Assessment of Bias in Measurement of Mercury Emissions from Coal Fired Power Plants – Comparison of Electronic CEMS and Sorbent Traps

Jim Staudt, Ph.D.
For questions: staudt@AndoverTechnology.com
(978) 683-9599

McIlvaine Hot Topic Hour

May 8, 2014

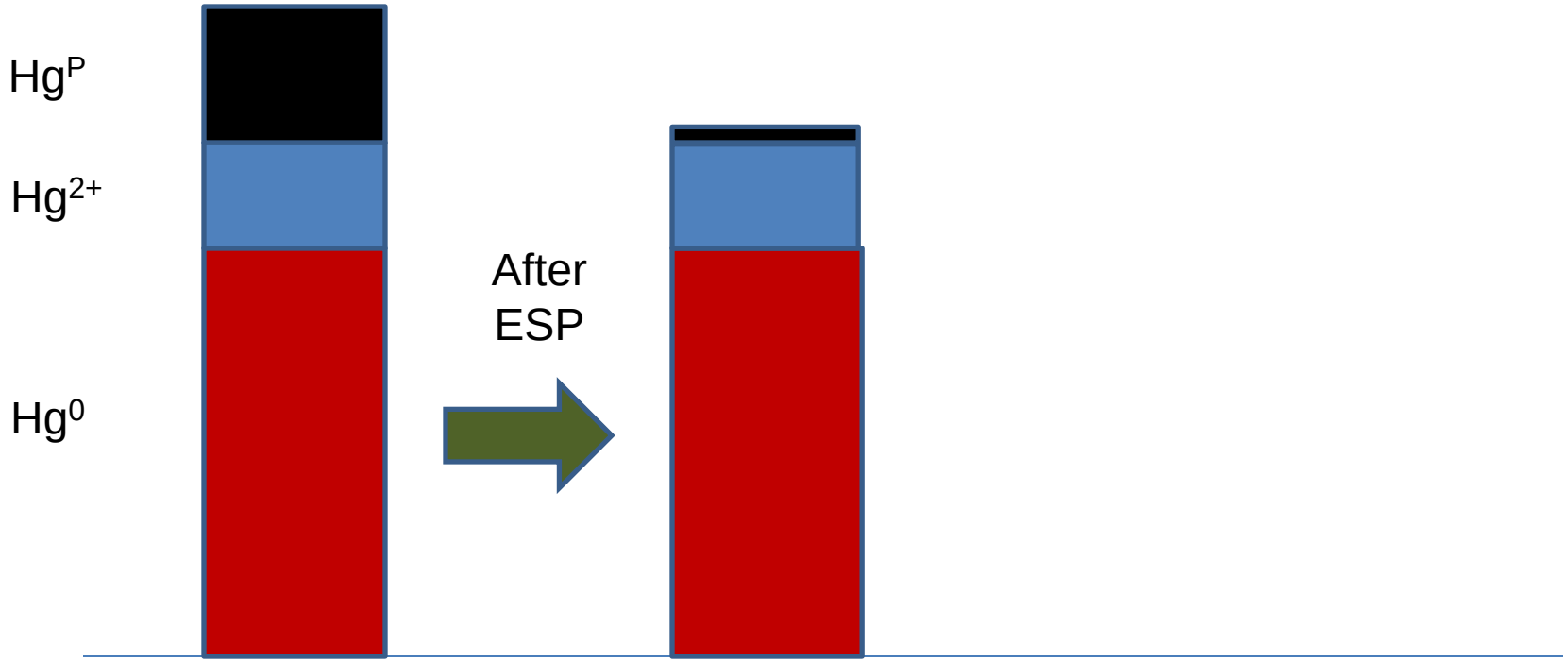
Adapted from IEA MEC Meeting Presentation

What might contribute to differences in Hg measurement in two methods?

- Hg on PM – Hg CEMS don't include Hg^P, but Sorbent Traps do
  - From EPA Method 30B: *"This method is only intended for use only under relatively low particulate conditions (e.g., sampling after all pollution control devices)."* - *30B assumes Hg^P can be neglected*
  - *2001 ICR data showed Hg^P ranging from non-detect to 0.93µg/Nm^3 on uncontrolled units, but typically a small part of total Hg.*
- What about when *high* Br is added to flue gas?
  - URS and EERC have reported some effect
- Random or otherwise unexplained measurement errors
  - Especially important for field measurements!

