PM Compliance Options for MACT and MATS Rules

Ed McCall
PCME

First Some Definitions: PM- CEM, PM-CPMS and BLDs

PM-CEM (PM- Continuous Emission Monitor)

PM-CPMS (PM-Continuous Parametric Monitoring System)

- Forward scatter/ Beta or mass CEM (for wet and dry processes)
- PM-CEM: Calibration in mg/m^3
- PM-CPMS: Simpler calibration (Operating Limit)

BLD: Bag Leak Detector

- Provides trend of emissions
- Automatic self-checks save end user doing manual drift checks
- Often required if using Fabric Filter (FF)

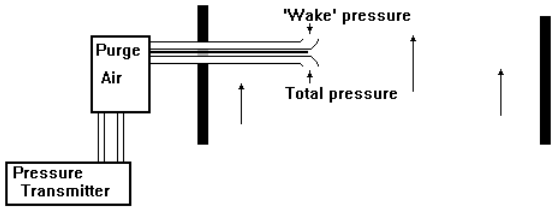
HAP Surrogates & the MACT Rules

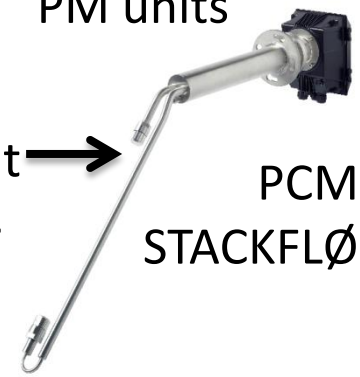
- Non-mercury metals and the many non-dioxin/furan organic HAP's are difficult to measure with continuous monitors.
- Instead, easily measured pollutants that correlate with HAP's are substituted as *surrogates.*
  - Two types of particulate matter (PM)
    - Filterable : Solid phase in stack
      - Filterable PM is a surrogate for non-mercury hazardous metals (arsenic, beryllium, cadmium, chromium, manganese, nickel).
    - Condensable: Gas phase in stack. Forms PM after reacting in atmosphere.
      - Selenium correlates somewhat with condensable PM (Se in gas phase in stack - forms PM after cooling).
      - Condensable PM is difficult to measure continuously & with reference methods so only solid phase PM is used.

Portland Cement MACT

- Appeals to CAA Section 112 to reduce HAP's emissions from Portland Cement kilns via Maximum Achievable Control Technology (MACT)
- Lowers PM, mercury and HCL limits
- Requires PM CEMS / CPMS (dry stack continuous particulate monitors)
  - PM limits (30 day rolling averages)
    - Existing kilns = 0.07 lbs/ton clinker (~10 mg/Am^3)
    - New kilns = 0.02 lbs/ton clinker (~3mg/Am^3)
  - Clinker Cooler Stack must have PM CEMS / CPMS
- Bag houses (fabric filters) need Bag Leak Detector
- Need stack flow monitor due to plant "output-based" PM units
  - Technologies of interest for stack flow include
    - Ultrasonic time-of-flight
    - Hot wire anemometer
    - Pitot tube

PCME 181





PCME STACKFLØW 400

MATS Rule

- Mercury and Air Toxics Standard (a.k.a. Utility MACT) applies to Electric Generating Units (EGU's)
  - 3 PM compliance options
    - PM CPMS (not typically used in MATS rule)
    - PM CEMS (certified using PS-11)
    - Quarterly reference method tests (MATS Method 5 or metals method)
  - PM limits for bituminous coal fired EGU's (30 day rolling averages)
    - Existing Source: 0.03 lbs/mmBTU (~24 mg/Am^3)
    - New Source: 0.007 lbs/MHr (~4 mg/Am^3)

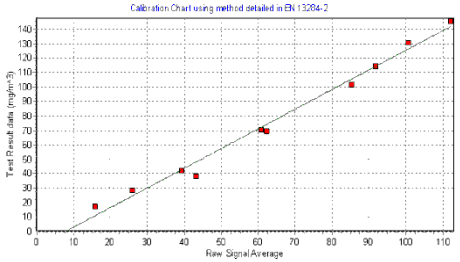
ICI Boiler MACT

- Industrial/Commercial/Institutional Boiler MACT rule has a long complicated history
  - Typical affected sources are pulp and paper mills, other manufacturers (grain processors, autos, etc.), steam heating boilers for large commercial & institutional building complexes
  - PM CEMS/CPMS needed for coal & oil fired boilers (biomass excluded) with heat rate >= 250 mmBTU/Hr, which is about 75 MW.
  - PM limits for existing boilers vary by subcategory (biomass, oil, pulverized coal, etc.) but are similar to EGU MATS rule limits.
  - Bag houses (fabric filters) need Bag Leak Detector
  - Opacity limit of 10% for sources >10 mmBTU/Hr and <250 mmBTU/Hr

