Performance Audit Standard Operating Procedures for $PM_{2.5}$ Speciation Samplers and Technical System Audit Form

Final

May 13, 2002

Version: 3.1

Performance Audit Procedures for $PM_{2.5}$ Speciation Samplers

Date: May 13, 2002

Version: 3.1

Approval:

5/13/2002

Dennis Mikel
Quality Assurance Manager,
Speciation Trends Network, OAQPS

5/13/2002

Emilio Braganza
Center Director,
Center for Indoor Environments, ORIA

Performance Audit Procedures for $PM_{2.5}$ Speciation Samplers

Table of Contents

1. 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 Speciation Trends Network. Accurate assessments of the 2.5 micrometer (:m) 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, filter, and other temperatures, barometric pressure, and leak test performance. Overall performance is determined by differences between values obtained from audit transfer standards and those obtained from the $PM_{2.5}$ samplers, as specified in Section 16 of the $PM_{2.5}$ Speciation Trends Network Field Sampling Quality Assurance Project Plan (STN QAPP).

1B. Speciation $PM_{2.5}$ Sampler Specifications

The audit procedures presented here are applicable to the Anderson RAAS 400 and 401, the MetOne SASS, and the URG MASS 400 and 450. Different versions of the operating software may exist on these deployed samplers and description of specific software manipulations has been avoided. Additionally, modifications in sampler configurations may require some changes in audit techniques.

Because flow rates (and therefore total volumes) for samples collected in the Speciation Trends Network are reported for actual collection conditions, audit measurements are also reported for actual conditions. Audit measurements must be made in the same configuration used for routine sample collection to represent similar flow characteristics. Loaded filter cassettes for the individual sampler type are 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, audit data worksheets (see appendix) are necessary. Required information may include, but is not limited to, sampler and audit transfer standard types, models, and serial numbers, traceability and calibration information, sampler locations, and current meteorological conditions.

1C1. Flow Rate Audit Apparatus

The following equipment is required to perform a flow rate audit of the speciation $PM_{2.5}$ samplers:

- **S** Digital flow meter with intake adaptor (Met One SASS and URG 400 and 450) or in line adapter (Anderson RAAS 400 or 401).

- **S** Loaded flow rate audit cassette.

1C2. Temperature Sensor Audit Apparatus

The following equipment is required to perform a temperature sensor audit of the speciation $PM_{2.5}$ samplers:

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

1C3. Ambient Pressure Audit Apparatus

- **S** Barometer capable of measuring ambient pressure to ±1 mmHg over a range of 500 to 800 mmHg.

1C4. Leak Test Audit Apparatus

- **S** Downtube leak test adapter (Anderson RAAS 400 and 401, URG MASS 400 and 450). Impactor inlet cap (MetOne SASS).

IC5. Clock Test Apparatus

- **S** Clock capable of telling true time to ±5 min.

2. Audit Procedure for Anderson RAAS

2A. Background

The Anderson RAAS utilizes a size selective inlet followed by two cyclone fractionator. Each cyclone allows a total flow of 24 L/m that is divided between two sampling channels with nominal flows of 16.7 and 7.3 L/m respectively. The field audit of this sampler includes the determination of the accuracy of the flow rate readings, ambient, filter, and manifold temperature readings, and the ambient pressure reading as compared to those measured with the audit equipment. Prior to the audit it should be verified that the required sampler calibration and maintenance procedures have been performed according to the frequencies specified in Section 16 of the STN QAPP.

2B. Audit Procedure for the Anderson RAAS Speciation Sampler

2B1. On the Performance Audit Worksheet for the RASS record the audit date, location sampler operating agency, sampler operator's name, auditor's name. Also record the model types, serial numbers, calibration dates, etc. for the sampler and audit equipment as indicated.

2B2. Remove the inlet assembly from the down tube on the top of the RAAS cabinet box. Attach the leak test adapter to the tube and turn the valve lever to the off position.

