1. Purpose

The Quality Assurance procedures consist of two distinct and equally important functions. One function is the assessment of the quality of the data produced by the Continuous Emission Monitoring System (CEMS) by estimating its accuracy. The other function is the control and improvement of the quality of the CEMS data by implementing Quality Control policies and corrective actions. These two functions form a control loop: when the assessment function indicates that the data quality is inadequate, the control effort must be increased until the data quality is acceptable. In order to provide uniformity in the assessment and reporting of data quality, this procedure explicitly specifies the assessment methods for response drift and accuracy.

This Procedure also requires analyses of the audit samples concurrent with certain reference method (RM) analyses, as specified in the applicable RM.

2. Scope

This procedure is used to evaluate the effectiveness of quality control (QC) and quality assurance (QA) procedures and the quality of data produced by a Continuous Emission Monitoring System (CEMS) that is used for determining compliance with the emission standards on a continuous basis, as specified in the applicable regulation.

This procedure specifies the minimum QA requirements necessary for the control and assessment of the quality of CEMS data.

This procedure also specifies that the CEMS equipment must be calibrated whenever calibration drift measurements fail to meet specified limits or upon failure to pass a relative accuracy audit or relative accuracy test audit (RATA) (using Form O-EF 016.A).

3. Forms Used

- CEMS Audit, O-EF 016.A
- Data Assessment Report (DAR), O-EF 016.B
- CEMS Calibration Form, O-EF 016.C

4. References

- USEPA – 1977 – Calculation and Interpretation of Accuracy for CEMS, Section 3.07 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods EPA - 600/4-77-027b.
- USEPA, 1993, Test Methods, Appendix A, 40 CFR, PART 60.
- USEPA, 1993, CEMS Performance Specifications, Appendix B, 40 CFR, PART 60..
- Requirements for Gas Continuous Emission Monitoring Systems Used for Compliance Determination (adoption of EPA APPENDIX F TO 40 CFR PART 60).

5. Definitions

Continuous Emission Monitoring System: total equipment required for the determination of a gas concentration or emission rate.

Diluent Gas: a major gaseous constituent in a gaseous pollutant mixture. For the combustion sources, CO_2 and O_2 are the major gaseous constituents of interest.

Span Value: the upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable subpart of the regulation.

Zero, Low-Level, and High-Level Values: the CEMS response values related to the source specific span value. Determination of zero, low-level, and high-level values is defined by the appropriate performance specification in Appendix B, 40 CFR 60.

Calibration Drift (CD): the difference in the CEMS output reading from a reference value after a period of operation during which no unscheduled maintenance, repair or adjustment took place. The reference value may be supplied by a cylinder gas, gas cell, or optical filter and need not be certified.

Relative Accuracy (RA): the absolute mean difference between the gas concentration or emission rate determined by the CEMS and the value determined by the RMs plus the percent error confidence coefficient of a series of tests divided by the mean of the RM tests or the applicable emission limit.

Percent Error Confidence: coefficient of a series of tests divided by the mean of the RM tests or the applicable emission limit.

Out-Of-Control Period Definition: The beginning of the out-of-control period is the time corresponding to the completion of the sampling for the Relative Accuracy Test Audit (RATA), or Cylinder Gas Audit (CGA). The end of the out-of-control period is the time corresponding to the completion of the sampling of the subsequent successful Audit.

6. Procedure

6.1 CD Assessment

CD Requirement: the CEMS operators (EAC or Chemical Engineer) must check, record, and quantify the CD at two concentration values at least once each week, following the method prescribed by the manufacturer. The CEMS calibration must, as a minimum, be adjusted whenever the zero (or low-level) CD or the high-level CD exceeds four times the limit or for the fifth consecutive measurement that it exceeds two times the limit of the applicable performance specification (PS) in Appendix B, 40 CFR 60.

Recording Requirement for Automatic CD Adjusting Monitors: monitors that automatically adjust the data to the corrected calibration values (e.g., microprocessor control) must be programmed to record the unadjusted concentration measured in the CD prior to resetting the calibration, if performed, or record the amount of adjustment.

Criteria for Excessive CD: If either the zero (or low-level) or high-level CD result exceeds four times or twice for five consecutive measurements, the applicable performance specification in Appendix B, 40 CFR 60, the CEMS is out-of-control. If the CEMS is out-of-control, file a CAR as per procedure O – EP 019. Following corrective action, repeat the CD checks.

