



Air Pollution Control Division

Technical Services Program

APPENDIX PM2

Field Standard Operating Procedure for Operation and Maintenance of the Low Volume Filter Based PM_{2.5} and PM₁₀ Particulate Samplers

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PART I

Field Standard Operating Procedures for Operation and Maintenance of the R&P Partisol 2000 FRM Single Sampler

Part I - Field SOP for the R&P 2000

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1.0 SCOPE AND APPLICATION

Introduction

In July 1997, the U.S. EPA promulgated a new National Ambient Air Quality Standard (NAAQS) for particulate matter with a diameter smaller than 2.5 microns, or PM_{2.5}. In 2012 the annual standard was revised for PM_{2.5} and is currently 12 µg/m³, while the 24-hour standard is 35 µg/m³. Fine particles (smaller than 2.5 microns) penetrate more deeply into the lungs than coarse particles (2.5 - 10 microns). Recent health studies indicate a link between fine particle concentrations in the outdoor air and certain health effects (40 CFR Part 58). Fine particles are generally emitted from combustion activities (such as industrial and residential fuel burning and motor vehicles) while coarse particles mainly come from dust emitted during activities such as construction and agricultural tilling.

Some of the health effects that have been linked to fine particulate matter pollution include: Premature death and increased hospital admissions and emergency room visits, primarily by the elderly and individuals with cardiopulmonary disease; Increased respiratory symptoms and disease in children and individuals with cardiopulmonary disease; Decreased lung function and alterations in lung tissue and structure, particularly in children and people with asthma.

This document is intended to instruct local Colorado operators that use the Rupprecht & Patashnick 2000 Federal Reference Method (FRM) sampler to monitor ambient air PM_{2.5} and PM₁₀. Because this supplemental information is intended for method users, it emphasizes the operational aspects of the method, rather than the design and performance specifications for the sampler. The document also provides recommended quality assurance (QA) procedures and guidance to help monitoring agencies reliably achieve the data quality objectives (DQOs) established for PM monitoring. The goal for acceptable measurement uncertainty has been defined as 10 percent coefficient of variation (CV) for total precision and ±10 percent for total bias (Papp et al. 1998). The information provided here together with the instructions provided by Rupprecht & Patashnick (R&P or RP) and contained in the sampler's operation or instruction manual (R&P, 1999), have been used by the Air Pollution Control Division (APCD) to develop its own agency-specific standard operating procedure (SOP) for the RP2000 sampler. An SOP for the Rupprecht and Patashnick 2025 FRM is also included as Part II of this document below.

Method Overview

An electrically powered air sampler draws ambient air at a controlled volumetric flow rate into a specially shaped inlet (PM₁₀ head) and through an inertial particle size separator (if sampling for PM_{2.5}), very sharp cut cyclone (VSCC), where the suspended particulate matter in the appropriate size range is separated for collection on a Teflon (PTFE) filter over the specified sampling period. Each filter is weighed before and after sample collection to determine the net gain due to collected PM (see the Lab SOP of this QAPP Appendix LSD2 for a complete description of lab activities). The sampler records sample duration, flow rate, interval temperature and pressure values, and average temperature and pressure. The total sample volume is determined from the measured flow rate at actual ambient temperature and pressure and the sample duration. The mass concentration of PM in the ambient air is computed as the total mass of collected particles in the PM divided by the actual volume of air sampled, and is expressed in micrograms per cubic meter of air (µg/m³). A complete description of the method can be found in 40CFR Part 50, Appendix L, § 7.0.

2.0 SUMMARY OF METHOD

2.1 The Inlet

The RP2000 PM sampler uses an impaction inlet (See Figure 2-1). The symmetrical design of the inlet ensures wind-direction insensitivity. Ambient air that is drawn into the inlet is accelerated through jets into an impaction chamber. The jets have critical diameters to provide necessary changes in velocity to affect particle size fractionation.

2.3 VSCC

The flow path through the VSCC PM_{2.5} fractionator is shown in a cutaway view in Figure 2-2. PM₁₀ aerosol enters tangentially after being pre-separated by the PM₁₀ FRM fractionator. Particles greater than 2.5 µm in diameter are collected in the grit pot on the side of the VSCC PM_{2.5} fractionator, and the PM_{2.5} sample is then channeled through the cyclone separator to the filter holder in the sampler.

2.4 PM₁₀ Monitoring

The RP2025 instrument can be adapted to monitor PM₁₀ as an FRM. The instrument should be configured with a ‘VSCC’ bypass offered as a supplemental part by R&P. The bypass is simply a straight tube that sits in the same spot within the sampler otherwise occupied by a VSCC. All the setup parameters, instrument configurations, maintenance requirements, calibration steps, and QA/QC are exactly the same as those for PM_{2.5} sampling.

2.5 Measurement

The total volume of air sampled is determined from the measured mass flow rate, sampling time, ambient pressure, and ambient temperature. The concentration of PM in the ambient air is calculated as the total collected mass divided by the volume of air sampled. The PM measurement is expressed as micrograms per actual cubic meter (µg/m³). The performance parameters of PM samplers, including the RP2025, are tested in accordance with test procedures prescribed in 40 CFR Part 53.

Figure 2-1 - PM_{2.5} Sampler First Stage PM₁₀ Head

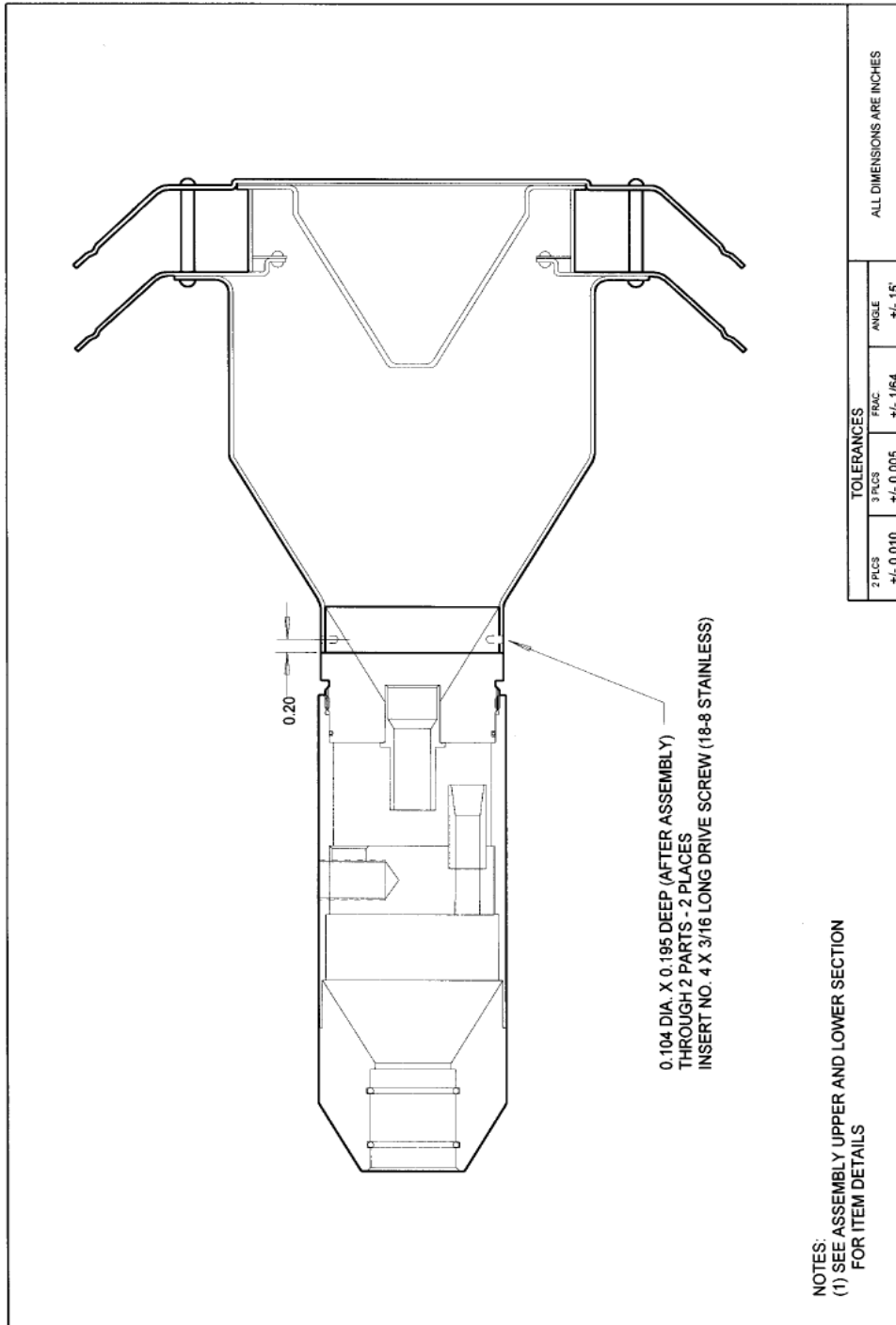
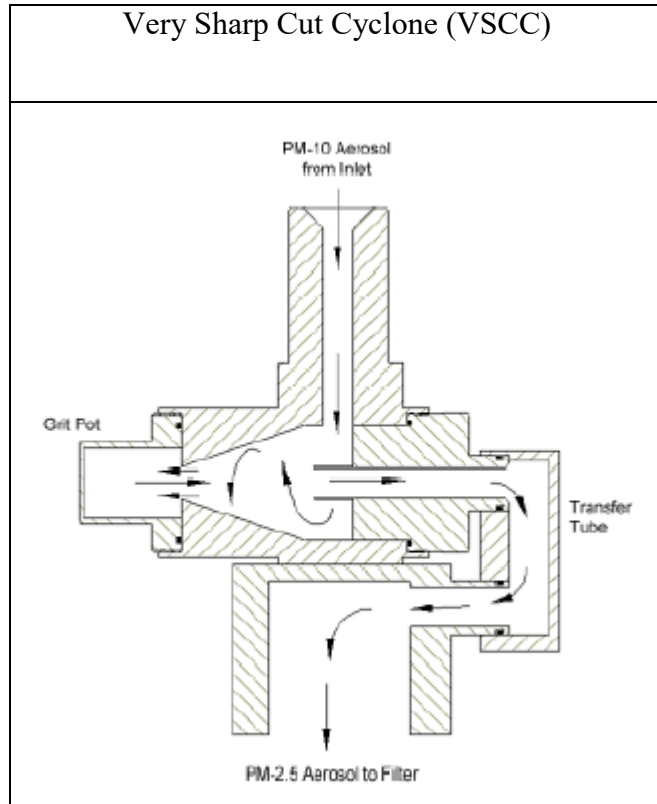


Figure 2-2 Very Sharp Cut Cyclone (for PM_{2.5} Sampling Only)



3.0 DEFINITIONS AND ACRONYMNS

AQS	EPA Air Quality System
ANSI	Air Pollution Control Division
ASQC	American Society for Quality Control
ASTM	American Society for Testing and Materials
CFR	<i>Code of Federal Regulations</i>
CV	coefficient of variation
DOP	diethylphthalate
DQO	data quality objective
EPA	Environmental Protection Agency
FEM	Federal Equivalent Method
FR	flow rate
FRM	Federal Reference Method
FTS	Flow Transfer Standard
HEPA	high-efficiency particulate air
NAAQS	National Ambient Air Quality Standards
NIST	National Institute of Standards and Technology
NVLAP	National Voluntary Laboratory Accreditation Program
OAQPS	Office of Air Quality Planning and Standards
P _a	pressure, ambient
PAMS	Photochemical Assessment Monitoring Stations
PM	particulate matter
PM ₁₀	particulate matter < 10 microns (µm) in aerodynamic diameter
PM _{2.5}	particulate matter < 2.5 microns (µm) in aerodynamic diameter
PMP	polymethylpentene
Po ₂₁₀	polonium-210
PSD	prevention of significant deterioration
PTFE	polytetrafluoroethylene
QA/QC	quality assurance/quality control
QA	quality assurance
QAD	Quality Assurance Division
QAPP	quality assurance project plan
QC	quality control
RH	relative humidity
R&P or RP	Rupprecht & Patashnick
SLAMS	State and local air monitoring stations
SOP	standard operating procedure
SRM	Standard reference material
SVOC	semi-volatile organic compound
T _a	temperature, ambient a
TSP	total suspended particulate
VSCC	BGI, Inc., Very Sharp Cut Cyclone

4.0 HEALTH AND SAFETY WARNINGS

Repair of the RP2000 should only be attempted by properly trained APCD personnel, and should only be conducted in accordance with Rupprecht & Patashnick system documentation. High voltages may be present in all instrument enclosures. Use established safety precautions when working with this instrument. Instrument is supplied with a grounded three-prong plug designed for outdoor use. When operating the instrument outdoors, be sure that it is plugged into a properly rated exterior (outdoor) outlet. The Partisol-Plus stand must be anchored when installed outdoors to prevent tipping of the sampler and/or stand in high winds. Some assembly of the inlet or the VSCC is required for installation and regular maintenance. Be careful to avoid pinching your fingers between the assembly parts when assembling these components. Never place your hands or fingers in the filter exchange mechanism. Refer to the RP2000 Service Manual (September 1998, Revision B) for instructions on clearing a filter jam. Use of this product in any manner not intended by the manufacturer will void the safety protection provided by the equipment, and may damage the equipment and subject the user to injury.

In addition:

- Use caution on ladders and rooftops, especially in inclement weather or under snow pack condition.
- Wear sturdy work shoes with a good traction sole.
- Only one person at a time on ladders. Where possible secure ladder to rooftop.
- Always unplug the sampler when servicing or replacing parts. This excludes normal sampling operations.
- Use extreme caution if any electrical outlets or connections are in contact with standing water.
- Secure or remove front door while working on the sampler.
- Sunscreen and eye protection is recommended.
- Maintain an awareness and familiarity with immediate surroundings including activities of pedestrians below sampling location and near ladder.

4.1 Cautions

Keep the instrument exterior (including ambient temperature weather shield) and interior clean of dust to maintain optimal operation and avoid contamination.

4.2 Interferences

- Handling the filter cassettes excessively or handling with dirty hands can cause inaccurate mass measurements.
- Excessive precipitation, especially combined with high winds, can cause problems with sample recovery.

4.3 Personnel Qualifications

At program startup critical field and QA staff from APCD were sent to Cary, NC and were certified in the 1998 Air and Waste Management Association PM_{2.5} Monitoring Workshop. These individuals have also taken part in the 1998 WESTAR PM_{2.5} Hands-On Training as attendees and trainers. EPA sponsored both of these workshops and these individuals have since left APCD. However, with the knowledge from the training sessions, APCD personnel have been able to provide information to local operators and new APCD employees regarding the operation and maintenance of the RP2000 sampler. It is through the training and field experience that a “train the trainer” system has been established.

The APCD provides training to field personnel and local operators. Although some site operators from Colorado attended the 1998 WESTAR workshop, APCD will only permit site operators to operate the PM samplers after passing an onsite proficiency evaluation. The PM Program Coordinator, or other qualified APCD personnel, evaluate each operator’s proficiency after each site operator has been given sufficient time to review the SOPs and practice on the PM sampler. If failure should occur during the evaluation, the

APCD will provide onsite training until the local operator becomes proficient.

5.0 CALIBRATION PROCEDURES

This section contains instructions for performing an interface board, ambient temperature, filter temperature, ambient pressure, and flow calibration of the RP2000 FRM Sampler. The temperature and pressure calibrations must be done before the flow calibration. R&P recommends that these procedures be executed minimally on an annual basis.

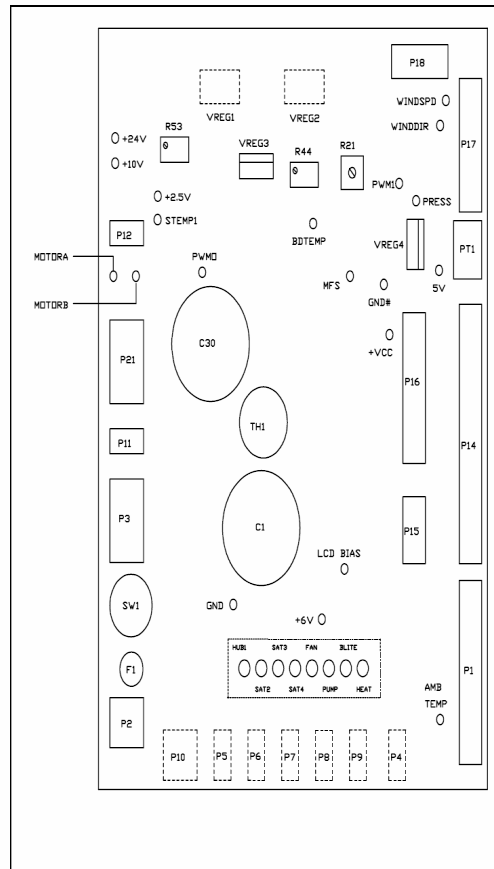
5.1 Interface Board Calibration

The interface electronics board is located on the bottom panel of the sampler's electronics compartment.

CAUTION: Use proper anti-static protection when the door to the electronics compartment is open and when taking measurements on any electronic components. Failure to use anti-static protection could result in damage to electronic components. Perform the calibration of the interface electronics board in the following manner:

1. Locate the test point labeled “+6V” in the front section of the interface board, and the “+2.5V” and “+10V” test point in the back part. All three test points are red.
2. Locate the black ground test point labeled “GND” in the front portion of the interface board. Ensure that the sampler is turned on and that the display backlight is on. The backlight *must* be on during the +6 V calibration. If the backlight is off, press any key on the keypad to turn it on.
3. Place the positive lead of a multimeter on the +6 V test point.
4. Place the ground lead on the ground test point.
5. Locate R21 on the rear section of the interface board. R21 is a horizontal pot, and its designation “R21” is silk-screened on the board.
6. Adjust R21 until the multimeter reads $6.00 \text{ VDC} \pm 0.05 \text{ V}$.
7. Place the positive lead on the +2.5V test point.
8. Locate R53 on the rear section of the interface board. R53 is a blue vertical pot, and its R53 designation is silk screened on the board.
9. Adjust R53 until the multimeter reads $2.500 \text{ VDC} \pm 0.002 \text{ V}$ Place the positive lead of the multimeter on the +10 V test point.
10. Locate R44 on the rear section of the interface board. R44 is a blue vertical pot, and its designation “R44” is silk-screened on the board.
11. Adjust R44 until the multimeter reads $10.000 \text{ VDC} \pm 0.002 \text{ V}$.

Figure 5-1 RP2000 Interface Board



5.2 Analog Input Calibration

Please note that the following procedure must be performed *after* the interface board calibration and *before* the temperature, pressure and flow calibrations.

CAUTION: Use proper anti-static protection when the door to the electronics compartment is open and when taking measurements on any electronic components. Failure to use anti-static protection could result in damage to electronic components. Perform the analog input calibration in the following manner: Return the sampler to the Main Screen. The device must be in the Stop Operating Mode to perform an analog input calibration. If the hardware is currently in a different operating mode, refer to Section 5.3 for instructions to switch to the Stop Operating Mode.

- 1) Press <F5: Setup> and then <F2: Calib> when in the Main Screen to access the Calibration Screen.
- 2) Locate connector P18 in the rear section of the interface board. Unplug the cable connected to P18.
- 3) Plug in the Analog Calibration Cable (51-004282) provided with the sampler into P18.
- 4) Attach the positive lead from a multimeter with four-digit resolution to the green test point labeled “PWM1” on the interface board. Attach the ground lead to the ground test point.
- 5) Using the arrow key, position the cursor so that it is in the location labeled “A/O.”
- 6) Press <F1: Edit> to enter the Edit Mode. Type in a number between 0.050 and 0.150 volts and press <ENTER>.

- 7) Observe the number displayed in the row labeled “A/I” in the column labeled “Calc.” Ensure that this number does not vary more than ± 0.005 volts after watching it for 5 seconds. If this number is not stable, choose a new number for “A/O” between 0.050 and 0.150 volts
- 8) Read the voltage displayed on the multimeter.
- 9) Using the arrow keys, position the cursor so that it is in the row labeled “A/I” and the column labeled “Act.”
- 10) Press <F1: Edit> to enter the Edit Mode. Type the voltage reading from the multimeter (to three digit accuracy, i.e., 0.xxx) in this position and press <ENTER>. This calculates the “Offset.”
- 11) Ensure that the number now displayed in the row labeled “A/I” and the column labeled “Calc” matches the number displayed on the multimeter within ± 0.005 volts.
- 12) Using the arrow key, position the cursor so that it is in the location labeled “A/O.”
- 13) Press <F1: Edit> to enter the Edit Mode. Type in a number between 4.800 and 4.900 volts and press <ENTER>.
- 14) Observe the number displayed in the row labeled “A/I” in the column labeled “Calc.” Ensure that this number does not vary more than ± 0.005 volts after watching it for 5 seconds. If this number is not stable, choose a new number for “A/O” between 4.800 and 4.900 volts.
- 15) Read the voltage displayed on the multimeter.
- 16) Using the arrow keys, position the cursor so that it is in the row labeled “A/I” and the column labeled “Act.”
- 17) Press <F1: Edit> to enter the Edit Mode. Type the voltage reading from the multimeter (to three digit accuracy, i.e., 0.xxx) in this position and press <ENTER>. This operation will result in the A/I circuit ‘SPAN’ being calculated.
- 18) Ensure that the number now displayed in the row labeled “A/I” and the column labeled “Calc” matches the number displayed on the multimeter within ± 0.005 volts.
- 19) Remove the multimeter leads from the interface board and the Analog Input Calibration Cable from the back of the electronics compartment.

After the analog input calibration has been performed successfully, the temperature, pressure and flow calibrations must be performed.

5.3 Ambient Temperature Calibration

Perform an ambient temperature calibration in the following manner:

The sampler must be in the Stop Operating Mode to perform an ambient temperature calibration.

- 1) Press <F5: Setup> and <F2: Calib> when in the Main Screen to access the Calibration Screen.
- 2) Determine the current temperature ($^{\circ}\text{C}$) at the ambient temperature sensor using an external thermometer, [$^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$].
- 3) Press <F1: Edit> to enter the Edit Mode, and move the cursor to the “Act” (actual) column in the row labeled “AmbT.”
- 4) Enter the current ambient temperature ($^{\circ}\text{C}$) and press <ENTER> to leave the Edit Mode. Use the <F6: +/-> key (Shift F1) to enter negative temperatures when in the Edit Mode.
- 5) Upon receiving the actual temperature, the system's microprocessor automatically computes “Span” for the ambient temperature. Note this number on the calibration form.

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

5.4 Filter Temperature Calibration

Perform a filter temperature calibration in the following manner:

Return the sampler to the Main Screen.

The device must be in the Stop Operating Mode to perform a filter temperature calibration.

- 1) Press <F5: Setup> and <F2: Calib> when in the Main Screen to access the Calibration Screen.

- 2) Determine the current temperature (°C) at the location of the sample filter in the Partisol-FRM sampler using an external thermometer, [$^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$].
- 3) Press <F1: Edit> to enter the Edit Mode, and move the cursor to the “Act” (actual) column in the row labeled “FltT.”
- 4) Enter the current filter temperature (°C) and press <ENTER> to leave the Edit Mode. Use the <F6: +/-> key to enter negative temperatures when in the Edit Mode.
- 5) Upon receiving the actual temperature, the system's microprocessor automatically computes “Span” for the filter temperature. Note this number on the calibration form.

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

5.5 Ambient Pressure Calibration

Perform an ambient pressure calibration in the following manner:

The device must be in the Stop Operating Mode to perform an ambient pressure calibration.

- 1) Press <F5: Setup> and <F2: Calib> when in the Main Screen to access the Calibration Screen.
- 2) Determine the current ambient station pressure in mm Hg (absolute pressure, not corrected to sea level).
 - To convert from Atmospheres to mm Hg, multiply by 760.
 - To convert from millibars to mm Hg, multiply by 0.75012.
 - To convert from inches Hg to mm Hg, multiply by 25.4.
- 3) Press <F1: Edit> to enter the Edit Mode, and move the cursor to the “Act” (actual) column in the row labeled “Pres”.
- 4) Enter the current ambient pressure (mm Hg) and press <ENTER> to leave the Edit Mode.
- 5) Upon receiving the actual pressure, the system's microprocessor automatically computes “Span” for the ambient pressure. Note this number on the calibration form.

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

5.6 Flow Calibration

The temperature and pressure calibrations described above *must* be performed before the flow calibration is undertaken. In addition, an external leak check must also be undertaken before executing the following instructions.

The RP2000 Sampler supports both a single-point and five-point flow calibration routine. The five-point calibration is the preferred method of calibration by APCD, and is described below. Flow calibration is recommended whenever the sampler has been transported, any electromechanical maintenance has been done, or the sampler flow deviates from the set flow by $\pm 5.1\%$. Additionally, the sampler should be calibrated at least once per calendar year.

5.6.1 Five-Point Calibration

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

The device must be in the Stop Operating Mode to perform a five-point flow calibration.

- 1) Carefully remove the 1st stage inlet from the sampler.
- 2) Install a filter cassette containing a 47 mm filter into the filter holding mechanism.
- 3) Display the Flow Calibration Screen by pressing <F5: Setup>, <F2: Calib> and then <F2: FlowCal> when in the Main Screen.
- 4) Confirm the FTS calibration constants, m and b, have been entered in the Setup Screen. Execute the following steps to do so:
 - Press <ESC> to display the Setup Screen

- Press <F1: Edit>
 - Scroll down to the FTS CONST field
 - Enter the m constant from the FTS Calibration label
 - Enter the b constant from the FTS Calibration label
 - Press Enter
 - Press <F2:Calib> to return to the Calibration Screen
- 5) Attach the FTS Flow Transfer Standard to the sample tube.
 - 6) Press <F2: Start> to begin the five-point flow calibration routine.
 - 7) With the pump turned off, the sampler first computes the Flow Offset value before automatically starting the span calibration using five flow rates around the default sample flow rate of 16.7 l/min.
Note the instructions issued by the sampler at the bottom of the Flow Calibration Screen.
 - 8) Determine the flow in actual l/min using the external flow meter. Enter the pressure (inches H₂O) in the FTS Pres field by pressing F1:Edit>, input the value using the keypad, press Enter. The sampler will calculate the volumetric flow in units of l/min.
 - 9) The unit then operates at flow rates of 16.7, 17.5, 15.8, 18.3 and 15.0 l/min in succession. The sampler will automatically enter the calculated flow into the ACT field and compute "Span" which is the span offset for the mass flow controller.
NOTE: If the instrument has been reset and you have recorded the value of "Offset" and "Span" for the flow, you may enter these numbers directly when in the Edit Mode.
 - 10) Return to the Main Screen by pressing <ESC> three times.
 - 11) Restore the sampling hardware to its original state by removing the flow metering hardware and reinstalling the VSCC (if appropriate) and the 1st stage inlet on the sample tube.

6.0 SAMPLER OPERATION AND MAINTENANCE SUMMARY

The current PM program field operation and maintenance procedures for the RP 2000 FRM can be divided into three general areas: Filter/sample handling procedures, routine maintenance or cleaning, and verification procedures. Filter/sample handling can be further broken down into sending and receiving filters from the lab, transporting filters to and from the sampling site, loading unexposed filters into the instrument, setting the instrument up for a sample run, recovering exposed filters, and data transfer. Routine maintenance/cleaning and verification procedures can be divided into **Every 5-Sample Event** procedures, **Every 4-Week Verification** procedures, **Every 15-Sample Event** procedures, and routine cleaning procedures. Additionally, there are paperwork requirements that accompany each procedure that allow site operators to document the procedures to help demonstrate sample and data quality. These procedures are all listed in EPA's Method 2.12, **Quality Assurance Guidance Document for PM_{2.5} Monitoring** or are recommended by the instrument manufacturer. All these procedures are described in detail below.

6.1 Forms

One of the most important aspects of the PM Program from the site operator's perspective is the paperwork required to document the procedures mentioned above. Site operators routinely use two forms:

- Filter Data Sheet/Chain of Custody,
- PM Field Form,

APCD/PM personnel create all the forms for every site prior to a particular batch being shipped to the field. The forms are then sent to each site operator along with any necessary supplies, as needed. Should an operator be missing any of the required forms they can get replacements by contacting the appropriate APCD/PM personnel.

There are five field criteria that APCD considers critical to determining the validity of any sample. The critical criteria are as follows:

- 1) Once a filter has been removed from the RP2000 it must be transported and stored at or below 4°C,
- 2) The sample duration is between 1380 and 1500 minutes (23 to 25 hours),
- 3) The average sample flow rate is within 5 % of 16.67 l/min,
- 4) The flow coefficient of variation (%CV) is less than 2%, and
- 5) The actual flow rate must be within 4.1% of the reported flow rate as documented in the every four weeks flow verification.

The failure to satisfy even one of these criteria will result in an invalid sample.

There are five field criteria that APCD considers having an effect on the quality of the sample. Not meeting these "operational criteria" will not necessarily invalidate a sample, only give cause for APCD to examine the sample, the performance of the instrument, or the efficiency of the site operator. The operational criteria are:

- 1) That there are no flow rate excursions greater than 5% for more than five minutes,
- 2) External and internal leak checks be less than 80 ml/min and are checked at least once every five sampling events,
- 3) One point ambient temperature and pressure verifications are performed at least once every four weeks,
- 4) The VSCC (if present for PM_{2.5} sampling) is cleaned or replaced at least once every 15-sample events, and
- 5) The PM₁₀ inlet and sample downtube are cleaned at least once every 15-sample events.

To satisfy these 10 criteria (five critical criteria and five operational criteria) each site operator must handle the filters properly (including transport and shipping), perform the required cleaning/maintenance on schedule, AND document that he or she has done so. It is critically important that site operators fill out the required paperwork; without this documentation a site operator can do all the required maintenance correctly and on time and still not prove they have satisfied critical and operational criteria. The forms provided by APCD give site operators a medium via which they can document the timely completion of the required maintenance/cleaning.

6.1.1 Filter Data Sheet/Chain of Custody

This form, the FDS, ([Figure 6-1](#)) is the keystone of the program. These forms are generated by APCD and sent out to site operators with the filter shipments. If a site operator receives a shipment of filters without an FDS he or she should contact the appropriate APCD/PM personnel immediately. Since this form serves as a chain of custody document it must accompany the filters to and from the field and return with the filters to the laboratory. Most of the 'critical criteria' are documented on this form.

6.1.1.1 Field Standard Operating Procedures, Filter Data Sheet Explanation

The Filter Data Sheet (FDS) is key to the sample validation process of Colorado's low volume PM program. APCD requires that site operators understand the FDS and fill it out completely. The records generated by site operators (specifically the FDS and other required forms) serve as the only proof of sample validity; additionally, the FDS serves as a chain of custody document. Without a complete, properly filled out FDS APCD/PM personnel cannot link an electronic record with the physical sample. Without this link it cannot be shown that a sample is valid. In fact, just the opposite is true. Without the proof offered by a complete FDS it is assumed that a sample is invalid. To summarize: when a site operator fails to fill out the FDS completely, even if they've performed all the required work, they are putting sample validity in jeopardy.

Below, there is an example of a complete FDS with all necessary information entered. The Boulder PM_{2.5} site is used in this example. The data is imaginary and reflective of no actual data. It is there only to demonstrate completeness and format. The image itself is a bitmap and can be copied, enlarged, and printed out.

There are five different areas of the FDS that site operators need to fill out. The image below identifies these five parts. Site operators should read through the associated notes for an explanation of each portion of the FDS. If further explanation is necessary the site operator should contact the appropriate APCD/PM personnel.

