Particulate Matter (PM) CEMS

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PM CEMS

- ◆ Many Existing PM CEMS Represent "Monitoring by Extortion" - Consent Decree Requirements

- ◆ More Recently, PM CEMS Installed In Lieu of Opacity on New Wet Scrubbers

- ◆ A Few Have Accepted PM CEMS in Permits for New Units

- ◆ PM CEMS or CPMS an option in EGU MACT Rule – February 16, 2012

Main Issues with PM CEMS

◆ Limited knowledge with respect to long-term stability or robustness of PM CEMS correlations – Particularly at Low Levels

- PM CEMS do <u>not</u> actually measure mass
- Sensitivity to stratification & size distribution

◆ Obtaining valid correlation on wet stacks or locations after a baghouse

◆ PM stratification

- Can be an issue in certain situations
- Testing is not well defined or straightforward

PM CEMS
What Are Some of My Choices?

Measurement Techniques

◆ Beta Attenuation

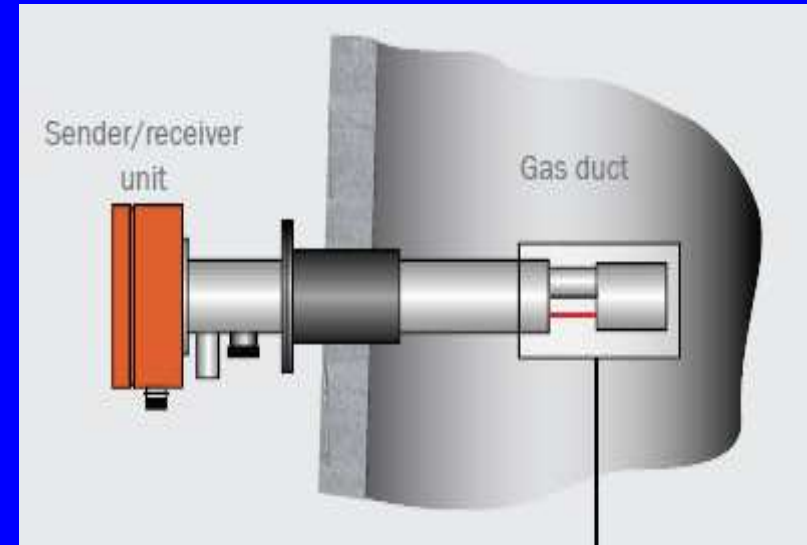◆ Light Scattering

◆ Hybrid with TEOM

M&C Particle Tracker

◆ Forward - Light Scatter

◆ Dilution-Extractive

- ● Typical DR = 8:1

◆ Can be used in a wet environment

◆ Aersol Generator to conduct daily span checks

◆ Complete check of the sampling system

◆ Collects isokinectic sample (Input from stack flow monitor)

M&C Particle Tracker

◆ Participated in EPRI PM CEMS Study

- Struggled with probe pluggage early in the program
- Upgraded nozzle design & system blowback to help reduce probe pluggage
- Improved performance at the end of project

◆ Tested versus a QAG

- Showed a good linear response ($R^2 > 0.95$)

Sick Maihak FW-100

- Forward - Light Scatter

- In-situ

- Dry stack applications only

- Has passed PS-11 Correlation Testing

- Variable slopes for correlation curves on similar units

- Quarterly maintenance is requiring a 3-4 man-hours

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Sick Maihak FWE-200

- ◆ Forward - Light Scatter

- ◆ Straight-Extractive

- ◆ Dry or Wet stack applications

- ◆ Has passed PS-11 Correlation Testing

- ◆ Uses "Thermocylone" to heat sample to prevent moisture interference with light-scatter measurement

