

**DIVISION OF ENVIRONMENT
QUALITY MANAGEMENT PLAN**

PART III:

**INTERAGENCY MONITORING OF PROTECTED VISUAL
ENVIRONMENTS (IMPROVE) PROTOCOL SAMPLING
STANDARD OPERATING PROCEDURES**

Revision 1

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Section 1

INSTALLATION OF THE VERSION II IMPROVE SAMPLER

I. Overview

This procedure describes installation of the Version II IMPROVE Sampler. The sampler will be installed in an appropriate shelter as described in the *Version II IMPROVE Sampler Operating Procedures Manual* (manufacturer's operating manual).

II. Technical Qualifications

All personnel involved are required to have the necessary experience and training to perform this monitoring activity correctly. A description of the principle of operation, operating parameters, and function of the sampler controller for the Version II IMPROVE Sampler are contained in the manufacturer's operating manual. This information must be reviewed prior to installation or operation of the sampler.

III. Installation Equipment

A. Power tools

1. Electric drill, hole saw, and drill bits
2. Power saw; circular and/or scroller saw

B. Hand tools

1. Assorted screwdrivers
2. Assorted wrenches

IV. Installation Procedure

Prior to the installation of the sampler, the site will be prepared by the local site operator for power and a shelter. The sampler will be housed in the shelter to protect it from direct sunlight and to provide protection for the filters during sample-changing in rain or snow. The shelters at IMPROVE protocol sites will not be heated or air-conditioned. The length of the inlet stacks will be 1.83m at all sites. The sampler will be shipped to the site. Assistance with sampler installation will be provided by a field technician from the

IMPROVE contract laboratory. The following steps are to be followed during sampler installation:

- A. Attach the controller and filter modules to a wall of the shelter.
- B. Cut a hole in the ceiling for the inlets.
- C. Connect the cables between the controller, filter modules, and pumps
- D. Connect the vacuum hoses between the modules and the pumps.
- E. Using the advanced menu, select the appropriate sampling parameters.
- F. Using the advanced menu, calibrate the flow rates of the filter modules. (See Section 4, Flow Rate Calibration)
- G. Attach the sample changing instructions to the inside of the controller door.
- H. Train the site operators and jointly install the initial set of filter cartridges.

VI. Safety Precautions

General safety precautions related to electrical hazards must be observed at all times when working with electrical equipment. Electrical receptacles and equipment must be properly grounded. Use caution when servicing or operating electrical equipment in wet conditions, as frequently encountered at field monitoring sites. Electrical equipment should be switched off and disconnected prior to servicing of internal parts. (Note: Some internal adjustments may require the equipment to be switched on.)

Specific safety procedures are contained in the Ambient Air Monitoring Procedures (Section 17. Field Personnel Safety).

Section 2

SAMPLER CONFIGURATION

I. Overview

Every controller needs to be assigned a configuration. There are currently 2 protocols preloaded in the processor for the IMPROVE network, Wed/Sat and 1-in-3. The current screen displays the protocol in the upper right corner, with 1 = Wed/Sat and 2 = 1-in-3.

II. Technical Qualifications

All personnel involved are required to have the necessary experience and training to perform this monitoring activity correctly. A description of the principle of operation, operating parameters, and function of the sampler controller for the Version II IMPROVE Sampler are contained in the manufacturer's operating manual. This information must be reviewed prior to installation or operation of the sampler.

III. Equipment

No special equipment is needed for sampler configuration.

IV. Sampler Configuration Procedure

A. Open the Configuration Menu.

To enter the configuration menu, press the **↓F2** key in the advanced menu. (From the current status mode, press **ENTER** to reach the main menu. From the main menu press the **←F3** key to enter the advanced menu.) Press the **ENTER** key to return to the main menu and **ENTER** a second time to return to the current status mode.

B. Enter the Sampler Code.

Each sampler will have a code equal to the last four digits of the Inventory Number on the tag inside Module A near the inlet stack. When a digit is entered it will appear on line 3. When four digits are entered a fourth line will say "Site Code Accepted". If an incorrect digit is entered, you may erase it using the backspace key.

C. Set Averaging Time

When a second screen appears asking for the averaging time for the flow rate and temperature sensors, enter 15 minutes. The numbers will appear on the fourth line.

D. Select Protocol 2: IMPROVE: One day in Three Sampling Schedule.

Selecting this program will set the sampler to sample every third day for 24 hours. The start time will always be 00:00 (midnight). The sampler will be changed every Tuesday. Select the following options for the IMPROVE: One day in three protocol.

1. Select **IMPROVE**. Press **ENTER** to save and continue.
2. Select 1/3. Press the **ENTER** key to save and continue.
3. Select **Module Types**. Use the **←F3** and **→F4** keys to move left or right, and the **↑F1** and **↓F2** keys to increase or decrease to letter designation (A, B, C, D, E, S, or nothing).
4. Press the **ENTER** key to save and return to the advanced menu.
5. If any number was entered incorrectly, press the **↓F2** key to rerun the site configuration program.
6. Press the **ENTER** key to return to the main menu and **ENTER** a second time to return to the current status mode.