PS-11 & Procedure 2 Approach

Note that due to Feb 2014 change to PS-11, Calibration Drift is now assessed versus **Range** (previously was versus Upscale Reference).

PS-11 Correlation Test



RRA: (Relative Response Audit) 3 Run Calibration check

RCA: (Relative Correlation Audit) 12 Run Calibration check

Initial calibration

On going QA

Zero and Span

Quarterly ACA

RRA

RCA

7 day drift test (self check error <=2% of range)

3 years

1 year

Time →

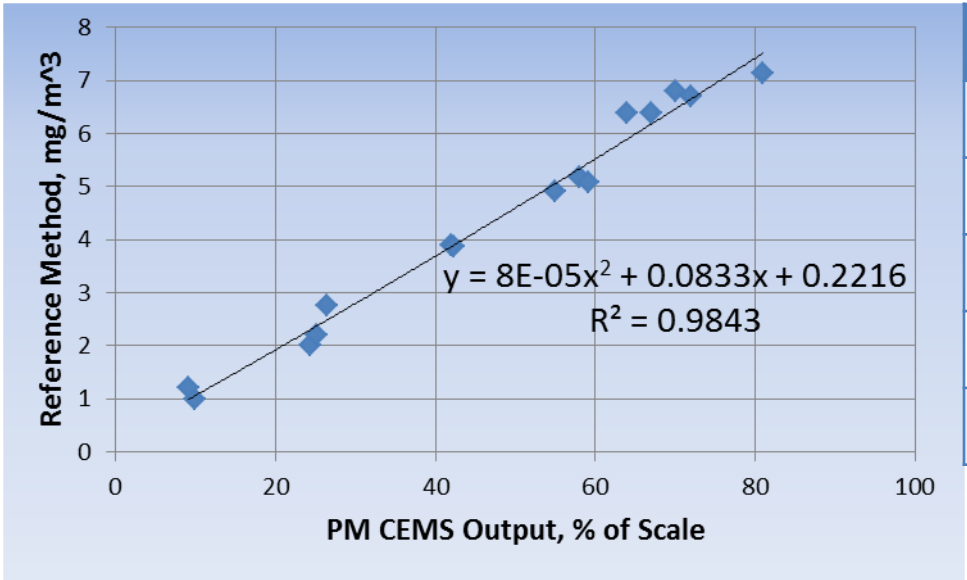
← **PS-11** →

← **Procedure 2** →

PS-11 Correlation Test

- Minimum of 15 runs in 3 bins (0 to 50%, 25% to 75%, 50% to 100% of maximum RM value of PM).
  - Bag house sources w/o bypass have difficulty elevating emissions
  - Ash from ESP or bag house can be injected downstream (not recommended for wet sources)
  - PS-11 does allow use of zero point data from the PM CEMS in lieu of the 3 bins
- Acceptance criteria
  - Correlation Coefficient <= 0.85
  - Confidence Coefficient <= 10% of emission limit
  - Tolerance Interval <= 25% of emission limit