Figure 6-1 Filter Data Sheet

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PM2.5 Federal Reference Method Filter Data Sheet/Chain of Custody

SAMPLER DATA

Site Name: Boulder
 AIRS Code: 08-013-00121
 Sampler Model: RP 2025A
 Sampler S/N: 200700001
 Reviewed by: _____ Date: _____

SITE VISITS:

	#1	#2	#3	#4	#5	#6
Date	000810	000814	000818	000821	000828	
Time	0:00	10:20	8:25	11:15	14:25	
Operator	Jr	Jr	Jr	Jr	Jr	

The filters accompanying this shipment are to be returned to LARS on: Wednesday 30 August

FILTER DATA

Filter ID/Cassette Screen ID Label	Sample Start/End Date	Sample Number/Filter No.	Walk & Total Sample Time (hh:mm)	Average Amb. Pres. (mm Hg)	Average Amb. Temp. (°C)	Average Sample Flow Rate (L/min)	Max. Temp. Diff. (°C) / @ Time	Coefficient of Variation (CV%)	Sample Volume (m ³)	Operator Comments
	Start 000813	1	23:50				3.5			
	End 000814	2	23:50	23.6	6.16	16.7	13.56	0.0	24.0	
	Start 000816	1	23:50				4.1			
	End 000817	3	23:50	24.7	6.12	16.7	14.02	0.0	24.0	
	Start 000817	1	0:00							blank
	End 000817	3	0:00	0	0	0	0	0	0	
	Start 000819	1	23:38				2.1			D, Audit Performed
	End 000820	4	23:38	25.2	6.14	16.7	13.22	0.0	23.5	
	Start 000822	1	23:42				6.5			T1, Sample Temperature Out of Range
	End 000823	4	23:50	25.7	6.18	16.7	14.71	0.5	24.0	
	Start 000825	1	23:50				3.7			
	End 000826	5	23:50	26.3	6.10	16.7	12.21	0.2	24.0	
	Start									
	End									
	Start									
	End									

FILTERS SHIPPED TO FIELD

Date: _____ By: _____

FIELD LAB DATA

	#1	#2	#3	#4	#5	#6
Temp. at Field Lab (°C):	n/a	-1.1	-4.2	-3.1	2.1	
Refrigerator Temperature at Field Lab (°C):		-1.5	-1.7	-1.0	-2.2	
Refrigerator Temperature when shipped:	-6.5					

Date: 8/30/00 Samples Shipped By: Jr

SAMPLES RETURNED TO LARS

Date Received at LARS: _____ By: _____

Maximum Temperature of Shipping _____

Container When Received: _____ °C

Container When Returned: _____ °C

unloaded by: _____

Notes: _____

NOTES:

Each FDS is produced by APCD personnel to accompany a specific batch of filters to a specific site. Each FDS is sent out to the appropriate site with pre-printed information pertinent to that site. This data is site information, including the site name, site code, AQS ID, and sampler serial number. If there is information on this form that is incorrect (i.e. sampler serial number) contact the appropriate APCD/PM personnel.

Note 1: Site visit information.

Every time an operator visits his or her site it is necessary for them to fill in this information. APCD personnel need to know the date and time of the site visit and which site operator(s) was there. Operators need to fill this section out every site visit, completely, no exceptions.

Note 2: Sample Load/Retrieval Site Visit #.

When an operator goes to the site to load a new batch of filters into the instrument they should note which Site Visit the filters were loaded. This Site Visit # goes in the column labeled Sample Loaded/Retrieved Site Visit # and adjacent to the row corresponding with the sample start date. When an operator goes to the site to retrieve filters they should note which filters were retrieved on that particular site visit. This Site Visit # goes in the column labeled Sample Loaded/Retrieved Site Visit # and adjacent to the row corresponding with the sample end date. When an operator fills this out they document when they pulled a filter off the instrument. APCD determines if site visits are being conducted at appropriate intervals.

Note 3: Operator Comments:

The operator may make any comments associated with a particular sample or filter including weather events, high pollution events, condition of the filter upon receipt, etc. The operator should also use this space to document any status conditions associated with that sample.

Note 4: Filter data information.

This data the operator retrieves from the instrument with a couple of important exceptions...The filter IDs are printed on each individual filter-holding bag received from the lab. The next two columns of data refer to 1) Sample start/end date(s) (the column heading is 'Date (yymmdd)') and 2) On what site visit was a filter loaded into the machine and when was that filter retrieved after sampling (column heading 'Site Visit #).

Start date and end date should be self-explanatory. Site operators receive each FDS with the 'Start Date' already filled in per EPA's sample schedule. All samples should be 24 hours long, which means that the 'End Date' will be the day following the 'Start Date'. There may be exceptions to this but as it's a critical criteria that each sample should be 24 hours long the exceptions will be infrequent. Please note if a filter did not sample on the prescribed start/end date then it is necessary to make this notation on the FDS and write in the correct information.

The next eight columns after the Sample Loaded/Retrieved column (previously discussed in Note 2) are all concerned with actual sample data. These values serve a two-fold purpose. Firstly, they allow site operators to verify that the sample has met some of the critical criteria for a sample to be considered valid, and secondly these data serve as a hardcopy backup to the electronic record. Should a sample not meet one or more of the criteria concerning sample time, average flow, coefficient of variation, and sample volume they should contact the appropriate APCD/PM personnel.

Note 5: Field Lab Data.

The data a site operator should write in this section refers to temperatures of their transport container and field lab refrigerator. When you visit your site and recover a filter record the temperature on your transport cooler (after it has stabilized at a temperature below 4 °C) and the temperature of your refrigerator when you place the exposed filter in the fridge for storage until shipment. An exposed filter must stay at or beneath 4 °C from the time it is retrieved from the site to the time it arrives at the lab. An additional space is given for site operators to record the temperature of the shipping container after it has been packed for return to the lab.

6.1.2 PM Field Form

The PM Field Form is the form which site operators use to document all regular scheduled maintenance, e.g. the 'operational criteria' mentioned above. These forms are numbered from 1 to 26, each correspond to a specific two-week period of the calendar year. Each form is labeled with the time period dates, what maintenance is to be performed in the time period, and on what date the maintenance is to be performed. These forms are used to document all 4-Week Verifications (leak check, one point temperature, pressure, and flow verifications), and all 15-Sample Event Cleanings (VSCC, PM₁₀ inlet and downtube cleaning). All Field Forms are produced by APCD personnel and sent to the laboratory. The laboratory mails these forms out with the tare-weighed filters. Field Forms are returned to the laboratory with the samples filters at the end of the two-week period to which it corresponds. The APCD retrieves these forms up from the

laboratory every two weeks to perform the data validation procedures. This form also serves to keep maintenance schedules consistent among sites across the network.

6.2.1 VSCC Cleaning

Perform a VSCC cleaning after protecting the filters as above.

Open the filter exchange assembly and remove the filter cassette carrier from the filter platform. Push the filter exchange mechanism toward the back slightly, and lift the rollers through the slots in the left and right guides. Allow the filter platform to settle downward, and remove the VSCC and adapter.

- 1) Pull the VSCC up and off the flow splitter.
- 2) Pull off the transfer tube. If it is too tight to remove it by hand, pry it off with a rigid plastic lever.
- 3) Remove the top and emptying cup from the chamber.
- 4) Wet a lint-free wipe with deionized water and remove all visible deposits. Deposits are most likely to be found in the cone (inside the top cap) and inside the emptying cup.
- 5) Inspect all O-rings for shape and integrity and replace if necessary. There are 6 O-rings in the VSCC, located as follows: 3 on the chamber (2 are located inside the chamber), 2 on the top cap and 1 in the emptying cup.
- 6) Reassemble and reinstall the VSCC onto the flow splitter. Lubricate the transfer tube to aid in reassembly.

6.2.2 External Leak Check

Note: Some RP2000 in the Colorado network are fitted with an automatic leak check procedure. The following description of the External Leak Check procedure can be performed on all the RP2000s in the Colorado network. Refer to Rupprecht & Patashnick Partisol FRM Model 2000 Operating Manual for a complete description of the automatic external leak check procedure.



- 1) Remove PM₁₀ inlet.
- 2) Place the flow audit adapter on the sample down tube, as in the adjacent picture, and close the valve (open is vertical).
- 3) From the Main Screen ([Figure EOD-1](#)), press <F5: Setup> to access the Setup Screen ([Figure EOD-5](#)).
- 4) When in the Setup Screen press <F5: Audit> to access the Audit Screen ([Figure EOD-6](#)).
- 5) Ensure an External Leak Check Cassette has been installed in the exchange assembly.
- 6) Turn on the flow by pressing <F2: Valve>, and then press <F3: Pump>
- 7) Shut off the valve on the flow audit adapter.
 - 8) Shut off the flow to the flow controller assembly by turning the manual shut off valve (attached to the large air filter on the left side of the manifold in the hub.
 - 9) Once the vacuum gauge is stable note the value.
 - 10) Shut off the flow to the pump by turning the other manual shut off valve located on the bottom of the manifold in the hub.
 - 11) Turn off the pump by pressing <F3: Pump>. Note the reading on the vacuum gauge one minute after the pump valve is closed.
 - 12) Subtract this value from the one you originally noted.
 - 13) Multiply this value by 25.4 mm/in; this is the leak rate, this value should not exceed 25mmHg/min.
 - 14) If the leak rate is greater than 25 mmHg/min place a different audit filter into the chamber, check the VSCC for tightness, make sure the flow audit adapter is closed, and the VSCC adapter (the aluminum cup that fits on bottom of the VSCC) is on tightly.
 - 15) Attempt another external leak check.
 - 16) If the leak rate continues to exceed the leak check criteria contact the appropriate APCD/PM personnel.

- 17) If the leak rate passes note the external leak rate in the appropriate space on the PM Field Form.
- 18) Open the valve to the flow controller assembly and the valve on the flow audit adapter.
- 19) Prepare the instrument for the next sample run as described above or continue with the scheduled maintenance as appropriate.

6.2.3 Internal Leak Check

- 1) Perform an internal leak check if the External Leak Check Fails.
- 2) Remove the VSCC and install an internal leak check cassette (solid backing screen) into the filter carrier.
- 3) From the Main Screen press <F5: Setup> to get to the Setup Screen ([Figure EOD-5](#)).
- 4) Press <F3: Audit> for the Audit Screen ([Figure EOD-6](#)). Press <F2: Valve>, turn on the pump by pressing <F3: Pump>.
- 5) Shut off the flow to the flow controller assembly by turning the manual shut off valve attached to the large air filter on the left side of the manifold in the hub.
- 6) After the vacuum gauge has steadied note the initial reading. Shut off the flow to the pump by turning the other manual shut off valve located on the bottom of the manifold in the hub.
- 7) Turn off the pump by pressing <F3: Pump>.
- 8) Record the reading on the vacuum gauge after one minute. Subtract this value from the initial reading of the vacuum gauge, this is the leak rate. Multiply this value by 25.4 mm/in and note the result in the appropriate spot on the PM_{2.5} Field Data Form.
- 9) Press <F2: Valve>. Open the flow control manual valve and the pump manual valve.
- 10) If the leak rate is greater than 140 mmHg/min check the seals in the exchange assembly and ensure that the cassette with the Internal Leak Check disk is tight and secure.
- 11) Repeat the above procedure. If the leak rate is still >140 mmHg/min then contact the appropriate APCD/PM personnel for further direction.
- 12) After a successful internal leak check replace the VSCC assembly.

6.3 Every 4-Week Verification procedures

Supplies:

Thermometer, Barometric Pressure standard, Flow Transfer Standard (FTS), digital manometer, FDS, and PM Field Form.

Before starting a 15-event, operators should put the instrument in 'Audit' mode with an audit filter in the sample chamber.

PERFORM THE EVERY 4-WEEK VERIFICATION PROCEDURES IN THE FOLLOWING ORDER:

6.3.1 Sampler Clock Verification

All RP2000s in the Colorado network are set to Mountain Standard Time (MST) all year. This means that during Daylight Savings Time (MDT in Colorado) the instrument will be behind by an hour from the verification devices. On the Main Screen, note the sampler time. Site operators may use their watch as a standard if it has been set accurately, but a cell phone is preferred, as they are synchronized frequently. There is a web site to the atomic clock in Boulder, Colorado where operators may set their watches; the URL is <http://www.time.gov/>. Note the sampler time and the operator's time verification device time in the appropriate spaces on the PM Field Form (on the PM Field Form the abbreviation, 'Inst' always refers to the RP2000's value). If the instrument's time is more than 15 minutes different than the standard contact the appropriate APCD/PM personnel. Continue the rest of the verification.

6.3.2 Ambient Temperature Verification

Perform the ambient temperature verification after performing the 5-Sample Event procedures and the sampler clock verification.

- 1) From the Main Screen ([Figure EOD-1](#)) note the current Ambient Temperature in the appropriate space on the PM Field Form.
- 2) Determine the current temperature ($^{\circ}\text{C}$) at the ambient temperature sensor using the external temperature standard (thermometer) supplied by the APCD.
- 3) Insert the thermometer probe next to the instrument probe by loosening the left screw on the probe housing and sliding the external probe adjacent to the instrument probe.
- 4) Note the instrument and the standard values in the appropriate spaces on the PM Field Form. Verify that the value of ‘Amb Temp’ displayed on the Main Screen ([Figure EOD-1](#)) is within $\pm 2^{\circ}\text{C}$ of the measured temperature. If this is not the case, notify the appropriate APCD/PM personnel. Continue with the rest of the verification procedures.

6.3.3 Ambient Pressure Verification

Perform the ambient pressure verification after performing the ambient temperature verification.

- 1) Note the value of ‘Amb Pres’ displayed on the Main Screen ([Figure EOD-1](#)).
- 2) Compare this to an external standard such as a barometer supplied by APCD. The barometers all report Barometric Pressure in units of inches of Mercury (inHg). This can be converted to millimeters of Mercury (mmHg) by multiplying the value given by 25.4 in/mm. Operators will be supplied with a conversion chart that will allow them to convert from the units of the barometer to mmHg.
- 3) Note the instrument pressure and the adjusted local standard in the appropriate spaces on the PM Field Form.
- 4) Verify that the value of ‘Amb Pres’ displayed on the Main Screen is within ± 10 mmHg of the local standard. If this is not the case, notify the appropriate APCD/PM personnel. Continue with the rest of the verification procedures.

6.3.4 Flow Verification

Perform the temperature verification, and pressure verification **before** executing the flow verification procedure.

NOTE: Ensure that an external leak check filter is installed in the sampler for the flow verification.

- 1) Remove the flow audit adapter and install the FTS on the sample tube making sure the FTS is snug and completely attached.
- 2) From the Main Screen press <F5: Setup>. Each FTS is calibrated to accurately quantify flow. The RP2000 will perform the FTS calculation if it has the proper FTS “m” and “b” calibration constants.
- 3) Verify that the constants printed on the side of the FTS (the PM Field Form also lists these constants) are entered in the Setup screen.
- 4) If changes are required press <EDIT>, enter the appropriate changes, and then press <ENTER> to accept the changes.
- 5) After verifying the correct FTS constants press <F5: Audit> to get to the Audit Screen ([Figure EOD-6](#)).
- 6) Confirm that 16.7 l/min is the set flow in the Set Flow field.
- 7) Press <F3: Pump> and then <F2: Valve1>. Wait for the flow rate displayed in the Cur Flow column to stabilize.
- 8) Zero the manometer.
- 9) Hook the manometer to the pressure port on the FTS.
- 10) Press <EDIT>, enter the pressure drop (inches H_2O) from the Manometer in the appropriate field, and then press <ENTER>.
- 11) The sampler will calculate and display the FTS volumetric flow (FTS Flow).

- 12) Note this value and the RP2000's current flow in the appropriate spaces on the PM Field Form. Press <F2: Valve1> and then <F3: Pump> to turn off the pump. The measured flow should be within $\pm 4.1\%$ of the displayed Current Flow.
- 13) At a Set Flow rate of 16.67 l/min the design flow verification is acceptable if the FTS flow is between 15.82 and 17.52 l/min.
- 14) Remove the manometer, FTS, and thermometer. If the site operator needs to perform 15-Sample Event procedures then skip to that section. Otherwise, the site operator must return the instrument to the 'WAIT' mode and prepare the instrument for sample operation as described above.
- 15) Collect the audit filters used for the leak checks and flow audit, collect the verification supplies, close and lock the instrument enclosure, and return to the office with the supplies, paperwork, and transport cooler.

6.4 Every 15-sample event procedures

Supplies: bottle brush, lint-free swabs, paper towels, spray bottle (water or water with rubbing alcohol), PM Field Form

All the RP2000 instruments in the Colorado network are configured to operate on a 1 in 6-day schedule. The maintenance schedule of these sites is configured so that APCD/PM personnel perform 15-Event maintenance (once per quarter). Exceptions to this will occur, and the APCD may rely on local operators to perform the 15-Sample Event Maintenance. Follow the procedures below ONLY after performing the 4-Week Verification procedures and if directed by APCD/PM personnel.

PERFORM THE EVERY 15-SAMPLE EVENT PROCEDURES IN THE FOLLOWING ORDER:

6.4.1 Top Collector Assembly Cleaning and Maintenance

- 1) Using a Phillips-blade screwdriver, remove the four pan head screws from the top of the top plate.
- 2) Lift the top plate off the four, threaded, spacer standoffs and set aside.
- 3) Inspect the insect screen for contamination. Clean the screen by lifting it off the lower plate rain deflector and brushing or rinsing it with water until it is clean.
- 4) Dry and reinstall.
- 5) Using a general-purpose cleaner and paper towel, clean the top plate deflector cone and internal wall surface of the acceleration assembly.
NOTE: Be sure that after cleaning the assembly the acceleration nozzle is clean. If not, use a cotton swab and cleaner to remove any contamination.
- 6) Inspect the large diameter impactor nozzle O-ring for damage or wear. Contact the appropriate APCD/PM personnel to arrange replacements, if necessary.
- 7) After reinstalling the bug screen, align the four holes in the top plate with the four-spacer standoffs. Insert the top plate into the lower plate and tighten the four pan-head screws.

6.4.2 Lower Collector Assembly Cleaning and Maintenance

NOTE: Most of the contamination in the inlet is usually found on the collector plate.

- 1) Using either a weak isopropyl (rubbing) alcohol/water mix or water alone with a paper towel, clean the collector assembly walls, collection plate, and three vent tubes. The operator may need to use a swab to clean the vent tubes. Also, clean the bottom side of the collector assembly. Using a swab, clean the weep hole in the collector plate where the moisture runs out to the moisture trap.
- 2) Remove the rain jar and clean it.
- 3) Inspect the rain jar's brass nipple fitting to ensure that it is secure and free from blockages. Inspect the two inlet-to-inlet, tube-sealing O-rings for damage or wear. Contact the appropriate APCD/PM personnel to arrange for replacements, if necessary.
- 4) Clean the lower collector assembly's threads to ensure a tight seal when the two halves are reassembled.

- 5) Reassemble the top and bottom inlet assemblies until the threads tighten. Hand-tighten only. Replace the inlet on the 1-1/4-inch OD sample tube. Take care not to damage the internal O-rings.

6.4.3 Perform Down-tube Maintenance

- 1) Unscrew the gray compression fitting from the base of the down-tube.
- 2) Twist and lift the down-tube upwards until it is free and clear of the sampler.
- 3) Inspect the down-tube by looking through it, pointing it at an angle to a light source, clean the interior only if necessary.
- 4) If interior cleaning seems needed, use a brush of a slightly larger diameter than the down-tube and gently brush.
- 5) The exterior of the down-tube can be cleaned with tap water or a general (non-ammonia) all-purpose cleaner.
- 6) Reinsert the down-tube into the gray compression fitting by twisting and pushing down until it clicks in place.
- 7) Hand-tighten the compression fitting, and place the inlet assembly onto the down-tube.
- 8) Return the instrument to the proper condition as described previously.
- 9) Make a notation on the PM Field Form in the 'Comments' section regarding cleaning/maintenance activities, including the date and what procedures were performed.
- 10) After completing all the maintenance procedures ready the instrument for the next sampling run by following the procedures described above.

6.5 General Cleaning and Maintenance Procedures

In addition to the maintenance/cleaning activities described above every site operator should perform other cleaning to help maintain the presentation and performance of the RP2000. Site operators should perform the following activities on an as-needed basis unless otherwise specified:

6.5.1 “V” seals

Check the “V” seal immediately above the VSCC when the cover is up while performing an internal leak check. Inspect them for contamination or degradation. If significant contamination is found then wipe the “V” seal with a slightly dampened paper towel. The “V” seal should be checked at least once every month. If replacement is warranted contact the appropriate APCD/PM personnel.

6.5.2 Rain-hoods

Clean the air screens located under the sampler’s three rain-hoods or replace as necessary. The fans can affect the efficiency with which the RP2000 maintains its internal temperature. Remove the screen and replace the filter with a clean one provided by APCD. Rinse the dirty filter with water and allow them to dry before using again. There are four air screens on the RP2000, two with filters.

6.5.3 RP2000 Exterior

The exterior (including the ambient temperature probe housing) needs to be kept clean and free of dust. Site operators have been provided with the necessary materials. Contact the appropriate APCD/PM personnel to arrange for replacements.

6.5.4 RP2000 Sample Compartment

Despite the designer’s intent, the sample compartment collects fine dust. The electronic boards, sample filters, and pneumatics are all sealed from water intrusion. Periodically site operators need to remove this dust by liberally spraying the sample compartment with water or a rubbing-alcohol/water mix and wiping up the run off. The sample compartment should be kept clean and free of dust to minimize any possible

source of external contamination.

7.0 SAMPLE HANDLING AND PRESERVATION

7.1 Filter Shipping/Receiving Procedures

To ensure network-wide consistency all low volume PM site operators receive and ship filters on the same schedule. Briefly, shipping to site operators is done every two weeks so that the operator should receive a new batch of filters on every other Tuesday (or Wednesday depending on their proximity to Denver). Operators will ship exposed filters back to the lab every other Wednesday in the intervening weeks. This schedule affords operators continuity, maintains a continuous supply of filters and shipping materials in the system, and allows operators the flexibility that is required by their own schedules. Deviations from the shipping schedule to account for variations in personal schedules or other special arrangements can be made by contacting the appropriate APCD/PM personnel.

7.2 Receiving Filters from the Lab

Each shipment of filters is comprised of the shipping container, UTEK type ice substitute, a static free baggie containing the unexposed filters in each in their own static proof bag labeled with the filter ID, a printed FedEx return label, a Filter Data Sheet/Chain of Custody form, and a Verification/Maintenance form. If one or more of these components are not received on time or are damaged, the site operator should inform the appropriate APCD/PM personnel to arrange for replacements. Upon receipt the site operator should inspect all the filters and cassettes for visual defects (pinholes, chaff or flashing, loose material, discoloration, or non-uniformity). The site operator should check each cassette to be sure they are snug and tight fitting. If there is any physical damage to the filter or cassette (including the backing screen) or if there appears to be significant particle contamination the site operator should contact the appropriate APCD/PM personnel. APCD personnel will direct the site operator in using/discarding the filter, arranging for replacement filter(s), returning discarded filters to the lab, and scheduling make-up samples as required.

After completing the physical inspection of the filters/cassettes the site operator should verify that the Filter ID's correspond to the labels on each bag. The site operator should also verify that the number of filters in the shipment matches the number of scheduled sampling days listed on the FDS. Each FDS should be photocopied and the copy brought to the field. This preserves the original from damage due to handling and weather. The site operator **PRINTS** the filter and cassette ID's in the appropriate location on the copy of the FDS (Attachment 1). The filters should be kept in their respective bag in a clean, out-of-the-way location until each filter is ready to be transported to the site. The upper-right corner of the FDS lists the date ALL the filters in that shipment should be sent back to the lab, the site operator should make a note of this date.

The UTEK ice substitute should be placed in a freezer until it is needed to transport the filters back to the lab. The shipping container and thermometer should be kept in a clean area away from possible sources of contamination and damage from foot traffic, being dropped, etc.

7.3 Shipping Filters to the Lab

As mentioned previously, exposed filters are returned to our laboratory for analysis once every two weeks on a Tuesday via FedEx Standard Overnight Delivery. Site operators should transfer the information from the copy of the FDS they bring to the field to the original prior to shipping filters back to the lab. The transport coolers are packed in the following manner: A layer of frozen UTEK ice substitute is laid flat on the bottom of the cooler. The bag containing the exposed filters is placed upon the frozen ice substitute. A layer of bubble wrap or similar padding is placed on top of the bag. UTEK ice substitute is placed on top and all around the bag of filters/cassettes. Any remaining space is then filled with bubble wrap to prevent shifting during transport. The operator should note the refrigerator temperature in the appropriate space on the FDS. The FDS should then be placed inside the cooler, and the cooler can then be taped closed. The cooler is then shipped to the lab. Operators should pack the cooler as close to shipping time as possible so

as to have better control of the shipping temperature. It is critical to the quality of the samples that the exposed filters be stored and transported back to the laboratory at a temperature less than 4 °C. It is for this reason that the operators must take care while loading and shipping the filters.

7.4 Recovering/Loading filters

7.4.1 Initial Instrument Inspection

Supplies:
PM Field Form

Upon arrival at the sampling site each operator should perform an initial inspection of the instrument and its operating status. With the PM Field Form in hand the operator notes their initials, the date, and the time. The operator then records the instrument status and the instrument mode (SAMP, WAIT, DONE, STOP, or ERR, see [Figure EOD-1](#)). These two conditions are listed on the Main Screen and are in the upper left and upper right corner, respectively. The operator then records the results of their Visual Inspection, whether there is any moisture in the condensate jar, whether the status light is OFF, ON, or BLINKING, the current flow rate, the current ambient temperature, and the current ambient pressure. The current flow rate, ambient temperature, and ambient pressure are all listed on the Main Screen ([Figure EOD-1](#)). Additionally, the site operator should note any special conditions (such as weather, nearby construction or demolition, etc) that may affect the quality of the sample.

7.4.2 Retrieving a Filter from the RP2000 After a Sample Run

Supplies:
FDS, PM Field Form, new filter in baggie, transport cooler with UTEK ice and min/max thermometer.

Upon arriving on site the operator should perform initial instrument inspection as above. If the instrument has sampled since the last site visit the RP2000 will be in 'DONE' mode and the operator should press <F4: Run/stop> once. The instrument will now be in 'STOP' mode. The site operator should remove the filter cassette in the carrier from the sample chamber by pulling the handle of the filter exchange mechanism forward. The mechanism will open, allowing the operator access. Remove the entire filter assembly, including the carrier. The site operator should verify that the filter being recovered is the one that should have sampled by verifying the Filter ID. Place the filter, including the cassette, into its baggie containing the corresponding Filter ID number. Place the sealed baggie in the transport cooler.

The site operator should check the sampling run status on the Main Screen. Note any status code other than 'OK' in the 'Operator Comment' portion of the FDS. From the Main Screen ([Figure EOD-1](#)) press <F3: Data> to view the Filter Data Screen ([Figure EOD-3](#)) from the sampling run. The operator should record the data from the Filter Data Screen onto the FDS (see Attachment 1). From this screen pressing <F2: - Rec> allows the operator to scroll through earlier sample records. While the sample chamber is open the operator should perform a visual inspection and remove any material that could cause contamination; make the appropriate notation on the FDS.

7.4.3 Installing a New Filter in the RP2000

Supplies:
FDS, New filter (and baggie) that is to be loaded transported in carrying case in transport box

Note: All RP2000 in the Colorado PM network are configured by APCD personnel to sample every one in six days for twenty-four hours. The one in six day schedule corresponds to the rest of the Colorado and national sampling schedule. On rare occasions, deviations from this schedule can be arranged to accommodate personal schedules by contacting the appropriate APCD/PM personnel.

Upon arrival the site operator should make the initial inspection as above. Recover the exposed filter as

described above, if necessary. If any regular maintenance is prescribed the operator should finish it prior to installing a new filter. Visually inspect the seals inside the filter holder to ascertain that they are secure and undamaged. If there is foreign material on the seal then wipe them with a lint-free swab or a Kimwipe dust-free cloth. If the seals are in need of replacement contact the appropriate APCD/PM personnel. These seals need to be clean and in good condition for the instrument to sample properly.

Remove the new filter and carrier from the baggie. Carefully insert the filter cassette carrier with its installed filter cassette and filter into the lower part of the filter exchange mechanism. The carrier contains a slot and hole that fit into the appropriate locations of the lower part of the filter exchange mechanism. Push the handle of the filter exchange mechanism toward the back of the instrument to raise the filter platform and enclose the filter cassette. Ensure that the seals around the VSCC housing and the filter assembly are secure. When properly closed the handle (bar) will pop back into place firmly. The sampler is now ready to sample. The site operator must program the instrument to sample on the next scheduled sample day.

To program a new sample definition the instrument must be in 'Stop' mode. If the sampler is in any other mode than 'Stop' then, from the Main Screen press <F4:Run/stop> once; the instrument is now in 'Stop' mode.

From the Main Screen ([Figure EOD-1](#)) press <F1: FilSet> to get the Filter Setup Screen ([Figure EOD-2](#)).

Using the arrow keys, scroll to the field labeled, 'Start Date'. Press <F1: Edit> enter the scheduled start date from the FDS, and press 'Enter'.

All RP2000 in the Colorado network accept dates in the following format: yy/mm/dd. Program the 'End Date' in a similar fashion. All samples should be 24 hours in duration so the end date is simply the day after the start date.

Verify that the 'Start Time' and 'End Time' are set to 00.00. If this is not the case make any necessary edits, as above.

The site operator should now enter the filter ID. Using the arrow keys, scroll to the space labeled 'ID1', press <F4: Edit> and enter the numeric portion of the filter ID, only. Press 'Enter' to accept the changes.

All filter ID's in the Colorado network are a combination of alpha and numeric characters. The alpha portion is always a 'T'. It is not necessary to enter this part of the Filter ID; nor is it necessary to enter the cassette ID.

The site operator should now verify that the Sample Flow Rate is set to 16.7 l/min. Verify that the filter ID is correct and that the sample definition corresponds with the schedule on the FDS.

Hit 'Esc' to return to the Main Screen, press <F4: Run/stop> to return the instrument to 'Wait' mode. Close and lock the door to the sampler.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance (QA) and quality control (QC) are two terms commonly discussed, but often confused. Quality assurance refers to the overall process of ensuring that the data collected meet previously stated measurement quality objectives (MQOs). Quality control covers specific procedures established for obtaining and maintaining data collection within those limits.

8.1 Quality Assurance

There are six commonly used data quality indicators for pollutants. The data quality indicators are discussed in the following sections.

8.1.1 Precision

The APCD is required by EPA to conduct a precision assessment program for the PM monitoring network. The precision testing program, for manual samplers, is different from that used for automated samplers. The manual sampler precision program is based on comparisons of the primary sampler to a concurrently operated collocated sampler. Identical collocated instruments are operated at several sites, operated on an every sixth day sample schedule, and the resulting measurements are used as precision checks. The primary sampler represents the “actual value” and a collocated sampler represents the “indicated value”.

Annually, the APCD evaluates the previous year’s precision data and publishes the precision results in the annual Data Quality Report. The annual APCD Data Quality Report documents all precision and accuracy results for all monitoring networks managed by the APCD. Calculations used in the estimates of precision are listed in APCD’s QAPP.

8.1.2 Accuracy

Accuracy is defined as the degree of agreement between a measured value and the true, expected, or accepted value. Quantitative comparisons are made between the measured value and the true, standard value during audits.

APCD Quality Assurance staff, which is independent of the PM program, conducts field audits quarterly on all manual samplers. The field audit is performed by measuring flow, temperature, pressure and time of the sampler with standards that are independent of those used in the calibration of the sampler. Audit standards must be certified against a NIST traceable standard and be of the same or of higher quality than of those being certified.

To ensure a quality audit, it is important that the audit is performed during a period of good weather and stable conditions. If the weather and/or conditions are not suitable, the audit should be rescheduled.

See Appendix QA1: Standard Operating Procedures for Audits.

8.1.3 Bias

Bias is defined as a systematic error in measurement wherein the measured value displays a consistent positive or negative error as compared to a true value. Bias measurements are calculated either as a percent difference or as a mean arithmetic difference. The signed arithmetic difference is used for assessment where values are too small or too close to the limit of detection to calculate a meaningful percent difference. Calculations used in the estimates of bias are listed in Section 40 CFR Part 58 Appendix A

8.1.4 Representativeness

Representativeness refers to whether the data collected accurately reflect the conditions being measured. It is the data quality indicator most difficult to quantify. Unless the samples are truly representative, the other indicators are meaningless. Representativeness is assured, as best as possible, by precise definitions of monitor siting criteria.

8.1.5 Completeness

Completeness is defined as the amount of data collected compared to a pre-specified target amount. Ideally, 100% of the target amount of data would always be collected; in practice, that value is less for many reasons, ranging from calibration time and site relocation to power outages and equipment failure. For PM, EPA requires a minimum completeness of 75% (40 CFR, 50, App. H.3). APCD believes 90% completeness is an achievable goal.

8.1.6 Comparability

Comparability is defined as the process of collecting data under conditions that are consistent with those used for other data sets of the same pollutant. The goal is to ensure that instruments purchased and operated by states and local agencies produce comparable data. All manual PM samplers utilized by the APCD for compliance monitoring have been pre-designated as Federal Reference Method (FRM) samplers by EPA. Samplers that achieve the FRM designation have been thoroughly evaluated against other PM samplers and have met EPA's criteria for comparability. Additionally, for sites that have collocated continuous PM_{2.5} analyzers, the APCD will compare data from manual FRM samplers with data from continuous analyzers.

8.2 Quality Control

As stated earlier, quality control (QC) refers to procedures established for collecting data within pre-specified tolerance limits. Almost all QC procedures have already been covered under specific topics throughout this document. Documentation and standard operating procedures, however, are discussed below because they apply to many topics.