E. Change Date and Time if necessary.

1. From the AUTO MODE, press **ENTER** to reach the main menu.
2. From the main menu, press the **↓F2** key to enter the change time menu. The item to be changed is underlined. By pressing the **←F3** and **→F4** keys, you can move the underline left or right to the desired category (month, day, year, hour, minute). To increase or decrease the value of the category, use the **↑F1** or **↓F2** key.
3. The day of the week will automatically change with the date.

4. When finished, press the **ENTER** key to record this information and return to the main menu.
5. Press the **ENTER** key a second time to return to the AUTO MODE.

Section 3

FLOW RATE CALIBRATION

I. Overview

This procedure describes the Version II IMPROVE Sampler flow rate calibration. An initial flow rate calibration is performed at installation of the sampler. The site operator will be requested to check the flow rate calibration at approximately six months after installation and at approximately six months after annual maintenance. Detailed instructions and the appropriate equipment will be sent from the IMPROVE contract laboratory. This check will be done more frequently if some problem is detected in the flow rate values.

II. Technical Qualifications

All personnel involved are required to have the necessary experience and training to perform this monitoring activity correctly. A description of the principle of operation, operating parameters, and function of the sampler controller for the Version II IMPROVE Sampler are contained in the manufacturer's operating manual. This information must be reviewed prior to installation or operation of the sampler.

III. Calibration Equipment

- A. Sampler cartridge with four calibration cassettes for each filter type
- B. Calibration log sheets
- C. Electronic calculator
- D. Flow calibration device for the PM_{2.5} and PM₁₀ modules (See Figure 3.1.)
- E. Flow calibration filter cartridge

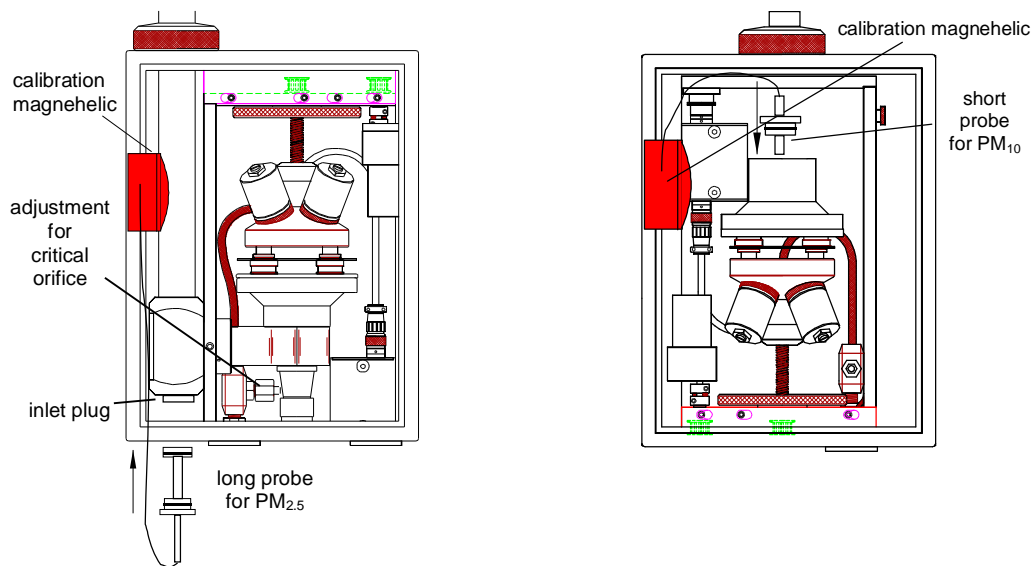


Figure 3.1. Insertion of calibration probe in PM_{2.5} and PM₁₀ modules.

IV. Frequency of Calibration

Field flow calibrations are conducted at least every six months, and when there is a potential problem with flow measurements. A field calibration is performed annually by an IMPROVE contract laboratory field technician during annual maintenance. The site operator performs a field calibration six months after the annual maintenance using a standard calibration device mailed from the IMPROVE contract laboratory.

V. Calibration Procedure

A. Purpose

This procedure is employed in order to calibrate the Version II IMPROVE sampler air flow. The calibration device is an orifice meter with a meter to measure the pressure drop across the orifice. The meter for the standard computer-based device is a transducer similar to that in the Version II sampler. For a system with manual readout, the meter is a magnehelic

gauge similar to that used in the Version I sampler. Calibration units utilized for this procedure are certified by calibration against an NIST-traceable DryCal Flow Calibrator.