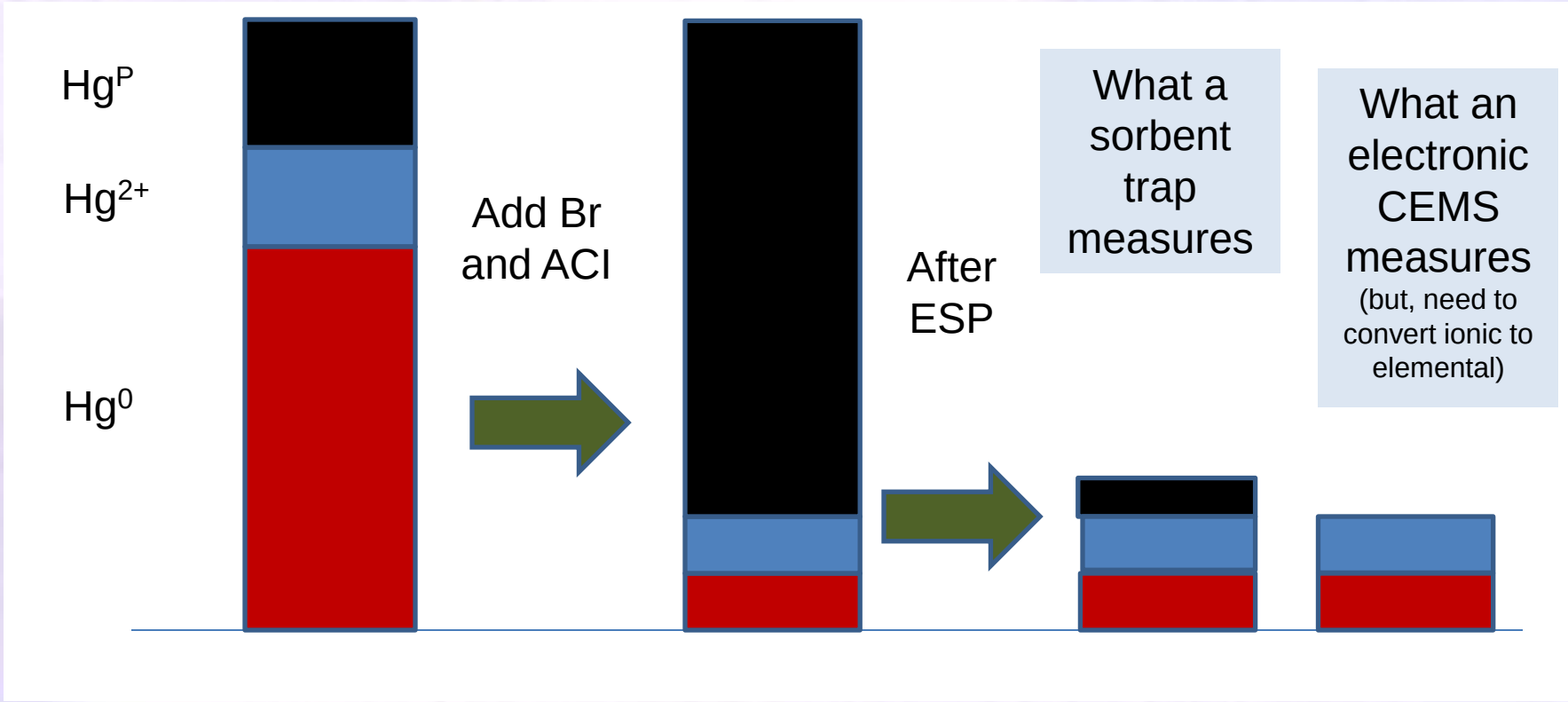
Contribution of Hg^P for Uncontrolled Units

Hg^P is mostly captured in ESP on an uncontrolled unit and is generally a very small part of total Hg



Effect of Controlling Hg on Hg^P

Br helps oxidize Hg^0 making it easier to capture on PM or in a scrubber, ACI captures Hg as Hg^P
- Which increases the Hg content of the fly ash!



