

STATE OF CALIFORNIA  
AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME V

AUDIT PROCEDURES  
FOR  
AIR QUALITY MONITORING

APPENDIX U

SYSTEM AUDIT PROCEDURES  
FOR  
PM10 MASS ANALYSIS

MONITORING AND LABORATORY DIVISION

JANUARY 2003

**APPENDIX U**

**SYSTEM AUDIT PROCEDURES  
FOR  
PM10 MASS ANALYSIS**

**TABLE OF CONTENTS**

	<u>PAGES</u>	<u>REVISION</u>	<u>DATE</u>
<b>U.1.0</b>			
<b>SYSTEM AUDIT PROCEDURES FOR PM10 MASS ANALYSIS PROGRAMS</b>	1	1	01-15-03
U.1.0.1			
Introduction			
U.1.0.2			
Preliminary Assessment and System Audit Planning			
<b>U.2.0</b>			
<b>CRITERIA FOR EVALUATION</b>	14	1	01-15-03
U.2.0.1			
Introduction			
U.2.0.2			
PM10 Laboratory Operations System Audit Questionnaire			
<b>U.3.0</b>			
<b>PM10 MASS ANALYSIS SYSTEM AUDITS</b>	9	1	01-15-03
U.3.0.1			
Components of a PM10 Mass Analysis System Audit			
U.3.0.2			
Pre-Audit Activities			
U.3.0.3			
On-Site Activities			
U.3.0.4			
Post-Audit Activities			
<b>U.4.0</b>			
<b>PM10 MASS ANALYSIS LABORATORY PERFORMANCE AUDIT</b>	3	1	01-15-03
U.4.0.1			
Components of a PM10 Mass Analysis Performance Audit			
U.4.0.2			
Performance Audit			
<b>U.5.0</b>			
<b>REFERENCES</b>	1	1	01-15-03

**APPENDIX U**  
**SYSTEM AUDIT PROCEDURES**  
**FOR**  
**PM10 MASS ANALYSIS**

**FIGURES**

	<u>Page</u>
Figure U.2.0.1. . . PM10 Laboratory Operations System Audit Questionnaire . . . . .	2
Figure U.3.0.1. . . U.S. EPA Letter . . . . .	7
Figure U.4.0.1 . . PM10 Performance Audit Worksheet . . . . .	2
Figure U.4.0.2. . . 24-Hour Air Sample Report Form . . . . .	3

STATE OF CALIFORNIA  
AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME V

AUDIT PROCEDURES  
FOR  
AIR QUALITY MONITORING

APPENDIX U.1.0

SYSTEM AUDIT PROCEDURES  
FOR  
PM10 MASS ANALYSIS PROGRAMS

MONITORING AND LABORATORY DIVISION

JANUARY 2003

## **U.1.0 SYSTEM AUDIT PROCEDURES FOR PM10 MASS ANALYSIS PROGRAMS**

### **U.1.0.1 INTRODUCTION**

Particulate matter (PM10) mass analysis system audits are conducted by the California Air Resources Board's (CARB) Quality Assurance Section (QAS). A PM10 mass analysis system audit entails the completion of a PM10 laboratory operations system audit questionnaire and an on-site inspection and assessment of the total measurement system (sample collection, sample analysis, data processing, etc.). The audit assesses an agency's ability to comply with established rules and regulations governing the preparation, transport, analysis, and storage of PM10 filters as well as the reporting of PM10 data. A system audit includes an assessment of the following program areas: staff, facilities, data and document control, and quality control. The on-site inspection includes a review of the data trail from the point of generation, to entry into the data acquisition system, through the review process, and submittal to the United States Environmental Protection Agency (U.S. EPA) Aerometric Information Retrieval System (AIRS).

The system audit also includes a performance audit consisting of an on-site review to check the accuracy of the PM10 filter weighing balance, the relative humidity and temperature sensors, and a check of the laboratory operations to verify their ability to generate data of acceptable quality. Performance audits are conducted annually following the initial system audit.

### **U.1.0.2 PRELIMINARY ASSESSMENT AND SYSTEM AUDIT PLANNING**

In conducting a system audit of a given agency, the auditor is seeking a complete and accurate representation of that agency's PM10 mass analysis program. The auditor should conduct the on-site inspections and interviews with key program personnel, evaluate the laboratory operations, and examine the data processing procedures.

THE STATE OF CALIFORNIA  
AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME V

AUDIT PROCEDURES  
FOR  
AIR QUALITY MONITORING

APPENDIX U.2.0

CRITERIA FOR EVALUATION

MONITORING AND LABORATORY DIVISION

JANUARY 2003

## **U.2.0 CRITERIA FOR EVALUATION**

### **U.2.0.1 INTRODUCTION**

A system audit is typically conducted in three steps. First, a questionnaire is sent to the organization prior to the audit visit. The organization should then fill out the questionnaire as completely as possible and return it with sufficient documentation. Second, the questionnaire is reviewed by the auditor to become familiar with the system operations and to determine any deficiencies and potential problem areas. Third, after the questionnaire has been reviewed, the on-site inspection and assessment are scheduled which includes a performance audit of the laboratory operations and equipment. The preliminary review of the questionnaire serves the purpose of allowing a greater amount of time to be spent on-site examining potential problem areas.