- ◆ Widely used in the EGU Industry

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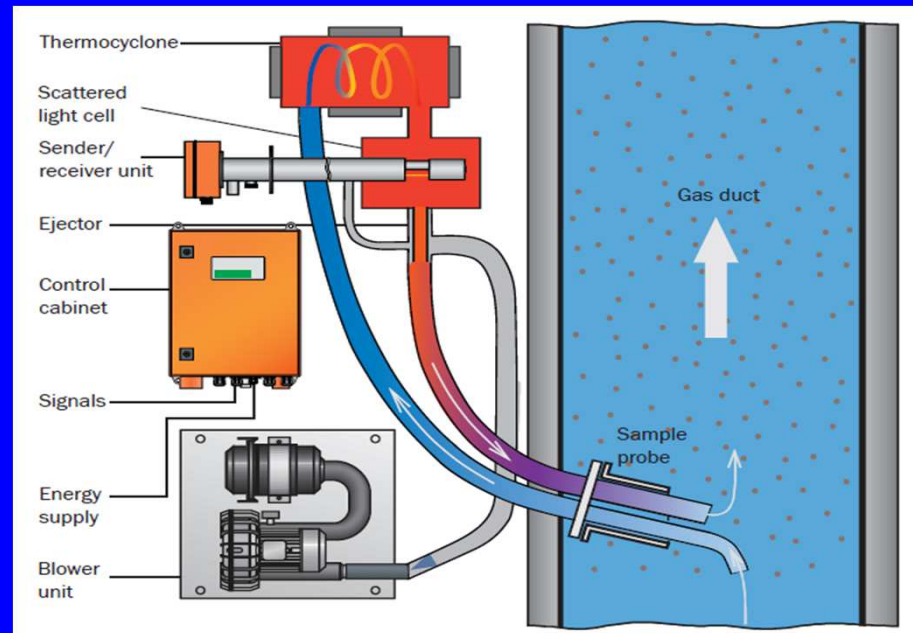
PCME QAL-181
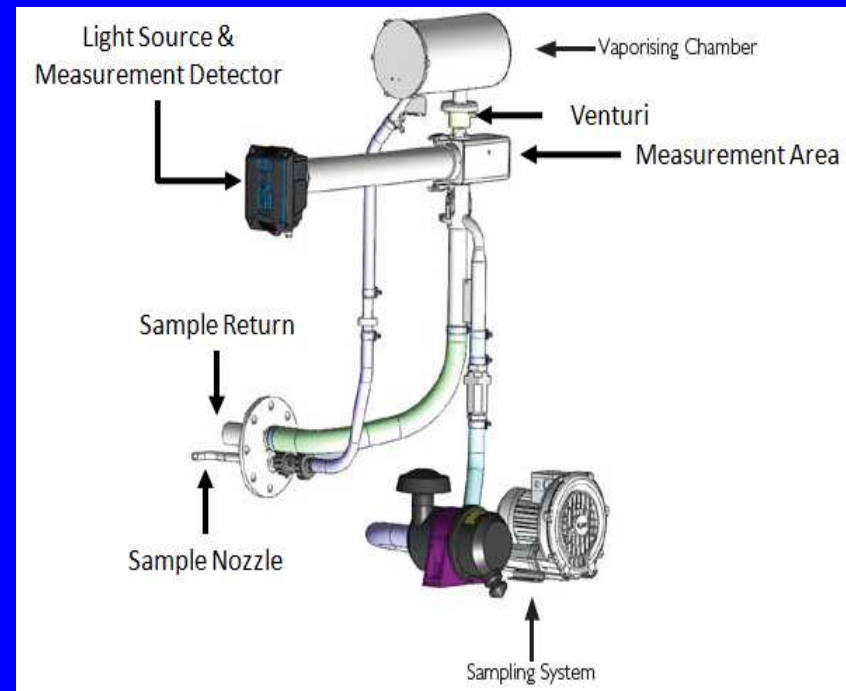
◆ Forward - Light Scatter

◆ In-situ

◆ Dry stack applications only

◆ Limited US EGU Data

◆ For Span Checks, inserts reference scattering material to check detector measurement.

