METHOD 203. DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES BY CONTINUOUS OPACITY MONITORING SYSTEMS

1. APPLICABILITY AND PRINCIPLE

1.1 Applicability. This method applies to the measurement of the opacity of emissions from stationary sources by continuous opacity monitoring systems (COMS), in order to determine compliance with an emissions standard. The method is not applicable where water droplets are present in the effluent being measured.

1.2 Principle. The opacity of emissions from a stationary source is continuously measured and recorded using a COMS that meets all the requirements of Performance Specification 1 (PS 1) of 40 CFR Part 60, Appendix B. Minimum quality control (QC) and quality assurance (QA) requirements are specified to assess the quality of COMS performance. Daily zero and span checks, quarterly performance audits, and annual zero alignment checks are required in order to assure the proper functioning of the COMS and the accuracy of the COMS data.

Because control and corrective action encompasses a variety of policies, specifications, standards, and corrective measures, this method treats QC requirements in general terms to allow the development of a QC system that is most effective and efficient for the circumstances.

2. DEFINITIONS

2.1 Continuous Opacity Monitoring System (COMS). The total equipment required for the determination of the opacity of emissions which meets the minimum requirements of Performance Specification 1 of 40 CFR Part 60.

2.2 Simulated Zero Check. Method or device used to provide a simulated zero opacity (or low-level value between zero and 20 percent of the applicable opacity standard). Where a standard of less than 10 percent opacity has been specified, a surrogate opacity standard of 10 percent shall be used for determining this value.

2.3 Out-of-Control Periods.

2.3.1 Daily Assessments. Whenever the calibration drift (CD) exceeds twice the specification of PS-1, the COMS is out-of-control. The beginning of the out-of-control period is the time corresponding to the last successful drift-check. The end of the out-of-control period is the time corresponding to the completion of appropriate adjustment and subsequent successful CD assessment.

2.3.2 Quarterly and Annual Assessment. Whenever a quarterly performance audit or annual zero alignment audit indicates unacceptable results, the COMS is "out-of-control." The beginning of the out-of-control period is the time corresponding to the completion of the performance audit indicating and unacceptable performance. The end of the out-of-control period is the time

corresponding to the completion of appropriate corrective actions and subsequent successful audit (or, if applicable, partial audit).

2.4 Upscale Opacity Condition. Method or device used to provide a simulated upscale opacity (50 to 100 percent of the opacity standard).

2.5 External Zeroing Device (Zero-Jig). An external, removable device for simulating or checking the cross-stack zero alignment of the COMS.

3. COMS INSTALLATION, DESIGN, AND PERFORMANCE SPECIFICATIONS

In addition to the installation, design, and performance requirements of PS 1, the following are added:

3.1 External Calibration Filter Access. The COMS must be designed to allow for the evaluation of both the linearity and accuracy relative to a simulated zero value and provide a check of all system components. An adequate design would accommodate a calibration filter assembly and permit periodic use of external (i.e., not intrinsic to the instrument) neutral density filters.

3.2 Data Reduction/Recording. The COMS shall be designed to allow for the data reduction, recording, and reporting in accordance with the applicable opacity standards. Monitors that automatically adjust the data to the corrected calibration value must be capable of recording the amount of adjustment that is applied to the exhaust gas stream measurement. Data recorded

during periods of COMS breakdowns, repairs, calibration checks, and adjustments shall not be used in the data averages of Section 3.4.

3.3 Zero and Upscale Calibration Evaluations. All COMS installed pursuant to these procedures shall include a method for producing a simulated zero opacity condition and an upscale opacity condition using a certified neutral density filter to produce an known obscuration of light. Such procedures shall provide a system check of the analyzer internal optical surfaces and all active electronic circuitry including the lamp and photodetector assembly used in the measurement mode.

3.4 Data Averages. All COMS installed pursuant to these requirements shall complete a minimum of one cycle of sampling and analyzing for each successive 10-second period and one cycle of data recording for each specified data average, e.g., 6-minute average. An arithmetic or integrated average of all data should be used.

