Performance Audit Standard Operating Procedures for IMPROVE Sampler and Technical System Audit Form

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Performance Audit Procedures for *IMPROVE* Network Samplers

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Performance Audit Procedures for IMPROVE Samplers

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General Information

1A. Audit Procedures

The intent of the described audit procedures is to identify technical system errors that may compromise the validity of the samples collected in the Interagency Monitoring of Protected Visual Environments (IMPROVE) Network. Accurate assessments of the 2.5 and 10 micrometer particulate matter measurement systems may be obtained by following these procedures, provided that,

- no special preparations or adjustments are made to the audited system,
- transfer standards used in the audit are completely independent of those used for routine calibration of the audited system,
- all transfer standards are traceable to the National Institute of Standards and Technology (NIST),
- all necessary data is provided by the operating agency, such as calibration information, standard traceability, model and serial numbers, etc.,
- the audit is performed by qualified personnel with a thorough knowledge of the technical system.

The procedures describe the quantitative measurement of flow rates, ambient temperature, and leak test performance. Overall performance is determined by differences between values obtained from audit transfer standards and those obtained from the IMPROVE samplers, as specified in Section 5 of *IMPROVE: Interagency Monitoring of Protected Visual Environments, Quality Assurance Project Plan* (Draft Final Document), March, 2001.

1B. IMPROVE Sampler Specifications

The audit procedures presented here are applicable only to the IMPROVE $PM_{2.5}$ and PM_{10} samplers. Only one version of the IMPROVE operating software is currently in use , and the sampler hardware and configurations are consistent throughout the Network. Because flow rate information in IMPROVE is reported as magnehelic and vacuum readings that are used to calculate flows at standard conditions, correlation factors for each individual module and altitude and temperatures for each site must be known to

obtain ambient conditions at the time of the audit. (Factors for the modules, site elevation, and operator contact information must be obtained from Pat Feeney, feeney@crocker.ucdavis.edu , or Peter Beveridge, beveridge@crocker.ucdavis.edu). Audit measurements must be made in the same configuration used for routine sample collection to represent similar flow characteristics. A loaded audit filter cassette is required for the measurements.

1C. Audit Apparatus

All transfer standards must be certified against a primary standard traceable to NIST, and the certification must be current. In addition to the equipment listed in the following sections, filed audit worksheets (see appendix) are necessary. Required information may include, but is not limited to, and audit transfer standard types, models, and serial numbers, traceability and calibration information, site locations, module serial numbers, and current meteorological conditions.

1C1. Flow Rate Audit Apparatus

The following equipment is required to perform a flow rate audit of the IMPROVE samplers:

- **S** Digital flow meter with appropriate adaptor(s).
- **S** Loaded flow rate audit filter cassette.

1C2. Temperature Sensor Audit Apparatus

The following equipment is required to perform a temperature sensor audit of the IMPROVE samplers:

- **S** Digital temperature probe capable of measuring temperature to within ±0.5°C with a resolution of ±0.1°C.

1C3. Leak Test Audit Apparatus

- **S** Plug suitable for completely blocking the air flow to the inlet tee (Modules A,B,C) or the intake manifold (Module D).

1D. Safety Considerations

Many safety precautions should be considered prior to and during the IMPROVE site audit. The samplers are operated with 110 V power and care should be taken when touching any of the attached cables. The sites are located in remote areas away from medical facilities. Prudence must be exercised with regard to terrain, wildlife, and inclement weather.

2. Audit Procedure for IMPROVE Samplers

2A. Background

The standard IMPROVE sampler consists of four sampling Modules (A-D) and a controller housed in a weather shelter. Each module has it's own pump and a 1.8 m inlet stack. Modules A, B, and C pass air through a cyclone to remove particles larger than 2.5 :m with nominal flow rates of 22.8 L/min controlled by a critical orifice. The D Module has a commercial PM_{10} inlet on top of the stack with no cyclone and a nominal flow of either 16.9 or 19.1 L/min.