PCME 181-WS

◆ Forward - Light Scatter

◆ Straight-Extractive

◆ Dry or Wet stack applications

◆ Has passed PS-11 Correlation Testing

◆ Uses a vaporizing chamber to heat sample to prevent moisture interference with light-scatter measurement

◆ Can vary sample flow rate to maintain isokinectic sampling.

Light Source & Measurement Detector — Vaporising Chamber — Venturi — Measurement Area — Sample Return — Sample Nozzle — Sampling System

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MSI BetaGuard

◆ Beta-Attenuation

◆ Dilution-Extractive

◆ Dry or Wet stack applications

◆ Batch Samples – 716-sec per cycle

◆ 4 PM readings per hour

◆ Sample umbilical up to 150 ft.

◆ Has passed PS-11 Correlation

◆ Must perform daily & quarterly sample volume audits

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Thermo Hybrid PM CEMS

◆ Light-Scatter

- Forward – Primary Measurement Output

- Back – Used as a QA Check

  » Shift in the Forward-to-Back scatter response ratio indication of change in PM physical characteristics
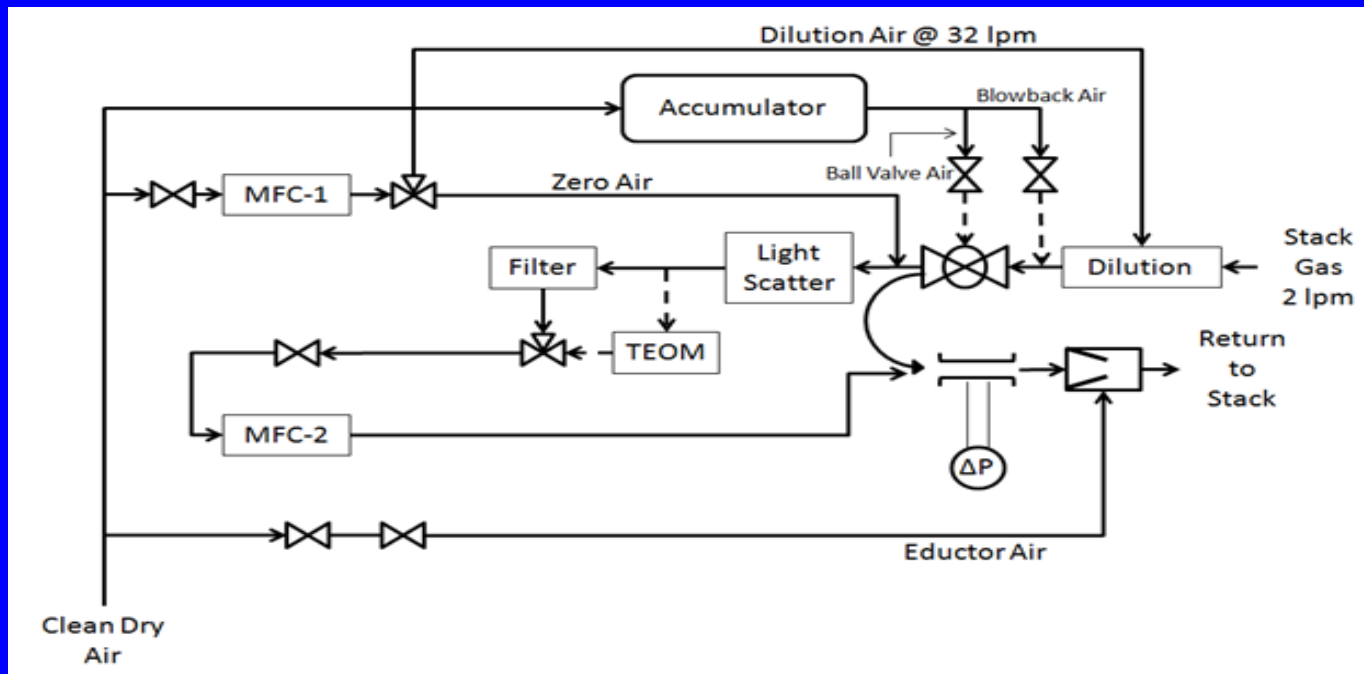
◆ TEOM Measurement

- Used as a baseline for Forward Light-Scatter

- TEOM measurement only acquired periodically

◆ Dilution-Extractive

- Target Dilution Ratio of 16:1

Thermo Hybrid PM CEMS

◆ Can vary sample flow rate to maintain isokinectic sampling rate.

