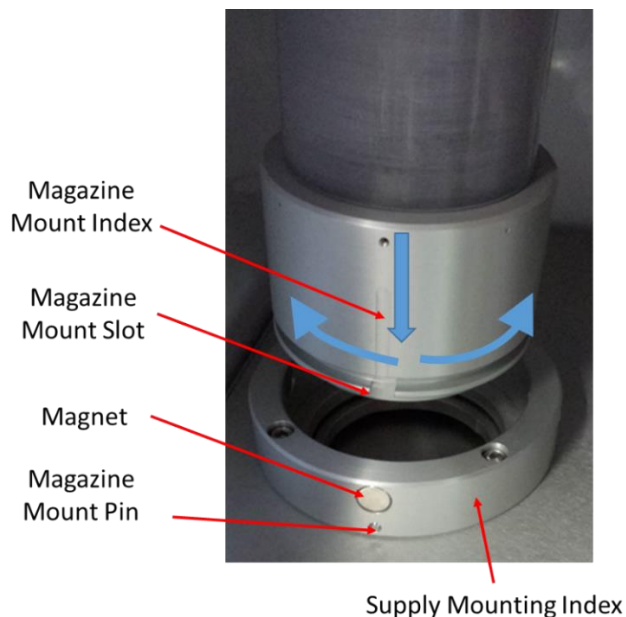
### 3.5.2 Installing a Supply Filter Cassette Magazine

Installing the supply magazine loaded with new filters is a simple process. The procedure below assumes the operator is at the sampler with a magazine that has been loaded in accordance with the instructions provided in section 3.5.1. It also assumes there are no filters remaining in the supply magazine (if one is installed) and that any previously loaded filters have already been moved to the storage 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 (Figure 3-19).
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 3-20).
5. Insert supply magazine into mounting index and rotate it as shown by the arrows in Figure 3-20. The magazine can be rotated in either direction. Rotate it until the magnets catch the magazine stops and retract them. When the stops retract, an audible clicking sound should be heard and the filters should drop down in to place.



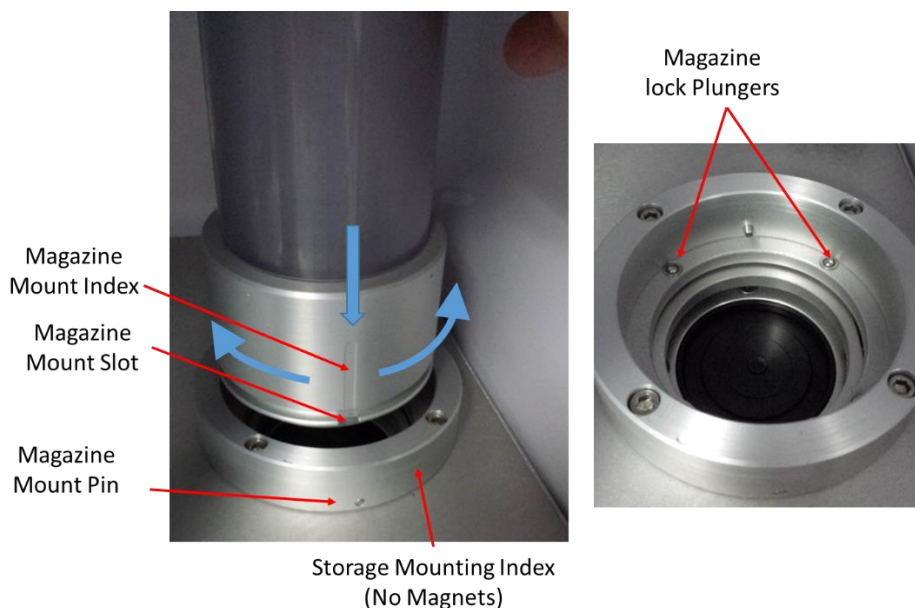
**Figure 3-19 Preparing Magazine for Installation**



**Figure 3-20 Supply Magazine Installation into Supply Mounting Index**

### 3.5.3 Installing a Storage Filter Cassette Magazine

The storage filter is where the used sample filters are placed until they can be removed and sent out for evaluation. Note that the storage mounting index is slightly different than the supply mounting index as shown in Figure 3-21. The storage magazine should always be empty when it is loaded into the sampler. Never load a storage magazine that already contains used filters.



**Figure 3-21 Storage Magazine Installation into Storage Mounting Index**

1. Align the storage magazine's mount slot with the storage mount index pin.
2. Insert storage magazine into storage mounting index, push down, and then turn the magazine as shown by the arrows in Figure 3-21. The magazine can be rotated in either direction. Rotate it until the magnets catch and it clicks in place.

### 3.5.4 Removing a Filter Cassette Magazine

1. Rotate until the magazine mounting index aligns with the magazine mounting pin (see Figure 3-20 and Figure 3-21).
2. Gently lift up on the magazine to remove it from the mounting index.

### 3.5.5 Removing Filter Cassettes from a Magazine

Removing used filter cassettes from the storage magazine is essentially reversing the sequence for installation that is detailed in section 3.5.1.

1. If it is not already installed, install the adjustable bottom lid into the base of the filter cassette magazine.
2. Rotate the adjustable bottom lid to secure it in place.
3. Remove top magazine lid.
4. Turn the knob of the bottom lid counterclockwise until the plunger raises the top of the used filters just above the top of the magazine. This will make it easy to lift off the stack.

5. Remove the top filter and follow local directives and handling procedures for used sample filters.
6. Once the removed filter has been properly addressed, rotate the knob in the bottom lid counterclockwise to raise the plunger just far enough to set the next filter cassette holder in place so that it is easy to remove.
7. Repeat steps five and six as needed until all of the used filter cassette holders have been removed and then install the top lid. This will keep the lid with the magazine and prevent it from becoming lost.
8. The adjustable bottom lid may now be lowered and placed in storage or used elsewhere.

## 4 USER INTERFACE and MENU SYSTEM

This section describes the E-SEQ-FRM user interface system, and describes the functions of the main menu options, including how to view data and errors.

E-SEQ-FRM

2020-01-23 10:22:12

Filter ID	6
Status	Sampling
Remaining	30:37:48
Sample Duration	41:21:56
Sample Start	2020-01-21 17:00:14
Sample Stop	2020-01-24 17:00:00

Figure 4-1 The E-SEQ-FRM Initial Screen shows current status of the Sampler

### 4.1 The User Interface – Touchscreen Display Functions

The E-SEQ-FRM user interface is a touchscreen display used to control almost all of the features and functionality of the sampler. It is mounted inside the enclosure and is only accessible when the front door of the E-SEQ-FRM is open.

### 4.2 Main Operating Screens

The main operating screen is designed to provide the current status of the sampler and any programmed events. Additionally, if there is no event programmed, a shortcut to the Event Manager will be presented. The left hand image shown in Figure 4-2 will normally be displayed at startup while the right hand image shows a typical main screen while waiting for a programmed event to begin. Note that it provides indication of the ID of the filter being used for the sample, the start and stop times of that sample, and the current status.

E-SEQ-FRM		2016-07-23 15:51:15
Event Manager		
Status	Stopped	

E-SEQ-FRM		2016-07-23 16:14:59
Filter ID	8675309	
Status	Waiting	
Sample Start	2016-07-24 00:00:00	
Sample Stop	2016-07-27 00:00:00	

Figure 4-2 The E-SEQ-FRM Main Screen

Note that once an event is pending or in progress the Event Manager shortcut is no longer available on this screen. To access the event manager when the shortcut is not present, go to the Operate Menu (see section 4.4).

Table 4-1 describes the real-time fields displayed on the main operating screen:

Parameter	Description
<b>Filter ID</b>	Designated ID of the filter cassette for the sample event
<b>Status</b>	Current operation such as sampling, waiting, stopped, etc.
<b>Sample Start</b>	The start time of the sample in the following format: YYYY-MM-DD HH:MM:SS
<b>Sample Stop</b>	The stop time of the sample in the following format: YYYY-MM-DD HH:MM:SS

**Table 4-1 Main Display Parameter Descriptions**

See section 6 for more details about programming sample events.

### 4.3 Menu Hierarchy and Navigation

The E-SEQ-FRM menu structure is outlined in the following table.

Main Menu	Sub Menu Options	Overview
Operate See section 4.4	Stop Sample Event Manager Transfer Data About	Cancel the current sampling event (not always visible) Configure upcoming sample events Download stored data to a USB memory stick Details the current BAM-1020 firmware type and version number
Test See section 0	Temp Calibrate Pres Calibrate Flow Calibrate Fans Leak Test Parameters Transport	Calibrate temperature sensors or restore default settings Calibrate pressure sensors or restore default settings Calibrate flow rate or restore default settings Manually start and stop individual cooling fans Perform the leak check View current real-time sensor values Test the filter positioning system
Setup See section 4.6	Event Defaults Standard Temp Clear Memory Set Clock Unit ID Password Serial Port Sound Volume Touch Calibrate	Set the default values for the Event Manager Set the standard temperature value Clear all stored data and alarm logs Set the date and time Set or change the numerical ID of the sampler Change or disable the master password Set the baud rates for serial communications Adjust the volume of the touchscreen sounds Calibrate the touch screen
Alarms See section 4.7	No sub menu	View alarms

**Table 4-2 E-SEQ-FRM Menu Hierarchy**

Menu selections and instructions are detailed in the following sections of this operating manual as assigned in the Main Menu column of Table 4-2 above.



To access the various main menus, press the three horizontal lines in the top left corner. A drop down menu will appear (Figure 4-3) to allow selection of any of the four main menus. This option is available on all main menu screens (such as the Setup Menu shown in Figure 4-4) and on the main operating screen.



Figure 4-3 Main Menu Drop Down Selections

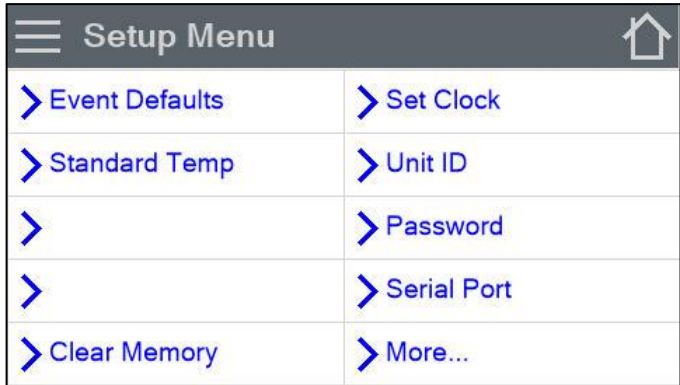


Figure 4-4 Setup Menu

To return to the main operating screen (see section 4.2), press the Home icon in all main menu screens. This icon can clearly be seen in the Setup Menu image shown here in Figure 4-4.

To cancel and action and return to the previous menu screen, press the X icon in all sub menu screens. This icon can clearly be seen in the Clock Setup screen image shown in Figure 4-5.

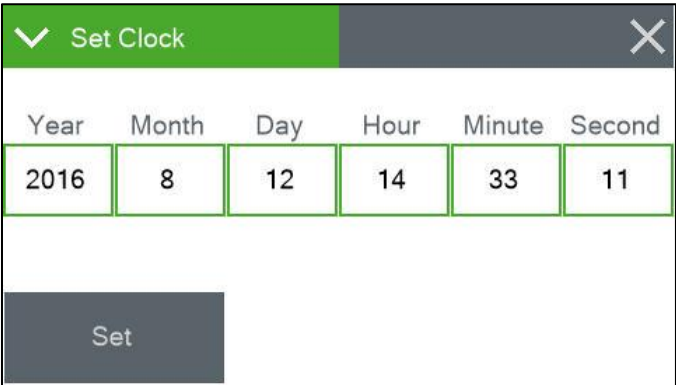


Figure 4-5 Clock Setup Screen

▼ Year					
2016		1	2	3	⏮ X ⏭
		4	5	6	
		7	8	9	
OK	Cancel	0			

**Figure 4-6 Visual Keypad for Numeric Entry**

Some parameters, such as the Date and Time settings (Figure 4-5) or a Unit ID value, require numeric entry. When a button to edit such a field is pressed, a visual keypad (Figure 4-6) will open up allowing users to input the value. Press the OK key to accept the changes or the Cancel key to return to the previous screen. The X key on the far right performs a backspace operation.

Other parameters, such as the filter cassette ID value, may require alphabetical entry along with numerical values. When a button to edit such a field is pressed, a visual alphanumeric keypad (Figure 4-7) will open up allowing users to input the value. Press the OK key to accept the changes or the Cancel key to return to the previous screen. The X key performs a backspace operation.

					OK		CANCEL		
1	2	3	4	5	6	7	8	9	0
q	w	e	r	t	y	u	i	o	p
a	s	d	f	g	h	j	k	l	
z	x	c	v	b	n	m	/	⏮ X ⏭	ABC

**Figure 4-7 Keypad for Alphanumeric Entry**

The ABC key performs the function of a SHIFT key. It toggles between upper and lower case letters and allows the numbers across the top to switch to special characters such as the dollar sign, asterisk, or ampersand.

## 4.4 Operate Menu

The Operate Menu is the doorway to the most used areas for normal operation of the E-SEQ-FRM. 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 4-8.

≡ Operate Menu		🏠
> Event Manager		
> Transfer Data	> USB Import	
> About		

≡ Operate Menu		🏠
> Pause/Stop Sample	> Advance Cassette	
> Event Manager		
> Transfer Data	> USB Import	
> About		

**Figure 4-8 The Operate Menu**

#### 4.4.1 Pause/Stop Sample

If it is necessary to interrupt or halt sampling, the Pause/Stop Sample button should be used. Press the key and the selection screen shown on the far left of Figure 4-9 will appear. Use the PAUSE button to temporarily suspend the current sample but be able to resume normal operations when maintenance or testing is complete. Use the STOP button if it is necessary to completely cease operations and delete all subsequent events.

