Reinhold Environmental Ltd.

2007 APC Round Table & Expo Presentation

July 8-10, 2007
Chattanooga, TN
Hosted by TVA

Mercury CEMs

Reinhold APC Roundtable

July 9, 2007

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WE Energies

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Mercury CEM: Workshop Overview

- Installation
- Operation
  - Quality Assurance Requirements
  - Performance
- Relative Accuracy Testing
  - Ontario Hydro
  - Sorbent Traps
  - Instrumental Reference Method

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ADA-ES, WE Energies and Mercury CEMs

- WE Energies was awarded a Clean Coal Power Initiative (CCPI) through DOE NETL for installation of Toxecon at Presque Isle Power Plant in 2003
- Key task: advance the mercury CEM state-of-the art. Significant fast-track improvements to the Thermo mercury CEM were made possible through field testing support from ADA-ES and this program from 2003 through 2007
- In 2006-2007, ADA-ES developed a portable system for use as an Instrumental Reference Method with CCPI funding in response to industry needs

Early Mercury CEM Installation Presque Isle Power Plant

- First Commercial Hg Control System
- $50 Million program funded by We Energies and DOE
- Units 7 – 9 (270) MW on PRB Coal
- System designed for 90% Hg control

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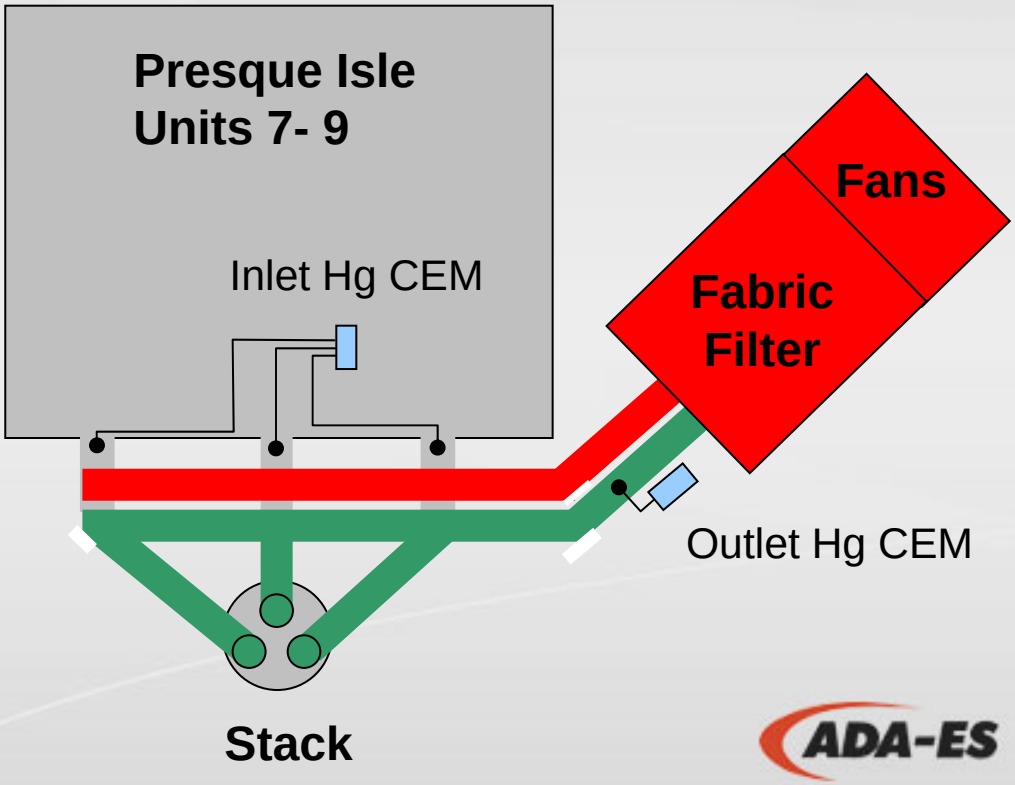
Presque Isle Power Plant (PIPP)



“Outlet” Installation

- Integrated with CEM DAS and Plant DCS

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Installation Lessons

- The Hg probes can be heavy. Both the probes your system will use and the probes for the stack testers. Provide some means of to help support the weight of these probes.
- The heaters these probes use are energy hogs, so make sure you have plenty of power available.

Installation Lessons (continued)

- Installing heated sample lines can be a little tricky – don't damage them during installation.
- The heaters these sample lines use consume a lot of power, so make sure you have plenty of power available so that you don't have cold spots.

Installation Lessons (continued)

- Try to select a sampling location that provides easy access to the probe so you can work on it in place.
- It's unlikely that you are going to remove these probes and bring them down to work on them. Think ahead about working on them in the stack or near by.

Integration of CEM into DAHS and DCS

- Hg CEM monitored and externally controlled for "compliance-like" CEM DAHS interface
  - Alarms reported to DAHS
    - General, Critical
  - Calibration conditions reported to DAHS
    - Analyzer zero, analyzer cal, orifice zero or blowback, orifice cal, filter zero or blowback, filter cal
  - Plans for additional controls to accommodate 90+% expected Hg removal across FF
    - High and low range Hg concentration
    - Initiate low, mid and high span gas range
- Hg CEM monitored by DCS to allow feedback control of PAC injection

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CEM Quality Assurance Procedures

- Procedures outlined in 40 CFR Part 75.20 and 75.21.
  - Appendix A details the certification requirements for installation of a mercury monitor
  - Appendix B outlines the on-going quality assurance/quality control (QA/QC) procedures

CEM Performance Requirements

Performance Tests	Certification Limits	QA/QC Limits – Post Certification
Calibration Error Test	7-Day, no adjustments CE ≤5.0% of Span OR |R-A| ≤ 1.0 μg/m^3	Daily CE ≤5.0% of Span OR |R-A| ≤1.0 μg/m^3
Linearity Test 3 points	Error in Linearity (LE) ≤10% OR |R-A| ≤1.0 μg/m^3	Quarterly LE ≤10% OR |R-A| ≤1.0 μg/m^3
Cycle Time Test	Longest phase not >15 minutes	Not required.
System Integrity Test ($HgCl_2$)	3 levels, Average value at each concentration ≤5.0% of Span	Weekly – 1 level, Average value at each concentration ≤5.0% of Span

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Certifying the Calibration Source

- Calibrators pending certification by NIST
- Other recommended checks
  - Annual:
    - Calibrate mass flow controllers
    - Calibrate thermistor
    - Check output against “standard”
      - Compare CEM response of fully tested gas generator and gas generator on-site
      - Use sorbent trap to capture output mercury, analyze for accuracy

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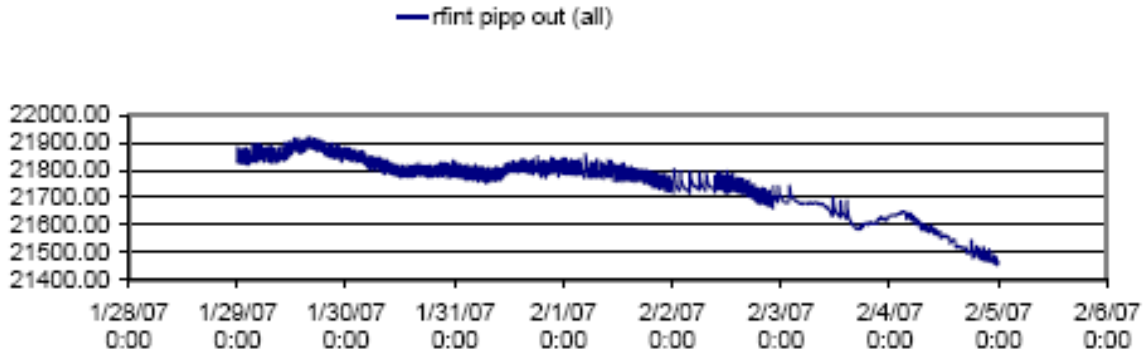
ADA-ES Weekly Maintenance Reports