◆ Dry or Wet stack applications

Teledyne-ML LaserHawk

- Back - Light Scatter

- In-situ

- Dry stack applications only

- Has been installed on a few US EGU sites

- Signal detector located in the optical head assembly

- Equipped with blower assembly to protect optics from corrosive stack gases
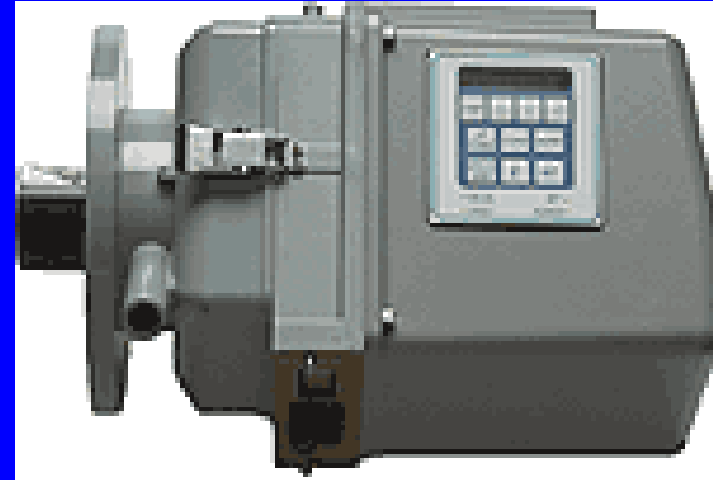
Altech Beta 5M