4. OPACITY MEASUREMENT.

4.1 The opacity of emissions shall be continuously measured and recorded in units of percent opacity, and shall be expressed in the averaging period specified in the applicable regulation.

4.2 The COMS shall be operated, maintained and calibrated to meet these requirements in accordance with the instructions provided by the instrument manufacturer.

4.3 Except for COMS breakdowns, repairs, calibration checks, zero and span checks and other quality-assurance activities, the COMS shall be in continuous operation during all periods of source operation.

4.4 A data average shall be considered valid if no less than 83 percent of the opacity readings upon which the data average is based are obtained.

4.5 Any and all valid data averages may be used to determine compliance with the applicable opacity standard. Data obtained during "out-of-control" periods shall not be used for compliance determination; however, the data can be used for identifying periods of failure to meet quality assurance and control criteria.

5. QUALITY CONTROL (QC) REQUIREMENTS

5.1 Calibration Drift (CD) Assessment. The COMS shall be checked, at least once daily and the CD quantified and recorded at the zero (or low-level) and upscale-level opacity. The COMS shall be adjusted whenever the CD exceeds the specification of PS-1, and the COMS shall be declared "out-of-control" when the CD exceeds twice the specification of PS-1. Corrective actions, followed by a validating CD check are required when the COMS is out-of-control.

5.2 Fault indicators Assessment. At least daily, the fault lamp indicators, data acquisition system error messages, and other system self diagnostic indicators shall be checked. The appropriate corrective actions should be taken when the COMS is

operating outside preset limits. All COMS data recorded during periods in which fault indicators are illuminated shall be considered invalid.

5.3 Performance audits. Checks of the individual COMS components and factors affecting the accuracy of the monitoring data, as described below, shall be conducted on a quarterly basis. Examples of detailed audit procedures may be found in Reference 1, "Performance Audit Procedures for Opacity Monitors", and Reference 2, "CEMS Pilot Project: Evaluation of CEMS Reliability and QA Procedures Volume 1". The following identify the absolute minimum checks that shall be included in the performance audit:

5.3.1 Optical Alignment Assessment. The status of the optical alignment of the monitor components shall be checked and recorded according to the procedures specified by the monitor manufacturer. Realign as necessary.

5.3.2 Optical Surface Dust Accumulation Assessment. The apparent effluent opacity shall be compared and recorded before and after cleaning of each of the exposed optical surfaces. The total optical surface dust accumulation shall be determined by summing the apparent reductions in opacity for all of the optical surfaces that are cleaned. Caution should be employed in performing this check since fluctuations in effluent opacity occurring during the cleaning cycle may adversely affect the results.

5.3.3 Zero and Upscale Response Assessment. The zero and upscale response errors shall be determined and recorded according to the CD procedures. The error is defined as the difference (in % opacity) between the correct value and the observed value for the zero and high-level calibration checks.

5.3.4 Zero Compensation Assessment. The value of the zero compensation applied at the time of the audit shall be calculated as equivalent opacity, corrected to stack exit conditions as necessary, according to the procedures specified by the manufacturer. Record the compensation applied to the effluent recorded by the monitor system.

5.3.5 Stack Exit Correlation Error Assessment. The optical pathlength correction ratio (OPLR) shall be computed form the monitor pathlength and stack exit diameter and shall be compared, and the difference recorded, to the monitor setup value. The stack exit correlation error shall be determined as the absolute value of the difference between the measured value and the correct value, expressed as a percentage of the correct value.

5.3.6 Calibration Error Assessment. A three-point calibration error test of the COMS shall be conducted. For either calibration error test methods below, three neutral density filters meeting the requirements of PS-1, shall be placed in the COMS light beam path five consecutive times and the monitor responses shall be independently recorded from the permanent COMS data recorder.