Out-Of-Control Period Definition: the beginning of the out-of-control period is the time corresponding to the completion of the fifth consecutive, daily CD check with a CD in excess of two times the allowable limit, or the time corresponding to the completion of the CD check preceding the one that results in a CD in excess of four times the allowable limit. The end of the out-of-control period is the time corresponding to the completion of the CD check following corrective action that results in the CDs at both the zero (or low-level) and high-level measurement points being within the corresponding allowable CD limit (i.e., either two times or four times the allowable limit in Appendix B).

CEMS Data Status During Out-of-Control Period: during the period the CEMS is out-of- control, the CEMS data may not be used in calculating

emission compliance, nor be counted towards meeting minimum data availability as required and described in the applicable subpart.

Data Recording and Reporting: all measurements from the CEMS must be retained on file by the Macaé Merchant Power Plant for at least two years. However, emission data obtained on each successive day while the CEMS is out-of-control may not be included as part of the minimum daily data requirement of the applicable subpart, nor be used in the calculation of reported emissions for that period.

6.2 Data Accuracy Assessment

Auditing Requirements: each CEMS unit must be audited at least once each calendar year. The audits shall be conducted as follows:

- Relative Accuracy Test Audit (RATA) and Relative Accuracy Audit (RAA). The RATA must be conducted at least once every four calendar quarters. Conduct the RATA as described for the RA test procedure performance specification in Appendix B, 40 CFR 60 (e.g., PS 2 for SO2, CO and NOx). In addition, analyze the appropriate performance audit samples received as described in the applicable sampling methods (e.g., EPA, Methods 6 and 7). RAA must be performed each six months according to procedures below.

- Cylinder Gas Audit (CGA). If applicable, a CGA may be conducted in three of four calendar quarters, but in no more than three-quarters in succession.

To conduct a CGA:

(1) Challenge the CEMS with an audit gas of known concentration at two points within the following ranges:

Audit point	Audit Range		
	Pollution monitors	Diluent monitors for	
		CO_2	O_2
1	20 to 30% of span value.	5 to 8% by volume	4 to 6% by volume
2	50 to 60% of span value	10 to 14% by volume	8 to 12% by volume

Challenge the CEMS three times at each audit point, and use the average of the three responses in determining accuracy.

Use of separate audit gas cylinder for audit points 1 and 2. Do not dilute gas from audit cylinder when challenging the CEMS.

The monitor should be challenged at each audit point for a sufficient period of time to assure adsorption-desorption of the CEMS sample transport surfaces has stabilized.

(2) Operate each monitor in its normal sampling mode, i.e., pass the audit gas through all filters, scrubbers, conditioners, and other monitor components used during normal sampling, and as much of the sampling probe as is practical. At a minimum, the audit gas should be introduced at the connection between the probe and the sample line.

(3) Use audit gases that have been certified.

The difference between the actual concentration of the audit gas and the concentration indicated by the monitor is used to assess the accuracy of the CEMS.

Relative Accuracy Audit (RAA) : The RAA must be conducted each six months. To conduct a RAA, follow the procedure described in the applicable performance specification in Appendix B, 40 CFR 60 for the relative accuracy test audit

(RATA), except that only three sets of measurement data are required, instead of nine. Analyses of performance audit samples are also required.

The relative difference between the mean of the RM values and the mean of the CEMS responses will be used to assess the accuracy of the CEMS.

Other Alternative Audits: other alternative audit procedures may be used as approved by the Administrator for three of four calendar quarters. One RATA is required at least once every four calendar quarters.

Excessive Audit Inaccuracy: if the RA, using the RATA, RAA or CGA, exceeds the criteria in section 5.2.3, the CEMS is out-of-control. If the CEMS is out-of-control, file a CAR as per procedure O-EP-018. Following corrective action, the source owner or operator must audit the CEMS with a RATA and CGA, to determine if the CEMS is operating within the specifications. A RATA must always be used following an out-of-control period resulting from a RATA. The audit following corrective action does not require analysis of performance audit samples. If audit results show the CEMS to be out-of-control, the CEMS operator shall report both the audit showing the CEMS to be out-of-control and the results of the audit following corrective action showing the CEMS to be operating within specifications.

CEMS Data Status During Out-Of-Control Period: during the period the monitor is out-of- control, the CEMS data may not be used in calculating emission compliance nor be counted towards meeting minimum data availability as required and described in the applicable subpart.

Criteria for Excessive Audit Inaccuracy: unless specified otherwise in the applicable subpart, the criteria for excessive inaccuracy are:

(1) For the RATA, the allowable RA in the applicable PS in Appendix B.
(2) For the CGA, ±15 percent of the average audit value or ±5 ppm, whichever is greater.
(3) For the RAA, ± 15 percent of the three run average or ± 7.5 percent of the applicable standard, whichever is greater.