2B. Audit Procedure for the IMPROVE $PM_{2.5}$ and PM_{10} Samplers

2B1. Prior to the site visit, obtain the flow rate correlation factors, site altitude, and site operator information from the contacts given in 1B. Record this information on the IMPROVE Performance Audit Worksheet.

2B2. Record the system clock time (from the display) and the NIST traceable clock time on the Performance Audit Worksheet.

2B3. A single probe is used to determine ambient temperature. It is normally plugged into the bottom of the inlet tee of Module C. Open the box containing the probe (it can be found by tracing the temperature probe wire from the controller box) and carefully remove the probe plug and allow it to hang away from direct sunlight. Hang the reference temperature probe beside it and allow them to equilibrate.

2B4. On the terminal keypad in the controller box press *Enter* twice to enter the *Main Menu*. Press *1* **(not *F1*)** . Record the sampler temperature and the reference probe temperature on the Performance Audit Worksheet.

2B5. Press *Enter* twice to return to the *Beginning Menu*.

2B6. Leak and flow tests for Modules A, B, and C are identical. Prior to beginning, open the door of the module box and press the upper red button (in the lower right hand corner) to raise the solenoid valve manifold. Remove the sample cassette (if one is installed) and place aside during the audit procedure. Install audit filter cassette **of the same type** (two types are currently in use) and press the lower red button until the manifold is down and locked in place.

2B7. Lift the inlet stack from the inlet tee by loosening the compression sleeve on the top of the module box. Retighten the sleeve so that the stack is high enough above the tee to allow access to the tee inlet port. (Note that the Module B stack contains a carbonate-coated annular denuder that slides freely. The denuder structure is fragile and must be protected from impact - handle carefully.)

2B8. On the terminal keypad press *Enter* to enter the *Main Menu*.

2B9. Press *F3* to enter the *Advanced Menu*. The terminal will prompt for an authorization code. Enter *1123*.

2B10. Press *F1* and *Enter* to enter the *Calibration Menu*. Press *Enter* again to start the pump for Module A.

2B11. Block the inlet port of the tee so that no air can pass and allow the system to stabilize. Record the vacuum reading from the controller terminal on the Leak Test portion of the Performance Audit Worksheet for the module. (On the module with the temperature probe place a plug in the bottom of the inlet tee before conducting the leak test. After the test, remove the plug and reinsert the temperature probe to its original position making sure that it is completely sealed in place.)

2B12. Very slowly remove the block from the inlet tee and insert the adapter for the reference standard flow meter. Allow the system to stabilize. On the Performance Audit Worksheet record the magnehelic and vacuum readings in the row marked *Readings (Raw)*. Also record the reference flow meter reading.

2B13. Press *Enter* twice to return to the *Beginning Menu*.

2B14. Remove the adaptor and return the inlet stack into the inlet tee by loosening the compression sleeve, **pushing the stack down until it is properly seated**, and retightening the sleeve.

2B15. Using the red buttons to control the solenoid valve manifold, remove the audit filter cassette and reinsert the sample filter cassette, being sure that it is seated and completely closed before moving to the next module.

2B16. Perform steps B5 through 2B14 for Modules B and C. In the *Calibration Menu* use the *F3 and F4* keys to toggle to the appropriate module. The selected module will appear in the upper left hand corner of the display.

2B17. Module D (the PM10 sampler) does not use an inlet tee assembly and only a vacuum reading is used to measure the air flow. Switch the sample filter cassette with the same type audit cassette using the bottom red button to open the manifold and the top button to close it.

2B18. The Module D sampling stack drops directly into the top of the manifold. After loosening the compression sleeve on the top of the module box raise the stack high enough so that the inlet can be completely blocked with a plug. Allow the

system to stabilize and record the vacuum reading on the Leak Test portion of the Performance Audit Worksheet for Module D.

2B19. Slowly remove plug and insert an adaptor for the reference standard flow meter. After the flow is stabilized, record the vacuum reading for the module in the row marked *Readings (RAW)* on the worksheet. Also record the reference standard flow rate reading.

2B20. Replace the sampling filter cassette and return and tighten the sampling stack into place.