B. Calibration

1. This procedure is performed at installation and at least every six months thereafter. Perform this procedure on site.
2. Connect the flow calibration device to the inlet of the sampler. The probe is shortened for the PM₁₀ module by removing the two extreme sections. The magnehelic gauge has a magnetic backing; use this to attach it to the module door in the vertical position.
3. Record the 'zero' reading on the log sheet.
4. Insert the probe in the base of the PM_{2.5} inlet or in the top of the PM₁₀ inlet manifold, as shown in Figure 3.1.
5. Install a calibration filter cartridge. The calibration cassette in position 1 contains a standard filter for the module. The other positions have different pressure drops to vary the flow rate through the module in the same way that a loaded filter would decrease the flow rate.
6. Enter the appropriate Calibration Controller commands.
 - a. From the operational/current status mode, press **ENTER** to reach the main menu.
 - b. From the main menu, press the **←F3** key to enter the advanced menu.
 - c. From the advanced menu, press the **↓F2** key to enter the calibration menu.
 - d. Pressing the **←F3** and **→F4** key will move backward or forward between filters.
 - e. When the calibration is completed, press the **ENTER** key to return to the main menu and **ENTER** to return to the current status mode.

- f. The controller will keep the solenoid for this filter open until the next solenoid is requested.
7. Adjust the nominal flow rate.

Warning: Once sampling has begun, do not adjust the critical orifice until after you have made a full four-point calibration of the current settings.

The nominal flow rate is adjusted by varying the diameter of the critical orifice. This is done using the filter in the first position. After adjustment a full calibration must be done.

The appropriate nominal flow rate would be one that gave a flow rate of 22.8 L/min at the mean temperature of the network, which is approximately 15°C. The nominal flow rate will be set to give a flow rate of 23 L/min at 20°C. This corresponds to 22.8 L/min at 15°C.

- a. Record the reading for the nominal flow rate on the calibration log sheet. The elevation factors as a function of elevation are listed in Table 3.1.
- b. Rotate the black knob on the critical orifice until the calibration magnehelic gauge has the desired reading.
- c. Record the final measurements on the log sheet.

Table 3.1. Elevation factors as a function of elevation in meters.

meters	feet	F(elev)	P	meters	feet	F(elev)	P	meters	feet	F(elev)	P
0	0	1.000	29.90	1200	3,936	1.075	25.88	2400	7,872	1.158	22.32
50	164	1.003	29.72	1250	4,100	1.078	25.73	2450	8,036	1.161	22.18
100	328	1.006	29.55	1300	4,264	1.081	25.57	2500	8,200	1.165	22.04
150	492	1.009	29.37	1350	4,428	1.085	25.41	2550	8,364	1.168	21.90
200	656	1.012	29.20	1400	4,592	1.088	25.26	2600	8,528	1.172	21.76
250	820	1.015	29.02	1450	4,756	1.091	25.10	2650	8,692	1.176	21.63
300	984	1.018	28.85	1500	4,920	1.095	24.95	2700	8,856	1.180	21.49
350	1,148	1.021	28.68	1550	5,084	1.098	24.80	2750	9,020	1.183	21.35
400	1,312	1.024	28.51	1600	5,248	1.101	24.65	2800	9,184	1.187	21.22
450	1,476	1.027	28.34	1650	5,412	1.105	24.49	2850	9,348	1.191	21.09
500	1,640	1.030	28.17	1700	5,576	1.108	24.34	2900	9,512	1.195	20.95
550	1,804	1.033	28.00	1750	5,740	1.112	24.19	2950	9,676	1.198	20.82
600	1,968	1.036	27.83	1800	5,904	1.115	24.05	3000	9,840	1.202	20.69
650	2,132	1.040	27.67	1850	6,068	1.119	23.90	3050	10,004	1.206	20.56
700	2,296	1.043	27.50	1900	6,232	1.122	23.75	3100	10,168	1.210	20.43
750	2,460	1.046	27.34	1950	6,396	1.126	23.60	3150	10,332	1.214	20.30
800	2,624	1.049	27.17	2000	6,560	1.129	23.46	3200	10,496	1.218	20.17
850	2,788	1.052	27.01	2050	6,724	1.133	23.31	3250	10,660	1.221	20.04
900	2,952	1.055	26.84	2100	6,888	1.136	23.17	3300	10,824	1.225	19.91
950	3,116	1.059	26.68	2150	7,052	1.140	23.02	3350	10,988	1.229	19.79
1000	3,280	1.062	26.52	2200	7,216	1.143	22.88	3400	11,152	1.233	19.66
1050	3,444	1.065	26.36	2250	7,380	1.147	22.74	3450	11,316	1.237	19.53
1100	3,608	1.068	26.20	2300	7,544	1.150	22.60	3500	11,480	1.241	19.41
1150	3,772	1.072	26.04	2350	7,708	1.154	22.46	3550	11,644	1.245	19.28
1200	3,936	1.075	25.88	2400	7,872	1.158	22.32	3600	11,808	1.249	19.16

8. Perform a four-point calibration.
 - a. Record on the calibration logsheet the calibration magnehelic readings and the system readings from the terminal display. Calculate the flow rates corrected to 20°C and sea level with the following equation:

$$Q = 10^{a_o} (\Delta P_o)^{b_o},$$

using the readings from the *Calibration Magnehelic ("H2O)* column and the constants for the calibration magnehelic. Write these in the second column, *Calibration Flow Rate (L/min)*.