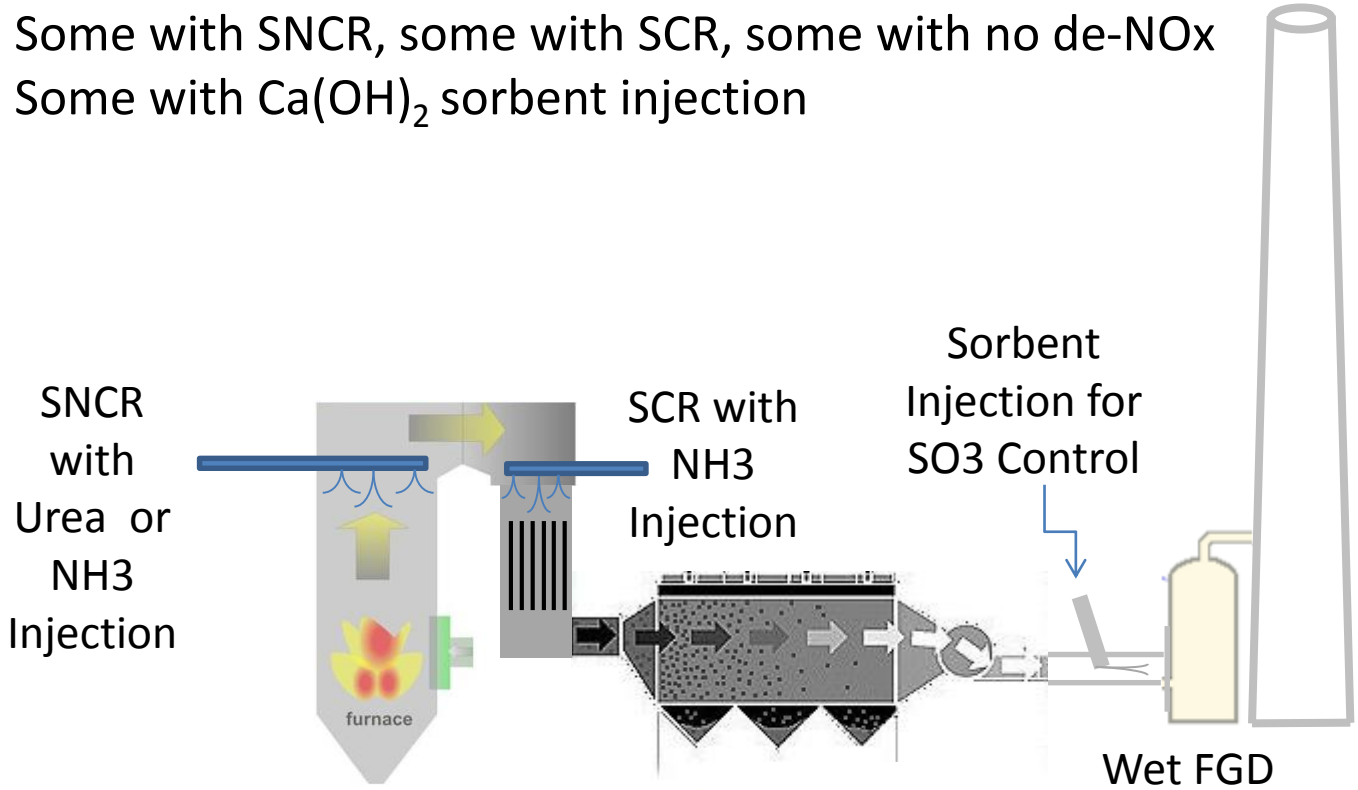
X = PM CEMS, %	Y = RM, mg/m^3
10	1
9.2	1.2
24.3	2
25.2	2.21



