Reinhold Environmental Ltd.

2008 APC Round Table & Expo Presentation

July 13-15, 2008, in Savannah, GA

Continuous Particulate Mass Monitors for Wet Stacks

Reinhold

ACP Roundtable

July 15, 2008

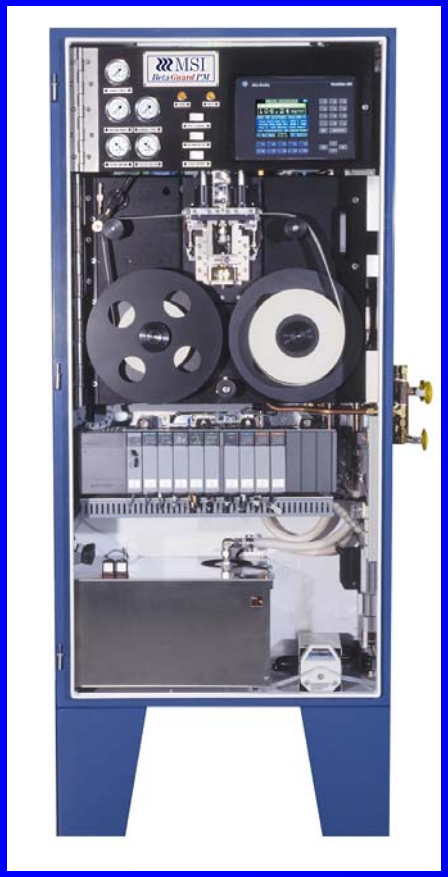
Craig Clapsaddle

MSI/Mechanical Systems, Inc.

Commercially Available Monitors

Extractive Beta Gauge

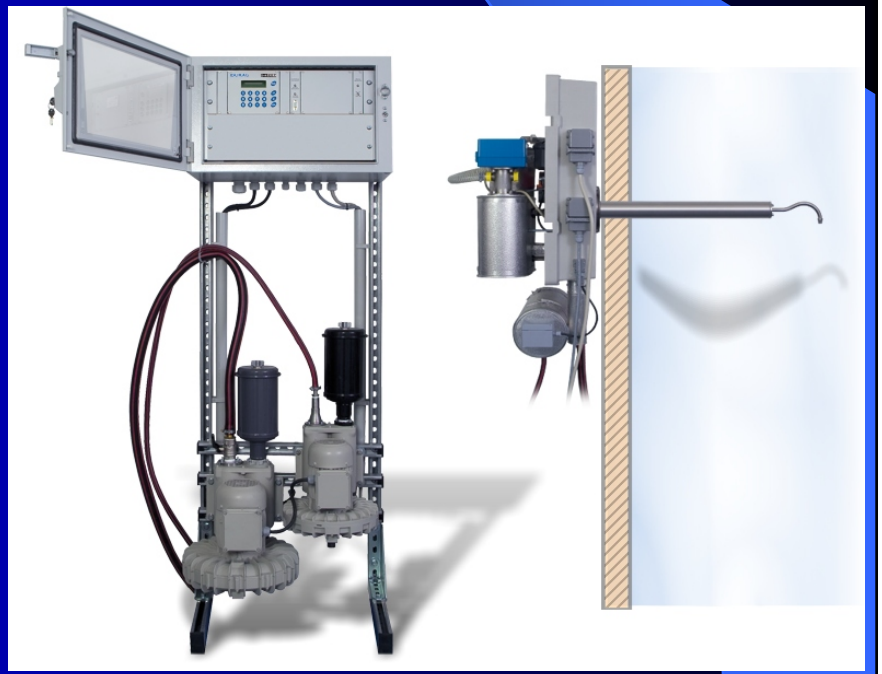
MSI BetaGuard PM



Extractive Light Scatter

Sick Miahak FWE200

Durag D-R 820f



Why Use a PM Monitor?