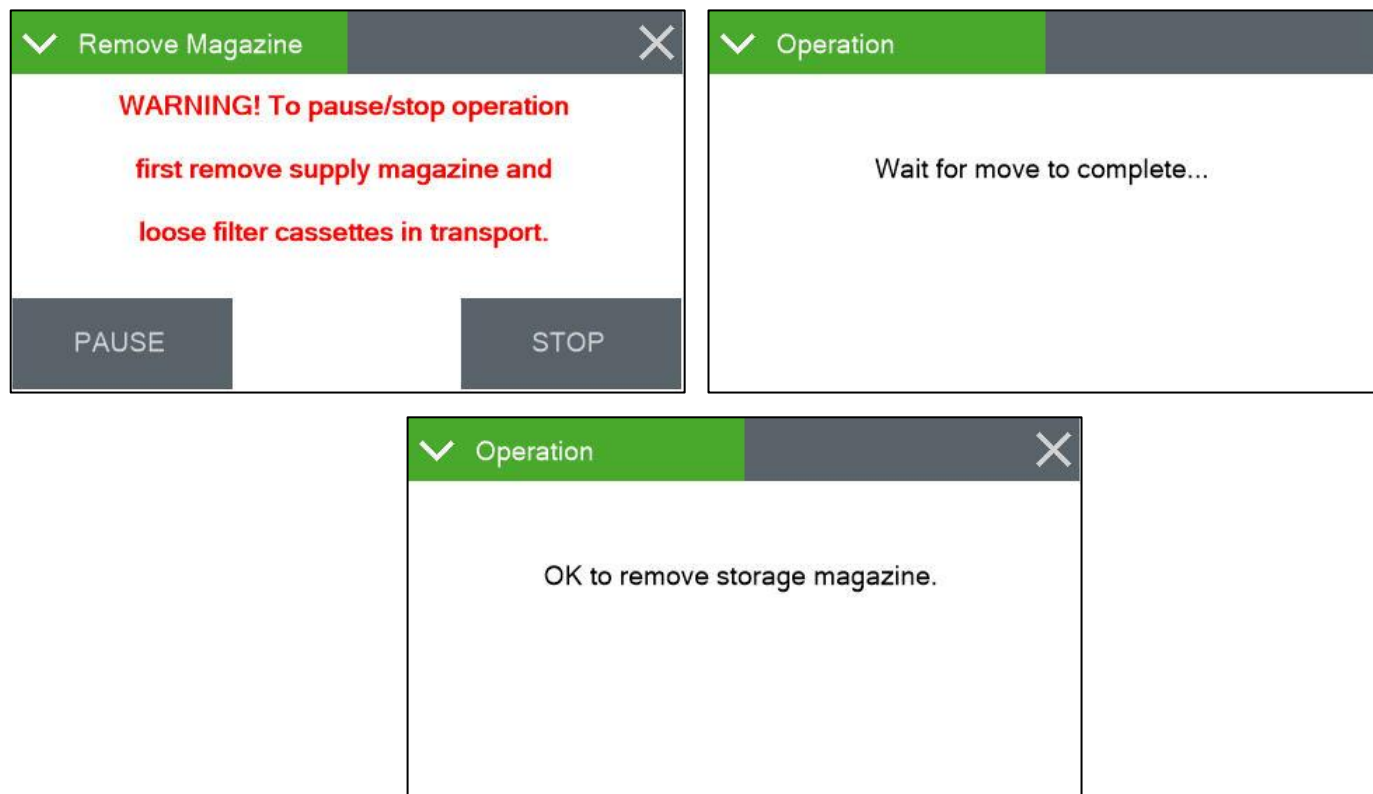


Figure 4-9 Pause Sample Sequence

Note that before a selection is made, the supply magazine and any loose filter cassettes beneath it should be removed. Once either PAUSE or STOP is chosen, the current sample will immediately cease, and the sample filter will be moved to the storage magazine. Wait for this operation to complete and screen to provide indication that it is OK to remove the storage magazine. See Figure 4-9 for an example of the full sequence.

If the event is only paused, all programmed sampling events, including the one that was interrupted, may be resumed once the work is complete. Note that any loose filter cassettes must be reloaded into the supply magazine in the appropriate sequence to match the programmed event schedule. If there is still time remaining in the interrupted event itself, the cassette must be removed from the storage magazine and placed in the bottom position of the supply magazine as it will be moved into place first and the interrupted sample will resume until its scheduled ending time.

To resume operations, return to the Operate Menu and press the Resume Sample option as shown in Figure 4-10. Verify that both the supply and storage magazines are in place and press the RESUME button. The sample event schedule will now proceed as programmed.

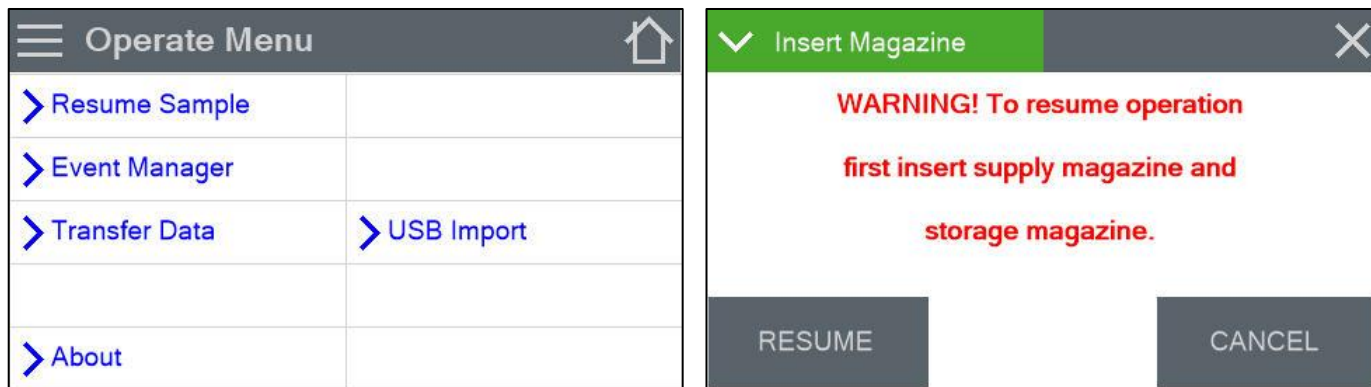


Figure 4-10 Resume Sample Sequence

If the STOP option is used, any remaining scheduled sample events will be erased. In this case, a completely new schedule will need to be created or loaded from a USB flash drive (see section 4.4.5) before sampling can resume.

#### 4.4.2 Event Manager

This screen provides the options needed to manage the sampling event schedule. It displays the currently programmed samples and allows for adding more. It also has options for removing or modifying existing events. See section 6 for detailed instructions on creating and managing the sampling event schedule.

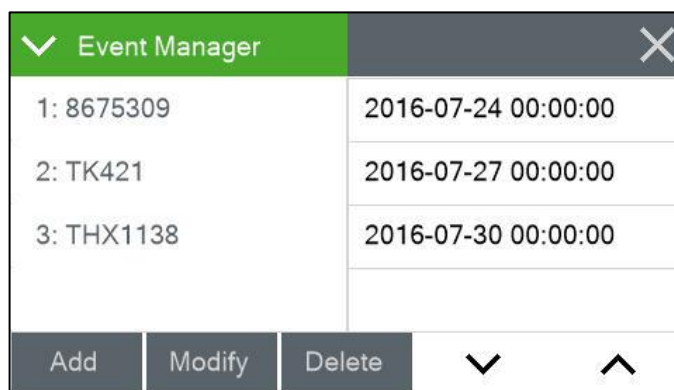


Figure 4-11 The Event Manager Screen

#### 4.4.3 Transfer Data

Copying data to a USB memory stick is performed from this screen. See section 9.2 for detailed instructions.

#### 4.4.4 Advance Cassette

Once a sample event is complete, the used filter cassette remains in the sample position until the start of the next sample. If it is necessary to collect the sample before the next scheduled sample begins, use the Advance Cassette feature (see Figure 4-8) to manually place the used filter into the storage magazine. This option will only appear after a sample has completed and the feature can be used.

To prevent accidental cassette advancement, when the Advance Cassette option is selected on the Operate menu, the warning screen shown in Figure 4-12 is displayed.

Press the ADVANCE key to move the sample to the storage magazine immediately. This will also move the next sample cassette into the sampling position.

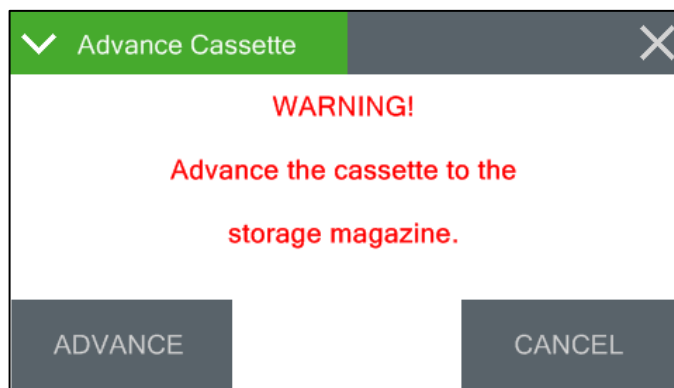


Figure 4-12 The Advance Cassette Warning Screen

Press the CANCEL key if it is not desired to move the cassettes at this time.

#### 4.4.5 USB Import

Importing event schedules from a USB memory stick is performed from this screen. See section 6.5 for detailed instructions.

#### 4.4.6 About

This screen shows the monitor's serial number and installed firmware type and version number.

About	
Website	www.metone.com
Serial Number	U15912
Firmware Version	82465, R1.4.7
FPGA Version	82464, R1.0.0
Display Version	82451, R1.0

Figure 4-13 The About Screen

## 4.5 Test Menu

The Test Menu provides a means of testing and calibrating individual sensor inputs and calculations. Because these settings directly impact flow rates, most of these tests are password protected.

Test Menu	
> Temp Calibrate	> Leak Test
> Pres Calibrate	> Parameters
> Flow Calibrate	> Fans
	> Transport

Figure 4-14 The Test Menu

### 4.5.1 Temp Calibrate

This screen provides the options and indications needed to default, verify, and calibrate the various temperature sensors. This can be done as an independent verification or as part of the flow calibration procedure. See sections 7.4 and 7.5 for detailed instructions.

Temp Sensors	
Temp Sensor	AT
E-SEQ-FRM	23.3 C
Standard	+23.3
DEFAULT	3 PT CAL
CALIBRATE	

Figure 4-15 The Temp Calibrate Screen

### 4.5.2 Pres Calibrate

This screen provides the options and indications needed to default, verify, and calibrate the various pressure sensors. This can be done as an independent verification or as part of the flow calibration procedure. See sections 7.4 and 7.5 for detailed instructions.

Pres Sensors	
Pres Sensor	BP
E-SEQ-FRM	731.1 mmHg
Standard	+731.1
DEFAULT	
CALIBRATE	

Figure 4-16 The Pres Calibrate Screen

4.5.3 Flow Calibrate

This screen provides the options and indications needed to default, verify, and calibrate the flow sensor as part of the flow audit and calibration procedures. See sections 7.2 and 7.5 for detailed instructions.

✓ Flow Calibrate

✕

Set Point	16.67
E-SEQ-FRM	16.67 LPM
Reference	+16.67

DEFAULT

CALIBRATE

Figure 4-17 The Flow Calibrate Screen

4.5.4 Leak Test

The main external and follow-up internal leak tests use this screen. See section 7.2 for detailed instructions on performing these tests.

✓ Leak Test

✕

Current	731.2 mmHg
Vacuum	
Leak	
Elapsed	

Press START to begin.

START

Figure 4-18 The Leak Test Screen

4.5.5 Parameters

These screens provide the ability to view the real time value of a wide variety of parameters. Results are updated every second. No changes can be made; they are for viewing purposes only.

✓ Parameters

✕

AT	22.7 C
FT	22.1 C
BT	22.4 C
BRH	37.4 %
▼	

✓ Parameters

✕

FP	731.1 mmHg
BP	731.0 mmHg
Flow	0.00 LPM
▼	

Figure 4-19 The Test Menu Parameters Screens

Note that the display has a limited amount of space and cannot show all the real time data on one screen. Press the down arrow key to toggle between the two screens shown in Figure 4-19.

4.5.6 Fans

This screen provides a means of verifying that the enclosure cooling fans are functioning correctly. The Pump Fan is located on the bottom of the enclosure and the Box Fan is located near the top on the rear wall. The fans are toggled on and off using the associated buttons located in the lower corners of this screen.



Figure 4-20 The Fans Screen

Pressing the button for a fan causes that fan to change state from either OFF to ON or from ON to OFF. The current state of each fan is listed to the right of the fan name as shown in Figure 4-20. In this example, both fans are currently off. When the fans are turned on, operators should be able to both hear the fan spin and feel air in motion around it. Cool air is pulled up into the enclosure from the bottom using the Pump Fan. It then flows across the internal components (primarily the pump) and cools them. The warm air is and then exhausted out of the rear of the enclosure near the top using the Box Fan.

4.5.7 Transport

This screen allows a means of testing the filter transport mechanism. See section 8.5 for details on performing this test.

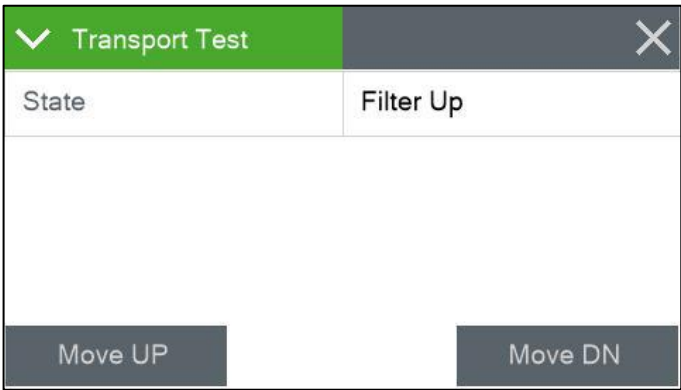


Figure 4-21 The About Screen



## 4.6 Setup Menu

The E-SEQ-FRM uses a comprehensive system of setup menus which contain all of the settings and parameters needed for operation of the sampler. Most of these settings are set at factory default values. Some settings may be altered by the operator. This section describes the SETUP menu in detail and should be reviewed when the instrument is first put into service. Once set, most of the values in the SETUP menus will not need to be changed. The SETUP values will not be lost if the E-SEQ-FRM is unplugged or powered down.

**WARNING: Entering the SETUP menu system requires stopping the sample cycle.**

Press the SETUP key on the main menu drop down selection (see Figure 4-3) to enter the menu as shown in Figure 4-22 below. The setup menu provides a choice of operations. Select the desired field and then press the key to enter that screen.

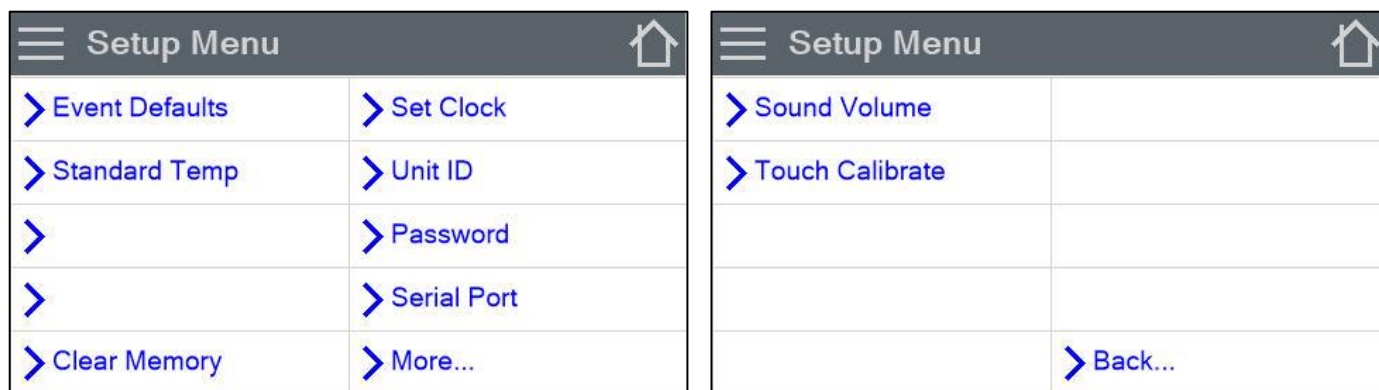


Figure 4-22 The Setup Menu Screens

Note that the display has a limited amount of space and cannot show all the menu options on one screen. Tap the “More...” and “Back...” arrow keys at the bottom of the display to navigate between the two screens shown in Figure 4-22.