Model Types
Linear
2nd Order Polynomial
Logarithmic
Exponential
Power

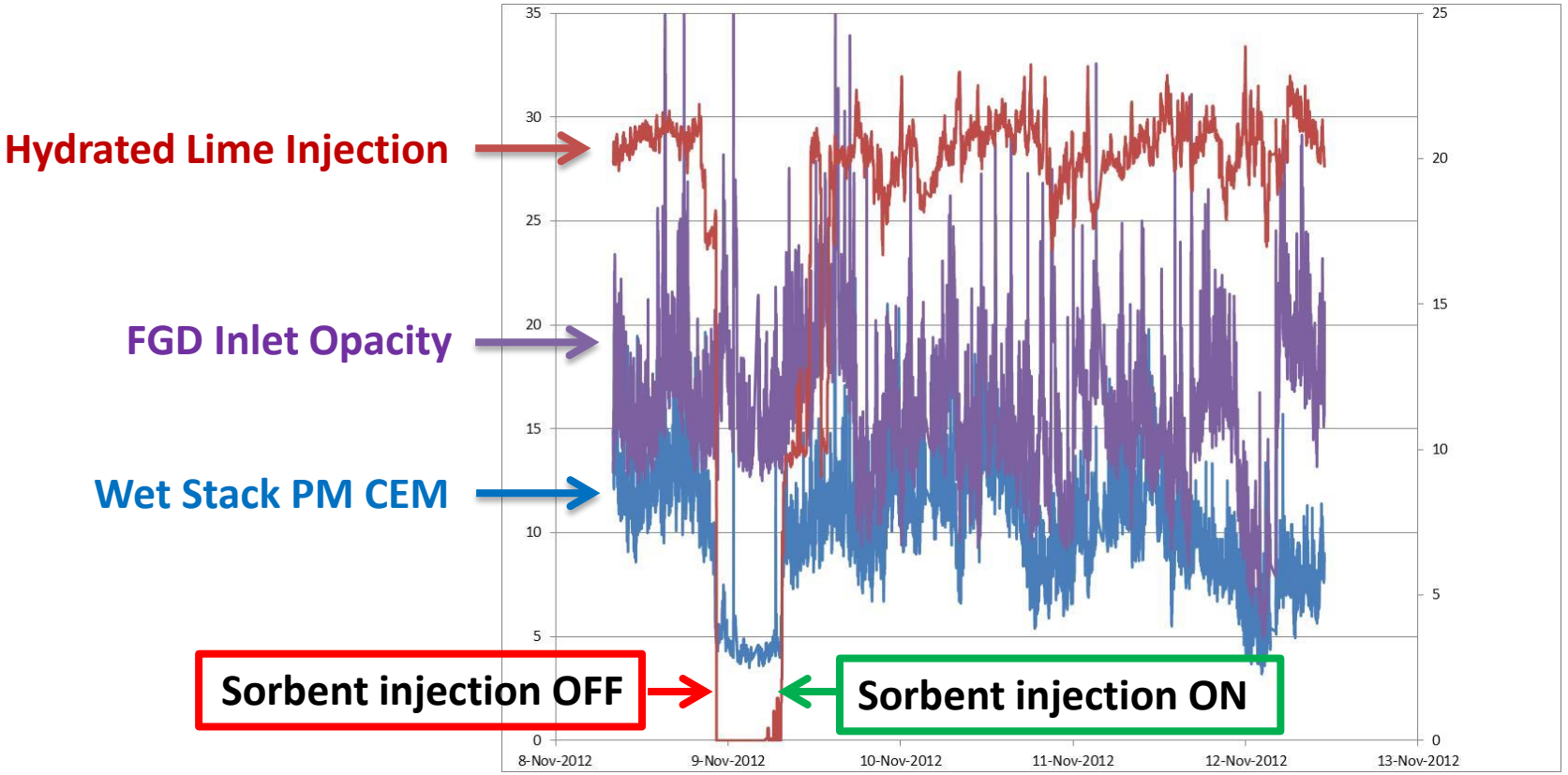
EGU Wet FGD Plant Abatement Processes

- PM CEM's have been installed on many US EGU wet stacks after various abatement processes
  - Wet FGD and ESP with occasional bag house in place of ESP
  - Some with SNCR, some with SCR, some with no de-NOx
  - Some with $Ca(OH)_2$ sorbent injection