The auditor should interview the laboratory manager; any person who has direct responsibility for PM10 mass analysis; personnel associated with data validation, analysis and reporting; and the person responsible for quality assurance as designated by the laboratory manager. The information gathered from these interviews should be complete and up-to-date, and should present an accurate picture of the current and proposed levels of implementation of all quality assurance activities, including internal quality control.

At the conclusion of the audit, the QAS auditor informs the organization of the audit results and discusses any potential data-impacting problems revealed. During this meeting, the auditor also explains the reporting procedures schedule. The questionnaire described below is specific to the PM10 mass analysis system audit.

The system and performance audits are conducted in accordance with U.S. EPA Title 40 Code of Federal Regulations (CFR), Part 50, Appendix J.

### **U.2.0.2 PM10 LABORATORY OPERATIONS SYSTEM AUDIT QUESTIONNAIRE**

The PM10 Laboratory Operations System Audit Questionnaire is presented in Figure U.2.0.1. The questionnaire includes information on staff; laboratory equipment and environment; pre-run filter inspection and weighing; post-run filter inspection and weighing; and data reporting. The questionnaire should be completed by the person responsible for the overall program and should be returned to the auditor.

PM10 MASS ANALYSIS LABORATORY OPERATIONS SYSTEM AUDIT  
QUESTIONNAIRE

Agency \_\_\_\_\_

Address \_\_\_\_\_

Phone Number ( ) \_\_\_\_\_

Organization Director \_\_\_\_\_

PM10 Program Supervisor \_\_\_\_\_

Data Management Supervisor \_\_\_\_\_

Quality Assurance Officer \_\_\_\_\_

Questionnaire Completed \_\_\_\_\_  
(By) (Date)

On-Site Visit Date \_\_\_\_\_ Audit Team Members \_\_\_\_\_

Affiliation of Audit Team \_\_\_\_\_

Figure U.2.0.1 PM10 Laboratory Operations System Audit Questionnaire

TABLE OF CONTENTS

	<u>Page No.</u>
A. STAFFING .....	3
B. QUALITY ASSURANCE PLAN/STANDARD OPERATING PROCEDURE ....	4
C. EQUIPMENT AND ENVIRONMENT .....	4
1. Calibration Weights	
2. Balance	
3. Temperature	
4. Relative Humidity	
5. Filter Handling and Equilibration	
D. PRE-RUN FILTER INSPECTION AND WEIGHING .....	8
1. Filters	
2. Logbooks/QC Checksheets	
3. Balance	
E. POST-RUN FILTER INSPECTION AND WEIGHING .....	10
1. Filters	
2. Balance	
3. Calculations	
4. Quality Control	
F. DATA REPORTING .....	13

A STAFFING

1. Please provide a current organizational chart indicating each responsible person's role in the program.
2. Please include a list of educational background, experience, and training for each responsible person identified in the program organizational chart.
3. Are staff members adequately conversant with appropriate standard operating procedures (SOP) to fulfill job duties? Yes[ ] No[ ]

Comments: \_\_\_\_\_  
\_\_\_\_\_

B. QUALITY ASSURANCE PLAN/STANDARD OPERATING PROCEDURES

1. Has your organization developed a quality assurance project plan? Yes[ ] No[ ]
2. Does your organization have an SOP that includes filter processing and weighing? Yes[ ] No[ ]
3. Does the SOP include procedures to ensure complete chain of custody? Yes[ ] No[ ]

Comments: \_\_\_\_\_  
\_\_\_\_\_

C. EQUIPMENT AND ENVIRONMENT

1. Calibration Weights

- a. Are American National Standards Institute (ANSI)/American Society of Testing and Materials (ATSM) Class S or better weights used? Yes[ ] No[ ]
- b. If so, are the weights accurate to the nearest 0.1mg? Yes[ ] No[ ]

- c. Are the weights calibrated annually? Yes[ ] No[ ]
- d. Are the weights calibrated by a laboratory using National Institute of Standards (NIST) certified standards? Yes[ ] No[ ]
- e. Does the laboratory have 2 separate sets of mass reference standards (working calibration and laboratory primary standards)? Yes[ ] No[ ]
- f. Are the working calibration standards verified against the laboratory primary standards every 3 to 6 months and the results recorded? Yes[ ] No[ ]
- g. Are smooth, non-metallic forceps used exclusively for handling the mass reference standards? Yes[ ] No[ ]
- h. Are the forceps cleaned each weighing day with alcohol and lint-free wipes and allowed to air dry before handling standards? Yes[ ] No[ ]
- i. Record the actual readings obtained using your Class S weights:
- (1) \_\_\_\_\_ (2) \_\_\_\_\_ (3) \_\_\_\_\_
- (4) \_\_\_\_\_ (5) \_\_\_\_\_ (6) \_\_\_\_\_

2. Balance

- a. What is the make and model of the laboratory's balance(s)? \_\_\_\_\_
- \_\_\_\_\_
- b. Is a serial/property number assigned? Yes[ ] No[ ]
- If so, what is the serial/property number? \_\_\_\_\_
- c. Do balance specifications have :
- (1) Resolution of 1mg? Yes[ ] No[ ]
- (2) Precision of 0.5mg? Yes[ ] No[ ]