Additional guidance for conducting this test is included in Section 7.0 of PS-1. The low-, mid-, and high-range calibration error results shall be computed as the mean difference and 95 percent confidence interval for the difference between the expected and actual responses of the monitor as corrected to stack exit conditions. These values shall be calculated using the procedures of Section 8.0 of PS-1.

5.3.6.1 Primary Calibration Error Method. The calibration error test requires the installation of an external calibration audit device (zero-jig). The zero-jig shall be adjusted to provide the same zero response as the monitor's simulated zero.

5.3.6.2 Alternative Calibration Error Method. Conduct an incremental calibration test by superimposing the neutral density filters over the effluent opacity and comparing the COMS responses to the expected value calculated from the filter and opacity values immediately preceding the superimposing. Record both the stack effluent opacity and the calibration filter value prior to each test. This method is sensitive to fluctuations in the effluent opacity during the test.

5.3.6.3 Attenuators. Use calibration attenuators (i.e. neutral density filters) with values that have been determined according to Section 7.1.3 "Attenuator Calibration" of PS 1, Appendix B, 40 CFR Part 60, and produce simulated opacities (corrected to stack exit conditions as necsesary) in the ranges

listed in Table 1 below. For emission standards of 10 percent (or less) opacity, attenuator selection may be based on a 10 percent opacity standard.

5.3.6.2. Attenuator Stability. The stability of the attenuator values should be checked at least once per year according to the procedures specified in PS-1. The attenuators shall be recalibrated if the stability checks indicate a change of two percent opacity or greater.

TABLE 1 - FILTER RANGES FOR COMS PERFORMANCE AUDITS

Audit Point	Audit Filter Range (% Op)
1	20 - 60 Percent of the Emission Limit (low)
2	80 - 120 Percent of the Emission Limit (mid)
3	150 - 200 Percent of the Emission Limit (high)

5.4 Zero alignment Assessment. Compare the COMSs simulated zero to the actual clear path zero of the installation annually. The audit may be conducted in conjunction with, but prior to, a performance audit.

5.4.1 Primary Zero Alignment Method. The primary zero alignment shall be performed under clear path conditions. This may be accomplished if the process is not operating and the monitor

pathlength is free of particulate matter or the monitor may be removed from its installation and set up under clear path conditions. The absence of particulate matter shall be demonstrated prior to conducting the test at the installed site. No adjustment to the monitor is allowed other than the establishment of the proper monitor pathlength and correct optical alignment of the monitor components. Record the monitor response to a clear path condition and to the monitor's simulated zero condition as percent opacity corrected to stack exit conditions as necessary. For monitors with automatic zero compensation, disconnect or disable the zero compensation mechanism or record the amount of correction applied to the monitor's simulated zero condition. The response difference in percent opacity to the clear path and simulated zero conditions shall be recorded as the zero alignment error. Adjust the monitor's simulated zero device to provide the same response as the clear path condition. Restore the COMS to its operating mode.

5.4.2 Alternate Zero Alignment Method. Monitors capable of allowing the installation of an external, removable zero-jig, may use the equipment for an alternative zero alignment provided that the zero-jig setting is established for the monitor pathlength and recorded for the specific COMS by comparison of the COMS responses to the installed zero-jig and to the clear path condition; the zero-jig is demonstrated to be capable of producing a consistent

zero response when it is repeatedly (i.e., three consecutive installations and removals prior to conducting the final zero alignment check) installed on the COMS. The zero-jig setting shall be permanently set at the time of the initial COMS zeroing to the clear path zero value and protected when not in use to ensure that the setting equivalent to zero opacity does not change. The zero-jig setting shall be checked and recorded prior to initiating the zero alignment. Source owners and operators that employ a zero-jig shall perform a primary zero alignment audit once every 3 years.