8.2.1 Documentation

Documentation is important for all measurements. Extensive certification paperwork must be rigorously maintained for each standard and analyzer.

APCD takes special care to prepare and preserve backup copies of all data, including calibration data. All data and supporting documentation should be held for a minimum of five years. See the PM Data Handling SOP Appendix D3 within APCD's QAPP for additional information.

8.2.2 System of Quality Control

Currently an APCD staff person services on 4-week event and 15-sample event schedule. For more information regarding what tasks are routinely performed during these events, refer to Section 6 in this SOP.

The Flow Rate Verification Checks performed every two weeks by the site operators is the most important quality control check that is performed, and thus is required to be submitted to AQS.

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Thermo Scientific Partisol® 2000-FRM PM₁₀ Air Sampler or Thermo Fisher Scientific Partisol® 2000i PM₁₀ Air Sampler or Rupprecht and Patashnick Partisol®-FRM 2000 PM₁₀ Air Sampler Manual Reference Method: RFPS-1298-126 "Thermo Scientific Partisol® 2000-FRM PM₁₀ Air Sampler" or "Thermo Fisher Scientific Partisol® 2000i PM₁₀ Air Sampler" or "Rupprecht and Patashnick Partisol®-FRM 2000 PM₁₀ Air Sampler," with PM₁₀ inlet or louvered inlet specified in 40 CFR 50, Appendix L, Figs. L-2 through L-19, configured as a PM₁₀ reference method with a U.S. EPA PM₁₀ inlet with straight downtube adapter and operated for 24-hour continuous sampling periods in accordance with the Partisol® 2000-FRM or Partisol® 2000i instruction manual, as appropriate, and with the requirements specified in 40 CFR Part 50, Appendix J. Model 2000i operated with firmware version 2.0 or greater. **Federal Register: Vol. 63, page 69625, 12/17/1998 Latest modification: 06/ 2011**

Rupprecht & Patashnick Partisol®-FRM Model 2000 PM_{2.5} Air Sampler Manual Reference Method: RFPS-0498-117 "Rupprecht & Patashnick Company, Incorporated Partisol®-FRM Model 2000 PM_{2.5} Air Sampler," operated with software versions 1.102 - 1.202, with either R&P-specified machined or molded filter cassettes, with or without the optional insulating jacket for cold weather operation, for 24-hour continuous sample periods, in accordance with the Model 2000 Instruction Manual and with the requirements and sample collection filters specified in 40 CFR Part 50, Appendix L. **Federal Register: Vol. 63, page 18911, 04/16/1998**

Figure EOD-1 Main Screen

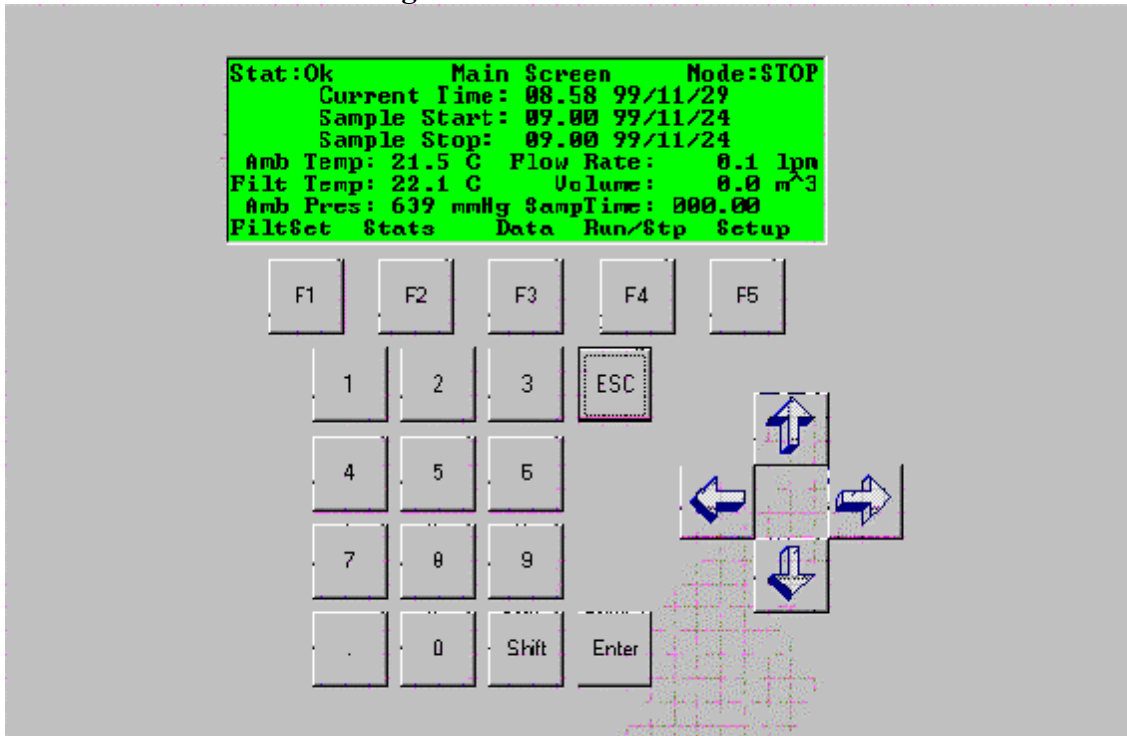


Figure EOD-2 Sample Setup Screen

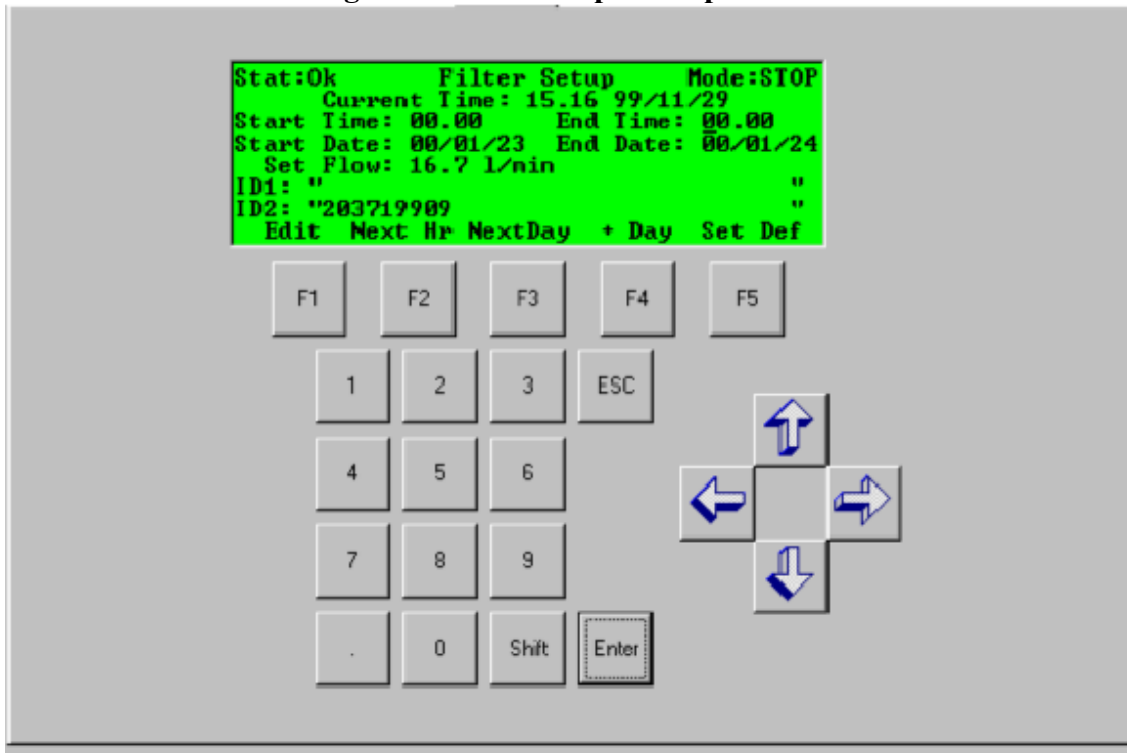


Figure EOD-3 Sample Data Screen

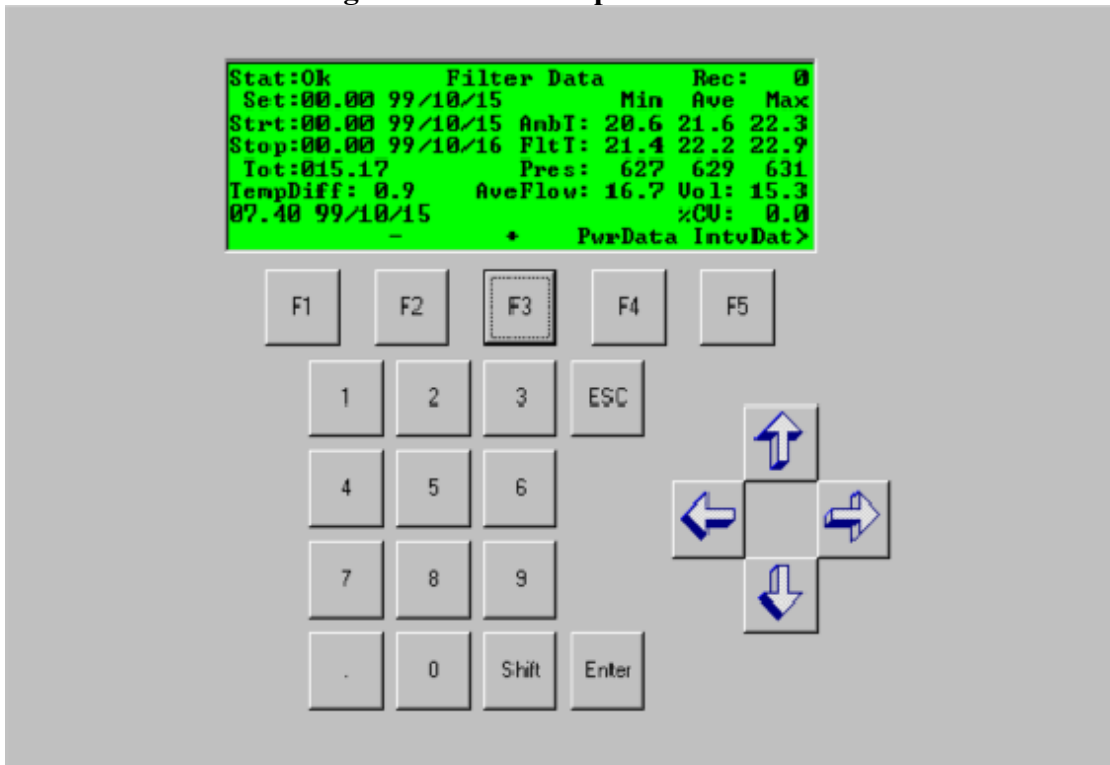


Figure EOD-4 Current Statistics Screen

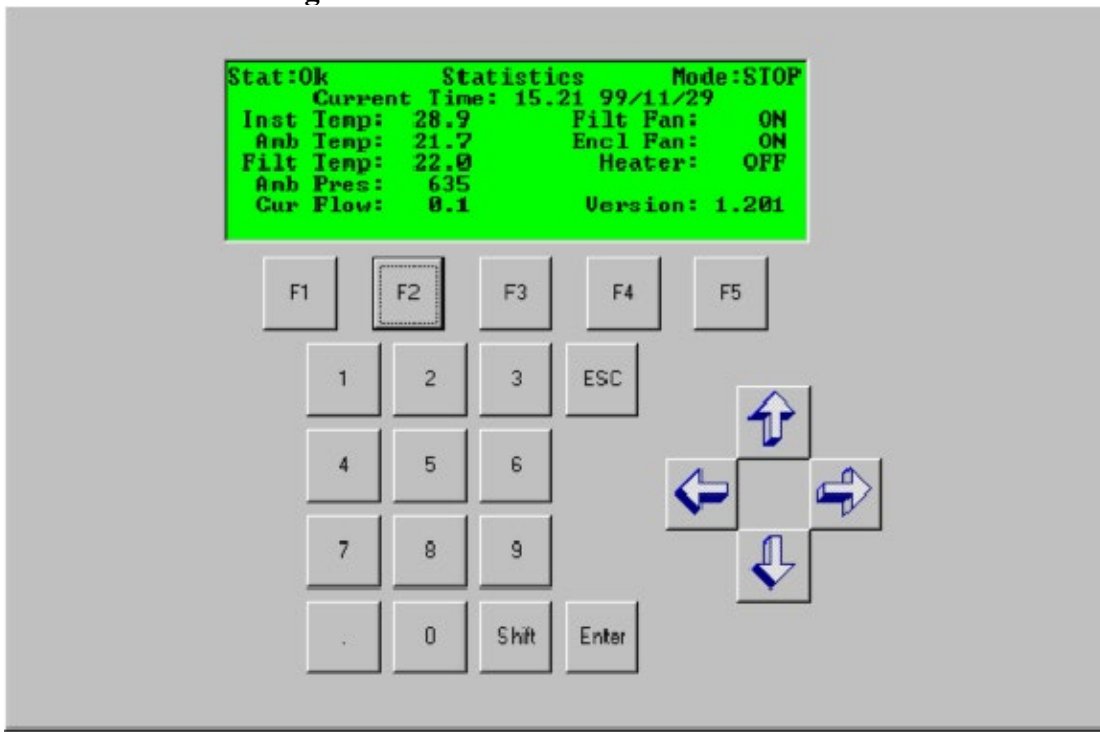


Figure EOD-5 Instrument Setup Screen

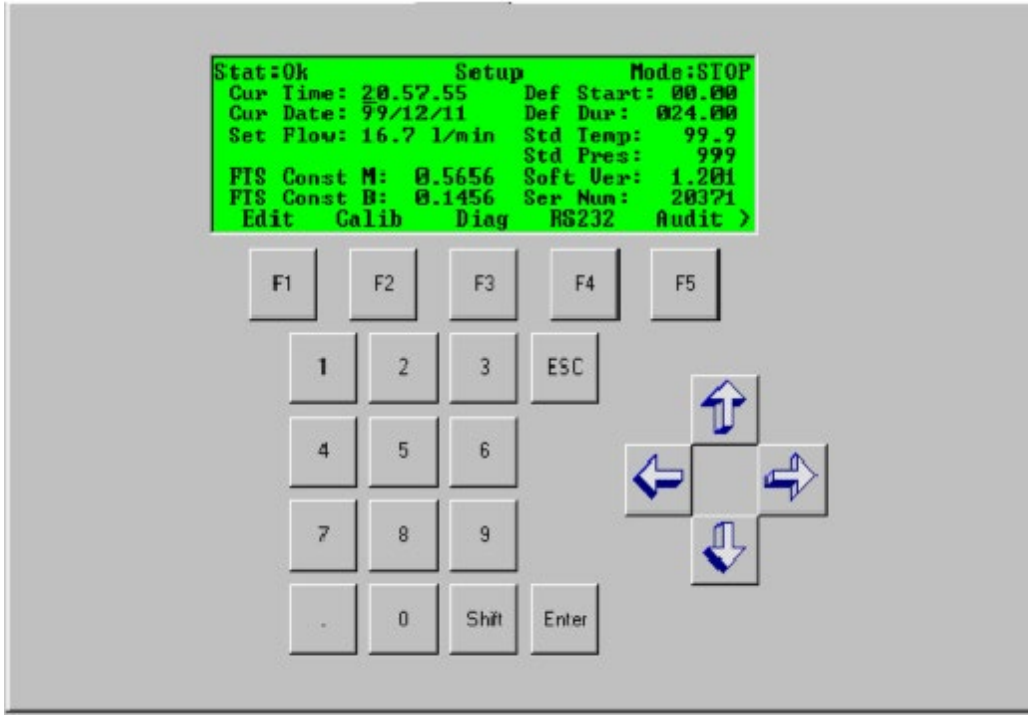


Figure EOD-6 Audit Screen

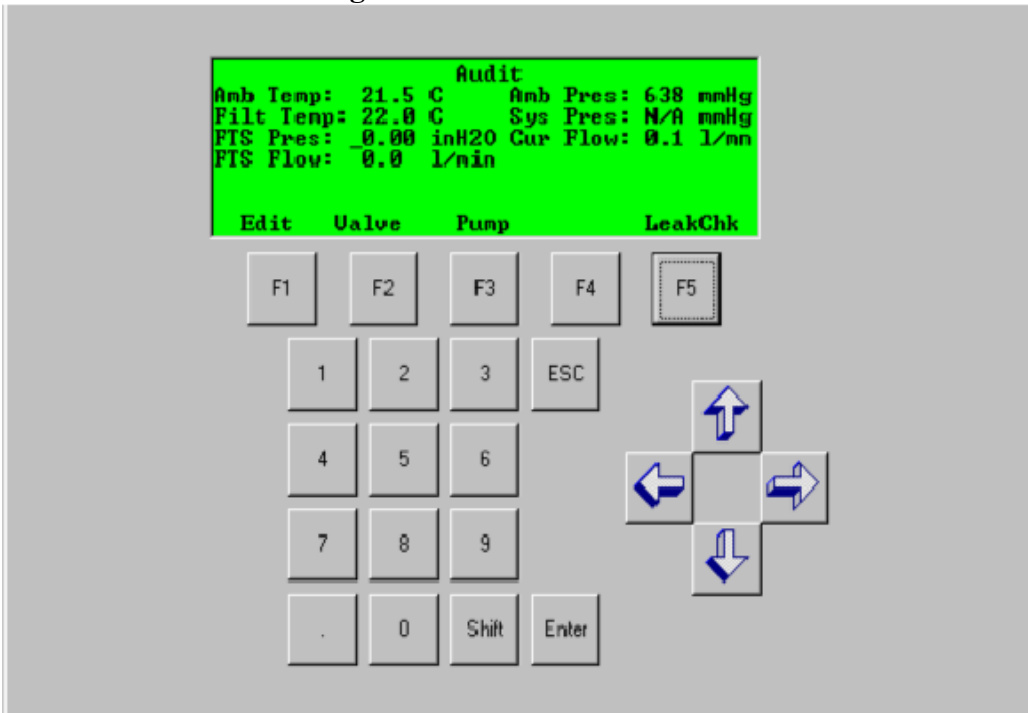
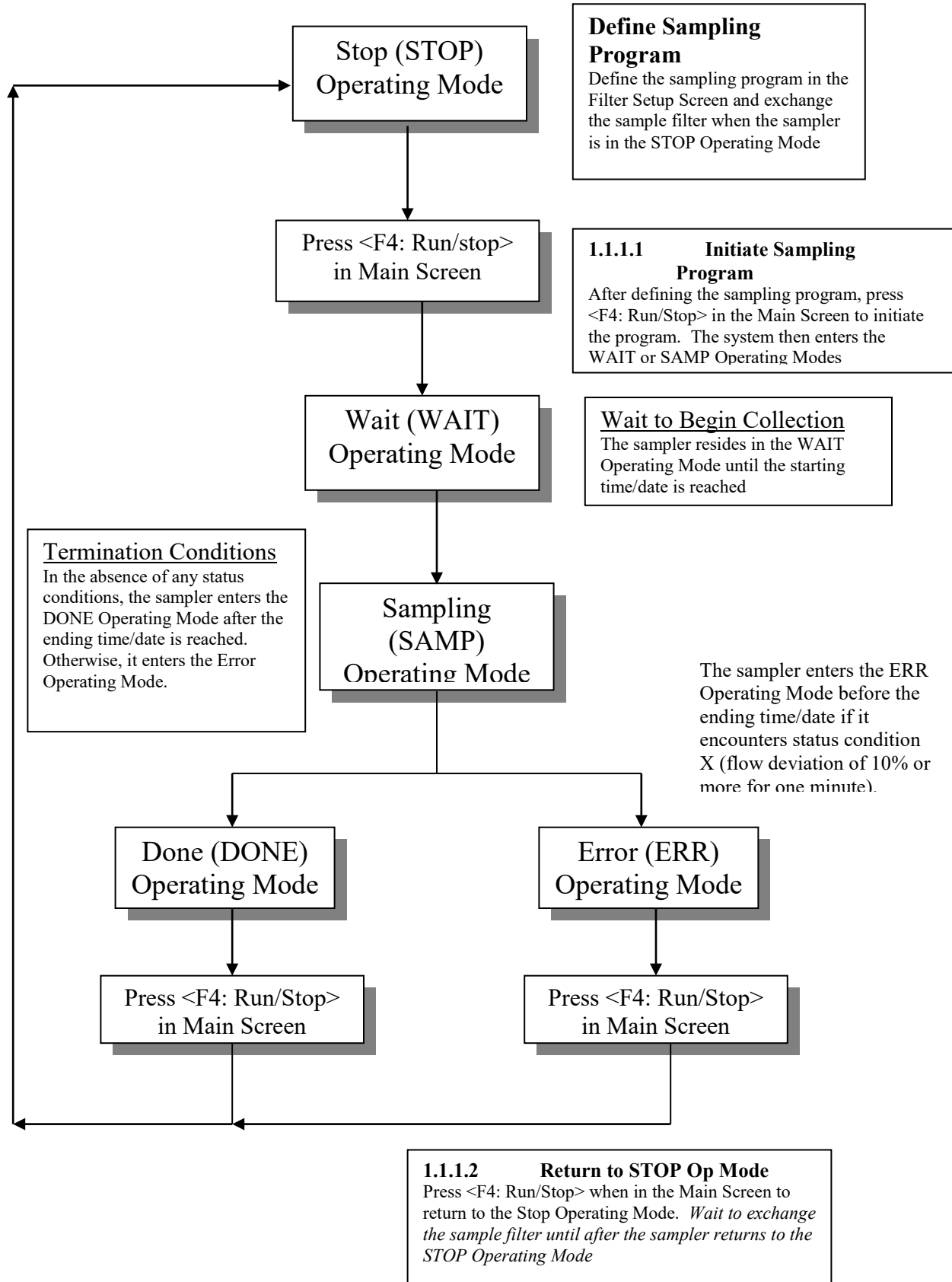


Figure EOD-7 Maneuvering through operating modes



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PART II

Standard Operating Procedures for Monitoring PM in Ambient Air Using the Rupprecht & Patashnick Partisol Plus 2025 FRM Sampler

Revised Date: September, 2003
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Part II - Field SOP for the R&P 2025

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1.0 SCOPE AND APPLICATION

1.1 Introduction

In July 1997, the U.S. EPA promulgated a new National Ambient Air Quality Standard (NAAQS) for particulate matter with a diameter smaller than 2.5 microns, or PM_{2.5}. The new annual standard for PM_{2.5} as of December 2012 is 12 µg/m³, while the current 24-hour standard is 35 µg/m³. Fine particles (smaller than 2.5 microns) penetrate more deeply into the lungs than coarse particles (10 - 2.5 microns). Recent health studies indicate a link between fine particle concentrations in the outdoor air and certain health effects (40 CFR Part 58). Fine particles are generally emitted from combustion activities (such as industrial and residential fuel burning and motor vehicles) while coarse particles mainly come from dust emitted during activities such as construction and agricultural tilling.

Some of the health effects that have been linked to fine particulate matter pollution include: Premature death and increased hospital admissions and emergency room visits, primarily by the elderly and individuals with cardiopulmonary disease; Increased respiratory symptoms and disease in children and individuals with cardiopulmonary disease; Decreased lung function and alterations in lung tissue and structure, particularly in children and people with asthma.

This document is intended to instruct Colorado local operators that use the Rupprecht & Patashnick 2025 Federal Reference Method (FRM) sampler to monitor ambient air for particulate matter. The formal specifications for the RP2025 sampler and for obtaining valid reference method measurements are set forth in the U.S. Environmental Protection Agency's (EPA) monitoring regulations in 40 CFR Part 50, Appendix L (EPA 2006). This document reviews those formal requirements, manufacturer guidelines, good QA/QC protocol, and provides clarifications and supplemental information in greater detail than can be provided in the formal regulatory requirements. Because this supplemental information is intended for method users, it emphasizes the operational aspects of the method, rather than the design and performance specifications for the sampler. The document also provides recommended quality assurance (QA) procedures and guidance to help monitoring agencies reliably achieve the data quality objectives (DQOs) established for PM_{2.5} monitoring. The goal for acceptable measurement uncertainty has been defined as 10 percent coefficient of variation (CV) for total precision and ±10 percent for total bias (Papp et al. 1998). The information provided here together with the instructions provided by Rupprecht & Patashnick and contained in the sampler's operation or instruction manual (R&P, 1999), have been used by the Air Pollution Control Division (APCD) to develop its own agency-specific standard operating procedure (SOP) for the RP2025 sampler.

1.2 Method Overview

An electrically powered air sampler draws ambient air at a constant volumetric flow rate into a specially shaped inlet (PM₁₀ head) and (in the case of sampling for PM_{2.5}) through an inertial particle size separator, very sharp cut cyclone (VSCC) where the suspended particulate matter in the PM_{2.5} size range is separated for collection on a Teflon (PTFE) filter over the specified sampling period. Each filter is weighed before and after sample collection to determine the net gain due to collected PM (see the Lab SOP Appendix LSD2 of this QAPP for a complete description of lab activities). The sampler records sample duration, interval temperature and pressure values, and average temperature and pressure. The total sample volume is determined from the measured flow rate at actual ambient temperature and pressure and the sample duration. The mass concentration of PM_{2.5} in the ambient air is computed as the total mass of collected particles in the PM_{2.5} size range divided by the actual volume of air sampled, and is expressed in micrograms per cubic meter of air (µg/m³). A complete description of the method can be found in 40CFR Part 58, Appendix L, § 7.0.

2.0 SUMMARY OF METHOD

2.1 The Inlet

The RP2025 PM₅ sampler uses an impaction inlet (See [Figure 2-1](#)). The symmetrical design of the inlet ensures wind-direction insensitivity. Ambient air that is drawn into the inlet is accelerated through jets into an impaction chamber. The jets have critical diameters to provide necessary changes in velocity to affect particle size fractionation.

2.3 VSCC

The flow path through the VSCC PM_{2.5} fractionator is shown in a cutaway view in [Figure 2-2](#). PM₁₀ aerosol enters tangentially after being pre-separated by the PM₁₀ FRM inlet. Particles greater than 2.5 µm in diameter are collected in the grit pot on the side of the VSCC PM_{2.5} fractionator, and the PM_{2.5} sample is then channeled through the cyclone separator to the sample collection filter.

2.4 PM₁₀ Monitoring

The RP2025 instrument can be adapted to monitor PM₁₀ as an FRM. The instrument should be configured with a 'VSCC' bypass offered as a supplemental part by R&P. The bypass is simply a straight tube that sits in the same spot within the sampler otherwise occupied by the VSCC. All the setup parameters, instrument configurations, maintenance requirements, calibration steps, and QA/QC are exactly the same as those for PM_{2.5} sampling.

2.5 Measurement

The total volume of air sampled is determined from the measured mass flow rate, sampling time, ambient pressure, and ambient temperature. The concentration of PM in the ambient air is calculated as the total collected mass divided by the volume of air sampled. The PM measurement is expressed as micrograms per actual cubic meter (µg/m³). The performance parameters of PM samplers, including the RP2025 are tested in accordance with test procedures prescribed in 40 CFR Part 53.

Figure 2-1 PM_{2.5} Sampler First Stage PM₁₀ Head

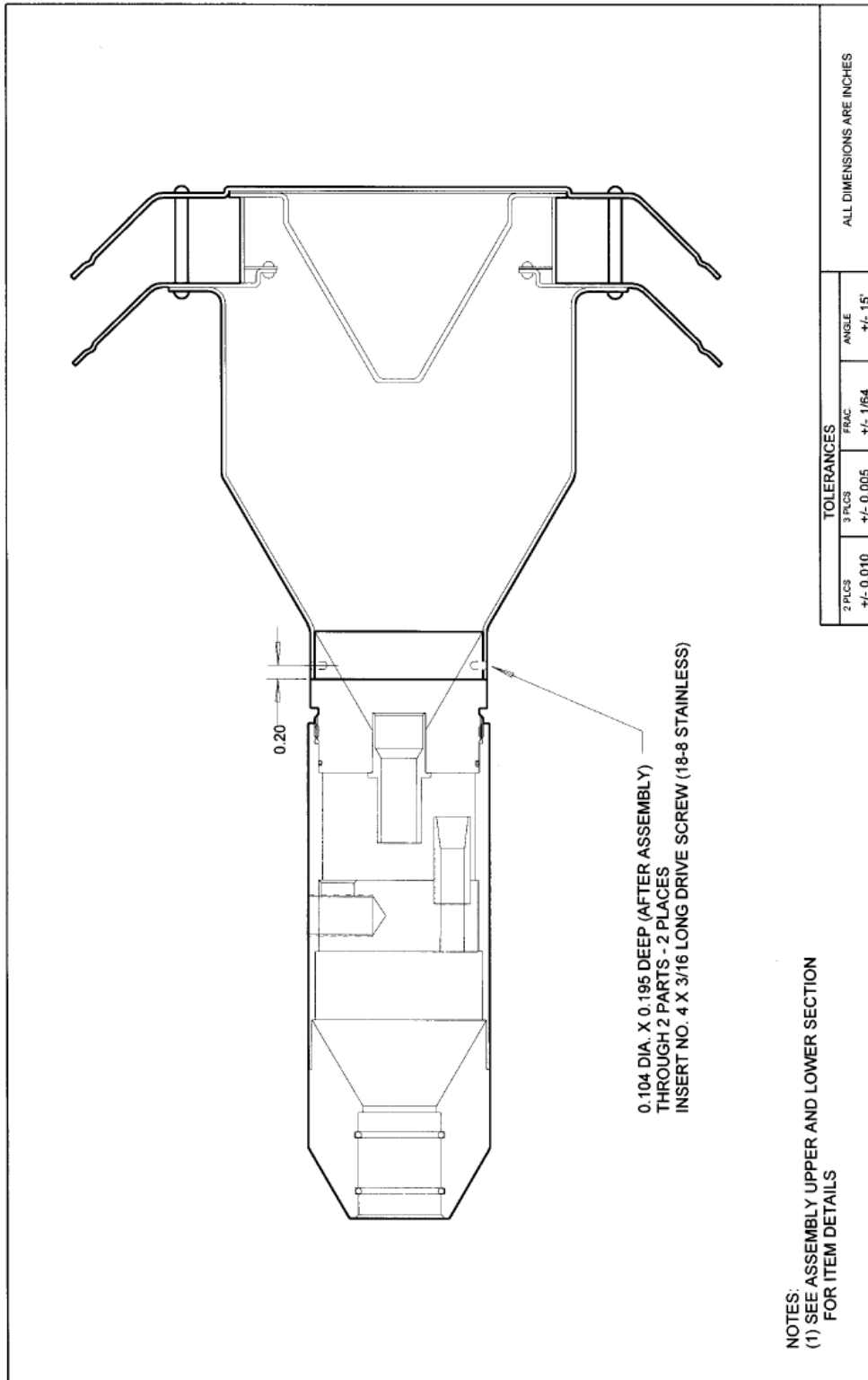


Figure 2-2 Very Sharp Cut Cyclone (for PM_{2.5} Sampling Only)

