

STATE OF CALIFORNIA
AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME V

AUDIT PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX D

PERFORMANCE AUDIT PROCEDURES
FOR
HIGH VOLUME SAMPLERS

MONITORING AND LABORATORY DIVISION

AUGUST 2012

California Environmental Protection Agency



Standard Operating Procedure (SOP) Approval

Title: Performance Audit Procedures for High Volume Samplers

SOP: QMB SOP Appendix D, Revision 4

Section: Quality Assurance Section

Branch: Quality Management Branch

Division: Monitoring and Laboratory Division

Approval: This SOP has been reviewed and approved by:

/s/

Merrin J. Wright, Manager
Quality Assurance Section
Quality Management Branch

08/30/2012
Date

/s/

Michael Miguel, Chief
Quality Management Branch

08/30/2012
Date

TABLE OF CONTENTS

PERFORMANCE AUDIT PROCEDURES FOR HIGH VOLUME SAMPLERS

APPENDIX D

	<u>PAGE</u>	<u>REVISION</u>	<u>DATE</u>
D.1.0 Introduction	1	4	8-30-12
D.1.0.1 General Audit Information			
D.1.0.2 Flow Rate Audit Assumptions			
D.1.1 Audit Equipment	3	4	8-30-12
D.1.2 Flow Rate Audit Procedure	4	4	8-30-12
D.1.3 Audit Data Reporting	11	4	8-30-12

FIGURES

PERFORMANCE AUDIT PROCEDURES FOR HIGH VOLUME SAMPLERS

APPENDIX D

	<u>PAGE</u>
Figures	
Figure D.1.2.1 Total Suspended Particulate (TSP) High Volume Sampler	8
Figure D.1.2.2 Size Selective Inlet (SSI) High Volume Sampler	9
Figure D.1.2.3 QA Audit Worksheet PM10 and TSP	10
Figure D.1.3.1 QA Audit PM10 Report	12

D.1.0 INTRODUCTION

The primary goal of an auditing program is to identify system errors that may result in suspect or invalid data. The reliability of the data collected is contingent upon effective quality assurance procedures.

D.1.0.1 GENERAL AUDIT INFORMATION

The true assessment of the accuracy of the High Volume (Hi-Vol) particulate measurement system can only be achieved by conducting an audit under the following guidelines:

- A. Without special preparation or adjustment of the system to be audited.
- B. By an individual with a thorough knowledge of the instrument or the process that is being evaluated, but not by the routine operator.
- C. With accurate calibrated National Institute of Standards Technology (NIST) traceable transfer standards that are completely independent of those used in routine calibration.
- D. With complete documentation of audit data for submission to the operating agency. Audit information includes, but is not limited to, types of instruments and audit transfer standards, model and serial numbers, transfer standard traceability, calibration information, and collected audit data.

An independent observer should be present, preferably the routine operator of the sampling equipment. This practice not only contributes to the integrity of the audit, but also allows the operator to offer any explanations and information that will help the auditor to determine the cause of the discrepancies between measured audit data and the sampling equipment response.

D.1.0.2 FLOW RATE AUDIT ASSUMPTIONS

The audit procedures provided here are specific to Hi-Vol samplers. Hi-Vol samplers in the California Air Monitoring network are generally divided into two types of samplers: Total Suspended Particulate (TSP) samplers (figure D.1.2.1) and Size Selective Inlet (SSI) samplers (figure D.1.2.2). Audit techniques may vary among different models of samplers because of differences in required flow rates, flow controlling devices, options utilized (i.e., continuous flow recorder), and the configuration of the sampler. In this subsection, the following conditions are assumed:

- A. For TSP samplers, the volumetric flow rate at the sampler inlet is designed to operate in the range of 1.1 to 1.7 m³/min (38.8 to 60.0 CFM), and for SSI samplers, the volumetric flow rate at the sampler inlet is designed to operate in the range of 1.02 to 1.24 m³/min (35.9 to 43.9 CFM) at actual conditions.
- B. The calibrated transfer standard will be a BGI variable orifice equipped with a digital manometer. This equipment is certified once a year to be within $\pm 2\%$ of a NIST-traceable standard.
- C. The audit orifice calibration relationship is expressed in terms of the true volumetric flow rate (Q_c) as indicated by the audit orifice; these units being CFM.
- D. The types of samplers used for Hi-Vol particulate measurement are provided in Figures D.1.2.1 and D.1.2.2.

