QUALITY ASSURANCE AND CONTROL TESTS FOR CEMS – USA

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QUALITY ASSURANCE AND CONTROL PLAN

- Part 75, Appendix B establishes the types of on-going QA tests that are required for CEMS. The frequency of each type of test and the performance criteria are specified.
  - Daily Calibration
  - Linearity
  - Relative Accuracy Test Audit (RATA)
- Data validation procedures are specified
- Grace period provisions are provided:
  - 720 unit or stack operating hour for RATAs
  - 168 unit or stack operating hours for linearity checks
  - 8 clock hours for daily calibrations after startup commences (i.e., startup grace period)

QUALITY ASSURANCE AND CONTROL PLAN

- Part 75, Appendix B includes the requirement to create a written QA/QC plan.
- Facility must maintain a written record of certification and QA test procedures, maintenance activities, and corrective actions
- The QA/QC plan is a "living document" that is updated as necessary

FREQUENCY OF QA/QC TESTS

- With the exception of QA tests conducted during conditional data periods, QA tests validate hourly Part 75 emissions data *prospectively*
- Hourly data collected during a "grace period" are considered valid until the grace period test is attempted; then, if the test is failed, data are invalidated prospectively
- QA tests conducted during a "grace period" do not eliminate or reduce the requirement to conduct additional QA tests
  - For instance when a linearity check is done in a grace period, if the quarter in which the grace period test is done is a "QA operating quarter", the grace period test does not satisfy the linearity check requirement for that quarter---a second test is required in that quarter

FREQUENCY OF QA/QC TEST

- Daily calibration checks and interference checks (flow monitors, only)
  - Once every operating day except where a monitor has qualified to use offline calibrations to validate data on a limited basis
- Linearity check
  - Once every QA operating quarter
  - Maximum interval between tests--- four calendar quarters plus a grace period

FREQUENCY OF QA/QC TESTS

- Gas RATAs
  - Once every two or four "QA operating quarters" (depending on the results obtained in the previous test, i.e., two QA quarters if the relative accuracy (RA) is 7.6 to 10.0% and four quarters if the RA is 7.5% or less).
  - Some alternative RA specifications are available for "low emitters"
  - "QA operating quarter" means a calendar quarter in which there are at least 168 unit or stack operating hours
  - Maximum interval between successive RATAs ---- eight calendar quarters plus a grace period

QA/QC TEST PERFORMANCE SPECIFICATIONS

- Part 75, Appendix A includes procedures for conducting RATAs, linearity checks, 7-day calibration error tests, and cycle time tests
- § 75.20(c) specifies the types of tests required for initial certification and recertification purposes
- Note: Data acquisition and handling system (DAHS) verification requirements are part of the certification process, and are found in § 75.20(c)
- Section 3 of Appendix A provides the performance specifications that must be met for each type of CEMS *certification and recertification* test

ALTERNATIVE SPECIFICATIONS

- Note that there are " alternative" performance specifications for the QA/QC tests (daily calibrations, linearity checks and RATAs) for "low emitters"
  - For example, if the reference method (RM) NOx rates are less than 0.200 lb/mmBtu (86 ng/J), and the relative accuracy (RA) is > 10.0%, the RATA can still be passed if the difference between the mean RM and mean CEMS values is less than .020 lb/mmBtu (8.6 ng/J) and qualify for annual testing if the difference is less than .015 lb/mmBtu (6.45 ng/J).
- There are some certification and QA test exemptions
  - Linearity checks are not required for SO_2 and NO_x spans ≤ 30ppm (79.8 mg/sm^3, 57.36 mg/sm^3)
  - For dual range monitors, linearity checks are not required on a range that is not used during the quarter
  - SO_2 RATAs are not required for units that combust only very low sulfur fuel(s), e.g., natural gas

QA/QC TEST SPECIFICS

- RATA
- Linearity check
- Calibration error test (i.e. daily calibration)
- 7-day drift test
- Cycle time test

CYCLE TIME TEST

- The cycle time test is one of the certification and recertification test requirements for gas monitors
  - **Note**: "like-kind" analyzer recertifications do not require a cycle time test
- Zero and upscale calibration gases are injected to determine the upscale and downscale cycle or " response" times
- Starting with a stable stack gas concentration, zero gas is injected and the time it takes for 95% of the step change between the stack gas and zero gas concentrations to be achieved is the downscale cycle time
- Repeat using the *high* reference gas to determine the upscale cycle time
- The higher of the upscale and downscale cycle times is reported as the cycle time for the monitor

7-DAY CALIBRATION TEST

- Manual and automatic adjustments are allowed *after* the zero and upscale injections are made each day
  - Unadjusted values must be used to determine the calibration error
- **Note:** The calibration error limits for the 7-day test (i.e., 2.5% of span for SO_2 and NO_x monitors, 0.5% CO_2 or O_2 for diluent gas monitors, and 3.0% of span for flow monitors) are twice as stringent as the daily calibration error limits, which are 5.0% of span for SO_2 and NO_x monitors, 1.0% CO_2 or O_2 for diluent gas monitors, monitors and 6.0% of span for flow monitors.