CHAMBER LAMP INTENSITY



DATA	AVERAGE	RANGE	STDEV
rfint	21744.16	21453 / 21920	105.15

lamp intensity not below 20000 Hz

chamber lamp intensity degradation typical

lamp intensity close to 20000 Hz limit

recommend replacement

17 Operating Parameters Monitored

CEM Operation

- Components and Software are still improving
  - Thermo beginning to ship “upgrade kits” this month
- Systems are fairly reliable, once up and running

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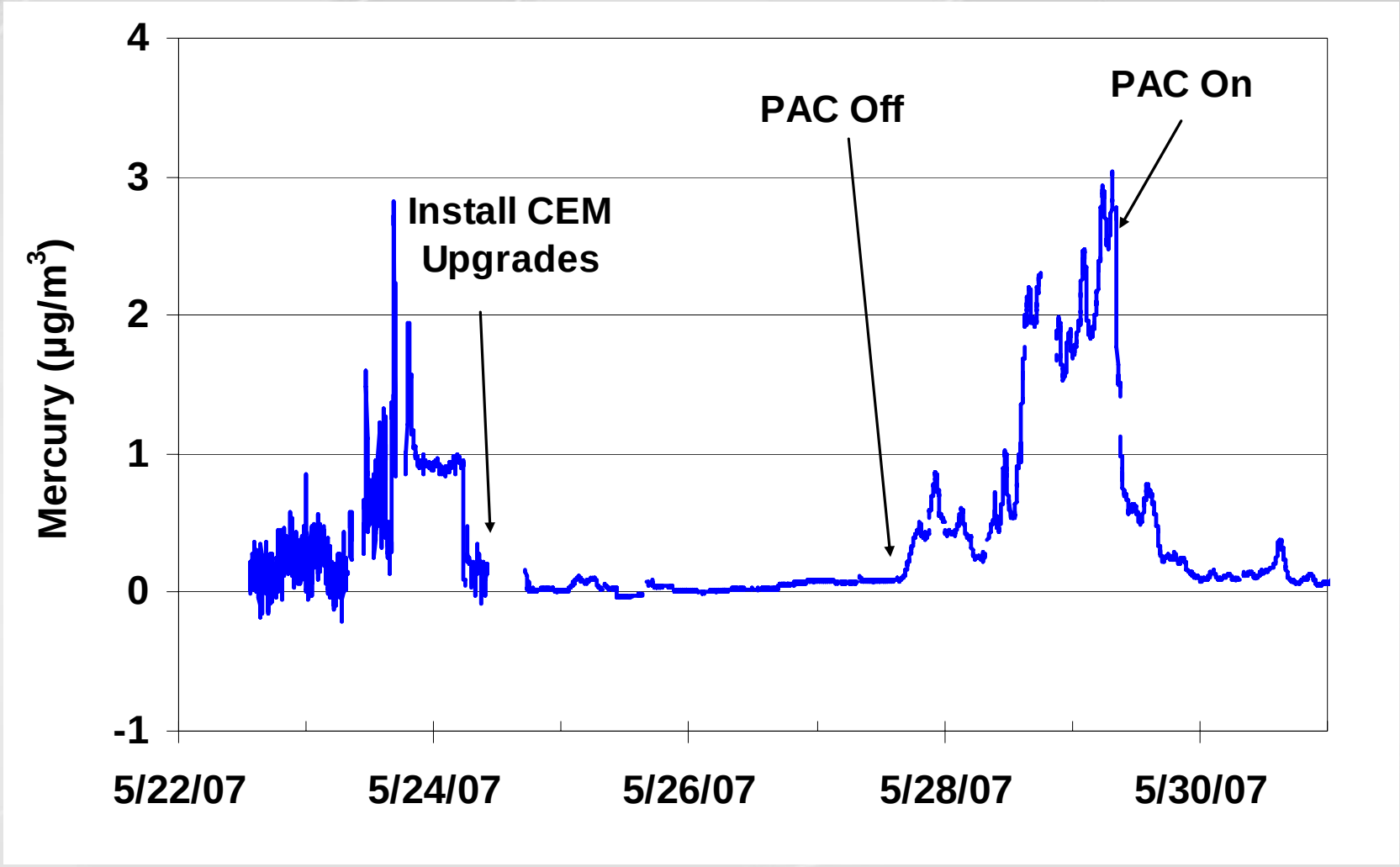
CEM Upgrades



Operating Issues ?

- We are very early in the learning curve. We're having flash backs to 1993 for performing RATAs on flow monitors.
- Wet stacks will be a challenge.
- High particulate loading locations will be another challenge.
- System Integrity checks need to be addressed.
- We need time and experience in operating these systems to understand their long term performance achievements and problems.

RATA Testing

RATA Requirements

- Hg CEMS and sorbent trap monitoring systems will need RATAs in 2008 to meet 1/1/09 deadline
- Many utilities are also planning preliminary RATAs this year (2007)

RA $\leq$20.0% OR 1.0 µg/m^3 if average <5 µg/m^3

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RATA Options

- Current Method:
  - –Ontario Hydro
    - Turn around time: several hours (on-site analysis) to several days or weeks
- Alternative Methods
  - –Sorbent Trap (EPA Draft M30B)
    - Turn around time: several hours (on-site sorbent trap analysis)
  - –Instrumental Reference Method (IRM) (EPA Draft M30A)
    - Real Time

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Status of Alternative RATA Methods

- Conceptual IRM posted on EPA EMC website in February 2006 (www.epa.gov/ttn/emc)
- Draft M30A and Draft M30B were issued in June 2007 http://www.epa.gov/ttn/emc/prelim.html)

- EPA is finalizing direct rule package for alternative reference methods
  - Rule is expected to be signed in early August and published in the Federal Register in late August
  - Rule would become final in October if no adverse comments are received

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Instrumental Reference Method

- Consistent with SOx and NOx IRM
  - Real-Time
  - Performance Based

IRM Performance Requirements

- 3-Point System Hg(0) Calibration Error Test
- 2-Point System Integrity Check using Hg(+2)
- Measurement System Response Time Test
- Dynamic Spiking Test (required 1/1/09)
  - Spike with Hg(+2) span gas will be added at a volumetric flow rate of ≤20%
- Traversing (required 1/1/09)
  When might it be necessary?
  - ESP installations with activated carbon injection