### 4.6.1 Event Defaults

This is where the default values for creating new sample events are set. These fields should be set to the most common values that are expected to be used when deploying the sampler. This will greatly reduce the required setup time when programming a sequence of sample events. Press the green box of the field that needs to be modified.

✓ Event Defaults	✕
Start Time	14:00
Duration	0d 02h 00m
Repeat Time	0d 02h 00m
PM Inlet Type	PM2.5 VSCC

Figure 4-23 The Event Defaults Screen

<div>Start Time</div> <div>Hours Minutes</div> <div>14 0</div> <div>OK Cancel</div>	<div>Duration</div> <div>Days Hours Minutes</div> <div>0 2 0</div> <div>OK Cancel</div>								
<div>Repeat Time</div> <div>Days Hours Minutes</div> <div>0 2 0</div> <div>OK Cancel</div>	<div>PM Inlet Type</div> <table border="1"> <tr> <td></td> <td>PM2.5 VSCC</td> </tr> <tr> <td>PM2.5 VSCC</td> <td>PM2.5 SCC</td> </tr> <tr> <td>PM2.5 VSCC</td> <td>PM2.5 WINS</td> </tr> <tr> <td>OK Cancel</td> <td>↓ ↑</td> </tr> </table>		PM2.5 VSCC	PM2.5 VSCC	PM2.5 SCC	PM2.5 VSCC	PM2.5 WINS	OK Cancel	↓ ↑
	PM2.5 VSCC								
PM2.5 VSCC	PM2.5 SCC								
PM2.5 VSCC	PM2.5 WINS								
OK Cancel	↓ ↑								

**Figure 4-24 The Event Defaults Setting Screens**

The associated setting screen (see Figure 4-24) will be displayed. On the time and duration screens, select the specific parameter to modify and press the selection box. The numerical entry keypad (Figure 4-6) will be displayed and the value for that parameter may be entered. Once all fields have been set on a given screen, press the OK button to save them.

For the PM Inlet Type, simply select the type of sampling to be performed and press OK to save the setting. Note that not all the options for this field are able to be displayed on the same screen. Use the up and down arrows to see all the available selections.

See section 6.1 for detailed instructions on programming sample events and explanations of the various fields shown here.

## 4.6.2 Standard Temp

This is the value of standard air temperature, used for the standard calculations when the sampler is configured for PM<sub>10</sub> operation. It is typically set to 25 °C in the United States and this is the default value. However, local regulations may require different values. It can be set to 0, 20, or 25 °C. Just press the green bordered field and select from the list of available temperatures.



Figure 4-25 The Standard Temp Screen

## 4.6.3 Clear Memory

The Clear Memory screen provides a means of clearing all the currently logged data and alarms. The logs may be cleared individually or simultaneously. Press the green selection box to select from the list of available memory files. Once the choice is set, press the CLEAR button.

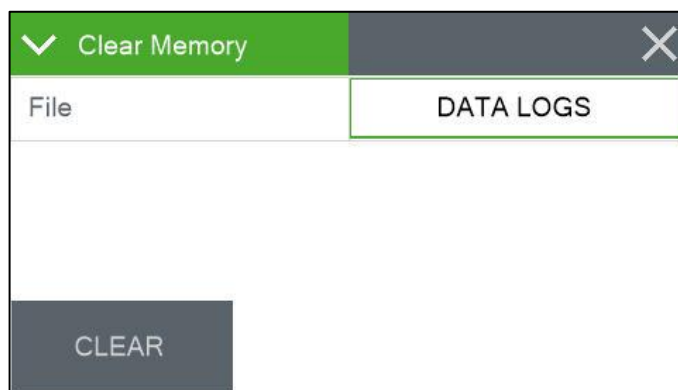


Figure 4-26 The Clear Memory Screen

A confirmation screen appears prior to deleting the selection to avoid accidental erasure. It will ask if to clear DATA LOGS, ALARM LOGS, or ALL LOGS, depending on the selection made. Press the CLEAR button to erase the selected data file(s).

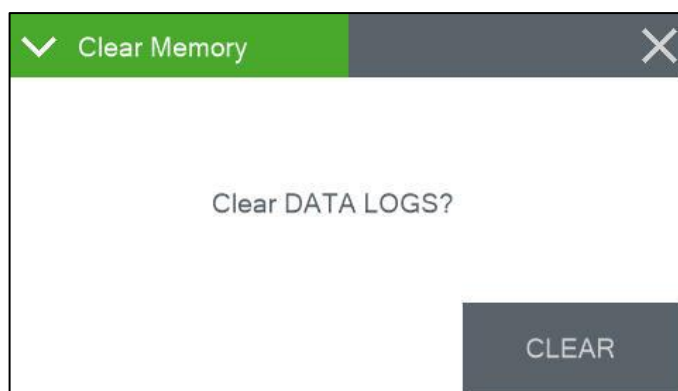


Figure 4-27 The Clear Memory Confirmation Screen

The sampler will return to the Setup menu when the operation is complete.

To cancel the procedure at any time during this sequence, press the X icon to exit back to the Setup menu without clearing anything.

#### 4.6.4 Set Clock

This is where the date and time are set. Time is a 24-hour clock only. Press the green box of the field that needs to be modified. The numerical entry keypad (Figure 4-6) will be displayed allowing users to enter the value for that parameter. Once all fields have been entered, press the Set button to set the clock.

Year	Month	Day	Hour	Minute	Second
2016	8	12	14	33	11

Set

Figure 4-28 The Set Clock Screen

The lithium battery backup keeps the clock running during power-down. Met One Instruments recommends a monthly check of the clock.

#### 4.6.5 Unit ID

Users may enter a Unit ID number up to three digits long for the E-SEQ-FRM. Press the green bordered value box and the numerical entry keypad (Figure 4-6) will be displayed. Enter the new Unit ID value.

This ID number will be included in the data reports.

Unit ID
1

Figure 4-29 The Unit ID Screen

#### 4.6.6 Password

Certain menus and options of the E-SEQ-FRM are password protected. Any four-digit password may be used, and this is the screen that is accessed to change it. Press the green bordered value box and the numerical entry keypad (Figure 4-6) will be displayed. Enter the new password.

Password
0

Figure 4-30 The Password Screen

Setting the password to 0000 means no password is used.

4.6.7 Serial Port

The baud rate for the serial communication ports is set here. Note that the USB connector on the front of the sampler and the RS-232 connection on the rear of the sampler share this one setting.

Press the green bordered value box and a list of the available baud rate settings will be displayed.

Serial Port	
Baud Rate	115200
Handshake	NONE

Figure 4-31 The Serial Port Screen

Tap the rate setting that is needed, and it will be applied. The baud rate options are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115,200. All other serial communication parameters are fixed as:

Data Bits: 8

Parity: None

Stop Bits: 1

In some cases, remote access over high latency Serial to Ethernet converters or modems may require flow control to compensate for slow or noisy connections. In these situations, the RS-232 serial connection can be configured to use XON/XOFF flow control. Flow control is set to NONE by default but can be changed using the Handshake selection box.

Section 9.1 has more details about serial communications.

4.6.8 Sound Volume

The touchscreen will beep every time a selection is made, and that volume may be adjusted in this screen. Press the green bordered value box and the numerical entry keypad (Figure 4-6) will be displayed. Enter a value from 0 – 100 with 100 being very loud and 0 being no beep at all. Any changes made here will not be active until exiting this screen.

Beep Volume	
Beep Volume	10

Figure 4-32 The Sound Volume Screen

### 4.6.9 Touch Calibrate

This screen allows for calibration of the touchscreen. Press the CALIBRATE button to begin and then simply follow the instructions on the screen to calibrate it. If each step is not completed within five seconds, the test will cancel itself and return to page two of the Setup menu.

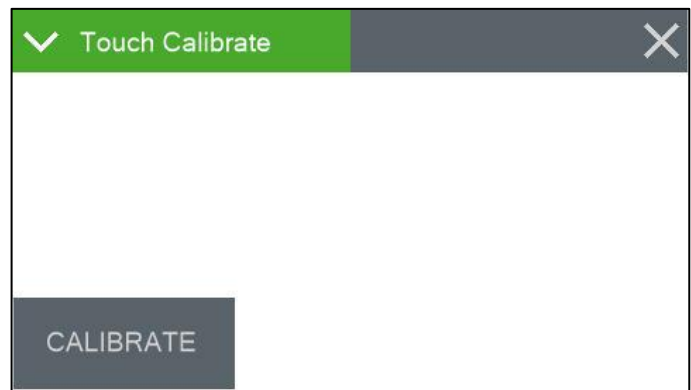


Figure 4-33 The Touch Calibrate Screen

There is a countdown clock for this feature displayed on each step of the calibration process.

## 4.7 Alarms Menu

This screen is used to view time-stamped alarm events with the most recent alarm will be displayed first. If there are more errors than can be displayed on the screen at one time, use the up and down arrow keys that will appear at the bottom of the screen to scroll through the alarm log.

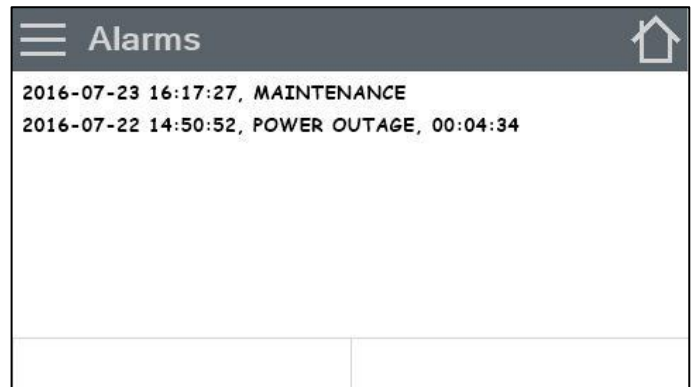


Figure 4-34 The Alarms Menu

## 5 THE SAMPLE CYCLE

Once fully set up and programmed, the E-SEQ-FRM sampler is capable of performing up to 16 consecutive sample events with no user interaction required.

Filters are moved from the supply magazine to the sample position. The sample is taken. The filter is then moved from the sample position to the storage magazine while a new filter is simultaneously loaded from the supply magazine.

The process repeats for as long as there are filters in the supply magazine and scheduled events to perform.

## 6 SCHEDULING SAMPLER EVENTS and SAMPLER OPERATION

The E-SEQ-FRM sampler is capable of performing up to 16 consecutive sample events with no user interaction required. This section explains in detail how to use the event manager to create, modify, and delete sample events. It also explains how to view the historical data.

### 6.1 Configuring New Sample Events Using the Event Manager

From either the Main Operating Screen or the Operate Menu, select the Event Manager to enter the Event Manager interface (see section 4.4.2). Any programmed events will be listed on this screen. If there are currently no events programmed, the display will be empty.

The filter cassette ID list (see section 3.5.1) for the supply magazine to be used should be available when setting up new events.

Sampling events must be configured in the order they will need to be run.

Press the Add button to bring up the Event Add interface shown in Figure 6-1.

Enter the ID number or name of the filter cassette in the Filter ID field.

✓ Event Add	✕
Filter ID	NCC1701
Start Time	2016-07-31 00:00
Duration	3d 00h 00m
PM Inlet Type	PM10
Cancel	Save

Figure 6-1 The Event Add Screen

Next, set the start time. Initially, the start time will be set to the next occurrence of the value configured in the Event Defaults screen (see section 4.6.1). Change this field to indicate the desired start date and time, if needed.

Once the start time is correct, verify the duration setting. The duration is the length of time the sampler will run the pump and collect particulate on the filter media.

Finally, verify the PM Inlet Type configuration. The E-SEQ-FRM is not able to sense the installed configuration accessories so it is important that the operator properly set this field to mark the data set with the correct type of collected particulate. To change this field, press the green bordered value box and choose the correct option from the list of choices. If using the BX-808 cyclone separators, select PM<sub>2.5</sub> VSCC. If using the BX-804 WINS Impactor, use PM<sub>2.5</sub> WINS. For any other PM<sub>2.5</sub> accessory, use PM<sub>2.5</sub> SCC. If using only the BX-802 inlet head for PM<sub>10</sub> monitoring, select PM<sub>10</sub>. Select PM<sub>1</sub> SCC or TSP if the sampler is configured for monitoring PM<sub>1</sub> or TSP sampling, respectively.

Once all of the fields are set as desired, press the Save button to save the settings and return to the Event Manager screen.

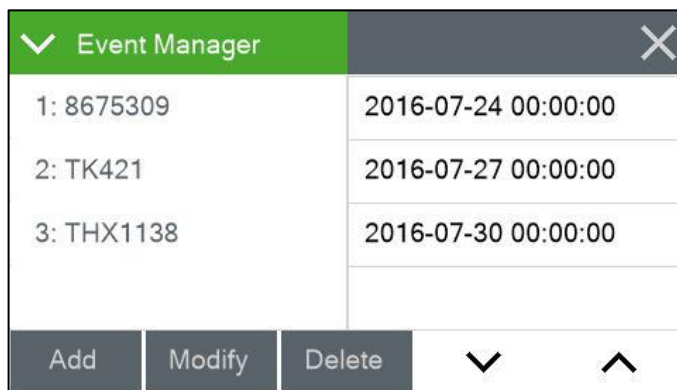
If additional sample events still need to be configured, press the Add button again and repeat the above sequence. Note that when adding additional sample events, the start time will be calculated by adding the amount of time set in the Repeat Time field of the Event Defaults screen (see section 4.6.1) to the Start Time of the last programmed sample event.



## 6.2 Modifying Sample Events Using the Event Manager

From either the Main Operating Screen or the Operate Menu, select the Event Manager to enter the Event Manager interface (see section 4.4.2). Any programmed events will be listed on this screen.

To review the settings for a particular cassette, select the filter cassette ID of interest and press the Modify button.



Event Manager	
1: 8675309	2016-07-24 00:00:00
2: TK421	2016-07-27 00:00:00
3: THX1138	2016-07-30 00:00:00
Add	Modify Delete
▼ ▲	

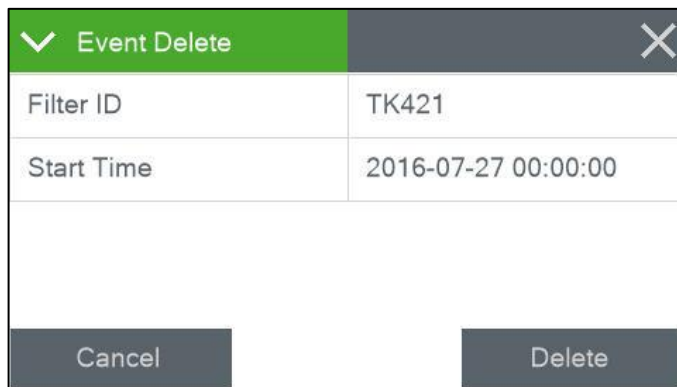
Figure 6-2 The Event Manager Screen

The event details will be displayed just as they were when adding it in the first place. Simply modify whichever parameter needs to be updated and then press the Save button to set the changes.