Hg concentration on PM

Mercury tends to be on fly ash that is most difficult to capture – more concentrated in small size fraction that escapes PM control device

- from ESP inlet: 1.0925 mg/kg (ppm)
- inside ESP: 0.6615 mg/kg (ppm)
- from ESP outlet: 7.5303 mg/kg (ppm)

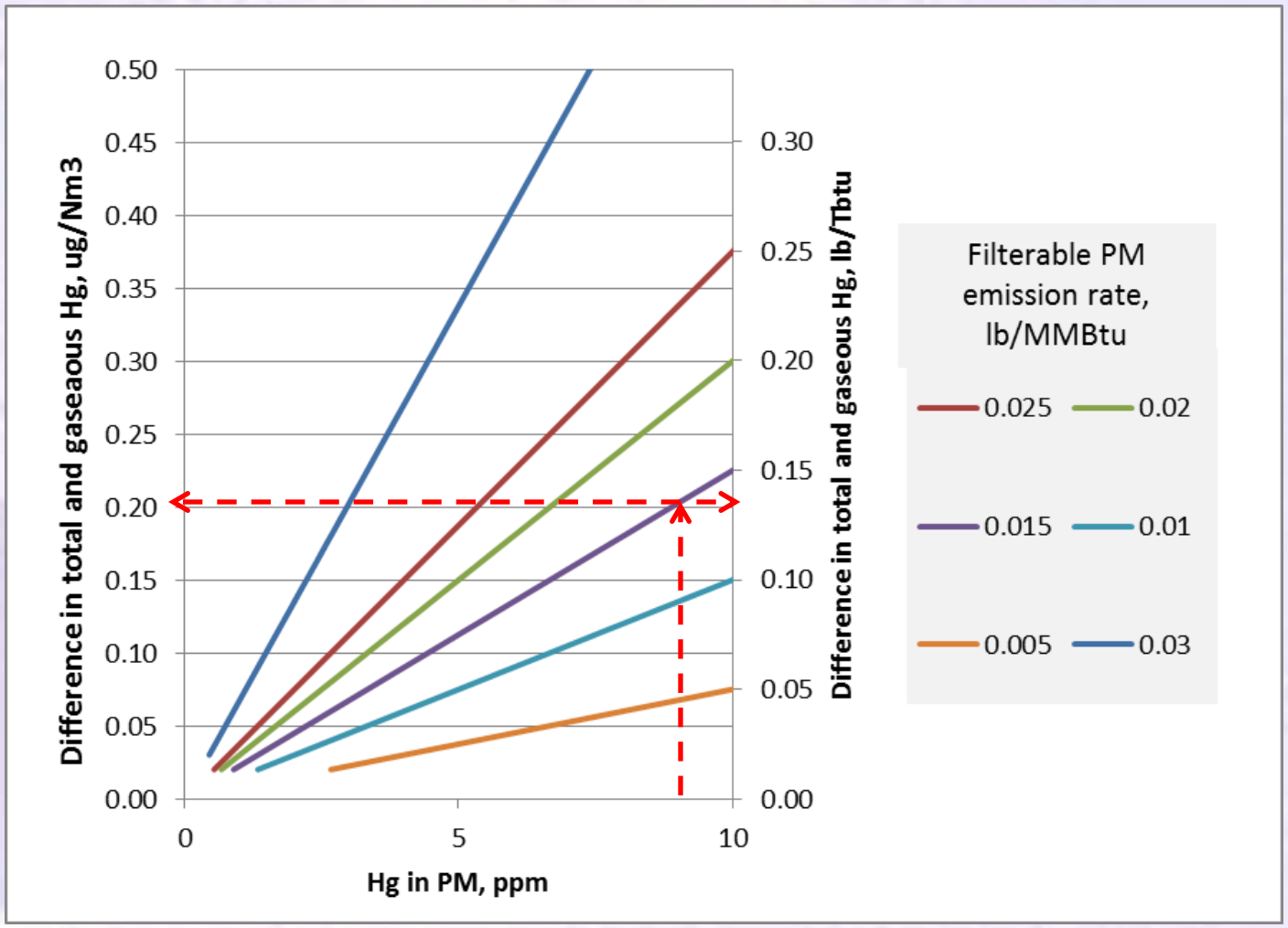
Mercury concentration (mg/kg or ppm) in fly ash particles at ESP outlet

- Higher concentration on smaller particles
- Would expect concentration of Hg in activated carbon to be significantly higher

	Dust diameter (µm)			
Dia. µm	0-3	3-10	10-24	24-45
Hg, mg/kg	9.0827	6.2917	3.6420	1.0657

Jedrusik, M., and Swierczok, A., "The influence of unburned carbon particle on electrostatic precipitator collection efficiency", 13th International Conference on Electrostatics, Journal of Physics: Conference Series 301 (2011) 012009

Hg in PM, PM emission rate and difference in gaseous and total Hg – how they relate



Andover Technology Partners

How could Br impact Hg CEMS?

