

CARB 220

Compliance Assurance Monitoring (CAM)



Effect of Title V

- ◆ Required "continuous" monitoring of many sources
- ◆ Standard CEM is impractical for most small sources.
- ◆ No CEM exists for some pollutants
- ◆ This forced a new approach to monitoring



Pre-CAM MONITORING ALTERNATIVES

- ◆ Emissions data for some smaller sources limited to occasional "stack tests".
- ◆ Instrumental CEMs are expensive ==> limited to big sources
- ◆ Indirect monitoring holds promise, but was unproven.
- ◆ AQMD/APCD permits required various data recorded that define or imply compliance for non Title V sources.

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CONCEPTS BEHIND CAM

- ◆ If the emissions control system is working properly, there is "reasonable assurance of compliance".
- ◆ Monitoring the control system is more practical than monitoring emissions - e.g. instruments for temperature, flow, volts, etc. are much cheaper and more reliable than CEM systems. ☒ FLEXIBILITY
- ◆ So - relate control system indicators to compliance.
- ◆ Many sources with no active emission controls can be monitored in other ways.

CAM Presentation Overview

- ◆ Background
- ◆ Some New Concepts
- ◆ Part 64 (CAM) applicability
- ◆ Exemptions
- ◆ CAM Monitoring Design Criteria
- ◆ Source, District, and EPA Roles
- ◆ Quality Improvement Plan



CAM Background

- ◆ CAA Origins: Titles V & VII
- ◆ Promulgated 10/22/97
- ◆ Codified in CFR, Part 64
- ◆ Regulation implementing the Title V monitoring principle:
 - ◆ Implement monitoring for a reasonable assurance of compliance

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Enhanced Monitoring Rule History

- 1990 - CAAA requires EPA to publish monitoring rules for major sources
- 1992 - EPA proposes Enhanced Monitoring rules
 - ◆ CEMS based
 - ◆ All major sources subject
- 1995 - EPA changes direction
 - ◆ Reasonable assurance of compliance
 - ◆ Focus on add-on control devices



CAM Background

- ◆ Targets facilities with add-on control devices
- ◆ "assure that control measures...are properly operated and maintained so that they do not deteriorate to the point where the owner/operator fails to remain in compliance..."
- ◆ "long-term, significant loss of control efficiency that can occur without complete failure of a control device"

Purpose of CAM

- Intended to provide a "reasonable assurance of compliance" with applicable requirements for large emission units with add-on controls
- Monitoring is conducted to determine that control measures are properly operated & maintained



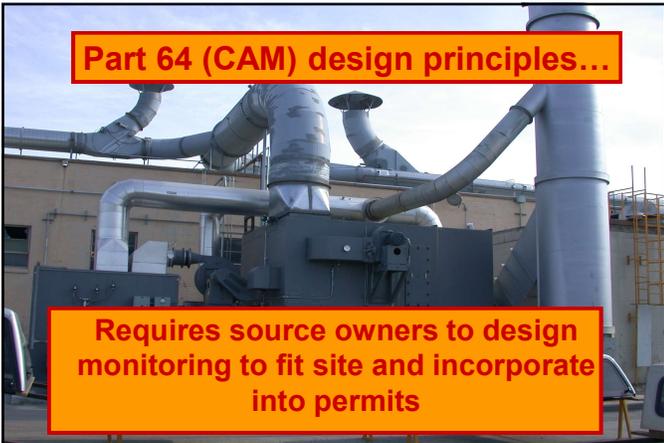
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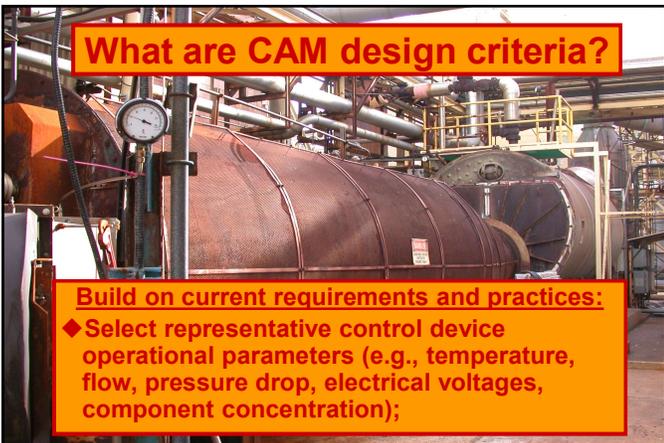
Part 64 (CAM) design principles

Monitoring sufficient to also ensure operators pay the same level of attention to pollution control measures as to production activities.



Part 64 (CAM) design principles...

Requires source owners to design monitoring to fit site and incorporate into permits



What are CAM design criteria?

Build on current requirements and practices:

- ◆ Select representative control device operational parameters (e.g., temperature, flow, pressure drop, electrical voltages, component concentration);

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What are CAM design criteria?

- ◆ Establish *indicator ranges* for reasonable assurance of compliance
 - ◆ Accounting for site-specific factors such as margin of compliance, emissions control variability, correlation with emissions,
 - ◆ Relying on design information, historical data, similar sources, test data; and
 - ◆ Establish data collection method and averaging time.