## 6.3 Deleting Sample Events Using the Event Manager

From either the Main Operating Screen or the Operate Menu, select the Event Manager to enter the Event Manager interface (see section 4.4.2). Any programmed events will be listed on this screen.

To remove a particular event, select the filter cassette ID of interest and press the Delete button (see Figure 6-2). The Event Delete screen shown in Figure 6-3 will be displayed. If this is the desired event to delete, press the Delete button to erase it. To cancel the delete action, use the Cancel button or press the X icon.



Event Delete	
Filter ID	TK421
Start Time	2016-07-27 00:00:00
Cancel	Delete

Figure 6-3 The Event Delete Screen

## 6.4 Viewing Current and Previous Sample Events

The current sample details, including both instantaneous and five minute averages, can be seen using the down arrow key of the main operating screen.

Historical data can be viewed using the left arrow key. When viewing past data, the header at the top of the screen will display the word HISTORY in bold red letters.

Viewing current or historical data does not interrupt the current sampler state and may be done at any time.

## 6.5 Importing New Sample Events from a USB Flash Drive

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. Note that

the event schedule must be configured to match the serial number of the sampler. See the FSCommAQ software manual for instructions on creating the event schedule and saving it to the USB flash drive.

From the Operate Menu, select the USB Import option to enter the USB Import interface (see section 4.4.5). A warning will be displayed indicating that any events added in this manner will not replace currently scheduled events but will be added to the end of the list (see Figure 6-4).

Press the APPEND button to acknowledge the notice and proceed to the import screen. The Status and Error fields will be blank. If it is not already installed, insert the USB flash drive containing the event schedule into the slot below the E-SEQ-FRM display.

Press the IMPORT button and the sampler will locate the pre-configured schedule and import it, appending all the events to the end of any remaining samples already in the sample queue.

**Figure 6-4 The USB Import Sequence**

Use the arrow keys to scroll through the list and verify it is correct. If there are no more than four events scheduled, the arrow keys will not be displayed. To manually add additional samples, press the ADD button and follow the procedure listed in section 6.1. See sections 6.2 and 6.3 to make any necessary modifications or deletions.

The supply magazine holds up to 16 filter cassettes. If the importation of the new schedule causes the total number of scheduled events to exceed this value, an error message will be displayed in the Error field and the Status field will show IMPORT ERROR. See Figure 6-5 for an example. Review the list and remove any unnecessary events.

✓ USB Import		✕
Status	IMPORT ERROR	
Error	APPEND EVENTS > 16	
IMPORT		

Figure 6-5 Too Many Events Error

Once the event schedule has been configured satisfactorily and the new filters are loaded in the supply magazine, press the X icon to return to the Operate Menu.

## 7 FLOW SYSTEM and FLOW CALIBRATIONS

### 7.1 Flow System Diagram

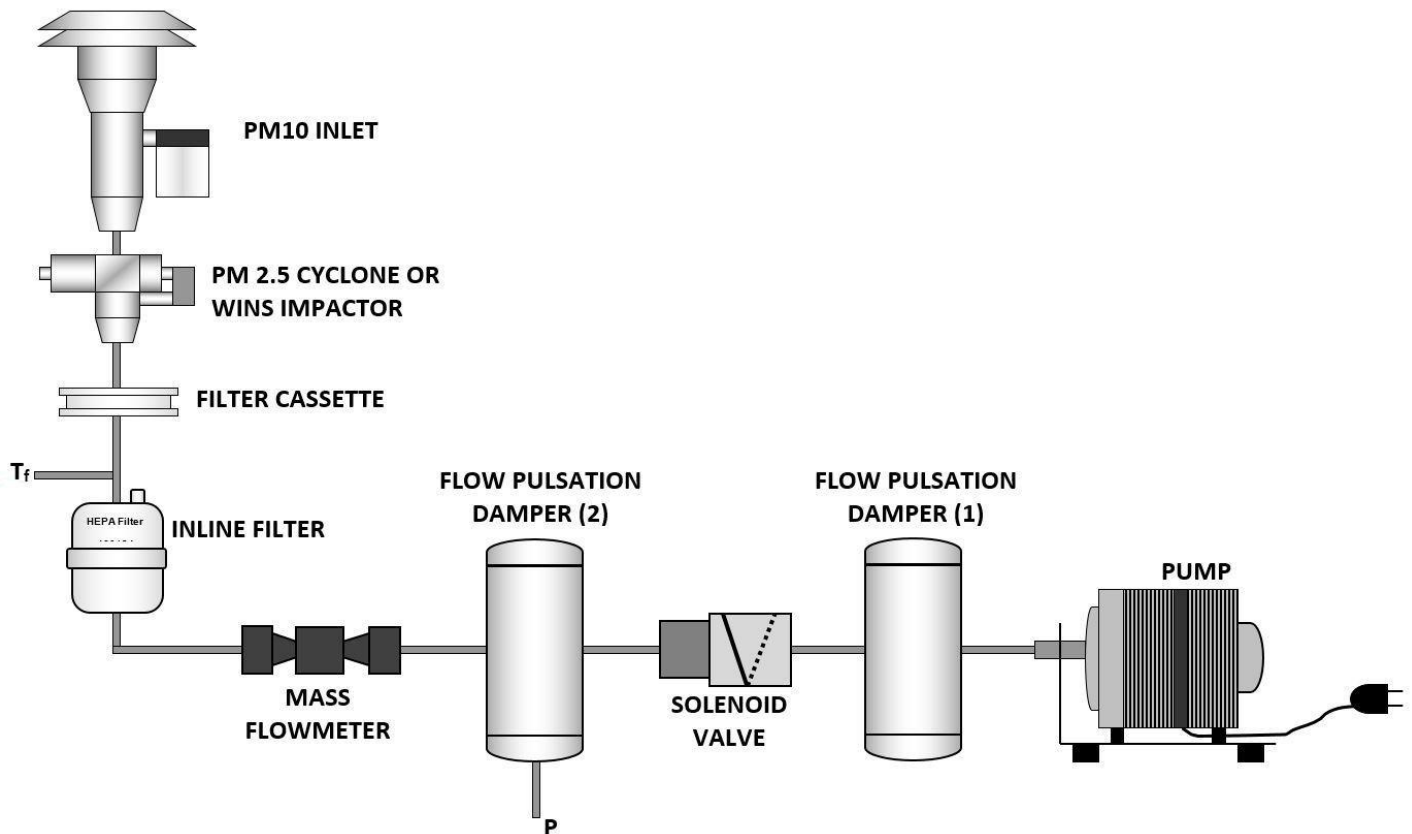


Figure 7-1 E-SEQ-FRM Flow System Diagram

### 7.2 Leak Tests and Flow Audits

The critical aspects of filter sampler flow system maintenance include routine leak tests (also commonly referred to as leak checks) and temperature, pressure, and flow audits. Agencies that routinely verify these aspects almost always obtain high-quality concentration data from the instrument. In general, the sampler flow rate accuracy should be audited periodically, and the flow bias assessed at least quarterly and annually. These activities are usually separated into two levels.

“Audits” usually consist of checking the leak, temperature, pressure, and flow values from the sampler at a single point (usually at ambient conditions) comparing these values to a traceable standard device, and simply recording the results with no adjustments. Because these audits are fairly quick, they are usually performed on a regular basis, such as monthly. See section 7.3 for the leak check procedure and section 7.4 for AT, RH, BP, and Flow audits.

“Calibrations” usually consist of comparing the sampler values to the traceable standard device at one or multiple points, and making calibration adjustments to the sampler as needed. Calibration may be required as the result of a problem found during an audit, or may simply occur at a fixed

interval as a matter of standard operating procedures, such as quarterly. Calibrations must always be documented. See section 7.5 for detailed AT, RH, BP, and Flow calibration procedures.

See section 8.1 for the recommended intervals of these verifications.

## 7.3 Leak Tests

To perform the leak test, the following accessories will be needed:

- BX-305 Isolation valve
- 82623 Internal Leak Test Cassette (solid cassette)
- 82632 External Leak Test Cassette (cassette with small hole in the center)

The leak test consists of two stages, the external leak test and the internal leak test. The external leak test is really a total system leak test including all internal and external fittings. If that test passes, there is no need to perform the internal leak test. If the external check fails, then the internal test is run to narrow down the leak location.

### 7.3.1 The External Leak Test

1. Remove the PM<sub>10</sub> inlet head but leave the inlet tube installed.
2. Inside the sampler, remove both the supply and storage magazines along with all filters, if installed.
3. Install the BX-305 inlet adapter and place the valve on it in the closed position.
4. Go to the Test > Leak Test > EXTERNAL screen (see section 4.5.4). The Insert Cassette screen shown on the far right of Figure 7-2 should appear:

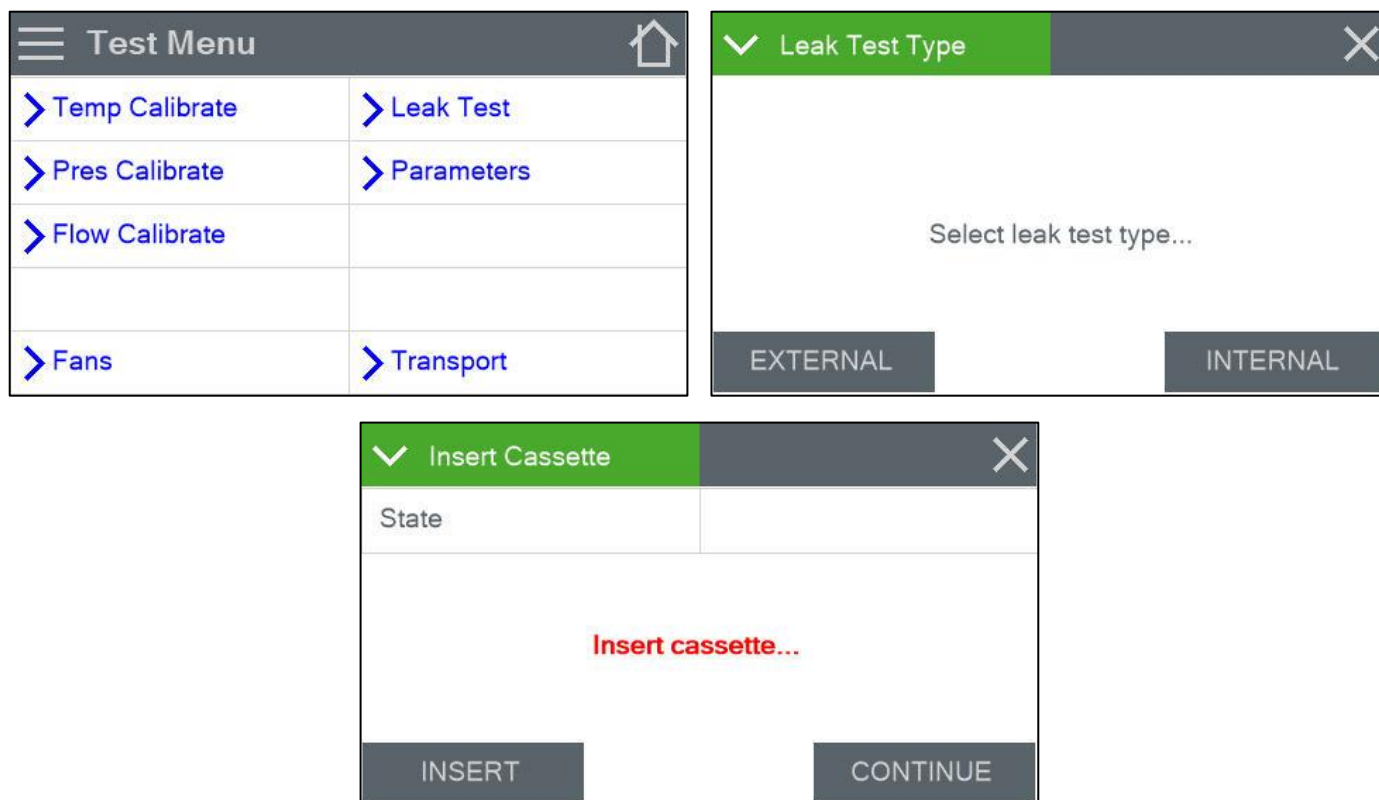


Figure 7-2 External Leak Test Cassette Insertion Screen

- Place the External Leak Test Cassette (part number 82632) in the supply side magazine receiver as shown in Figure 7-3. Note that this is the test cassette with the hole in the center.



**Figure 7-3 Inserting the External Leak Test Cassette**

- Once the test cassette is in position, press the INSERT button on the Insert Cassette screen (Figure 7-2).
- The sampler should advance the test cassette to the sample position and display the Leak Test screen shown in section 4.5.4.
- Press the START button. The pump will turn on for a couple of seconds to draw a vacuum on the system. It will then turn the pump off and measure the leak over time. The leak rate must not exceed the factory set reference leak rate over a 3.4 minute time frame. The sequence should look as shown in Figure 7-4.

Leak Test	
Current	731.2 mmHg
Vacuum	
Leak	
Elapsed	
Waiting for pressure...	
START	

Leak Test	
Current	661.5 mmHg
Vacuum	69.4 > 54 mmHg
Leak	PASS
Elapsed	0.3 Min
Measuring leak...	
START	

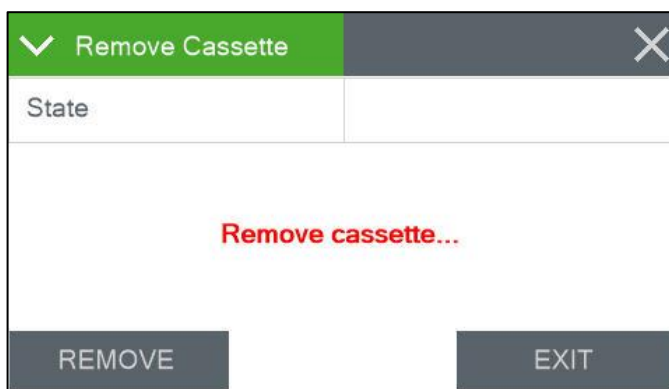
Leak Test	
Current	684.8 mmHg
Vacuum	50.9 > 5 mmHg
Leak	PASS
Elapsed	3.4 Min
Leak test PASS.	
START	

**Figure 7-4 Leak Test Sequence**

Figure 7-4 shows the absolute internal pressure (the Current field), the vacuum rate and how it compares to the reference vacuum decline rate (the Vacuum field), whether the test is passing or

failing (the Leak field), and how much time has elapsed since the start of the test (the Elapsed field). The current stage of the test procedure is shown just above the START button.