4. References:

- *Visibility Guidance Document*, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, EPA-454/R-99-003, June, 1999.

- *Version II IMPROVE Sampler Operating Procedures Manual for use in the IMPROVE Monitoring Network*, Crocker Nuclear Laboratory, University of California Davis, CA, Technical Information Document TI 201A, July, 2000.

- *IMPROVE: Interagency Monitoring of Protected Visual Environments, Quality Assurance Project Plan* (Draft Final Document), Crocker Nuclear Laboratory, University of California Davis, CA, Research Triangle Park, NC, March, 2001.

Appendix 1.
Quality Assurance IMPROVE Network Sampler Audit Worksheet

IMPROVE Worksheet

Location	
Date	

Audit Iformation

Auditor(s)		Collocated ?	Yes	
Affiliation			No	
Operator				
Affiliation				
Last Cal Date				
Alititude				
Ref. Stn.				
Site Code				
Cal Date				

Temp. Test Degrees C

	Ref Std	IMPROVE	Difference	Criteria Pass	<2 deg. Fail
Ambient					

Clock Test

Tem Verification Minutes

Ref Std	IMPROVE	Difference	Criteria Pass	<5 min Fail

Location _____ Date _____

Module A

			Criteria	>37
Leak Test	Vacuum (Raw)		Pass	Fail

Flow Test	Mag. Coeff.		Vac Coef.	
	A		C	
	B		D	
Readings (Raw)				

Ref Std		Magnehelic	% Difference		Criteria	>10%
					Pass	Fail
				L/min		

	Vacuum	% Difference		
			Pass	Fail

Module B

			Criteria	>37
Leak Test	Vacuum (Raw)		Pass	Fail

Flow Test	Mag. Coeff.		Vac Coef.	
	A		C	
	B		D	
Readings (Raw)				

					Criteria	<10%
Ref Std		Magnehelic	% Difference		Pass	Fail
	l/min					

Vacuum	% Difference	Pass	Fail

Location _____ Date _____

Module C

		Criteria	>37
Leak Test	Vacuum (Raw)	Pass	Fail

Flow Test	Mag. Coeff.		Vac Coef.	
	A		C	
	B		D	
Readings (Raw)				

			Criteria	<10%
Ref Std	Magnehelic	% Difference	Pass	Fail

Vacuum	% Difference	Pass	Fail

Module D

Leak Test	Vacuum (Raw)	Criteria	>37
		Pass	Fail

Flow Test	Vac.Coef.
C	
D	

	Reading (Raw)				
Ref Std	Vacuum	% Difference		Criteria	>10%
				Pass	Fail
			L/min		

Appendix 2.
Systems Audit Checklist for Quality System Documentation

IMPROVE Network - Technical Systems Audit Form

Part 1 - Quality System Documentation and Facilty Operations

Monitoring Site Location _____

Assessor Name and Affiliation _____

Observer(s) Name and Affiliation _____

Reporting Organization _____

Assessment Date _____

AUDIT QUESTIONS	RESPONSE			COMMENTS
	Y	N	NA	
1. Is there a copy of the Version II IMPROVE sampler Operating Procedures Manual Version V2.00.04 July 200 available to be reviewed by all appropriate personnel?				
2. Is a copy of the IMPROVE Standard Operating Procedures - SOP 176, Calibration, Programming and Site Documentation available for the site operator?				
3. Are corrective actions in place when MQOs (e.g., out-of-control calibration data) are not met? If yes, when was the last visit by the UC Davis field technician?				
4. Is a copy of the IMPROVE Standard Operating Procedures - SOP 201, Sampler Maintenance by Site Operator available for the site operator?				
5. Is a copy of the IMPROVE Standard Operating Procedures - SOP 201a Aerosol Sampler Operations Manual available for the site operator?				
Additional Comments:				

AUDIT QUESTIONS	RESPONSE			COMMENTS
	Y	N	NA	
ORGANIZATION AND RESPONSIBILITIES				
1. Field Operations Manager: (Name)_____ (Phone) (email)_____ - Development of monitoring network, - Coordinates field operations, - Logistical support of field operations, - Training monitoring site operators, and - Review of routine sampler data and quality control data.				
2. Monitoring Site Operator(s): (Name)_____ (Phone) (email)_____ (Name)_____ (Phone) (email)_____ - Operation of samplers, - Calibration of samplers, - Maintenance of samplers, - Maintenance of monitoring site, and				
3. Who is authorized to halt the program in the event of a health or safety hazard or inadequate quality?				