CAM Monitoring

- Documenting continued operation of add-on controls within *ranges* of specified indicators of performance
- Indicating excursions from ranges
- Correcting of excursions



Who will be affected by CAM (§64.2)

- ◆ An emission unit (except some backup utility power emission units) &
- ◆ With an emission limit or standard
- ◆ With a control device &
- ◆ With pre-control emissions greater than major source thresholds &
- ◆ At a major source subject to title V permitting

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Part 64 applicability examples

Major source threshold = 100 t/y

Pre Control (tons/yr)	Post Control (tons/yr)	Is §64 applicable
600	20	???
200	105	???
90	25	???
110	110	???

- ◆ Pollutant Specific Emissions Unit (PSEU)
- ◆ Pre-control Potential to Emit
- ◆ Excursion
- ◆ Exceedances

Some New Concepts

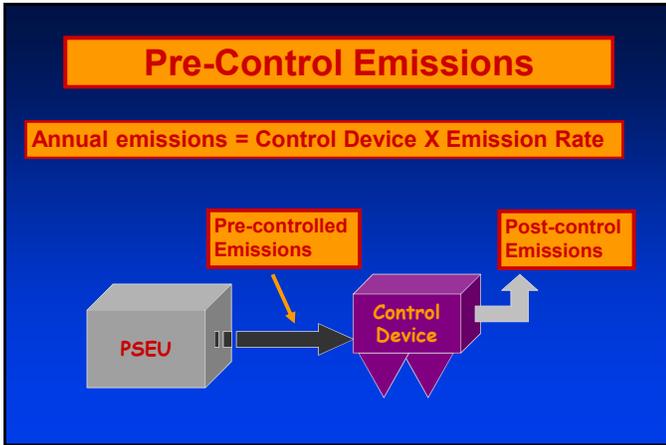
Defining Excursions & Exceedances

- Exceedance – condition detected by monitoring (in units of pollutant emissions) that emissions are beyond permit limit
- Excursion – departure from indicator range established in accordance with part 64



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Determining Emissions Rates

- ◆ Emissions testing
 - ◆ EPA test methods
 - ◆ Control device inlet and outlet
- ◆ Mass balance measurements
 - ◆ e.g., VOC from solvents
 - ◆ Chemical reactions
- ◆ Emissions factors X throughput
- ◆ Industry standards

The slide includes two photographs: one showing an industrial facility with monitoring equipment and another showing a worker in a hard hat and safety glasses operating a device.

Let's discuss Mass Balance Calculations

The image shows a large industrial facility with a tall cylindrical tower and various pipes and structures.

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Mass balance example:
 coal-fired boiler

→ Coal-fired boiler

- ◆ 9% ash
- ◆ 12,000 Btu/lb coal

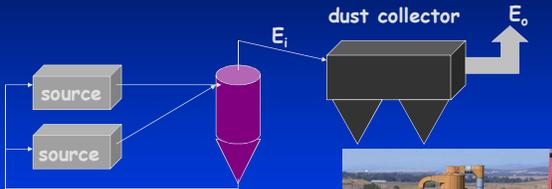
→ Calculate precontrol emissions:

0.09 lb ash/lb coal = 7.5 lb/mmBtu

0.012mmBtu/lb coal



Mass balance example:
 wood-working facility



$E_o = 8 \text{ T/Y}$ (measured via source test)
 Control Eff = 90%
 $E_i (\text{T/Y}) \times (1 - 90/100) = 8 \text{ T/Y}$
 $E_i = 80 \text{ T/Y}$





Definition of Control Device

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Control Devices Do NOT Include:

- Combustion or other process design features
 - Low NOx Burners
- Passive control measures
 - Seals & lids
 - Low sulfur fuel



Who is exempt from CAM?

- ◆ Post-1990 NSPS and NESHAP emission limits (does not include rules amended after Nov 15, 1990)(example)
- ◆ CFC rules
- ◆ Acid Rain requirements
- ◆ Emissions trading programs
- ◆ Emission caps
- ◆ Title V permit requiring continuous compliance determination method (CEM)

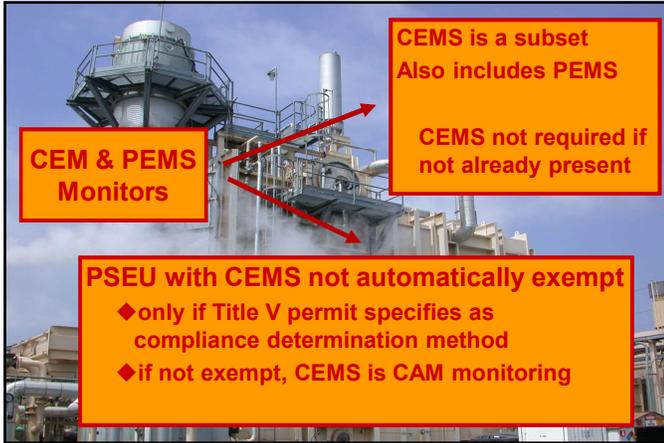
Who is exempt from CAM?