- Permit requirement
- Consent decree requirement
- Superior monitoring vs. parameter monitoring
  - Revised NSPS; Subparts D, Da
- Using surrogates such as opacity is becoming more difficult, less accurate, and an **operational problem**
- To take credit for added PM removal by wet FGD
  - Showing 60 – 95% PM removal, PM Emissions < 20% of limit
  - Eliminate 6-min opacity monitoring, get a 24-hr PM average interval
- To blend coals your boiler & ESP were not designed for w/o building a bigger ESP box

What Rules Do You Follow?

- PS-11 governs your PM CEMS installation, certification and initial QA/QC
  - Section 2.0 gives basic requirements overview
    - Type of PM CEM
    - Where to install probe
    - Initial certification testing
  - Section 6.0 gives equipment specifications
    - Isokinetic sampling
    - Drift checks
    - Measurement range
  - Section 7.0 gives drift check specifications

More On PS-11

- Section 8.0 details performance specifications
  - How to select and set up your PM CEMS
  - Where to install the probe
  - Pre-correlation test steps
  - Exactly how to conduct the correlation test
  - How to handle the correlation data
  - Limitations on effective range of your correlation
- Section 9.0 points to Procedure 2 for future QA/QC requirements

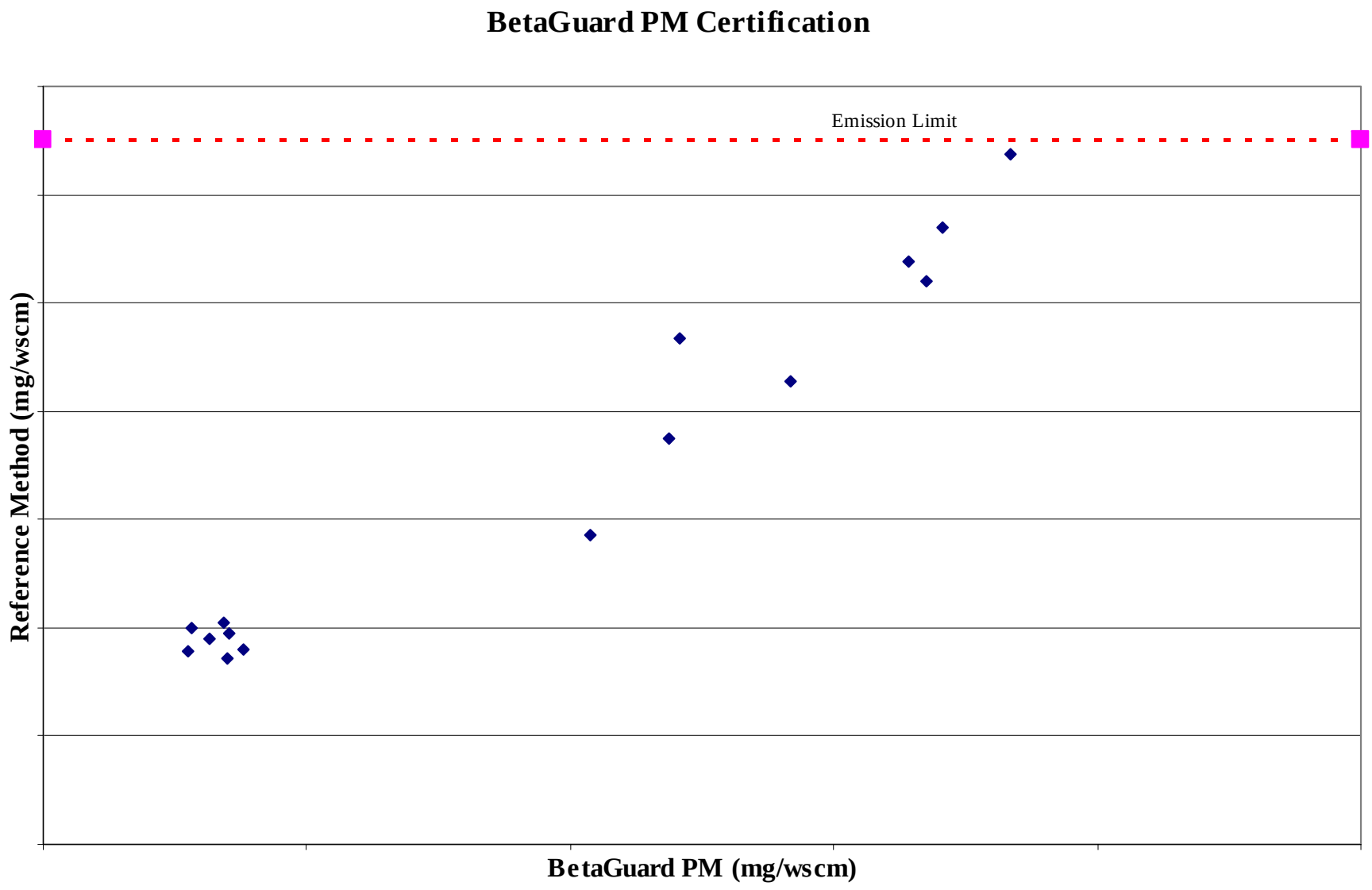
More on PS-11

- Section 12.0 shows all the calculations
  - Drift check
  - Correlation regression analysis
  - Which correlation model to use
- Section 13.0 gives performance criteria
  - For 7-day drift check
  - For your PM CEMS correlation acceptability