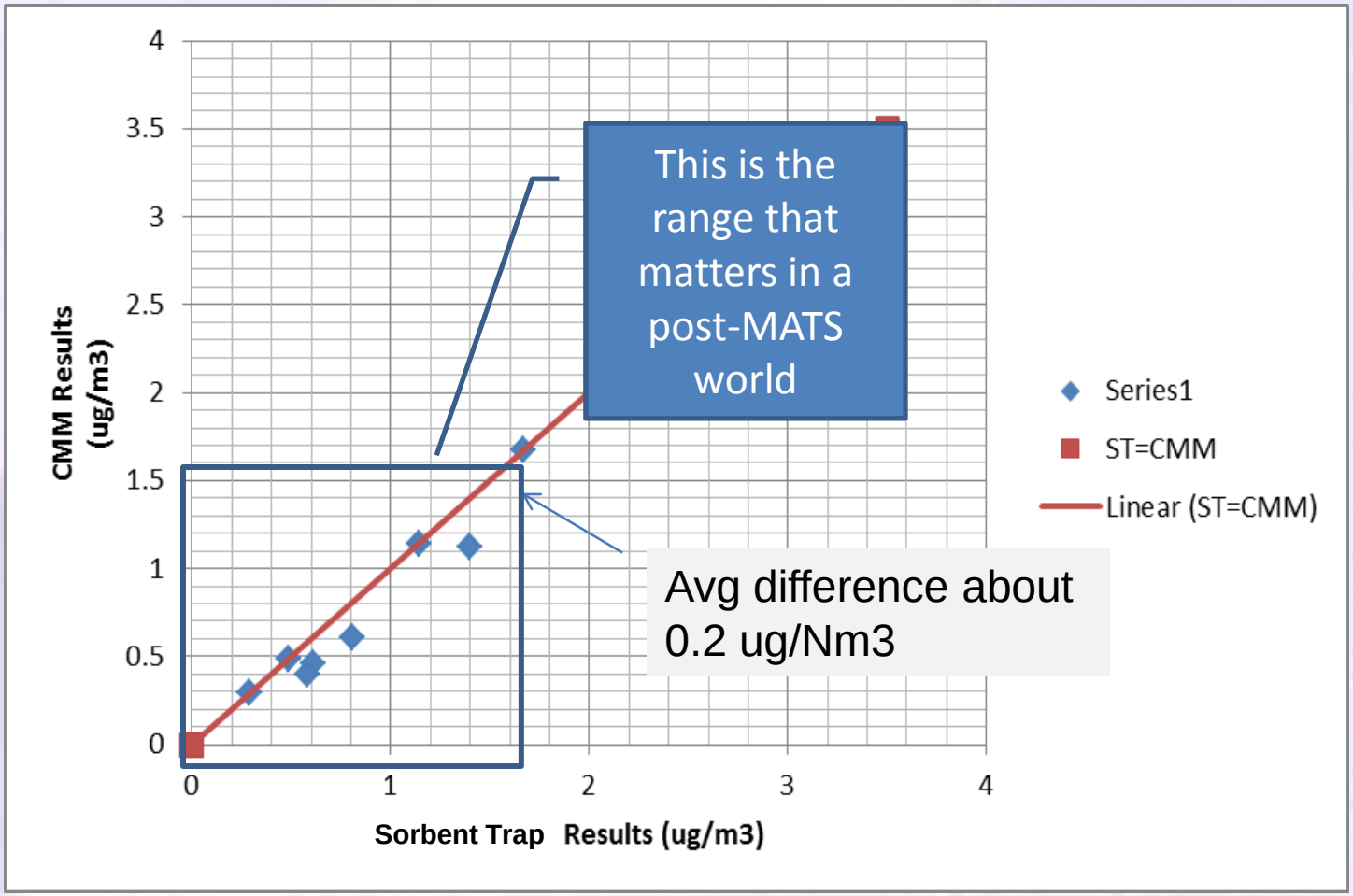
Aside from the Hg^P effect discussed earlier