2B3. From the *Main Menu* select *Leak Test*. Record the flow for the all four channels and their *sum* on the Performance Audit Worksheet (a total of $\leq$80 ml/min constitutes a significant leak).

2B4. Press the *Cancel* button to stop the test and return to the *Main Menu*. Remove the leak test adaptor. Replace the inlet assembly on the down tube.

2B5. Detach the sample cartridge (if one is installed) from the fractionator on the first channel. Attach the assembled flow rate audit cassette to the bottom tube assembly for the first channel leading to the manifold in the bottom of the sampler cabinet. Attach the adaptor and flow rate digital meter to the top of the audit cartridge.

2B6. From the *Main Menu* select *Verify Flow*. Allow the pump for several minutes to reach a stable flow rate. Record the sampler flow rate and the audit meter flow rate of the channel on the Performance Audit Worksheet.

2B7. Press the *Cancel* button to stop the test and return to the *Main Menu*. Remove the adapter, flow rate meter, and audit cartridge and replace the sample cartridge as in the sampler's original state.

2B8. Repeat the same procedure for the remaining channels. Continue to attach the adapter and flow meter to the audit cartridge even if a denuder tube is present (do not attach them above the denuder tube). Record all results on the Performance Audit Worksheet.

2B9. Attach the probe to the digital thermometer. Attach the temperature probe to the gill screen of the RAAS ambient temperature sensor avoiding direct sunlight and wind as much as possible. Allow the reading to stabilize for several minutes and record the system ambient temperature and the audit thermometer ambient temperature on the Performance Audit Worksheet.

2B10. From the *Main Menu* select *Maintenance* and *Monitor* to view the current sampler temperature and pressure readings. Record the sampler ambient temperature on the Performance Audit Worksheet.

2B11. Move the temperature probe to the location of the cabinet temperature sensor and allow the reading to stabilize. Record the audit cabinet temperature and sampler temperature on the Filed Audit Worksheet.

2B12. Obtain an ambient barometric pressure reading from the audit barometer. Record it and the sampler ambient pressure on the Performance Audit Worksheet.

2B13. Record any other applicable observations in the "Comments" portion of the Performance Audit Worksheet.

2B14. Press *Cancel* twice to return the RAAS controller to the *Main Menu*.

3. Audit Procedure for the MetOne SASS Speciation Sampler

3A. Background

The MetOne SASS utilizes five independent channels with spiral impactors attached directly to the filter cartridges that are arrayed in a raised carousel. The field audit of this sampler includes the determination of the accuracy of the total flow rate reading for each channel under normal operating conditions (nominally 6.7 L/m), ambient and filter temperature readings, and the barometric pressure reading as compared to those measured with the audit equipment. Prior to the audit it should be verified that the required sampler calibration and maintenance procedures have been performed according to the frequencies specified in Section 16 of the STN QAPP.

3B. Audit Procedure for MetOne SASS

3B1. On the Performance Audit Worksheet for the SASS record the audit date, location sampler operating agency, sampler operator's name, auditor's name. Also record the model types, serial numbers, calibration dates, etc. for the sampler and audit equipment as indicated.

3B3. In the Setup menu, select *clock* and record the MetOne stated time and the clock, NIST traceable clock time.

3B2. Attach the assembled flow rate audit cassette (with attached spiral impactor) to the first of the SASS channels. Cap the inlet tightly so that no air can pass.

3B4. In the Calibrate menu, select *System Test* (F1), *Pump*, and *Continue*. Allow the system to stabilize at a constant flow rate for several minutes. Record the leak flow rate for that channel on the Performance Audit Worksheet.

3B5. Move the audit filter cartridge and impactor to the next two channel positions in succession. Record the leak flow rate for each channel. It is not necessary to stop the pump or change the menus.

3B6. Move the audit filter cartridge and impactor to the first channel. Remove the inlet cap and attach the hose from the audit flow device. Allow the flow to stabilize and record the reported sample flow rate for that channel and the audit device flow rate on the Performance Audit Worksheet.