- b. Repeat for the other three filters, using the YES button to shift between solenoids.
- c. Perform a regression of the log of the calibration flow rate (y) as a function of the log of the sampler magnehelic reading (x). A reasonable fit yields a correlation coefficient (r^2) of 0.999. The constant a for the sampler magnehelic is the intercept, while the constant b is the slope. Record on log sheet.
- d. Perform a regression of the calibration flow rate (y) as a function of the small gauge reading (x). Do **not** use logs. A reasonable fit yields a correlation coefficient (r^2) of 0.999. The constant c for the small gauge is the intercept, while the constant d is the slope.
- e. If the calibration is unacceptable you will have to cycle through all the modules to get back to this module.
- f. When satisfied with the calibration, replace the calibration cassettes with the regular sampling cassettes.

VI. Safety Precautions

General safety precautions related to electrical hazards must be observed at all times when working with electrical equipment. Electrical receptacles and equipment must be properly grounded. Use caution when servicing or operating electrical equipment in wet conditions, as frequently encountered at field monitoring sites. Electrical equipment should be switched off and disconnected prior to servicing of internal parts. (Note: Some internal adjustments may require the equipment to be switched on.)

Specific safety procedures are contained in the Ambient Air Monitoring Procedures (Section 17. Field Personnel Safety).

Section 4

FLOW RATE AUDIT

I. Overview

The relative precision in the flow rate can be estimated from flow audits and from an examination of possible sources of variability. Accuracy is influenced by the degree of random error (precision) and systematic error (bias) inherent in the measurement operation (e.g., environmental sampling and analytical operations). Accuracy is determined by comparing instruments to reference standards traceable to the National Institute of Standards and Technology (NIST). The reference standard for flow rate is an NIST-traceable DryCal Flow Calibrator.

II. Technical Qualifications

All personnel involved are required to have the necessary experience and training to perform this monitoring activity correctly. A description of the principle of operation, operating parameters, and function of the sampler controller for the Version II IMPROVE Sampler are contained in the manufacturer's operating manual. This information must be reviewed prior to installation or operation of the sampler.

III. Flow Audit Equipment

- A. Sampler cartridge with four calibration cassettes for each filter type
- B. Calibration log sheets
- C. Flow audit kit
 - 1. Calibrated flow audit device
 - 2. Calibration cassettes in cartridges
 - 3. Memory card

IV. Frequency of Flow Audits

Audit devices will be shipped from the contract laboratory every six months. Site operators or KDHE Ambient Air Monitoring technical staff will conduct flow audits. At a minimum, flow audits will be performed as scheduled.

V. Audit Procedure

Sampler airflow accuracy is maintained by referencing all field calibration devices to a DryCal Flow Calibrator that is certified NIST traceable. The results are verified using a dry gas meter. The contract laboratory maintains a set of calibration orifice meters for field and mail calibrations. All calibration devices are calibrated by the contract laboratory using the same reference flow calibrator. The calibration of each device is verified before and after each use. Problem situations will be examined and a solution will be found to correct the problem.

- A. Install the calibration cartridge.
- B. Install the audit device.
- C. Initiate the calibration audit sequence. (See Section 3, Flow Rate Calibration.) Upon completion of sampling, the microprocessor will calculate the audit parameters and compare them with the previous parameters.
- D. Record the results on a Sampler Field Audit Form.
- E. If values have changed by more than $\pm 5\%$, perform a complete four-point calibration.

VI. Safety Precautions

General safety precautions related to electrical hazards must be observed at all times when working with electrical equipment. Electrical receptacles and equipment must be properly grounded. Use caution when servicing or operating electrical equipment in wet conditions, as frequently encountered at field monitoring sites. Electrical equipment should be switched off and disconnected prior to servicing of internal parts. (Note: Some internal adjustments may require the equipment to be switched on.)

Specific safety procedures are contained in the Ambient Air Monitoring Procedures (Section 17. Field Personnel Safety).

Section 5

FIELD OPERATION AND WEEKLY SAMPLE CHANGES

I. Overview

The operator will receive a "Blue Box" shipping container from the IMPROVE contract laboratory every three weeks. Inside will be three resealable bags each containing the filters for one week and the corresponding log sheet. The bag will be labeled with the date that the filters are to be installed. The Blue Box will be labeled with all three dates. The Blue Box will also have a memory card in a pouch on the inside of the top cover. In each bag there will be cartridges, with four cassettes per cartridge. The cartridges will be color-coded for each module: A = red, B = yellow, C = green, D = blue.