- d. Is the balance calibrated annually? Yes[ ] No[ ]
- Date of last calibration \_\_\_\_\_  
Who calibrated the balance? \_\_\_\_\_
- e. Is the balance located on a sturdy base to prevent vibrations and away from sources of vibration that could interfere with weighing? Yes[ ] No[ ]
- f. If not, is the balance located on top of a stabilizing slab and/or are composite vibration dampening pads placed at 3 points under the balance's legs or stabilizing slab? Yes[ ] No[ ]
- g. Is the balance located so that it can be leveled according to the manufacturer's instructions? Yes[ ] No[ ]
- h. Is the balance located out of direct sunlight and away from heating and cooling sources such as open flames, hot plates, water baths, ventilation ducts, air conditioning units, windows, and heat-producing lamps? Yes[ ] No[ ]
- i. Is the weighing chamber covered to prevent interference from air drafts caused by: doors, aisles with frequent traffic, ventilation ducts, windows, and other equipment with fans or moving parts? Yes[ ] No[ ]
- j. Is the balance located in the same controlled environment in which the filters are conditioned? Yes[ ] No[ ]
- k. Is a slightly positive pressure maintained in the environment where the balance is kept? Yes[ ] No[ ]
- l. Are entry and exit, as well as other unnecessary traffic in the weighing room environment kept to a minimum? Yes[ ] No[ ]
- m. Is dust contamination minimized in the weighing room by:
- (1) Cleaning the weighing room daily? Yes[ ] No[ ]
- (2) Installing a sticky floor covering on the entrances(s) to the weighing area? Yes[ ] No[ ]
- (3) Wearing clean lab clothing over anything exposed to uncontrolled environments? Yes[ ] No[ ]

Figure U.2.0.1 PM10 Laboratory Operations System Audit Questionnaire (cont'd.)

3. Temperature

- a. Is the temperature held constant between 15° C and 30° C with a variance of no more than  $\pm 3^\circ$  C? Yes[ ] No[ ]
- b. Is the temperature sensor accurate to  $\pm 1^\circ$  C? Yes[ ] No[ ]
- c. Is the temperature checked and continually recorded on equilibration days? Yes[ ] No[ ]
- d. If the temperature is checked manually, how often are the readings recorded? \_\_\_\_\_
- e. Is the thermometer checked semi-annually against a reference thermometer? Yes[ ] No[ ]

4. Relative Humidity

- a. Is the relative humidity in the weighing room and where filters are stored held constant between 20% and 45% with a variance of no more than  $\pm 5\%$ ? Yes[ ] No[ ]
- b. Is the relative humidity checked and continually recorded on equilibration days? Yes[ ] No[ ]
- c. If the humidity is checked manually, how often are the readings recorded? \_\_\_\_\_
- d. Is the humidity instrument checked semi-annually against a sling psychrometer or other reference RH meter? Yes[ ] No[ ]

5. Filter Handling and Equilibration

- a. Are anti-static and powder-free gloves used while handling the filters? Yes[ ] No[ ]
- b. Are the forceps used to handle filters cleaned each weighing day with alcohol and lint-free wipes and allowed to air dry before handling filters? Yes[ ] No[ ]
- c. Are filters equilibrated for a minimum of 24 hours in a controlled environment before weighing? Yes[ ] No[ ]

- d. Is the heating and air conditioning for the weighing room and the filter storage area (if separate from the weighing room) maintained 24 hours a day, including weekends and holidays? Yes[ ] No[ ]
- e. Are the filters equilibrated at the same conditions (mean %RH within  $\pm 5\%$  and mean temperature within  $\pm 2^\circ$  C) before pre- and post-sampling weighings? Yes[ ] No[ ]
- f. During filter equilibration, are filters placed on a covered rack or open-sided cabinet within the conditioning chamber? Yes[ ] No[ ]

D. PRE-RUN FILTER INSPECTION AND WEIGHING

1. Filters

- a. What type of filters are used? \_\_\_\_\_
- b. From where are the filters obtained? (U.S. EPA, ARB, etc.) \_\_\_\_\_  
\_\_\_\_\_
- c. If the filters were obtained from the ARB, are the filters delivered pre-weighed by the ARB? Yes[ ] No[ ]
- d. Do the filters meet the specifications set forth in the U.S. EPA 40 CFR, Part 58? Yes[ ] No[ ]
- e. Visual Inspection. Are the filters checked for:
  - (1) Pinholes? Yes[ ] No[ ]
  - (2) Loose material? Yes[ ] No[ ]
  - (3) Poor/defective workmanship? Yes[ ] No[ ]
  - (4) Discoloration? Yes[ ] No[ ]
  - (5) Non-uniformity? Yes[ ] No[ ]
  - (6) Irregularities? Yes[ ] No[ ]
- f. What actions, if any, are taken if any defects or problems are found? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Figure U.2.0.1 PM10 Laboratory Operations System Audit Questionnaire (cont'd.)