3B7. Without stopping the pump, move the audit cassette to next two channel positions recording the reported and audit device flow rates for each.

3B8. When finished, select *End*. Remove and stow the audit cassette and audit flow meter.

3B9. Attach the temperature probe to the digital audit thermometer and place the probe in the open sample orifice of the First channel position and allow the temperature to stabilize. Return to the *Current Event* screen and record the system filter temperature and the audit thermometer filter temperature on the Performance Audit Worksheet.

3B10. Attach the temperature probe to the gill screen of the SASS ambient temperature sensor avoiding direct sunlight and wind as much as possible. Allow the reading to stabilize and record the system ambient temperature and the audit thermometer ambient temperature on the Performance Audit Worksheet.

3B11. Obtain the ambient barometric pressure from the audit barometer and the system ambient barometric pressure from the *Current Event* screen. Record both on the Performance Audit Worksheet.

3B12. Record any other applicable observations in the "Comments" portion of the Performance Audit Worksheet.

3B13. Replace any routine samples in their original positions and return the SASS controller to the *Main Menu*.

4. Audit procedure for URG MASS Units

4A. Background

The URG MASS sampler consists of two modules, each with a size selective inlet and a WINS impactor to obtain a PM2.5 cutpoint. Flow rate through each module is nominally 16.7 L/m. The field audit of this sampler includes the determination of the accuracy of the flow rate readings, ambient, filter, and manifold temperature readings, and the ambient pressure reading as compared to those measured with the audit equipment. Prior to the audit it should be verified that the required sampler calibration and maintenance procedures have been performed according to the frequencies specified in Section 16 of the STN QAPP. Prior to the audit it should be verified that the required sampler calibration and maintenance procedures have been performed according to the frequencies specified in Section 16 of the STN QAPP.

4B. Audit Procedure for the URG MASS Speciation Sampler(s)

4B1. On the Performance Audit Worksheet for the MASS-400, -450 record the audit date, location, sampler operating agency, sampler operator's name, auditor's name. Also record the serial numbers, calibration dates, etc. for the sampler and audit equipment as indicated.

4B2. From the *Main Menu* select *View Run* and *Current Sample*. Scroll down the screen to find the current date and time on the MASS sampler. Record this and the time from the audit clock on the Performance Audit Worksheet. Press *Cancel* to return to the *Main Menu*.

4B3. Detach the sample cartridge in the cabinet, if one is installed, and attach the assembled flow rate audit cassette in it's place.

4B4. Remove the inlet assembly from the down tube on the top of the first MASS cabinet box. Attach the leak test adapter to the tube and turn the valve lever to the off position.

4B5. From the *Main Menu* select *Leak Check*. Allow the flow to stabilize and record the leak flow rate on the Performance Audit Worksheet.

4B6. Press the *Cancel* button to stop the test and return to the *Main Menu*. Attach the hose from the audit flow meter to the inlet of the leak test adapter and turn the lever to the on position.

4B7. From the *Main Menu* select *Verify Flow*. Allow the pump time to reach a stable flow rate. Record the sampler flow rate and the audit meter flow rate on the Performance Audit Worksheet.

4B8. Press the *Cancel* button to stop the test and return to the *Main Menu*. Remove the adapter, flow rate meter, and audit cartridge and replace the sample cartridge and the inlet assembly as in the sampler's original state.

4B9. Attach the probe to the digital thermometer. Attach the temperature probe to the

gill screen of the MASS ambient temperature sensor avoiding direct sunlight and wind as much as possible. From the *Main Menu* select *Maintenance* and *Monitor* to view the current sampler temperature and pressure readings. Allow the reading to stabilize and record the system ambient temperature and the audit thermometer ambient temperature on the Performance Audit Worksheet.