◆ Exemptions are by rule type, not facility type:

- ◆ Acid rain rules, Post-1990 EPA rules,
- ◆ Rules requiring CEMs



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CEM & PEMS Monitors

**CEMS is a subset
Also includes PEMS**

**CEMS not required if
not already present**

PSEU with CEMS not automatically exempt

- ◆ only if Title V permit specifies as compliance determination method
- ◆ if not exempt, CEMS is CAM monitoring

Exemption for Backup Utility Power Plants

- Municipally owned &
- Exempt from Part 75 monitoring &
- Peaking unit throughout Title V permit term &
- Actual emissions over last 3 years < 50% of major source threshold



- ◆ CAM applicability determination
- ◆ CAM submittal
- ◆ Review & approval of CAM submittal
- ◆ CAM implementation

CAM Process + RECAP

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CAM Timing (§64.5)

- ◆ "Large" units: post-control PTE GREATER than major source threshold
 - ◆ CAM addressed at initial permit issuance if source had not submitted application (or if PA did not determine application complete) by 4/20/98 (Rule effective date of Nov 21, 1997)
 - ◆ When the unit becomes subject to a significant modification
 - ◆ Otherwise, at permit renewal
- ◆ "Other" units: post-control PTE LESS than major source thresholds
 - ◆ CAM must be addressed at permit renewal

Source's Role

- Develop and propose monitoring in permit application (CAM Plan)
- Monitoring in CAM Plan must "provide a reasonable assurance of compliance" to provide a basis for certifying compliance with applicable requirements for PSEUs with add-on control devices



Monitoring Approach (CAM) Objectives

- Identify the indicators of performance of the control device
- Identify the ranges to be maintained
- Rationale for selecting the indicators & ranges

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**Monitoring Approach
SOx Control -
Wet Scrubber:

Case Study**



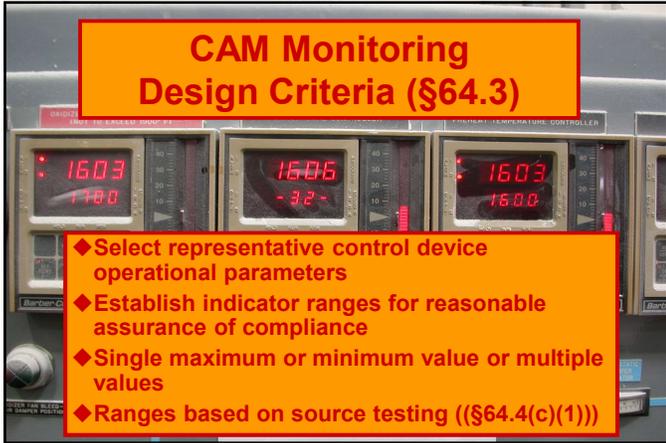
Monitoring Approach – SO ₂		
Indicator	Slurry pH	Slurry flow rate gpm
Indicator range	<9.0 - corrective action, reporting	<175 – corrective action, reporting
Measurement location	Recirculation line	Recirculation line
QA/QC	Annual cal.	Annual cal.
Frequency	Once /15 minutes	Once /15 minutes
Data Collection	pH monitor	Flow rate monitor
Averaging time	hourly	hourly
QIP Threshold	< 10 excursions	< 6 excursions

Examples of Indicators of Performance of Control Device



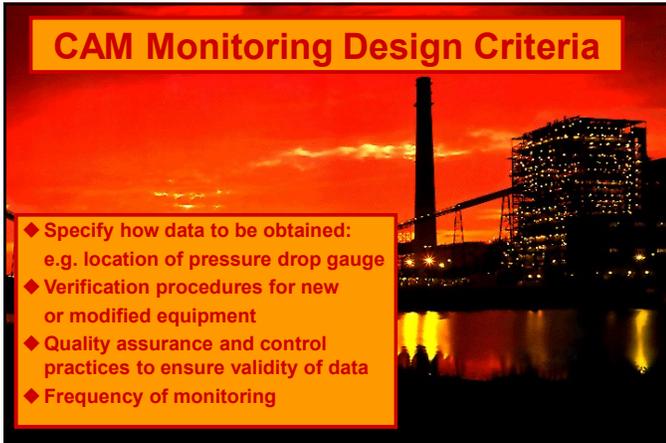
- ◆ **Measured Indicators**
 - ◆ NOx conc., Opacity or VEE
 - ◆ Total HC conc.
- ◆ **Control Device Operating Indicators**
 - ◆ Temp., ΔP, pH, gallons/min
- ◆ **Process Operating Indicators**
 - ◆ Temperature or Flow
- ◆ **Record Keeping**
 - ◆ Lbs VOC/gal of coating
 - ◆ Maintenance Activity @ fabric filter baghouse inspection

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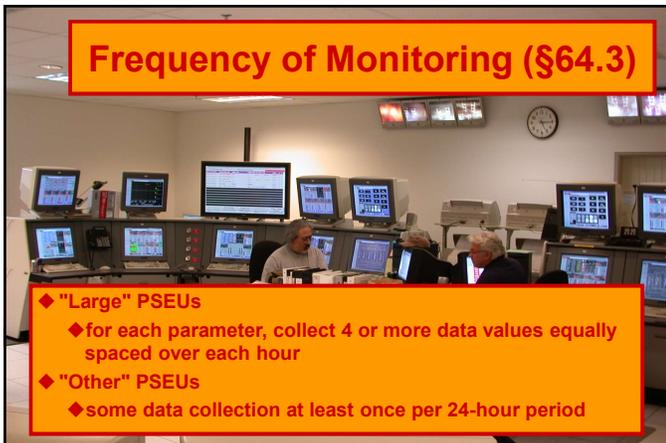
CAM Monitoring Design Criteria (§64.3)

- ◆ Select representative control device operational parameters
- ◆ Establish indicator ranges for reasonable assurance of compliance
- ◆ Single maximum or minimum value or multiple values
- ◆ Ranges based on source testing ((§64.4(c)(1)))