- g. Are filters outside the 3.7g to 4.7g range rejected or investigated? Yes[ ] No[ ]
- h. Are filters numbered sequentially and listed in a bound laboratory logbook or computer? Yes[ ] No[ ]
- i. Are filters placed in glassine envelopes and stored in protective manila folders? Yes[ ] No[ ]
- j. If the filters are mailed, are they sufficiently protected in the mailing envelope, and are field operators supplied with proper shipping materials to protect exposed filters during shipment back to the laboratory? Yes[ ] No[ ]
2. Logbooks/QC Checksheets
- a. Are logbooks/QC checksheets maintained? Yes[ ] No[ ]
- b. Is a maintenance log maintained for all laboratory equipment? Yes[ ] No[ ]
- c. Are logbooks/QC checksheets current? Yes[ ] No[ ]
- d. Are logbooks/QC checksheets legible? Yes[ ] No[ ]
- e. Do logbooks/QC checksheets show calibrations? Yes[ ] No[ ]
- f. Are logbooks/QC checksheets initialed by the operator? Yes[ ] No[ ]
- g. Are logbooks/QC checksheets dated? Yes[ ] No[ ]
- h. Do logbooks/QC checksheets show filter weights? Yes[ ] No[ ]
- i. Do the logbooks/QC checksheets show times of each filter preweighing and sampling? Yes[ ] No[ ]
- j. Is the data archived? Yes[ ] No[ ]
- If so, for how long and where is the data stored? \_\_\_\_\_
-

3. Balance

- a. Is the balance calibrated by weighing a set of standard weights? Yes[ ] No[ ]
- b. Is the balance zero value rechecked after every 5 to 10 weighings? Yes[ ] No[ ]
- c. Is a calibration check of the balance performed after every 15 or fewer weighings? Yes[ ] No[ ]
- d. What actions are taken if the zero and calibration checks exceed the acceptable limits (electronic zero and calibration within  $\pm 5\mu\text{g}$  ( $\pm 0.0005\text{g}$ )).

---

---

---

- e. Are tare weights checked by reweighing 5 to 7 unexposed filters on days of operation (duplicates)? Yes[ ] No[ ]
- f. Describe what action is taken if reweighed filters are not within  $\pm 2.0\text{mg}$  of their original weights? \_\_\_\_\_

---

---

---

E. POST-RUN FILTER INSPECTION AND WEIGHING

1. Filters

- a. Are exposed filters logged in for processing? Yes[ ] No[ ]
- b. Are anti-static and powder-free gloves used during filter handling? Yes[ ] No[ ]

c. Are filters invalidated for:

- (1) Flow outside nominal 40 CFM ( $\pm 10\%$  after altitude correction?) Yes[ ] No[ ]
- (2) Contamination or damage? Yes[ ] No[ ]
- (3) Dickson recorder chart discrepancies? Yes[ ] No[ ]
- (4) Non-midnight start/stop times ( $\pm 30$  minutes)? Yes[ ] No[ ]
- (5) Increases/decreases in flow rate of more than 10% from ideal operating flow rate? Yes[ ] No[ ]
- (6) Changes in flow rate calibration of more than 10% as determined by field QC checks? Yes[ ] No[ ]
- (7) Samplers not operating for 24 hours ( $\pm 1$  hour)? Yes[ ] No[ ]
- (8) Missing or unobtainable information from data sheet? Yes[ ] No[ ]
- (9) Air leaks due to worn filter gaskets? Yes[ ] No[ ]

c. Briefly describe what action is taken if any of the above criteria are not met.

---

---

---

d. Are exposed filters stored after analysis? Yes[ ] No[ ]

If yes, where, under what conditions, and for how long?

---

---

---

2. Balance

- a. Are post-run balance checks performed as described in the pre-run filter inspection and weighing subsection? Yes[ ] No[ ]
- b. Are gross weights checked by reweighing 5 to 7 exposed filters on days of operation (duplicates)? Yes[ ] No[ ]
- c. Describe what actions are taken if the reweighed filters are not within  $\pm 5.0\text{mg}$ ?

---

---

3. Calculations

- a. Are readings corrected to standard conditions (temperature and pressure) for calculations? Yes[ ] No[ ]
- b. Give a brief description of the procedure and/or formula used to convert field data to final concentrations.

---

---

---

4. Quality Control (QC)

- a. As part of your QC program, what percent of the filters are reweighed (duplicates)? \_\_\_\_\_% Yes[ ] No[ ]
- b. As part of your QC program, what percent of data are verified by recalculation? \_\_\_\_\_% Yes[ ] No[ ]
- c. Are QC control charts maintained? Yes[ ] No[ ]

For which parameters? \_\_\_\_\_

---

- d. Are QC control charts reviewed at least quarterly by the laboratory supervisor? Yes[ ] No[ ]
- e. Does the laboratory supervisor certify on the laboratory data forms the acceptability of filter weighing, QC checks, and the completeness of the data? Yes[ ] No[ ]
- f. Is sample handling verified by participation in system audits? Yes[ ] No[ ]

**Note:** Please submit a copy of your quarterly QC report to the ARB's QAS when you return the questionnaire.

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

F. DATA REPORTING

- 1. What type data handling software (laboratory information management system) is used to input and report data?  
\_\_\_\_\_  
\_\_\_\_\_
- 2. To whom are the results of the filter weighings reported (e.g., U.S. EPA, ARB, etc.)?  
\_\_\_\_\_
- 3. To whom are the results of the mass determinations delivered? (Division/Section/name of person) \_\_\_\_\_  
\_\_\_\_\_
- 4. How often are the results forwarded to the reporting organization (e.g., monthly, quarterly, semi-annually)? \_\_\_\_\_