AUDIT QUESTIONS	RESPONSE			COMMENTS
	Y	N	NA	
Additional Questions or Comments:				
TRAINING, SAFETY and MODULE HANDLING AT OFFICE				
1. Have the monitoring site operators been trained by the UC Davis Field Tech? Have they visited within the last year? If so, what date?				
2. Has the operator been trained in the particular hazards of the instruments/materials with which they are operating?				
3. Are personnel outfitted with any required safety equipment?				
4. Are personnel adequately trained regarding appropriate safety procedures?				
5. Are the field and Chain of Custody forms being filled out properly?				
6. Are the filters being packed according to the SOPs in the Field QAPP?				

AUDIT QUESTIONS	RESPONSE			COMMENTS
	Y	N	NA	
Additional Questions or Comments:				

Part 2- Systems Audit Checklist for Monitoring Site

Monitoring Site Location _____

Assessment Date _____

AUDIT QUESTIONS	RESPONSE			COMMENT
	Y	N	NA	
A. Sampler Siting				
1. Does the location for the samplers and collocated sampler(s) conform with the siting requirements of 40CFR58, Appendices A and E?				
2. Are there any visible hazards or noticeable problems at the site?				
3. Are there any changes at the site that might compromise original siting criteria (e.g., fast-growing trees or shrubs, new construction)?				
4. Are there any visible sources that might influence or impact the monitoring instrument?				

AUDIT QUESTIONS	RESPONSE			COMMENT
	Y	N	NA	
Briefly draw the monitoring location and illustrate all obstructions including distances to the nearest roadways and/or obstructions. If you need more paper, use the back side of this sheet. After your sketch, please photograph the shelter from 8 cardinal directions, then take photographs looking from the shelter in the 8 directions.				

AUDIT QUESTIONS	RESPONSE			COMMENT
	Y	N	NA	
B. Monitoring Site				
1. Are site logbooks and required data sheets filled in promptly, clearly, and completely?				
2. Does the operator keep the module handling area neat and clean? Is there adequate room to perform the needed operations?				
3. Do the sampler(s) appear to be well maintained and free of dirt and debris, bird/animal/insect nests, excessive rust and corrosion, etc.?				
4. Are the walkways to the station and equipment kept free of tall grass, weeds, and debris?				
5. What are the latitude and longitude of the site?				
6. Is the station shelter (if any) clean and in good repair?				
Additional Comments:				

AUDIT QUESTIONS	RESPONSE			COMMENT
	Y	N	NA	
C. Sample Handling				
1. Are all samples handled with the necessary care and finesse to avoid contamination and/or loss of material?				
2. Are blanks routinely used by the monitoring organization? Check log books at the site to verify field blanks are run periodically, as specified by the weighing laboratory. *Field blanks one set every 120 days*				
3. Observe the following handling steps for routine samples, verifying that the operator follows the sample handling SOPs correctly: - receipt of samples at the sampling site and unpacking - completion of sample logbook entries and other required documentation - inspection of the sample prior to sampling - installation of sample in the sampler - retrieval from the sampler after sampling - packing and sending to the laboratory - completion of chain of custody and field data forms supplied by the reporting organization - samples shipped				
4. Request the operator to perform the field blank sample-handling procedures (if not possible, go through the SOP step-by-step and verify that the operator knows the correct procedures.): - receipt of samples at the sampling site and unpacking - completion of sample logbook entries and other required documentation - inspection of the sample prior to sampling - installation of sample in the sampler - retrieval from the sampler (without sampling) - packing and sending to the laboratory - completion of chain of custody and field data forms supplied by the reporting organization				