CAM Monitoring Design Criteria

- ◆ Specify how data to be obtained: e.g. location of pressure drop gauge
- ◆ Verification procedures for new or modified equipment
- ◆ Quality assurance and control practices to ensure validity of data
- ◆ Frequency of monitoring



Frequency of Monitoring (§64.3)

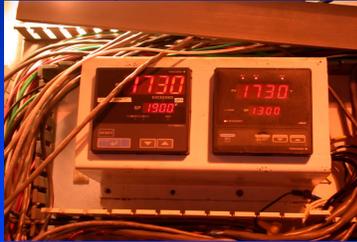
- ◆ "Large" PSEUs
 - ◆ for each parameter, collect 4 or more data values equally spaced over each hour
- ◆ "Other" PSEUs
 - ◆ some data collection at least once per 24-hour period

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Design Evaluation Factors

Averaging periods:

- ◆ Sufficient to detect control device or other potential compliance problems
- ◆ Not so short as to flag minor perturbations as excursions



Design Evaluation Factors

Level of confidence issues:

- ◆ Subjective - provides reasonable assurance of proper operation and compliance
- ◆ Permit application must include justification for selection



Example: Indicator Level of Confidence

Indicator

Level of confidence

- | | | |
|---|---|--------------|
| 1. VEE | → | 1. Low |
| 2. Aux. burner flame inspection | → | 2. Low |
| 3. Combustion temp. daily monitoring | → | 3. Low |
| 4. Combustion temp. hourly monitoring | → | 4. Moderate |
| 5. Combustion temp. hourly monitoring + CO monitoring | → | 5. Very high |

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Equipment needs - factors to consider

- ◆ Location and installation logistics
- ◆ Maintenance and training needs
- ◆ Cost factors – inherent in source owner's planning and design

Design Evaluation Factors

Design Evaluation Factors

Selecting and justifying indicator ranges - define a basis:

- ◆ Parameter data collected during testing
- ◆ Historical data → Baseline Data (months/years)
- ◆ Design or engineering data
- ◆ From similar operations

Selecting & justifying indicator ranges:

- ◆ Type of data
(e.g., instrumental or manual)
- ◆ Frequency (temp. @ 1/min vs. temp. @ 1/day)
- ◆ Quantity of data
for analysis (temp. @ 1/min during 3 hour source test vs. temp. @ 1/min over 3 months)
- ◆ Data variability (example: pH between 9 & 11)

Design Evaluation Factors

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Design Evaluation Factors

Selecting and justifying indicator ranges
(continued) - performance criteria:

- ◆ Data measured during compliance test must fall within range
- ◆ Range must be indicative of good operations and compliance performance
- ◆ Range must be sensitive to control device changes
- ◆ Range should account for normal operational variability (pulsejet cleaning cycle spike @ baghouse; wet ESP flushing causes drop in KV)

Design Evaluation Factors

Indicator range formats:

- ◆ Mean value \pm set value (e.g., 1650 F \pm 50 F)
- ◆ Mean value \pm percent of mean
- ◆ Max/min value(s) observed
- ◆ Max/min \pm set value
- ◆ Max/min values \pm percent of mean (e.g. 11-15% O₂)
- ◆ Combination of more than one of above (e.g., if "x" and "y", then excursion) (e.g. ΔP : 3-5 in w.c.)





Let's Discuss Submittal Requirements for CAM

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§64.4 (a)	Information on indicators, ranges or processes by which indicators are to be established & performance criteria
§64.4 (b)	Justification for the proposed elements of the monitoring
§64.4 (c)	Control device operating data recorded during test, supplemented by engineering & manufacturer's recommended ranges
§64.4 (d)	Test plan and schedule for obtaining data, if performance data is not available
§64.4 (e)	Implementation plan, if monitoring requires installation, testing or other activities prior to implementation



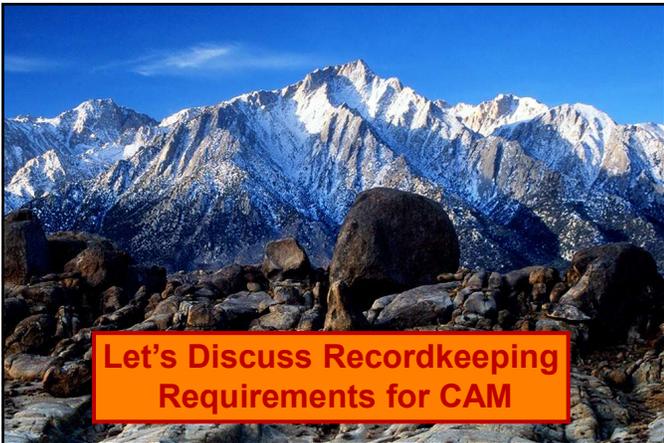
Let's Discuss Required Permit Conditions for CAM

§64.6 (c)(1)	Approved monitoring approach, including the indicators, method of measuring indicators, and the performance criteria
§64.6 (c)(2)	Means of defining exceedances & excursions, level which constitutes an exceedances & excursions, averaging period and procedures for notifying permitting authority for exceedances & excursions
§64.6 (c)(3)	Obligation to conduct monitoring
§64.6 (c)(4)	Minimum data availability requirements for valid data collection for each averaging period

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§64.9 (a)(2)(i)	Summary of number, duration, and cause of excursions or exceedances and the corrective action taken
§64.9 (a)(2)(ii)	Summary of number, duration, and cause of monitoring equipment downtime incidents, other than routine downtime for calibration
§64.9 (a)(2)(iii)	Descriptions of the actions taken to implement a QIP & upon completion of QIP, reduced likelihood of similar excursions or exceedances



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§64.9 (b)	Records of monitoring data and monitor performance data
§64.9 (b)	Records of corrective actions taken
§64.9 (b)	Records of written QIP's and actions taken to implement a QIP

What does source do with monitoring results?