Value of PM CEMS

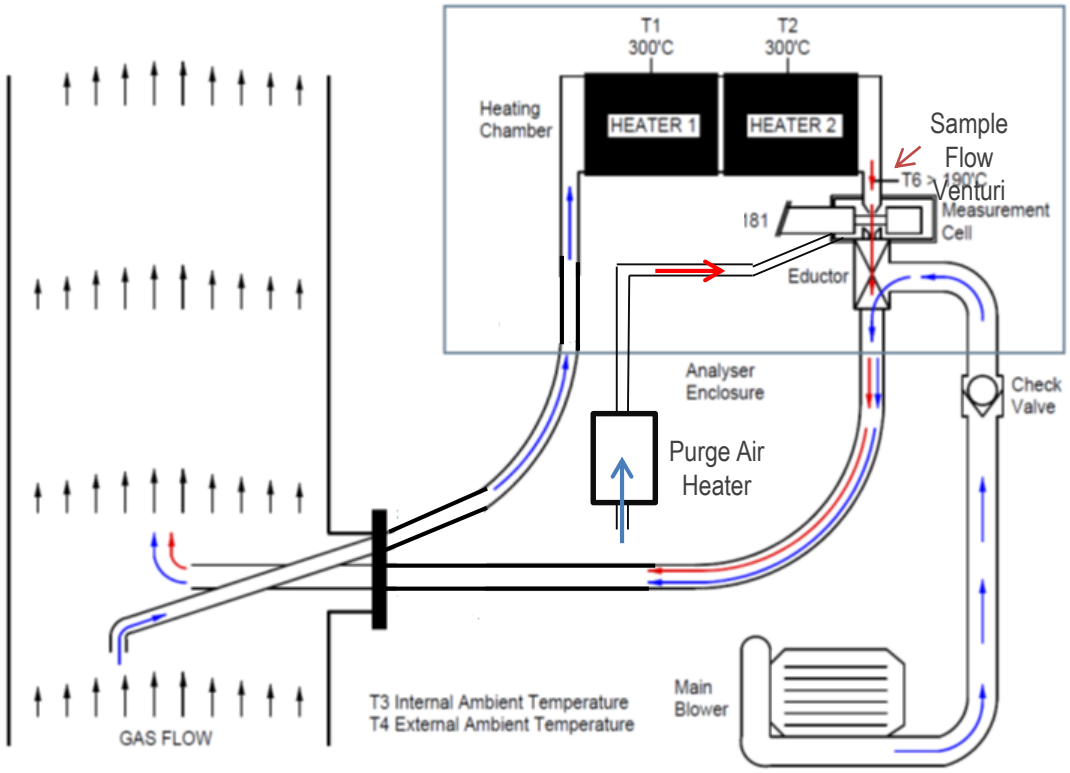
- Abatement plant optimization
- Annual vs Quarterly Testing
- Continuous feedback on plant operation