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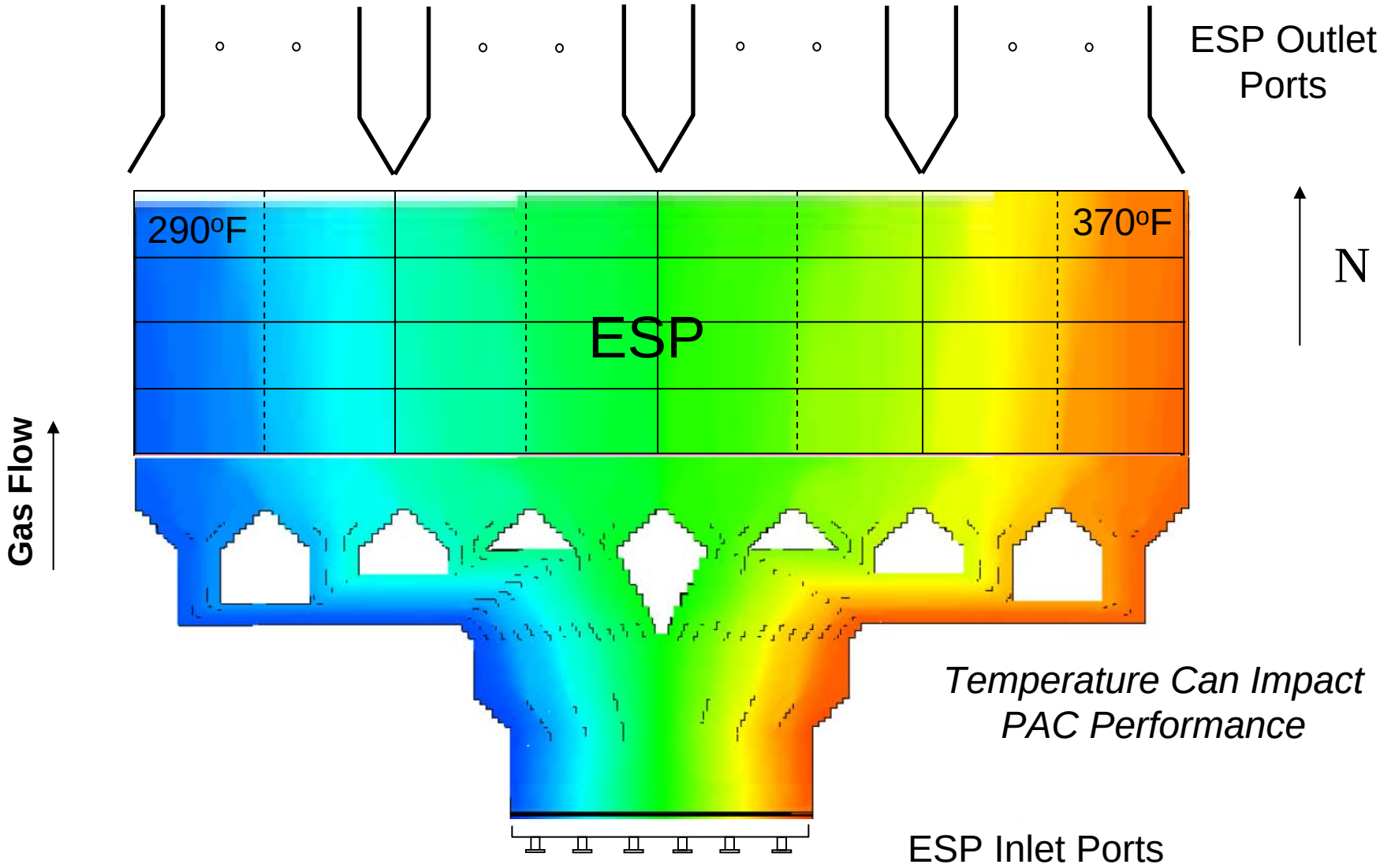
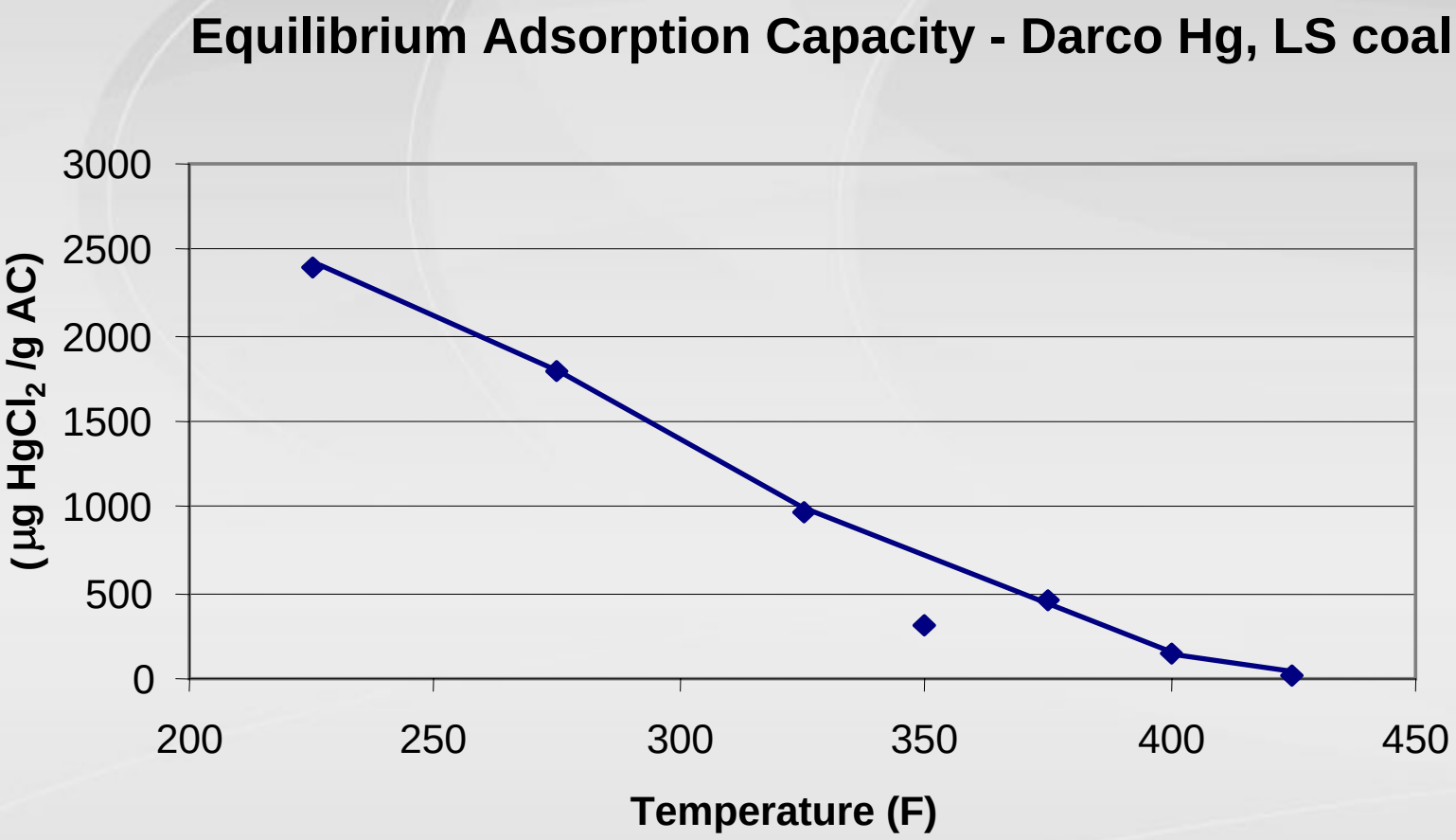
Sorbent Distribution and Mercury Stratification

Are single point measurements okay?

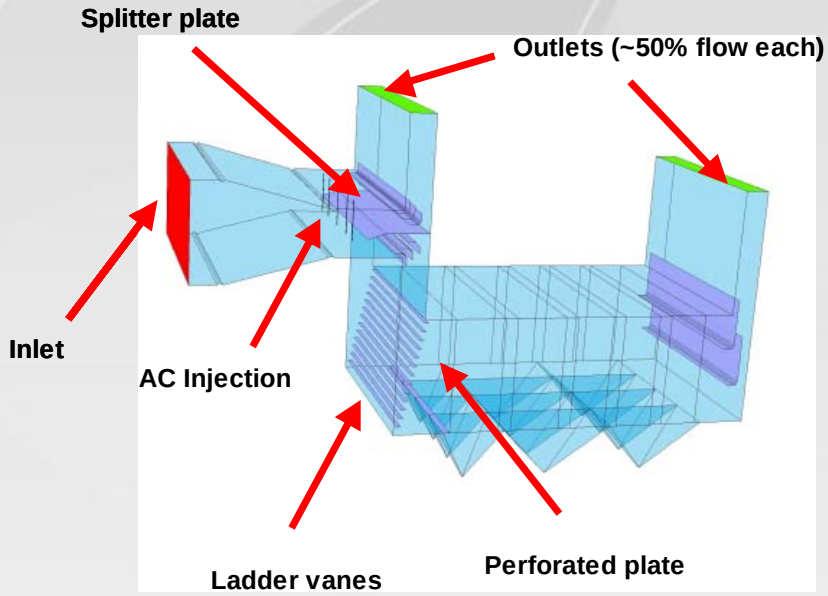
Conesville ESP: Temperature Stratification