- Report deviations, excursions & exceedances in semi-annual monitoring reports
 - ◆ date & duration
 - ◆ nature of corrective action
- Certify compliance status for each applicable requirement
 - ◆ Operating control device(s) within designated CAM or other indicator ranges



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Quality Improvement Plan (§64.8)

- District or EPA can require
- Permit may specify appropriate threshold, such as an accumulation of exceedances or excursions exceeding 5% of PSEUs operating time
- Implementation of QIP does not shield source from noncompliance with emission limit

Quality Improvement Plan (§64.8)

- Written QIP available for inspection
- Evaluate performance problems
- Modify QIP to include
 - ◆ improved preventive maintenance practice
 - ◆ process operation changes
 - ◆ improvements to control methods
 - ◆ more frequent or improved monitoring



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Defining Excursions & Exceedances

- **Exceedance** – condition detected by monitoring in units of pollutant emissions) that emissions are beyond limit
- **Excursion** – departure from indicator range established in accordance with part 64



Status of Compliance: Excursions

- ◆ Potential problem in the operation & maintenance of the control device,
- ◆ Possible exception to compliance with applicable requirements,
- ◆ Owner or operator to take appropriate corrective action, but
- ◆ Not necessarily a failure to comply with the underlying emissions limitation or standard.



Status of Compliance: Excursions

- ◆ Reporting requirements already established in existing requirements,
- ◆ May have to specify an appropriate time period for averaging data to report exceedances,
- ◆ Exceptions to compliance.



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Status of Exception to Compliance

- ◆ Certification of intermittent compliance is not necessarily a certification of noncompliance
 - ◆ Periods for which one does not really know (e.g., excursions from operating conditions),
 - ◆ Excused periods (e.g., SS&M),
 - ◆ Monitoring errors offset by other information indicating compliance.



What is required for compliance certification?

40 CFR 70.6(c)(5) - annual or more frequent certification requires the source owner (responsible official) to:

- ◆ Certify as to status of compliance for each permit term or condition, &
- ◆ Indicate whether compliance is continuous or intermittent.



What constitutes continuous or intermittent compliance?

- ◆ From preamble to part 70 revisions (06/27/03):
 - ◆ Any failure to meet permit terms or conditions (e.g., deviations or possible exceptions to compliance as per part 64 excursions) will result in intermittent compliance certification;
- ◆ From other EPA documents : Certification of intermittent compliance is not necessarily a certification of noncompliance:
 - ◆ Periods for which one does not really know (e.g., excursions from CAM Indicator ranges),
 - ◆ Monitoring errors offset by other information indicating compliance.

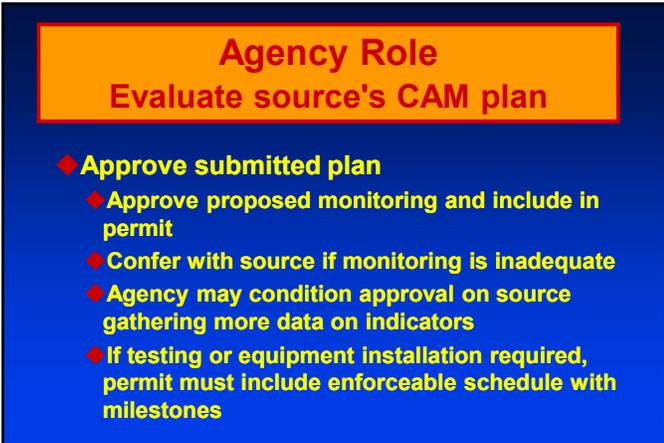
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Agency Role
Evaluate source's CAM plan

- ◆ Disapprove submitted plan
 - ◆ draft or final permit must include periodic monitoring
 - ◆ compliance schedule in permit



Agency Role
Evaluate source's CAM plan

- ◆ Approve submitted plan
 - ◆ Approve proposed monitoring and include in permit
 - ◆ Confer with source if monitoring is inadequate
 - ◆ Agency may condition approval on source gathering more data on indicators
 - ◆ If testing or equipment installation required, permit must include enforceable schedule with milestones



Agency Role: Issue final permit

- ◆ Indicators to be monitored
- ◆ Means or device used to measure indicators (e.g. temperature measurement device, VE, CEMS)
- ◆ Performance requirements
- ◆ Definitions of exceedance or excursion
- ◆ Obligation to conduct monitoring, reporting & recordkeeping, implement QIP

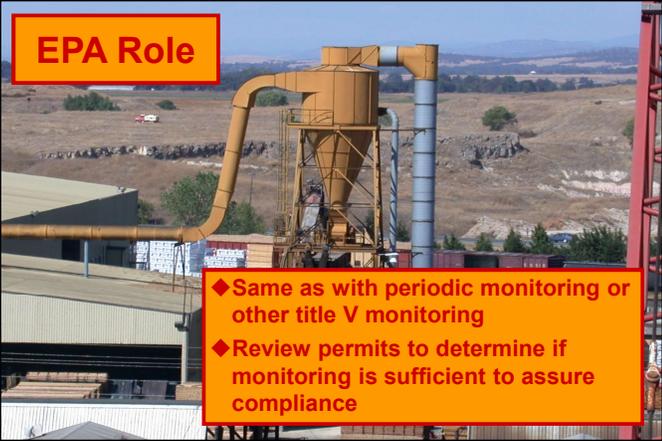
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Compliance Certification Condition

- ◆ Part 70 (§70.6(c)(5)(iii)) revised when Part 64 promulgated
- ◆ Certification conditions must “identify as possible exceptions to compliance any periods during which compliance is required and in which an excursion or exceedance as defined under part 64 of this chapter occurred.”

