

**IMPROVE  
STANDARD OPERATING PROCEDURES**

**SOP 201  
Sampler Maintenance by Site Operators**

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**Technical References**

- TI 201A IMPROVE Aerosol Sampler Operations Manual
- TI 201B Forms for Flow Rate Audits by Site Operators
- TI 176A Calibration of Audit Devices Using Spirometer
- TI 176B Flow Rate Audit Calculations
- TI 176C Flow Rate Audits and Adjustment

## **1.0 PURPOSE AND APPLICABILITY**

This standard operating procedure (SOP) describes the procedures and schedules for maintenance of equipment in the IMPROVE aerosol sampling network. Weekly maintenance is primarily the responsibility of the site operator, though any deviations from expected behavior are reported to and solved in conjunction with the lab manager or field specialist. Repairs are generally performed by the site operator under the supervision of the field specialist. Similarly, biannual audits are performed by the site operator under the supervision of Air Quality Group personnel. In all cases, the site operator is fully supported by Air Quality Group personnel over phone or fax lines. If a malfunction is complex or dangerous to repair, the Field Specialist will send a Field Technician to the site to resolve the malfunction.

The procedural steps for weekly maintenance and repairs performed by the site operator are included in TI 201A IMPROVE Aerosol Sampler Manual.

Biannual audits are performed to verify the flow calibration equations for the aerosol sampling modules at the site. The audit devices are sent through the mail, and the audit is performed by the site operator. If the site calibration equations are abnormal, a complete four point audit for each module is taken. The steps are outlined in TI 201A IMPROVE Aerosol Sampler Manual, and the forms included in TI 201B.

## **2.0 RESPONSIBILITIES**

### **2.1 Field Specialist**

The field specialist shall:

- oversee and maintain records on site and sampler operation
- recommend and oversee emergency maintenance when appropriate.
- schedule and review flow rate audits

### **2.2 Lab Manager**

The lab manager shall:

- review operator comments on log sheets
- review sampler readings on all log sheets to ensure validity of the samples
- track shipments of filter cassettes to and from the sites
- provide information and assistance, as required, to site operators
- contact field specialist when problems requiring maintenance are encountered
- take corrective action as necessary.

### **2.3 Site Operator**

The site operator shall:

- perform routine weekly maintenance
- perform emergency repairs as instructed by Field Specialist
- note deviations from normal operation and inform Air Quality Group personnel
- perform flow rate audits as directed by Air Quality Group personnel

### **3.0 REQUIRED EQUIPMENT AND MATERIALS**

The equipment and materials required to perform maintenance and audits have been separated by activity into the sections listed below.

3.1 Weekly Site Maintenance

3.2 Operator Assisted Determination and Repair of Malfunctioning Samplers

3.3 Biannual Audits

#### **3.1 Weekly Site Maintenance**

The materials required to perform weekly site maintenance at an IMPROVE site include:

- Blue shipping box containing the cassette shipping bag, the red filter protecting caps, and the log sheet for the exposed filter cassettes currently in the IMPROVE sampler.
- Blue shipping box, labeled with the Tuesday date for the current week, containing a log sheet and unexposed filter cassettes for the IMPROVE sampler.
- Writing implement.
- IMPROVE Sampler Manual.

#### **3.2 Operator Assisted Determination and Repair of Malfunctioning Samplers**

The following materials are those most commonly required for emergency maintenance.

- IMPROVE Sampler Manual.
- Parts and/or instructions from Air Quality Group personnel
- Voltmeter (AC)
- Crescent wrench
- Screwdrivers, both Phillips and Standard
- Needle nose pliers
- Wire clipper and crimping tool
- Note paper and pencil or pen to record action taken and results to forward to the Air Quality Group.

#### **3.3 Flow Rate Audits and Calibrations**

The following materials will be mailed to the site operator when a flow rate audit or calibration is required

- Four calibration cassettes.
- One audit device (orifice meter )
- Audit instructions and worksheet.

## **4.0 METHODS**

This standard operating procedure has three subsections describing weekly maintenance procedures and sampler troubleshooting and repair procedures.

- 4.1 Weekly Maintenance Procedures
- 4.2 Operator Assisted Determination and Repair of Malfunctioning Samplers
- 4.3 Flow Rate Audit and Calibration Procedures

### **4.1 Weekly Maintenance Procedures**

The procedures for weekly maintenance at an IMPROVE site are listed in TI 201A IMPROVE Aerosol Sampler Manual.

### **4.2 Operator Assisted Determination and Repair of Malfunctioning Samplers**

The procedure for determining and repairing potential malfunctions at an IMPROVE site are listed in TI 201A IMPROVE Aerosol Sampler Manual.

### **4.3 Flow Rate Audit and Calibration Procedures**

Flow audits at IMPROVE sampling sites are performed whenever the gauges on the sampler indicate a potential error in the flow rate. Also, nominal flow audits are performed at randomly selected sites biannually. If an audit indicates the calculated flow rates in a module are off more than 5%, the module is re-calibrated. The procedures for site audits and calibrations are as follows.