STACK 181WS PM CEM / CPMS

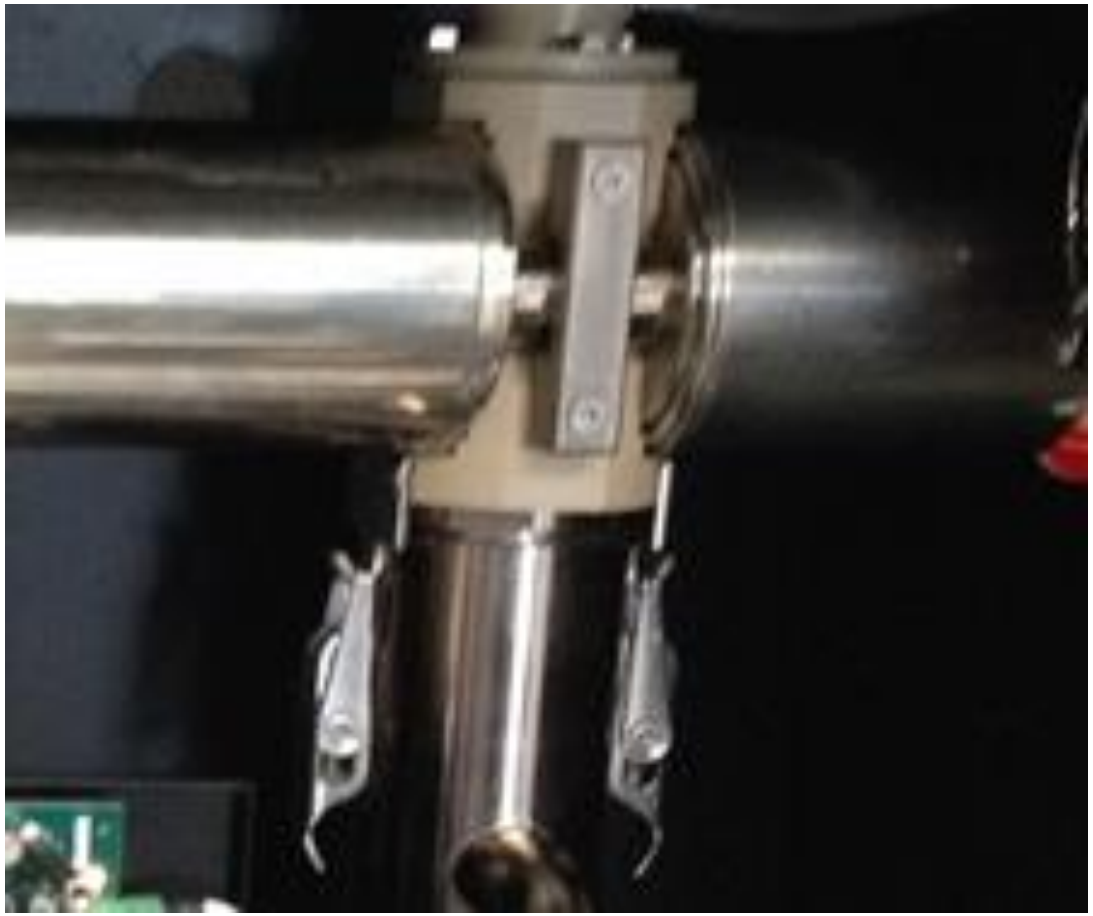
Measurement Concept

1. Extract wet flue gas at appropriate velocity (can sample at fixed or variable velocity)
2. Change liquid content into gas phase
3. Measure dust concentration with light scatter technique
4. Return sample back to stack



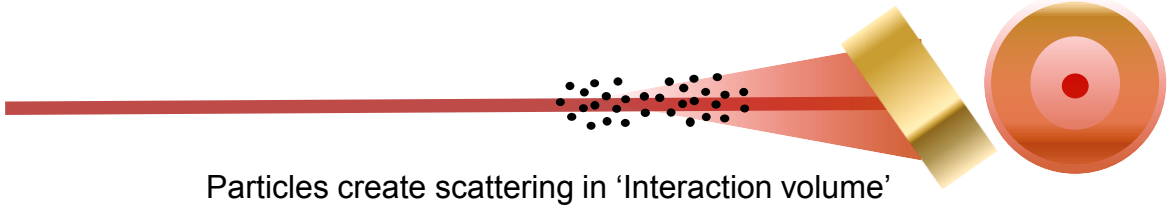
STACK 181WS Improvements

- Purged Sample Chamber (PSC)
  - Improves maintenance interval, reduces cost of ownership by
    - Reducing sample chamber dead spaces where contamination can accumulate
    - Heating purge air preventing formation of condensation on optics
  - Currently installed at several US Electrical Utility stacks with excellent results