◆ Beta-Attenuation

◆ Straight-Extractive

◆ Dry or Wet stack applications

◆ Batch Samples

◆ PM readings every 8-minutes

◆ Maintains isokinectic sample rate

◆ Equipped to measure stack flow directly

◆ Must perform daily & quarterly sample volume audits

Alternative Correlation Procedures

Correlation of PM CEMS

◆ PS-11 Requirements

- Vary PM loading (i.e., concentration) @ sample location

- Difficult to vary PM loading on baghouse or wet scrubber units

- Best correlations have data collected at or near the emission standard

- Allows the use of zero or out-of-stack measurements

  » Need multiple zero runs (i.e., ≥ 3) to give the points statistical weight in the correlation calculations
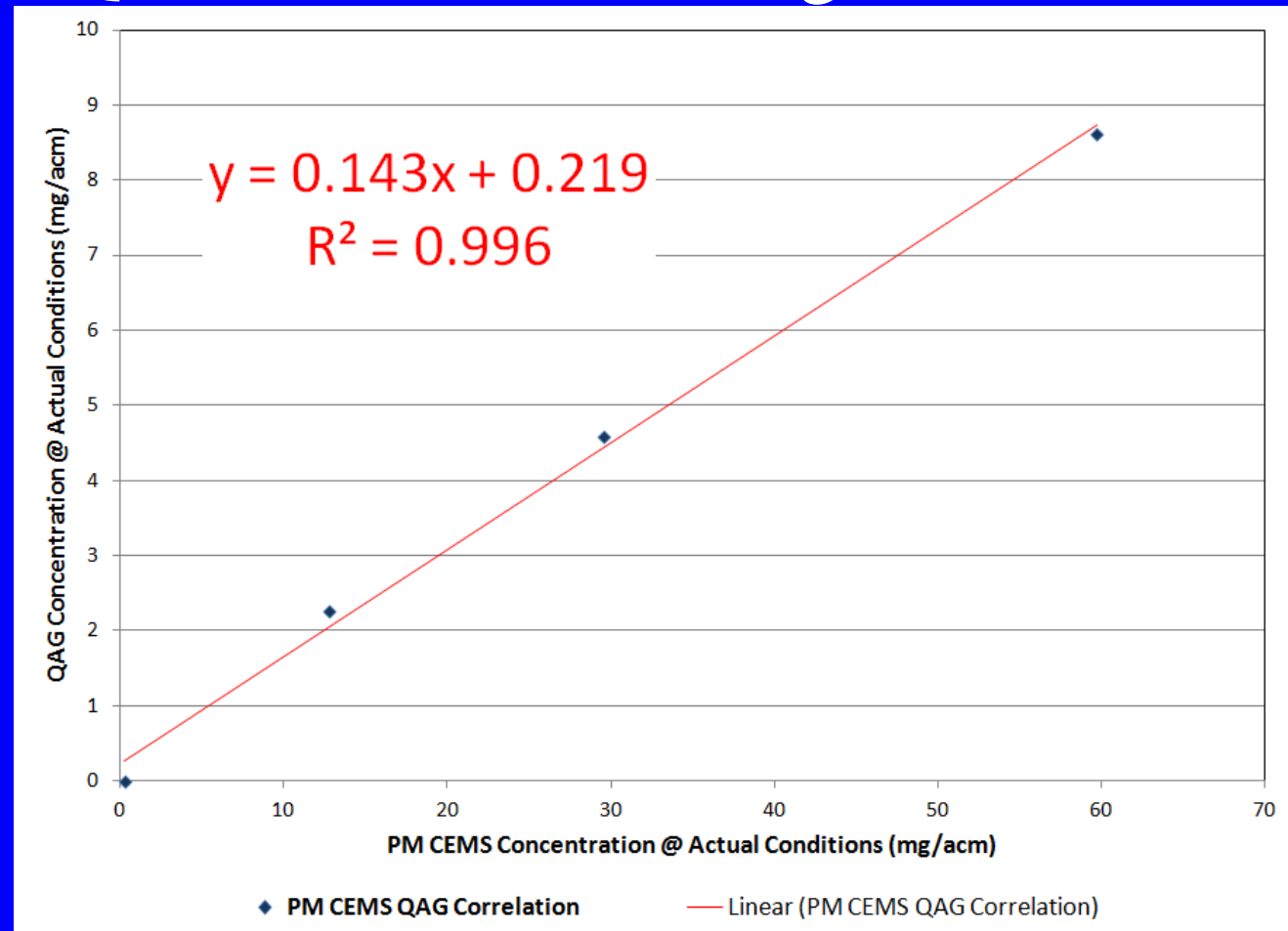
Correlation of PM CEMS

◆ Ash Reinjection

- Taking collected ash from the unit and injecting it back into the sample stream downstream of the last pollution control device

- Has been attempted at several units

- Does this represent normal operating conditions?

◆ Quantative Aersol Generator (QAG)

- Provides NIST traceable PM concentrations

- Does a QAG correlation yield comparable PS-11 correlations?

Correlation of PM CEMS

◆ Example QAG Correlation – Light-Scatter Device:

$$y = 0.143x + 0.219$$
$$R^2 = 0.996$$

Chart: QAG Concentration @ Actual Conditions (mg/acm) vs. PM CEMS Concentration @ Actual Conditions (mg/acm)

Legend: ◆ PM CEMS QAG Correlation — Linear (PM CEMS QAG Correlation)

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Correlation of PM CEMS

◆ PS-11 Correlation for same Light-Scatter Device:

PS-11 PM CEMS Correlation Test Summary - Linear Model

$y = 1.9844x + 0.0665$
$R^2 = 0.8641$

- Correlation Data
- Upper Tolerance Interval
- Lower Confidence Interval
- Lower Tolerance Interval
- Upper Confidence Interval
- Linear (Correlation Data)
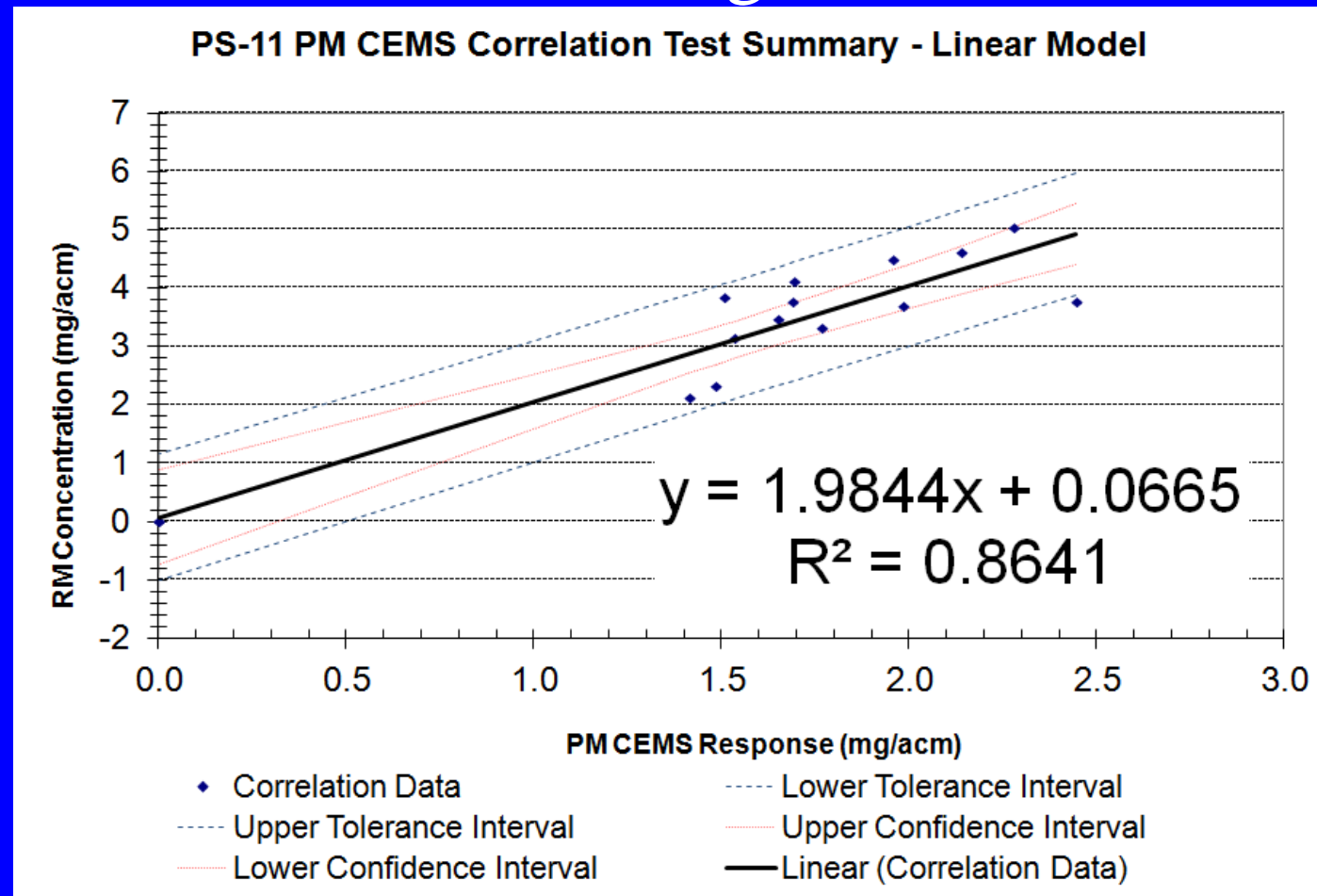
QAG Correlation Applications

◆ How can a QAG correlation be applicable?

- Used to demonstrate linear response of the detector over a wide range of PM Concentrations
  » Performed by manufacturer
- Apply site specific "Correction" factor to PM CEMS
  » Similar to Part 75 flow rate monitors
- Change PS-11 specifications from correlation to RATA.
  » 20 % RA or ±25% of applicable emission standard