- Surface reaction on probe filter (stinger) or probe internal surfaces
  - Corrosion, particulate build up, or inadequately coated surfaces
  - If reactive surface is available, the fastest and easiest reaction
- "Interference" with thermal converters?
  - Suggested by some, but thermodynamics suggests otherwise.
- Residual Br after converter and reformation of Hg^{2+} between converter and analyzer
  - Possible, but suppliers take measures to avoid this

Actual Field Data

- Without Br added
- With Br added

Comparison of Tekran Continuous Mercury Monitor (CMM) versus Sorbent Trap from Coal Power Plant RATAs (no bromine added)



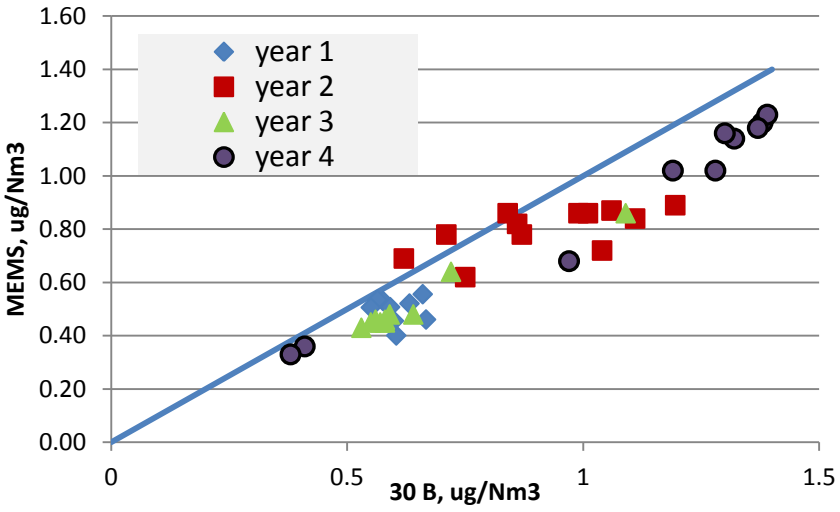
Andover Technology Partners

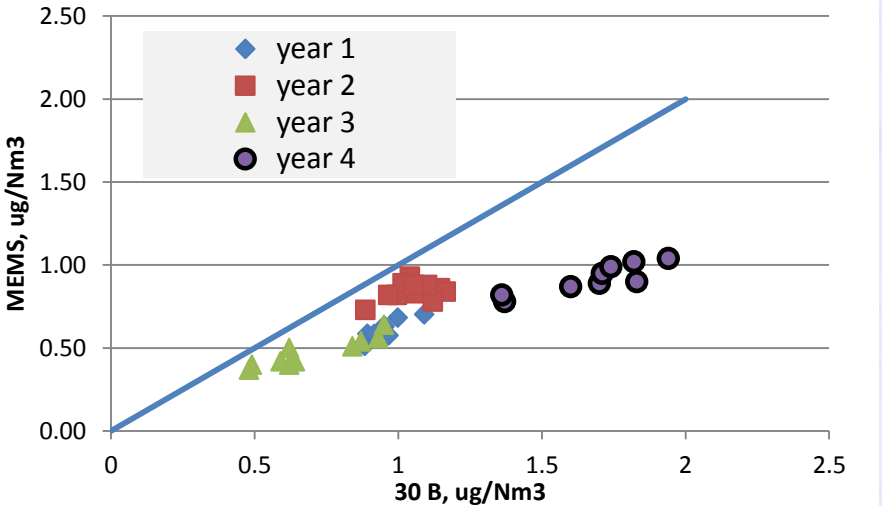
Data from four units over four years, with Br added