5. In what format are the results reported (e.g., hard-copy, diskette, electronic)? \_\_\_\_\_

6. Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

STATE OF CALIFORNIA  
AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME V

AUDIT PROCEDURES  
FOR  
AIR QUALITY MONITORING

APPENDIX U.3.0

SYSTEM AUDIT PROCEDURES  
FOR  
PM10 MASS ANALYSIS

MONITORING AND LABORATORY DIVISION

JANUARY 2003

## **U.3.0 PM10 MASS ANALYSIS SYSTEM AUDITS**

### **U.3.0.1 COMPONENTS OF A PM10 MASS ANALYSIS SYSTEM AUDIT**

The components of a PM10 mass analysis system audit are listed below:

1. Assessment of Staff
  - a. Background and Education
  - b. Chain of Command Regarding Description of Assignments and Specific Duties
  - c. Training
  - d. Level of Staffing
2. Assessment of Facilities
  - a. Laboratory and Support Facilities
  - b. Calibration Frequency
  - c. Documentation
3. Assessment of Data and Document Control
  - a. Chain of Custody
  - b. Validation and Processing Procedures
  - c. Reporting Formats
  - d. Storage of Filters and Data
  - e. Documentation
4. Assessment of the Quality Control Programs
  - a. Adequacy of Procedures
  - b. Adherence to Procedures

### **U.3.0.2 PRE-AUDIT ACTIVITIES**

Each agency is contacted to establish a timeframe for conducting the system audit. The auditor should inform the agency of the system audit details and that it will include completion of a questionnaire and an on-site inspection. The agency should be given thirty (30) calendar days to complete the questionnaire. Once the completed questionnaire is returned, it will be reviewed and the auditor will prepare a checklist detailing specific points for discussion with agency personnel.

### **U.3.0.3 ON-SITE ACTIVITIES**

The auditor should meet initially with the agency's director or designee to discuss the scope, duration and activities involved with the audit. A meeting should follow this with key personnel identified from the completed questionnaire.

Once the audit is completed, the auditor should meet again with key personnel and with the agency's director or designee to present the findings. This is also an opportunity for the agency to present any responses to the findings. The auditor should simply state the audit results including an indication of the potential data quality impact.

#### U.3.0.4 POST-AUDIT ACTIVITIES

The auditor, following the on-site visit, prepares a detailed system audit report. Preparation of the report requires that the auditor compare the agency's documented logs and procedures to the required regulations and guidelines.

A preliminary draft system audit report is submitted to the audited agency for review and comment together with a letter thanking agency personnel for their assistance, time, and cooperation. Comments on the report should be received from the audited agency within thirty (30) calendar days from the report date.

The agency's comments on the preliminary draft audit report should be reviewed for incorporation into the final draft report within thirty (30) days of receipt of the written comments. Their comments should include, where possible, the timeframe for implementing the recommendations. Many of the recommendations will require follow-up after completion of the final system audit report. A final draft report is then submitted to the agency for review and comment. Comments on the final draft report should be received from the audited agency within thirty (30) calendar days from the report date. A final report is submitted shortly thereafter to the agency, U.S. EPA, and CARB's Planning and Technical Support Division.

The system audit report includes an executive summary; conclusion; recommendations; system audit objectives; organization; laboratory facility and operations; data management; quality assurance and quality control; performance audit; data quality; follow-up; and a copy of the completed questionnaire. Details of a PM10 Mass Analysis System Audit Report are listed below:

1. Executive Summary -

The executive summary is a summary of the system audit report. This section indicates when the laboratory initiated PM10 mass analyses, why the audit was conducted (requirements), data quality, the outstanding areas of the program, and areas needing improvement.

2. Conclusion -

The conclusion section discusses data quality and CARB's audit findings.

3. Recommendations -

The Recommendations Section lists the areas of the program which must be improved to ensure the data are of acceptable quality, and can be considered data-for-record. The section also includes recommendations that should be implemented to improve the overall quality of the program.

4. System Audit Objectives -

This section discusses why the system audit was conducted.

5. Organization -

This section lists the staff responsible for overseeing the PM10 mass analysis program, from the staff conducting the weighings, to the air pollution control officer.

6. Laboratory Facility and Operations -

The Laboratory Facility and Operations Section discusses laboratory set-up, PM10 filter preparations, mass determination, and filter processing.

7. Data Management -

This section examines the data trail from the point of generation, to entry into the data acquisition system, through the review process, and submittal to the U.S. EPA and CARB.

8. Quality Assurance and Quality Control -

The Quality Assurance and Quality Control Section discusses the quality control procedures conducted by, and those which should have been conducted by, the laboratory. These are quality control guidelines outlined in the U.S. EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II (U.S. EPA, 1990). The following subsections are included in this section:

a. Pre-Run Filter Inspection and Weighing

U.S. EPA guidelines state that filters are to be visually inspected for pinholes, loose material, poor workmanship, discoloration, non-uniformity, and irregularities. Also, the weight of unexposed filters should be between 3.7 and 4.7 grams. Any filter outside this range should be inspected immediately.

b. Standard Weight Check

The U.S. EPA guidelines state that a standard weight check of the balance is to be conducted each day of filter weighing using standard weights between 3 grams and 5 grams. Also, a quality control log sheet should be maintained to record the weighings. The guidelines state that if the measured value differs by more than  $\pm 0.0005$  grams of the actual value, the supervisor is to be notified before proceeding. An investigation and appropriate corrective action may be necessary. If the actual and measured values agree within  $\pm 0.0005$  grams, the filters are then weighed.

c. Tare and Gross Weight Checks (Duplicate Weighings)