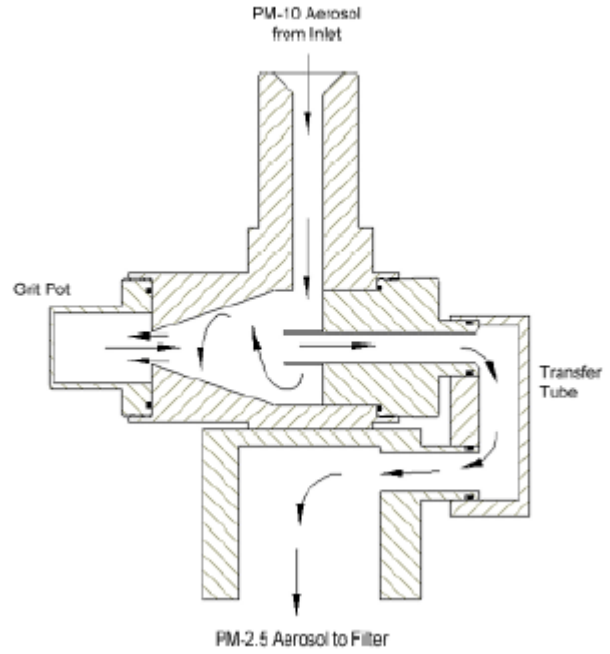
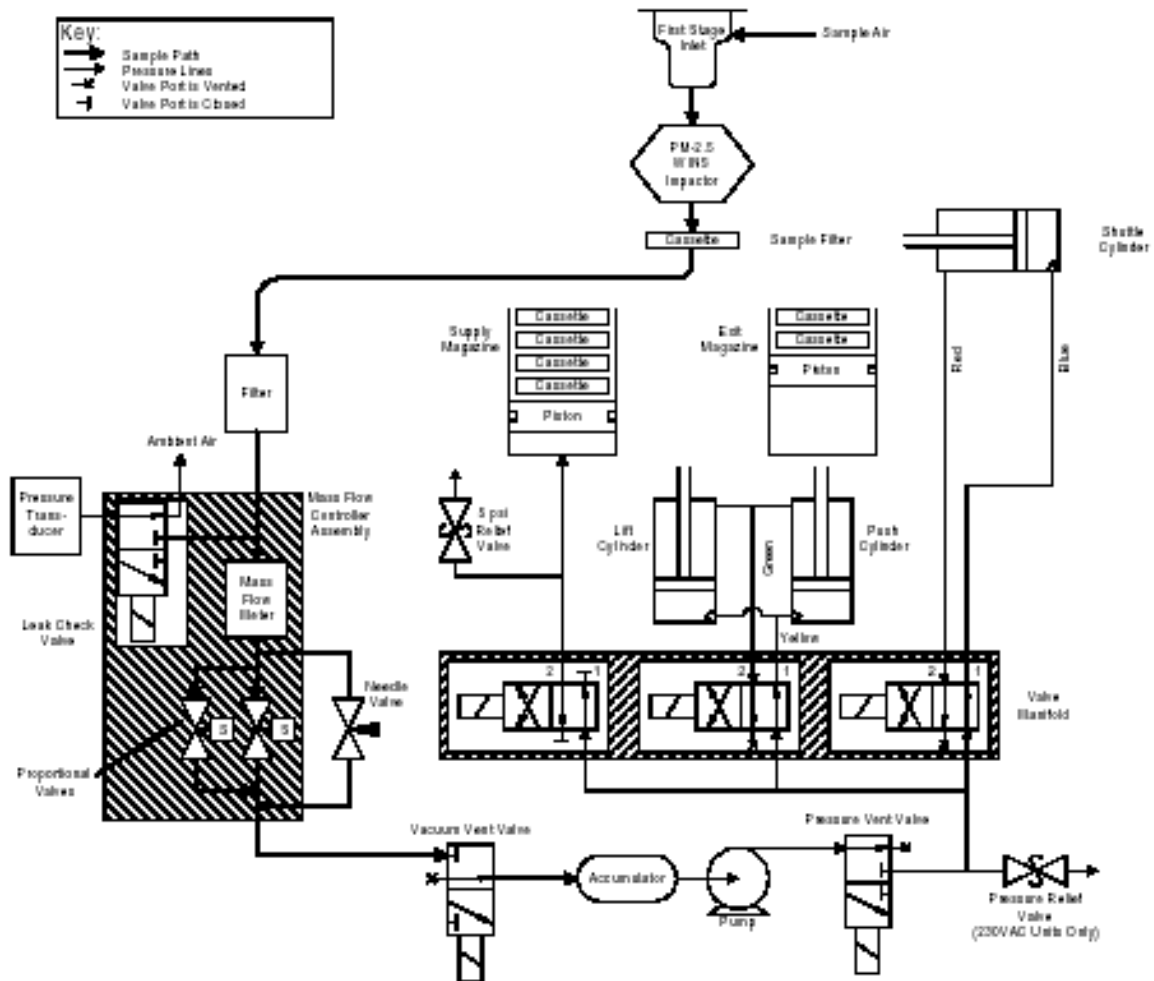


Figure 2-3 FRM Flow Schematic
 (Source: Operating Manual, Partisol® FRM Model 2025 PM_{2.5} Air Sampler)



3.0 DEFINITIONS AND ACRONYMS

AQS	EPA Air Quality System
ANSI	American National Standards Institute
APCD	Air Pollution Control Division
ASQC	American Society for Quality Control
ASTM	American Society for Testing and Materials
CFR	<i>Code of Federal Regulations</i>
CV	coefficient of variation
DOP	diethylphthalate
DQO	data quality objective
EPA	Environmental Protection Agency
FEM	Federal Equivalent Method
FR	flow rate
FRM	Federal Reference Method
FTS	Flow Transfer Standard
HEPA	high-efficiency particulate air
NAAQS	National Ambient Air Quality Standards
NIST	National Institute of Standards and Technology
NVLAP	National Voluntary Laboratory Accreditation Program
OAQPS	Office of Air Quality Planning and Standards
P _a	pressure, ambient
PAMS	Photochemical Assessment Monitoring Stations
PM	particulate matter
PM ₁₀	particulate matter < 10 microns (µm) in aerodynamic diameter
PM _{2.5}	particulate matter < 2.5 microns (µm) in aerodynamic diameter
PMP	polymethylpentene
Po ₂₁₀	polonium-210
PSD	prevention of significant deterioration
PTFE	polytetrafluoroethylene
QA/QC	quality assurance/quality control
QA	quality assurance
QAD	Quality Assurance Division
QAPP	quality assurance project plan
QC	quality control
RH	relative humidity
R&P or RP	Rupprecht & Patashnick
SLAMS	State and local air monitoring stations
SOP	standard operating procedure
SRM	Standard reference material
SVOC	semi-volatile organic compound
T _a	temperature, ambient a
TSP	total suspended particulate
VSCC	BGI, Inc., Very Sharp Cut Cyclone

4.0 HEALTH AND SAFETY WARNINGS

Repair of the RP2025 should only be attempted by properly trained APCD personnel, and should only be conducted in accordance with Rupprecht & Patashnick system documentation. High voltages may be present in all instrument enclosures. Use established safety precautions when working with this instrument. Instrument is supplied with a grounded three-prong plug designed for outdoor use. When operating the instrument outdoors, be sure that it is plugged into a properly rated exterior (outdoor) outlet. The Partisol-Plus stand must be anchored when installed outdoors to prevent tipping of the sampler and/or stand in high winds. Some assembly of the inlet or the VSCC is required for installation and regular maintenance. Be careful to avoid pinching your fingers between the assembly parts when assembling these components. Never place your hands or fingers in the filter exchange mechanism. Refer to the RP2025 Service Manual for instructions on clearing a filter jam. Use of this product in any manner not intended by the manufacturer will void the safety protection provided by the equipment, and may damage the equipment and subject the user to injury.

In addition:

- Use caution on ladders and rooftops, especially in inclement weather or snow pack condition.
- Wear sturdy work shoes with a good traction sole.
- Only one person at a time on ladders. Where possible secure ladder to rooftop.
- Always unplug the sampler when servicing or replacing parts. This excludes normal sampling operations.
- Use extreme caution if any electrical outlets or connections are in contact with standing water.
- Secure or remove front door while working on the sampler.
- Sunscreen and eye protection is recommended.
- Maintain an awareness and familiarity with immediate surroundings including activities of pedestrians below sampling location and near ladder.

4.1 Cautions

Keep the instrument exterior (including ambient temperature weather shield) and interior clean of dust to maintain optimal operation and avoid contamination.

4.2 Interferences

- Handling the filter cassettes excessively or handling with dirty hands can cause inaccurate mass measurements.
- Excessive precipitation, especially combined with high winds, can cause problems with sample recovery.

4.3 Personnel Qualifications

At program startup critical field and QA staff, from APCD, were sent to Cary, NC and were certified in the 1998 Air and Waste Management Association PM_{2.5} Monitoring Workshop. These individuals have also taken part in the 1998 WESTAR PM_{2.5} Hands-On Training as attendees and trainers. EPA sponsored both of these workshops and these individuals have since left APCD. However, with the knowledge from the training sessions, APCD personnel have been able to provide information to local operators and new APCD employees regarding the operation and maintenance of the RP2025 sampler. It is through the training and field experience that a “train the trainer” system has been established.

The APCD provides training to field personnel and local operators. The PM Program Coordinator, or other qualified APCD personnel, evaluate each operator’s proficiency after each site operator has been given sufficient time to review the SOPs and practice on the PM sampler. If failure should occur during the evaluation, the APCD will provide onsite training until the local operator becomes proficient. A

description of the training procedures is provided in Part III of this QAPP.

5.0 APPARATUS AND MATERIALS

5.1 Sampler Calibration

5.1.1 Introduction

Note: Only qualified APCD personnel should perform RP2025 calibrations. These activities should never be undertaken by local operators unless specifically directed and then only after they've received the proper training. While this SOP serves to describe calibration activities it is not a substitute for the proper training and experience.

This section contains the procedures needed to perform calibrations of the RP2025. This section was taken from the most recent RP2025 Service Manual and it has been modified wherever necessary to accommodate APCD specific practices. Calibrations should be performed according to the schedule in Figure 5-1.

Figure 5-1 Table of Calibration Order and Frequency*	
Calibration Procedures	Interval
Clock/Timer	1 year
Analog I/O Calibration	Automatic
Ambient Air Temperature calibration	1 year
Filter Compartment Temperature calibration	1 year
Filter Temperature(s) calibration	1 year
Ambient Pressure calibration	1 year
Flow controller calibration	1 year

**Reference document: U.S. EPA 2.12 Quality Assurance Handbook*

5.1.2 Calibration Procedure

Upon arrival at the site, APCD personnel should note the condition of the instrument, ambient conditions, instrument operating status and operating mode. Record these observations in the appropriate locations on the RP2025 Instrument Calibration Form. Protect all filters in the following manner:

- 1) Recover all sampled filters as described in the Sampler Operation and Maintenance section of this SOP.
- 2) Protect the supply filters by removing the supply magazine, capping it, and setting it aside.
- 3) Next, install a clean magazine containing an empty cassette (no backing screen and no filter), an external leak check cassette on top and a flow check cassette containing a new 46.2 mm PTFE filter on the bottom.
- 4) Install a clean empty magazine in the storage position.
- 5) Press the <RUN/STOP> button and choose 'STOP.'
- 6) Press any key, press the <MENU> key and select 'Service Mode' to enter the service menu.
- 7) Move the cursor to "System Maintenance Routines," press <F1: LeakChk> to enter the Leak Check Screen (Figure 3-15 in the R&P 2025 Service Manual, Revision B.001).
- 8) Press <F4: FiltAdv> and wait for the filter change to complete.
- 9) Remove and cap the storage magazine containing the filter that was either sampling or waiting in the sample position.

All the filters are now protected from any possible contamination. Proceed to the analog I/O calibration step.

5.1.2.1 Analog I/O Calibration

The RP2025 sampler performs automatic calibrations of its analog input and output channels on the following basis:

- If the sampler enters the Stop Operating Mode upon power-up by the user (not a recovery from a power failure), the unit automatically performs a calibration of its analog input *and* output channels.
- Every 30 minutes the RP2025 conducts an automatic calibration of its analog input channels.
- The user can manually initiate an analog input and output channel calibration.

The unit's automatic calibrations of analog input and output channel(s) is made possible by reference voltages of 0.025 and 2.5 VDC that are precisely maintained within the sampler.

Follow the steps below to execute an automatic calibration of the sampler's analog input and output channels:

- 1) In Service mode (SVC), from the Main Screen press <Menu> to enter the Service Menu. With the cursor pointing to 'Calibration/Audit', press <F2: I/O Cal> to enter the I/O Calibration Screen.
- 2) Press <F1: Start> to initiate the sampler's automatic calibration of its analog input and output channels. The "Calibrating..." indicator appears in the upper left-hand corner of the screen while the device executes the procedure.
- 3) The calibration procedure takes approximately 5 minutes, and continues until the "Calibrating..." indication no longer appears on the I/O Calibration Screen. Do not attempt to navigate to a different screen while the calibration is taking place.

5.1.2.2 Ambient Air Temperature Calibration

See Appendix A in the RP2025 Service Manual for the results of linearity testing performed on the ambient temperature sensor.

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

- 1) In Service Mode (SVC), from the Main Screen, press <MENU> to enter the Service Menu. With the cursor pointing to 'Calibration/Audit' press <F3: SensCal> to enter the Sensor Calibration Screen.
- 2) The calibration is done at ambient conditions; the reference temperature measurement is taken with the probe installed in the radiation sensor so the probes are within about 2 – 5 cm.
- 3) Press <Edit> then enter the measured reference temperature in °C in the Actual column of the Amb Temp row of the Sensor Calibration Screen, press <Enter>. Remove the calibration thermometer probe from the radiation cover.
- 4) The sampler automatically adjusts the corresponding offset based upon this input. Record the ambient temperatures (current and actual) and the offset on the calibration log sheet.

5.1.2.3 Filter Temperature Calibration

See Appendix A in the R&P Service Manual for the results of linearity testing performed on the filter temperature sensor.

- 1) In Service Mode (SVC), from the Main Screen, press <MENU> to enter the Service Menu. With the cursor pointing to 'Calibration/Audit' press <F4: FiltCal> to enter the Filter Temperature

Calibration Screen.

- 2) Advance an empty cassette (without backing screen or filter) into the sample chamber. Open the top compartment of the sampler and remove the VSCC assembly. Insert the probe of the calibration thermometer into the sample chamber via the inlet.
- 3) Allow the calibration thermometer to stabilize. Press <F2: Edit>, enter the measured reference temperature in °C in the Actual column of the Filter row of the filter Temperature Calibration Screen, press <Enter>. The sampler automatically adjusts the corresponding offset based upon this input.
- 4) Remove the calibration thermometer probe from the sample chamber. Advance a regular cassette and filter into the sample chamber.
- 5) Record the current and actual Filter temperatures and the offset on the calibration log sheet.

5.1.2.4 Filter Compartment Temperature Calibration

See Appendix A in R&P Service Manual for the results of linearity testing performed on the filter compartment temperature sensor.

In Service Mode (SVC), from the Main Screen, press <MENU> to enter the Service Menu. Press <MENU> to enter the Service Menu. With the cursor pointing to “Calibration/Audit,” press <F4: FiltCal> to enter the Filter Temperature Calibration Screen.

- 1) Insert the temperature probe of the calibrating thermometer into the dust cover of the Filter Compartment Temperature Sensor located on the lower left-hand side of the in the ventilated filter compartment of the RP2025.
- 2) Allow the calibration thermometer to stabilize. Press <F2: Edit>, enter the measured reference temperature in °C in the Actual column of the Filter row of the filter Temperature Calibration Screen, press <Enter>. The sampler automatically adjusts the corresponding offset based upon this input.
- 3) Remove the calibration thermometer probe from the sample chamber. Advance a regular cassette and filter into the sample chamber.
- 4) Record the current and actual Filter temperatures and the offset on the calibration log sheet.

5.1.2.5 Ambient Pressure Calibration

Perform an ambient pressure calibration in the following manner:

- 1) In Service Mode (SVC), from the Main Screen, press <MENU> to enter the Service Menu. With the cursor pointing to “Calibration/Audit,” press <F3: SensCal> to enter the Sensor Calibration Screen.
- 2) Determine the current ambient station pressure in mm Hg (absolute pressure, not corrected to sea level).
 - To convert from Atmospheres to mm Hg, multiply by 760 mm Hg/ATM.
 - To convert from millibars to mm Hg, multiply by 0.75012 mm Hg/mbar.
 - To convert from inches Hg to mm Hg, multiply by 25.4 mm/in.
- 3) Press <Edit> and enter the measured ambient pressure in the Actual column of the Amb Pres row of the Sensor Calibration Screen and press <Enter>. The sampler automatically adjusts the corresponding offset based upon this input.
- 4) Record the current and actual ambient pressures and the offset on the calibration log sheet.

5.1.2.6 Ambient Relative Humidity Calibration

Note: Currently APCD does not calibrate the RH sensor on any PM instruments in the Colorado network.

Perform an ambient relative humidity calibration in the following manner:

- 1) In Service Mode (SVC), from the Main Screen, press <MENU> to enter the Service Menu. With the cursor pointing to “Calibration/Audit,” press <F3: SensCal> to enter the Sensor Calibration Screen.
- 2) Determine the current ambient relative humidity (%).
- 3) Press <Edit> and enter the measured ambient relative humidity in the Actual column of the Amb RH row of the Sensor Calibration Screen. The sampler automatically adjusts the corresponding offset based upon this input.

5.2.1.7 External Leak Check

Perform an external leak check in the manner described below. To ensure a tight seal in the flow system of the sampler, a filter cassette containing a backing screen and clean 46.5 mm PTFE filter must be installed in the sampling position of the sampler.

- 1) Remove the PM₁₀ sample inlet from the external sample down tube.
- 2) Install the flow audit adapter on the end of the down tube.
- 3) Close the valve on the flow audit adapter.
- 4) In Service Mode (SVC), from the Main Screen, press <MENU> to enter the Service Menu. Press <F1: Leakcheck>. Press <F2: Start>. After prompt, press <F1: Externl> to perform an external leak test.
- 5) Follow instructions displayed on the screen.
- 6) Sampler will automatically pull a vacuum and check flow.
- 7) A pass or a fail message will display at the end of the leak check cycle. A pressure drop of 25mm Hg or less is the sampler’s external leak check pass criteria. Record the pressure drop in the calibrations log book.
- 8) If a leak check fail message is displayed on the screen, insert a filter cassette containing a new 47mm filter in the topmost position of the filter cassette supply tube, install the new filter cassette into the sample chamber and repeat the leak check procedure. If repeated failures occur follow the Leak Check Failure Procedure in the Troubleshooting section of this SOP.
- 9) After a successful leak check, slowly open the valve on the flow audit adapter to release the vacuum pressure.
- 10) Remove the flow audit adapter from the external sample tube and install the flow transfer standard over the down tube.

5.1.2.8 Flow Calibration

Perform the temperature and pressure calibrations and external leak test procedures described above.

- 1) In Service Mode (SVC), from the Main Screen, press <MENU> to enter the Service Menu. With the cursor pointing to “Calibration/Audit,” press <F5: FlowCal> to enter the Flow Calibration Screen.
- 2) Using a calibrated FTS to calibrate the flow of the RP2025, enter or confirm that the correct FTS calibration constants slope and intercept are entered in the Flow Calibration Screen. Confirm that a calibration of the FTS has been performed within one year.
- 3) Press <Edit> and enter the desired minimum (15.0) and maximum (18.4) calibration flow rates (Min Flow and Max Flow), as well as the number of calibration points (5) desired (Num Points) in the Flow Calibration Screen and press <Enter>.
- 4) Install a manometer (the APCD currently uses the Dwyer Series 477 digital manometer) to the FTS via ¼”I/O Tygon tubing. .

Note: During the calibration procedure, the sampler begins with the minimum flow rate (Min Flow), and performs measurements at equal flow rate intervals until it reaches the maximum flow rate (Max Flow).

- 5) Press <F5: More> followed by <F4: Start> to initiate the flow calibration.
- 6) Wait for the flow to stabilize at each flow point. Enter the pressure drop (in inches H₂O) recorded by the manometer in the appropriate space in the instrument. Record the value on the calibration log sheet.
- 7) The sampler automatically adjusts the Offset and Span values in the Flow Calibration Screen once it performs measurements at all flow rate levels. Record these values on the calibration log form.
- 8) Restore the sampling hardware to its original state by removing the flow metering hardware and reinstalling the PM₁₀ inlet on the down tube. Restore the sampler to the ‘STOP; or ‘WAIT’ mode as described in the Sampler Operation and Maintenance section of this SOP.

6.0 SAMPLER OPERATION AND MAINTENANCE

The current PM program field operation and maintenance procedures for the RP2025 can be divided into three general areas:

- 1) Filter/sample collection and handling procedures;
- 2) Routine maintenance/cleaning, and
- 3) Verification/QA procedures

Filter/sample handling can be further broken down into sending and receiving filters from the lab, transporting filters to and from the sampling site, loading unexposed filters into the instrument, setting the instrument up for a sample run, recovering exposed filters, and data transfer.

Routine maintenance/cleaning and verification procedures can be divided into **Every 4-Week Verification** procedures, **Every 15-Sample Event** procedures, and routine cleaning procedures. Additionally, there are paperwork requirements that accompany each procedure that allow site operators to document the procedures to help insure sample and data quality. These procedures are either listed in EPA’s Method 2.12, **Quality Assurance Guidance Document for PM_{2.5} Monitoring**, or are recommended by the instrument manufacturer. All pertinent field procedures are described below in detail.

6.1 Quality Control Forms

Note: For a complete list of consumable supplies needed for the operation and maintenance of this instrument refer to the manufacturer’s operator manual. Forms

One of the most important aspects of the PM Program from a field perspective is the paperwork required to document the procedures mentioned above. Site operators routinely use two forms:

- Filter Data Sheet/Chain of Custody (FDS), and
- PM Regular Maintenance/Sampler Verification Form (Field Form).

APCD/PM personnel create all the forms for every site prior to the beginning of the time period to which they apply and send them to each operator along with the normal filter shipment. Should an operator be missing or lose any of the required forms they can get replacements by contacting the appropriate APCD/PM personnel.

There are five field criteria that APCD considers critical to determining the validity of any sample. The critical criteria are as follows:

- 1) Once a **filter** has been removed from the RP2025 it must be **transported and stored at or below 4°C**,
- 2) The **sample duration** is between 1380 and 1500 minutes (23 to 25 hours),
- 3) The **average sample flow rate** is within 5% of 16.67 L/min,
- 4) The **flow coefficient** of variation (%CV) is less than 2%, and
- 5) The **one point flow verification** performed every four weeks is within 4.1% of the transfer standard.

The failure to satisfy even one of these five critical criteria will place a sample's validity in doubt.

Additionally, there are six field criteria that APCD considers having an effect on the quality of the sample. Not meeting these 'operational criteria' will not necessarily invalidate a sample, only give cause for APCD to examine the sample, the operational status of the instrument from which the sample was taken, and the competency of the site operator. The operational criteria are:

- 1) No flow rate excursions from the set point of 16.7 Lpm greater than or equal to 5% for more than five minutes,
- 2) No temperature excursions between measured ambient temperature and measured filter temperature (40CFR Part 58 App. K) for instrument design specifications greater than 5 °C lasting longer than 30 minutes. The filter temperature must be kept as close to ambient as possible.
- 3) External leak check be less than 80 ml/min¹ and are checked prior to every flow verification and after VSCC Cleaning,
- 4) Clock or timer, one point ambient temperature, pressure, and flow rate verifications at least once every four weeks,
- 5) The FEM VSCC is cleaned every fifteen-sample events, and
- 6) The PM₁₀ inlet and sample down-tube is cleaned at least once every fifteen-sample events.

To satisfy these 11 criteria (five critical and six operational criteria) each site operator must handle the filters properly (including transport and shipping), perform the required maintenance on schedule, AND **document these events on the required paperwork. It is critically important that site operators fill out the required paperwork; without the supporting documentation a site operator can do all the required maintenance correctly and on time and leave a particular sample's validity in doubt. The forms provided by APCD give site operators a medium via which they can document the timely completion of the required maintenance/cleaning.**

6.1.1 Filter Data Sheet/Chain of Custody

The FDS, ([Figure 6-1](#)) is the keystone of the program. These forms are generated by APCD and sent out to site operators with the filter shipments. If a site operator receives a shipment of filters without a FDS, they are to contact the appropriate APCD/PM personnel immediately. Since this form serves as a chain of custody document it must accompany the filters to and from the field and return with the filters to the gravimetric laboratory. Most of the 'critical criteria' are documented on this form.

6.1.1.1 Field Standard Operating Procedures, Filter Data Sheet Explanation

The Filter Data Sheet (FDS) is the cornerstone in the sample validation process of Colorado's low volume PM program. APCD requires that site operators understand the FDS and fill it out completely. The records generated by site operators (specifically the FDS and other required forms) serve as the only proof of sample validity; additionally, the FDS serves as a chain of custody document. Without a complete, properly filled out FDS APCD/PM personnel cannot link an electronic record with the physical sample. Without this link it cannot be shown that a sample is valid. In fact, just the opposite is true. Without the proof offered by a complete FDS it is assumed that a sample is invalid. To summarize: when a site operator fails to fill out the FDS completely, even if they've performed all the required work, they are putting sample validity in jeopardy.

Below, there is an example of a complete FDS with all necessary data, the Boulder PM_{2.5} site is used in this example. The data is imaginary and reflective of no actual data. It is there only to demonstrate completeness and format. The image itself is a bitmap and can be copied, enlarged, and printed out.

¹ An 80ml/min leak rate in the RP2025A equates to an external 'leak rate' of 25 mmHg/min and an internal 'rate' of 140 mmHg/min.

There are five different areas of the FDS that site operators need to fill out. The image below identifies these five parts. Site operators should read through the associated notes for an explanation of each portion of the FDS. If further explanation is necessary the site operator should contact the appropriate APCD/PM personnel.

Figure 6-1 Filter Data Sheet

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PM2.5 Federal Reference Method Filter Data Sheet/Chain of Custody

SAMPLER DATA

Site Name: Boulder
 AIRS Code: 08-013-0012.1
 Sampler Model: RP.20254
 Sampler S/N: 200700001
 Reviewed by: _____ Date: _____

SITE VISITS:

#1	#2	#3	#4	#5	#6
Date: 000810	000814	000818	000821	000828	
Time: 0900	1020	825	1115	1425	
Operator: Jr	Jr	Jr	Jr	Jr	

The filters accompanying this shipment are to be returned to LARS on: Wednesday 30 August

FILTER DATA

Filter ID/Cassette Screen ID Label	Sample	Sample Start/End Date	Sample Load/Retrieval Site Visit #	Walk & Total Sample Time (hh:mm)	Average Amb. Pres. (mm Hg)	Average Amb. Temp. (°C)	Average Sample Flow Rate (l/min)	Max. Temp. Diff. (°C) (20 min)	Coefficient of Variation (CV%)	Sample Volume (m³)	Operator Comments
See Note 2	Start	000813	1	23:50				3.5			
	End	000814	2	23:50	23.6	6.96	16.7	13.56	0.0	24.0	
	Start	000816	1	23:50				4.1			
	End	000817	3	23:50	24.7	6.12	16.7	14.02	0.0	24.0	
	Start	000817	1	0:00							blank
	End	000817	3	0:00	0	0	0	0	0	0	
	Start	000819	1	23:38				2.1			D, Ault Performed
	End	000820	4	23:38	25.2	6.44	16.7	13.22	0.0	23.5	
	Start	000822	1	23:42				6.5			T1 Sample Temperature Out
	End	000823	4	23:50	25.7	6.18	16.7	14.11	0.5	24.0	of Range
See Note 4	Start	000825	1	23:50				3.7			
	End	000826	5	23:50	26.3	6.10	16.7	12.21	0.2	24.0	
	Start										
	End										
	Start										
	End										

FILTERS SHIPPED TO FIELD **FIELD LAB DATA** **Site Visit** **SAMPLES RETURNED TO LARS**

Date: _____ Transport container: #1 #2 #3 #4 #5 #6 Date Received at LARS: _____ By: _____
 By: _____ Temp. at Field Lab (°C): n/a -1.1 -4.2 -3.1 2.1 Maximum Temperature of Shipping _____
 Refrigerator Temperature at Field Lab (°C): -1.5 -1.7 -1.0 -2.2 Container When Received: _____ °C
 Refrigerator Temperature when shipped: -5.5 Date: 8/30/00 Samples Shipped By: Jr unloaded by: _____
 Notes: _____

NOTES:

Each FDS is produced by APCD personnel to accompany a specific batch of filters to a specific site. Each FDS is sent out to the appropriate site with pre-printed information pertinent to that site. This data is site information, including the site name, site code, AQS ID, and sampler serial number. If there is information on this form that is incorrect (i.e. sampler serial number) contact the appropriate APCD/ PM personnel.

Note 1: Site visit information.

Every time an operator visits his or her site it is necessary for them to fill in this information. APCD personnel need to know the date and time of the site visit and which site operator(s) was there. Operators need to fill this section out every site visit, completely, no exceptions.

Note 2: Sample Load/Retrieval Site Visit #.

When an operator goes to the site to load a new batch of filters into the instrument they should note which Site Visit the filters were loaded. This Site Visit # goes in the column labeled Sample Loaded/Retrieved Site Visit # and adjacent to the row corresponding with the sample start date. When an operator goes to the site to retrieve filters they should note which filters were retrieved on that particular site visit. This Site Visit # goes in the column labeled Sample Loaded/Retrieved Site Visit # and adjacent to the row corresponding with the sample end date. When an operator fills this out they document when they pulled a filter off the instrument. APCD determines if a particular filter was retrieved under the 96-hour criteria.

Note 3: Operator Comments:

The operator may make any comments associated with a particular sample or filter including weather events, high pollution events, condition of the filter upon receipt, etc. The operator should also use this space to document any status conditions associated with that sample.

Note 4: Filter data information.

This data the operator retrieves from the instrument with a couple of important exceptions...The filter and cassette IDs are given on the preprinted labels on each filter you receive from the lab. The next two columns of data refer to 1) Sample start/end date(s) (the column heading is 'Date (yymmdd)') and 2) On what site visit was a filter loaded into the machine and when was that filter retrieved after sampling (column heading 'Site Visit #).

Start date and end date should be self-explanatory. Site operators receive each FDS with the 'Start Date' already filled in. All samples should be 24 hours long, which means that the 'End Date' will be the day following the 'Start Date'. There may be exceptions to this but the general rule is to sample for 24 hours. Please note that if a filter did not sample on the prescribed start/end date then it is necessary to make this notation on the FDS and write in the correct information.

The next eight columns after the Sample Loaded/Retrieved column (previously discussed in Note 2) are all concerned with actual sample data. These values serve a two-fold purpose. Firstly, they allow site operators to verify that the sample has met some of the critical criteria for a sample to be considered valid, and secondly these data serve as a hardcopy backup to the electronic record. Should a sample not meet one or more of the criteria concerning sample time, average flow, coefficient of variation, and sample volume the appropriate APCD/PM personnel should be contacted to arrange for a make-up sample.

Note 5: Field Lab Data.

The data a site operator should write in this section refers to temperatures of their transport container and field lab refrigerator. When you visit your site and recover a filter record the temperature on your transport cooler (after it has stabilized at a temperature below 4⁰C) and the temperature of your refrigerator when you place the exposed filter in the fridge for storage until shipment. An exposed filter must stay at or beneath 4⁰C from the time it is retrieved from the site to the time it arrives at the lab. An additional space is given for site operators to record the temperature of the shipping container after it has been packed for return to the lab.

6.1.2 PM Field Form

The PM Field Form is the form site operators use to document all scheduled maintenance, e.g. the 'operational criteria' mentioned above. These forms are numbered from 1 to 26, each correspond to a specific two-week period of the calendar year. Each form is labeled with the date interval, what maintenance is to be performed in the interval, and on what date the maintenance is to be performed. These forms are used to document all 15-Sample Events (VSCC cleaning, leak checks), and all 4-Week Verifications (one point temperature, pressure, and flow verifications). All Field Forms are produced by APCD personnel and sent to the laboratory. The laboratory mails these forms out with the tared filters. Field Forms are returned to the laboratory with the samples filters at the end of the two-week period to which it corresponds. The APCD picks these forms up from the laboratory every two weeks to perform the

data validation procedures. This form also serves to keep maintenance schedules consistent among sites across the network.

6.2 Every 5-Sample Event Procedures

6.2.1 When in ERR, STOP, or DONE mode

Note: Refer to the Troubleshooting section, 'Resetting the Sampler when in ERR, STOP, or DONE mode. Reset the sampler according to the instructions and then proceed with the 5-Sample Event procedures.