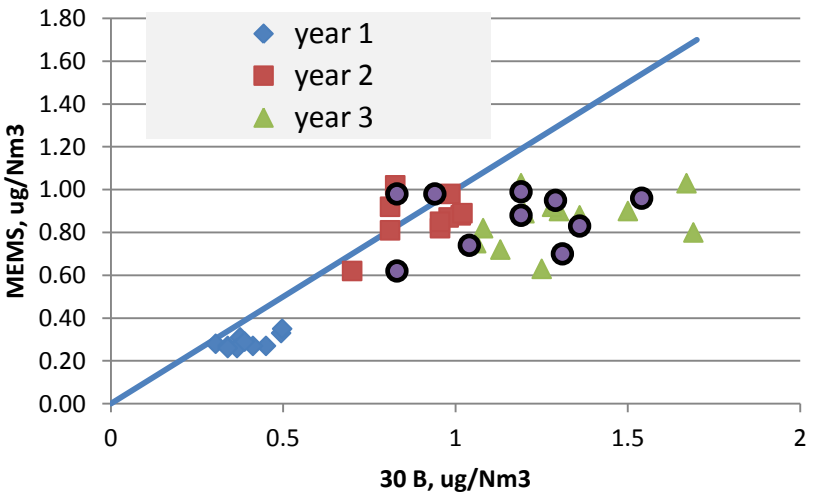
- Annual RATAs over a four-year period
  - Tekran Hg CEMS
  - Method 30 B reference method
- Units use wet scrubber for PM & SO_2 control
- Use ACI and also add bromine for Hg control
  - Have varied bromine injection rate (but don't have data on ACI rates)
  - Due to proprietary nature of additive, bromine vapor concentrations are not known. Results shown for bromine rates are normalized based upon rate of injection.
  - Don't know if any HBr makes it past the wet scrubber!