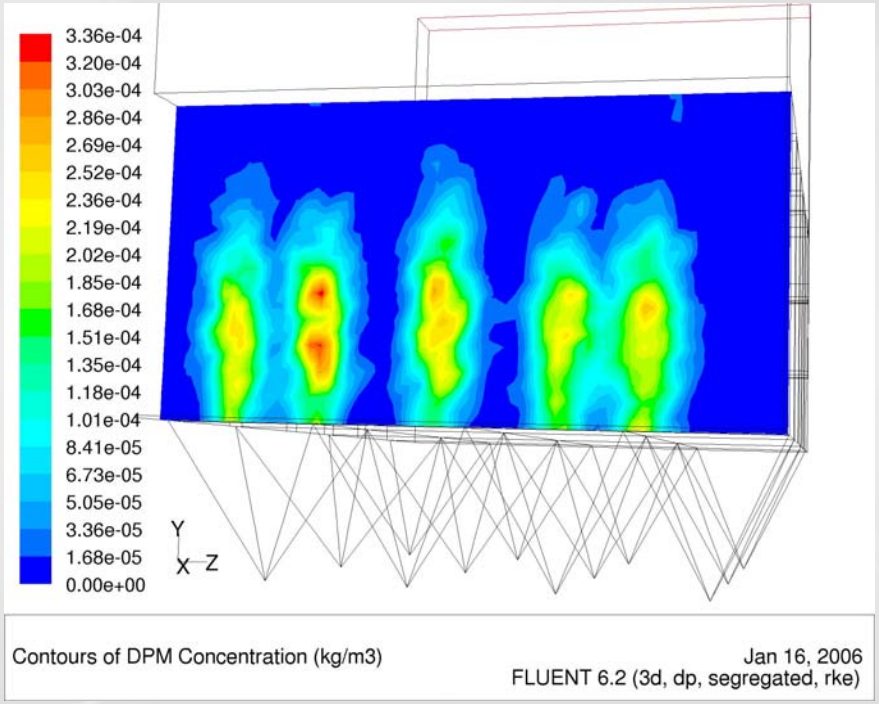
Adsorption Capacity vs. Temperature



CFD Modeling of Injection (Monroe)



Predicted Sorbent Mass Distribution at ESP Inlet



Model predicts non-uniform mass distribution

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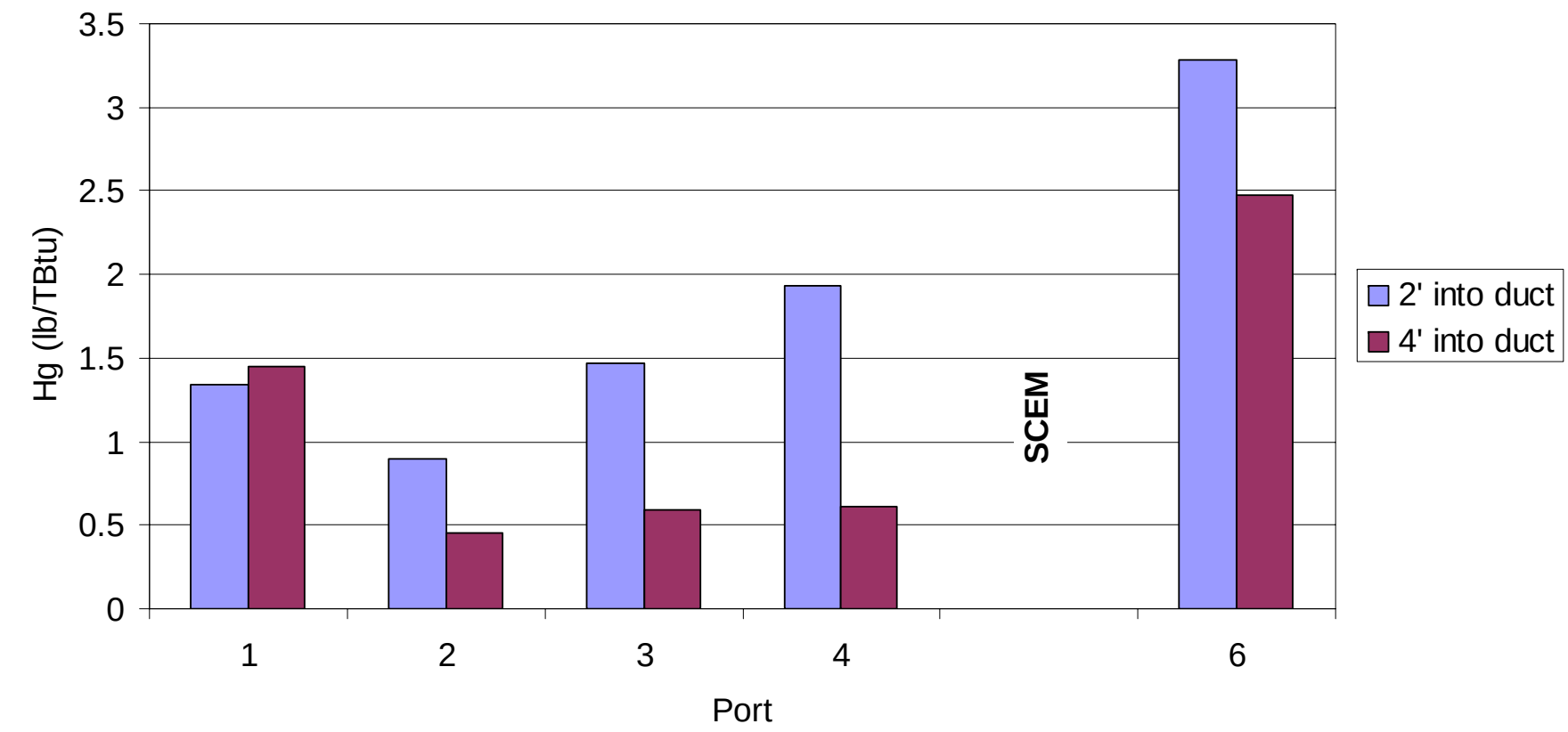
Measured ESP Outlet Mercury Stratification



Sorbent Trap measurements at ESP outlet ports during PAC injection testing, DTE Monroe

What would stratification look like at the stack??

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WE Energies RATA Testing

- September 2006: Oak Creek
  - Ontario Hydro Method
- October 2006: Pleasant Prairie
  - Ontario Hydro Method
- June 2007: Presque Isle
  - Ontario Hydro Method
  - Sorbent Trap
  - Instrumental Reference Method