Most sites will have two Blue Boxes, one being used at the site, and the other in transport or waiting at the site. The Blue Box should be received 10 days before the first sample-change day. At sites with possible delays in mail, there will be more than two Blue Boxes in the system. If the appropriate box is not present by the change date, the operator should contact the contract laboratory (530.752.1123).

Before going to the site, the operator must check the dates on the Blue Box(es). If the first date on the new Blue Box is today's date, the operator should bring both this Blue Box and the previous Blue Box.

Detailed sample changing and operating instructions appear in Section 4 of the manufacturer's operating manual.

II. Technical Qualifications

All personnel involved are required to have the necessary experience and training to perform this monitoring activity correctly. A description of the principle of operation, operating parameters, and function of the sampler controller for the Version II IMPROVE Sampler are contained in the manufacturer's operating manual. This information must be reviewed prior to installation or operation of the sampler.

III. Equipment

- A. "Blue Box" shipping container

1. Color-coded filter cartridges
2. Memory card

B. Sampler log sheet(s)

IV. Frequency of Sample Changes

Sample changes are made on a weekly basis.

V. Weekly Sample Changes

The filters are loaded into cassettes and cartridges at the central laboratory. All cassettes have caps to protect sample integrity. All the cartridges and the log sheet for a given change are enclosed in a resealable bag with the date of the sample change. Three bags will be shipped to and from the site in a “Blue Box” shipping container, labeled with all the sample changing dates.

The IMPROVE network will operate according to a one-day-in-three sampling schedule, with sample changes occurring on Tuesdays. This schedule will necessitate that the arrangement of ambient filters will vary slightly for each week, with the pattern repeating every third week. Each Blue Box will contain three bags, three log sheets, a one memory card. Shipments will be made every three weeks. The three types of cartridges to be shipped are listed in Table 5.1. All cartridges will be labeled with the appropriate Tuesday sample-changing date.

Table 5.1. Types of cartridges for 1-day-in-3 sampling.

cartridge type	position 1	position 2	position 3	position 4
Type 1	Thursday	Sunday	unused	unused or field blank
Type 2	Wednesday	Saturday	Tuesday	unused or field blank
Type 3	Friday	Monday	empty hole	unused or field blank

For two of the three weeks, the sampler will not be operating on the sample-changing day. For these sample changes, the operator records the final readings, replaces the old cartridges with new cartridges, and records the initial readings. The only difference is that there will be initial or final readings for the filter in position 3 on two of the three weeks. The log sheet and display will indicate when the values for position 3 are to be recorded.

The procedures are different every third week. In this case, the sampler will be operating when the operator arrives. When the operator presses the buttons to start the sample change, the controller will suspend sampling, read the flow rates for all the filters and display the information to be recorded. For this change, the operator will have to transfer the cassette in position 3 from the old cartridge to the new. The key information for the operator is that the new cartridges will not have any cassette in position 3. The cassette in position 3 has a black O-ring attaching it, and is the only one that can be removed without a special tool. After the cassette is transferred, the new cartridge is installed. After the initial readings are taken, the sampler will resume collection on the filters in position 3.

The field blanks in position 4 are completely transparent to the site operator and to the sampler controller. Flow rate measurements are not taken for field blanks.

VII. Sample Changing in the Field

- A. Initiate the changing sequence by pressing the **ENTER** and **↑F1** keys.
- B. Record the general data shown on the controller display, then press the **ENTER** key.
- C. Record the Final Readings for each exposed filter, using the **→F4** key to move to the next filter. When finished check that all blanks in the log sheet are filled in and the numbers are reasonable. If okay, press the **→F4** key. To redo the readings, press the **←F3** key.
- D1. If this is not a sampling day. (Two out every three weeks; the sampler is not running.) Remove the cartridge of exposed cassettes from each module and replace it with a cartridge of clean cassettes. Do not remove any cassettes from their cartridges. When finished press the **ENTER** key.
- D2. If this is a sampling day. (Every third week; the sampler should be running.) The old cartridges will have a black O-ring in position 3 and the new cartridges have holes in position 3. Remove the old cartridge from the sampler. Move the cassette in position 3 of the old cartridge to the hole in the new cartridge. This cassette is held in with a black O-ring and is the only cassette that can be easily removed. Install the new cartridge. When finished check that all blanks on the right side of the log sheet are filled in and the numbers are reasonable. If okay, press the **ENTER** key.