EPA Role

- 
- ◆ Same as with periodic monitoring or other title V monitoring
 - ◆ Review permits to determine if monitoring is sufficient to assure compliance



epa.gov/air-emissions-monitoring-knowledge-base/compliance-assurance-monitoring

epa.gov/sites/production/files/2016-05/documents/cam-tgd.pdf

CAM Technical Guidance Document

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Monitoring Approach – SO₂

Indicator	Slurry pH	Slurry flow rate gpm
Indicator range	<9.0 - corrective action, reporting	<175 – corrective action, reporting
Measurement location	Recirculation line	Recirculation line
QA/QC	Annual cal.	Annual cal.
Frequency	Once /15 minutes	Once /15 minutes
Data Collection	pH monitor	Flow rate monitor
Averaging time	hourly	hourly
QIP Threshold	< 10 excursions	< 6 excursions



Let's Discuss Oxidizers

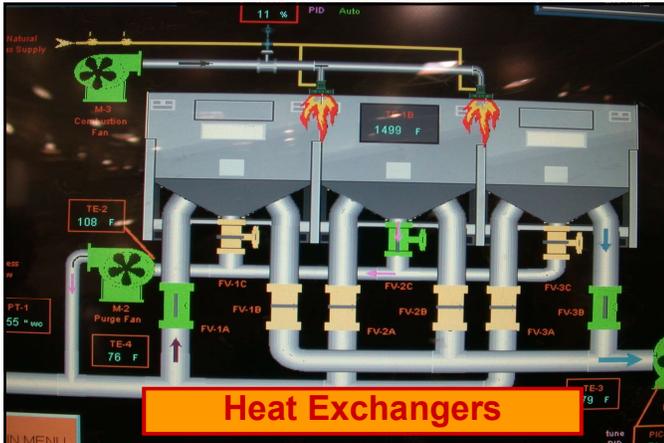


Thermal Oxidizer

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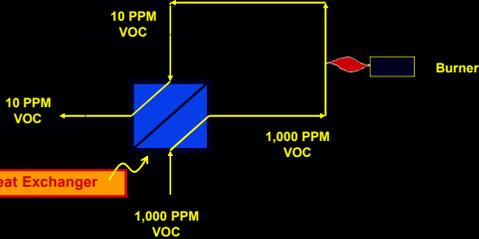
Thermal Oxidizer

- ◆ Performance indicators
- ◆ Outlet VOC concentration
- ◆ Outlet combustion temperature
- ◆ Outlet CO concentration
- ◆ Exhaust gas flow rate
- ◆ Outlet O₂ concentration
- ◆ Inspections



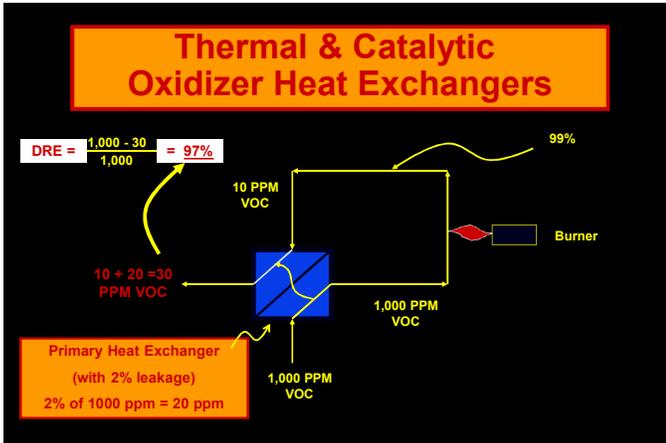
Thermal & Catalytic Oxidizer Heat Exchangers

$$DRE = \frac{1,000 - 10}{1,000} = 99\%$$



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Thermal & Catalytic Oxidizer Heat Exchangers

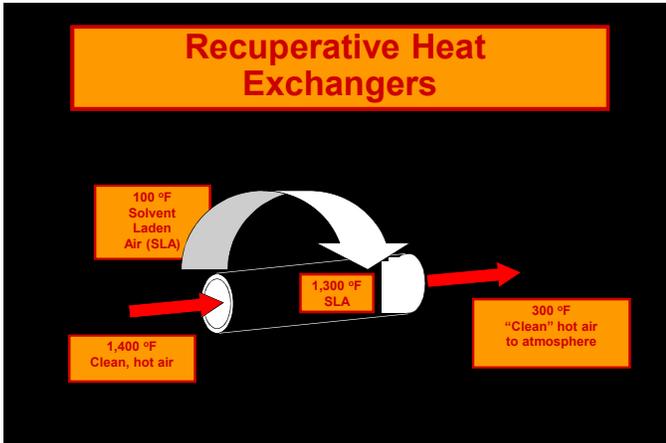
There are two basic types of heat exchangers used for thermal or catalytic oxidizers