- 4.3.1 Preparation of flow rate audit materials
- 4.3.2 Procedures for sites having anomalous flow readings
- 4.3.3 Biannual flow rate audit procedures

#### **4.3.1 Preparation of Flow Rate Audit and Calibration Materials**

- 1) Check calibration of one of the audit devices (orifice meters) with the spirometer following the procedures of TI 176A. If the flow rates are not within 2% of the previous calibration, re-calibrate the audit device.
- 2) Construct a set of 4 calibration cassettes for each module being audited, as indicated in Table 8: Calibration Filters for Pressure Drop Simulations.
  - Calibrated disks are prepared, tested, and stored by the Field Specialist or Lab Manager
  - Calibrated disks are mounted in the cassette above a polyolefin ring of the type used in Teflo™ filters.
  - The cassettes must be carefully labeled with the number and the module for which they are intended.
  - Recall mask size M0 creates a deposit area (area of filter through which air flows freely) of 3.6 cm<sup>2</sup>. Mask M1 has area 2.2 cm<sup>2</sup>.

- 3) Determine the appropriate instruction sheet from Table 7 below, and print a copy from the directory *v:\AQG\_Ops\Improve\Field\_Information\mailaudt*. Fill in the site name and magnehelic ID#. Hardcopies of the current forms are included in TI 201B.

**Table 7 Audit Instruction Forms**

<b>Purpose</b>	<b>filename</b>
anomalous flow rates for PM <sub>2.5</sub> modules A, B, or C (initial audit, revise nominal flow rate, final audit)	Mod_ABC_Audit,Set,Cal.doc
anomalous flow rates for PM <sub>10</sub> module D (initial audit, revise nominal flow rate, final audit)	Mod_D_Audit,Set,Cal.doc
Quality Assurance check (biannual audit)	1point.doc

- 4) Pack the audit device in a black magnehelic shipping box with the hose disconnected at the gauge end and wrapped around the probe.
- 5) If the **D** or **D+S** module is being audited or calibrated, include a PM10 funnel with the audit device.
- 6) Pack the black box, the calibration cassettes, the D module materials, and the instruction sheet in a padded blue box. Attach a reversible mailing label and send it out to the site.
- 7) **Record the site code, date and magnehelic ID** in the excel file *V:\field\audits\mail96.xls*.

**Table 8 Calibration Filters for Pressure Drop Simulations**

	<b>Filter #</b>	<b>Audit Cassette Parts</b>	<b>Pressure Drop</b>
<b>Module A</b>	1	M1 Nominal Teflo™ filter	1” Hg
	2	Disk with 7/64” calibrated hole	2” Hg
	3	Disk with #38 calibrated hole	3” Hg
	4	Disk with #44 calibrated hole	4.5” Hg
<b>Module B</b>	1	Nominal Nylasorb™	13” Hg
	2	Disk with #52 calibrated hole	15” Hg
	3	Disk with 1/16” calibrated hole	17” Hg
	4	Disk with #44 calibrated hole	11” Hg
<b>Module C</b>	1	Nominal Quartz	2.5” Hg
	2	Disk with #41 calibrated hole	5” Hg
	3	Disk with #44 calibrated hole	7” Hg
	4	Disk with 5/64” calibrated hole	9” Hg

	<b>PM<sub>10</sub> Inlet Flow Rate</b>	<b>Filter #</b>	<b>Audit Cassette Parts</b>	<b>Pressure Drop</b>
<b>Module D</b>	Wedding (18.9 lpm)	1	M0 nominal Teflo™ filter	1” Hg
		2	Disk with 7/64” calibrated hole	2” Hg
		3	Disk with #38 calibrated hole	3” Hg
		4	Disk with #44 calibrated hole	4” Hg
	Sierra/Andersen (16.7 lpm)	1	M0 nominal Teflo™ filter	0.5” Hg
		2	Disk with #38 calibrated hole	1” Hg
		3	Disk with #44 calibrated hole	2” Hg
		4	Disk with #50 calibrated hole	3” Hg
<b>Module D/S</b>	Wedding (18.9 lpm)	1	Disk with #44 calibrated hole	5” Hg
		2	Disk with #49 calibrated hole	7” Hg
		3	Disk with #52 calibrated hole	9” Hg
		4	Disk with #53 calibrated hole	11” Hg
	Sierra/Andersen (16.7 lpm)	1	Disk with #46 calibrated hole	4” Hg
		2	Disk with #50 calibrated hole	6” Hg
		3	Disk with 1/16” calibrated hole	8” Hg
		4	Disk with #55 calibrated hole	10” Hg