6.2.2 When in WAIT or SAMP Mode

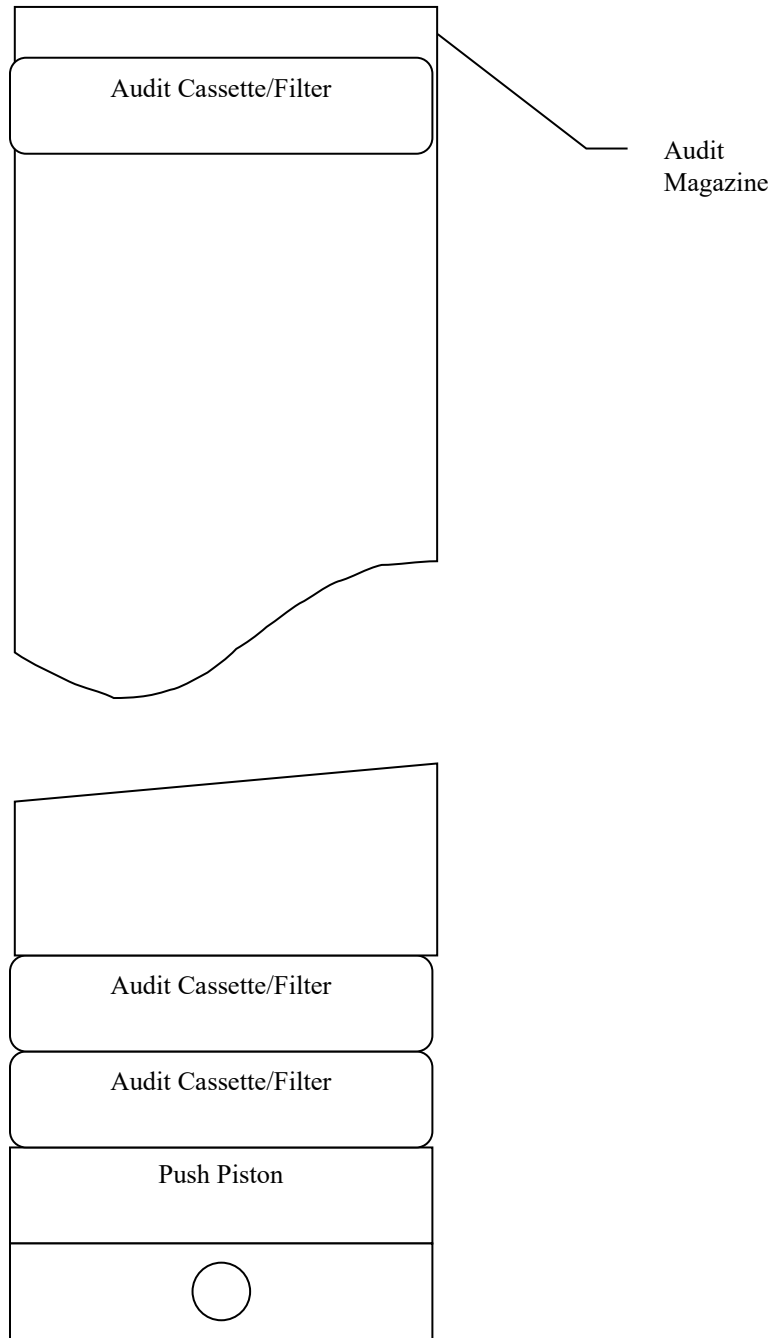
Supplies: Two clean cassette magazines with caps, one clean VSCC (where appropriate) and a flow audit adapter, FDS, PM Field Form.

6.2.3 Filter Protection

Protect the filters after performing the initial instrument inspection and filter recovery.

- 1) From the Main Screen press 'RUN/STOP' once. Select <F1: Audit> and press 'MENU' twice.
- 2) Select 'Leak Check' using the down arrow (↓) key and press <ENTER>. Remove the supply magazine from the left side of the sample compartment (when changing out magazines, take note of the condition of the o-rings, looking for wear and tear, on the bottom manifold where the pneumatic tubing attaches, notify the appropriate APCD personnel if condition is unsatisfactory), cover it with a clean cap and set the magazine aside.
- 3) Install the prepared audit magazine ([Figure 6-2](#)) on the left side and an empty magazine on the right side.
- 4) Press <F4: FiltAdv> ([Figure EOD-10](#)) to move the filter in the sample chamber into the storage magazine and advance the internal leak check disk (filter cassette with a solid metal disk that prevents air flow through the sample chamber) to the sample chamber.
- 5) After the filter advance has been completed remove the storage magazine containing the filter that was just ejected from the sample chamber. Place a clean orange cap on the magazine and set it aside. This filter will be re-inserted into the sample chamber after the audit is complete.

Figure 6-2 Order and Configuration of Audit Magazine



6.2.5 External Leak Check

Perform an external leak check after protecting the filters as above.

- 1) Place the flow audit adapter on the sample down tube and turn the valve handle to the horizontal position to close the valve (open is vertical).
- 2) While in 'Audit' mode from the Main Screen press 'MENU', select 'Leak Check', press <F2: Start>, press <F1: External>, and follow the prompts to eject the internal leak check cassette and insert the external leak check cassette, the external leak check will start automatically ([Figure EOD-14](#)). A Pass/Fail message will be displayed at the end of the leak check cycle ([Figure EOD-15](#)).
- 3) If a 'Fail' message is displayed advance a different filter into the chamber, check the VSCC for tightness, make sure the flow audit adapter is closed, and the VSCC adapter (the aluminum cup that fits on top of the VSCC) is on tightly. Attempt another external leak check. If a 'Fail' message is displayed contact the appropriate APCD/PM personnel.
- 4) If a 'Pass' message is displayed ([Figure EOD-15](#)) **slowly open the valve on the flow audit adapter** and press any key to view the External Leak Check Results Screen ([Figure EOD-16](#)), a pressure drop of 25 mmHg or less is the external leak check pass criterion. Note the external leak rate in the appropriate space on the PM Field Form.
- 5) **If the external leak check has passed and the operator now wishes to perform the 4-Week Verification procedure then skip down to the section entitled, 'Every 4-Week Verification Procedures'.**
- 6) If the external leak check has passed and the site operator is ready to return the instrument to the 'WAIT' or 'SAMP' mode, remove the audit magazine and replace it with the magazine that holds the filter that was in the sample chamber when you arrived. This is the filter that is scheduled to sample next or was sampling upon arrival.
- 7) Place the audit magazine in the storage position (right side of sample chamber), press <F4: FiltAdv>. After the filter advance remove the audit magazine from the storage side and replace it with a clean, empty magazine.
- 8) Reinstall the supply magazine (left side of sample chamber) that contains the filters to be sampled.
- 9) Press the 'Run/Stop' key to return the instrument from 'Audit' to 'WAIT' or 'SAMP' mode.
- 10) Collect the audit filters and the audit magazine, close and lock the instrument enclosure, and return to the office with the supplies, paperwork, and transport cooler, which probably contains a sampled filter(s). Be sure the thermometer in the transport container has been reset and the temperature is below 4 °C. If not repack the cooler and reset the thermometer after equilibration.

6.2.6 Internal Leak Check

Note: It is not necessary to perform an internal leak check if the External Leak check satisfies the leak check criteria. Refer to the Leak Check Guide in the Troubleshooting Section for details.

- 1) After cleaning the VSCC, from the Main Screen press 'MENU', select 'Leak Check' ([Figure EOD-8](#)), press <F2: Start> ([Figure EOD-10](#)), press <F2: Internal> ([Figure EOD-11](#)), and follow the prompts ([Figure EOD-18](#)), the leak check will be performed automatically ([Figure EOD-14](#)). A Pass/Fail message will be displayed at the end of the leak check cycle ([Figure EOD-19](#)), a pressure drop of 140 mmHg or less is the internal leak check pass criterion.
- 2) If a 'Fail' message is displayed immediately perform another leak check. If this results in a 'Fail' message contact the appropriate APCD/PM personnel for direction.
- 3) If a 'Pass' message is displayed note the internal leak rate in the appropriate space on the PM Field Form. Press <F5: Audit>, press <F2: Valve1> three or four times to release the pressure on the filter cassette. Press <F5: LeakChk>, press <F4: FildAdv> to advance the internal leak check disk from the sample chamber.

6.2.7 Cleaning the VSCC

Perform a VSCC cleaning after protecting the filters as above.

- 1) Pull the SCC up and off the flow splitter.
- 2) Pull off the transfer tube. If it is too tight to remove it by hand, pry it off with a rigid plastic lever.
- 3) Remove the top and emptying cup from the chamber.
- 4) Wet a lint-free wipe with deionized water and remove all visible deposits. Deposits are most likely to be found in the cone (inside the top cap) and inside the emptying cup.
- 5) Inspect all O-rings for shape and integrity and replace if necessary. Lubricate all O-rings with light grease. There are 6 O-rings in the SCC, located as follows: 3 on the chamber (2 are located inside the chamber), 2 on the top cap and 1 in the emptying cup.
- 6) Reassemble and reinstall the SCC onto the flow splitter. Lubricate the transfer tube to aid in reassembly.

6.3 Every 4-Week Verification Procedures

Supplies: Thermometer, Barometric Pressure standard, FTS, U-tube or digital manometer, FDS, and PM Field Form.

Note: Operators should put the instrument in 'Audit' mode. If the instrument is configured with a VSCC the operator must perform an external leak check prior to performing these verification procedures. This leak check will verify the integrity of the sample train. These procedures afford the APCD and local operators the ability to often and accurately gauge the operating condition of a particular instrument.

PERFORM THE EVERY 4-WEEK VERIFICATION PROCEDURES IN THE FOLLOWING ORDER:

- 1) Sampler Clock Verification
- 2) Ambient Temperature Verification
- 3) Ambient Pressure Verification
- 4) External Leak Check (only required here if sampler has a VSCC)
- 5) One Point Flow Verification

6.3.1. Sampler Clock Verification

All RP2025s in the Colorado network are set to Mountain Standard Time (MST) all year. This means that during Daylight Savings Time (MDT in Colorado) the instrument will be behind by an hour from the verification devices. On the Main Screen, note the sampler time. Site operators may use their watch as a standard if it has been set accurately, but a cell phone is preferred. There is a web site to the atomic clock in Boulder, Colorado where operators may set their watches; the URL is <http://www.time.gov/>. Note the sampler time and the operator's time verification device time in the appropriate spaces on the PM Field Form (on the PM Field Form the abbreviation, 'Inst' always refers to the RP2025's value). If the instrument's time is more than 15 minutes different than the standard contact the appropriate APCD/PM personnel. Continue the rest of the verification.

6.3.2 Ambient Temperature Verification

Note: Perform the ambient temperature verification after performing the 5-Sample Event procedures and the sampler clock verification.

- 1) From the Main Screen (while in 'AUDT' mode) press <MENU>, select 'Audit', this will bring up the

- Audit Screen ([Figure EOD-9](#)).
- 2) Determine the current temperature (°C) at the ambient temperature sensor using the external temperature standard (NIST traceable thermometer) supplied by the APCD. Slide the probe into the housing adjacent to the instrument probe and secure it with a document clip (e.g., binder clip).
 - 3) Note the instrument and the standard values in the appropriate spaces on the PM Field Form. Verify that the value of ‘Amb Temp’ displayed in the Audit screen ([Figure EOD-9](#)) is within $\pm 2^{\circ}\text{C}$ of the measured temperature. If this is not the case, notify the appropriate APCD/PM personnel. Continue with the rest of the verification procedures.

6.3.3 Ambient Pressure Verification

Note: Perform the ambient pressure verification after performing the clock and the ambient temperature verifications.

- 1) Note the value of ‘Amb Pres’ displayed in the Audit screen ([Figure EOD-9](#)). Compare this to an external standard such as a barometer supplied by APCD or a local airport adjusted barometric pressure. These operators must convert inches of mercury (inHg) to millimeters of Mercury (mmHg) by multiplying by 25.4 mm/in.
- 2) Note the instrument pressure and the adjusted local standard in the appropriate spaces on the PM Field Form. Verify that the value of ‘Amb Pres’ displayed in the Audit screen is within ± 10 mmHg of the standard. If this is not the case, notify the appropriate APCD/PM personnel. Continue with the rest of the verification procedures.

6.3.4 External Leak Check

Note: The external leak check is only required here if the VSCC is removed for cleaning.

- 1) Place the flow audit adapter on the sample down tube and turn the valve handle to the horizontal position to close the valve (open is vertical).
- 2) While in ‘Audit’ mode from the Main Screen press ‘MENU’, select ‘Leak Check’, press <F2: Start>, press <F1: External>, and follow the prompts to eject the internal leak check cassette and insert the external leak check cassette, the external leak check will start automatically ([Figure EOD-14](#)). A Pass/Fail message will be displayed at the end of the leak check cycle ([Figure EOD-15](#)).
- 3) If a ‘Fail’ message is displayed advance a different filter into the chamber, check the VSCC for tightness, make sure the flow audit adapter is closed, and the VSCC adapter (the aluminum cup that fits on top of the VSCC) is on tightly. Attempt another external leak check. If a ‘Fail’ message is displayed contact the appropriate APCD/PM personnel.
- 4) If a ‘Pass’ message is displayed ([Figure EOD-15](#)) **slowly open the valve on the flow audit adapter** and press any key to view the External Leak Check Results Screen ([Figure EOD-16](#)), a pressure drop of 25 mmHg or less is the external leak check pass criterion. Note the external leak rate in the appropriate space on the PM Field Form.
- 5) If the external leak check has passed and the operator now wishes to perform the 4-Week Verification procedure then skip down to the section entitled, ‘Every 4-Week Verification Procedures’.
- 6) If the external leak check has passed and the site operator is ready to return the instrument to the ‘WAIT’ or ‘SAMP’ mode, remove the audit magazine and replace it with the magazine that holds the filter that was in the sample chamber when you arrived. This is the filter that is scheduled to sample next or was sampling upon arrival.
- 7) Place the audit magazine in the storage position (right side of sample chamber), press <F4: FiltAdv>. After the filter advance remove the audit magazine from the storage side and replace it with a clean, empty magazine.
- 8) Reinstall the supply magazine (left side of sample chamber) that contains the filters to be sampled.
- 9) Press the ‘Run/Stop’ key to return the instrument from ‘Audit’ to ‘WAIT’ or ‘SAMP’ mode.

- 10) Collect the audit filters and the audit magazine, close and lock the instrument enclosure, and return to the office with the supplies, paperwork, and transport cooler, which probably contains a sampled filter(s). Be sure the thermometer in the transport container has been reset and the temperature is below 4 °C. If not repack the cooler and reset the thermometer after equilibration.

6.3.5 One Point Flow Verification

Note: Perform the clock, ambient temperature, ambient pressure verifications and an external leak check before performing the flow verification procedure

- 1) Remove the flow audit adapter and install the FTS on the sample tube. Be sure the FTS is snug and completely sealed by tightly twisting the compression fitting.
- 2) From the Main Screen press <MENU> and select 'Audit'. Each FTS is calibrated to accurately quantify flow. The RP2025 will perform the FTS calculation if it has the proper FTS "m" (slope) and "b" (intercept) calibration coefficients.
- 3) Verify that the constants printed on the side of the FTS (the PM Field Form also lists these constants) are entered in the Audit screen. If changes are required press use the ← ↑ → ↓ keys to scroll to the proper field, press <EDIT>, enter the appropriate changes using the keypad, and press <ENTER> to accept the changes.
- 4) Confirm that 16.7 l/min is the set flow in the Set Flow field. Press <F1: Pump> and then <F2: Valve1>. Wait for the flow rate displayed in the "Cur Flow" field to stabilize.
- 5) Hook the digital manometer to the pressure port on the FTS. Note the value displayed on the manometer on the PM Field Form labeled 'FTS Pres.'
- 6) Use the arrow keys to scroll to the field labeled 'FTS Pres', Press <EDIT>, enter the pressure drop (inches H₂O) from the manometer, and then press <ENTER>. The sampler will calculate and display the FTS volumetric flow (FTS Flow). Note this value and the RP2025's current flow in the appropriate spaces on the PM Field Form.
- 7) Press <F2: Valve1> and then <F1: Pump> to turn off the pump.
- 8) The measured flow should be within ± 4.1% of the displayed Current Flow ([Figure EOD-9](#)). At a 'Set Flow' rate of 16.7 l/min the flow verification is acceptable if the "FTS flow" is between 15.8 and 17.3 l/min.
- 9) Remove the manometer, FTS, and thermometer.
- 10) If the site operator needs to perform 15-Sample Event procedures then skip to that section. Otherwise, the site operator must return the instrument to the 'WAIT' or "SAMP" mode and prepare the instrument for normal operation.
- 11) Replace the PM₁₀ inlet on the downtube, remove the audit magazine and replace it with the magazine that holds the filter that was in the sample chamber. Place the audit magazine in the storage position, press <F4: FiltAdv>. After the filter advance remove the audit magazine from the storage side and replace it with a clean, empty magazine. Reinstall the supply magazine that contains the filters to be sampled. Press <ESC> twice to return to the Main Screen. Press the 'Run/Stop' key to return the instrument from 'AUDIT' to 'WAIT' or 'SAMP' mode. Collect the audit filters into the audit magazine, collect the verification supplies, close and lock the sampler door, and return to the office with the supplies, paperwork, and transport cooler.

6.4 Every 15-Sample Event Procedures

Note: The maintenance schedule is configured so that APCD/PM personnel perform every 15-Sample Event at every site. The occasion will arise, however, when APCD is unavailable and must ask the local operators to perform these cleaning events. Operators should never perform the 15-Sample Event procedures without already having performed the 4-Week Verification procedures. Therefore, the supply filters should already be in a capped magazine, there should be an audit filter in the sample chamber, exposed filters should have already been recovered and placed in the transport cooler, the instrument should be in 'Audit' mode, and the PM₁₀ inlet should be off. If this is not the case then the operator should follow the procedures previously discussed to protect the filters and place the instrument in 'Audit' mode.

Supplies: Bottlebrush with Teflon coated handle, lint-free swabs, paper towels, and spray bottle (mix of 50/50 water and isopropyl alcohol; add more alcohol in cold weather).

PERFORM THE EVERY 15-SAMPLE EVENT PROCEDURES IN THE FOLLOWING ORDER:

6.4.1 Top Collector Assembly Cleaning and Maintenance

- 1) Remove the PM₁₀ inlet from the down tube and place a flow audit adapter with the valve closed on the down tube to prevent contamination. Use a Phillips-blade screwdriver to remove the four pan-head machine screws from the top of the top plate of the PM₁₀ inlet. Lift the top plate off the four, threaded, spacer standoffs and set aside.
- 2) Inspect the insect screen for contamination. Clean the screen by lifting it off the lower plate rain deflector and brushing or rinsing it with water until it is clean. Dry the screen and reinstall. Using a general-purpose ammonia-free cleaner and paper towel, clean the top plate deflector cone and internal wall surface of the acceleration assembly. After cleaning the PM₁₀ assembly inspect the acceleration nozzle to be sure it is clean. If not, use a cotton swab and cleaner to remove any contamination.
- 3) Inspect the large diameter (approx. 2 5/8” or 6.25 cm) impactor nozzle O-ring (between the 1st and 2nd stages on the PM₁₀ inlet) for damage or wear. Contact the appropriate APCD/PM personnel to arrange replacements, if necessary.
- 4) After reinstalling the bug screen, align the four holes in the top plate with the four-spacer standoffs. Insert the top plate into the lower plate and tighten the four pan-head screws.

6.4.2 Lower Collector Assembly Cleaning and Maintenance

NOTE: Most of the contamination in the inlet is usually found on the collector plate.

- 1) Using a general-purpose ammonia-free cleaner with a paper towel, clean the collector assembly walls, collection plate, and three vent tubes. A swab may be needed to clean the vent tubes. Also, clean the bottom side of the collector assembly.
- 2) Using a swab, clean the weep hole in the collector plate where the moisture runs out to the moisture trap (glass rain jar).
- 3) Remove the rain jar and clean it. Inspect the rain jar’s brass nipple fitting to ensure that it is secure and free from blockages.
- 4) Inspect the two inlet-to-down tube, sealing O-rings (approx. 1 1/4” or 3.2 cm I.D.) for damage or wear. Contact the appropriate APCD/PM personnel to arrange for replacements, if necessary.
- 5) Clean the lower collector assembly’s threads to ensure a tight seal when the two halves are reassembled.
- 6) Reassemble the top and bottom inlet assemblies until the threads tighten. Hand-tighten only. Replace the inlet on the 1-1/4-inch O.D. sample tube. Take care not to damage the internal O-rings.

6.4.3 Perform Down-tube Cleaning

- 1) Open the sampler top compartment and place the flow audit adapter with the valve closed on the tube above the VSCC.
- 2) Unscrew the gray plastic compression fitting from the base of the down-tube. Twist and lift the down-tube upwards until it is free and clear of the sampler. Inspect the down-tube by looking through it pointing it at an angle to a light source. Clean the interior only if necessary. It is coated with Teflon and may not need cleaning. If interior cleaning seems needed, use a Teflon coated bottle brush of a slightly larger diameter than the down-tube and gently brush.
- 3) The exterior of the down-tube can be cleaned with tap water or a general (non-ammonia) all-purpose cleaner. Reinsert the down-tube into the grey compression fitting by twisting and pushing

down until it clicks in place. Hand-tighten the compression fitting, remove the flow audit adapter, close the sampler lid, and place the inlet assembly onto the down-tube.

- 4) Return the instrument to the proper working condition as described previously.
- 5) Make a notation on the PM Field Form in the 'Comments' section regarding cleaning/maintenance activities. Include the date, what procedures were performed and if any problems were found, such as torn O-rings, etc.

6.4.4 General Cleaning and Maintenance Procedures

In addition to the maintenance/cleaning activities described above every site operator should perform other cleaning to help maintain the presentation and performance of the RP2025. Site operators should perform the following activities on an as-needed basis unless otherwise specified:

6.4.4.1 “V” seals

Check the “V” seal immediately above the VSCC when the cover is up while performing an internal leak check. The “V” seals should be checked at least once every month. If replacement is warranted contact the appropriate APCD/PM personnel.

6.4.4.2 Rain-hoods

Clean the air screens located under the sampler’s three rain-hoods or replace as necessary. The fans can affect the efficiency with which the RP2025 maintains its internal temperature. Remove the screen and replace the filter with a clean one provided by APCD. Rinse the dirty filters with water and allow them to dry before using again. There are four air screens on the RP2025, two of which have filters (the two with filters also have fans). Spray and wipe all surfaces with shop towels to remove dust and dirt.

6.4.4.3 RP2025 Exterior

The exterior (including the ambient temperature probe housing) needs to be kept clean and free of dust. Site operators have been provided with the necessary materials (e.g., shop towels and spray bottles). Contact the appropriate APCD/PM personnel to arrange for replacements.

6.4.4.4 RP2025 Sample Compartment

Note: the filters should always be protected as discussed above before proceeding with the compartment cleaning.

It is the intent of the manufacturer that the electronic boards, the sample filters, and pneumatics are all sealed from water intrusion. Despite this, the sample compartment collects fine dust. Periodically, site operators need to remove this dust by liberally spraying the interior of the sample compartment with water and wiping up the run off. Point the spray bottle down and be careful not to spray water up into the magazine openings. The sample compartment should be kept clean and free of dust to minimize any possible source of external contamination.

6.5 Supplies and Consumables

Refer to the R&P 2025 Operating Manual for a list of supplies and consumables.

7.0 SAMPLE HANDLING AND PRESERVATION

7.1 Filter Shipping/Receiving Procedures

To ensure network-wide consistency, all PM_{2.5} site operators receive and ship filters according to the same schedule. Briefly, shipping to site operators is done every two weeks on a Friday (Monday if a holiday conflicts with a Friday shipping day). The operator should receive a new batch of filters every other Tuesday or Wednesday. Operators will ship sampled filters back to the lab via overnight courier every other Tuesday in the intervening weeks. This schedule affords operators continuity, maintains a continuous supply of filters and shipping materials in the system, and allows operators the flexibility that is required by their own schedules. Deviations from the shipping schedule to accommodate variations in personal schedules can be made by contacting the appropriate APCD/PM personnel.

7.1.1 Receiving Filters from the Lab

Each shipment of filters is comprised of the shipping container, UTEK™ or other suitable ice substitute, a shipping min/max thermometer, a static free baggie containing the unexposed filters in Petri dishes labeled with the filter and cassette ID, and a FDS. If one or more of these components are not received the site operator should immediately inform the appropriate APCD/PM personnel to arrange for replacements. Upon receipt the site operator should inspect all the filters, cassettes, and Petri dishes for visual defects (pinholes, chaff or flashing of the filter or support ring, loose material, discoloration, or non-uniformity). The site operator should inspect each cleaned filter and check each cassette to be sure they are snug and tight fitting. If there is any physical damage to the filter or cassette (including the backing screen) or if there appears to be significant particle contamination the site operator should contact the appropriate APCD/PM personnel. APCD personnel will direct the site operator in using/discarding the filter, arranging for replacement filter(s), and scheduling make-up samples as required.

After completing the physical inspection of the filters/cassettes the site operator should verify that the Filter IDs correspond with the labels on each Petri dish and that each filter/cassette combination is in the appropriate dish. The site operator should also verify that the number of filters in the shipment matches the number of scheduled sampling days on the FDS. The cassettes should then be loaded into a clean supply magazine in the order the filters are to be sampled (i.e., the filter to be sampled first needs to be in the top position of the supply magazine). The site operator **PRINTS** the filter IDs in the appropriate location on the copy of the FDS. The magazine should then be covered with a clean cap and placed in the refrigerator until they are transported to the field and loaded into the sampler. The upper-right corner of the FDS lists the date that ALL the filters in the shipment should be sent back to the lab, the site operator should make a note of the date.

The UTEK™ ice substitute should be placed in a freezer until it is needed to transport the filters back to the lab. The shipping container and thermometer should be kept in a clean area away from possible sources of contamination and damage from foot traffic, being dropped, etc.

7.1.2 Shipping Filters to the Lab

As mentioned previously, exposed filters are returned to the gravimetric laboratory for analysis once every two weeks on a Tuesday via FedEx Standard Overnight Delivery. Site operators should transfer the information from the copy of the FDS they bring to the field to the original FDS prior to shipping filters back to the lab.

The transport coolers are packed in the following manner: A layer of frozen UTEK™ ice substitute is laid flat on the bottom of the cooler. The bag containing the exposed filters is placed upon the frozen ice substitute. A layer of bubble wrap or similar padding is placed on top of the bag. The temperature probe of the min/max thermometer is placed directly on top of the bag holding the filters as near to the middle of the cooler as possible. UTEK™ ice substitute is placed on top and all around the bag of filters/cassettes. The thermometer control unit is placed on top of the last bag of UTEK™ ice substitute. Any remaining space is

then filled with bubble wrap to prevent shifting during transport. The operator should then place the lid on the cooler to allow the thermometer to equilibrate. After the temperature has equilibrated, to less than 4°C, the operator should open the cooler and press the RESET key on the thermometer. If the temperature is not well below 4°C, repack the cooler. Note the temperature in the appropriate space on the FDS (Figure 6-1). The FDS should then be placed between the top of the cooler and the lid of the cardboard shipping box. The cardboard box can then be taped closed. The box and cooler are then shipped to the lab on the appropriate day. Operators should pack the cooler as close to the FedEx pick-up time as possible so as to have better control of the shipping temperature. It is critical to the quality of the samples that the exposed filters be stored and transported back to the laboratory at a temperature less than 4°C. It is for this reason that the operators must take care while loading and shipping the filters.

7.2 Recovering/Loading filters

7.2.1 Initial Instrument Inspection

Supplies: FDS, PM Field Form

Upon arrival at the sampling site each operator should perform an initial inspection of the instrument and its operating status. With the PM Field Form in hand the operator notes their initials, the date, and the time. The operator then records the instrument status code (OK, or a letter code indicating a problem. See operating manual for a complete list) and the instrument mode (SAMP, WAIT, DONE, AUDT or ERR). The instrument status and mode are shown on the samplers' Main Screen (Figure EOD-1) and are in the upper left and upper right corner, respectively. The operator then records the results of their Visual Inspection, whether there is any moisture in the condensate jar, whether the status light is OFF, ON, or BLINKING, the current flow rate, the current ambient temperature, and the current ambient pressure. The current flow rate is listed on the Main Screen. The current temperature and pressure can be found by pressing <F2: STAT> from the Main Screen (Figure EOD-2).

7.2.2 Installing New Filters in the RP2025

Supplies: FDS, Newly received filters loaded in a clean magazine

Note: Currently all RP2025 monitors in the Colorado PM network are configured to operate in the 'Time Basic' Sampling mode (see the RP2025 Operating Manual, §5.3 for a complete description of the different sampling modes). This mode allows operators to program specific sample days for each filter. Using 'Time Basic' allows operators to schedule samples to run on days that are off the normal national schedule. Some reasons for sampling off schedule would be to run a make-up sample, to sample during a special event (such as a wildfire), or to allow an operator to schedule a sample if their personal schedule won't allow them to visit the site within a reasonable time after a sampling event. Arrangements for these special circumstances may be made by contacting the appropriate APCD/PM personnel.

7.2.3 When the RP2025 is in WAIT or SAMP Mode

When the site operator arrives at the sampling site to load filters and set the instrument to sample they should bring with them, the unexposed filters loaded in a clean magazine and the FDS. There will seldom be an occasion when an operator is on site to only load filters, e.g. they will usually recover exposed filters or be performing one or more of the regular maintenance routines (the supplies necessary for these other tasks are listed separately). To setup the instrument to run a batch of filters, the operator needs to load the filter and cassette IDs of all filters and program in their scheduled sample dates.

- 1) From the Main Screen (Figure EOD-1) press <F3: Filtset> to display the Filter Definition Screen (Figure EOD-4).
- 2) Press <F3: FiltLst> to display the Filter List Screen (Figure EOD-5).
- 3) Press the <EDIT> key once, you'll see the cursor change from a single underline to a blinking

box. Move the cursor to the first filter ID field you wish to edit and enter the filter and cassette ID numbers (Note: There may be filters already identified in the filter list, if these filters are already in the filter list then the operator shouldn't make any changes to this portion of the list but use the arrow keys to scroll to the first available line). The operator does not have to enter the 'T', only the numeric portion of the filter ID. The same is true for the "RP" in the cassette ID.

- 4) Enter in the new filter list, indicate whether a filter is set to be a blank by scrolling to the column whose heading is 'Blank' and pressing <F2: +List>.
- 5) When the operator is finished inputting all filter and cassette IDs, press <ENTER> to save your changes.
- 6) Return to the Main Screen by pressing the <ESC> key twice.

7.2.4 When the RP2025 is in ERR, STOP, or DONE mode

Refer to the section, 'Resetting the Sampler when in ERR, STOP, or DONE mode, below. Reset the sampler according to the instructions and then proceed with installing new filters.

7.2.5 Verification of Filter List and Sampling Definitions

Note: Currently all RP2025 monitors in the Colorado Network have been configured by APCD/PM personnel to present dates in mm/dd/yy format, dates on the FDS are presented in mmdyy format.

From the Filter List Screen press <ESC >one time to bring up the Filter Definition Screen ([Figure EOD-4](#)). The top line of the Filter Definition Screen indicates which filter in the filter list is currently displayed. 'Filter 01' refers to the first filter in the filter list, 'Filter 02' to the second, and 'Filter 16' refers to the last. The operator can advance to the next filter definition by pressing <F3: NEXT> and following the prompts. This screen is editable, allowing the operator to view and change the displayed sample definition. All RP2025 instruments in the Colorado Network are configured to sample according to one of three predetermined schedules, every day sampling, one in three day sampling, and one in six day sampling. If the operator hasn't already supplied a definition for each filter the RP2025 will create the definitions using the default sampling parameters programmed by APCD personnel. The information presented in the Filter Definition Screen ([Figure EOD-4](#)) tells the operator when the filter is set to run. The operator has the ability to change the date and/or the time. If an edit is necessary, then from the Filter Definition Screen press the 'EDIT' key, use the arrow keys to move the cursor to the appropriate fields (date, time, filter or cassette ID, or blank value) and make the appropriate edits. Press 'ENTER' to accept the changes. The operator should ensure that all filter definitions are correct and correspond to the scheduled sample dates on the FDS.

Occasionally the instrument will not accept changes to the sample definition for a particular filter. The most common reason for this is that the definition conflicts with (is later than) the definition of a subsequent filter; this is simple to fix:

- 1) From the Filter Definition Screen press <F5: More> and then <F3: Reset>. The RP2025 will prompt the operator with a message telling the operator that they are about to reset all the filter definitions after the current definition to the default conditions.
- 2) Select 'YES' and follow the prompts.
- 3) Press <F5: Back> to return to the Filter Definition Screen.

The operator has reset all the subsequent filter definitions and may make the appropriate edits as described above.

7.2.6 Sample Recovery

Supplies: FDS, PM Field Form, one clean cassette magazine (with cap), transport cooler with frozen UTEK™ ice substitute and thermometer, squeeze bulb.

Note: To satisfy APCD's site visit requirements site operators must visit their sites at least once per week for a one in six sample day site. The operator must visit their site two times per week for a one in three or every day sampling schedule. Once every four weeks the operator will visit the site to perform the 4-Week Verification procedures in addition to the 5-Sample Event procedures and sample recovery.

When recovering filters perform the instrument inspection procedures previously discussed. After inspecting the instrument and recording the information on the FDS and PM Field Form the operator is ready for sample recovery.

- 1) Gently push up and rotate the storage magazine (on the right side of the enclosure) to the left and pull it down.
- 2) Attach the quick connect hose of a squeeze bulb to the bottom of the filter magazine to push the filter to the top of the magazine. Verify that the filter in the storage magazine is the filter that should have sampled by holding the filter horizontally and lifting it above your head to look up at the cassette ID. Make sure this ID corresponds with the information on the FDS. If the filter that sampled is not the filter that should have sampled make the appropriate comments on the FDS and notify the appropriate APCD/PM personnel.
- 3) Gently return the filter cassette to the magazine. Place a clean orange cap over the open end of the cassette magazine to protect its contents during transport. Use the squeeze bulb to pump air into the magazine and tightly pack the cassettes together.
- 4) Place the magazine holding the sampled filter in the transport cooler and place the min/max thermometer probe as close the filters as possible. Then, pack UTEK™ ice substitute around the magazine.
- 5) Let the min/max thermometer equilibrate until the temperature in the cooler is well below 4 °C. If the temperature does not get below 4 °C, repack the cooler. Then press the reset button.

