Providing for the future
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CEMS are integrated systems comprised of:

- Sample extraction (sample probe)
- Sample transport (sample line, pumps, etc.)
- Sample conditioning
- Gas analyzers
- Calibration equipment
- Data acquisition, handling, and storage (DAS/DAHS)
Analyzers need a sample stream that is clean and dry

- Extractive systems use chillers to “condition” the gas by removing moisture
- Dilution systems use dry air to mix with the sample to achieve same
Wide variety in types of gas measurement used in CEMS:

- UV Fluorescence (SO$_2$, H$_2$S, TRS)
- Chemiluminescence (NO, NO$_2$, NOx, NH$_3$, O$_3$)
- Paramagnetic (O$_2$)
- NDIR – Non Dispersive Infrared (CO, CO$_2$)
- Gas Chromatography
- FTIR – Fourier-Transform Infrared Spectroscopy
REGULATORY REQUIREMENTS

- **Reference methods:** Substantiate the accuracy and precision of the CEMS
  - 40 CFR 60, Appendix A
  - 40 CFR 75, Appendix A

- **Performance specifications:** Evaluate the acceptability of the CEMS at time specified
  - 40 CFR 60, Appendix B

- **Quality assurance procedures:** Evaluate the effectiveness of QA/QC procedures
  - 40 CFR 60, Appendix F
  - 40 CFR 75, Appendix B
REFERENCE METHODS

- Identify the test methods to be used as reference methods to the facility subject to the respective standard
- Identify any special instructions or conditions to be followed when applying a method to the respective facility (ex. establish sampling rates, volumes, or temperatures)
PERFORMANCE SPECIFICATIONS

- PS-1: Opacity
- PS-2: SO$_2$ and NO$_x$
- PS-3: O$_2$ and CO$_2$
- PS-4/4A: CO
- PS-4B: CO and O$_2$
- PS-5: TRS
- PS-6: Flow rate
- PS-7: H$_2$S
- PS-8: VOC
- PS-8A: Total HC
- PS-9: GC
- PS-11: PM
- PS-12A/B: Hg
- PS-15: FTIR
- PS-16: PEMS
- PS-18: HCl
PERFORMANCE SPECIFICATIONS

Address:

- CEMS location requirements
- RATA specifications and procedures
- Calibration Drift Test specifications and procedures
- Equations
- Procedures for evaluating the acceptability of CEMS at the time of or soon after install
PERFORMANCE SPECIFICATIONS

Monitoring plans:
- Information and drawings of monitor specs
- Monitoring locations
- Description of the other parts of the system (DAS, etc.)
- Schedule of testing regarding the certification of the system
Performance Assessments

- Initial performance specifications / certification
- Daily performance assessments
- Periodic performance assessments
  - Quarterly
  - Annual
QUALITY ASSURANCE PROCEDURES

- Procedure 1: Gas CEMS Used For Compliance Determination
- Procedure 2: Particulate Matter CEMS
- Procedure 3: Continuous Opacity Monitoring Systems
- Procedure 5: Vapor Phase Mercury CEMS And Sorbent Trap Monitoring Systems Used For Compliance Determination
- Procedure 6: Gaseous HCl CEMS Used for Compliance Determination
CONTINUOUS MONITORING PLANS

For each CEMS, two monitoring plans are required:

- Quality assurance plan (QAP)
- Written standard operating procedures (SOP)

- Contain detailed, complete, step-by-step written procedures
- Submit to regulatory agency prior to operation
- Review periodically and revised as necessary
QUALITY ASSURANCE PLANS

Purpose

- Quality assurance - assessment of the quality of the data (accuracy and precision)
- Quality control - activities used to maintain or improve data quality
Quality Assurance

Written documentation of:

- Operation, calibration, and QC procedures
- Independent system and performance audits
- Data validation
- Evaluation of QC data
Quality control
Core activities of a QA program:
- Preventative maintenance
- Periodic calibrations
- Routine zero and span checks
- Routine leak checks
- Routine check of optical alignment

When updates or changes to any activities are necessary the QA Plan must be revised to reflect those changes
QUALITY ASSURANCE PLANS

Contents

▪ Data quality objectives
▪ Chain of responsibility for operation, corrective action, and training program
▪ Procedure for measuring the accuracy and precision including:
  – CMS calibrations
  – Zero and span drift checks
  – Performance audits
  – System audits
QUALITY ASSURANCE PLANS

Contents

- Quality control activities
- Quality control documentation
- Procedures for data recording, calculations, and reporting
- Criteria for taking corrective actions
- Procedure for corrective actions
STANDARD OPERATING PROCEDURES

Contents

- Monitor descriptions
- Company QA policies
- Monitor system QC procedures
- Audit procedures
- Description of the facility monitored
- Examples of all reporting and log forms
- Methods and procedures for analysis and data acquisition
- A listing of the manufacturer’s recommended spare parts inventory