4B10. Move the temperature probe to the location of the cabinet temperature sensor and allow the reading to stabilize. Record the audit cabinet temperature and sampler temperature on the Filed Audit Worksheet.

4B11. Obtain an ambient barometric pressure reading from the audit barometer. Record it and the sampler ambient pressure reading on the Performance Audit Worksheet.

4B12. Record any other applicable observations in the "Comments" portion of the Performance Audit Worksheet.

4B13. Press *Cancel* twice to return the MASS controller to the *Main Menu*.

4B14. Move the audit equipment to the second MASS module and repeat the above procedures beginning at item 4B1.

5. References

- *$PM_{2.5}$ Speciation Trends Network Field Sampling Quality Assurance Project Plan*, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, EPA-454/D-01-001, June 2000.

- *Performance Audit Procedures for PM2.5 Samplers*, Appendix Z of Air Monitoring Quality Assurance, Vol. V, Audit Procedures Manual, State of California Air Resources Board, Monitoring and Laboratory Division, December 2000.

- *Field Program Plan for the PM2.5 Chemical Speciation Sample Evaluation Study*, (Draft for Comment), US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, November, 1998.

Appendix 1.
Quality Assurance Speciation Trends Network Audit Worksheet

Andersen Worksheet

Location							
Date							
Auditor		Affiliation					
Operator		Affilication		Collocated?	Yes		
Model		S/N			No		
Last Cal							
Ref. Mdl		S/N					
Cal Date							

Clock Test

		Time			Minutes Difference	Criteira	> 5 min.
	Ref Std		RAAS			Pass	Fail

Flow Test L/min

	Ref Std		RAAS	% Difference		Criteria	> 10%
						Pass	Fail
Channel 1							
Channel 2							
Channel 3							

Temperature Test Degrees C

	Ref Std		RAAS	Difference		Criteria	>2 deg.
						Pass	Fail
Ambient							
Filter							

Pressure Test mm Hg

					Criteria	> 10 mm hg
	Ref Std		RAAS	Difference	Pass	Fail

Leak Test

	L/min				Criteria	> 10 cc/min
					Pass	Fail
Total						

Met One Worksheet

Location _____ Date _____

Audit Information

Auditor(s)		Affiliation				
Operator		Affiliation		Collocated?	Yes	
Sampler Model		Sampler SN			No	
Last Cal Date						
Ref. Mdl						
Calibration Date						
Ref. SN						

Clock Test Time Minutes Criteria > 5 min.

Ref Std	SASS	Difference	Pass	Fail

Leak Test

	L/min	Criteria	> 80 cc/min
		Pass	Fail
Channel 1			
Channel 2			
Channel 3			

Flow Test L/min

	Ref Std		SASS	% Difference	Criteira	> 10%
					Pass	Fail
Channel 1						
Channel 2						
Channel 3						

Temperature Degrees C

Test	Ref Std	SASS	Difference	Critieria	>2.0 deg.
				Pass	Fail
Ambient					
Filter					

Pressure Test mm Hg

Ref Std	SASS	Difference	Criteria	> 10 mm hg
			Pass	Fail

URG Worksheet

Location _____ Date _____

Audit Information

Auditor(s) _____ Affiliation _____

Operator _____ Affiliation _____

Last Cal. Date(s) _____ Collocated? Yes _____

No _____

Reference Std _____ Trical _____ Refe Stn SN _____

Model _____

Calibration Date(s) _____

URG-400 Sampler SN _____

Clock Test

	Time (hh:mm:ss)	Minutes	5 minutes or less?	
Ref Std	MASS	Difference	Pass	Fail
_____	_____	_____		

Leak Test < 0.08 L/min?

	L/min	Pass	Fail
Channel			

Flow Test

L/min Less than 10%?

Ref Std	MASS	% Difference	Pass	Fail
_____	_____	_____		

Temperature Test Degrees C < 2 degrees?