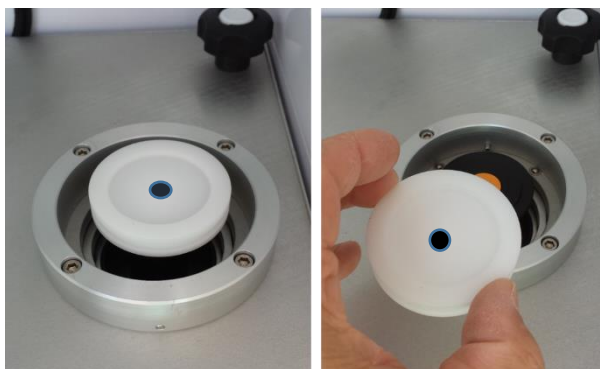
9. Check the results of the leak test.
  - a. If the test fails, go to section 7.3.2 and perform the internal test.
  - b. If the test passes, proceed to step 10.
10. Slowly open the valve on the inlet adapter to relieve the vacuum inside the sampler.
11. Remove the BX-305 adapter and reinstall the PM<sub>10</sub> inlet head.
12. Press the X icon to exit the test. The screen shown below in Figure 7-5 should appear:



**Figure 7-5 Leak Test Cassette Removal Screen**

13. Press the REMOVE button to advance the leak test cassette to the storage magazine position and lift it up.

Remove the cassette from the storage magazine receiver by hand as shown in Figure 7-6



**Figure 7-6 Removing the External Leak Test Cassette**

14. Press the EXIT button (see Figure 7-5) to exit the test and return to the Test Menu.

### **7.3.2 Internal Leak Test**

If the external leak test passes, there is no need to perform the internal leak test. The full sampler flow system is in good condition.

If External Leak Test failed, the internal leak test must be performed. The internal test uses the solid test cassette (part number 82623) 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 (see Figure 7-1).



To perform the internal leak test, perform with the following procedure. Note that this procedure assumes the External Leak Test (section 7.3.1) has just been completed.

1. Go to the Test > Leak Test > INTERNAL screen (see section 4.5.4). The Insert Cassette screen shown on the far right of Figure 7-7 should appear:

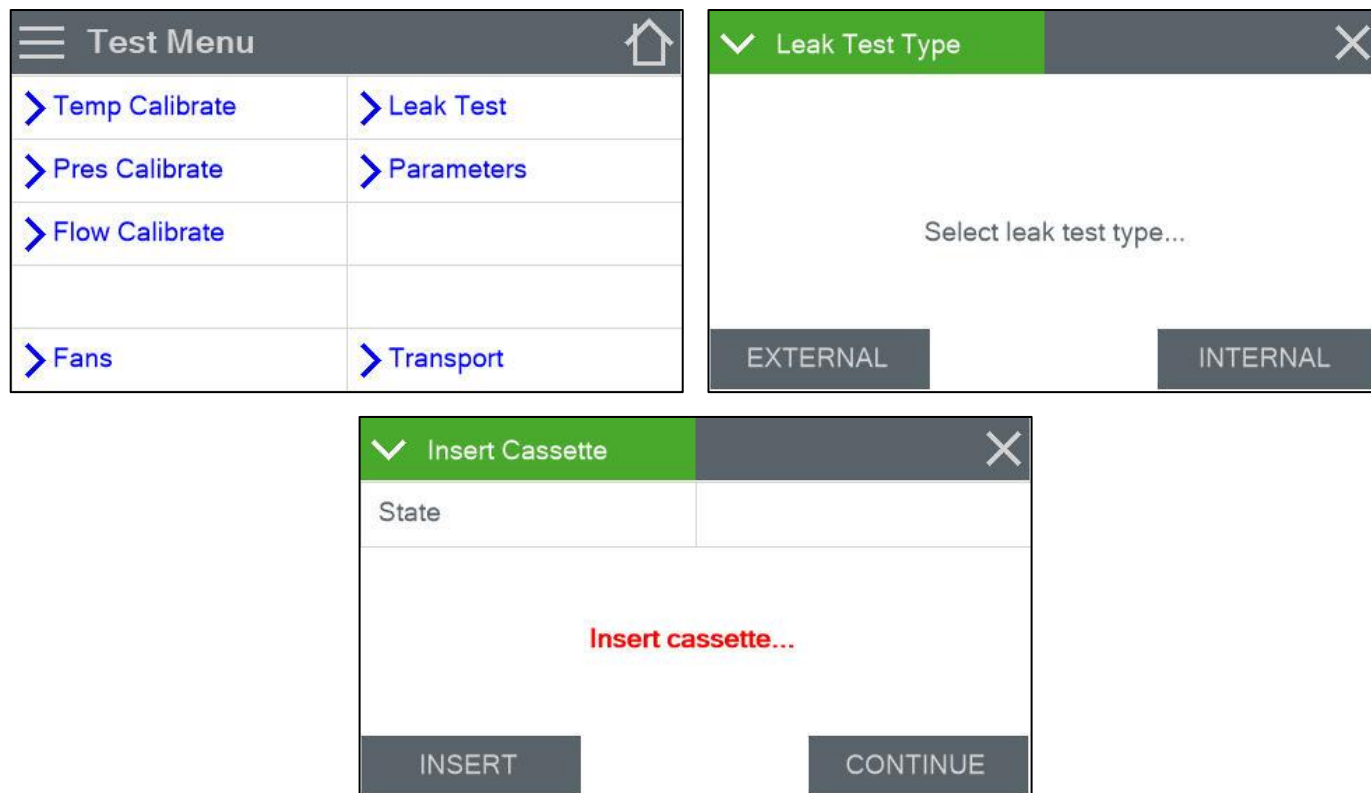


Figure 7-7 Internal Leak Test Cassette Insertion Screen

2. Place the Internal Leak Test Cassette (part number 82623) in the supply side magazine receiver as shown in Figure 7-8. Note that this test cassette is solid. *There is no hole in the center.*



Figure 7-8 Inserting the Internal Leak Test Cassette

3. Once the test cassette is in position, press the INSERT button on the Insert Cassette screen (Figure 7-7).
4. The sampler should advance the test cassette to the sample position and display the Leak Test screen shown in section 4.5.4.



5. Press the START button. The pump will turn on for a couple of seconds to draw a vacuum on the system. It will then turn the pump off and measure the leak over time. The leak rate must not exceed the factory set reference leak rate over a 3.4 minute time frame. The sequence should look as shown in Figure 7-9.

Leak Test	
Current	731.2 mmHg
Vacuum	
Leak	
Elapsed	
Waiting for pressure...	
START	

Leak Test	
Current	661.5 mmHg
Vacuum	69.4 > 54 mmHg
Leak	PASS
Elapsed	0.3 Min
Measuring leak...	
START	

Leak Test	
Current	684.8 mmHg
Vacuum	50.9 > 5 mmHg
Leak	PASS
Elapsed	3.4 Min
Leak test PASS.	
START	

**Figure 7-9 Leak Test Sequence**

Figure 7-9 shows the absolute internal pressure (the Current field), the vacuum rate and how it compares to the reference vacuum decline rate (the Vacuum field), whether the test is passing or failing (the Leak field), and how much time has elapsed since the start of the test (the Elapsed field). The current stage of the test procedure is shown just above the START button.

6. Check the results of the leak test.
  - a. If the test passes, there is a leak above the cassette. Complete the rest of this procedure and then go to section 8.9.1.
  - b. If the test fails, there is a leak below the cassette. Complete the rest of this procedure and then go to section 8.9.2.
7. *Slowly* open the valve on the inlet adapter to relieve the vacuum inside the sampler.
8. Press the X icon to exit the test. The screen shown in Figure 7-10 should appear:

✓ Remove Cassette		X
State		
Remove cassette...		
REMOVE	EXIT	

**Figure 7-10 Leak Test Cassette Removal Screen**

9. Press the REMOVE button to advance the leak test cassette to the storage magazine position and lift it up.

10. Remove the cassette from the storage magazine receiver by hand as shown in Figure 7-11.



**Figure 7-11 Removing the Internal Leak Test Cassette**

11. Press the EXIT button (see Figure 7-10) to exit the test and return to the Test Menu.

12. Follow the corrective actions in section 8.9 as determined in step 6 of this procedure.

## 7.4 Temperature, Humidity, Pressure, and Flow Audits

The audits in this section are performed using the Parameters screens. These screens are explained in more detail in section 4.5.5. It is recommended these audits be performed between sample cycles so sample runs will not be interrupted and internal components, such as the BX-808 or the PM<sub>10</sub> pass through adapter may be removed.

To perform the following audits, reference temperature, humidity, barometric pressure, and flow standards will be needed. For example, a calibrated Met One Instruments BX-307 able to provide reference temperature, pressure, and flow values.

### 7.4.1 Auditing the Ambient Air Temperature Sensor

Use the following procedure to verify the ambient temperature measured by the Sampler:

1. Place the reference temperature sensor near ambient temperature sensor mounted on the rear wall of the sampler. The sensors should be placed as close together as is practical, such as is shown in Figure 7-12.



Figure 7-12 Ambient Temperature Audit with BX-307

2. Allow the sensors enough time to fully equilibrate.
3. Read the current temperature (AT) on the Parameters screen and compare it to the reference temperature. The reference and AT readings should be within  $\pm 2$  °C of each other. If they are not, perform one of the temperature calibration procedures located in section 8.2.

### 7.4.2 Auditing the Filter Temperature Sensor

The filter temperature sensor is located about 1cm (0.4 ") below filter cassette sample location. Note that the internal particle size selector or PM<sub>10</sub> pass through adapter will need to be removed for these tests.



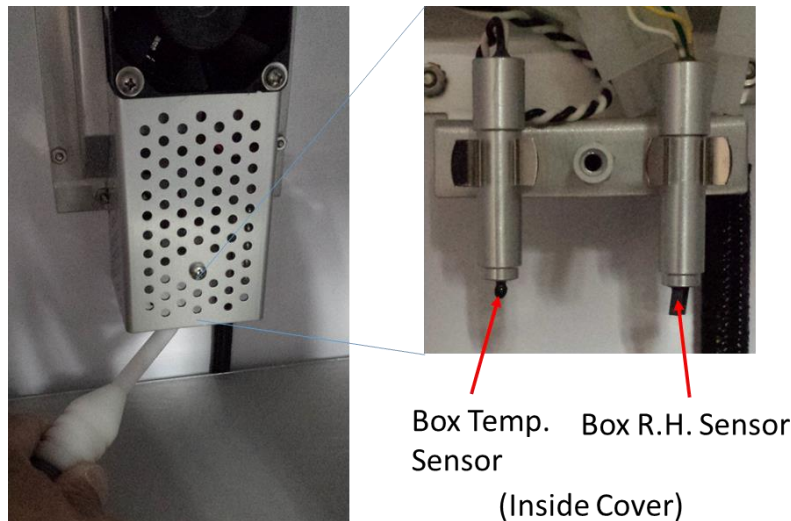
**Figure 7-13 Filter Temperature Audit with BX-307**

1. Remove the internal particle size selector or PM<sub>10</sub> pass through adapter, if installed.
2. Insert the reference temperature sensor near filter temperature sensor as shown in Figure 7-13. *Do not let the reference temperature sensor touch any of the components within the sampling chamber*
3. Allow the sensors enough time to fully equilibrate.
4. Read the current temperature (FT) on the Parameters screen and compare it to the reference temperature. The reference and FT readings should be within  $\pm 2$  °C of each other. If they are not, perform one of the temperature calibration procedures located in section 8.2.
5. Remove the reference temperature sensor.
6. Re-install the internal particle size selector or PM<sub>10</sub> pass through adapter.

### 7.4.3 Auditing the Box Temperature and Relative Humidity Sensors

The box temperature and RH sensors are located inside the enclosure. They are mounted near the top on the back wall, behind a ventilated cover beneath the exhaust fan. The left side of Figure 7-14 shows the sensors with the cover installed and on the right hand side the cover has been removed to show the specific sensor locations.

If desired, the internal particle size selector or PM<sub>10</sub> pass through adapter may be removed for easier access to these sensors.



**Figure 7-14 Box Temperature and RH Audit**

1. Remove the ventilated cover protecting the sensors. \*
2. Place the reference temperature sensor near the box temperature sensor. *Do not let the reference sensor touch any of the nearby components.*
3. Allow the sensors enough time to fully equilibrate.
4. Read the current temperature (BT) on the Parameters screen and compare it to the reference temperature. The reference and BT readings should be within  $\pm 2^{\circ}\text{C}$  of each other. If they are not, perform one of the temperature calibration procedures located in section 8.2.
5. Remove the reference temperature sensor.
6. Place the reference relative humidity sensor near box RH sensor. *Do not let the reference RH sensor touch any of the nearby components*
7. Allow the sensors enough time to fully equilibrate.
8. Read the current RH (BRH) on the Parameters screen and compare it to the reference RH measurement. The reference and BRH readings should be within  $\pm 5\%$  of each other. If they are not, see section 8.3.
9. Remove the reference RH sensor.
10. Re-install the ventilated cover.\*

\* - Removing the ventilated cover provides better access to the sensors. However, it is not strictly necessary and can be skipped if desired.

#### 7.4.4 Auditing the Filter and Box Pressure Sensors

The filter pressure sensor is located downstream of the sample filter location and the box pressure sensor is located completely outside of the flow path. This allows the filter pressure to measure the lower pressure inside the flow path while the box pressure indicates actual ambient conditions. This means the filter and box pressure values should both indicate actual ambient pressure when the pump is not running, and the sample flow path is vented. Because of this, these two sensors may be audited simultaneously using the following procedure.

1. Verify the pump is off and there is no sample filter cassette holder installed in the sample position.
2. Read the current filter pressure (FP) and box pressure (BP) on the Parameters screen and compare them to the reference pressure. The reference value should be within  $\pm 10$  mm Hg of each sampler pressure sensor. If it is not, perform the temperature calibration procedure located in section 8.4 for whichever pressure sensor does not meet the specification.
3. Verify that the Ambient Pressure (BP) and Filter Pressure (FP) on Parameter screen is within  $\pm 10$  mm Hg of the measured ambient pressure. If the differences is not within the limits, perform a pressure calibration when the Sampler is not in Sample mode.

#### 7.4.5 Auditing the Sampler Flow Rate

An accurate flow rate is critical to the proper operation of the PM<sub>10</sub> inlet head and any additional PM<sub>2.5</sub> or PM<sub>1</sub> particle size selectors. The system must pass the external leak test (see section 7.3.1) as the first step. An excessive leak in the system will result in too much air bypassing the cyclonic separators and the particulate sizes will not be accurate.

Also, the ambient temperature and pressure sensors are used in the calculation of the flow rate. As such, the AT and BP sensor audits in sections 7.4.1 and 7.4.4 must also pass prior to beginning this procedure.