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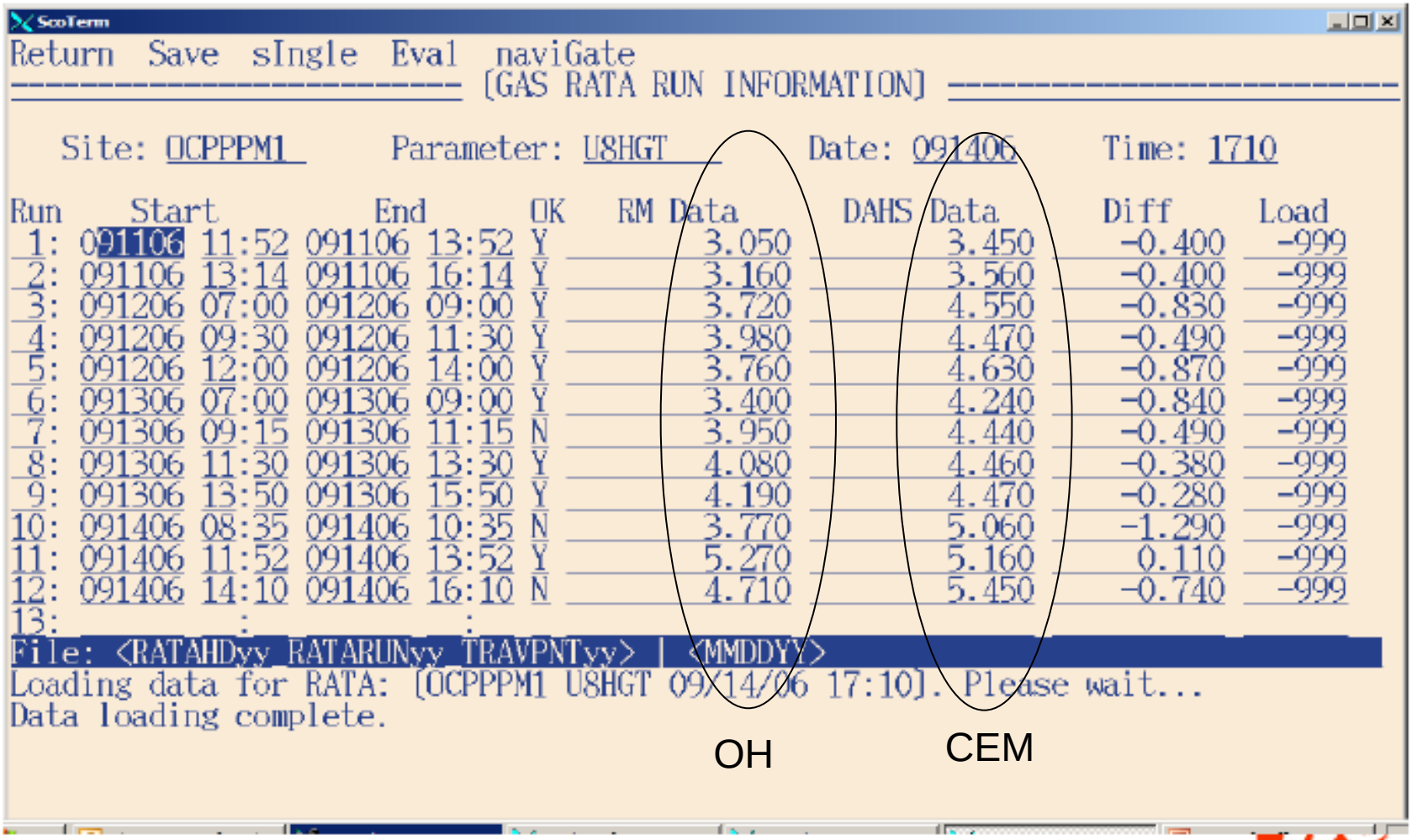
Actual Hg RATAs Experience

- After installing these systems in March 2006, the 7 day drift checks, linearities, and cycle response tests were successfully performed in July and August. 120+ days post installation.
- First RATA was concluded at We Energies Oak Creek PP – on the outlet duct of Unit 8 in September, 2006.
- Second RATA was conducted at our Pleasant Prairie PP – on the common stack in October, 2006.