	Ref Std	MASS	Difference	Pass	Fail
Ambient	_____	_____	_____		
Filter	_____	_____	_____		

Pressure Test mm Hg < 10 mm?

Ref Std	MASS	Difference	Pass	Fail
_____	_____	_____		

URG-450

Clock Test

	Time (hh:mm:ss)		Minutes	5 minutes or less?	
	Ref Std	MASS	Difference	Pass	Fail

Flow Test

	L/min			Less than 10%?	
	Ref Std	MASS	% Difference	Pass	Fail

Temperature Test

	Degrees C			<2 degrees?	
	Ref Std	MASS	Difference	Pass	Fail
Ambient					
Filter					

Pressure Test

	mm Hg			< 10 mm?	
	Ref Std	MASS	Difference	Pass	Fail

Appendix 2.
Systems Audit Checklist for Quality System Documentation

STN and 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 an approved quality assurance project plan (QAPP) for the overall program and has it been reviewed by all appropriate personnel?				
2. Is a copy of the approved QAPP available for review by field operators? If not, briefly describe how and where QA and QC requirements and procedures are documented.				
3. Is the EPA approved or IMPROVE QAPP being used by this organization?				
4. If yes on #3, is it signed?				
5. Are corrective actions in place when MQOs (e.g., out-of-control calibration data) are not met? If yes, briefly describe them.				
6. Are written and approved standard operating procedures (SOPs) used in the program? If so, are these the SOPs that were written in the EPA Field QAPP or IMPROVE QAPP? Are they available for review by field operators?				
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?				
4. Has the operator been trained in the particular hazards of the instrument/materials with which they are operating?				

AUDIT QUESTIONS	RESPONSE			COMMENTS
	Y	N	NA	
Additional Questions or Comments:				
TRAINING, SAFETY and MODULE HANDLING AT OFFICE				
1. Have the monitoring site operators attended the training that has taken place in Las Vegas or RTP? 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 coolers being packed according to the SOPs in Appendix A-5 (see EPA 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. Is the shelter (if any) clean and in good repair?				
6. What are the latitude and longitude readings at the site?				
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. *Trip blanks one set every 30 days* *Field blanks one set every 10 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				
Comments:				

Part 3- MQOs for Monitoring Sampler, Calibration and Audit Devices (STN Only)

Monitoring Site Location _____

Assessment Date _____

Table 1. Sampler Calibration, Maintenance Requirements and Traceability

Checks/Maintenance	Frequency	Requirement	Performed?	Date
Clock check	Every Run	Current date, time ± 5 minute		
Flow Rate check	Monthly	± 10% working standard		
Flow Rate Audit	Quarterly	± 10% of audit standard		
Leak check	Every Run	< 80 ml/min		
Clean inside of housing	Semiannual inspection	Per Service Manual		
Clean air screens	Semiannual inspection	Clear of obstructions to flow		
External Temperature Check	Monthly	Current temp ± 2^{o} C via NIST traceable thermometer		
External Temperature Audit	Quarterly	Current temp ± 2^{o} C via NIST audit thermometer		
Filter Temperature Check	Monthly	Current temp ± 2^{o}C via NIST traceable thermometer		
Filter Temperature Audit	Quarterly	Current temp ± 2^{o}C via NIST audit thermometer		
Ambient Pressure Check	Monthly	Current pressure +/- 10 mm Hg NIST traceable barometer		
Ambient Pressure Audit	Quarterly	Current pressure +/- 10 mm Hg NIST traceable barometer		
Flow rate Audit Device	Annually	Verify against NIST standard or sent to factory		
Temperature Audit Device	Annually	Verify against NIST standard or sent to factory		
Pressure Audit Device	Annually	Verify against NIST standard or sent to factory		
Flow rateCalibration Device	Annually	Verify against NIST standard or sent to factory		
Temperature Calibration Device	Annually	Verify against NIST standard or sent to factory		
Pressure Calibration Device	Annually	Verify against NIST standard or sent to factory		