Criteria for Acceptable QC Procedure: repeated excessive inaccuracies (i.e., out-of-control conditions resulting from the quarterly audits) indicates the QC procedures are inadequate or that the CEMS in incapable of providing quality data. Therefore, whenever excessive inaccuracies occur for two consecutive quarters, the source owner or operator must revise the QC procedures (see Section 3) or modify or replace the CEMS.

7. Calculation for CEMS Data Accuracy

RATA RA Calculation: follow the equations described in Appendix B, 40 CFR 60, to calculate the RA for the RATA. The RATA must be calculated in units of the applicable emission standard.

RAA Accuracy Calculation: use Equation 1-1 in Appendix B, 40 CFR 60, to calculate the accuracy for the RAA. The RAA must be calculated in units of the applicable emission standard.

CGA Accuracy Calculation: use Equation 1-1 to calculate the accuracy for the CGA, which is calculated in units of the appropriate concentration (e.g., ppm SO_2 or percent O_2). Each component of the CEMS must meet the acceptable accuracy requirement.

$$A = \frac{Cm - Cn}{Ca} \times 100 \qquad \text{Eq.1}$$

where:
A = Accuracy of the CEMS, percent.

Cm = Average CEMS response during audit in units of applicable standard or appropriate concentration.
Ca = Average audit value (CGA certified value or three-run average for RAA) in units of applicable standard or appropriate concentration.

8. CEMS Audit

Use CEMS Analysis System Audit, O-EF 016.A

9. Bibliography

"A Procedure for Establishing Traceability of Gas Mixtures to Certain National Bureau of Standards Standard Reference Materials." Joint publication by NBS and EPA-600/7-81-010. Available from the U.S. Environmental Protection Agency. Quality Assurance Division (MD-77). Research Triangle Park, NC 27711.

"Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors (Protocol Number 1)" June 1978. Section 3.0.4 of the Quality Assurance Handbook for Air Pollution Measurement Systems. Volume III. Stationary Source Specific Methods. EPA-600/4-77-027b. August 1977. U.S. Environmental Protection Agency. Office of Research and Development Publications, 26 West St. Clair Street, Cincinnati, OH 45268.

Calculation and Interpretation of Accuracy for Continuous Emission Monitoring Systems (CEMS). Section 3.0.7 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods. EPA-600/4-77-027b. August 1977. U.S. Environmental Protection Agency. Office of Research and Development Publications, 26 West St. Clair Street, Cincinnati, OH 45268.

Company:	Date:
Person Conducting Audit:	Analyzer Manufacturer:
Affiliation:	Model / Serial Number:
	Location:

1. Probe and Umbilical Line

Probe in the same location as when the unit was certified/ re-certified? Yes ( ) No ( )
Any unusual event(s) that required an explanation from the source? Yes ( ) No ( )
Filter blow back schedule _____
Filter change schedule _____

Comments:

2. Conditional and Dilution Air Systems

Any changes since the unit was last certified / re-certified?	Yes ( ) No ( )
Collected moisture drained from condenser?	Yes ( ) No ( )
Any contact between flue gases and condensed moisture?	Yes ( ) No ( )
Pumps preventive maintenance performed on schedule?	Yes ( ) No ( )
Dilution air scrubber preventive maintenance performed on schedule?	Yes ( ) No ( )

Comments:

3. Analyzers

	Manufacturer	Model	Comments
SO2			
CO			
NOX			
Diluent			
CO2			
O2			
Flow			
Opacity			
Other			

System configured, as it was when last certified / re-certified? Yes ( ) No ( )
Any modifications that may affect analyzer performance? Yes ( ) No ( )
Span setting in proper position? Yes ( ) No ( )
Proper sample flow rate setting? Yes ( ) No ( )
Analyzer preventive maintenance performed on schedule? Yes ( ) No ( )

Comments

Gases

Gas	Certified Conc.	Cylinder Number	Type of Gas (SRM/ CRM/ GMIS/ NTRM/ Protocol)	Cylinder Pressure	Expiration Date	Certificate on File

Are the proper types of regulators being used? Yes ( ) No ( )
Condition of regulators. OK? Yes ( ) No ( )

Comments

4. Data Acquisition and Handling System

How is the calibration drift data recorded?

How are the linearity and RATA tests recorded?

When and how frequently does the system backup the data?