The following accessories will be needed to perform this audit:

- Reference flow standard (such as the BX-307)
- Spare 47 mm filter cassette with a clean 47 mm filter installed

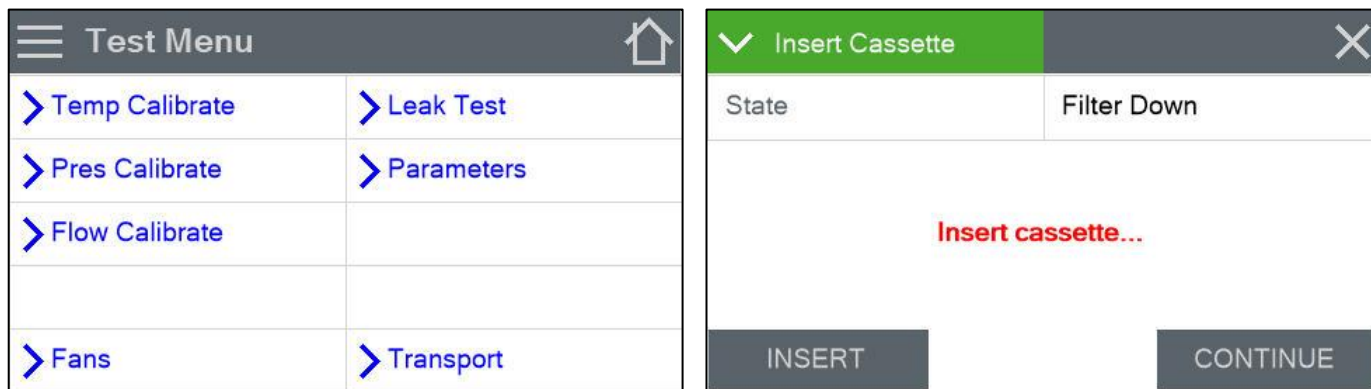
This audit should be performed while the system is as close to normal operating conditions as possible. This means having either the internal separator or PM<sub>10</sub> pass through device installed. It also means loading a clean sample filter. This filter will only be used for this audit and should not be used as a collection sample when finished. It should be discarded whenever it becomes damaged or is deemed to be excessively dirty by local standards.

Note that the internal size selector and loaded filter should be of the same type that is currently being used for sample collection. For example, when the E-SEQ-FRM is being used to sample for PM<sub>10</sub> particulate on Teflon filters, then the PM<sub>10</sub> pass through device should be installed and a Teflon filter should be loaded.

1. Remove the PM<sub>10</sub> inlet head but leave the inlet tube installed.
2. Inside the sampler, remove both the supply and storage magazines along with all filters, if installed.
3. Install the flow standard on the top of the inlet tube.

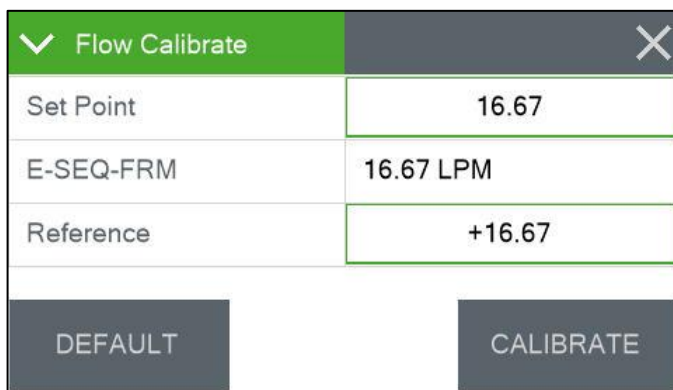


- Go to the Test > Flow Calibrate screen (see section 4.5.3). The Insert Cassette screen shown on the right of Figure 7-15 should appear:



**Figure 7-15 Flow Calibrate Cassette Insertion Screen**

- Place the test cassette (loaded with sampler filter) in the supply side magazine receiver.
- Once the test cassette is in position, press the INSERT button on the Insert Cassette screen (Figure 7-15). The sampler should advance the test cassette to the sample position and display the Flow Calibrate screen shown on the left side of Figure 7-16. The pump will start automatically and adjust flow to the 16.7 lpm test point.



**Figure 7-16 Flow Calibration Flow Rate Selection Screen**

- Compare the E-SEQ-FRM flow rate to the transfer standard. If the flow rate is within  $\pm 4\%$  of the transfer standard, skip the next step.
- If the difference exceeds  $\pm 4\%$  of the transfer standard, the flow rate needs to be calibrated. Go to section 7.5 and perform the Multi-Point Flow Calibration.
- Press the X icon to exit the test. The screen shown below in Figure 7-17 should appear:
- Press the REMOVE button to advance the leak test cassette to the storage magazine position and lift it up.
- Remove the cassette from the storage magazine receiver by hand.

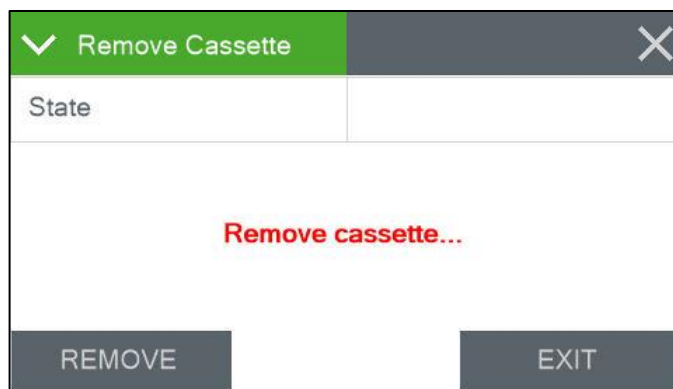


Figure 7-17 Flow Calibration Cassette Removal Screen

12. Press the EXIT button (see Figure 7-17) to exit the test and return to the Test Menu.
13. Remove the flow standard from the inlet tube and install the BX-802 sample head.
14. Resume normal operation of the sampler.

## 7.5 Multi-Point Flow Calibrations

The section details the steps required to calibrate the flow system of the E-SEQ-FRM. All of the prerequisites and accessories needed for the flow audit (see section 7.4.5) are the same for performing this flow calibration.

1. Remove the PM<sub>10</sub> inlet head but leave the inlet tube installed.
2. Inside the sampler, remove both the supply and storage magazines along with all filters, if installed.
3. Install the flow standard on the top of the inlet tube.
4. Go to the Test > Flow Calibrate screen (see section 4.5.3). The Insert Cassette screen shown on the right of Figure 7-18 should appear:

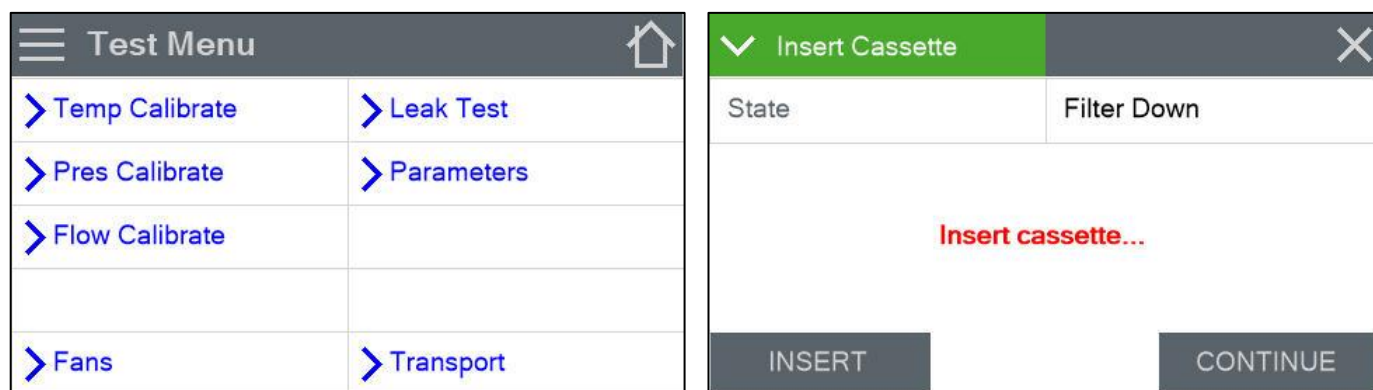


Figure 7-18 Flow Calibrate Cassette Insertion Screen

5. Place the test cassette (loaded with sampler filter) in the supply side magazine receiver.
6. Once the test cassette is in position, press the INSERT button on the Insert Cassette screen (Figure 7-18). The sampler should advance the test cassette to the sample position and display the Flow Calibrate screen shown on the left side of Figure 7-19. The pump will start automatically and adjust flow to the 16.7 lpm test point.

7. Press the green bordered Set Point field and the Set Point flow rate selection screen shown on the right hand side of Figure 7-19 will appear.

Flow Calibrate		Set Point	
Set Point	16.67		16.67
E-SEQ-FRM	16.67 LPM	16.67	18.34
Reference	+16.67	16.67	15.00
<div>DEFAULT</div> <div>CALIBRATE</div>		OK	Cancel
		↓	↑

**Figure 7-19 Flow Calibration Flow Rate Selection Screen**

8. Select 15.00 from the list of flow rate set points and then press the OK button. The display will return to the Flow Calibrate screen and adjust the flow to the new test point.
9. Allow the E-SEQ-FRM and the standard readings to stabilize (at least one minute) and then compare the sampler flow value (the E-SEQ-FRM field) and standard's flow reading.
10. Compare the sampler flow rate to the transfer standard. If the flow rate is within  $\pm 4\%$  of the transfer standard, record the results and skip the next step.
11. If the difference exceeds  $\pm 4\%$  of the transfer standard,
  - i. Press the DEFAULT button to remove any previous offsets.
  - ii. Select the remaining two set points and press the DEFAULT button on each of them, too.
- b. If the flow rate still does not pass it needs to be adjusted.
  - i. Press the green bordered Reference field and the numerical entry keypad (Figure 4-6) will be displayed. Enter the flow standard's value and press OK to return to the Flow Calibrate screen.
  - ii. Press SET to apply the change. When setting the 16.7 lpm flow rate, the SET option will change to read CALIBRATE (as shown in Figure 7-19).
12. Repeat steps 7 through 11 above for the 18.34 lpm flow rate.
13. Repeat steps 7 through 11 above for the 16.7 lpm flow rate.

14. Press the X icon to exit the test. The screen shown below in Figure 7-20 should appear:



**Figure 7-20 Flow Calibration Cassette Removal Screen**

15. Press the REMOVE button to advance the leak test cassette to the storage magazine position and lift it up.
16. Remove the cassette from the storage magazine receiver by hand.
17. Press the EXIT button to exit the test and return to the Test Menu.
18. Remove the flow standard from the inlet tube and install the BX-802 sample head.
19. Resume normal operation of the sampler.

## 8 MAINTENANCE AND TROUBLESHOOTING

This section provides information about routine maintenance, identifying errors and alarms, and performing diagnostic tests if a problem is encountered on the E-SEQ-FRM. The TEST menu functions are also described in this section.

### 8.1 Recommended Periodic Maintenance Table

Table 8-1 shows the recommended interval for the regular maintenance, field checks, and service tasks.

Maintenance Item	Period
Leak Check	Monthly
Flow system check/audit.	Monthly
Clean PM <sub>10</sub> inlet particle trap.	Monthly
Clean PM <sub>2.5</sub> cyclonic separator particle trap. (if used)	Monthly
Clean PM <sub>2.5</sub> WINS Impactor well, replace filter and oil. (If used)	Monthly
Clean PM <sub>1</sub> cyclonic separator particle trap. (if used)	Monthly
Check or set real-time clock.	Monthly
Verify proper pump and box fan operation.	Monthly
Complete flow system calibration.	Quarterly
Completely disassemble and clean PM <sub>10</sub> inlet and PM <sub>2.5</sub> cyclone.	Quarterly
Clean internal debris filter.	6 Months
Clean transport mechanism.	6 Months
Test operability of transport kill switch.	6 months
Rebuild vacuum pump (use rebuild kit)	12 months
Clean vertical inlet tube	12 Months

Table 8-1 Recommended maintenance Schedule for the E-SEQ-FRM Sampler

### 8.2 Ambient, Filter, and Box Temperature Calibrations

The E-SEQ-FRM monitor offers both single point and three-point calibration options for the three temperature sensors. Either method will be sufficient for performing a valid calibration, but some agencies require three-point capability. A reference temperature standard is required to perform any of the following calibration procedures. For example, a calibrated Met One Instruments BX-307 is able to provide reference temperature readings needed.

#### 8.2.1 Single Point Calibration Procedure

For the single point calibration tests, do NOT press the 3 PT CAL button located at the bottom of the Temp Calibrate screen.

1. Navigate to the Test> Temp Calibrate menu.
2. The display will show the ambient temperature sensor test interface first.
3. Place the reference temperature sensor near ambient temperature sensor mounted on the rear wall of the sampler. The sensors should be placed as close together as is practical, such as is shown in Figure 7-12.

4. Allow the sensors enough time to fully equilibrate.
5. Read the current temperature (AT) on the Parameters screen and compare it to the reference temperature. The reference and AT readings should be within  $\pm 2$  °C of each other.
  - a. If the sensors do not match within specification, press the green bordered Standard value field. The numeric entry keypad (Figure 4-6) will be displayed.
  - b. Enter the value reported by the standard and press the OK button to return to the Temp Calibrate screen.
  - c. Press the CALIBRATE button to set the new calibration.
6. Tap the green bordered Temp Sensor field and select FT for the filter temperature sensor.
7. Remove the internal particle size selector or PM<sub>10</sub> pass through adapter, if installed.
8. Insert the reference temperature sensor near filter temperature sensor as shown in Figure 7-13. *Do not let the reference temperature sensor touch any of the components within the sampling chamber*
9. Allow the sensors enough time to fully equilibrate.
10. Read the current temperature (FT) on the Parameters screen and compare it to the reference temperature. The reference and FT readings should be within  $\pm 2$  °C of each other.
  - a. If the sensors do not match within specification, press the green bordered Standard value field. The numeric entry keypad (Figure 4-6) will be displayed.
  - b. Enter the value reported by the standard and press the OK button to return to the Temp Calibrate screen.
  - c. Press the CALIBRATE button to set the new calibration.
11. Tap the green bordered Temp Sensor field and select BT for the filter temperature sensor.
12. Remove the ventilated cover protecting the box monitoring sensors (see Figure 7-14).
13. Place the reference temperature sensor near the box temperature sensor. *Do not let the reference sensor touch any of the nearby components.*
14. Allow the sensors enough time to fully equilibrate.
15. Read the current temperature (BT) on the Parameters screen and compare it to the reference temperature. The reference and BT readings should be within  $\pm 2$  °C of each other.
  - a. If the sensors do not match within specification, press the green bordered Standard value field. The numeric entry keypad (Figure 4-6) will be displayed.
  - b. Enter the value reported by the standard and press the OK button to return to the Temp Calibrate screen.
  - c. Press the CALIBRATE button to set the new calibration.
16. Remove the reference sensor. If all calibrations are complete, replace the ventilation cover and internal accessories and then resume normal sampling operations.

### 8.2.2 Three-Point Calibration Procedure

For the three-point calibration tests, stable hot and cold conditions must be provided in addition to the ambient point. If these conditions cannot be provided at consistent values for the duration of the procedure, a single point calibration must be performed. See section 8.2.1.

The three point calibration is performed by selecting one of the three temperature sensors and then testing it in ambient, hot, and cold conditions.