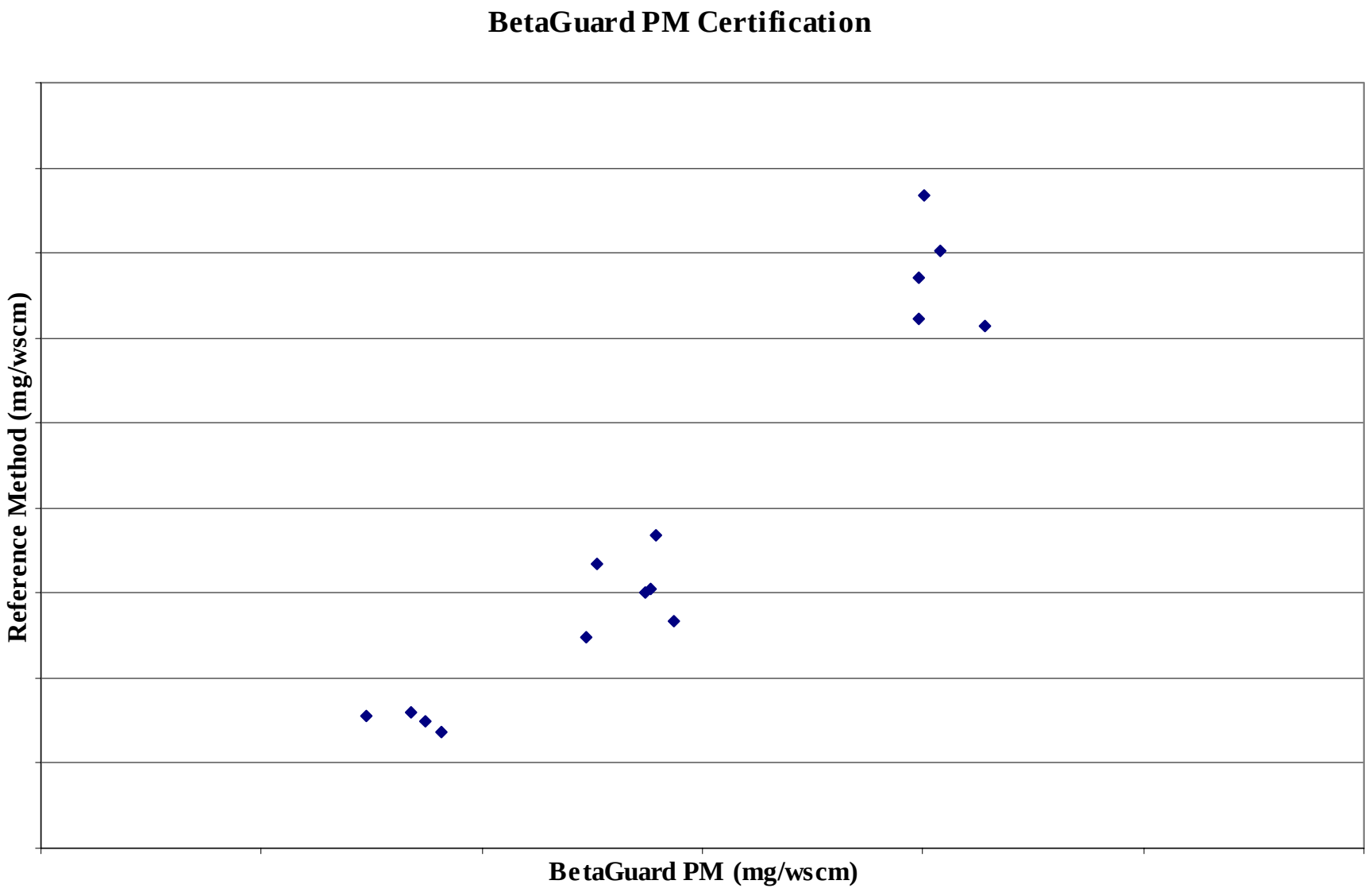
PS-11 Correlation Test

- Requires 15 data points over a wide range of PM concentrations – can discard up to 5 test runs
  - Need at least 3 PM levels
  - Need at least 20% of data points in each PM level
- Obtaining different PM concentrations after a wet scrubber is difficult but not impossible
  - Use different fuels or fuel blends
  - Use different unit loads
  - Must detune primary PM control equipment
  - State must allow unit to exceed opacity limit if have duct COMS
  - Pull probe from stack and sample ambient air for zero

Particulate Range Example 1



Particulate Range Example 2



Proper Probe Location

- §2.4(2) of PS-11 – install probe in a location that is most representative of PM emissions as determined by the reference method
- MSI has a testing program to characterize the PM concentration across the stack area
- We use this information to find the location in the stack that is equal to the average stack PM concentration at multiple PM concentration levels
- We build our probe so that the probe nozzle is at the optimal location

What Are The Issues When Monitoring PM in a Wet Stack?

- Moisture and sticky particulate

How do you reduce the effects?

- Use Hastelloy probe in stack
- Keep sample hot from probe tip to measurement (cold spots kill)
- Use dilution if monitor's sampling system has it

What Are The Issues When Monitoring PM in a Wet Stack?