- ◆ Metal Heat Exchangers or “recuperative heat exchangers”
- ◆ Ceramic Bed Heat Exchangers or “regenerative heat exchangers”

Recuperative Heat Exchangers

- ◆ Thermal efficiency range of 30% to 70%
- ◆ Shell & tube or plate-type
- ◆ Usually constructed of alloy steel
- ◆ Welded systems have very low leakage rates when new
- ◆ Susceptible to cross-leakage as heat exchanger ages
- ◆ Not typically used with acid gases
- ◆ Susceptible to thermal shock on startup and shutdown

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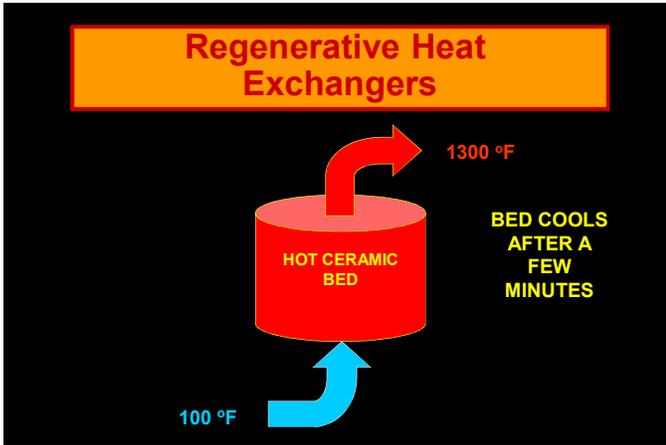
Recuperative HX – Monitoring Approach

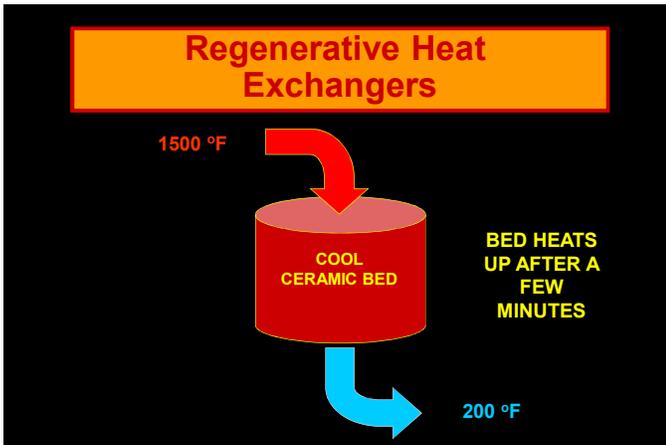
- ◆ **Key Factors to Consider When Monitoring a Recuperative HX:**
 - ◆ Annual inspection and/or testing of heat exchanger to assess leakage per manufacturer's recommendations.

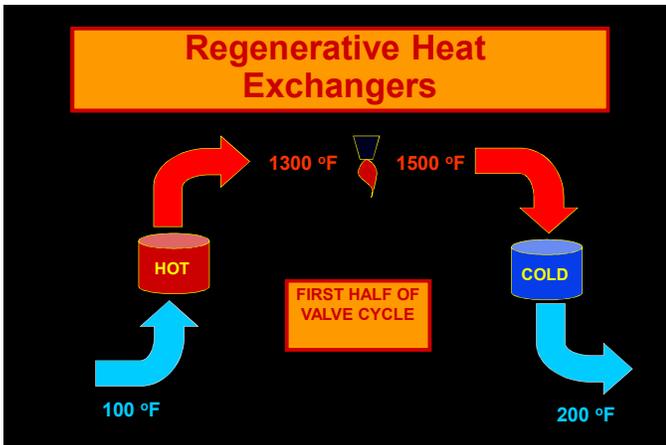
Regenerative Heat Exchangers

- ◆ Thermal efficiency range of 80% to 95%
- ◆ Can be random packing or structured
- ◆ Extremely tolerant of very high temperatures
- ◆ Highly resistant to thermal shock
- ◆ Can resist corrosion by many acid gases
- ◆ May be susceptible to fouling or plugging
- ◆ Subject to cross-leakage because of geometry
- ◆ It is a non-continuous process

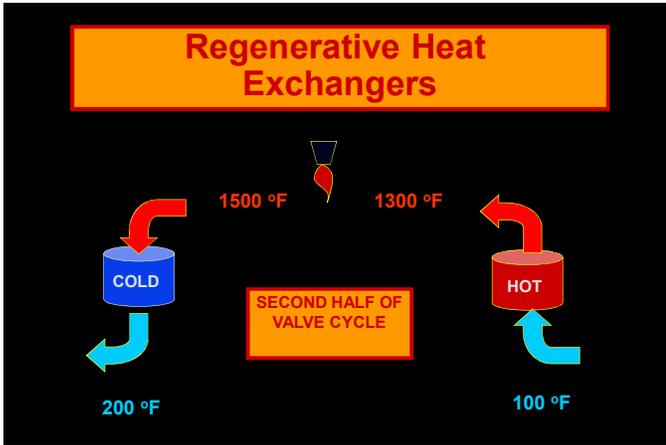
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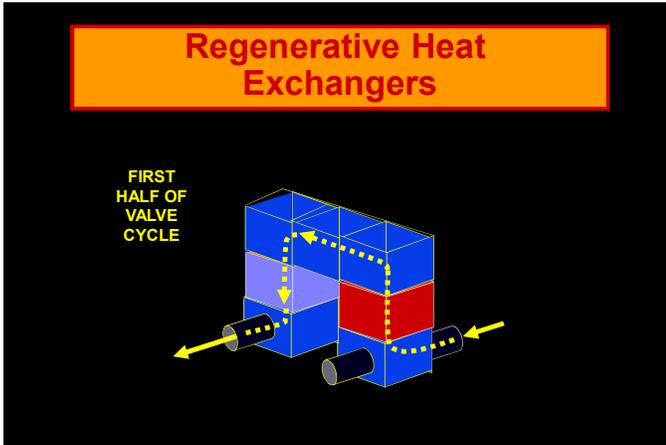