NOTE: It may be the case that the laboratory responsible for the gravimetric analysis utilizes an infrared (IR) temperature sensor to measure the temperature of the samples when they're received at the lab. If this is the case then a min/max thermometer will not accompany the shipment.

7.2.7 Data Transfer

- 1) Write the correct Sample Start and Sample End dates in the appropriate location adjacent to the Filter ID on the FDS.
- 2) Note the site visit number (refers to a batch of filters that accompanies each FDS) the filter was retrieved. For example, if this is the third site visit, then the operator should note a '3' on the corresponding line for the filter that was just retrieved. Sample data now needs to be retrieved from the RP2025.
- 3) From the Main Screen press <F3: DATA> for the Filter Data Times Screen ([Figure EOD-19](#)). This will bring up the record for the sample that was most recently taken. Verify that the sample dates correspond to the filter that you just recovered (via cassette & filter ID). The operator can scroll through all the sample records by pressing the <F1: -Rec> or <F2: +Rec> keys.
- 4) When the record (via cassette & filter ID) corresponding to the correct sampling event on the FDS is found, note the Valid and Total Elapsed Time on the FDS. Press <F3: MoreDat> to display the Filter Data screen ([Figure EOD-20](#)).
- 5) Verify that the filter and cassette ID numbers are correct.
- 6) Record the Volume, the %CV, and the Max. Temp. Difference.
- 7) Press <F3: MoreDat> to display the Filter Data Status Codes Screen ([Figure EOD-21](#)). Record any status codes in the 'Operator Comments' portion of the FDS.
- 8) Press <F3: MoreDat> to display the Filter Averages Screen ([Figure EOD-22](#)). Record the sample average flow rate, ambient temperature, and ambient pressure.
- 9) Press <F3: MoreDat> to display the Power Outages Screen ([Figure EOD-23](#)). Record any power outages if applicable.
- 10) Verify any earlier sample records as necessary by pressing <F1: -Rec>.
- 11) Return the instrument to the Main Screen and continue with the remainder of the required

maintenance as needed.

After the operator has returned to their office they should transfer the exposed filters from the magazine to their field refrigerators.

- 1) Note the maximum transport cooler and field refrigerator temperatures in the appropriate spaces on the FDS under the appropriate site visit number.
- 2) Attach the bulb pump to the magazine and gently advance the top cassette to the top of the magazine by gently squeezing the bulb.
- 3) Place the sampled filter cassette in the appropriate filterholder. Return the holder to the refrigerator.
- 4) Remove the magazine from the transport cooler.
- 5) Clean the cap and the magazine with a dust-free cloth. Cap the magazine and set it aside for the next site visit.
- 6) Return the UTEK™ ice substitute to a freezer.
- 7) Verify that all paperwork has been completed properly.

8.0 SAMPLE PREPARATION AND ANALYSIS

See the Lab low volume filter SOP of this QAPP for a detailed description of sample preparation and analysis.

8.1 Troubleshooting

8.1.1 Resetting the Sampler When in ERR, STOP, or DONE mode

Sometimes a site operator will arrive at the site and the status light is on or blinking. This indicates that an error has occurred and the instrument has halted normal operation. After finishing the initial inspection the operator should try to ascertain the nature of the error.

- 1) From the Main Screen the operator should press <F2: Stat> followed by <F2: StCode> to get the Status Code Screen ([Figure EOD-2](#)).
- 2) Operators should record the Status Code on the PM Field Form and in the ‘Operator Comments’ section of the FDS. The most common status codes when problems occur are: N – no more filters, X – filter exchange mechanism failure, and Z - power failure.
- 3) After making the proper notations on the forms the site operator should clear the status codes. This is done by pressing <F1: Reset> from the Status Codes Screen ([Figure EOD-3](#)) and following the prompts. Once the operator has cleared the status codes the instrument will be in ‘STOP’ mode, the status light will be off, and the status will be ‘OK’. The instrument is now ready to be set up for normal operation.
- 4) Return to the Main Screen by pressing <ESC> twice.
- 5) Enter the filter list and confirm the sample definition(s) as above.
- 6) The operator should notify the appropriate APCD/PM personnel of the malfunction to receive direction regarding troubleshooting the problem.

NOTE: The site operator must remember that regardless of what procedure(s) they will perform after resetting the instrument they must leave the filter that is to be scheduled next in the top position in the supply magazine and the corresponding filter and cassette IDs first in the filter list.

8.1.2 Resetting the Filter List When an Error Has Occurred

With the RP2025 in ‘STOP’ mode the operator must set it to run for normal operation as follows:

- 1) Enter the filter and cassette IDs as above with the filter to be sampled next as the first filter in the filter list.
- 2) **If** the instrument suffered a **filter exchange error** (Stat: X & Mode: ERR on Main Screen) then the filter that was to have been sampled next will have been deleted from the filter list. If the operator needs to insert a filter into the list they may edit the entire filter list or add a filter ID by pressing <F4: INSERT> from the Filter List screen ([Figure EOD-5](#)), pressing the ‘Edit’ key, making the appropriate additions to the filter list and pressing ‘Enter’ to accept the changes.
- 3) The filter to be sampled next needs to be in the top position of the supply magazine. If the instrument suffered a filter exchange error then this filter may be in the sample chamber and must be retrieved.
- 4) To retrieve a filter in the sample chamber from the ‘STOP’ mode the operator should first correct the filter list, as above, then, from the Main Screen press ‘RUN/STOP’ once, this will put the instrument into the ‘WAIT’ mode. The operator should press ‘RUN/STOP’ once more ([Figure EOD-6](#)), then press <F1: Audit> ([Figure EOD-7](#)).
- 5) From this screen press the ‘MENU’ key twice to get to the Audit Menu Screen ([Figure EOD-8](#)). Use the arrow keys to scroll down to ‘Leak Check’ and press ‘ENTER’. This will bring up the Leak Check Screen ([Figure EOD-10](#)).
- 6) Prepare an audit magazine with an audit filter to be used as a dummy or placeholder, in the top position and insert the supply magazine into the instrument. From the Leak Check Screen press <F4: FiltAdv> to advance the dummy into the sample chamber and the other sample filter out. Place the filter you just recovered in the top most position of the supply magazine with the other sample filters. This way the cassettes with clean filters will sample in the same order as listed in the samplers’ filter list.
- 7) Verify that the filter list and filter definitions are correct.
- 8) Make any appropriate changes to the sample dates listed on the FDS. Notify the appropriate APCD personnel of any changes in the sampling schedule.

8.1.3 Poor Leak Check Results

After performing an external leak check and receiving the status message, “Leak Check Failed, Please Check that Flow Audit Adapter is closed”, slowly open the flow audit adapter (assuming it’s closed). Replace the current external leak check disk if one is available. Verify that the current cassette and disk is tight. Perform an external leak check as before.

If the results of this second external leak check are similar then replace the current filter in the sample chamber with an internal leak check disk (an internal leak disk has a solid backing screen). Advance the internal leak check disk into the sample chamber by performing a Filter Advance, discussed previously. After the appropriate disk is in place simply perform an internal leak check as directed previously. If the result is a failed internal leak check then return the instrument to its original condition, leaving it in ‘STOP’ mode and notify the appropriate APCD personnel.

Alternatively, if the internal leak check passed then advance an external leak disk into the sample chamber, open the top hood, and remove the VSCC. Place the flow audit adapter on top of the sample chamber and prompt the instrument to perform an internal leak check.

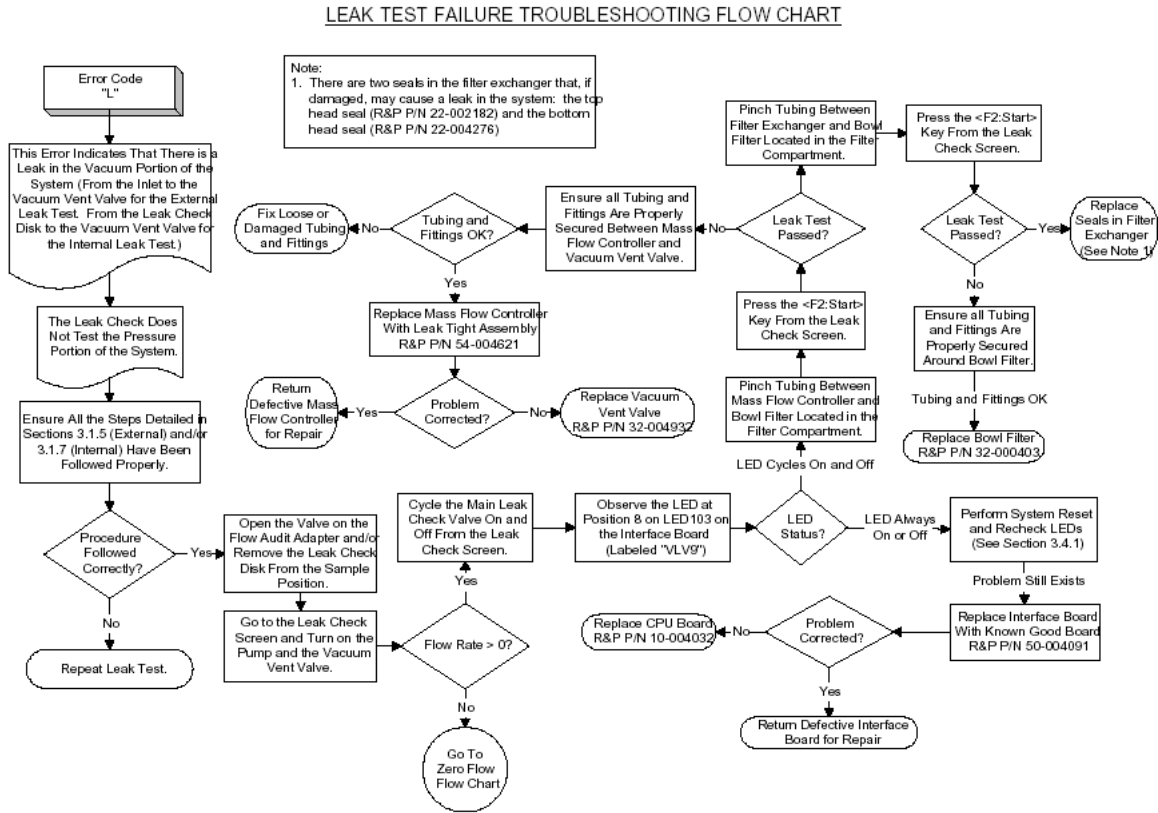
Note: At this and all subsequent steps you may notify APCD of a leak check failure. Be sure to be as accurate as possible when describing which leak checks passed and which failed.

Check the instrument for possible leaks by following the direction below. Verify that all fittings on the VSCC are properly screwed together or seated on the O-rings. Verify that the O-rings are clean and intact. Replace the VSCC back onto the sample chamber making sure it seats properly and place the flow audit adapter immediately on top of the VSCC. Perform another internal leak check.

Slowly open the flow audit adapter and look up underneath the hood of the sampler at the V-seal that impacts on top of the VSCC. Verify that this seal has no particles or debris on its face and appears to be

intact. Close the sampler hood and latch it securely. Loosen the compression fitting on top of the sampler and remove the sample down-tube. Verify that the down-tube seal is clean and intact by removal and inspection. Replace the seal and reinsert the down-tube, verifying that it seats properly. Tighten the compression fitting. Perform an external leak check. Should this last leak check pass then return the instrument to its previous mode and continue with the remaining cleaning/maintenance duties, otherwise leave the instrument in the 'STOP' (or Audit) mode and notify the appropriate APCD personnel. Refer to the Leak Check Troubleshooting Flow Chart, below.

Figure 8-1 Filter Exchange Error Trouble Shooting Flow Chart



Source: Service Manual, Partisol-Plus Model 2025 Sequential Air Sampler

9.0 DATA ACQUISITION, CALCULATIONS, AND DATA REDUCTION

The RP2025 stores three types of data in its internal data logger: filter data, interval data and input data. This information is stored in three separate circular buffers whose contents can be viewed on the screen of the sampler and/or downloaded through the RS232 port. Once these buffers are filled, the oldest data points are replaced with the most recent information (“first in, first out”). The following describes the three types of data stored internally in the hardware:

Filter Data - each record in this buffer contains information for a different collection filter exposed to the sample stream. The sampler displays records from this buffer in the Filter Data Time screen and its sub screens. These screens contain information about the operation and status of the sampler while each filter was exposed, calculated averages of filter data recorded by the sampler and a list of the unit’s recorded power failures during sampling. The RP2025 has a capacity of 49 records of filter data.

Interval Data - The sampler writes a new record of interval data every 5 minutes. Each record contains the latest 5-minute average of the filter temperature, ambient temperature, ambient pressure and average flow rate. The unit displays records from this buffer in the Interval Data screen. The RP2025 has a capacity of 16 days of interval data.

Input Data - The sampler stores calculated averages of meteorological data and other information received through its analog input channels at the rate specified by the user in the Average Time field of the System Setup screen. The unit displays these stored values in the Input Data screen. The sampler has a data storage interval of 30 minutes and a 32-day capacity of input data.

The APCD performs regular data downloads at least once every 15 sampling events while performing normal maintenance. Some operators have been given the use of Palm™ 105 handheld PDAs with RPCOMMPOS software loaded on each individual unit; the PDAs connect to the sampler through a RS232 (serial) connection. APCD requires operators to download Filter data unless a sampler is malfunctioning, in these cases APCD may request that operators download and store all three types of data for troubleshooting purposes.

When an operator downloads the data the PDA creates a comma delimited text file that it names according to the instrument’s five-digit serial number. The operator transfers the data file to his or her computer through the serial connection. Once the operator has stored the data on their local hard drive they email the file to APCD.

When APCD receives the data files it renames them according to the following convention:

xxxxxxxxxyyyyc,'F','I','P'Tyymmdd.csv, where

‘xxxxxxxxxx’ refers to the 9-digit AQS ID for the site the data is attributed, ‘yyyyy’ pertains to the parameter code (88101 for PM_{2.5} and 85101 for PM₁₀) which the file pertains, ‘c’ is the instrument POC, ‘F’ if Filter data, ‘I’ if Interval data, ‘P’ if Input data, and yymmdd is the date of download.

9.1 Computer Hardware and Software Requirements

Please refer to the particulate data handling section of this QAPP

9.2 Data Management and Records Management

Please refer to the particulate data handling section of this QAPP.

10.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance (QA) and quality control (QC) are two terms commonly discussed, but often confused. Quality assurance refers to the overall process of ensuring that the data collected meet previously stated measurement quality objectives (MQOs). Quality control covers specific procedures established for obtaining and maintaining data collection within those limits.

10.1 Quality Assurance

There are six commonly used data quality indicators for pollutants. The data quality indicators are discussed in the following sections.

10.1.1 Precision

The APCD is required by EPA to conduct a precision assessment program for the PM monitoring network. The precision testing program, for manual samplers, is different from that used for automated samplers. The manual sampler precision program is based on comparisons of the primary sampler to a concurrently operated collocated sampler. Identical collocated instruments are operated at several sites, operated on an every sixth day sample schedule, and the resulting measurements are used as precision checks. The primary sampler represents the “actual value” and a collocated sampler represents the “indicated value”.

Annually, the APCD evaluates the previous year’s precision data and publishes the precision results in the annual Data Quality Assessment (DQA) section of the Annual Data Report. The annual DQA within APCD Annual Data Report documents all precision and accuracy results along with a statistical evaluation of what these values represent for all monitoring networks managed by the APCD.

10.1.2 Accuracy

Accuracy is defined as the degree of agreement between a measured value and the true, expected, or accepted value. Quantitative comparisons are made between the measured value and the true, standard value during audits.

Persons independent of the PM program conduct field audits quarterly on all manual samplers. The APCD Quality Assurance staff typically performs the field audits. The field audit is performed by measuring flow, temperature, pressure and time of the sampler with standards that are independent of those used in the calibration of the sampler. Audit standards must be certified against a NIST traceable standard and be of the same or of high quality than of those being certified.

To ensure a quality audit, it is important that the audit is performed during a period of good weather and stable conditions. If the weather and/or conditions are not suitable, the audit should be rescheduled.

The APCD utilizes an Access database to enter and process audit results. A printout of the data entry form is used as a datasheet in which raw data is hand entered (see [Figure EOD-26](#)). Data from the datasheet is then inputted into the Access database via the use of a data input form. The datasheets are archived in case the electronic copy is lost or damaged. The Access database is typically located on the audits laptop computer called “QA Audits Database”. The QA Audits Database is used to store audits for several particulate monitoring networks. The main screen will be displayed once the database is opened. Select the button that pertains to the audit being performed. There is only one version of the Access data input form for each audit type, however it can be configured to input new audit records or to view old archive

records. Upon opening the appropriate form, the data entry form is displayed and a new audit record can be entered into the form. Data from the form can be saved to an archive table as an audit record by pressing the button <Save to Archive>. To view archive records you must open the “Archive” database located on APCD’s LAN Procedures to transfer accuracy audits to EPA’s AQS database are performed on a quarterly basis and are covered in Appendix D4 located within APCD’s QAPP.

The general order of the field audit is as follows:

- 1) Set up audit standards and record sampler information
- 2) Evaluate date and time
- 3) Test sampler for leak
- 4) Evaluate ambient temperature criteria
- 5) Evaluate ambient barometric pressure criteria
- 6) Evaluate sampler flow criteria

More specific details on how the audit is conducted can be found in Appendix QA1: the auditing SOP

10.1.3 Bias

Bias is defined as a systematic error in measurement wherein the measured value displays a consistent positive or negative error as compared to a true value. Bias measurements are calculated either as a percent difference or as a mean arithmetic difference. The signed arithmetic difference is used for assessment where values are too small or too close to the limit of detection to calculate a meaningful percent difference.

10.1.4 Representativeness

Representativeness refers to whether the data collected accurately reflect the conditions being measured. It is the data quality indicator most difficult to quantify. Unless the samples are truly representative, the other indicators are meaningless. Representativeness is assured, as best as possible, by precise definitions of monitor siting criteria.

10.1.5 Completeness

Completeness is defined as the amount of data collected compared to a pre-specified target amount. Ideally, 100% of the target amount of data would always be collected; in practice, that value is less for many reasons, ranging from calibration time and site relocation to power outages and equipment failure. For PM_{2.5}, EPA requires a minimum completeness of 75% (40 CFR, 50, App. H.3). APCD believes 90% completeness is an achievable goal.

10.1.6 Comparability

Comparability is defined as the process of collecting data under conditions that are consistent with those used for other data sets of the same pollutant. The goal is to ensure that instruments purchased and operated by states and local agencies produce comparable data. All manual PM_{2.5} samplers utilized by the APCD for compliance monitoring have been pre-designated as Federal Reference Method (FRM) samplers by EPA. Samplers that achieve the FRM designation have been thoroughly evaluated against other PM_{2.5} samplers and have met EPA’s criteria for comparability. Additionally, for sites that have collocated automated PM_{2.5} analyzers, the APCD will compare data from manual FRM samplers with data from automated analyzers.

10.2 Quality Control

As stated earlier, quality control (QC) refers to procedures established for collecting data within pre-specified tolerance limits. Almost all QC procedures have already been covered under specific topics throughout this document. Documentation and standard operating procedures, however, are discussed below because they apply to many topics.

10.2.1 Documentation

Documentation is important for all measurements. Extensive certification paperwork must be rigorously maintained for each standard and analyzer.

APCD takes special care to prepare and preserve backup copies of all data, including calibration data. All data and supporting documentation should be held for a minimum of five years. See the PM Data Handling SOP within APCD's QAPP for additional information.

10.2.2 System of Quality Control

Currently an APCD staff person services on 4-week event and 15-sample event schedule. For more information regarding what tasks are routinely performed during these events, refer to Section 6 in this SOP.

The Flow Rate Verification Checks performed every two weeks by the site operators is the most important quality control check that is performed, and thus is required to be submitted to AQS.

11.0 REFERENCES

- EPA. 2006. Reference method for the determination of fine particulate matter as PM_{2.5} in the atmosphere. U.S. Environmental Protection Agency. 40 CFR Part 50, Appendix L.
- Papp ML, Elkins JB, Musick DR, Messner MJ. 1998. Data Quality Objectives for the PM_{2.5} Monitoring Data. U.S. Environmental Protection Agency, Research Triangle Park, NC. In preparation.
- R&P, 1999. "Operating Manual: Partisol®-Plus Model 2025 Sequential Air Sampler". Rupprecht & Patashnick Co, Inc. Revision B.
- R&P, 1998. "Service Manual: Partisol-Plus Model 2025 Sequential Air Sampler." Rupprecht & Patashnick Co, Inc. Sept. 1998 Revision B.
- Quality Assurance Guidance Document 2.12: Monitoring PM_{2.5} in Ambient Air Using Designated Reference or Class I Equivalent Methods." U.S. Environmental Protection Agency, January 2016.
- EPA. 2006. Ambient air quality surveillance. U.S. Environmental Protection Agency. 40 CFR Part 58, App. K.
- Quality Assurance Handbook for Air Pollution Measurement Systems. Volume II: Ambient Air Quality Monitoring Program (EPA, January 2017)
- Rupprecht & Patashnick Partisol®-Plus Model 2025 Sequential Air Sampler Manual Reference Method: RFPS-0498-118 "Rupprecht & Patashnick Company, Incorporated Partisol®-Plus Model 2025 PM_{2.5} Sequential Air Sampler," operated with any software version 1.003 through 1.4.16, with either R&P-specified machined or molded filter cassettes, for 24-hour continuous sample periods, in accordance with the Model 2025 Instruction Manual and with the requirements and sample collection filters specified in 40 CFR Part 50, Appendix L. **Federal Register: Vol. 63, page 18911, 04/16/1998**
- Thermo Scientific Partisol®-Plus 2025 PM₁₀ Sequential Air Sampler or Thermo Fisher Scientific Partisol® 2025i PM₁₀ Sequential Air Sampler or Rupprecht and Patashnick Partisol®-Plus 2025 PM₁₀ Sequential Air Sampler Manual Reference Method: RFPS-1298-127 "Thermo Scientific Partisol®-Plus 2025 Sequential Air Sampler" or "Thermo Fisher Scientific Partisol® 2025i Sequential Air Sampler" or "Rupprecht and Patashnick Partisol®-Plus 2025 PM₁₀ Sequential Air Sampler," with PM₁₀ inlet or louvered inlet specified in 40 CFR 50, Appendix L, Figs. L-2 through L-19, configured as a PM₁₀ reference method and operated for 24-hour continuous sampling periods. Partisol®-Plus 2025 to be operated with any software version 1.003 through 1.5 and the Partisol® 2025i with firmware version 2.0 or greater, with the modified filter shuttle mechanism, in accordance with the Partisol®-Plus 2025 or Partisol® 2025i instruction manual, as appropriate, and with the requirements specified in 40 CFR Part 50, Appendix J. **Federal Register: Vol. 63, page 69625, 12/17/1998 Last modified: 06/ 2011**