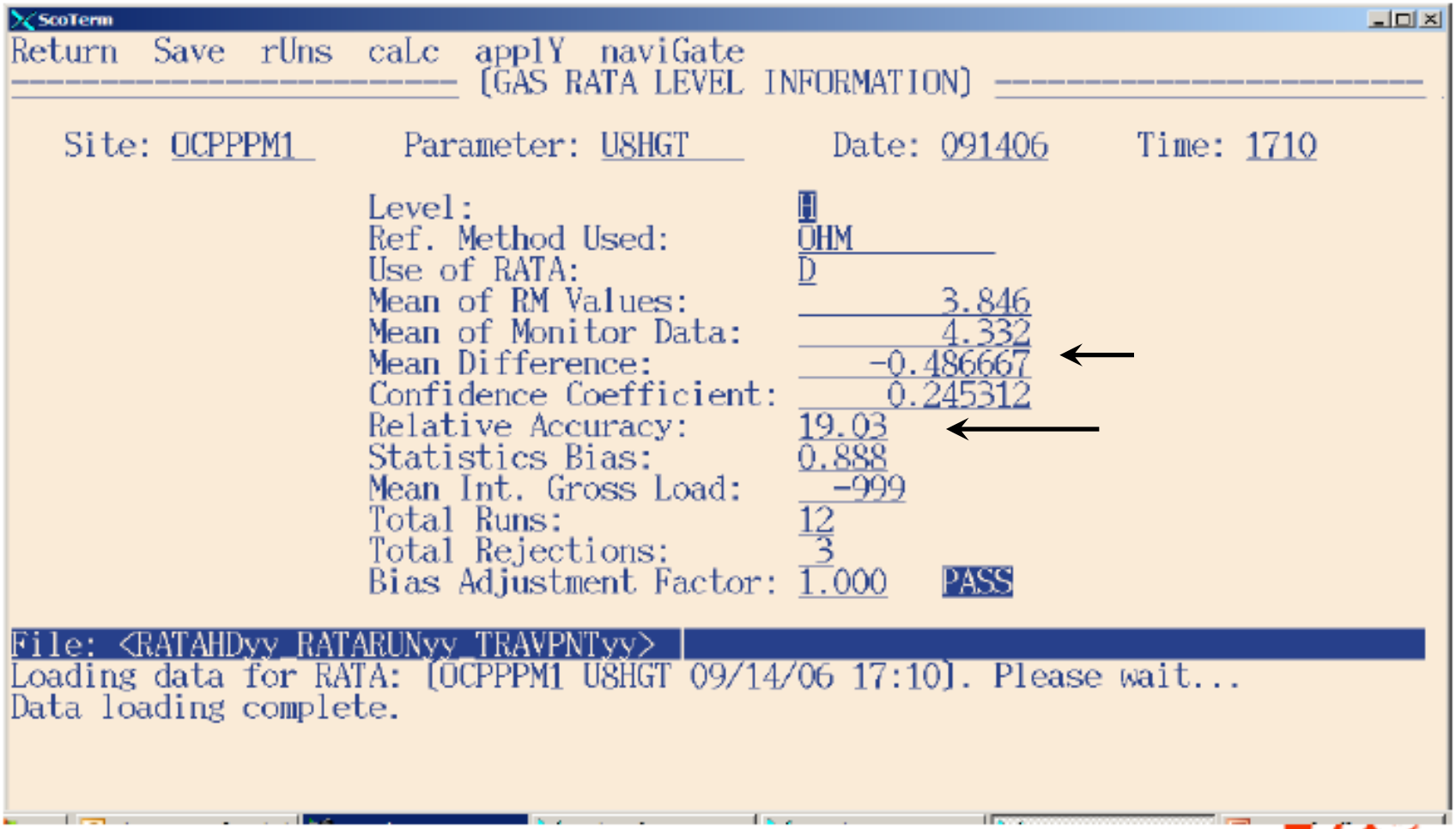
RATA Lessons Learned

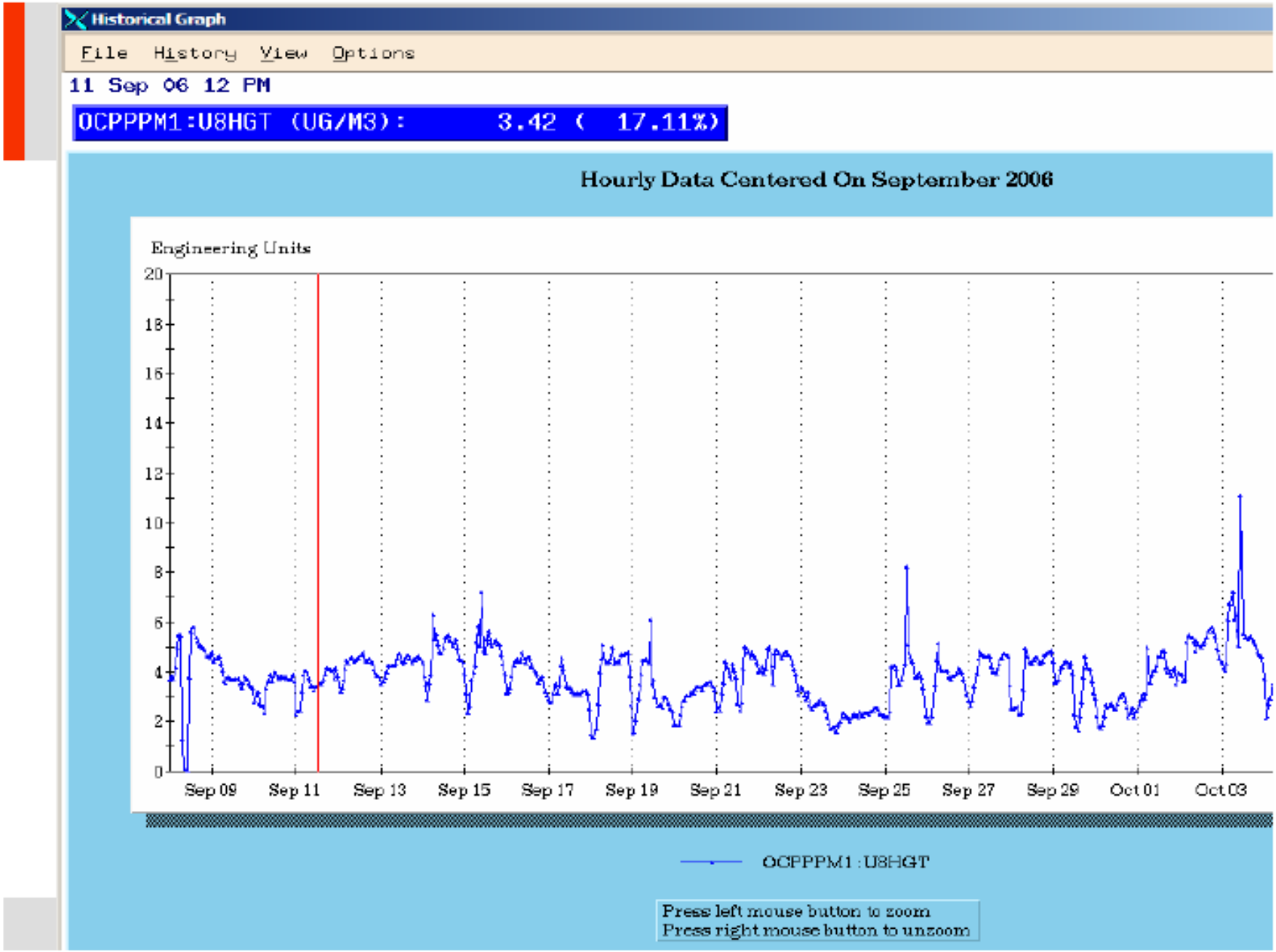
- A lot needs to be learned. Nothing beats experience.
- Typical gas RATAs last 5-7 hours. Each run last 21 – 40 minutes.
- Hg RATAs last 3-4 days. Each run last approximately 2 hours.
- As always, once a RATA begins, adjustments are not allowed.
- On site Hg analysis and results is **really desirable and possible.** This requires special consideration of performing the analytical techniques and checks in the field. **Have two standards on site and consider sending some samples to an outside lab for independent checks.**

