



MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

Continuous Emission Monitoring System (CEMS)

Quality Assurance:

40 CFR Part 60 Appendix B

40 CFR Part 60 Appendix F

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Personal Background Info (1/1)

- Missouri Department of Natural Resources Work History
 - Air Program 2008 – 2011:
 - Construction Permit Modeling
 - Environmental Services Program 2012 – 2013:
 - Ambient Air Monitoring
 - Air Program 2014 - Present:
 - Stack Test Observations/Reviews

Reason for Discussion (1/1)

- Recently, during quality assurance testing events, the Testing and Emissions Unit has started auditing CEMS information in order to ensure the CEMS are being maintained as required by applicable rules and/or construction permits.
- Audit is usually fairly comprehensive. The audit may take some time for preparation and while on site.
- Part of audit may include information related to 40 CFR Part 60 Appendix B (Appendix B) and 40 CFR Part 60 Appendix F (Appendix F).

40 CFR Part 60 Appendix B (1/1)

- Appendix B consists of Performance Specifications (PS) for an array of CEMS that are designed to evaluate the representativeness of the emissions data recorded.
- Many regulations and permits require CEMS be certified according to Appendix B.
- Daily calibration drift tests and annual relative accuracy assessments required for continuing quality assurance often reference the PS requirements in Appendix B.
- Will focus today on PS2.

PS2 Key Points (1/1)

- CEMS equipment specs
- CEMS measurement location
- Reference method measurement location
- 7-day calibration drift test
- Relative Accuracy test

PS2 Important Definitions (1/3)

- Continuous Emissions Monitoring System (CEMS): The total equipment required for the determination of a gas concentration or emission rate. The sample interface, pollutant analyzer, diluent analyzer, and data recorder are major subsystems of the CEMS.
- Sample Interface: The portion of the CEMS used for sample acquisition, sample delivery, sample conditioning, and/or protection of the monitor from the effects of the stack effluent.

PS2 Important Definitions (2/3)

- Calibration Drift (CD): The difference in the CEMS output readings from the established reference value after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.
- Relative Accuracy (RA): The absolute mean difference between the gas concentration or emission rate determined by the CEMS and the value determined by the reference method (RM), plus the 2.5% error confidence coefficient of a series of tests divided by the mean of the RM tests or the applicable emission limit.

PS2 Important Definitions (3/3)

- **Span:** The concentration specified for the affected source category in an applicable subpart of the regulations that is used to set the calibration gas concentration and in determining calibration drift.
- **Point CEMS:** Measures the gas concentration either at a single point or along a path equal to or less than 10% of the equivalent diameter of the stack or duct cross section.
- **Path CEMS:** Measures the gas concentration along a path greater than 10% of the equivalent diameter of the stack or duct cross section.

PS2 CEMS Equipment Specs (1/1)

- The data recorder scale must include a zero and high-level value. The high level value will vary based on the reason for the CEMS.
- The CEMS equipment specifications should allow determination of the calibration drift.

PS2 Selecting a CEMS Location (1/1)

- Emissions should be representative.
- PS2 Suggestions for representative data:
 - Measurement location should be two equivalent duct diameters downstream from the nearest disturbance.
 - Measurement location should be $\frac{1}{2}$ equivalent duct diameters upstream from the nearest disturbance.
 - For point CEMS, the measurement point should be no less than 1 meter from the stack wall or centrally located over the centroidal area of the stack.

PS2 Selecting a RM Location (1/1)

- RM location should generally meet the same upstream and downstream requirements as described for CEMS; however, RM and CEMS measurements do not need to be measured in the same location.
- Determine the required RM traverse points.

PS2 Performing a 7-day CD Test (1/2)

- The 7-day CD test is a major component of certifying a CEMS.
- CD test period: While the affected facility is operating, determine the magnitude of the CD once each day (at 24-hour intervals) for 7 consecutive calendar days **OR** 7 consecutive unit operating days.
- The CD test must be performed prior to periodic automatic/manual adjustments to the CEMS zero and calibration settings.
- Generally, the 7-day CD test is conducted at a zero-level and a high-level.

PS2 Performing a 7-day CD Test (2/2)

- The CEMS calibration must not drift or deviate from the reference value by more than 2.5 percent of the span value.
- Let us assume SO₂ reference concentrations of 0 ppmvd and 95 ppmvd, with a span of 100 ppmvd:
 - Day 1: CEMS Zero Response = 2 ppmvd
 - Day 1: CEMS High-Level Response = 96 ppmvd
 - Zero-Level CD = $[(0 \text{ ppmvd} - 2 \text{ ppmvd})/100 \text{ ppmvd}] * 100 = 2\%$
 - High-Level CD = $[(96 \text{ ppmvd} - 95 \text{ ppmvd})/100 \text{ ppmvd}] * 100 = 1\%$

PS2 Performing a RA Test (1/4)

- The main point of the RA test is to verify that the CEMS can produce results similar to the RM. The RM is the standard.
- Depending on the desired pollutant and the applicable regulation, the RM will vary.
- Diluent and moisture measurements should be taken simultaneously with the pollutant measurements, but within the same hour is approved in PS2.