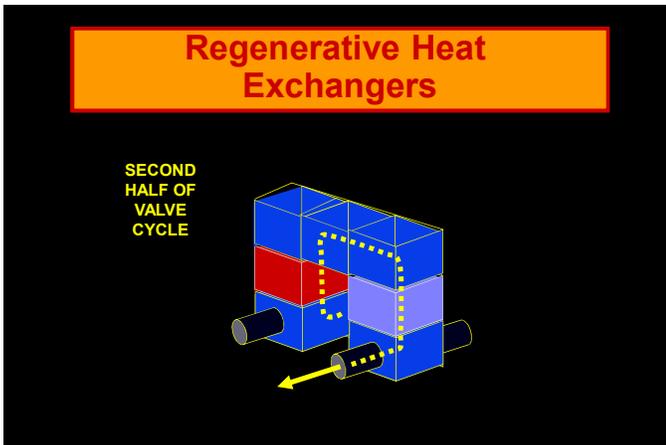




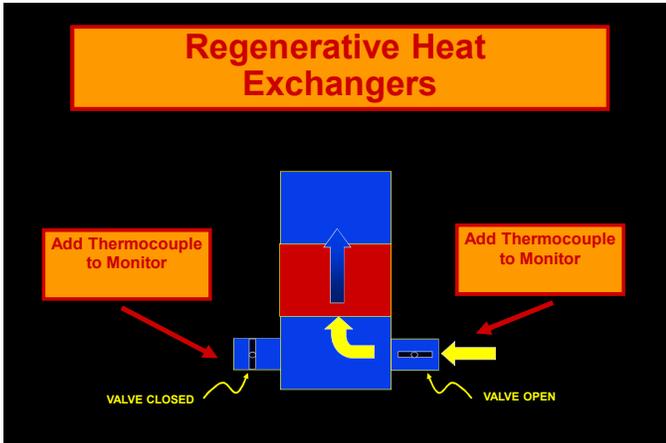
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Regenerative HX – Monitoring Approach

- ◆ Key Factors to Consider When Monitoring a Regenerative HX:
 - ◆ Assessment of proper closure of valves: Annual inspection/testing
 - ◆ Annual documentation of valve timing control system parameters

Heat Exchange Problems

- ◆ Any cracks or leaks in a recuperative HX will bleed emissions into the clean side
- ◆ Uncoordinated valves in a regenerative HX will transfer emissions into the clean air.
- ◆ A regenerative HX usually burps some emissions into the clean air each time the valves switch the flow.

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Indicator	Combustion T	Outlet CO conc.
Measurement Approach	Thermocouple	CO CEMs
Indicator Range	Excursion: < 1500 F Inspection & Reporting	Excursion: > 50 ppmv. Inspection & Reporting
Data Representation	Installed in incinerator \pm 10 F	PS 4, 40 CFR 60 Appendix B
QA/QC	Thermocouple calibration	Span gas & daily calibration
Monitoring Frequency	10 second	15 second interval
Data Collection Procedures	Continuous chart recorder	Record 1-min avg. by DAS
Averaging Period	1-hour average	1-hour average
QIP Threshold	No more than 6 excursions	No more than 10 excursions



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Compliance Assurance Monitoring (CAM)

Enforcement Authority §64.7(d)

- ◆ "Upon detecting an excursion or exceedance, the owner or operator shall restore operation of the pollutant-specific emissions unit (including the control device and associated capture system) to its normal or usual manner of operation as expeditiously as practicable in accordance with good air pollution control practices for minimizing emissions."

Relationship of CAM to Other Title V Monitoring

- ◆ PSEUs not subject to CAM are subject to periodic monitoring
- ◆ Periodic monitoring similar but less detailed approach than CAM
- ◆ Periodic monitoring could be used to develop data to support proposed CAM plan

Review of Key Concepts

- CAM applies if PSEU has control device
- New concepts in CAM
 - Pre-control PTE
 - PSEU
 - Excursion and exceedance
- Data collection to ensure control device operating properly
 - sources that don't address problems subject to enforcement

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Compliance Assurance Monitoring (CAM)

Recap: Elements of CAM	
§64.4 (a)	Describe indicators to monitored Describe process to set indicator ranges Describe performance criteria
§64.4 (b)	Provide justification for the proposed elements of the monitoring
§64.4 (c)	Provide control device operating/test data Provide engineering & manufacturer's recommended ranges
§64.4 (d) (e)	Test plan and implementation plan, if monitoring requires installation, testing or other activities
§64.4 (e)	Expediently correct control device performance problems