- Limestone carryover in scrubber

What does this do?

- Changes color and composition of particulate

How do you reduce the effects?

- Make sure your PM monitor is immune to effects of particulate color and composition change

What Are The Issues When Monitoring PM in a Wet Stack?

- Mist eliminator malfunction/degradation/pluggage

What does this do?

- Sends “mud” balls and more water droplets up stack

How do you reduce the effects?

- Have some serious blowback pressure
- Pull probe and clean it

What Are The Issues When Monitoring PM in a Wet Stack?

- SO_3 and Hg control additives

What does this do?

- Changes chemical and physical properties of particulate

How do you reduce the effects?

- Test PM monitor under multiple operating scenarios
- Make sure your PM monitor is immune to effects of particulate chemical and physical changes

What Are The Issues When Monitoring PM in a Wet Stack?

- SCR on/off

What does this do?

- When SCR is on, tends to produce more smaller size particles than when SCR is off – small particles can pass through scrubber

How do you reduce the effects?

- Test PM monitor under both operating scenarios
- Choose a PM monitor immune to changing particle size

What Are The Issues When Monitoring PM in a Wet Stack?

- Changes in stack gas velocity

What does this do?

- Requires isokinetic sample gas extraction from stack to maintain consistent PM concentration relationship

How do you reduce the effects?