Are all pertinent data recorded? Yes ( ) No ( )
Is any data input by hand? Yes ( ) No ( )
Does DAHS data agree with hard copy data? Yes ( ) No ( )
Can the DAHS calculate missing data? Yes ( ) No ( )
Can the last missing data period be displayed? Yes ( ) No ( )

Comments

5. CEMS Records AUDIT

Company	Date
Person Conducting Audit	Analyzer Manufacturer
Affiliation	Model/Serial Number
	Location

Type of Data Available:	Chart Recorder ( ) Computer Printout ( )
	Averaging Period ( ) Averaging Period ( )
Amount of Recorders Reviewed:	Data ( ) #of days
	Maintenance ( ) #of days
Did the Source have Difficulty Locating These Records?	( ) YES ( ) NO
Does the Source Have a Quality Assurance Plan?	( ) YES ( ) NO
Is the QA Plan Being Followed?	( ) YES ( ) NO
Comments:	

Data Record Review			
	YES	NO	COMMENTS
Organized			
Complete, No Data Missing			
Annotated Where Data is Missing			
Annotated Where Excess Emissions Occurred			
Legible (no inking, paper problems, etc)			
Data Trend Normal (not erratic, off-scale, Straight-lined, etc.)			
Data Appears Accurate			
Monitor and Sources Downtime Annotated			
Zero/Span Check Conducted During Inspection			
Agree With Recent Checks			
Comments:			

Maintenance Records Review

General Condition of Maintenance Records

( ) Thorough ( ) Adequate ( ) Marginal ( ) Unacceptable

Indicate if the following appear in the maintenance records	YES	NO	COMENTS
Recurring Failures or Malfunction			
Repeated Zero/Span Adjustments			
Preventive Maintenance			
Windows Cleaning, Filter Replacement, etc.			
Change in the Internal Path Length Correction			
Performance Evaluations, Audits, etc.			
Corrective Actions for Malfunctions, etc.			
Comments:			

Period ending on (date): _____
Year: _____
Company name: _____
Plant name: _____
Source unit no.: _____
CEMS manufacturer: _____
Model no.: _____
CEMS serial no.: _____
CEMS type (e.g., in situ): _____
CEMS sampling location (e.g., control device outlet): _____
CEMS span values as per the applicable regulation: _____
(e.g., SO_2 ____ ppm, NOx ____ ppm, CO ____ ppm.)

I. Accuracy assessment results (Complete A, B, or C below for each CEMS or for each pollutant and diluent analyzer, as applicable.) If the audit results show the CEMS to be out-of-control, report the results of both this audit and the audit following corrective action showing the CEMS to be operating properly.

A. Relative Accuracy Test Audit (RATA) for ____ (e.g., SO_2 in ng/J).

1. Date of audit _____
2. Reference methods (RM's) used ____ (e.g., Methods 3 and 6).
3. Average RM value ____ (e.g., ng/J, mg/Nm^3, or ppmdv, 15% O_2).
4. Average CEMS value ____.
5. Absolute value of mean difference [d] ____.
6. Confidence coefficient [CC] ____.
7. Percent relative accuracy (RA) ____ percent.
8. EPA performance audit results:
a. Audit lot number (1) ____ (2) ____
b. Audit sample number (1) ____ (2) ____
c. Results (mg/Nm^3) (1)____ (2) ____
d. Actual value (mg/Nm^3) (1) ____ (2) ____
e. Relative error (1) ____ (2) ____

B. Cylinder gas audit (CGA) for ____ (e.g., SO_2 in ppm).

	Audit point 1	Audit point 2	
1. Date of audit			
2. Cylinder ID number			
3. Date of certification			
4. Type of certification			(e.g., EPA Protocol 1 or CRM)
5. Certified audit value			(e.g., ppm)
6. CEMS response value			(e.g., ppm)
7. Accuracy			percent

C. Relative accuracy audit (RAA) for ____ (e.g., SO2 in ng/J).

1. Date of audit _____
2. Reference methods (RM's) used ____ (e.g., EPA Methods 3 and 6).
3. Average RM value ____ (e.g., ng/J).
4. Average CEMS value ____.
5. Accuracy ____ percent.
6. Performance audit results:
a. Audit lot number (1) ____ (2) ____
b. Audit sample number (1) ____ (2) ____
c. Results (mg/dsm 3) (1) ____ (2) ____
d. Actual value (mg/dsm 3) (1) ____ (2)
e. Relative error* (1) ____ (2) ____

D. Corrective action for excessive inaccuracy.

1. Out-of-control periods.
a. Date(s) _____
b. Number of days _____
2. Corrective action taken_____
3. Results of audit following corrective action. (Use format of A, B, or C above, as applicable.)

II. Calibration drift assessment.

A. Out-of-control periods.
1. Date(s) _____
2. Number of days ____.

B. Corrective action taken

_____
_____
_____
_____

CEMS N#	DATE	RESPONSIBLE	CALIBRATION OK?	REMARKS

DEVELOPED BY	REVIEWED BY	APPROVED BY