Tare and gross weight checks are the reweighing of unexposed and exposed filters to ensure proper weighing technique and adequate equilibration. The U.S. EPA has stated that these checks can be used to validate data when the equilibration information is missing or exceeds U.S. EPA limits. (See Figure U.2.0.1, U.S. EPA letter.) U.S. EPA guidelines state that on each day of filter weighing, five to seven unexposed and exposed filters should be reweighed per balance. The weight of the unexposed filter (tare weight) should be within  $\pm 0.0028$  grams of the original value. The weight of the exposed filter (gross weight) should be within  $\pm 0.005$  grams of the exposed filter's original value. If the weight exceeds the limits, the balance and filter are to be inspected and the filter reweighed immediately.

d. Filter Equilibration

U.S. EPA guidelines state that filters must be equilibrated in a controlled environment for a minimum of 24 hours prior to pre- and post-sample weighing. The guidelines also state that if filters must be weighed outside the conditioning chamber, care should be taken to avoid interference with ambient hygroscopic particles, and the weighing procedure should begin within 30 seconds. The controlled environment must meet the following U.S. EPA criteria over the 24-hour equilibration period:

- Temperature Range: 15°C to 30°C
- Temperature Control:  $\pm 3^\circ\text{C}$
- Relative Humidity Range: 20% to 45%
- Relative Humidity Control:  $\pm 5\%$

The relative humidity and temperature in the weighing room (conditioning chamber) must also be recorded on equilibration days.

e. Filter Sample Checks

In this subsection, the reasons why the laboratory would invalidate a filter sample are discussed. If a sample is invalidated, a make-up run should be immediately scheduled to ensure data representativeness.

f. Precision Data

The Precision Data Subsection discusses the submission, data validity, and useable data rates, as well as the overall average percent difference for data collected by collocated PM10 samplers.

g. Data Reporting

How often the data are reported and to whom are discussed in this subsection.

h. Calibrations/Certifications and Maintenance

The U.S. EPA requires that the balance be calibrated at least annually and maintained according to the manufacture's recommendations. If the balance is out of calibration, it should be calibrated per the manufacture's directions. Also, the relative humidity and temperature sensors should be calibrated annually.

9. Performance Audit -

The Performance Audit Section discusses the results of the standard weight checks and the review of the weighing techniques.

10. Data Quality -

This section discusses the quality of the data generated and submitted by the laboratory to the U.S. EPA and CARB.

11. Follow-up -

The follow-up section discusses the recommendations that will require follow-up and review at a future date.

The audits are conducted in accordance with U.S. EPA 40 CFR, Part 50, Appendix J. The audit results should include information on the network size, staff, data management system, equipment, and quality assurance and quality control functions.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION IX  
75 Hawthorne Street  
San Francisco, Ca. 94105

SEP 11 1991

Alice Westerinen, Manager  
Quality Assurance Section  
California Air Resources Board  
P.O. Box 2815  
1102 Q Street  
Sacramento, CA 95812

Re: PM10 Filter Equilibration

Dear Alice:

Based upon CARB's experiment results and concurrence with EPA Office of Air Quality Planning and Standards (OAQPS), this letter addresses the questions posed by your agency on filter equilibration for PM10 monitoring and supersedes the previous draft.

1. EPA's interpretation of 40 CFR Part 50, Appendix J, Sec. 7.4 Filter Conditioning Environment is as follows:
  - 7.4.1 Temperature Range: 15° to 30° C
  - 7.4.2 Temperature Control: +/- 3° C
  - 7.4.3 Humidity Range: 20% to 45% RH
  - 7.4.4 Humidity Control: +/- 5% RH

The purpose of the conditioning environment stipulated in the above regulation is to control the temperature and humidity at constant values in order to bring the filter into equilibrium before weighing. In the case of temperature, the set temperature T is to be controlled within +/-3° for at least 24 hours. The temperature must always be within the 15° to 30° C temperature range. For example, the laboratory technician may set the temperature T to be controlled at a mean T=25° C. This is within the 15° to 30° C temperature range. This temperature is to be controlled within +/- 3° C for at least 24 hours. Therefore, the temperature should actually be allowed to vary only between 22° and 28° C during the entire equilibration process for this case. Also, if the temperature control is no tighter than +/-3° C, then the mean value would have to be no higher than 27° C to avoid exceeding 30° C. The same process is true for humidity.

A relative humidity, RH, would be set somewhere between 20%

Printed on Recycled Paper

Figure U.3.0.1 U.S. EPA Letter

A relative humidity, RH, would be set somewhere between 20% and 45% RH. This RH is to be controlled within +/- 5% RH (staying within the 20% and 45% RH range) for at least 24 hours. By controlling the temperature and relative humidity in this way, both the preexposed blank filter and the exposed filter are weighed under the same environmental conditions to minimize error. It is most important that the equilibration and weighing conditions are relatively the same for both the blank filter weighing and the exposed filter weighing at least on a filter by filter basis. However, see the additional discussion below.