- E. If today's bag is the first in a new blue box, remove the memory card from the controller and place it in the pouch of the old blue box. Remove the memory card from the new box and place in the controller. If there is no memory card in the new box, leave the old one in the controller.
- F. Record the Initial Readings for each clean filter, using the →F4 key to move to the next filter. When finished check that all blanks in the log sheet are filled in and the numbers are reasonable. If okay, press the →F4 key. To redo the readings, press the ←F3 key. The sampler will automatically return to the current status (operational) mode.

VI. Safety Precautions

General safety precautions related to electrical hazards must be observed at all times when working with electrical equipment. Electrical receptacles and equipment must be properly grounded. Use caution when servicing or operating electrical equipment in wet conditions, as frequently encountered at field monitoring sites. Electrical equipment should be switched off and disconnected prior to servicing of internal parts. (Note: Some internal adjustments may require the equipment to be switched on.)

Specific safety procedures are contained in the Ambient Air Monitoring Procedures (Section 17. Field Personnel Safety).

Section 6

SAMPLER MAINTENANCE

I. Overview

This section describes routine preventive maintenance for the Version II IMPROVE sampler. Routine sampler maintenance is performed by the site operator. Maintenance activities are conducted in accordance with *IMPROVE Standard Operating Procedure, SOP201-3: Sampler Maintenance by Site Operators*; Crocker Nuclear Laboratory, University of California; Davis, CA; June 28, 2005. Ambient Air Monitoring technical staff from KDHE will maintain the IMPROVE sampler at the Flint Hills site and assist the KDWP site operator at Cedar Bluff State Park. Sampler maintenance will also be performed annually by a field technician from the IMPROVE contract laboratory.

II. Technical Qualifications

All personnel involved are required to have the necessary experience and training to perform this monitoring activity correctly. A description of the principle of operation, operating parameters, and function of the sampler controller for the Version II IMPROVE Sampler are contained in the manufacturer's operating manual. This information must be reviewed prior to installation or operation of the sampler.

III. Equipment

- A. Cleaning supplies
- B. Maintenance and repair tool kit

IV. Maintenance Procedures

- A. Check all sampler functions, including solenoid action, vacuum pressure, keypad function, and electronic control.
- B. Calibrate the flow rates of the filter modules.
- C. Adjust flow rates if necessary.

- D. Clean the sampler.
 - 1. Clean the inlet head.
 - 2. Clean the inlet stack.
 - 3. Clean the internal cyclone.
- E. Replace worn or damaged parts where needed.
- F. Make scheduled modifications to the sampler and controller program.
- G. Reset system clocks if necessary.
- H. Calibrate the flow rates of the filter modules a second time.
- I. Review and discuss procedures with the site operator.
- J. Provide any necessary training for new site operators.

VI. Safety Precautions

General safety precautions related to electrical hazards must be observed at all times when working with electrical equipment. Electrical receptacles and equipment must be properly grounded. Use caution when servicing or operating electrical equipment in wet conditions, as frequently encountered at field monitoring sites. Electrical equipment should be switched off and disconnected prior to servicing of internal parts. (Note: Some internal adjustments may require the equipment to be switched on.)

Specific safety procedures are contained in the Ambient Air Monitoring Procedures (Section 17. Field Personnel Safety).

Section 7

TROUBLESHOOTING

I. Overview

This section describes the procedures to be used by monitoring personnel when troubleshooting problems with the Version II IMPROVE Sampler. If time and weather conditions permit, please try the steps listed below for common sampler problems before calling the IMPROVE contract laboratory: Phone 530.752.1123, FAX 530.752.4107, e-mail fieldops@crocker.ucdavis.edu.

II. Technical Qualifications

All personnel involved are required to have the necessary experience and training to perform this monitoring activity correctly. A description of the principle of operation, operating parameters, and function of the sampler controller for the Version II IMPROVE Sampler are contained in the manufacturer's operating manual. This information must be reviewed prior to installation or operation of the sampler.

III. Troubleshooting Procedure

A. Missed change day.

1. If there are remaining sampling days in the week:

remove the exposed filters as would normally be done and put in the clean filters that were to have been installed on the last change day. Make a note on the log sheet.

2. If the week is completely missed:

remove the exposed filters as would normally be done but do not put in the filters for the missed change day. Keep these in the shipping box and send them back to the contract laboratory when both weeks in that box have passed. Install the appropriate filters for the current week. Make a note on the logsheet of the filters that were not installed.

B. The display is blank.

1. Power may be out.

- a. Check main circuit breaker, cycle it off and on if you are unsure if it has blown.
- b. Check power strip that sampler and pumps are plugged in to (this may be located inside the pump enclosure). There should be a switch on the power strip. If it is not lit, turn it off and then on again.
- c. Check the power cord for the sampler. This black cord runs from the base of the control module to the power strip. If it is unplugged, reconnect it.
- d. If you are still not sure if power is on:
 - i. Unplug one of the pumps from its outlet box.
 - ii. Disconnect the silver vacuum hose connecter from the top of the pump.
 - iii. Plug the pump cord directly into the power strip. It should start if there is power.
 - iv. Reconnect the vacuum hose and plug the pump back into the duplex outlet box.