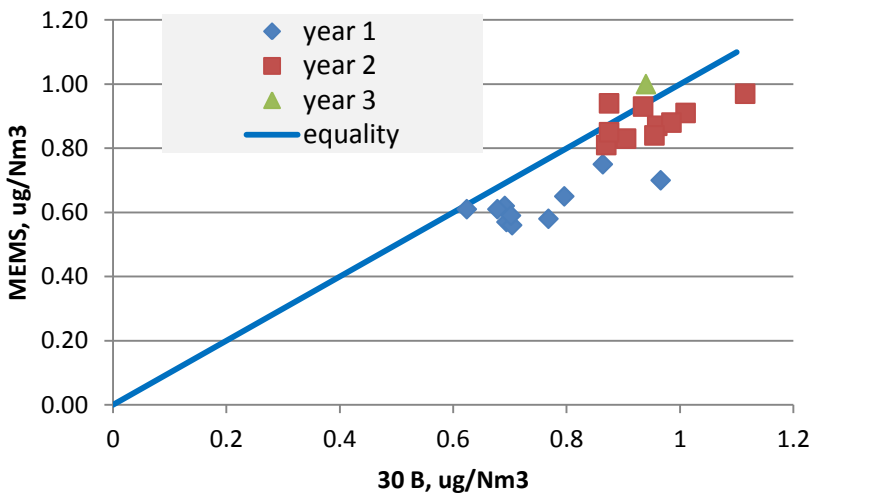
Results four units, four years

comparison of CEMS to 30B, Br addition varied each year



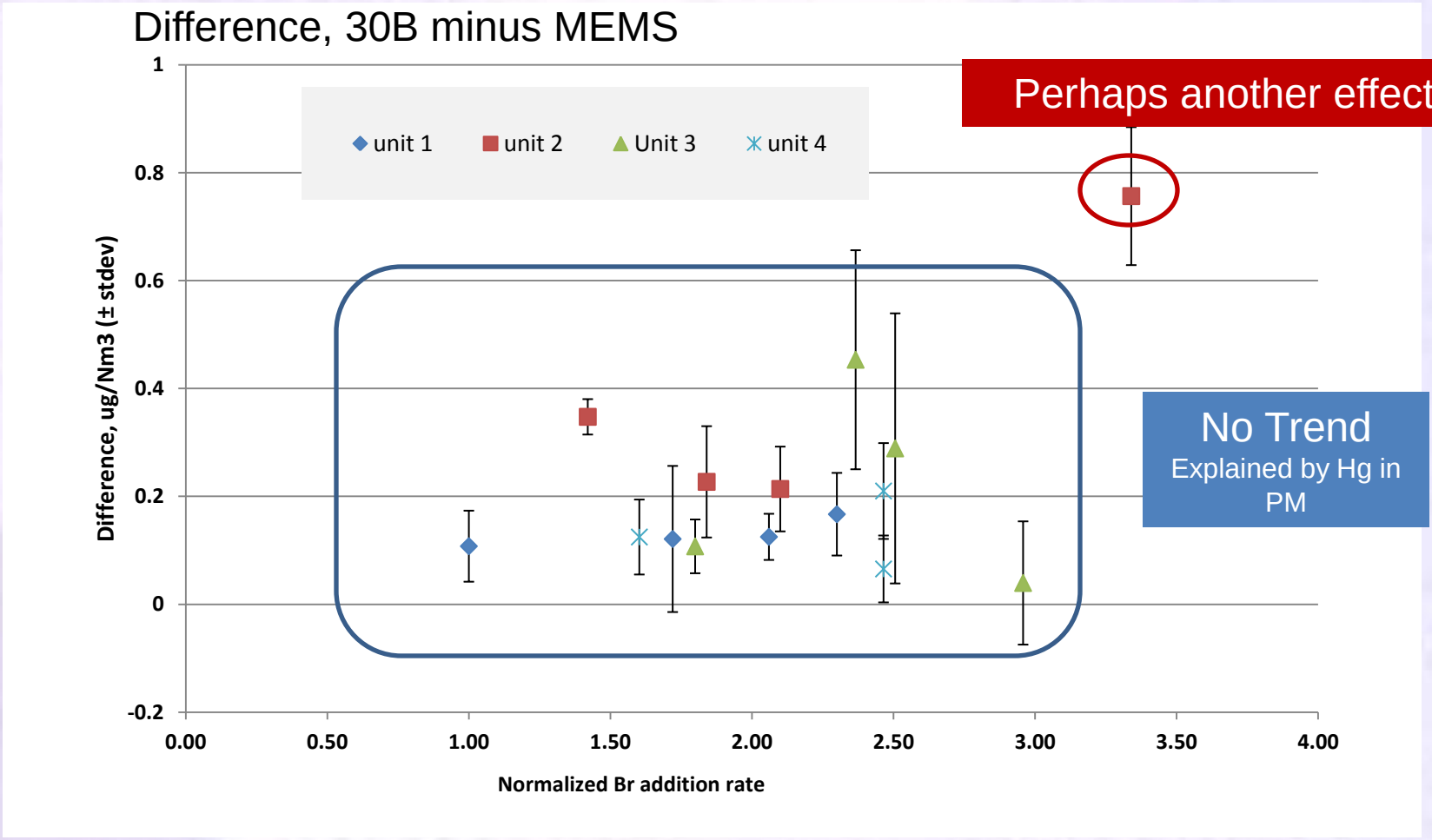






Andover Technology Partners

Effect of Bromine Addition
(stdev shown)



Andover Technology Partners

What does this data tell us?

- Differences in measurement are clearly explainable by Hg^P for all RATAs with one *possible* exception
- That one RATA at highest Br rate suggests *possible* effect of Br, but . . .
  - These were not well-controlled experiments. There could be something else going on, such as higher PM emissions.
  - *How much HBr makes it past a wet scrubber*? If there was little HBr there, it was due to other effects.
  - Might be increased Hg^P conversion
  - Could be other effects not explored here

Summary

- For controlled units ***expect*** some difference between electronic CEMS and Sorbent Traps due to effect of Hg^P
  - This effect can be significant at MATS compliance levels
  - Br addition or ACI should increase this effect
- Brominated PAC does not appear to impact electronic CEMS
- At most bromine addition rates, no impact observed
  - Difference can be explained by Hg^P
- At sufficiently "high" bromine addition rates, difference *may* increase
  - Impact was not enough to affect RATA

Practical Implications

- Method 30B includes Hg^P, which results in overestimation of gaseous Hg that *may* be significant at MATS Hg levels
  - But not enough to impact RATA pass or fail
- Differences in Hg^T up to about 0.50 ug/Nm3 (typically less, but sometimes more) may be explained by Hg^P when controlling Hg with ACI and/or Br
  - Will vary somewhat by coal Hg levels, PM emissions, ACI injection, etc.
- Bromine "interference" should not be a concern except *possibly* under extremely high furnace Br injection rates and is not a concern for brominated activated carbon
- With field measurements there are many other variables at play that could explain differences.

- Full paper is available at McIlvaine web site or at Andover Technology Partners web site
- Contact info
  - staudt@AndoverTechnology.com
  - (978) 683-9599 (office)
  - (978) 884-5510 (mobile)
  - Website: www.AndoverTechnology.com