2. With regard to EPA's concerns regarding districts that do not have proper equilibration facilities, all districts should follow the sampling procedure for PM10 monitoring plainly stipulated in 40 CFR Part 50, App. J, Sec 9.0, including the equilibration requirements specified and control measures stipulated in 40 CFR Part 50, App. J, Sec. 7.4. Minor deviations of the specified conditions during equilibration will not necessarily invalidate the PM10 measurements. In such cases, a judgement as to the validity of the measurements will be made by EPA Region IX based on the nature and extent of the deviations and other available information, such as compliance with paragraph 4.5.3 of Section 2.11 of the Quality Assurance Handbook, Vol. II discussed below and the CARB test results indicating reasonable acceptability of some deviation tolerance with respect to effects of humidity variation and equilibration time variation.

At this point, if it is impossible for a district to have equilibration chambers or an environmentally controlled weighing room, these districts are requested to keep a record of the temperature and humidity in the conditioning environment, which may be their weighing room, and in their weighing room during the weighing of both the preexposed blank filters and the exposed filters.

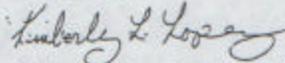
EPA does not recommend a particular type of instrument to read and/or record equilibration chamber temperature and relative humidity. It would seem reasonable to expect a humidity indicator to have a resolution of 1% RH or better and an accuracy of 2% to 3% or better. A temperature indicator should have a resolution of 0.5 degree or better and an accuracy of 1 degree or better.

Figure U.3.0.1 U.S. EPA Letter (cont'd.)

Also, the districts should follow paragraph 4.5.3 of Section 2.11 of the Quality Assurance Handbook, Vol. II. This check of the overall weighing procedures should be performed to show compliance with the limits of variation ( $\pm 2.8$  mg for unexposed filters and  $\pm 5$  mg for exposed filters). If this check shows consistent results within the limits stipulated, the filter equilibration and weighing techniques can be considered adequate and PM10 measurements will be considered valid. Otherwise, the results of non-compliance, with respect to the above limits stated in Section 2.11 and experimental test results, should be reported to EPA Region IX, and the data will be flagged accordingly.

If you should have any questions pertaining to the above matter, please call me at (415) 744-1256.

Sincerely,



Kimberly L. Lopez, A-2-1  
Air Quality Section

cc: Mike-Miguel, QA Sec., CARB

Figure U.3.0.1 U.S. EPA Letter (cont'd.)

STATE OF CALIFORNIA  
AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME V

AUDIT PROCEDURES  
FOR  
AIR QUALITY MONITORING

APPENDIX U.4.0

SYSTEM AUDIT PROCEDURES  
FOR  
PM10 MASS ANALYSIS PROGRAMS

MONITORING AND LABORATORY DIVISION

JANUARY 2003

## **U.4.0 PM10 MASS ANALYSIS LABORATORY PERFORMANCE AUDIT**

A performance audit of each PM10 mass analysis laboratory is conducted with the system audit and then annually following the initial system audit.

### **U.4.0.1 COMPONENTS OF A PM10 MASS ANALYSIS PERFORMANCE AUDIT**

The components of a PM10 mass analysis performance audit are listed below:

1. Assessment of Balance:
  - a. Weighing a set of Class S-1 standard weights, and
  - b. Reviewing the operator's weighing technique.
2. Assessment of Relative Humidity and Temperature Sensors:
  - a. Check of relative humidity and temperature sensors against certified relative humidity and temperature sensors.
3. Assessment of Documentation:
  - a. Review of maintenance log books,
  - b. Review of calibration log books, and
  - c. Review of quality control records.

### **U.4.0.2 PERFORMANCE AUDIT**

The performance audit entails the following: 1) conducting standard weight checks using a set of Class S-1 standard weights; 2) conducting relative humidity and temperature sensor checks; and 3) a review of the weighing technique, calibration and maintenance logs, and quality control (QC) records. The performance audit worksheet is presented in Figure U.4.0.1.

1. The standard weights used for the checks of the balance range from 1.0000 grams to 5.0000 grams. The U.S. EPA requires the balance response to be within  $\pm 0.0005$  grams of the actual weight. If the criteria is not satisfied, the laboratory should investigate and take any appropriate corrective action.
2. A Rotronics Hygroskop GT-L or Fisher Scientific relative humidity (RH) and temperature sensor is used to check the laboratory's RH and temperature sensors. The U.S. EPA requires the RH response to be within  $\pm 6\%$  of the actual RH and the temperature response to be within  $\pm 2^{\circ}\text{C}$  of the actual temperature. If the criteria is not satisfied, the laboratory should have the sensor calibrated or replaced.

## QA Performance Audit Worksheet PM10 Mass Analysis

Date of Audit: \_\_\_\_\_

Agency Audited: \_\_\_\_\_

Contact Person: \_\_\_\_\_

Auditors: \_\_\_\_\_

A. Standard Weight Checks of Balance: (Specs. =  $\pm 0.0005$  grams)  
 \*(1g) \_\_\_\_\_ \*(2g) \_\_\_\_\_ \*(3g) \_\_\_\_\_ \*(4g) \_\_\_\_\_  
 \*(5g) \_\_\_\_\_ \* Record balance response to the nearest 0.0000 grams.