Figure EOD-1 RP2025 Main Screen

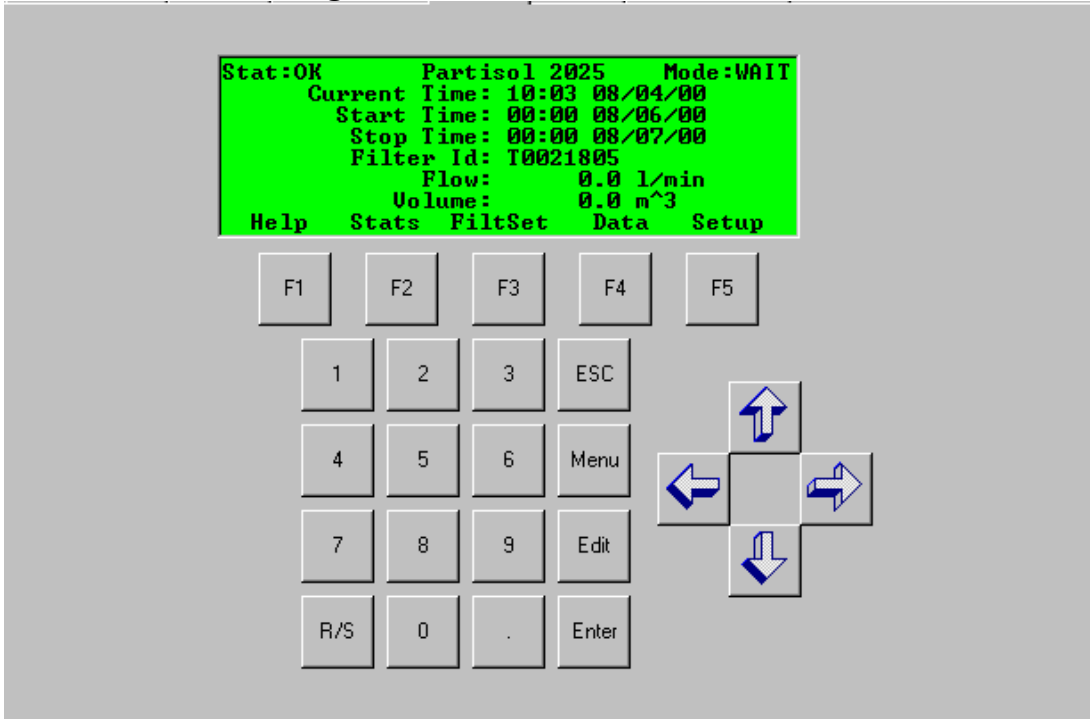


Figure EOD-2 RP2025 Current Stats Screen

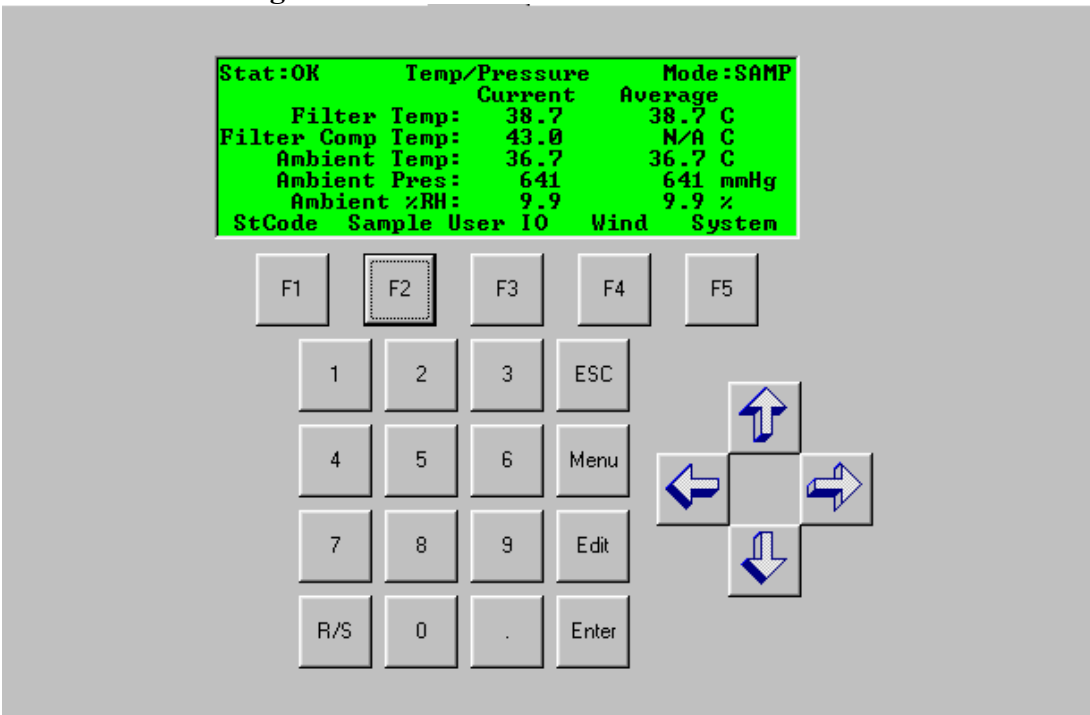


Figure EOD-3 RP2025 Status Code Screen

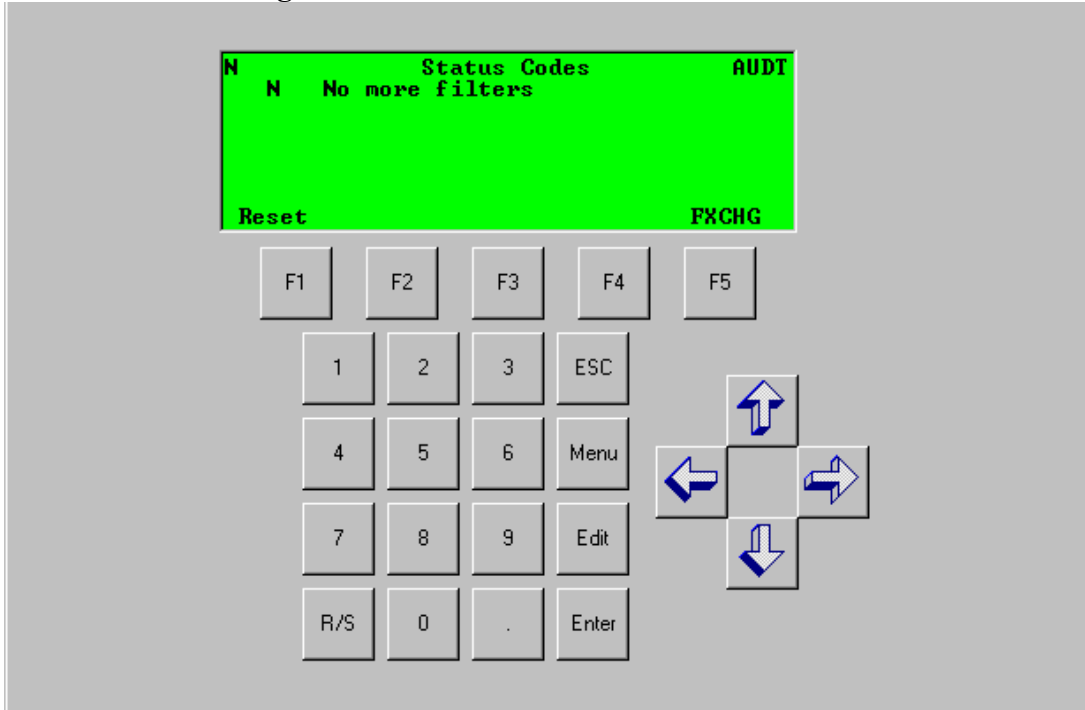


Figure EOD-4 RP2025 Filter Definition Screen

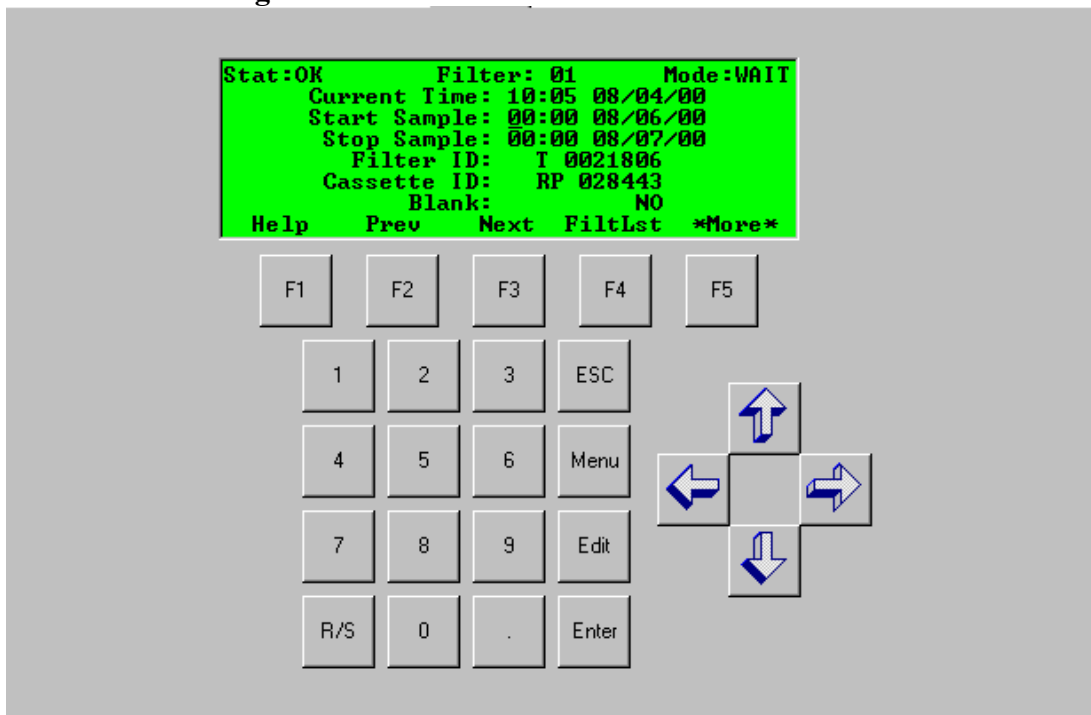


Figure EOD-5 RP2025 Filter List Screen

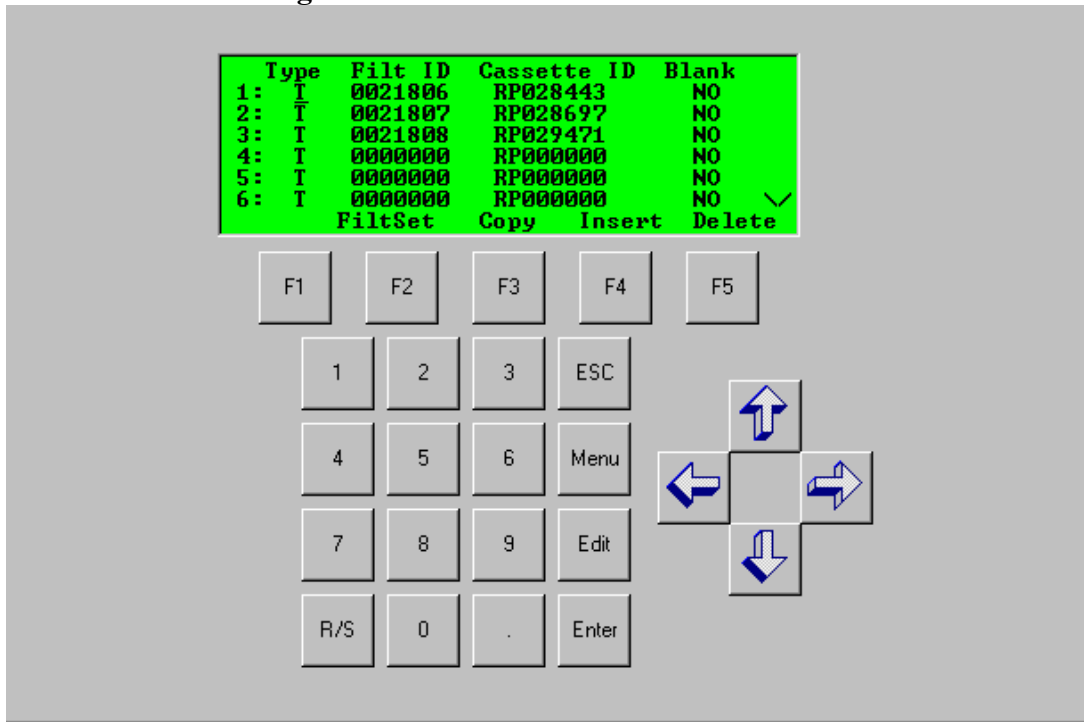


Figure EOD-6 RP2025 Run/Stop Prompt

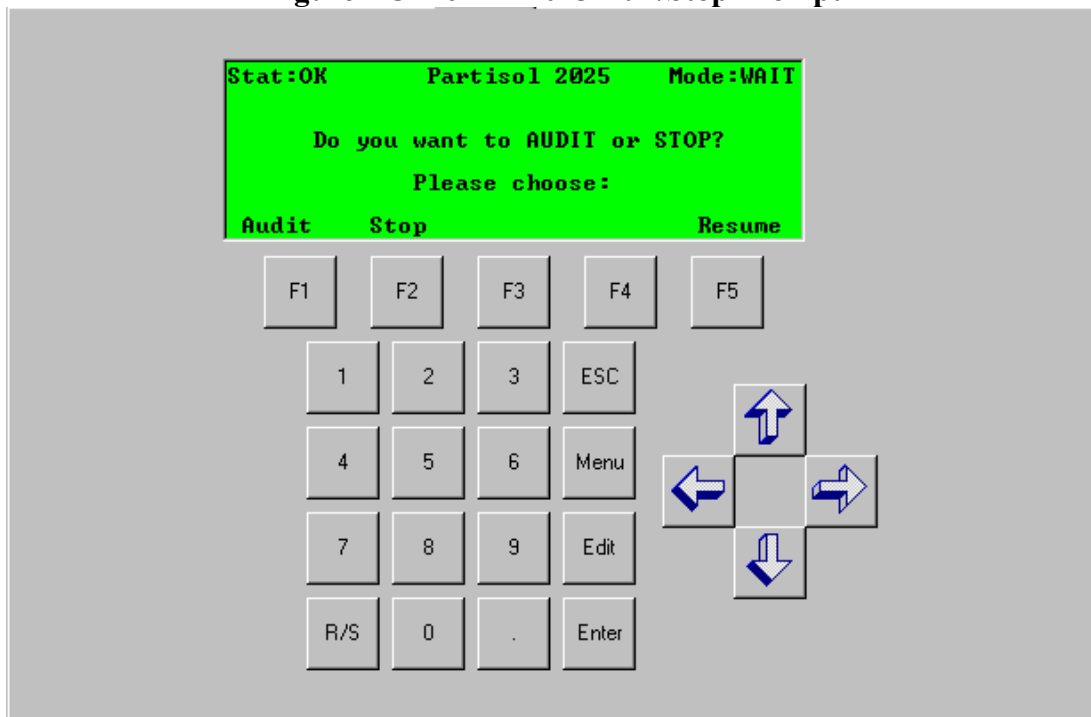


Figure EOD-7 RP2025 Audit Prompt Screen

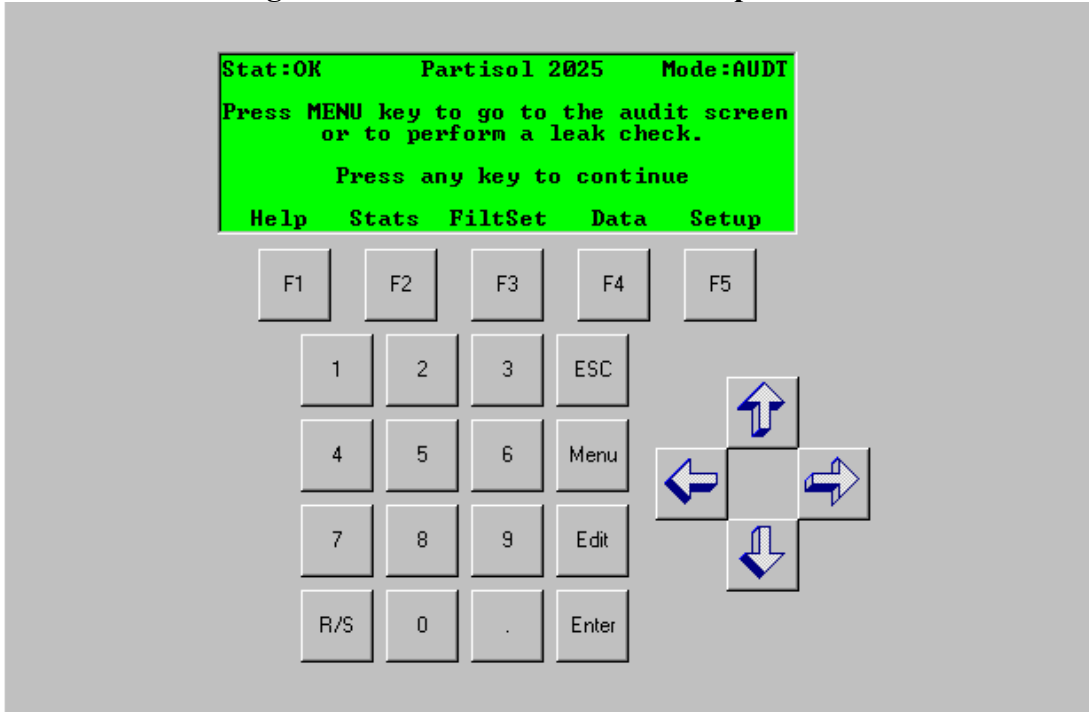


Figure EOD-8 RP2025 Audit Menu Screen

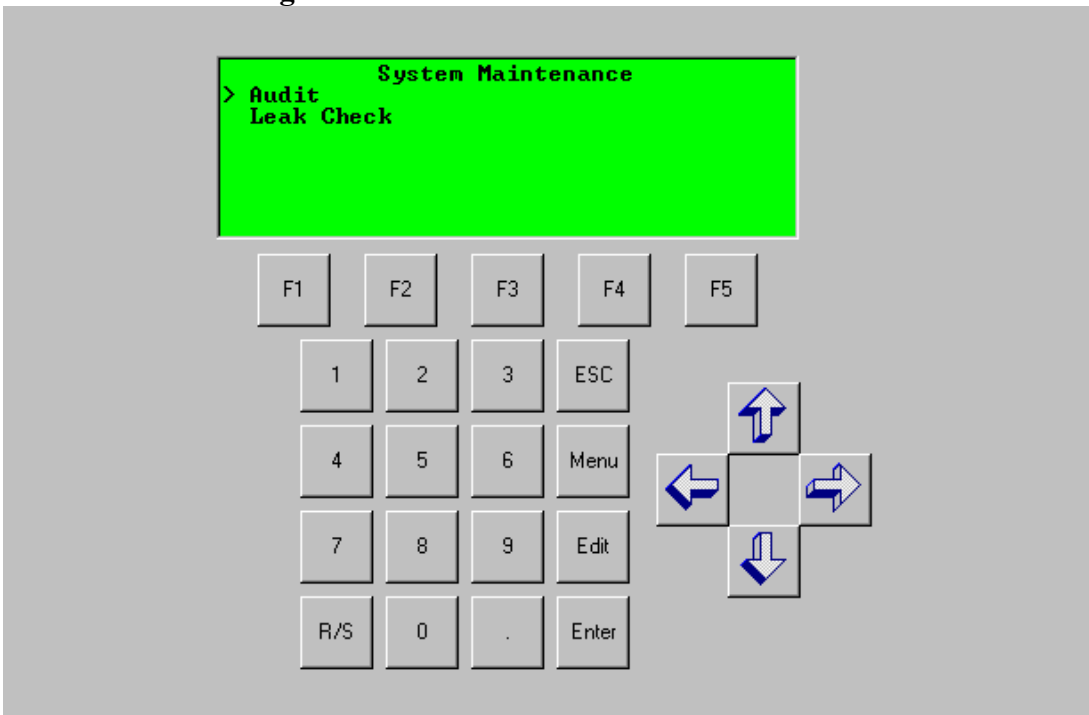


Figure EOD-9 RP2025 Audit Screen

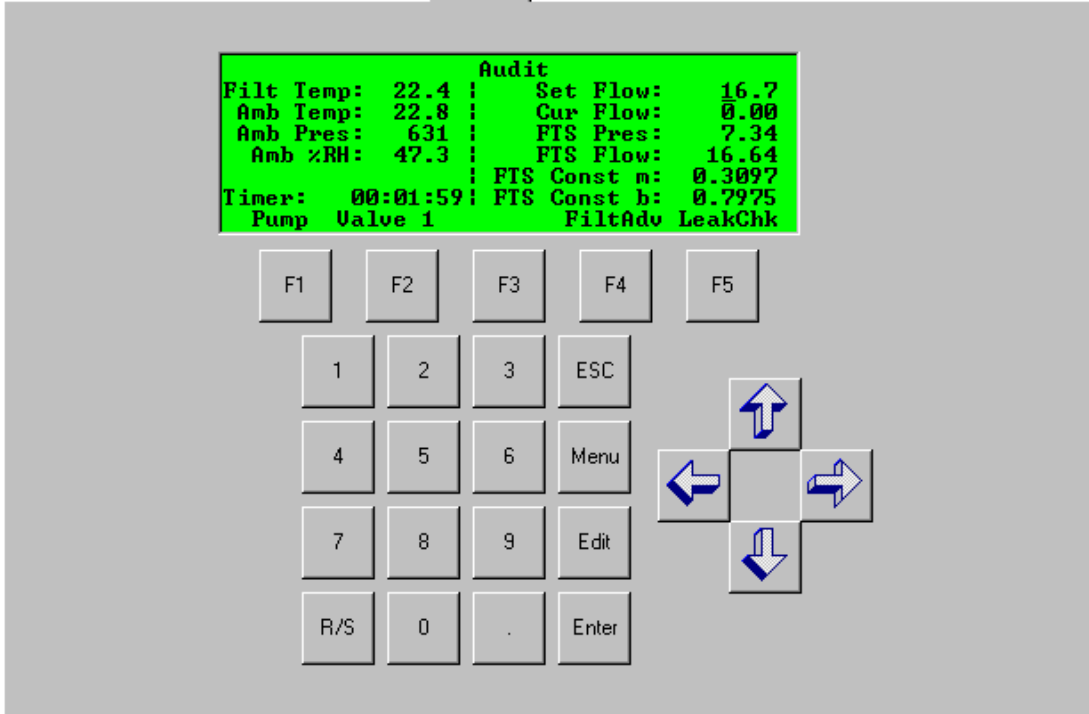


Figure EOD-10 RP2025 Leak Check Screen

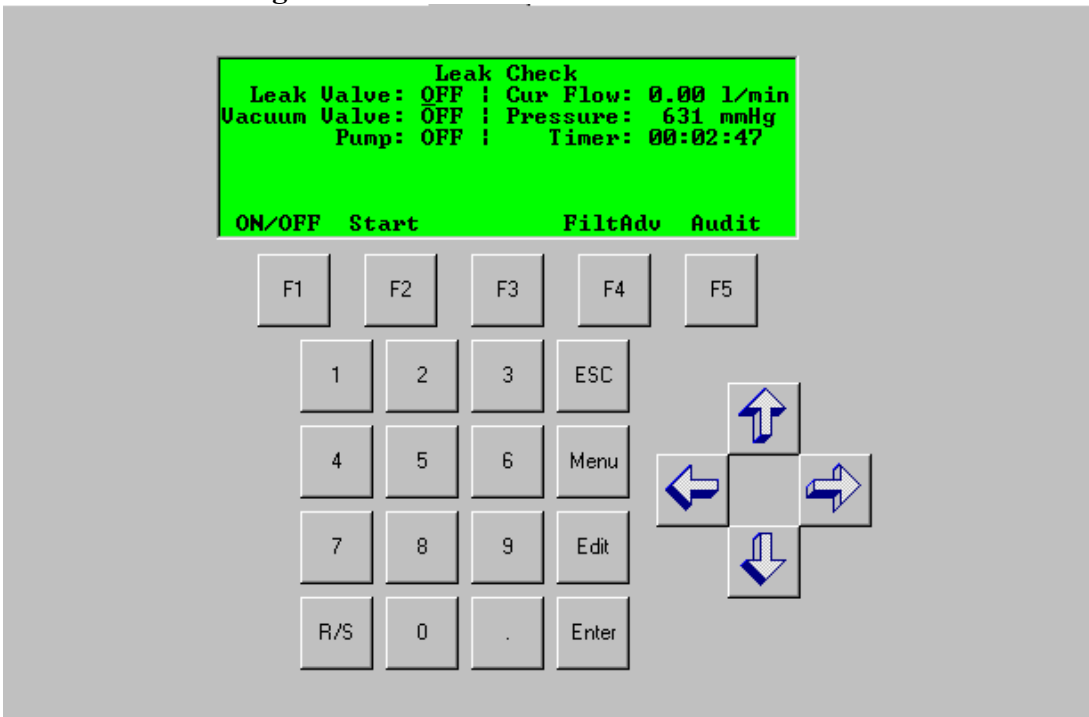


Figure EOD-11 RP2025 External/Internal Leak Check Prompt Screen

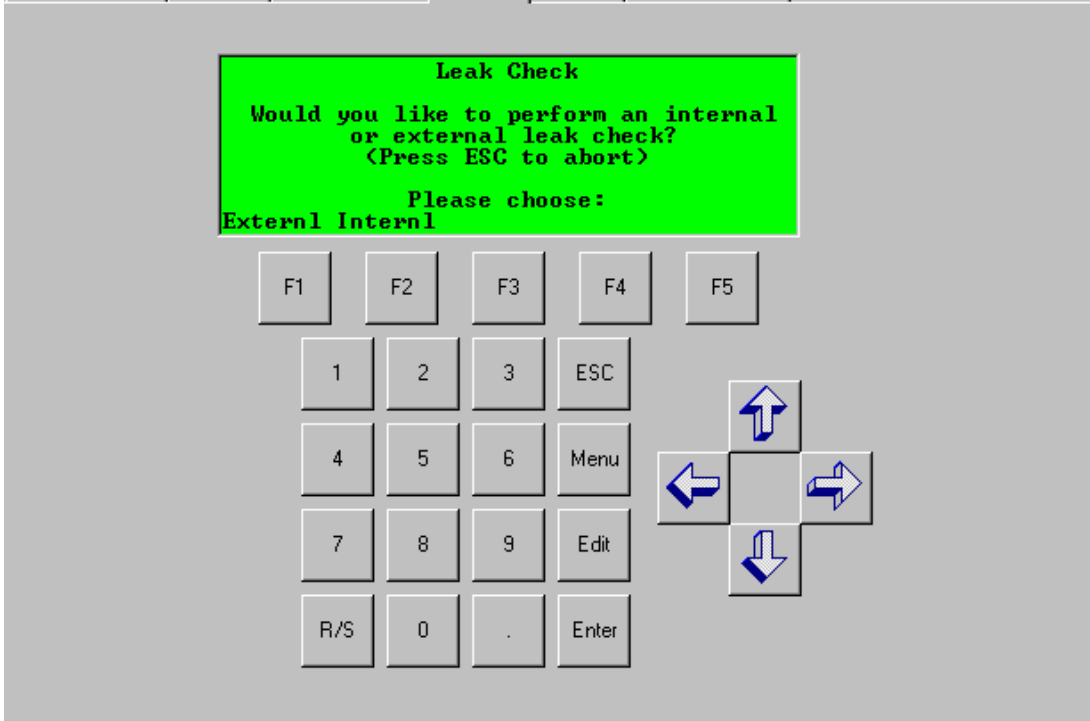


Figure EOD-12 RP2026 External Leak Check Prompt Screen

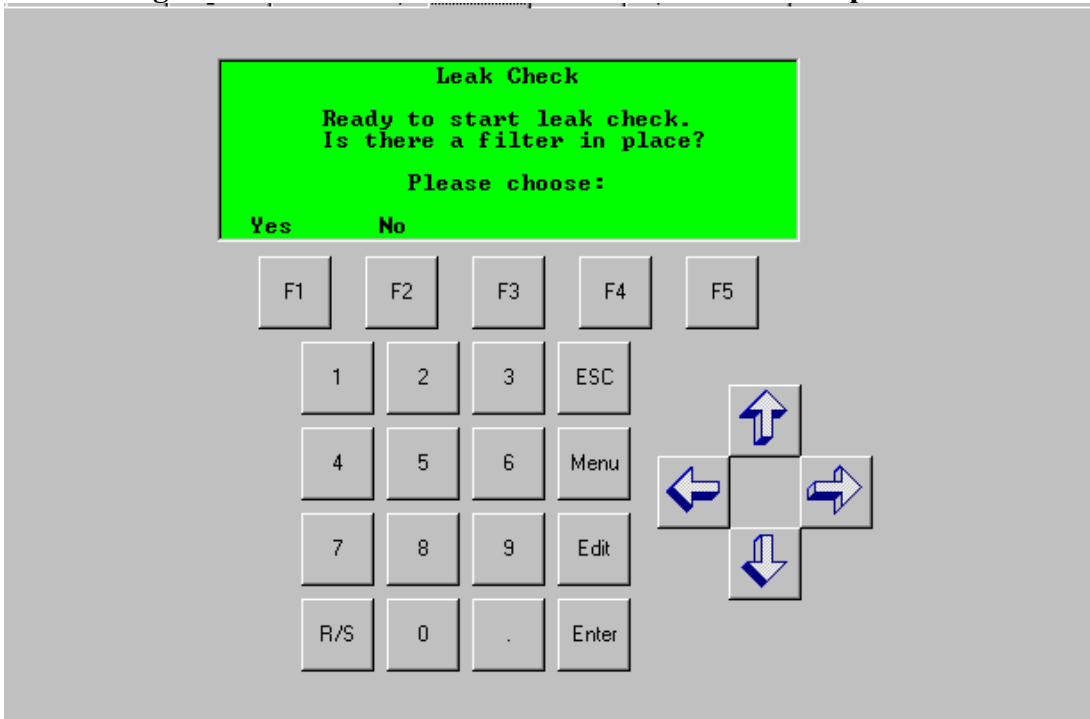


Figure EOD-13 RP2025 External Leak Check Prompt (Flow Audit Adapter) Screen

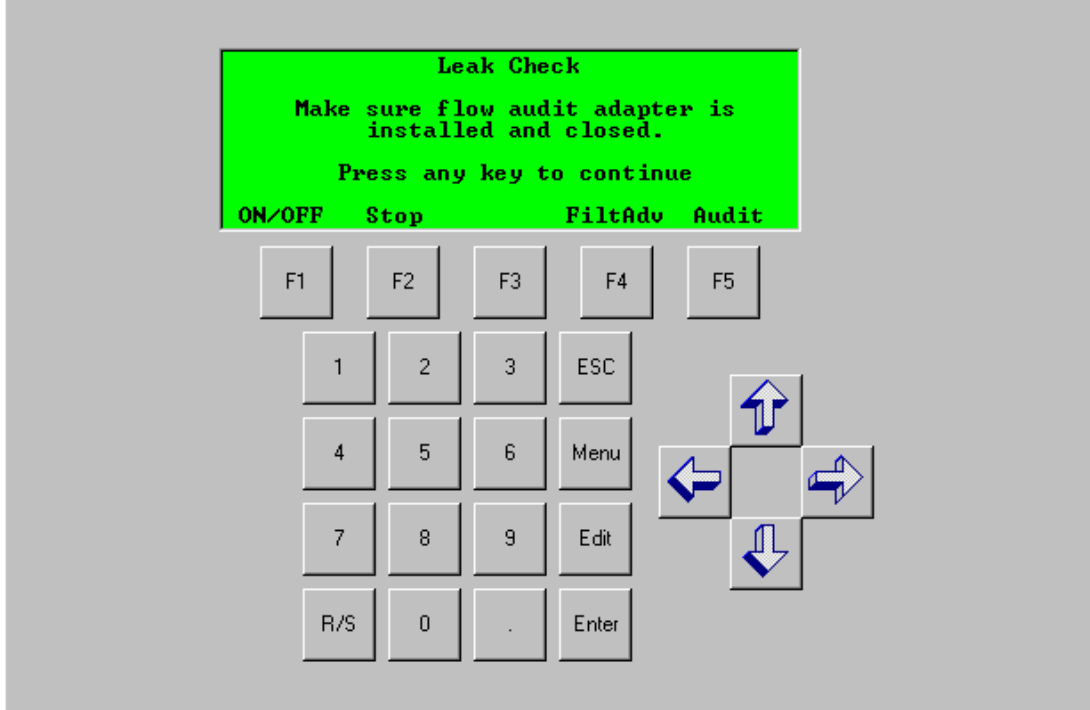


Figure EOD-14 RP2025 Leak Check Screen

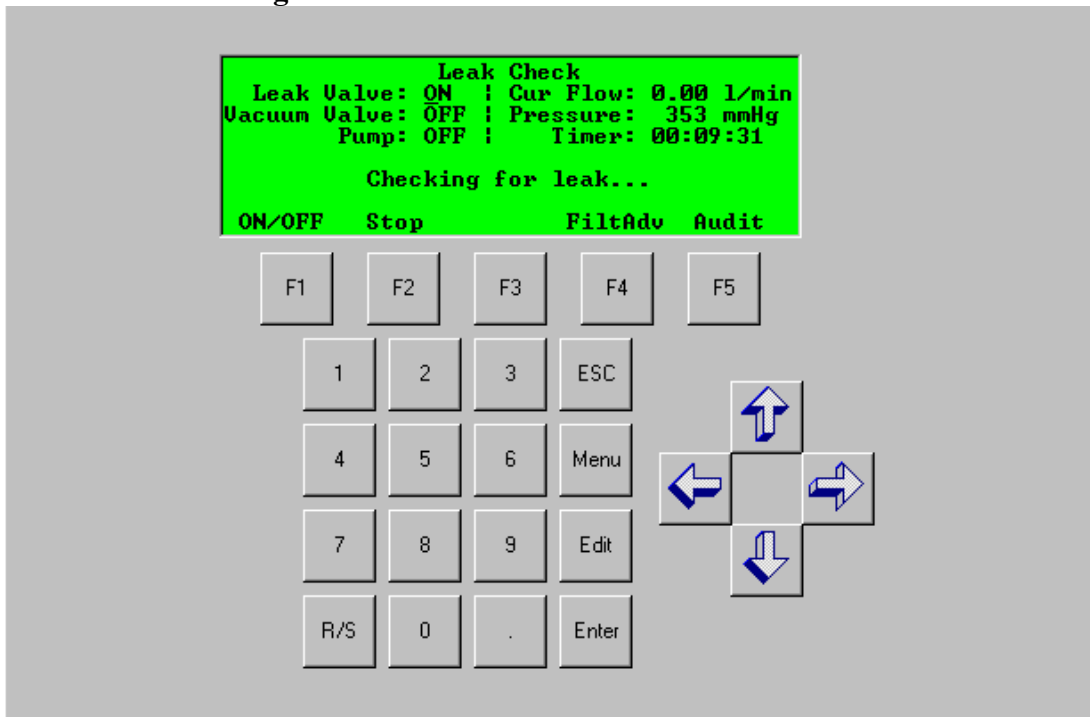


Figure EOD-15 RP2025 Successful External Leak Check Screen

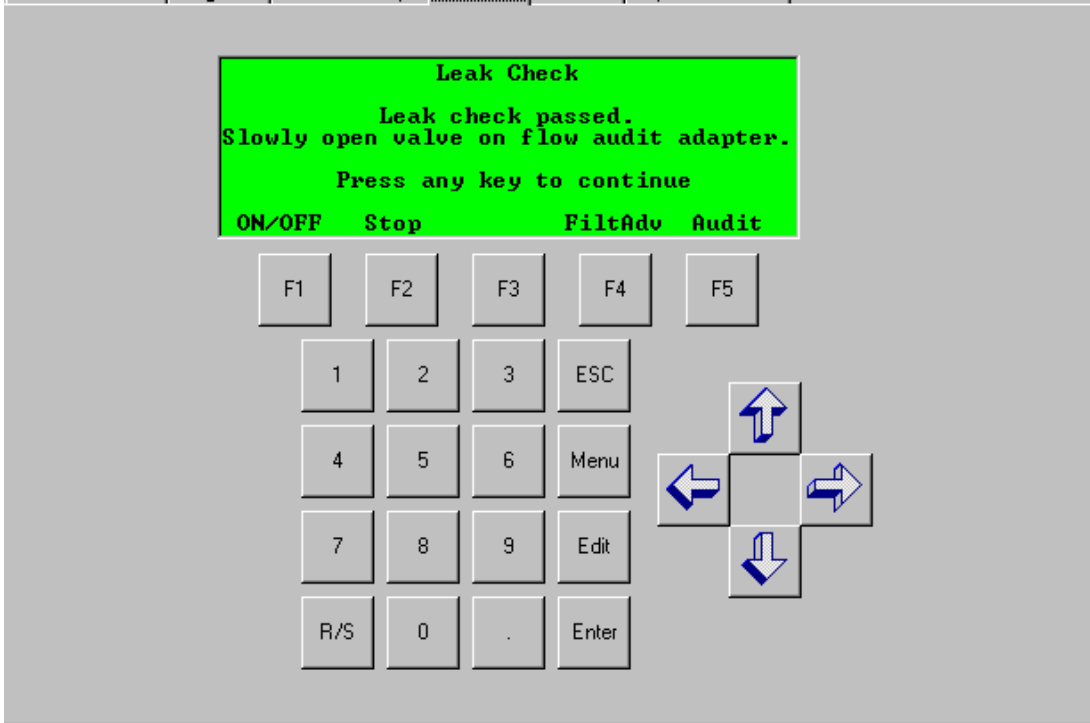


Figure EOD-16 RP2025 External Leak Check Results Screen

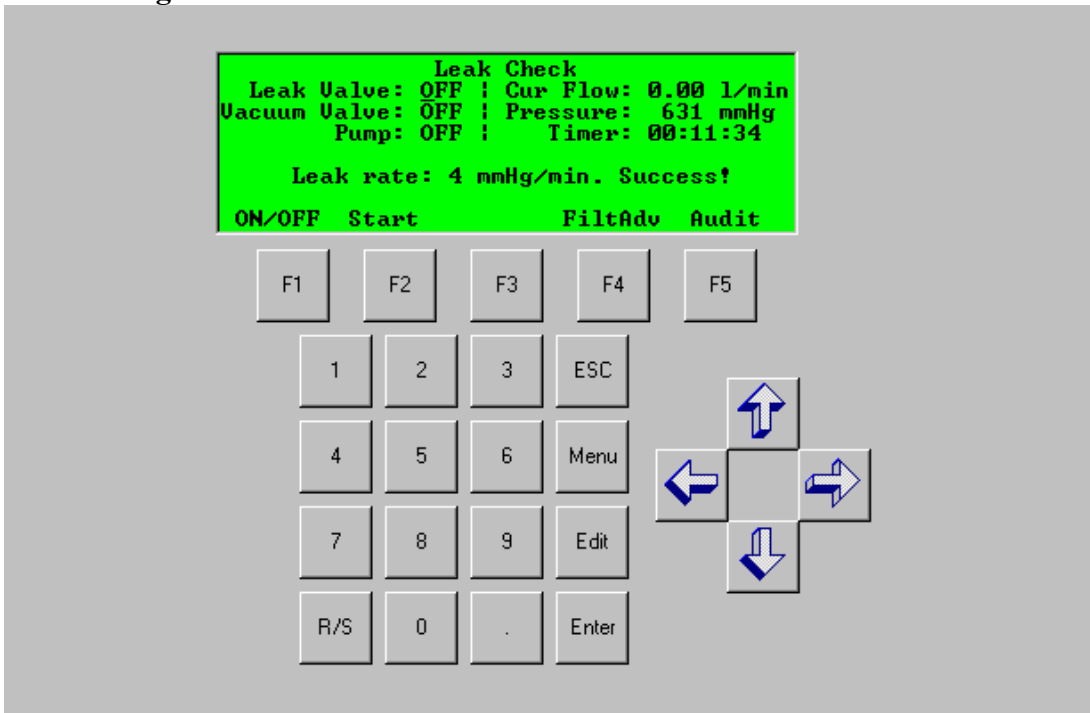


Figure EOD-17 RP2025 Internal Leak Check Prompt Screen

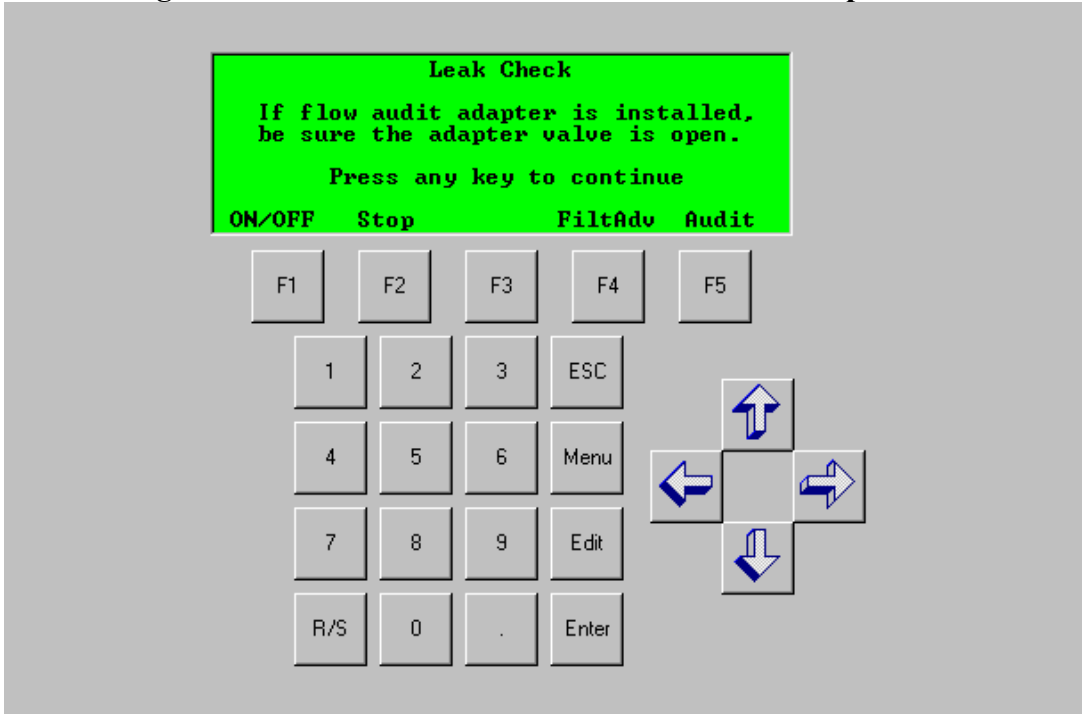


Figure EOD-18 RP2025 Internal Leak Check Results Screen

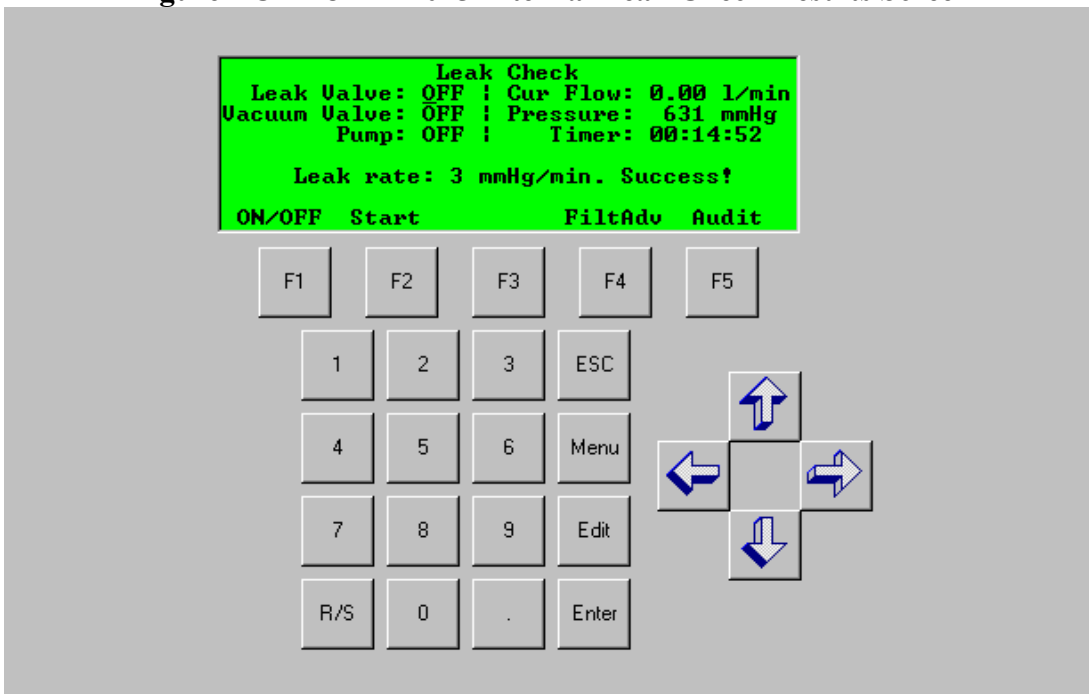


Figure EOD-19 RP2025 Filter Data Screen (Sample Run Time/Date)