PS2 Performing a RA Test (2/4)

- When comparing the facility CEMS results to the RM, ensure that the time matches up. This is a common concern.
- At a minimum, nine 21-minute runs must be included in the RA calculation; however, additional runs are allowable. At most, three runs may be discarded.
- Determine the mean difference between the RM and CEMS values in the units of the emissions standard, the standard deviation, the confidence coefficient, and the relative accuracy according to PS2.

PS2 Performing a RA Test (3/4)

- The calculated RA of the CEMS must be less than or equal to 20% when the average emissions during the test are greater than 50% of the emissions standard.
- The calculated RA of the CEMS must be less than or equal to 10% when the average emissions during the test are less than or equal to 50% of the standard.

PS2 Performing a RA Test (4/4)

$$RA = \frac{[|\bar{d}| + |CC|]}{\overline{RM}} \times 100$$

RA = Relative Accuracy

\bar{d} = Absolute value of the mean differences

CC = Absolute value of the confidence coefficient

\overline{RM} = Average RM value OR emission standard

40 CFR Part 60 Appendix F (1/1)

- Appendix F consists of procedures continually quality assuring and quality controlling data collected from an array of CEMS.
- Many regulations and permits require CEMS be continually evaluated according to Appendix F.
- Will focus today on Procedure 1.

Procedure 1 Key Points (1/1)

- Important definitions in PS2 still apply (e.g. CD, RA, Span, etc.)
- Quality control (QC) requirements
- Daily CD requirements
- Quarterly data accuracy assessments

Procedure 1 QC Program (1/1)

- At a minimum, affected facilities must have detailed, written documentation that address the following questions:
 - How is the CEMS calibrated?
 - How is the CD determined and when is the CEMS adjusted?
 - What/when is preventative maintenance performed?
 - What is required for the CEMS spare parts inventory?
 - How is data recorded, calculated, and reported?
 - How will accuracy audits be performed?
 - What kind of corrective action will be taken for malfunctioning CEMS?

Procedure 1 CD Assessment (1/1)

- CD is determined daily at a zero/low-level and high level concentration.
- The analyzer must be adjusted when either concentration exceeds two times the applicable PS limit.
- The CEMS is considered out-of-control if the daily CD is exceeded for five consecutive days.
- The CEMS is also considered out-of-control if one daily CD exceeds four times the applicable PS.
- After corrective action is taken, the CD checks must be again performed.

Procedure 1 Data Accuracy Assessments (1/4)

- CEMS must be audited at least once each calendar quarter with each audit being performed at least two months apart.
- Types of Audits:
 - Relative Accuracy Test Audit (RATA)
 - Cylinder Gas Audit (CGA)
 - Relative Accuracy Audit (RAA)

Procedure 1 Data Accuracy Assessments (2/4)

- During a CGA, the pollutant CEMS and diluent CEMS are challenged with an audit gas of known concentration.

Audit point	Audit range		
	Pollutant 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.

Procedure 1 Data Accuracy Assessments (3/4)

- The audit gas should traverse as much of the normal sample path as possible.
- The audit reference materials must be certified.
- The CEMS is challenged three times at each audit point. The operator must compare the average of the three responses to the reference material.
- The average CEMS response of each audit value during the CGA must be within 15% OR 5 ppm (whichever is greater)

Procedure 1 Data Accuracy Assessments (4/4)

- Criteria for excessive audit inaccuracy:
 - For the RATA, the allowable RA in the applicable PS in Appendix B.
 - For the CGA, the average CEMS response of each audit value during the CGA must be within 15% OR 5 ppm of the reference concentration (whichever is greater).
 - For the RAA, the average CEMS response when compared to the RM must be within 15% of the three run average or 7.5% of the applicable standard (whichever is greater).

Summary (1/1)

- We completed a quick overview of PS2 in Appendix B and Procedure 1 in Appendix F.
- Representatives from the air program's Testing and Emissions Unit may be auditing CEMS during RATA testing.
- On a side note, unless otherwise specified, the Testing and Emissions Unit prefers all stack testing documents to be submitted electronically in lieu of hard copies.

Questions (1/1)

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