2. Sometimes the display gets too cold. If this is a possible problem, remove the keypad by disconnecting the phone jack on the back and allow it to warm up.

C. The Elapsed time reads zero.

Check the following to determine why sampling did not occur on the scheduled day. Indicate problem on log sheet. If the cause of the problem cannot be determined, call the IMPROVE contract laboratory at 530.752.1123 as soon as possible.

1. Check that the date and time on the controller screen are correct. Adjust if necessary using menu option F2.

2. If possible, check whether there was a power outage for the entire day.
 3. Look at the Module A filter—can any sample be seen? Even if clean, do not reuse the filter.
- D. Pump will not start.
1. Check that the pumps are all plugged in (the outlet box that the pump is plugged into may have a switch on it but this does not control the pump power).
 2. Test the pump that is not starting by doing the following:
 - a. Unplug one of the pumps from its outlet box.
 - b. Disconnect the silver vacuum hose connecter from the top of the pump.
 - c. Plug it the pump cord directly into the power strip. It should start if there is power.
 - d. Reconnect the vacuum hose and plug the pump back into the duplex outlet box.
 3. Extreme cold may prevent pumps from starting. Remove pump to warm location (or come back when the weather is warmer) and test. If cold may be a problem:
 - a. Run pumps continuously by plugging into unswitched outlets (power strip or wall outlet).
 - b. Keep pumps warm by placing an automotive electric blanket or other heat source under the pumps.
- E. The motor drive is not working.

You can raise and lower the cassette assembly using the hand wheel. Before this can be done, it is necessary to disengage the motor drive. For the PM_{2.5} module, push down on the top of the drive while pulling the bottom toward yourself. Then swing the motor to the left to lock it in the disengaged position. The hand wheel may now be

used to raise or lower the solenoid manifold. The procedure is the same for the PM₁₀ module (D), except the motor is upside down compared to the PM_{2.5} modules. Notify the IMPROVE contract laboratory by calling or making a note on the log sheet.

- F. The temperature probes give incorrect readings.

Use an external thermometer and write the readings of both the internal probe and the external thermometer on the logsheet. Please note whether readings are in Fahrenheit or Centigrade.

IV. Safety Precautions

General safety precautions related to electrical hazards must be observed at all times when working with electrical equipment. Electrical receptacles and equipment must be properly grounded. Use caution when servicing or operating electrical equipment in wet conditions, as frequently encountered at field monitoring sites. Electrical equipment should be switched off and disconnected prior to servicing of internal parts. (Note: Some internal adjustments may require the equipment to be switched on.)

Specific safety procedures are contained in the Ambient Air Monitoring Procedures (Section 17. Field Personnel Safety).

Section 8

TRAINING

I. Overview

This section describes the required training for operation of the Version II IMPROVE sampler.

II. Technical Qualifications

- A. All personnel involved are required to have the necessary experience and training to perform monitoring activities correctly. A description of the principle of operation, operating parameters, and function of the sampler controller for the Version II IMPROVE Sampler are contained in the manufacturer's operating manual. This information must be reviewed prior to installation or operation of the sampler.
- B. Computer skills are essential for programming many types of monitors/samplers and for problem diagnosis and troubleshooting. Persons operating many types monitors/samplers must have PC (and/or Laptop and/or Palmtop) computer skills to input commands and download data.
- C. Working familiarity with electronic and mechanical test equipment and procedures is required in order to troubleshoot and repair samplers.

III. Training Procedures

A. Required Reading

All KDHE Monitoring and Planning Section (MPS) technical staff and Kansas Department of Wildlife and Parks (KDWP) operators for the Cedar Bluff State Park site shall read each of the following documents:

1. *IMPROVE Protocol Sampling Quality Assurance Program Plan (QAPP)*;
2. *IMPROVE Protocol Sampling Standard Operating Procedures (i.e., these SOPs)*; and

3. *Version II IMPROVE Sampler Operating Procedures Manual.*

B. Practical Training

1. Self-instructional

- a. Immediate access to the Version II IMPROVE sampler during this phase is recommended. Printed materials intended for study include the documents listed above.
- b. Obtain access to a samplers. This is recommended in order to:
 - i. Develop familiarity with the sampler; and
 - ii. Provide initial hands-on experience in preparation for the practical phase of training.

2. Training from IMPROVE contract laboratory

- a. At the time of sampler installation, site operators shall receive initial training in operation of the Version II IMPROVE sampler from an IMPROVE contract laboratory field technician.
- b. The IMPROVE technician will also review and discuss procedures with site operators at annual maintenance visits.