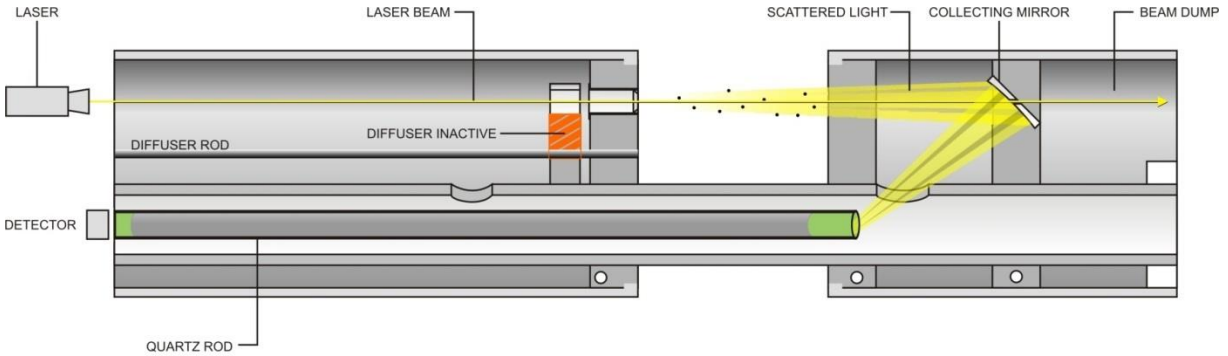


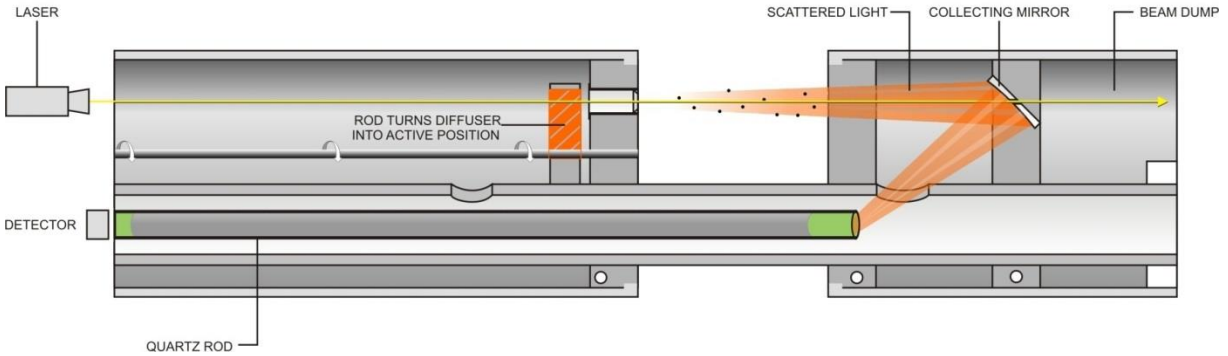
181 ProScatter™ Forward Scatter Technology

- Conical mirror improves light collection by gathering full cone of scattered light.
- Narrow forward scatter angle minimizes effect of changing particle size.
- While the calibration is still sensitive to changes in particle size, ProScatter has reduced sensitivity compared to designs using angles further from angle of incidence.
- Span check is provided by introducing a scatter body in light path.



Particles create scattering in 'Interaction volume'





PCME Wet Stack Particulate Monitor
STACK 181WS PS-11 Correlation Tests

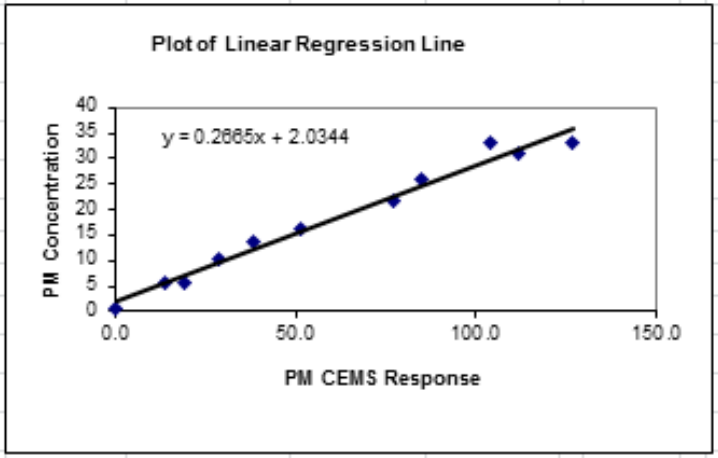
- Upscale particulate achieved by detuning plant (removing precipitator banks, turning off FGD pumps)
- Reference was MATS Method 5 (160º C filter temperature)

Correlation equation:	y =	2.034	+	0.266	x

Summary of Acceptance Criteria for PS-11

Criterion	Actual	Allowable	Acceptable?
Correlation coefficient	0.987	≥ 0.85	yes
Confidence interval	6.35%	≤ 10%	yes
Tolerance interval	18.3%	≤ 25%	yes

* Indicates correlation coefficient is undefined.

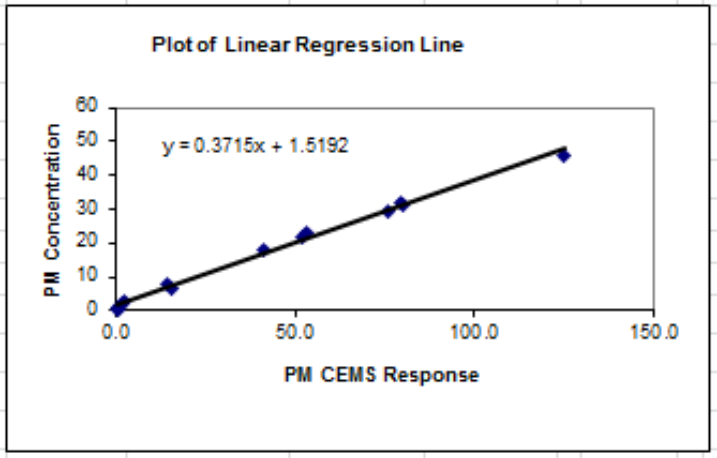


Correlation equation:	y =	1.519	+	0.371	x

Summary of Acceptance Criteria for PS-11

Criterion	Actual	Allowable	Acceptable?
Correlation coefficient	0.997	≥ 0.85	yes
Confidence interval	3.57%	≤ 10%	yes
Tolerance interval	11.3%	≤ 25%	yes