5.5 Monitor Acceptance Criteria.

5.5.1 Performance Assessment. The following criteria are to be used for determining acceptable performance of and out-of-control periods for the COMS:

TABLE 2 - PERFORMANCE AUDIT CRITERIA

Stack Exit Correlation Error:	≤ 2 percent
Fault Indicators:	Inactive - no error messages
Zero and Upscale Responses:	≤ 2 percent opacity Zero Compensation: ≤ 4 percent opacity
Optical Alignment:	Misalignment error ≤ 2 percent opacity
Optical Surface Dust Accumulation:	≤ 4 percent opacity
Calibration Error:	≤ 2 percent opacity

Zero Alignment	≤ 5 percent opacity for one check ≤ 2 percent opacity for three consecutive checks
Valid Data Average Capture	≥ 95 percent of source operating time

5.5.2 Zero Alignment. The zero alignment is acceptable if the error at the simulated zero check is less than 2 percent opacity prior to adjustment. The simulated zero check shall be adjusted to provide the correct response each time the zero alignment check is performed.

5.5.3 Unacceptable Results - Single Performance Assessment. The COMS is out-of-control whenever the results of a quarterly performance audit indicate non-compliance with any of the performance assessment criteria of TABLE 2 of §5.5.1 above. If the COMS is out-of-control, take necessary corrective action to eliminate the problem. Following corrective action, the source owner or operator must re-conduct the appropriate failed portion of the audit and other applicable portions to determine whether the COMS is operating properly and within specifications. The COMS owner or operator shall record both audit results showing the COMS to be out-of-control and the results following corrective action. COMS data obtained during any out-of-control period are may not be used for compliance determination or to meet the data capture requirement of §5.5.6, hoever the data can be used for identifying

periods where there has been a failure to meet quality assurance and control criteria.

5.5.4 Unacceptable Results - Multiple Performance Assessments. Repeated audit failures (i.e., out-of-control conditions resulting from the quarterly audits) indicate that the QC procedures are inadequate or the COMS is incapable of providing quality data. The source owner or operator shall increase the frequency of the above QC procedures until the performance criteria is maintained or modify or repalce the COMS whenever two consecutive quarters of unacceptable performance occurs.

5.5.5 Unacceptable Zero Alignment. If the error of the simulated zero check prior to adjustment exceeds 5 percent opacity for any zero check, or exceeds the 2 percent opacity acceptance criterion for three consecutive checks, the performance of the COMS is unacceptable. The source owner or operator shall take corrective action to resolve the problem and improve the stability of the simulated zero check method or device or replace the COMS. If the COMS is not replaced, zero alignment audits shall be conducted at least biannually during non-consecutive quarters.

5.5.6 Unacceptable Results- Insufficient Data Capture. Compliance with the 95 percent data capture requirement shall be determined by considering COMS downtime for all causes (e.g., monitor malfunctions, data system failures, preventive maintenance, unknown causes, etc.) except for downtime associated with routine

zero and span checks and QA/QC activities required by this method. Failure of a COMS to obtain valid opacity data for at least 95 percent of the source operating time during any reporting period (e.g., day, month, quarter, semiannual period, etc.) indicates that the QC/QA procedures are not sufficient or that the COMS is not capable of continuously providing quality data. Whenever less than 95 percent valid data are obtained for a reporting period, the source owner or operator shall either: (1) perform such additional QC/QA activities as deemed necessary to assure acceptable data capture; or (2) modify or replace the COMS. Additional QC/QA procedures include, but are not limited to,: implementation or revision of a QC program; maintenance of a spare-parts inventory; conducting more frequent system performance audits.

6. CALCULATIONS FOR COMS ASSESSMENTS.

6.1 Performance Audit Calculations. The calculations contained in Section 8 of PS-1 shall be followed.

6.2 Zero Alignment Checks. The procedures contained in Reference 1, Section 10, Zero Alignment Checks, shall be followed.