Oak Creek RATA Results

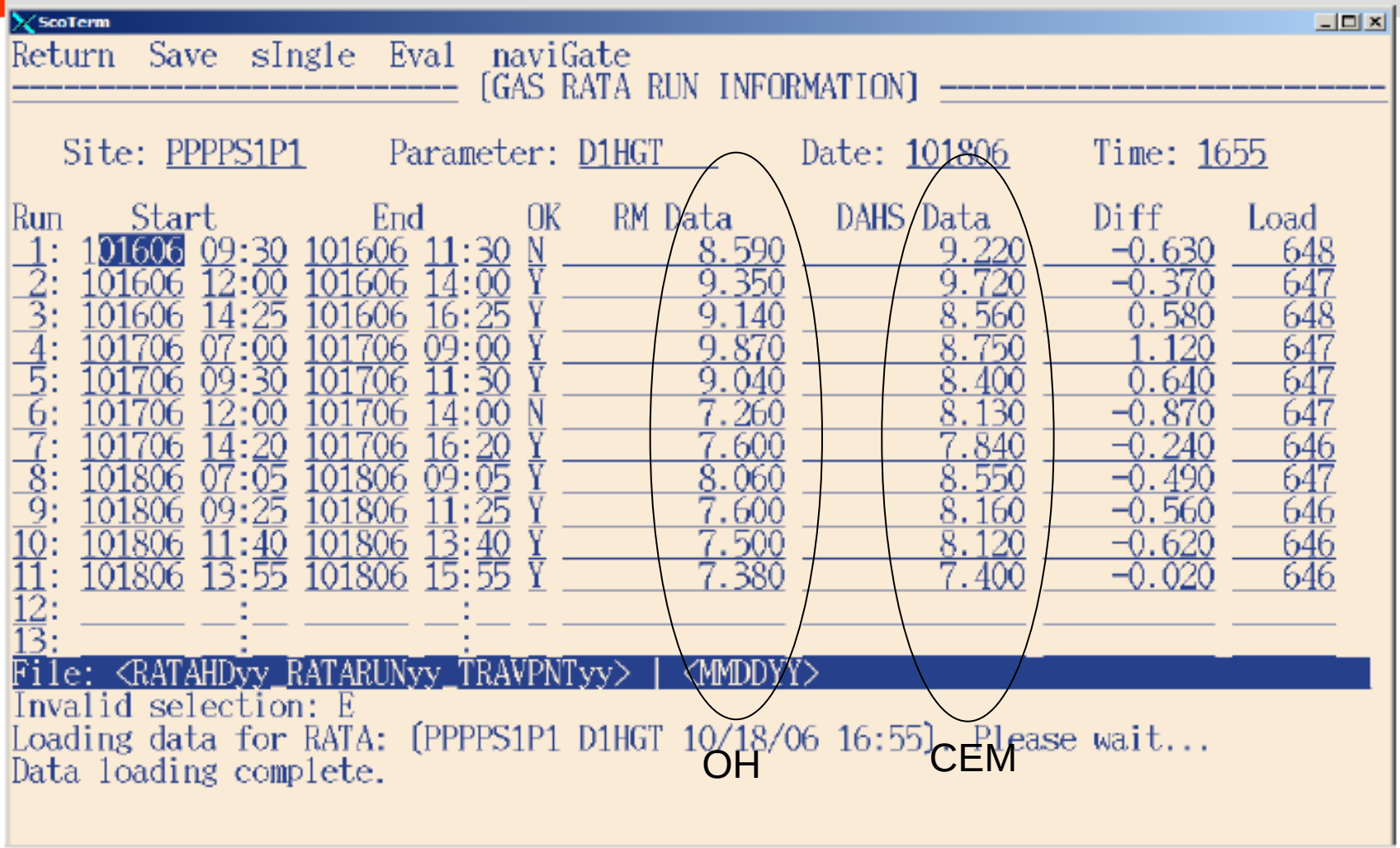


Oak Creek RATA Results

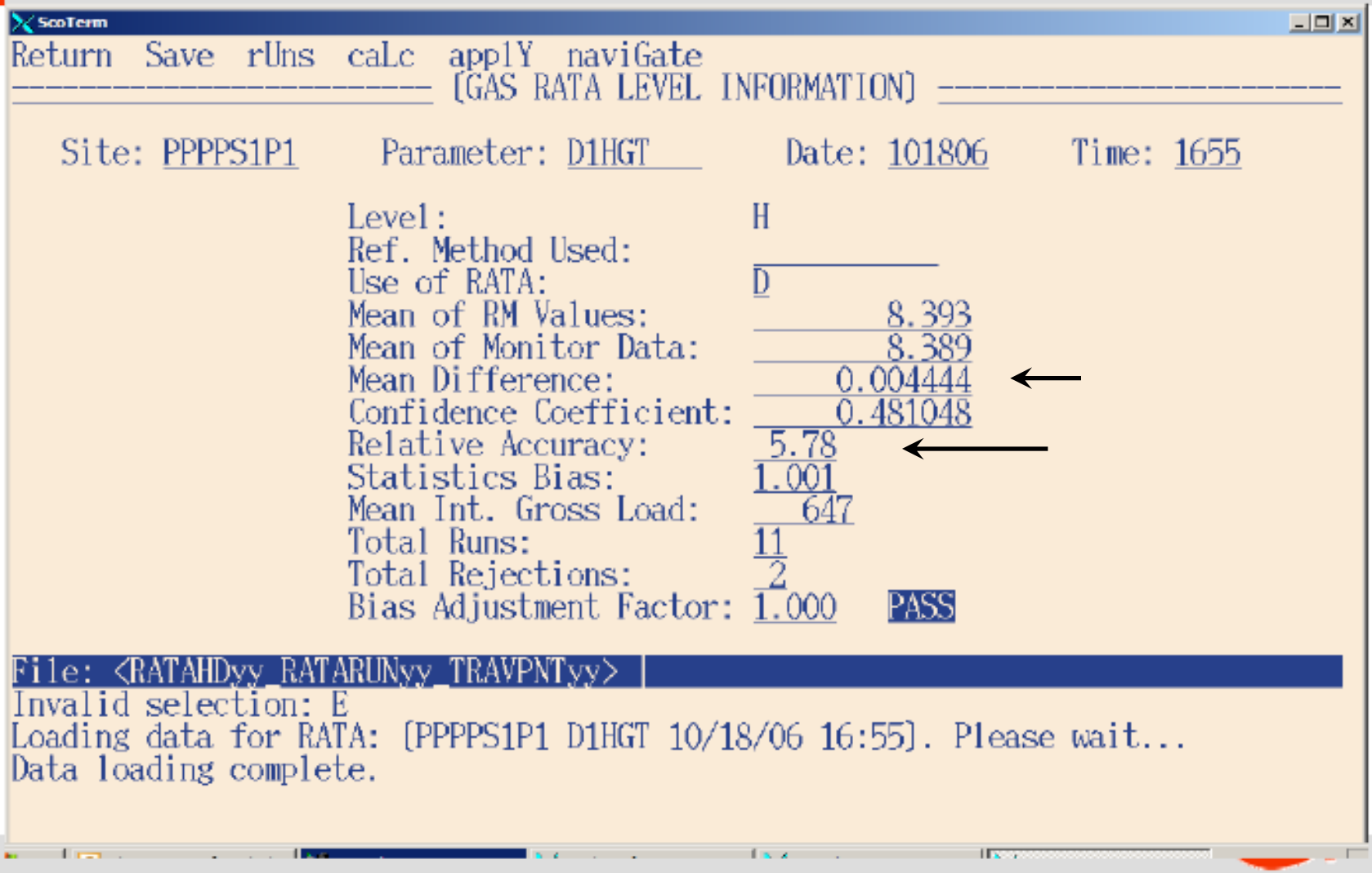


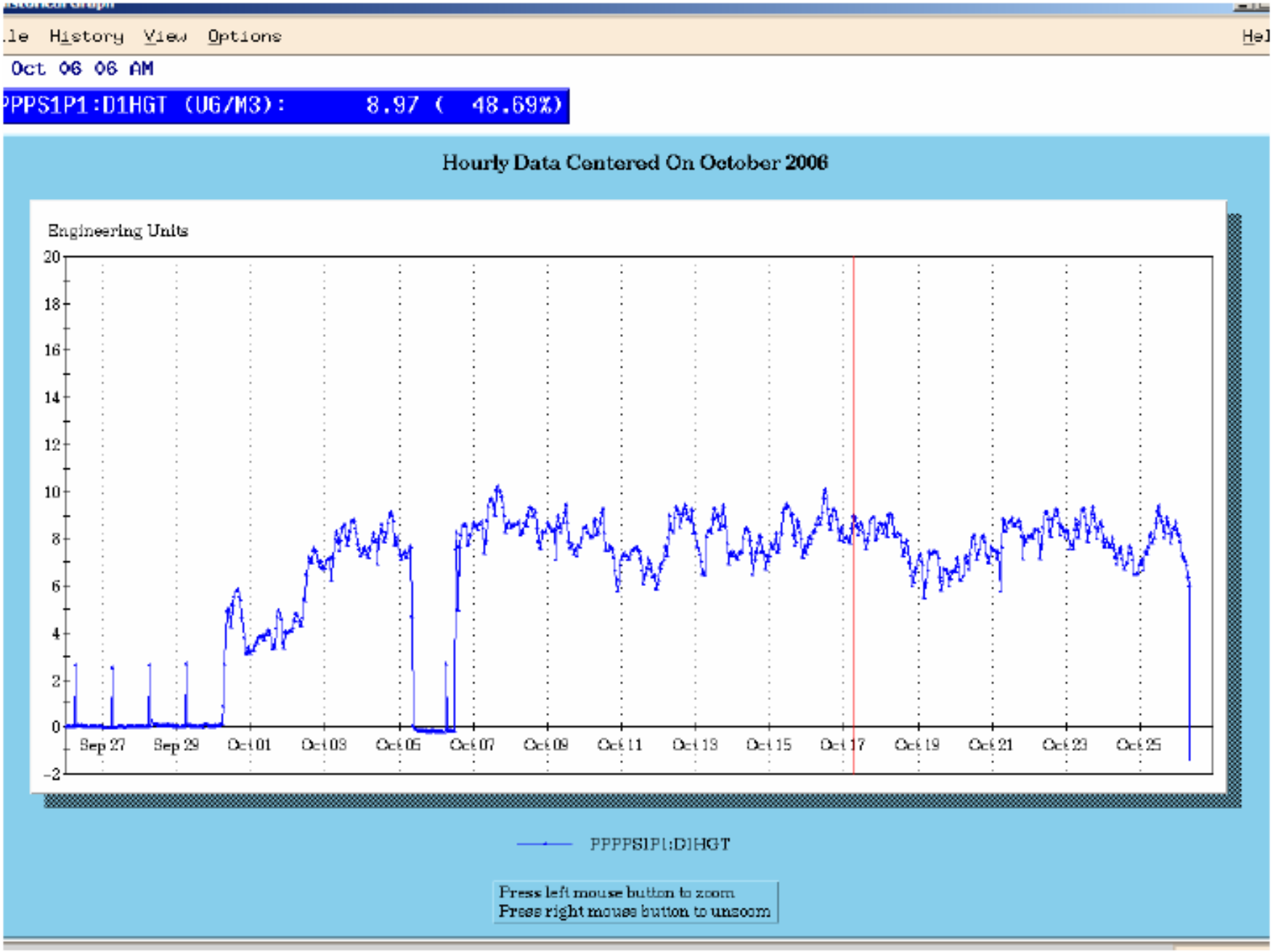

Historical Graph
File History View Options
11 Sep 06 12 PM
OCPPPM1:U8HGT (UG/M3): 3.42 (17.11%)
Hourly Data Centered On September 2006
Engineering Units
20
18
16
14
12
10
8
6
4
2
0
Sep 09
Sep 11
Sep 13
Sep 15
Sep 17
Sep 19
Sep 21
Sep 23
Sep 25
Sep 27
Sep 29
Oct 01
Oct 03
OCPPPM1:U8HGT
Press left mouse button to zoom
Press right mouse button to unzoom

PPPP RATA Results



Pleasant Prairie RATA Results




le History View Options Hel
Oct 06 06 AM
PPS1P1:D1HGT (UG/M3): 8.97 (48.69%)
Hourly Data Centered On October 2006
Engineering Units
20
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10
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4
2
0
-2
Sep 27
Sep 29
Oct 01
Oct 03
Oct 05
Oct 07
Oct 09
Oct 11
Oct 13
Oct 15
Oct 17
Oct 19
Oct 21
Oct 23
Oct 25
PPPPS1P1:D1HGT
Press left mouse button to zoom
Press right mouse button to unzoom

Hg RATAs Experience

- RATAs can be very challenging.
  - Hg RATAs are also very challenging because they are a much different type of RATA.
  - They take longer.
  - Results are not immediately known.
  - We desperately need an instrumental Reference Method to replace the Ontario Hydro Method.
    - To pass, the Relative Accuracy ≤ 20.0%, with an alternate specification of ≤ 1.0 ug/scm if average Reference Method value is ≤ 5.0 ug/scm.