### 4.3.2 Procedures for Sites having Anomalous Flow Rates

The flow rates are calculated from the log sheet readings recorded by the site operator. If these readings appear to be anomalous, or the flows derived from the two gauges do not agree, the site is marked as having a suspected flow problem. The procedures followed to resolve the problem are as follows:

1. Request that the site operator check for leaks in the vacuum system following the instructions in TI 201A IMPROVE Aerosol Sampler Manual. Request that the operator perform the procedure as soon as possible and phone or fax the Air Quality Group with the results. If the site operator does not have the instructions, fax a copy immediately.
2. If the flow remains anomalous, an audit device (orifice meter), four audit cassettes, and the appropriate instruction form are sent to the operator. If the PM<sub>10</sub> module (D) is involved, include an audit funnel. The instruction form is specified in Table 6.
  - a. The flow rate audit will indicate whether the system calibration equations are valid.
    - If the audit indicates the calibration equations for the system gauges are incorrect, the audit will provide the data necessary to reconstruct a calibration equation valid for the samples collected under the anomalous conditions.
    - If the audit indicates the flow rate through the sampler is incorrect, the data will be flagged if any of the following conditions apply.
      - For Modules A, B, or C,
        - if the resultant cut point is above 3.0  $\mu\text{m}$ , corresponding to ambient flow rates below 21.5 lpm
        - if the resultant cut point is below 2.0  $\mu\text{m}$ , corresponding to ambient flow rates above 24.5 lpm
      - For Module D with Wedding low volume PM<sub>10</sub> inlets,
        - if the resultant cut point is above 10.3  $\mu\text{m}$ , corresponding to ambient flow rates below 17.2 lpm
        - if the resultant cut point is below 9.7  $\mu\text{m}$ , corresponding to ambient flow rates above 21.0 lpm.
      - For Module D having Sierra Anderson PM<sub>10</sub> inlets (SA 246 B)
        - if the resultant cut point is above 10.3  $\mu\text{m}$ , corresponding to ambient flow rates below 15.0 lpm
        - if the resultant cut point is below 9.7  $\mu\text{m}$ , corresponding to ambient flow rates above 18.4 lpm

- b. If the audit indicates the flow rate is wrong, the critical flow device must be reset. Instructions to reset the flow rate are in the Flow Rate Adjustment Procedures. Note that the critical flow device is never to be adjusted by site operators unless directly instructed to do so by Air Quality Group personnel.
- The critical flow device is unlocked, adjusted until the audit device displays the nominal flow rate reading indicated on the instruction and log sheet form, then locked in position.
- c. Once the critical flow device has been adjusted, a new flow rate calibration equation must be derived. This procedure is identical to the audit procedure described in step a. Once the second audit is done, the recorded gauge readings should be phoned or faxed to the Air Quality Group for review and interpretation.
- The audit is considered acceptable if all the following conditions are met.
    - The flow rates calculated from the system magnehelic, the small gauge readings, and the audit device readings are within 1% of the nominal flow rate.
    - The line produced by the regression of  $\log_{10}$  of the audit device flow rate versus  $\log_{10}$  of the system magnehelic reading has an  $r^2$  greater than 0.990.
    - The line produced by the regression of the audit device flow rate versus the system small gauge reading has an  $r^2$  greater than 0.985.
  - The audit is unacceptable if the conditions listed above are not met. If the audit is invalid,
    - The audit procedure must be repeated until a usable equation is derived.
    - If the nominal flow rate is incorrect, it must be reset, and the sampling module re-audited.
    - Air Quality Group personnel will contact the site operator with instructions and suggestions for repeating the audit.
- d. Once deemed acceptable, the final audit is entered into the IMPROVE database and used to calculate the new calibration equation for the sampler gauges. The Air Quality Group will phone the site operator with instructions to return the audit device, calibration cassettes, and the data form.

### 4.3.3 Biannual Flow Rate Audits

Flow audits are sent to randomly selected sites roughly six months following a site maintenance visit. For biannual audits, a nominal flow check, involving the two clean cassettes installed during weekly site maintenance, is all that is required.

The procedure for nominal flow audits involves the following:

1. An audit orifice meter and an instruction form is sent to the site. The form requests that the site operator perform the audit during the next regularly scheduled sample change at the site. The instruction form is specified in Table 6.
2. The operator records audit magnehelic readings, system magnehelic, and small gauge readings for the two clean, newly installed filter cassettes in each sampling module.
3. The audit device and data are returned to the field specialist for analysis.
  - Flow rates for the system readings are calculated using the most recent calibration equations.
  - Flow rates for the audit orifice meter are generated from the audit device calibration equation.
  - If the flow rates derived from the system gauges and the audit device agree within 3%, the sampler is considered to have a valid calibration and the audit data are stored in the annual mail audit database.
  - If the flows for a sampling module do not agree within 3%, the sampling module must be re-calibrated according to the procedures in section 4.3.2: Procedures for sites having anomalous flow rates. The audit data, even if it is not within acceptable bounds, is stored in the annual mail audit database.