7. REPORTING REQUIREMENTS.

At the reporting frequency and in the format specified in the applicable regulation, report on a quarterly basis the performance and accuracy results from Section 5.0. The quarterly performance and accuracy report must contain the drift and audit result information as a Data Assessment Report (DAR), see example format

Figure 1. A copy of the quarterly DAR should be included as a separate report with the periodic reports of emissions required under applicable regulatory requirements. As a minimum, the DAR must contain the following information:

1. Source owner and operator name and address.

2. Identification (by serial number) and location of the monitors in the COMS.

3. Manufacturer and model of each monitor in the COMS.

4. Results of COMS performance and date of assessment as determined by performance audit or zero alignment audit, including performance audit results for each of the tests described in Sections 5.3 and 5.4, the calculation of these results, as well as the zero error and its calculation. If the performance audit results show the COMS to be out-of-control, the COMS owner or operator shall report both the audit results showing the COMS to be out-of-control and the results of the audit following corrective action showing the COMS to be operating within specification.

5. Summary of all corrective actions taken when COMS was determined to be out-of-control, as described in Sections 5.5.

8. Bibliography

8.1 " CEMS Pilot Project: Evaluation of CEMS Reliability and QA Procedures Volume 1", EPA - 340/1-86-009a, May 1986, U.S.EPA,

Office of Air Quality Planning and Standards, Washington, D.C. 20460

8.2 "Performance Audit Procedures For Opacity Monitors", EPA-450/4-92-010, April 1992, U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711

8.3 Specification and Test Procedures for Opacity Continuous Emission Monitoring Systems in Stationary Sources, Performance Specification 1, 40 C.F.R. Part 60, Appendix B.

8.4 Procedure 1. Quality Assurance Requirements for Gas Continuous Emission Monitoring Systems Used for Compliance Determination, 40 C.F.R. Part 60, Appendix F.

Figure 1. EXAMPLE FORMAT FOR COMS DATA ASSESSMENT REPORT

Period ending date:_____Year:_____
Company Name: _____
Plant Name: _____ Unit No._____
COMS Manufacturer:_____ Model:____
COMS Serial No.(s): _____

I. Performance Audit

1. Stack Exit Correlation Error

a. Actual pathlength correction factor _____

b. Correct pathlength correction factor _____

c. Stack exit Correlation Error _____

2. Active Fault Indicators; error messages present:____

_____

3. Zero and Upscale Calibration Check Responses

	Correct Value	Response	Difference
Zero	_____	_____	_____
Upscale	_____	_____	_____

4. Zero Compensation Value (percent opacity): _____

5. Optical Alignment Status: _____

6. Dust Accumulation on Optical Surfaces

	Initial Opacity	Final Opacity	Difference
Window 1	_____	_____	_____
Window 2	_____	_____	_____
		Total	_____

7. Calibration Error

a. Filter Values (equivalent opacity)

Low: _____ Mid: _____ High: _____

b. Test Results

	Low	Mid	High
1.			
2.			
3.			
4.			
5.			

c. Calibration Error

Low: _____ Mid: _____ High: _____

8. Corrective Action for Unacceptable Performance
Out-of-control periods:
Date(s)and Time(s): _____
Number of hours: _____
Corrective action taken: _____
Results of audit (or partial audit) following corrective action. (Use format,as applicable, as shown in I-8 above)

II. Zero Alignment Audit
1. Clear Path Zero Response: _____ percent opacity
2. Simulated Zero Response: _____ percent opacity
3. Zero Alignment Error: _____ percent opacity
4. Zero Error of Previous Two(2) Assessments: _____

_____

III. Calibration Drift Assessment
Out-of-control periods:
Date(s): _____
Number of days: _____

Corrective action taken: _____

Results of CD after corrective action. (Use format above)

IV. Data Capture Assessment
1. Source operating hours: _____
2. Total hours of valid COMS data: _____
(During source operating hours, <u>including</u> valid data obtained during routine calibration checks and QA/QC activities required by this method.)

3. Percent data capture: _____

V. Calculations (Include on a separate page.)