- Have PM monitor that samples 100% isokinetic
- Prove that non-isokinetic sampling does not bias measurement

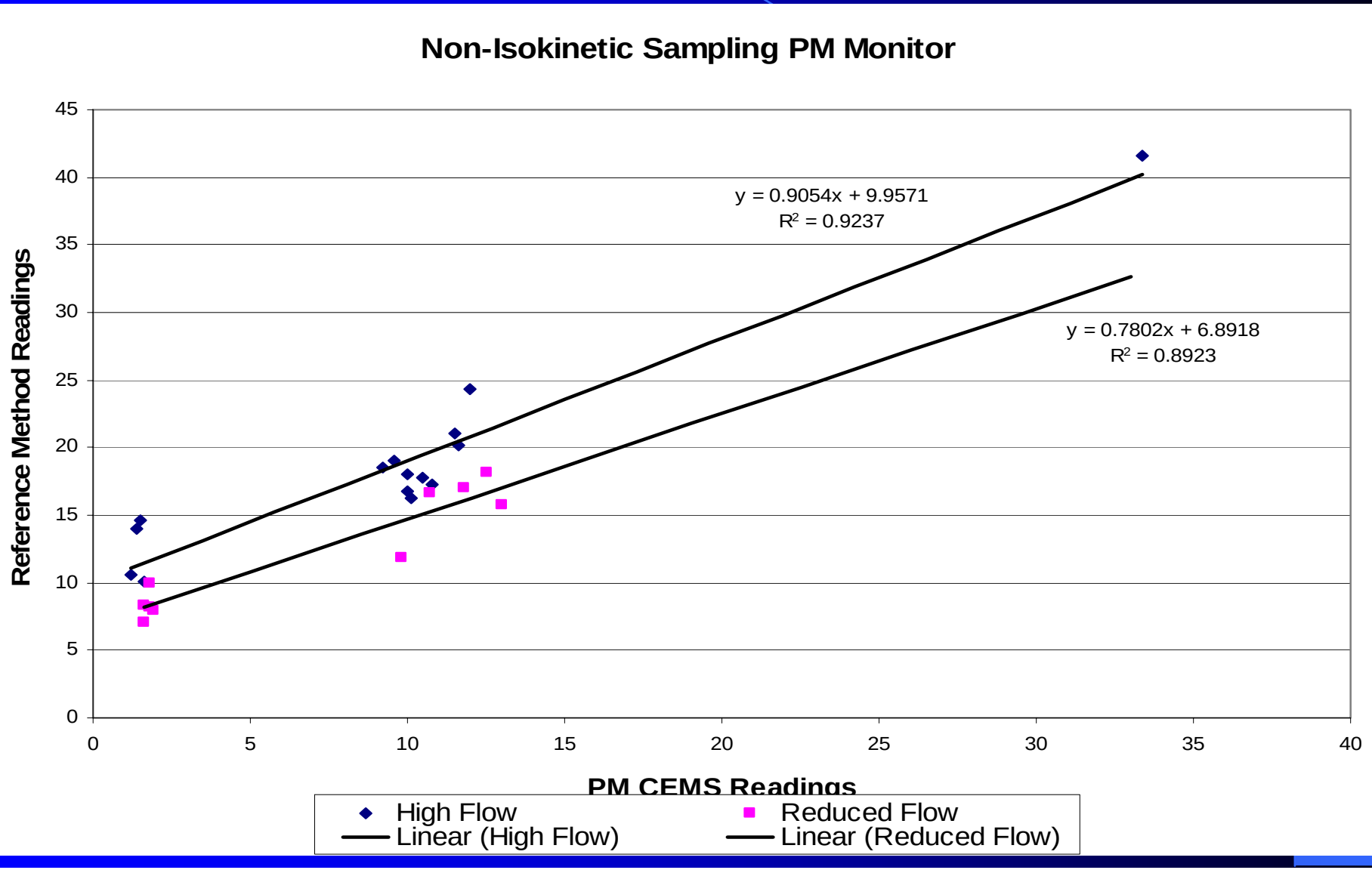
PS-11 & Non-isokinetic Sampling in a Wet Stack

- §6.1(3) of PS-11
  - If your PM CEMS is an extractive type and your source's flue gas volumetric flow rate varies by more than 10% from nominal, your PM CEMS should maintain an isokinetic sampling rate (within 10% of true isokinetic).
  - If your extractive-type PM CEMS does not maintain an isokinetic sampling rate, **you must use actual site-specific data or data from a similar installation** to prove to us, the State and/or local enforcement agency that isokinetic sampling is not necessary.