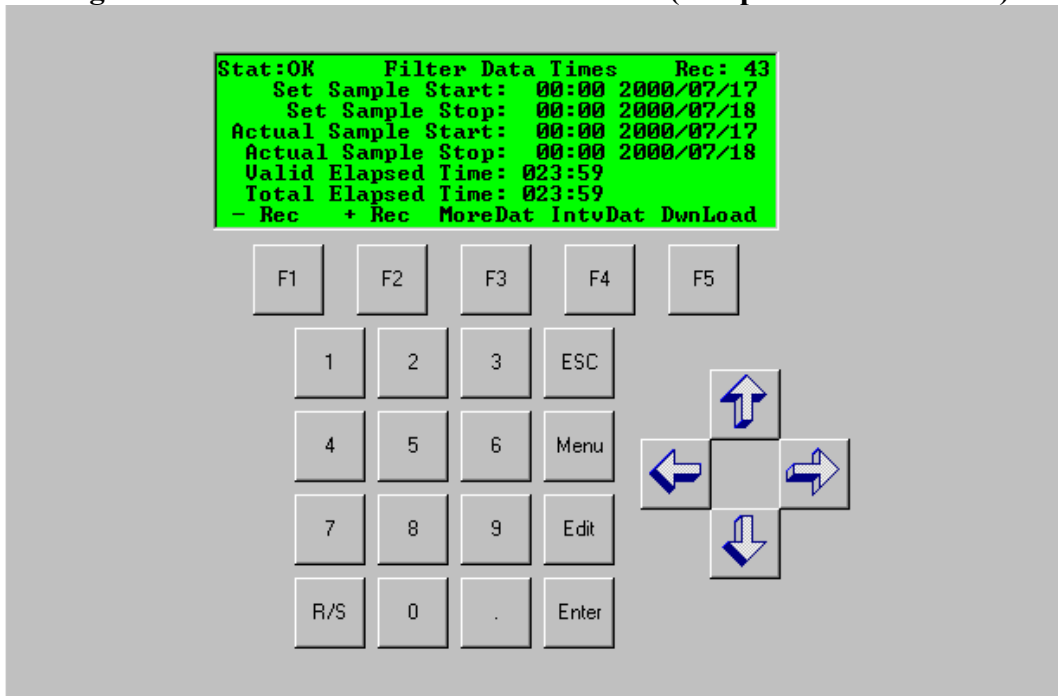


Figure EOD-20 RP2025 Filter Data Screen (Filter ID, Sample Volume)

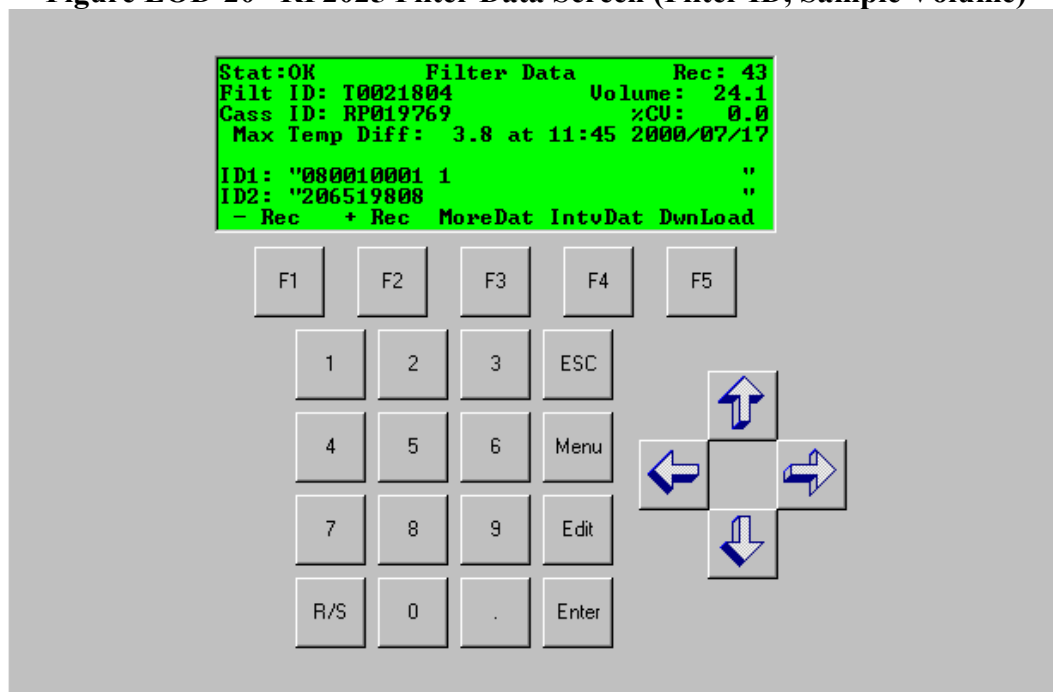


Figure EOD-21 RP2025 Filter Data Screen (Status Conditions)

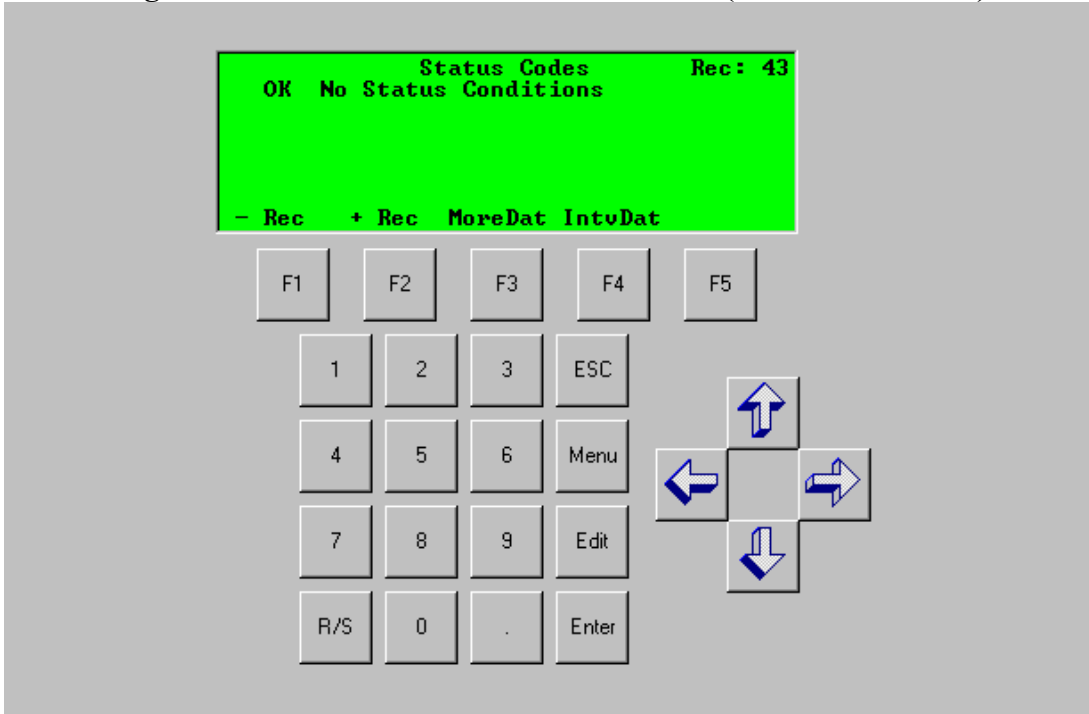


Figure EOD-22 RP2025 Filter Data Screen (Minimums, Averages, and Maximums)

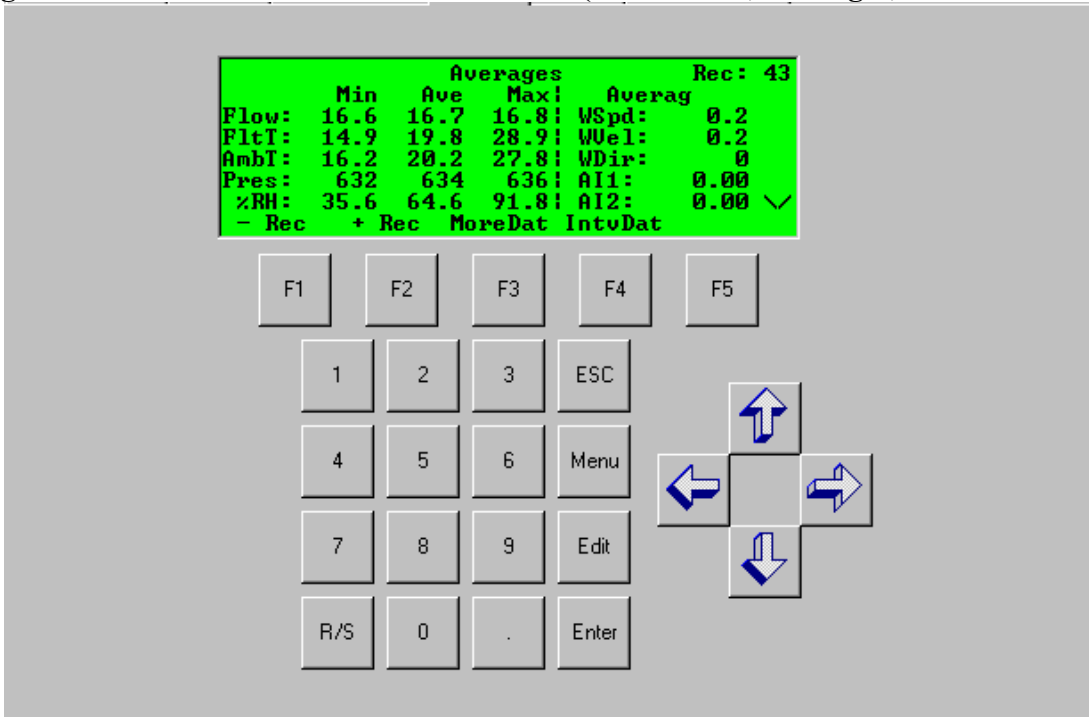


Figure EOD-23 RP2025 Filter Data Screen (Power Failure)

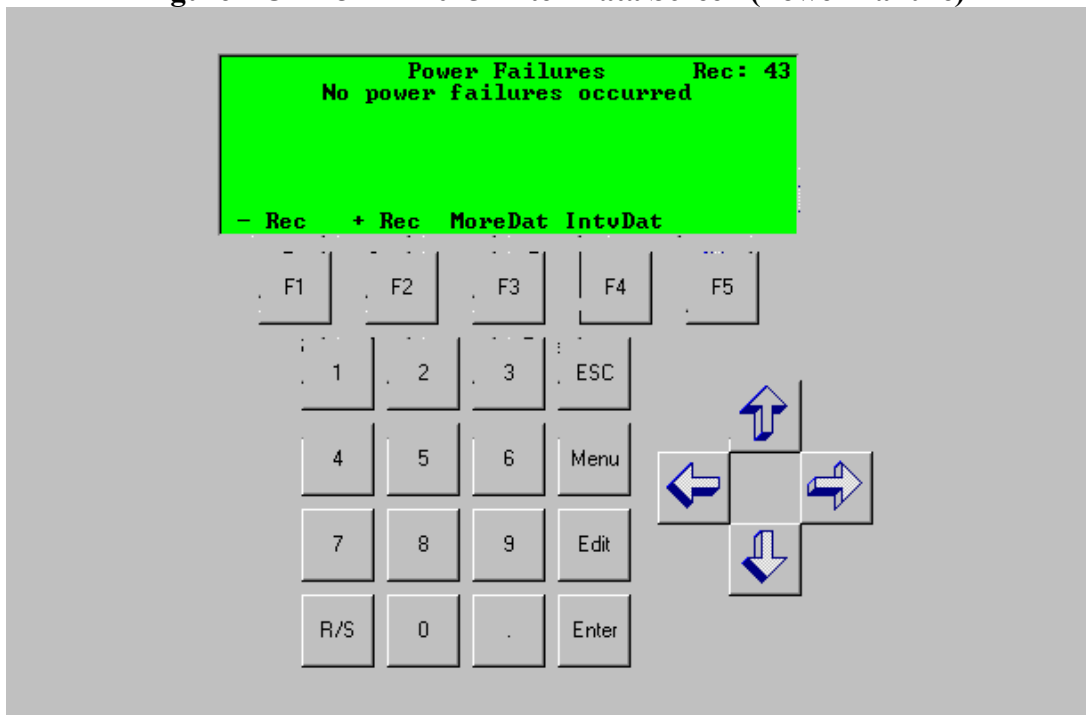


Figure EOD-26 PM_{2.5} Audit Datasheet and Access Data Input Form

Lo-Vol / Continuous PM Analyzer Audit

COLORADO
 Air Pollution Control Division
 Worksheet # A-10-1-2019-01-000001

Site	080310002				
Site Name	DENVER - CAMP				
Method	R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC - Gravimetric				
Parameter	88101	POC	2	Method Code	145
Auditor	Clyde	Audit Date	11/17/2022	Audit Time	13:31
Serial #	216220304				
FTS	IA179H				
Cal. Date	1/25/2022	Slope	0.2160	Intercept	0.2131

	Ambient Pressure			Ambient Temperature		
	(mm Hg)	(atm)	(inches Hg)	(Fahrenheit)	(Celsius)	(Kelvin)
Audit Standard		0.8386	25		-4.6	268.6
Sampler		0.8368	25		-4.6	268.6

Leak Check Verification Upload to AQS?

Flow Rate Verification							
Assessment Number	Audit Set Point (lpm)	Sampler Flow (lpm)	Audit Flow (lpm)	Delta H2O	Temp. (C)	Audit Rel. Error (%)	Design Rel. Error (%)
1	16.70	16.68	16.64	18.040	-4.4	0.3%	0.4%
	16.00	15.96	15.87	16.400	-4.4	0.6%	0.8%
	17.30	17.26	17.20	19.290	-4.3	0.4%	0.6%

Audit Results							
Pressure		Temperature		Audit Flow		Design Flow	
-0.002	PASS	0.0	PASS	0.4%	PASS	0.6%	PASS
+/- 0.013 atm		+/- 2 degrees C		+/- -%		+/- 5%	

Comments

PART III

Standard Operating Procedures for Training Field Technicians and Site Operators in the Operation of Low Volume Particulate Sampler

TRAINING CERTIFICATION

Part III - Field SOP for Training Site Operators

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1.0 INTRODUCTION

The purpose of this document is to provide an outline of activities included in the training procedures of the field technicians and site operators. When the program was being initiated in 1998 the PM_{2.5} Program Coordinator and the QA SLAMS Coordinator attended the Air and Waste Management Association workshop on PM_{2.5} Monitoring in Carey, NC and a “Hands-on” WESTAR workshop in Golden, CO. EPA sponsored both of these workshops and these individuals have since left APCD. However, with the knowledge from the training sessions, APCD personnel have been able to provide information to local operators and new APCD employees regarding the operation and maintenance of the RP2000 and RP2025 samplers. It is through the training and field experience that a “train the trainer” system has been established.

The APCD provides training to field personnel and local operators. The PM Program Coordinator, or other qualified APCD personnel, evaluate each operator’s proficiency after each site operator has been given sufficient time to review the SOPs and practice on the PM sampler. If failure should occur during the evaluation, the APCD will provide onsite training until the local operator becomes proficient. A description of the training procedures is provided in below.

General aspects of personnel qualifications, training, and guidance are discussed in Volume II, Part I, Section 4 of the Quality Assurance Handbook for Air Pollution Measurement Systems. APCD has used this information, the information extracted from the above-mentioned training courses, EPA Method 2.12, “Monitoring PM_{2.5} in Ambient Air Using Designated Reference or Class I Equivalent Methods”, and practical experience to develop a training program for all field technicians and site operators.

2.0 OVERVIEW

A new site operator is given training and instruction prior to operating a PM instrument in the Colorado network. As a mature program APCD expects that there is overlap between a new operator and a previously trained operator. This overlap offers the new operator ample opportunity to begin to learn, generally, instrument operation and program requirements prior to their formal training. All field technicians are given training and a practical hands-on proficiency evaluation before they are allowed to do any unsupervised site operator work in the field. The formal APCD training begins with a broad overview of the program, followed by general instruction regarding field sampling activities (especially documentation and sample handling), followed by identification of specific critical and operational sample criteria, step by step instrument operation, maintenance and verification procedures, sample handling (including shipping and receiving), and is finished up by actual instrument work that incorporates all the elements listed previously. The new operators are each given a current manufacturer’s operating manual, and a copy of the Field Standard Operating Procedures (FSOP) specific to the instrument they will be operating, including detailed step-by-step instruction for sampler operation and performing all maintenance/verification procedures. All FSOP(s) contain examples of the paperwork used as a training aid for the site operators; examples are given to the operators so that they may become familiar with the paperwork requirements. The documentation includes copies of the Field Data Sheet/Chain of Custody (FDS), Every 4-Week Verification/Maintenance forms, and the station anomaly forms. The paperwork is designed to aid the operator by serving as a guide through each step of the maintenance procedures as well as serving to document the completion of the maintenance, instrument malfunction, simple operator errors, and anomalous events.

3.0 TRAINING TOPICS

3.1 Program Overview

Every new operator is given a basic overview of the program including monitoring history, a brief summary of statewide ambient concentrations, monitoring objectives, shipping and receiving schedules,

paperwork overview, and a brief description of the sampler. These topics are all discussed thoroughly throughout training so that each operator develops a thorough understanding of the program and monitoring objectives. APCD feels that giving operators a detailed understanding of the program goals allows them the freedom to meet the goals while still accomplishing the duties associated with their primary jobs.

3.2 Field Sampling

APCD feels that proper field sampling techniques are necessary to ensure valid samples. New operators are instructed to the appropriate methods of sample handling, field documentation of critical and operational criteria, scheduling, and other concerns such as weather effects on field sampling and situational effects and documentation (e.g. nearby forest fires, etc).

3.3 Critical and Operational Criteria

There are several critical criteria identified in Method 2.12 that must be satisfied to ensure a valid sample. These include sample time requirements, flow rate criteria, sample handling criteria, and some sampler verification procedures among others. All critical criteria are identified for new operators along with an explanation of their importance. The methods by which the critical criteria are verified are demonstrated and explained. The operator must demonstrate an understanding of the criteria and the method by which they are determined.

There are several operational criteria identified in Method 2.12 that must be satisfied or be a cause for additional investigation by the operator and/or APCD. Among these are leak checks, periodic programmed maintenance and sampler verification procedures. All the operational criteria are identified to the new operators along with an explanation of their importance. The methods by which the operational criteria are verified are demonstrated and explained. The new operator must demonstrate an understanding of the criteria and the method by which they are determined. Additionally, basic troubleshooting is discussed in context of these critical and operational criteria.

Further information on these criteria can be found in the Critical Criteria Tables from [App D](#) of the QA Handbook or Appendix MQO of this QAPP.

3.4 Sampler Operations

Sampler operations, including sample loading, sampler set up, data downloading, proper sample documentation, sample collection, sample shipping and receiving/inspection procedure are all demonstrated for the operator. Each operator is required to demonstrate an understanding of the specific steps involved in these operations as well as the significance of the operations. Additional topics include the use of make-up samples and special monitoring to cover local events such as forest fires.

3.5 Field Maintenance/ Verification Procedures

Topics covered include basic maintenance responsibilities including instrument cleaning, VSCC cleaning and replacement (where applicable), and replacing of the fan filters. Detailed instructions of these topics can be found in the appropriate SOP. Each new operator is required to demonstrate their ability to accomplish these tasks as prescribed by the maintenance schedule established by APCD. Additional topics covered include leak checks (and associated troubleshooting activities), and time, temperature, pressure, and flow verification activities. The latter topics include a description of verification equipment provided by APCD (i.e. temperature, pressure and flow standards), the methods APCD utilizes to maintain their NIST traceability (and the effects on local operators), verification troubleshooting, and paperwork documentation.

3.6 Field Lab Work

New tare weighed filters are received from the laboratory via courier or USPS Mail. Field technicians are trained to inspect the new clean filters and cassettes for visual defects (pin holes tears, fingernail marks, etc.) or possible contamination, including discoloration and looking for things like, particles, hairs and/or fibers upon receipt and to document their finding on the FDS. The technician also checks to be sure that the

cassette ID matches the number on the container label. Operators are instructed to ensure a tight fit between filter and cassette by squeezing on both sides simultaneously and then squeezing the top and bottom simultaneously.

Each site operator is given a proficiency test for each procedure. All field technicians are then given additional on-the-job training as determined by APCD or as requested of APCD by the operator.

The following data sheets are present for each site operator's proficiency evaluation (certification). The evaluation is performed by having each operator and back-up operator go through the actual procedures of filter handling and inspection, routine sample exchanges, verifications, sampler maintenance, documentation, data downloading, filter shipping and troubleshooting procedures. In the event that a site operator was unable to complete the task, an impromptu training session occurred and the site operator was asked to repeat the task on their own.

4.0 REFERENCES:

CFR Vol. 62, No. 138 Friday, July 18, 1997. App. L, section 8.3.6

Figure EOD-1 Week Verification Form

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Air Pollution Control Division - Technical Services Program
 PM_{2.5} Regular Maintenance/Sampler Verification Form



SITE/SAMPLER DATA				Site Visit					EQUIPMENT DATA	
Site Name:	Boulder	#1	#2	#3	#4	#5			Goshu-Heck FTS S/N ¹ :	GH-027
Sampler Model:	RP2025A	Operator							Goshu-Heck FTS	
Sampler S/N:	200700001	Date							Certification Date:	12/27/00
AIRS ID:	08-013-0012	Time							FTS m ³ h ⁻¹ :	0.2847
		Inst. Status							FTS b ² h ⁻¹ :	-0.2110
		Inst. Mode							Thermometer Type:	VWR Scientific
		Vis. Insp ³							Thermometer S/N:	341821
		Jar Cond. (Y/N) ⁴							Barometer S/N:	HWS
		Status Light ⁵								
		Inst. Flow Rate								
		Temp. (T _a)								
		Pres.(P _a)								

Five Event Information ⁶				Four Week Instrument Verification ⁷									
Site Visit #	Flow W/H/S ID #	Leak Checks		Pass/Fail Criteria	Clock		Amb. Temp.		Amb. Pres.		FTS Pres. F	Flow	
		Est. Rate < 2 mmHg	In Rate < 1.6 mmHg		Current	Standard	Current	Standard	Current	Standard		Current	FTS
					± 15 minutes		± 4°C		± 10 mmHg			± 4%, RA ⁸	
Visit 1													
Visit 2													
Visit 3													
Visit 4													
Visit 5													

- a - Before proceeding with verification remember to protect any exposed filters, the filter in the sampling position, and supply lines as required
- b - Information reported on the side of Goshu-Heck Flow Transducer Standard (FTS)
- c - Indicate whether instrument appears to be OK (i.e. presence of obvious damage, bullet holes etc.)
- d - Indicate presence of condensation in pit, Yes or No, note amount
- e - Is status light On (O), Off (F), or Blinking(B)?
- f - Monometer pressure. F using an U-tube manometer the FTS reading is taken by adding the difference between the two manacles
- g - After entering current FTS parameters (m & b) and FTS Pressure into the instrument note the given FTS Flow and indicated (Current) Sample Flow
- h - FTS Relative Accuracy = 100 % * |(FTS Flow - Sample Flow) / FTS Flow|, RA is acceptable if 100 < FTS Flow < 1124

Comments (Note date and time of comment)

Sheet 25 of 26

TIME PERIOD: 01.12.01 to 01.12.14

LIST OF SCHEDULED EVENTS/ SCHEDULED DATES:

Scheduled Events: 4-wk,5-event ,12.01.01

Figure EOD-4 Filter Data Sheet (FDS)

Page 1 of 1

PM2.5 Federal Reference Method Filter Data Sheet/Chain of Custody

SAMPLER DATA

Site Name: Boulder
 AIRS Code: 08-013-06121
 Sampler Model: RP2025A
 Sampler S/N: 209700001
 Reviewed by: _____ Date: _____

SITE VISITS:

	#1	#2	#3	#4	#5	#6
Date	000810	000814	000818	000821	000828	
Time	0902	1020	825	1115	1425	
Operator	Jr	Jr	Jr	Jr	Jr	

The filters accompanying this shipment are to be returned to LARS on: Wednesday 30 August

See Note 1

FILTER DATA

Filter ID/Cassette Screen ID Label	Sample	Sample Start/End Date	Sample Load/Reference Mass	Volts & Total Sample Time (hh:mm)	Average Amb. Pres. (mm Hg)	Average Amb. Temp. (°C)	Average Sample Flow Rate (l/min)	Max. Temp. Diff. (°C) / @ Time	Coefficient of Variation (CV%)	Sample Volume (m³)	Operator Comments
See Note 2	Start	000813	1	2350				3.5			
	End	000814	2	2350	23.6	6.16	16.7	13.66	0.0	24.0	
	Start	000816	1	2350				4.1			
	End	000817	3	2350	24.7	6.12	16.7	14.02	0.0	24.0	
	Start	000817	1	0:00							blank
	End	000817	3	0:00	0	0	0	0	0	0	
	Start	000819	1	2338				2.1			D, Analyte Performed
	End	000820	4	2338	25.2	6.14	16.7	13.22	0.0	23.6	
See Note 4	Start	000822	1	2342				6.5			T1, Sample Temperature Out of Range
	End	000823	4	2350	25.7	6.18	16.7	14.71	0.5	24.0	
	Start	000826	1	2350				3.7			
	End	000826	5	2350	26.3	6.10	16.7	12.21	0.2	24.0	
	Start										
	End										
	Start										
	End										

See Note 3

See Note 5

FILTERS SHIPPED TO FIELD **FIELD LAB DATA** **Site Msl** **SAMPLES RETURNED TO LARS**

Date: _____ Transport container: #1 #2 #3 #4 #5 #6 Base Received at LARS: _____ By: _____
 By: _____ Temp. at Field Lab (°C): n/a -1.1 -4.2 -3.1 2.1 Maximum Temperature of Shipping _____
 Refrigerator Temperature at Field Lab (°C): _____ -1.5 -1.7 -1.9 -2.2 Container When Received: _____ °C
 Refrigerator Temperature when Shipped: -6.5 Date: 8/30/00 Samples Shipped By: Jr unloaded by: _____
 Notes: _____

Figure EOD-4 (Continued)

NOTES

Each FDS is produced by APCD personnel to accompany a specific batch of filters to a specific site. Each FDS is sent out to the appropriate site with pre-printed information pertinent to that site. These data are site information, including the site name, site code, AQS ID, and sampler serial number. If there is information on this form that is incorrect (i.e. sampler serial number) contact the appropriate APCD/PM personnel.

Note 1: Site visit information. Every time an operator visits his or her site it is necessary for them to fill in this information. APCD personnel need to know the date and time of the site visit and which site operator(s) was there. Operators need to fill this section out every site visit, completely, no exceptions.

Note 2: Sample Load/Retrieval Site Visit #. When an operator goes to the site to load a new batch of filters into the instrument they should note which Site Visit the filters were loaded. This Site Visit # goes in the column labeled Sample Loaded/Retrieved Site Visit # and adjacent to the row corresponding with the sample start date. When an operator goes to the site to retrieve filters they should note which filters were retrieved on that particular site visit. This Site Visit # goes in the column labeled Sample Loaded/Retrieved Site Visit # and adjacent to the row corresponding with the sample end date. When an operator fills this out they document when they pulled a filter off the instrument. APCD determines if a particular filter was retrieved under the 96-hour criteria. **(Remember sample loaded goes in the Sample 'Start' row and sample retrieved goes in the Sample 'End' row.)**

Note 3: Operator Comments: The operator may make any comments associated with a particular sample or filter including weather events, high pollution events, anomalous site conditions, and condition of the filter upon receipt, etc. The operator should also use this space to document any status conditions associated with that sample.

Note 4: Filter data information. This data you pull from the machine with a couple of important exceptions...The filter and cassette IDs are given to you on the preprinted labels on each filter you receive from the lab. The next two columns of data refer to 1) Sample start/end date(s) (the column heading is 'Date (yyymmdd)') and 2) On what site visit was a filter loaded into the machine and when was that filter retrieved after sampling (column heading 'Site Visit #).

Start date and end date should be self-explanatory. Site operators receive each FDS with the 'Start Date' already filled in. All samples should be 24 hours long which means that the 'End Date' will be the day following the 'Start Date'. There may be exceptions to this but the general rule is to sample for 24 hours. If a filter did not sample on the prescribed start/end date, then it is necessary, to make this notation on the FDS and write in the correct information.

The next eight columns after the Sample Loaded/Retrieved column (previously discussed in Note 2) are all concerned with actual sample data. These values serve a two-fold purpose. Firstly, they allow site operators to verify that the sample has met some of the critical criteria for a sample to be considered valid, and secondly these data serve as a hardcopy backup to the electronic record. Should a sample not meet one or more of the criteria concerning sample time, average flow, coefficient of variation, and sample volume they should contact the appropriate APCD/PM personnel to arrange for a make-up sample.

Note 5: Field Lab Data. The data a site operator should write in this section refers to temperatures of their transport container and field lab refrigerator. When you visit your site and recover a filter, record the maximum temperature (outdoor probe) of your transport cooler (after it has stabilized at a temperature below 4°C) and the maximum temperature (outdoor probe) of your refrigerator after you place the sampled filter in the refrigerator for storage until shipment. An exposed filter must stay at or beneath 4°C from the time it is retrieved from the site to the time it arrives at the lab. An additional space is given for site operators to record the maximum temperature of the shipping container after it has been packed for return

to the lab. Record the maximum temperatures only after the cooler or refrigerator has equilibrated to a temperature below 4°C.