3. On-the-job Training (OJT)

- a. Overlap of OJT with self-study of printed materials may be necessary and may facilitate learning. OJT provides hands-on experience that is derived from activities in the shop as well as in the field. OJT will be used for all personnel. The trainee will perform the following steps in order to complete OJT for a task.
- b. Observe an experienced person doing the necessary task.
- c. Study any available operational procedures for the task.

- d. Perform the task under the direct supervision of an experienced person.
- e. Repeat the above steps until the supervisor judges the performance of the trainee to be satisfactory.
- f. When working in the field with technical equipment and scientific instrumentation, unique problems may arise for which there is no precedent. The solutions to such problems must be achieved through application of paragraph 3.c above in conjunction with consultation with coworkers.

C. Continuing Education

Continuing educational courses, workshops, or symposia offered by colleges, vocational educational institutions, or various governmental agencies may be attended by appropriate staff. In order for an employee to participate, the subject matter must be applicable to a program or project, funding must be available, and supervisory and administrative approval must be secured in advance.

Any conferences or workshops on IMPROVE protocol aerosol sampling will be attended if funding can be arranged. Usually only one person will attend such events (he/she relays the information to applicable personnel after returning to the office) in order to conserve resources.

Satellite downlinks on air monitoring are occasionally available in the office. These are attended by air monitoring personnel.

D. General Field Training Requirements

1. Practical training is emphasized. This includes on-the-job training (OJT) and hands-on experience for each of the following:
 - a. sampler operation;
 - b. data collection;
 - b. maintenance;
 - c. calibration; and

d. major repair

2. To ensure consistent operation of IMPROVE samplers within the Kansas Ambient Air Monitoring Network, all site operators must demonstrate proficiency in sampler calibration, operation, and data collection to the KDHE Field Technician Supervisor. KDHE/BAR will train, assist, and observe all new operators.
3. The Field Technician Supervisor will randomly accompany site operators to observe their on-site procedures.

E. Health and Safety Warnings

1. General safety precautions related to electrical hazards must be observed at all times when working with electronic equipment. Electrical receptacles and equipment must be properly grounded. Use caution when servicing or operating electronic equipment in wet conditions, as frequently encountered at field monitoring sites.
2. General precautions for working with heavy equipment, and electro/mechanical equipment with moving parts must be observed.

Specific safety procedures are contained in the Ambient Air Monitoring Procedures (Section 17. Field Personnel Safety).

F. Cautions

Although field equipment is manufactured to withstand environmental extremes, it is precision equipment with relatively fragile electronic and mechanical parts. All field equipment used for environmental measurements should be handled with care.

Section 9

CORRECTIVE ACTION

I. Overview

This procedure is intended to provide guidance for action to be taken if procedures or equipment show anomalous results.

II. Technical Qualifications

All personnel involved are required to have the necessary experience and training to perform this monitoring activity correctly. A description of the principle of operation, operating parameters, and function of the sampler controller for the Version II IMPROVE Sampler are contained in the manufacturer's operating manual. This information must be reviewed prior to installation or operation of the sampler.

III. Determination of Appropriate Corrective Action

Possible Quality Control (QC) failures and appropriate corrective actions appear below in Table 9.1.

Table 9.1. Possible QC Failures and the Associated Corrective Actions.

Instrument	QC Failure	Corrective Actions
Field Instrument		
IMPROVE Sampler	Site not serviced	If sample days remain then change cassettes and record time missed on log sheet. If no sample days remain then change to current cassette and record days missed on log sheet.
	Equipment malfunctions	Use troubleshooting guide in manual to determine corrective action. Call contract laboratory if further assistance is needed. (the Laboratory Manager will help fix the problem or send replacement units with repair instructions.)
	Display values outside operating range	Record values on log sheet. Call contract laboratory to determine cause.
	New cartridge missing or mislabeled	Call contract laboratory to receive a new box of cartridges or to determine correct labeling.
Field Documentation		
IMPROVE Sampler	Log sheet missing	Call contract laboratory to receive a new log sheet.
	Log sheet improperly completed or incorrect	Laboratory staff searches out the correct values and flags the data as questionable. If values are unknown, the sample is discarded.

Appendix A

REFERENCES

1. *IMPROVE Particulate Monitoring Network Procedures for Site Selection*; Crocker Nuclear Laboratory, University of California; Davis, CA; February 24, 1999.
2. *IMPROVE Protocol Sampling Quality Assurance Program Plan (QAPP)*; Kansas Department of Health and Environment; Topeka, KS; Revision 1; January 2006.
3. *Version II IMPROVE Sampler Operating Procedures Manual*; Crocker Nuclear Laboratory, University of California; Davis, CA; v02.01.01: January 2001.
4. *IMPROVE Standard Operating Procedure, SOP201-3: Sampler Maintenance by Site Operators*; Crocker Nuclear Laboratory, University of California; Davis, CA; June 28, 2005.