✓ Temp Sensors		✕
Temp Sensor	AT	
E-SEQ-FRM	23.3 C	
Standard	+23.3	
<div> <div>DEFAULT</div> <div>3 PT CAL</div> <div>CALIBRATE</div> </div>		

Figure 8-1 Temp Calibrate Screen

✓ 3 Pt Temp Cal		✕
Set Point	AMBIENT	
Temp Sensor AT	23.2 C	
Reference	+0.00	
<div> <div>DEFAULT</div> <div></div> <div>CALIBRATE</div> </div>		

Figure 8-2 Three-Point Calibrate Screen

1. Navigate to the Test> Temp Calibrate menu (Figure 8-1).
2. The green bordered Temp Sensor field will show AT. This indicates that the ambient temperature sensor test interface is being used. If a different sensor is to be tested, tap the green bordered Temp Sensor field and select either the FT or BT sensor.
3. Press the 3 PT CAL button at the bottom of the screen (Figure 8-1).
4. Place the reference temperature sensor near ambient temperature sensor mounted on the rear wall of the sampler. The sensors should be placed as close together as is practical, such as is shown in Figure 7-12.
5. Allow the sensors enough time to fully equilibrate.
6. The Set Point field will read AMBIENT. This indicates that the current ambient conditions are being calibrated.
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  $\pm 2$  °C of each other.
  - a. If the sensors do not match within specification, press the green bordered Reference value field. The numeric entry keypad (Figure 4-6) will be displayed.
  - b. Enter the value reported by the reference and press the OK button to return to the 3 Point Temperature Calibrate screen.
  - c. Press the CALIBRATE button to set the new ambient calibration point.
8. Press the green bordered Set Point button and select HOT.
9. Place the two probes in the hot environment, maintaining the same proximity to one another as much as possible. Repeat steps 5 through 7 above.
10. Remove the sensors and allow them to cool down to approximately room temperature.
11. Press the green bordered Set Point button and select COLD.
12. Place the two probes in the cold environment, maintaining the same proximity to one another as much as possible. Repeat steps 5 through 7 above.
13. Remove the sensors, allow them to warm up to room temperature, and then return the ambient sensor to operation.



14. Press the X icon to return to the Temperature Calibration screen. Tap the green bordered Temp Sensor field and select FT for the filter temperature sensor.
15. Press the 3 PT CAL button to enter the three-point calibration screen for the filter temperature sensor.
16. Remove the internal particle size selector or PM<sub>10</sub> pass through adapter, if installed.
17. Insert the reference temperature sensor near filter temperature sensor as shown in Figure 7-13. *Do not let the reference temperature sensor touch any of the components within the sampling chamber*
18. Allow the sensors enough time to fully equilibrate.
19. The Set Point field will read AMBIENT. This indicates that the current ambient conditions are being calibrated.
20. Read the current temperature (FT) on the Temp Sensor field and compare it to the reference temperature. The reference and FT readings should be within  $\pm 2$  °C of each other.
  - a. If the sensors do not match within specification, press the green bordered Reference value field. The numeric entry keypad (Figure 4-6) will be displayed.
  - b. Enter the value reported by the reference and press the OK button to return to the 3 Point Temperature Calibrate screen.
  - c. Press the CALIBRATE button to set the new ambient calibration point.
21. Press the green bordered Set Point button and select HOT.
22. Place the two probes in the hot environment, maintaining the same proximity to one another as much as possible. Repeat steps 18 through 20 above.
23. Remove the sensors and allow them to cool down to approximately room temperature.
24. Press the green bordered Set Point button and select COLD.
25. Place the two probes in the cold environment, maintaining the same proximity to one another as much as possible. Repeat steps 18 through 20 above.
26. Remove the sensors, allow them to warm up to room temperature, and then return the filter sensor to operation.

27. Press the X to return to the Temperature Calibration screen. Tap the green bordered Temp Sensor field and select BT for the filter temperature sensor.
28. Press the 3 PT CAL button to enter the three-point calibration screen for the box temperature sensor.
29. Tap the green bordered Temp Sensor field and select BT for the filter temperature sensor.
30. Remove the ventilated cover protecting the box monitoring sensors (see Figure 7-14).
31. Place the reference temperature sensor near the box temperature sensor. *Do not let the reference sensor touch any of the nearby components.*
32. Allow the sensors enough time to fully equilibrate.
33. The Set Point field will read AMBIENT. This indicates that the current ambient conditions are being calibrated.
34. Read the current temperature (BT) on the Temp Sensor field and compare it to the reference temperature. The reference and BT readings should be within  $\pm 2^{\circ}\text{C}$  of each other.
  - a. If the sensors do not match within specification, press the green bordered Reference value field. The numeric entry keypad (Figure 4-6) will be displayed.
  - b. Enter the value reported by the reference and press the OK button to return to the 3 Point Temperature Calibrate screen.
  - c. Press the CALIBRATE button to set the new ambient calibration point.
35. Press the green bordered Set Point button and select HOT.
36. Place the two probes in the hot environment, maintaining the same proximity to one another as much as possible. Repeat steps 32 through 34 above.
37. Remove the sensors and allow them to cool down to approximately room temperature.
38. Press the green bordered Set Point button and select COLD.
39. Place the two probes in the cold environment, maintaining the same proximity to one another as much as possible. Repeat steps 32 through 34 above.
40. Remove the sensors, allow them to warm up to room temperature, and then return the box sensor to operation.
41. Press the X to return to the Temperature Calibration screen.
42. If all calibrations are complete, replace the ventilation cover and internal accessories and then resume normal sampling operations.

### **8.3 Box Relative Humidity Calibrations**

The RH sensor is provided as an indication of humidity levels inside the main enclosure. There are no calibration options available for this sensor, however a reference comparison should be made whenever the temperature and pressure sensors are calibrated. This sensor should be replaced if it is found to deviate from the reference sensor by more than 15% RH.

### **8.4 Filter and Box Barometric Pressure Sensor Calibrations**

A reference pressure standard will be needed to perform the following calibration procedures. For example, a calibrated Met One Instruments BX-307 is able to provide the reference pressure readings needed.

1. Navigate to the Test> Pres Calibrate menu.
2. The display will show the ambient pressure sensor (BP) test interface first.
3. Place the reference pressure sensor near sampler. The exact location isn't critical as the pressure will not vary enough around the sampler to make a noticeable impact.
4. Allow the sensors enough time to fully equilibrate.
5. Verify the pump is off and there is no sample filter cassette holder installed in the sample position.
6. Read the current box pressure (BP) in the E-SEQ-FRM field and compare it to the reference pressure. The reference value should be within  $\pm 10$  mm Hg.
  - a. If the sensors do not match within specification, press the green bordered Standard value field. The numeric entry keypad (Figure 4-6) will be displayed.
  - b. Enter the value reported by the standard and press the OK button to return to the Temp Calibrate screen.
  - c. Press the CALIBRATE button to set the new calibration.
7. Tap the green bordered Pres Sensor field and select FP for the filter pressure sensor.
8. Read the current filter pressure (FP) in the E-SEQ-FRM field and compare it to the reference pressure. The reference value should be within  $\pm 10$  mm Hg.
  - a. If the sensors do not match within specification, press the green bordered Standard value field. The numeric entry keypad (Figure 4-6) will be displayed.
  - b. Enter the value reported by the standard and press the OK button to return to the Temp Calibrate screen.
  - c. Press the CALIBRATE button to set the new calibration.
9. Remove the reference sensor. If all calibrations are complete, replace the ventilation cover and internal accessories (if removed) and then resume normal sampling operations.

## 8.5 Cleaning and Testing the Transport

The transport mechanism is responsible for removing the filter cassettes from the supply magazine, positioning them in the sample location, and then transferring them to the storage magazine once the sample is complete. During normal operations, if the cassettes are being routed correctly, no other verification will typically be needed. However, the mechanism should be disassembled and cleaned on a semi-annual basis.

Additionally, there is a switch located just past the storage magazine position. This switch is an interlock that prevents the transport mechanism from moving if a filter cassette should move past the storage magazine. If this happens, the cassette will trip this switch and stop the transport motor. The motor cannot be activated again until the cassette is cleared. See Figure 8-3 for an example of a filter cassette in this position. To remove the cassette, the top plate must be removed.

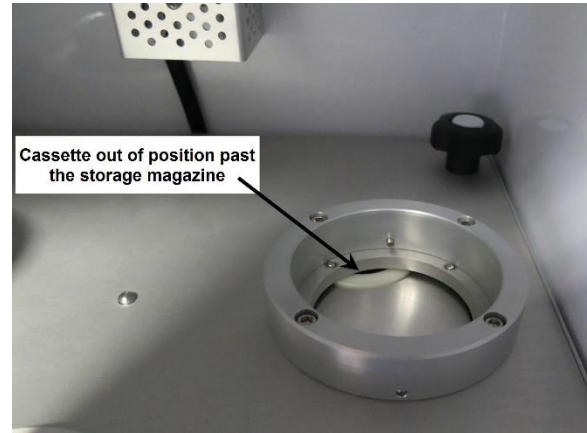


Figure 8-3 Cassette Out of Position

To disassemble and test the transport mechanism, use the following procedure:

1. Pause or stop the sampler operation (see section 4.4.1).
2. Remove the PM<sub>10</sub> pass through adapter or inlet particulate size selector.
3. Remove the supply magazine and any loose filters loaded below it.
4. Remove the storage magazine.
5. Unscrew the four black bolts in the corners that are securing the top plate in place and set them aside.
6. Grip the PM<sub>10</sub> pass through receiver, lift up to loosen the top plate, and then remove as shown in Figure 8-4.

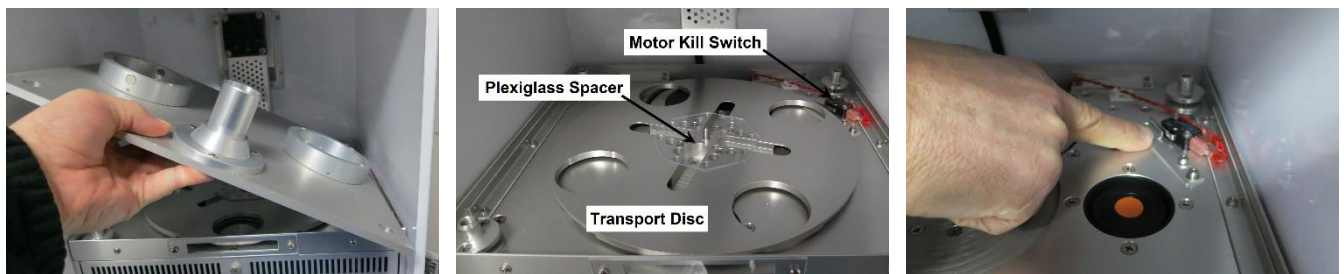


Figure 8-4 Disassembly of the Transport Mechanism and Kill Switch Testing

7. If clearing an out of position cassette, carefully remove it now and place it with the storage magazine.
8. Remove the plexiglass spacer (see Figure 8-4).
9. Remove the transport disc (see Figure 8-4).

10. Using canned air and lint free cleaning cloths, clean out any dirt or debris that may be present inside the sampler and on the components that have been removed.
11. Examine the O-rings at the sample position in both the top and bottom plates. Replace them both if either one looks compromised. Replacement O-rings are available as a kit (see section 10.1).
12. Enter the Test / Transport screen and press the either the Move UP or Move DN button. Both buttons will attempt to rotate the transport disc. The UP button will cease operation after the storage plunger reaches the fully raised position whereas the DN button will cease operation after it returns to the fully lowered position. Verify both actions stop at the correct position.
13. Press the Move DN button one more time. While the motor is turning, use a finger to depress the kill switch and confirm the motor stops operation when it is pressed and resumes operation when it is released (see Figure 8-4).
14. Replace the transport disc by placing it over the center spindle and then rotating it until it drops into position.
15. Replace the plexiglass spacer.
16. Replace the top plate and secure it in place with the four black bolts.
17. Replace the supply and storage magazines.
18. Install the PM<sub>10</sub> pass through adapter or inlet particulate size selector.
19. Resume normal operations.

## **8.6 Box Fan Operation**

The box exhaust fan is used to help lower humidity by engaging whenever the internal humidity levels exceed 85%. The exhaust fan also turns on when the internal box temperature rises to more than 2 Deg C above ambient temperature.

## 8.7 Error and Alarm Descriptions

Errors and alarms may occur in the sampler as a result of operational conditions outside of the specified ranges, machine malfunctions, or data flags. The alarms may be shown on the sampler display or in the sample event data log files.

The E-SEQ-FRM error codes are detailed in Table 8-2.

Code	Description	Cause																																
1	Power Outage	The event occurs for a power cycle or whenever the micro-processor is reset.																																
2	Flow failure	The event occurs when the sample flow is +/-10% out of regulation for 1 minute. The event occurs when the sample flow is +/-5% out of regulation for 5 minutes.																																
4	Temp Delta	Occurs when the filter temperature is greater than ambient temperature by 5°C or more for 30 minutes.																																
8	Elapsed Time	This error is logged when a sample event runs for either less than 23 hours or greater than 25 hours.																																
16	Transport	This condition is flagged when the plunger does not reach the Up or Down position (as appropriate) after 30 seconds or when a filter cassette fails to load into the storage magazine and is detected in the Down position.  This alarm also occurs when the transport motor stalls.																																
32	Sensor Range	Occurs when a sensor is outside of the following limits: <table><tr><th>Sensor</th><th>Minimum</th><th>Maximum</th><th>Stop Operation</th></tr><tr><td>AT</td><td>-40</td><td>70</td><td>Yes</td></tr><tr><td>FT</td><td>-40</td><td>70</td><td>Yes</td></tr><tr><td>BT</td><td>-40</td><td>70</td><td>No</td></tr><tr><td>BRH</td><td>0</td><td>100*</td><td>No</td></tr><tr><td>FP</td><td>228</td><td>818</td><td>No</td></tr><tr><td>BP</td><td>228</td><td>818</td><td>Yes</td></tr><tr><td>Flow</td><td>0</td><td>20</td><td>Yes</td></tr></table> Sensors that do not stop operations will be flagged and logged but the sample cycle will continue. *BRH must exceed 100 for 24 consecutive hours to trigger alarm.	Sensor	Minimum	Maximum	Stop Operation	AT	-40	70	Yes	FT	-40	70	Yes	BT	-40	70	No	BRH	0	100*	No	FP	228	818	No	BP	228	818	Yes	Flow	0	20	Yes
Sensor	Minimum	Maximum	Stop Operation																															
AT	-40	70	Yes																															
FT	-40	70	Yes																															
BT	-40	70	No																															
BRH	0	100*	No																															
FP	228	818	No																															
BP	228	818	Yes																															
Flow	0	20	Yes																															
64	Flow Link Down	This error occurs if the link to the flow sensor is interrupted for more than 10 seconds. This will keep the unit from running if stopped or, if running, will halt the current sample.																																
128	Maintenance	The event occurs when the user stops normal operation.																																

**Table 8-2 The E-SEQ-FRM Alarm Conditions**

An alarm is indicated and logged at the time it occurs. The resolution time is not recorded. See section 4.7 for an explanation of viewing alarms through the front panel display.

**Note:** If multiple errors or alarms occur in the same data period, then the logged alarm code will be the sum of the two individual code numbers. This is a rare occurrence.

## 8.8 Basic Problem and Cause/Solution Table

The following table contains information on some of the more common problems that may be encountered, and some steps to identify and remedy the problems. Met One Instruments welcomes customer suggestions for new items to include in this section of future manual revisions. If the solution cannot be found in the following table, then contact one of our expert service technicians for help in resolving the problem.