Interesting Development

- EPA Regions 3 and 5 will not accept approval for non-isokinetic sampling from a similar source
- No State agency we've talked to so far will accept blanket approval for non-isokinetic sampling from a similar source (PA, MD, VA, OH, KY, SC, IN)
- PS-11 gives no guidance on approval testing or acceptance criteria for non-isokinetic sampling
- PA DEP, OH EPA, KY DAQ are requiring extensive site-specific testing at various stack flows and multiple PM concentrations to prove non-isokinetic sampling is acceptable

Example of Non-isokinetic Sampling Bias



MSI BetaGuard PM Non-isokinetic Sampling Bias

Isokinetic Sampling 43.6 fps	PM Concentration **13.42 mg/wscm**
Super-isokinetic Sampling 88.7 fps	PM Concentration **16.17 mg/wscm**
Isokinetic Sampling 47.1 fps	PM Concentration **13.84 mg/wscm**
Sub-isokinetic Sampling 29.9 fps	PM Concentration **12.49 mg/wscm**

What Are The Issues When Monitoring PM in a Wet Stack?

- Proper PM CEMS concentration units

What does this mean?

- At least 2 permits are using PM CEM as follows
  - Total PM10 = PM_{CEM} + CPM – $PM_{>10}$
  - Filter PM10 = PM_{CEM} – $PM_{>10}$

How do you handle this?

- PM CEM must report concentration in same units as condensible PM and $PM_{>10}$ mass fraction from stack test

What Are The Issues When Monitoring PM in a Wet Stack?

- Calculating mass emission rates

How do you do this?

- Calculate lb/mmBtu from corrected hour average

$lb/mmBtu = mg/wscm * 1800 * 6.24x10^{-8} * (100/\%CO_{2w})$

$0.0298 = 30 * 1800 * 6.24x10-8 * 100/11.3$

- PM measurement must be at same conditions as % CO_2 or flow rate for proper emission rate calculation

Variation In PM Emissions

- Have 15 BetaGuards installed
- Have units on bituminous, subbit., lignite coals
  - Not enough units to make specific statements on monitor operation vs. coal type, boiler type, scrubber type, etc
  - Probably need 50 monitors in service to make statements on monitor operation before installation
- Can say PM concentrations are generally lower than expected – 60 to 95% PM removal by scrubber
- **But** PM emissions are more variable than expected
  - Color
  - Concentration

Summary

- Many reasons to use PM CEMS in wet stacks
- Follow PS-11 procedures
- PS-11 correlation test is difficult but not impossible – you must plan
- Wet stack gas presents many challenges for particulate sampling (as well as all monitoring)
- Encourage you to talk to the vendors
  - Choose wisely
  - You get what you pay for

BetaGuard PM Experience at Coal-fired Power Plants with Wet Scrubbers

Tampa Electric

- Big Bend
- Unit 4 Stack
- February 2002

Dominion Generation

- Mt. Storm
- Units 1 & 2 Stack
- July 2004

Western Kentucky Energy

- Henderson Municipal Power & Light
- Unit 2 Stack
- August 2005

We Energies

- Pleasant Prairie Power Plant
- Unit 1 and Unit 2 Stacks
- September 2006

Western Kentucky Energy

- Henderson Municipal Power & Light
- Unit 1 Stack
- February 2007

Minnkota Power Coop.

- M.R. Young Station
- Unit 2 Stack
- July 2007

FirstEnergy

- Bruce Mansfield Plant
- Unit 3: Flue A and Flue B
- June 2008