D.1.1 AUDIT EQUIPMENT

Performance audits of Hi-Vol samplers require the following equipment:

- A. A calibrated (NIST traceable) orifice device capable of measuring flow rate or pressure differential, with the most recent calibration report.
- B. The orifice device should be $\pm 2\%$ of a NIST-traceable standard, checked on an annual basis.
- C. A thermometer capable of accurately measuring temperature in the range of -20°C to $+60^{\circ}\text{C}$ and accurate to $\pm 0.5^{\circ}\text{C}$ with a resolution of $\pm 0.1^{\circ}\text{C}$. It must be referenced to a NIST thermometer and be checked annually. The thermometer should be within $\pm 0.5^{\circ}\text{C}$ of the NIST-traceable thermometer on the annual check.
- D. A barometer capable of accurately measuring ambient pressures to the nearest millimeter of mercury (mm Hg) in the range of 500 to 800 mm Hg. The barometer must be referenced within ± 5 mm Hg of a barometer traceable to NIST at least annually.
- E. The QA Audit Worksheet for PM₁₀ and TSP Samplers. (Figure D.1.2.3).
- F. Spare recorder charts, clean filters, and miscellaneous hand tools.

NOTE: The site operator is responsible for providing the sampler's calibration relationship (calibration curve or factor) for the subsequent determination of the Hi-Vol sampler's actual flow rate (Q_a).

D.1.2 FLOW RATE PERFORMANCE AUDIT PROCEDURES FOR HIGH VOLUME SAMPLERS

When conducting an audit of a particulate sampler, the following procedures should be adhered to:

- A. For TSP and mass flow controlled samplers, record the following parameters on the back side of a new chart for the chart recorder:
- Sampler ID number
 - Site name
 - Site number
 - Date
 - Auditors' names
- B. Open the front door of the sampler and install the clean, annotated chart in the recorder. Remove the center cross tab on the chart so the chart can be rotated freely to mark the pen's position.

NOTE: Use the operator's chart style if possible to eliminate error due to different brand variation in the chart printing, e.g. if the Hi-Vol sampler was calibrated using a square root function chart, the audit must be conducted with the same type of chart. Observe the recorder zero setting. Ask the operator if they normally adjust the zero as part of their weekly routine. If they do, instruct them to adjust the pen to indicate true zero.

- C. Install a clean filter in the Hi-Vol sampler. **DO NOT** use a filter cassette; place the filter directly on the sampler filter screen.
- D. Install the faceplate and audit orifice on the sampler. Do not restrict the flow rate through the orifice (i.e. by using plates or closing the valve). Use an unrestricted orifice. Simultaneously tighten the faceplate nuts on alternate corners to prohibit leaks and to assure even tightening. The fittings should be hand-tightened; too much compression can damage the sealing gasket. Make sure the orifice gasket is present and the orifice is not cross-threaded on the faceplate.

NOTE: The sampler inlet may be partially lowered, within 2 inches, over the audit orifice to act as a draft shield.

- E. If using a digital manometer turn on the manometer and adjust the zero, if necessary.
- F. Switch on the sampler and allow it to warm up to operating temperature (3 to 5 minutes).
- G. Observe and record the following parameters on the QA Audit Worksheet for PM10 and TSP (Figure D.1.2.3) as applicable:
- Site name and date
 - Station operator and auditors' names
 - Sampler model and ID number
 - Sampler designation – collocated, primary or secondary, and POC
 - Last calibration date and magnehelic reading
 - Calibration equipment certification date, calibration slope, and intercept
 - Ambient barometric pressure (P_a) in mm Hg and ambient temperature (T_a) in degrees Centigrade ($^{\circ}\text{C}$)
 - Inlet cleaning schedule and last cleaning date
- H. When the sampler has warmed up to operating temperature, read the pressure deflection across the orifice by reading the differential pressure gauge and record in the Audit Orifice Delta P box on the audit worksheet. Alternatively, a flow rate in CFM provided directly from the audit orifice may be recorded.
- NOTE:** If the magnehelic reading for volumetric flow controlled samplers or the chart reading for mass flow controlled samplers is outside the range the operator normally sees, re-position the filter on the screen. If this fails to bring the reading into the normal range, choose another filter and replace the previous one.
- NOTE:** If utilizing the chart recorder, make sure the recorder pen drag is relieved by tapping the side of the recorder and rotating it before reading the chart. This ensures a true reading.
- I. Ask the operator to calculate the instrument's actual flow (Q_a) as he or she normally would. Record this reading on the QA Audit Worksheet as the station instrument flow rate. If the operator normally calculates the flow

under standard conditions (Q_{std}), check the appropriate box in the audit report.

- J. If the sampler is a volumetric flow sampler (VFC), switch off the sampler until zero is attained on the differential pressure gauge and repeat Steps H and I, two more times to give you a total of three observations.
- K. If the sampler is an ARB VFC, record the magnehelic reading. Be sure to use the ARB VFC audit screen in the Audit Information System (AIS) to enter your audit data.
- L. If the sampler is utilizing a mass flow controller, confirm the flow controller and motor are operating properly. Run the sampler with one filter in place and mark the recording device (chart recorder). Without turning off the sampler, partially close the valve on the audit orifice and check that the flow drops and returns to the original operating point within a few minutes. Then without turning off the motor, reopen the valve on the audit orifice and check again for over-shoot and verify that the flow again returns to the original operating point. If the flow controller and motor are not responding to this type of systems check, then a double filter test must be performed. The filter test is done by removing the audit orifice and allowing the sampler to reach normal operating conditions with a filter in place. The flow controller is then tested by the addition and removal of a second filter to the system. Check again for the correct flow responses and document the information on the QA Audit worksheet (Figure D.1.2.3).