B. Equilibration Room/Chamber Temperature Check: (Specs. =  $\pm 2^{\circ}\text{C}$ )  
 ARB \_\_\_\_\_ District \_\_\_\_\_

C. Equilibration Room/Chamber Relative Humidity Check: (Specs. =  $\pm 6\%$ )  
 ARB \_\_\_\_\_ District \_\_\_\_\_

D. Review of Calibration and Maintenance Logs and Quality Control Records:

1) Are logs complete, accurate, and up-to-date? Yes[ ] No[ ]

2) Are results within required specifications?  
 Daily calibrations within  $+0.0005$  grams? Yes[ ] No[ ]  
 RH = 20% to 45%,  $\pm 5\%$ ? Yes[ ] No[ ]  
 Temperature =  $15^{\circ}\text{C}$  to  $30^{\circ}\text{C}$ ,  $\pm 3^{\circ}\text{C}$ ? Yes[ ] No[ ]  
 Unexposed duplicate weighings within  $\pm 0.0028$  grams? Yes[ ] No[ ]  
 Exposed duplicate weighings within  $\pm 0.005$  grams? Yes[ ] No[ ]

3) When was the balance last calibrated?  
 (Required at least annually.) \_\_\_\_\_

What type of balance is used? \_\_\_\_\_

Who performed the certification/calibration? \_\_\_\_\_

4) When were the RH and temperature sensors last calibrated? (Required annually) \_\_\_\_\_

When were the RH and temperature sensors last checked? (Recommended semi-annually.) \_\_\_\_\_

5) When were your primary weights last calibrated? \_\_\_\_\_

6) What is the date of the last PM10 lab audit? \_\_\_\_\_

Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

- During the weighing of filters, laboratory staff should be observed performing sanitary practices to prevent contamination of the filters; checking and recording the weighing room RH and temperature; conducting and recording the daily standard weight check; rechecking the balance zero after each weighing; and cross-checking the filter's identification numbers with the chain-of-custody document (e.g., a 24-Hour Air Sample Report form). See Figure U.4.0.2.

The laboratory's quality control reports and calibrations and maintenance logs should be reviewed for accuracy, completeness, and adherence to specified requirements. The reports and logs should be easily accessible.

A letter should be sent to the laboratory within 30 days following the performance audit. The letter should include the results of the audit and any findings, if appropriate. If there are any adverse findings, the letter should specify a timeframe for corrective action to be taken by the laboratory.

The audits are conducted in accordance with U.S EPA 40 CFR, Part 50, Appendix J. The balance, RH and temperature sensors are checked against National Institute of Standards and Technology traceable weights and sensors.

24-HOUR PM10 AIR SAMPLE REPORT										SAMPLE NO. (FILTER PAPER NO.)			LAB. NO.														
MLD-13 (REV. 2/90)										STATION NAME			ELEVATION			COUNTY			SITE			AGENCY			PROJECT		
STATION ADDRESS										INSTRUMENT NO.																	
REPORTING AGENCY																											
SAMPLING CONDITIONS	LOCAL CONDITION CODES (ENTER APPROPRIATE CODE IN BOX AT LEFT)										H. RAIN			DATE OF LAST CALIBRATION			YEAR			MONTH			DAY				
<input type="checkbox"/>	A. NO UNUSUAL CONDITIONS      D. FARMING OPERATION NEARBY B. WIND-BLOWN SAND/DUST      E. FIRE NEARBY C. CONSTRUCTION NEARBY      F. SAMPLER MALFUNCTION (Explain Below)										Z. OTHER (Explain in Remarks)																
SAMPLE COLLECTION DATA																											
		DATE			TIME		ELAPSED TIME METER (MIN.)			FILTER PAPER WEIGHT (GRAMS)			SLOPE														
		YEAR	MONTH	DAY	HOURS	MIN.																					
FINISH																											
START																											
INDICATED FLOW RATE										NET:			NET:			AVERAGE STD FLOW (SCFM)						AVERAGE IND. FLOW RATE					
0200					0800					1400					2000												
<b>TO BE COMPLETED BY PM10 SAMPLER OPERATORS:</b> <input type="checkbox"/> Inspection of sampler and filter indicates that sample collected is in compliance with quality control standards for PM10 sampling. Filter and Dickson recorder chart enclosed. <input type="checkbox"/> Sample does not meet quality control standards for PM10 sampling and should be invalidated. Dickson recorder chart and filter enclosed. Make up sample scheduled for _____																											
<b>Reasons:</b> <input type="checkbox"/> Filter Contaminated or Damaged <input type="checkbox"/> High/Low Flowrate <input type="checkbox"/> Erratic Flowrate <input type="checkbox"/> Power Outage <input type="checkbox"/> Dickson Chart Recorder Problem <input type="checkbox"/> Timer Problem <input type="checkbox"/> Other																											
OPERATOR _____										PHONE NO. _____																	
CALIFORNIA AIR RESOURCES BOARD Monitoring and Laboratory Division P.O. Box 2815 Sacramento, CA 95812										REMARKS: _____										PRE-ANA.			POST-ANA.				

Figure U.4.0.2 24-Hour Air Sample Report

STATE OF CALIFORNIA  
AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME V

AUDIT PROCEDURES  
FOR  
AIR QUALITY MONITORING

APPENDIX U.5.0

SYSTEM AUDIT PROCEDURES  
FOR  
PM10 MASS ANALYSIS PROGRAMS

MONITORING AND LABORATORY DIVISION

JANUARY 2003

**U.5.0 REFERENCES**

U.S. EPA 40 Code of Federal Regulations (CFR), Part 50, Appendix J, July 1, 1999.

U.S. EPA Letter, dated September 11, 1991; Subject: PM10 Filter Equilibration.

Volume II, ARB Quality Assurance Handbook, April 3, 2000.