LINEARITY CHECK

- Three calibration gases (low, mid, and high)
- Three runs
- Through the entire sampling system including filters, scrubbers, conditioners, and as much of the sampling probe as practical
- From Appendix A § 5.2, the definitions of the low, mid, and high gas levels are:
  - Low: 20-30% of span
  - Mid: 50-60% of span
  - High: 80-100% of span

LINEARITY CHECK

- The same gas may not be injected twice in succession (e.g., L,M,H,H,M,L,L,M,H is an unacceptable sequence)
- Unit must be combusting fuel during the test and must be operating at conditions of "typical" stack temperature and pressure
- It is not necessary for the unit to be generating electricity during the test

$$LE = \frac{|R-A|}{R} \times 100$$

LINEARITY CHECK

Acceptance Criteria

NO_X and SO_2

- The error shall not exceed or deviate from the reference value by more than 5.0%
- The results are also acceptable if absolute value of the difference between average of the monitor response values, and the average of the reference values is less than or equal to 5 ppm (13.3 mg/sm^3 SO_2 , 9.56 mg/sm^3 NO_x)

Diluent O_2 or CO_2

- The error shall not exceed or deviate from the reference value by more than 5.0%
- The results are also acceptable if absolute value of the difference between average of the monitor response values, and the average of the reference values is less than or equal to 0.5 percent O_2 and CO_2, whichever is less restrictive.

LINEARITY CHECK

RELATIVE ACCURACY TEST AUDIT(RATA)

- A RATA is a set of simultaneous measurements made by a CEM *system* and a reference method (or methods), in order to determine the relative accuracy (RA) of the CEMS.
- The RA is calculated using Equation A-10 in Appendix A
- The parameters used in the calculation include
  - Average CEMS value
  - Average reference method (RM) value
  - Mean difference between the CEMS and RM values
  - Confidence coefficient

RELATIVE ACCURACY TEST AUDIT(RATA)

- Each RATA must consist of at least 9 runs
- It may consist of more than 9 runs; however, a maximum of 3 runs may be discarded
  - For example, 9 of 12 runs or 10 of 13 runs must be used in the RA calculation)
- Each run of a gas or moisture monitoring system RATA must be at least 21 minutes in duration

RELATIVE ACCURACY TEST AUDIT(RATA)

- Perform each RATA while firing the primary fuel for the unit
- For dual range analyzers, perform the gas RATA on the range normally used for measuring emissions (in most cases, this will be the low range)
- Gas RATAs shall be conducted at the normal load level (low, mid, or high), as identified in the electronic monitoring plan
  - **Note**: Two load levels may be designated as normal; if so, perform the test at either load level

OPERATING HOURS

Range of Operation (Lower Boundary): 150 MW

Range of Operation (Upper Boundary): 473 MW

Operating Level	Range	Operating Hours	Percent of Time (within range)
Below Lower	Below 150.0	139.4	N/A
Low	150.0 thru 246.9	764.0	11.5 %
Mid	247.0 thru 343.8	716.0	10.8 %
High	343.9 thru 473.0	5,157.0	77.7 %
Above Upper	Above 473.0	0.0	N/A

RELATIVE ACCURACY TEST AUDIT(RATA)

- Determine if stratification is present prior to testing.
  - Stratification test consists of a minimum of 6 point on each axis (12 twelve points total)
  - Using USEPA Method 1 criteria

  Or
  - An alternate three-point traverse according to Part 60, Appendix B, Performance Specification 2: located at 16.7%, 50%, and 83.7% of the diameter of the stack.

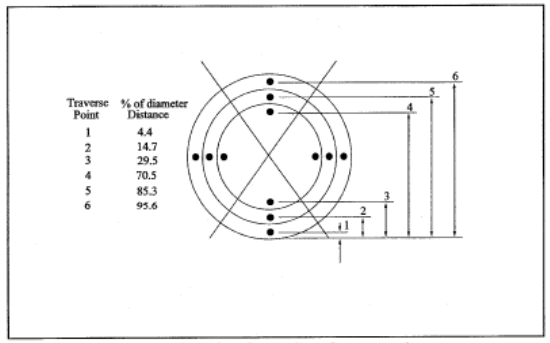

Figure 1-3. Example showing circular stack cross section divided into 12 equal areas, with location of traverse points.

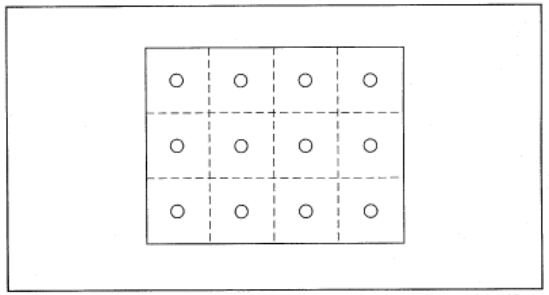

Figure 1-4. Example showing rectangular stack cross section divided into 12 equal areas, with traverse points at centroid of each area.

RELATIVE ACCURACY TEST AUDIT(RATA)

Stratification (cont.)