NOTE: In the event the sampler does not pass the flow controller tests notify the operator of equipment failure and document the actual flow rate data.

- M. Gather all audit data, including the audit orifice calibration information, the Hi-Vol sampler's calibration data (calibration curve), and the recorder chart that graphically displays the sampler response.
- N. Verify the correct calibrator and sampler recorder responses have been written on the QA Audit worksheet.
- O. Verify that the true flow rate determined by the audit orifice is within the specified volumetric flow rate range of 1.02 to 1.24 m³/min. (35.9 to 43.9 CFM) for PM10 High Volume samplers and 1.1 to 1.7 m³/min. (38.8 to 60.0 CFM) for TSP samplers. If the true flow rate is outside the specified range, an Air Quality Data Action (AQDA) request is to be issued. Upon investigation, the invalidation or correction of all data from the last calibration forward or known date of change (to be determined by the reporting agency) may result.

- P. Generate an audit report (Figure D.1.3.1) by entering the recorded responses into AIS.
- Q. Remove the audit orifice and ask the operator to return the sampler to normal conditions.



Figure D.1.2.1
Total Suspended Particulate (TSP) High Volume Sampler



Figure D.1.2.2
Size Selective Inlet (SSI) High Volume Sampler

QA AUDIT WORKSHEET PM 10 and TSP SAMPLERS

Site Name: _____ Date: _____
 Operator: _____ Inlet Cleaning Schedule: _____
 Auditors: _____ Inlet Last Cleaned: _____

Collocated Yes [] No [] Primary Yes [] No [] Secondary Yes [] No [] POC

Model: _____ ID #: _____

Audit Orifice ΔP or CFM		
Run 1	Run 2	Run 3

Station Instrument Flow Rate		
Run 1	Run 2	Run 3

Cal. Date: _____ Magnehelic Reading: _____ Passed FCT Yes [] No []
 Cal. Equip. Cert Date: _____ Slope: _____ Intercept: _____ Baro: _____ Temp: _____ °C

Collocated Yes [] No [] Primary Yes [] No [] Secondary Yes [] No [] POC

Model: _____ ID #: _____

Audit Orifice ΔP or CFM		
Run 1	Run 2	Run 3

Station Instrument Flow Rate		
Run 1	Run 2	Run 3

Cal. Date: _____ Magnehelic Reading: _____ Passed FCT Yes [] No []
 Cal. Equip. Cert Date: _____ Slope: _____ Intercept: _____ Baro: _____ Temp: _____ °C

Collocated Yes [] No [] Primary Yes [] No [] Secondary Yes [] No [] POC

Model: _____ ID #: _____

Audit Orifice ΔP or CFM		
Run 1	Run 2	Run 3

Station Instrument Flow Rate		
Run 1	Run 2	Run 3

Cal. Date: _____ Magnehelic Reading: _____ Passed FCT Yes [] No []
 Cal. Equip. Cert Date: _____ Slope: _____ Intercept: _____ Baro: _____ Temp: _____ °C

Data recorded and verified by: _____

Figure D.1.2.3
 QA Audit Worksheet PM10 and TSP

D.1.3 AUDIT DATA REPORTING

The operating agency should be given a copy of the audit results when the audit is completed. If a sampler exhibits unsatisfactory agreement with the audit results (audit differences exceed ARB's control limits), the station operator needs to be informed and an AQDA must be issued as soon as possible.

Deviations exceeding $\pm 7\%$ may require recalibration. Differences exceeding $\pm 10\%$ require an AQDA to be issued. Upon investigation, the invalidation or correction of all data from the last calibration forward or known date of change (to be determined by the reporting agency) may result.

NOTE: Sections of D.1.2 were taken from 40 CFR 50 Appendix J, Reference Method for Determination of Particulate Matter as PM₁₀ in the Atmosphere, published by the Environmental Protection Agency.

Technical Appendix - ARB PM10

Audit Information						
Audit Display (Inches H ₂ O)	Audit Flow (CFM)	Station Magnehelic Reading	Station Flow (CFM)	Audit Average	Percent Difference	Percent Difference from Design
3.05	38.2	-				
3.03	38.1	-				
3.07	38.3	21.5	40.0	38.2	4.7	-4.5
Audit Temperature (corrected): 12.3 °C Ambient Pressure (corrected): 755.7 mmHg Design flow rate limits are 36 to 44 CFM for PM10 SSI samplers.						
Failures and Warnings						
All audit parameters are within specified limits!						
Instrument/AIRS Information						
ARB Number	06646	AIRS Number	060111002			
Audit Date	2012-03-13	Instrument-Method	Sierra Anderson 1200			
Van	X	Serial Number	04074			
Quarter	1	Last Cal Date	2011-06-27			
Comments						

Figure D.1.3.1
 QA Audit PM10 Report