Goals for June 2007 PIPP Testing

- Demonstrate the compliance CEM can pass CAMR certification tests using the Ontario Hydro Method as a reference
- Demonstrate that an IRM can achieve the performance requirements identified in Draft M30A, compare well with the Ontario Hydro Method and be used for a RATA on the compliance CEM.
- Demonstrate that the Sorbent Trap Method (STM) can achieve the performance requirements identified in Draft M30B, compare well with the Ontario Hydro Method and be used for a RATA on the compliance CEM.

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RATA Plans for PIPP

- "Compliance" CEM at FF Outlet
  - Used for IRM reference during traverse
- IRM, OH and Sorbent Traps at Stack
  - Conduct traverse with IRM to determine stratification
  - If insignificant stratification, test all methods at single location
  - Test series one:
    Elevated Hg (inject PAC for ~ 1.2 to 3 μg/m^3). Measure with all methods at stack
  - Test series two:
    ~90% control (inject PAC for ~ 0.5 to 1 μg/m^3). Measure with IRM and sorbent trap at stack

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Portable CEM/ IRM

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Key Aspects of ADA-ES IRM

- Uses ThermoFisher analyzer and calibrator
- Configured for rapid installation
- Uses only 120V power
- No long umbilicals required
- Automated operation
  - RATA testing with $HgCl_2$ system integrity checks
  - Dynamic spiking
- Ability to traverse
- Real-time feedback

IRM Installation

- Set-up time required for portable system
  - ~ 4 hours and warm-up overnight expected

    Actual time required for installation and full check-out on first installation (PIPP) was > 1 week
- Requirements
  - Power: 3 x 120V, 20A
  - Air: 4 cfm at 70 psi

IRM Installed at PIPP

Traversable Probe

Sampling Times

- Traverse

  2 x response time
  (add 2 x response time to flush if port change required)

- Sampling (single point)

  2 x response time or minimum of 10 minutes

  Example: 4 minute response time
  8 minute flush + 10 minute sample
  8 minute flush + 8 minute zero
  8 minute flush + 8 minute system integrity
  = 50 minutes per run x 9 runs = 7.5 hours

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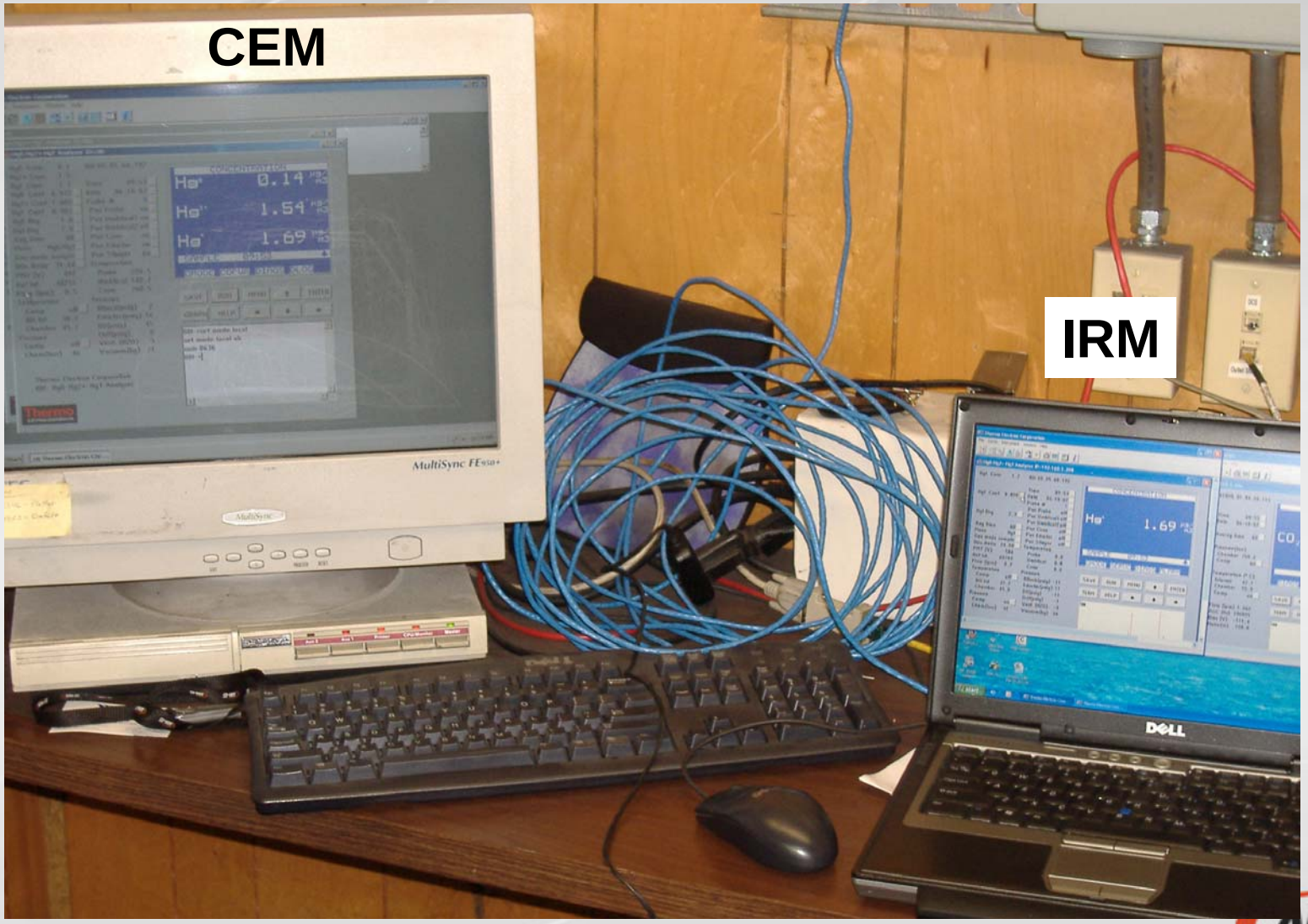
RATA Results

- Passed high level (1.5 to 3.2 µg/m^3)
  - √ OH to CEM
  - √ STM to CEM
  - √ IRM to CEM
- Passed low level (0.48 to 0.93 µg/m^3)
  - √ STM to CEM
  - √ IRM to CEM

Relative Accuracy Testing



System Integrity Check

- Zero and span with $HgCl_2$ between each RATA run
- System integrity check was automated for hands-off operation

Summary
Hg CEMs - How close are we?

- Installation
  - We have learned many lessons and can streamline installation with proper planning
- Operation
  - Performance is continuing to improve with hardware and software upgrades.
    - System can work GREAT with right components
    - Is 18 months enough time to work out ALL of the bugs?
  - Systems are passing ongoing QA checks and RATAs
  - Need NIST certified calibrators and $HgCl_2$ calibration sources

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IRM Method – Where are we?

- Successful IRM completed
  - Support from Thermo
    Dieter Kita and Jeff Socha
  - Designed and Operated by ADA-ES
    Sharon Sjostrom and Steve Modrak

- Can just anyone pull this off?

  With the right equipment and proper training

More Information

Hg CEM or IRM

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Hg CEM or RATA Testing

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