- Procedures for calculating and converting CEMS data into the reporting units of the standard

- For each CEMS:
  - Monitor’s brand
  - Model number
  - Serial number
  - Monitoring location
  - Data handling and acquisition system
• Record keeping and reporting procedures including:
  – Reporting of instrument precision and accuracy
  – Reporting of emissions data

• Calibration procedures including:
  – Calibration error limits and linearity
  – Calibration gas type as applicable, quality, and traceability to the National Institute of Standards and Technology
  – Calibration frequency
  – Criteria for recalibration, and analysis procedures to periodically verify the accuracy of span and calibration standards
Operation procedures including:
- Daily procedures
- Quantifying and recording daily zero (0) and high level drift
- Other operating parameter checks indicating correct operational status

Preventive maintenance procedures and corrective maintenance procedures that include those procedures taken to ensure continuous operation and to minimize malfunctions
Quality control and quality assurance procedures including:

- Quality policy and objectives
- Organization and responsibilities description
- Calibration and span and zero (0) drift criteria
- Excessive drift criteria
- Corrective action for excessive drift
- Precision and accuracy results
- Corrective action for accuracy audits failure
- Data validity criteria
- Participation in department performance audits
- Data recording and calculation audits
Continuous operation except:

- System breakdowns, repairs, calibration checks, and zero and span adjustments

- Monitor downtime is acceptable for reasonable periods of time when the downtime is due to one of the following causes:
  - Natural disasters which render the monitor inoperative
  - Monitor breakdown which makes it necessary to return the monitor to the manufacturer for repair
  - Monitor breakdown which makes it necessary to order parts not included in the QA/QC plan list of spare monitor parts
MINIMUM DATA REQUIREMENTS

– Scheduled monitor maintenance based on equipment manufacturer's recommended maintenance schedule
– Performance of daily drift checks
– Performance of monitor audits required by permit or by request of the regulatory agency
MINIMUM DATA REQUIREMENTS

- CEMS - minimum of one cycle of operation (sampling, analyzing, and data recording) for each successive 15-minute period

- COMS - minimum of one cycle of sampling and analyzing for each successive 10-second period and one cycle of data recording for each successive 6-minute period
MINIMUM DATA REQUIREMENTS

CEMS

- Full operating hour: 4 data points (1 data point for each successive 15-minute period)
- Partial operating hour: $\geq 1$ data point in each 15-minute period the unit operated
CEMS

- Data during periods of system breakdown, repair, calibration checks, and zero/span adjustments are not included in averages.

- Operating hours during which required maintenance or QA activities are performed:
  - If the unit operates in 2 or more quadrants of the hour, a minimum of 2 valid data points, separated by at least 15 minutes, is required to calculate the hourly average.
  - If the unit operates in only 1 quadrant of the hour, at least 1 valid data point is required to calculate the hourly average.
- CEMS – reduce all data to 15-minute averages and 1-hour averages
- COMS – reduce all data to 6-minute averages calculated from 36 or more data points equally spaced over each 6-minute period
Data Assessment Report (DAR)

- Owner or operator name and address
- Identification and location of each CEMS
- Manufacturer and model number of each CEMS
- Assessment of CEMS data accuracy and date of assessment as determined by a RATA, RAA, or CGA
- Results from EPA performance audit samples described the applicable RM's
- Summary of all corrective actions taken during any “out-of-control” periods
Violation examples:

- Monitor failure
- RATA failure
- Failure to submit reports
- Emissions violations
- Excess monitor downtime
CONSIDERATIONS

- Appropriate rounding of data (significant figures) for calibrations and emissions data
- Data averaging periods
- Treatment of down time when instrument isn’t monitoring data for calibrations or errors
- Detailed recordkeeping of all maintenance and QC activities
- Regulatory retention requirements
CONSIDERATIONS

- Audits
- Modifications to CEMS require recertification
- Acid Rain requirements
FREQUENTLY ASKED QUESTIONS

- If I install a different monitor or move a monitor to a new sampling location, what do I have to do?
  - The monitoring system must repeat the certification procedures per the appropriate PS

- If I just replace a component of the system (i.e. a new probe, gas conditioner, etc.)?
  - If the change will have no effect on the data being collected by the system, no action other than notification that it was completed is necessary
  - If the replacement could change the data in some way, the monitoring system must repeat the certification procedures per the appropriate PS
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The Role of the DAHS and Some Best Practices

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Data Acquisition & Handling System

- Collects and manages data from continuous monitoring systems (CMS) – CEMS, CPMS, COMS, PM CEMS, etc.
- A DAS (or DAHS) is not just a passive data logger
- Data validation, calculations and averaging happen in the DAS, not later in spreadsheets
- Alarms, signals and data are available in realtime
DAS vs. Spreadsheets - Data Flow
Continuous Monitoring Data Flow with Spreadsheets

- Analyzers
- DCS
- Historian
- Spreadsheets

- E & I Techs
- Operators
- IT
- Environmental
Where Does Data Validation Occur?