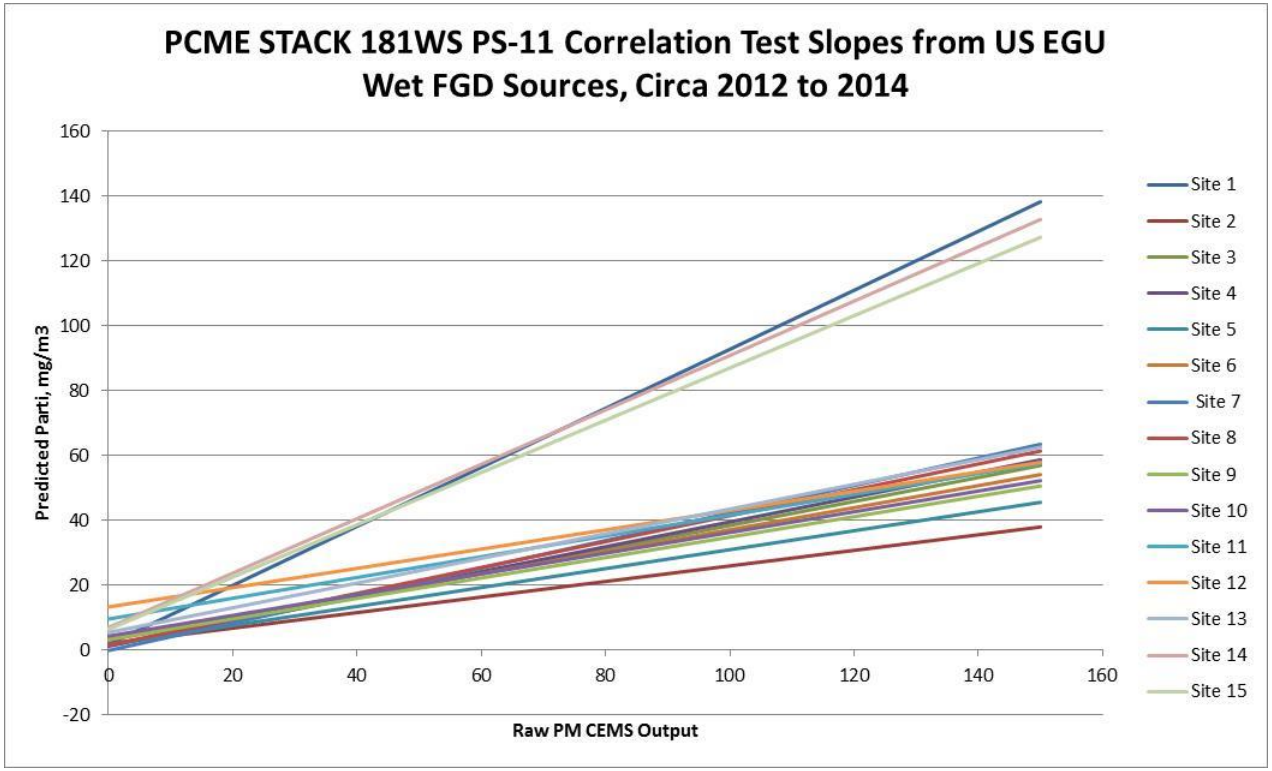
* Indicates correlation coefficient is undefined.



Variability in PS-11 Correlation Test Slopes at Fifteen STACK 181WS Sites

	PS-11 Correlation Curve Coefficients														
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15
b0	1.751	1.945	1.416	1.211	1.758	3.11	-0.146	1.528	3.30	4.29	9.59	13.30	5.43	6.95	6.41
b1	0.910	0.24	0.37	0.383	0.292	0.34	0.424	0.399	0.315	0.32	0.32	0.30	0.38	0.84	0.81
b2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- Plant configurations
  - All had Wet FGD & Precipitator; many other differences
- Slopes clustered in two groups
  - 0.24 to 0.42
  - 0.81 to 0.91
- Why the difference?
  - May be due to particle size dissimilarity from various but constant plant configurations



PCME's background in PM monitoring

- Specialist supplier of PM monitors (30,000 to industrial processes across 6 continents)
- Core technologies
  - Light scatter
  - Electrodynamic
  - Scintillation
- Recently expanded US based service and support capability