- Unit load must remain constant +/- 3.0 %
- The amount of stratification for each pollutant and diluent present at the test elevation determines the number of sampling points for the reference method.

Acceptable to use a three-point traverse (based on PS-2)

- +/- 10%, from the arithmetic average concentration for all traverse points, or
- If no single point is +/- 5 ppm (pollutant) +/-0.5% O_2 or CO_2 from the average

Acceptable to use a single point traverse (1.0 meter from the stack wall)

- +/- 5.0%, from the arithmetic average concentration for all traverse points, or

BIAS ADJUSTMENT FACTOR

- Bias is the amount of systematic error of a system
- A statistical analysis of RATA reference method and CEMS test data
- To determine whether the CEMS measurements are biased low with respect to the reference method
- The bias test is required for each SO_2 monitor, NO_X monitoring system, and flow monitor
- If a bias test is failed, Part 75 requires a bias adjustment factor (BAF) to be applied to each hour of subsequent CEMS Data
- **Note**: BAFs are not required for CO_2, O_2, or moisture monitors

$$BAF = 1 + \frac{|\bar{d}|}{CEM_{avg}} \qquad \text{(Eq. A-12)}$$

Part 75 SO2 Relative Accuracy Data
Emission Rate Basis

Load (MW): 552 Fc-Factor: 1800 (scf/mmBtu)

Run No.	Run Times Start	Run Times End	Reference Method EMR (lb/mmBtu)	CEMS EMR (lb/mmBtu)	Difference (lb/mmBtu)	Use Run?	CEMS Percent Difference from RM
1	n/a	n/a	n/a	n/a	n/a	n	n/a
2	12:18	13:18	0.067	0.067	0.000		0.0%
3	13:39	14:39	0.069	0.068	0.001		1.4%
4	15:00	15:20	0.070	0.069	0.001		1.4%
5	15:41	16:01	0.070	0.069	0.001		1.4%
6	16:22	16:42	0.070	0.067	0.003		4.3%
7	17:03	17:23	0.071	0.070	0.001		1.4%
8	17:44	18:04	0.070	0.069	0.001		1.4%
9	18:25	18:45	0.076	0.076	0.000		0.0%
10	19:06	19:26	0.078	0.078	0.000		0.0%
MEAN			0.071	0.070	0.000889		
STD DEV			---	---	0.001		

RELATIVE ACCURACY SUMMARY		
Total Runs Used=	9	
t_0.025 Value :	2.306	
CONFIDENCE COEFFICIENT =	0.000713	
BIAS TEST=	BIAS ADJ. REQUIRED	
BIAS ADJ. FACTOR =	1.013	
RELATIVE ACCURACY=	2.25	% of the RM
RATA FREQUENCY=	ANNUAL	

NOx Relative Accuracy Data
Emission Rate Basis

Load (MW): 552 Fc-Factor: 1800 (scf/mmBtu)

Run No.	Run Times Start	Run Times End	Reference Method EMR (lb/mmBtu)	CEMS EMR (lb/mmBtu)	Difference (lb/mmBtu)	Use Run?	CEMS Percent Difference from RM
1	10:49	11:49	0.081	0.085	-0.004		-4.9%
2	12:18	13:18	0.081	0.085	-0.004		-4.9%
3	13:39	14:39	0.082	0.085	-0.003		-3.7%
4	15:00	15:20	0.081	0.085	-0.004		-4.9%
5	15:41	16:01	0.080	0.084	-0.004		-5.0%
6	16:22	16:42	0.080	0.084	-0.004		-5.0%
7	n/a	n/a	n/a	n/a	n/a	n	n/a
8	17:44	18:04	0.080	0.084	-0.004		-5.0%
9	18:25	18:45	0.080	0.083	-0.003		-3.8%
10	19:06	19:26	0.081	0.085	-0.004		-4.9%
MEAN			0.081	0.084	-0.003778		
STD DEV			---	---	0.000		

RELATIVE ACCURACY SUMMARY		
Total Runs Used=	9	
t_0.025 Value :	2.306	
CONFIDENCE COEFFICIENT =	0.000339	
BIAS TEST=	PASS	
BIAS ADJ. FACTOR =	1.000	
RELATIVE ACCURACY=	5.10	% of the RM
RATA FREQUENCY=	ANNUAL	

BIAS ADJUSTMENT

Sources of Bias

- Probe effect (plugging and scrubbing)
- Dilution Probe
  - Temperature, pressure, gas density
  - Contaminated dilution air
- Water entrainment
- Leaks
- Absorption
- Conditioning system
- Calibration error

IMPORTANT NOTES

- Certification of CEMS are provisional until approved by the administrator
  - All steps must pass
  - RATA is recommended to be the last step in the process
- Recertification is required when there is modification to the sampling system, or analyzers are changed.
- Air emissions testing body (AETB) accreditation is required under Part 75 to perform RATAs
  - An "AETB" is a team (e.g., contractor) that performs stack tests and demonstrates conformance with ASTM D7036-16.
  - Requires a Qualified Individual (QI) or Qualified Source Test Individual (QSTI) to oversee the testing program

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THANK YOU FOR LISTENING

ANY QUESTIONS?

Your name
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