- How and when will you exclude invalid data?
- Is one set of data used for operations and another for reporting?
Where Will Compliance Calculations Take Place?

- Are calculations spread across several systems?
- Can Environmental see and confirm?
- Who can edit?
- How will you document?
- Can you assure and demonstrate compliance?
Are Values Flagged and Alarmed?

- Status from instrument or monitor passed along?
- Downtime discovered in spreadsheets?
- Can you respond in real time to avoid exceedances?
Can you Store and Retrieve?

- Hold data 2-5 years?
- Retrieve easily?
- Traceable?
- Data management?
- Excel™ limitations
Continuous Monitoring Data Flow with a DAS

- Analyzers
  - Environmental
  - DAS
  - DCS
  - Historian

- E & I Techs
  - Validation
  - Calculations
  - Downtime
  - Exceedances
  - Reporting

- Responsible Official
Helpful Tips for Success
Good Communication is Key

- Part 60 regs silent on many QA and data validation issues
- Each state administers the Part 60 regs in their state
- Can lead to inconsistency, agency to agency
- Review expectations of your state and local air control agencies – communicate questions
- Know your QA/QC plan thoroughly
- Maintain good documentation
A DAS should...

- Be configurable, including compliance calculations
- Communicate with devices and DCS
- Validate data upon acquisition and flag as needed
- Display how data is built
- Provide dashboards, charts, editing tools, logbook
- Automate calibration checks (validations), blowbacks, etc.
- Make data storage and retrieval easy and transparent
- Generate reports
- Alarm
Be Sparing with Alarms

- Alarm fatigue from too many = ignored
- Alarm for what matters
- Alarm for what must be corrected quickly
- Many other tools in the DAS for monitoring the less urgent
More Helpful Tips

- Schedule reports to print/email in the morning
- Spend a few minutes a day in quick checks
- Do at least weekly data reviews
- Set up saved views of what you need to see
- Make checklists and keep them updated
A Daily Dose of DAS
Are there any Active Alarms?

- Types: data, system, application
- Review: sorting, filtering, color coding
- Respond: Fix the problem or inform those who can
- Manage:
  - Acknowledge
  - Return to Normal
  - Add Reason and Action Codes
  - Add Notes
Check the Basics

- Is data being acquired?
  - This should be alarmed / obvious
  - Data controller can hold data during interruption in some systems
- Then review scheduled reports
Is the Data Being Processed?

• Reports should give status and troubleshooting info
  • Math, averages, data substitution, accumulations, etc.
  • Checking conditions: startup-shutdown, flow-no flow, etc.
Calibration Checks (Validations)

- Calibration checks can be
  - Scheduled in DAS
  - Kicked off by Data Controllers (PLC)
  - Alarmed and reported

- Review Report
  - Is analyzer OOC?
  - Is it *trending* toward OOC?
  - Perform Maintenance
Review Data

- Review average data reports
- Use summary and detail views of data in DAS to drill down
- Check downtime
- Check exceedances
- Review reason and action codes
  - A logbook integrated into the DAS makes this easier
A Daily Dose of DAS Checklist

- Communications and Polling
  - Check Status
  - Check Polling

- Alarms
  - Alarm History Report
  - Acknowledge Alarms

- Review ProcessNow
  - ProcessNow History Report – Daily PN Completed without Error
  - ProcessNow Task Report - Troubleshoot Errors

- Review Data
  - Average Data Report or Custom Linked Reports
  - Data Lab and Charts – Custom Views

- Check Downtime
- Check Exceedances
- Review Reason and Action Codes

- Check Calibrations
  - Calibration Detail Report
  - CalLab

- Quarterly or Annual Tests Completed or Due

- Certification Events
  - Repair or Replaced analyzer, etc.
  - Recertification test required?
  - Diagnostic tests only

- Generate Reports
ESC Resource Library

- Main Resource Library
  - https://go.envirosys.com/resource-lib

- “Staying Ahead of the Data Review Game?”
  - https://go.envirosys.com/webinar-stay-ahead
Material for handout
40 CFR 60 Hourly Average

Minutes

Minutes

Integrates

Quadrants

It

Depends

Hour

Arithmetic

Hour

Integrated
1 Hour Limit

01 Total or Average
02 How many minutes to be online
03 How is the value built
04 How many valid minutes
05 SU/SD Exclusions
06 Other Exclusions
07 Is it fuel specific
Calculating Multi-Hour Average

- How many hours?
- Rolling or Block?
- Percent Validity?
- SU/SD?
- Average, Total?
- CLOCK, OP, VALID?
- Online Criteria?