<b>Problem:</b>	<b>The airflow won't regulate at the correct rate of 16.7 lpm.</b>
<b>Cause/Solution:</b>	<ul style="list-style-type: none"><li>• This usually indicates that the air pump is losing vacuum capacity due to wear.</li><li>• Check for leaks. Leaks will often cause the inlet flow to be low even though the flow sensor is measuring the correct flow rate. This is because the flow sensor is downstream of the filter cassette. Correct any leaks found.</li><li>• Perform a flow calibration. If the flow regulates at the lower calibration point, but not the higher point, the pump is probably worn out or there is a leak.</li><li>• Check the inlet and PM heads for obstructions.</li></ul>

<b>Problem:</b>	<b>The sampler has flow leaks, even after cleaning.</b>
<b>Cause/Solution:</b>	<ul style="list-style-type: none"><li>• Check the O-rings on the very sharp-cut cyclone (if used). These frequently leak.</li><li>• Check for bad O-rings on all other components.</li><li>• Check all of the push-in air fittings throughout the air flow system.</li></ul>

<b>Problem:</b>	<b>The clock settings are lost when the mass monitor is powered down.</b>
<b>Cause/Solution:</b>	<ul style="list-style-type: none"><li>• There is a lithium coin cell battery inside the mass monitor that maintains the clock when the mass monitor is powered off. The battery may need to be replaced if the clock resets when the mass monitor is powered off.</li></ul>

<b>Problem:</b>	<b>The sampler won't run the scheduled events or the transport motor won't actuate.</b>
<b>Cause/Solution:</b>	<ul style="list-style-type: none"><li>• Check that a filter cassette has not gotten out of position and activated the transport kill switch and verify proper operation of the transport mechanism. See section 8.5.</li></ul>

## 8.9 Leak Correction

The PM<sub>10</sub> inlet head and any subsequent cyclonic or impact separators require an accurate flow rate for proper performance. If there are leaks downstream of these separators, a portion of the air flow will bypass the separators which can result in too low of a flow rate. This results in improper performance and will invalidate the sample.

If leaks are detected during the periodic leak tests (see section 7.3) they must be corrected immediately.

### 8.9.1 Correcting an External Leak

Leaks determined by the isolation procedure (see section 7.3.2) to be located in the external section of the sampler are usually caused by one or more components not being fully seated. If all of the inlet components are confirmed to be properly installed, the leak is likely a failed O-ring seal.



### **8.9.2 Correcting an Internal Leak**

Leaks determined by the isolation procedure (see section 7.3.2) to be located in the internal section of the sampler are usually caused by a failed O-ring or one of the push-in fittings not being properly seated.

## 9 DATA RETRIEVAL

### 9.1 Using the RS-232 or USB Cable Connections

The E-SEQ-FRM can communicate via serial commands using RS-232 or USB Serial. The sampler only allows one of these connections at a time. These connections allow users to both download data and operate the instrument

The default RS-232 settings are as follows:

Baud Rate: 115200

Data Bits: 8

Parity: None

Stop Bits: 1

#### 9.1.1 User Communication

In the User Communication (or Terminal) mode, commands are issued by entering a letter or number command and then pressing the Enter, <cr>, key. The <Esc> key is not used when sending commands in this mode.

Press the Enter key three times to enter User Communication mode. An asterisk character appears confirming the mode is active and that the instrument is ready for a new command. Commands will be echoed back from the instrument and an asterisk will appear after a command has completed.

Some commands (designated with \$) require the password to unlock the command. Use the PW command to unlock. The Password is set in the Password screen.

COMMAND	DESCRIPTION
1	Request settings report
2	Request All data report
3	Request New data report
4	Request Last data report
6	Request Event summary report
7	Request Alarm log report
C	Clear data log files – \$
D	Get/Set date part of the real time clock – \$
H	Help menu
T	Get/Set time part of the real time clock – \$
CA	Clear the Alarm log file – \$
DS	Report data log channel descriptors
DT	Get/Set the date and time of the real time clock – \$
ID	Get/Set location ID or address – \$
OI	Get/Set output interval – \$
OP	Get/Set operation state

PM	Get/Set PM inlet type – \$
PR	Print report – 0-Settings, 1-Alarms, 2-Data, 3-Factory
<b>COMMAND</b>	<b>DESCRIPTION</b>
PW	Unlock protected commands: Unlock user commands (User setting) – \$
QH	Report Data log record header
RQ	Report current data log readings
RV	Report Model/Part/Revision
SB	Get/Set baud rate – \$
SS	Get Met One Instruments serial number
ST	Get Data log period – \$
UN	Get/Set data record descriptor channel units
DDT	Get/Set default event duration time – \$
DRT	Get/Set default event repeat time – \$
DST	Get/Set default event start time – \$
GTC	Start a touch screen calibration – \$
RPW	Report password encrypted
SPW	Get/Set user password – \$
XRD	Get record descriptor report
XRF	XMODEM read file
STDT	Get/Set standard temperature – \$
DSCRC	Get data log channel descriptor CRC
EVENT	Get the requested CSV event report
XRDCRC	Get file descriptor CRC

**Table 9-1 Common Serial Command Set**

To issue one of the commands listed in Table 9-1, type the command listed and press the Enter key. The command will run and display the requested information or current setting, as appropriate.

For example, to view the current date setting type the letter D followed by the Enter key. The current date will be reported. The sequence would appear like this:

```
D<cr>
D 2013-01-18<cr><lf>
```

To change a setting, the typical sequence is to type the command, press the space bar one time, enter the new value in the same format that is displayed when checking the setting, and then pressing the Enter key.

Continuing the example above, to change the date setting type the letter D, space, and then the current date in YYYY-MM-DD format followed by the Enter key. A confirmation of the new date will be reported. The sequence would appear like this:

```
D 2016-02-28<cr>
D 2016-02-28<cr><lf>
```

Pressing <Esc> or Q<cr> will exit terminal mode.

For a detailed listing of all commands and their formats, consult the E-SEQ-FRM 7500 document contained on the CD included with the sampler or contact the Met One Instruments service department. See section 1.2.

### 9.1.2 Computer Communication

In the Computer Communication mode, character echo is suppressed. This means if commands are issued in this mode using a keyboard, there will be nothing displayed on the screen. The command format includes a checksum to verify data integrity.

The mode is entered whenever an <Esc> character is sent to the instrument. Commands are issued using the following format:

```
<Esc>Cmd p1 p2*cs<cr>
```

Computer commands are prefaced with an <Esc> character followed directly by a command (Cmd). After the command there can be zero or more parameter field (p1 and p2) where each field is separated by a space. The end of the message is signaled by the Checksum Delimiter character (\*) followed by the checksum itself (cs). Finally, the command is terminated with a carriage return (<cr>).

A computer command example requesting the Model/Part/Revision numbers would look like this:

```
<Esc>RV*1234<cr>
```

All command responses are terminated with a checksum. The above command response would have this format:

```
E-SEQ-FRM, 82465, R1.2.0<cr><lf>
```

```
FPGA, 82464, R1.0.0<cr><lf>
```

```
Display, 82451, R1.0<cr><lf>
```

For a listing of all commands and their formats along with additional in-depth Computer Communication details, consult the E-SEQ-FRM 7500 document contained on the FSCommAQ software CD included with the sampler or contact the Met One Instruments service department. See section 1.2.

## 9.2 Using a USB Flash Drive

The E-SEQ-FRM can copy data files directly to a user-supplied USB flash drive. This drive must be installed in the USB port located beneath the control panel display inside the monitor. This USB port is not used for any other purpose.

✓ Copy to USB Drive		✓ Copy to USB Drive	
Days	99		
Files	ALL	Status	COPY COMPLETE
		Progress	100 %
		Error	
COPY			

Figure 9-1 Data Transfer Interface Screens

1. Enter the Operate > Transfer Data menu (see Figure 9-1).
  - 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 (Figure 4-6) 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.

When the COPY COMPLETE message is displayed (see Figure 9-1), remove the USB memory stick and close the front door of the sampler.

## 9.3 Using FSCommAQ Software

Data can easily be retrieved from the E-SEQ-FRM directly to a PC using the included FSCommAQ software package. Simply establish a communication link between the sampler and the computer as described in section 9.1 and then follow the procedure outlined in the FSCommAQ manual. The software and manual are provided on a CD-ROM with the sampler. They are also available to download for free; contact the Met One Instruments, Inc. service department (see section 1.2) for more information.

## 10 SPARE PARTS and ACCESSORIES





### 10.1 Consumables, Replacement Parts, and Accessories

The following parts are available from Met One Instruments for maintenance, replacement, service, and upgrades. If unsure about a part, please contact the Service department and provide the serial number of the E-SEQ-FRM. Some of these parts require technical skills or special considerations before use or installation.




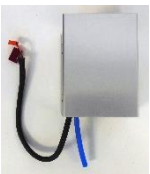
#### Consumables

Description	Part Number
Filter, 47MM, PTFE, FRM	460122
Filter Cassette, FRM, 47 MM	460128
Fan Filter, Replacement, 5 PACK	560001
Silicone O-Ring Grease, mini packet	995712

#### Temperature, Pressure, and Humidity Sensors





Description	Part Number	Graphic
Ambient Temp Sensor Assembly -30 To +50°C	80866-1	
Pressure Sensor Circuit Board	80940-1	
Box Temperature Sensor	80213	
Box R.H. Sensor	80212	
Filter Temperature Sensor	82673	

## Flow System Components





Description	Part Number	Graphic
Flow Sensor Assembly	<b>82311</b>	
Solenoid Valve Assy	<b>82405</b>	
Inline Filter Assembly	<b>82529</b>	
Pump Assembly	<b>82534</b>	
Pump Diaphragm Rebuild Kit	<b>82493</b>	
Pump Head Rebuild Kit	<b>82494</b>	





## Electrical & Electronic Parts

Description	Part Number	Graphic
Board Stack Assembly	<b>82526</b>	
Proximity Sensor	<b>82521</b>	
Transport Motor Replacement Kit	<b>82233</b>	
Power Supply	<b>82522</b>	

## Inlet Components

Description	Part Number	Graphic
PM <sub>10</sub> Size-Selective Inlet Head, EPA Specified	<b>BX-802</b>	
TSP Sampling Inlet, with insect screen	<b>BX-803</b>	
PM <sub>2.5</sub> Sharp Cut Cyclone	<b>BX-807</b>	
PM <sub>2.5</sub> Very Sharp Cut Cyclone (required for PM <sub>2.5</sub> FEM monitoring)	<b>BX-808</b>	
PM <sub>2.5</sub> WINS Impactor	<b>BX-804</b>	
O-Rings, BX-807 SCC Cyclone (set of 6)	<b>720097</b>	
O-Rings, BX-808 VSCC Cyclone (set of 8)	<b>720105</b>	
O-Ring kit for BX-802 PM <sub>10</sub> Inlet Head (set of 3)	<b>8965</b>	
O-Ring, Inlet Tube Receiver, 2 required.	<b>720069</b>	
O-Ring Kit for Inlet Couplers and 81210 PM <sub>10</sub> Pass Through Adapter (set of 6)	<b>82682</b>	
O-Ring Kit for Sample Position (set of 2)	<b>82688</b>	



## Calibration & Service Tools

Description	Part Number	Graphic
Flow Inlet Adapter Kit (Leak Test Valve) Includes short inlet tube adapter.	<b>BX-305</b>	
Volumetric Flow Calibration Kit (includes Flow, Temp, and Pressure Reference Standards)	<b>BX-307</b>	

## Communications Options & Accessories

Description	Part Number	Graphic
FSCommAQ Software CD	<b>82530</b>	
USB Communication Cable, Type A-B Male	<b>500784</b>	
RS-232 Communication Cable	<b>82459</b>	

## General Accessories

Description	Part Number	Graphic
Replacement Door Assembly	<b>82693</b>	
Replacement Cassette Magazine	<b>82625</b>	
Replacement O-Ring for Cassette Magazine Cap	<b>760081</b>	

## Audit Sheet

<b>Model:</b>		<b>Serial Number:</b>	
<b>Audit Date:</b>		<b>Audited By:</b>	

Flow Audits			
<b>Flow Reference Standard Used:</b>	Model:	Serial No:	Calibration Date:
<b>Temperature Standard Used:</b>	Model:	Serial No:	Calibration Date:
<b>Barometric Pressure Standard Used:</b>	Model:	Serial No:	Calibration Date:

<b>Leak Check Value:</b>	as found:	Pass / Fail	as left:	Pass / Fail									
<b>Ambient Temperature:</b>	as found:	<table border="1" style="width: 100%; text-align: center;"> <tr> <th style="width: 50%;">E-SEQ-FRM</th> <th style="width: 50%;">Ref. Std.</th> </tr> <tr> <td>C</td> <td>C</td> </tr> </table>	E-SEQ-FRM	Ref. Std.	C	C	as left:	<table border="1" style="width: 100%; text-align: center;"> <tr> <th style="width: 50%;">E-SEQ-FRM</th> <th style="width: 50%;">Ref. Std.</th> </tr> <tr> <td>C</td> <td>C</td> </tr> </table>	E-SEQ-FRM	Ref. Std.	C	C	N/A <input style="width: 20px; height: 20px;" type="checkbox"/>
E-SEQ-FRM	Ref. Std.												
C	C												
E-SEQ-FRM	Ref. Std.												
C	C												
<b>Barometric Pressure:</b>	as found:	<table border="1" style="width: 100%; text-align: center;"> <tr> <th style="width: 50%;">mmHg</th> <th style="width: 50%;">mmHg</th> </tr> <tr> <td></td> <td></td> </tr> </table>	mmHg	mmHg			as left:	<table border="1" style="width: 100%; text-align: center;"> <tr> <th style="width: 50%;">mmHg</th> <th style="width: 50%;">mmHg</th> </tr> <tr> <td></td> <td></td> </tr> </table>	mmHg	mmHg			
mmHg	mmHg												
mmHg	mmHg												
<b>Flow Rate (Actual Volumetric):</b>	as found:	<table border="1" style="width: 100%; text-align: center;"> <tr> <th style="width: 50%;">lpm</th> <th style="width: 50%;">lpm</th> </tr> <tr> <td></td> <td></td> </tr> </table>	lpm	lpm			as left:	<table border="1" style="width: 100%; text-align: center;"> <tr> <th style="width: 50%;">lpm</th> <th style="width: 50%;">lpm</th> </tr> <tr> <td></td> <td></td> </tr> </table>	lpm	lpm			N/A <input style="width: 20px; height: 20px;" type="checkbox"/>
lpm	lpm												
lpm	lpm												

### Mechanical Audits

Fan filters clean:	as found		as left	
PM <sub>10</sub> particle trap clean:	as found		as left	
PM <sub>10</sub> drip jar empty:	as found		as left	
PM <sub>10</sub> bug screen clear:	as found		as left	
PM <sub>2.5</sub> particle trap clean:	as found		as left	
Pump muffler unclogged	as found		as left	

Error	Date	Time	Error	Date	Time
1			4		
2			5		
3			6		

**Audit Notes:**

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[illegible]