Continuous Mercury Emissions Monitoring Feasibility and Costs

Prepared for:

Lake Michigan Air Directors Consortium
Emissions Controls and Monitoring Technologies
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by

Karl R. Wilber, PE

Tekran Instruments Corporation

Objectives:

1. *Understand the Mercury Abatement and Monitoring Goals of LADCO Membership*
2. *Present HgCEMS Technology and Applications*
3. *Discuss Installation and Operations Challenges and Results*
4. *Outline Measurements Challenges and HgCEMS Traceability Requirements*
5. *Outline Total Ownership Costs*
6. *Address Questions*

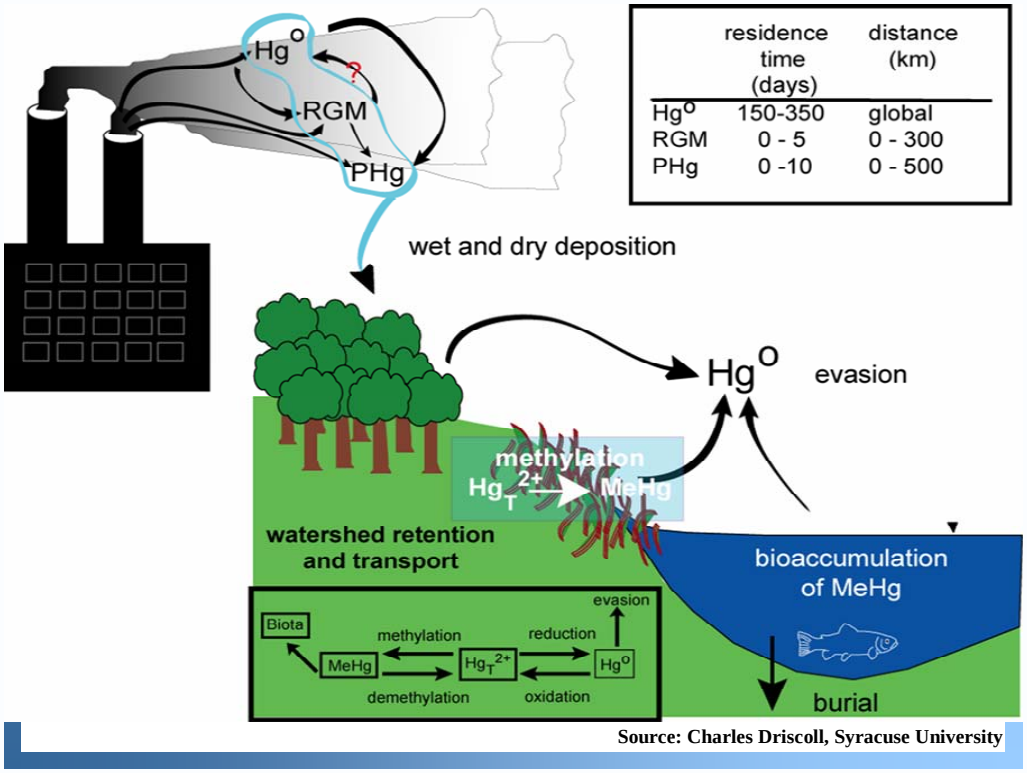
Presentation Outline

1. *Situation Analysis*
2. *FAQs*
3. *Monitoring Approaches/Solutions including Abatement Performance Measurements*
4. *Constituents of Electronic HgCEMS*
5. *Total Cost of Ownership*
6. *Example Applications, Challenges, and Solutions*
7. *Group Discussion*

1. Situation Analysis

1. Mercury is a known neurotoxin – and can also negatively impact plants, animals and human organs
2. Regulations will require that mercury emissions be monitored and reduced,
3. Mercury emissions and concentrations are in the parts per billion vs. parts per million like other regulated emissions such as NOx and SOx,
4. Mercury CEMS are more expensive to procure and maintain than criteria pollutant CEMS

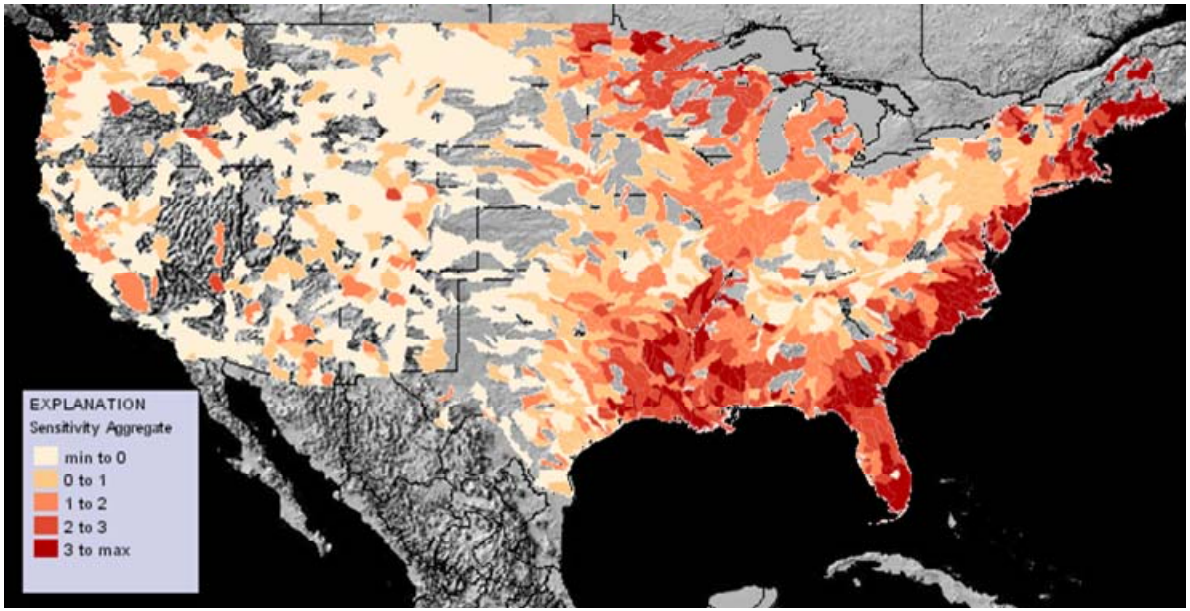
Mercury Generation, Transport and Fate



	residence time (days)	distance (km)
Hg^0	150-350	global
RGM	0 - 5	0 - 300
PHg	0 -10	0 - 500

- *Two thirds of mercury in the environment is anthropogenic (i.e. man made).*
- *Mercury is a neurotoxin. It bio-accumulates and impacts the heart and other organs.*

USGS Mercury Methylation Sensitivity Map for Aquatic Ecosystems (Preliminary)



Based on USGS data for TOC, pH, aquatic sulfate concentration, and hydric soils. Areas not colored are missing data for one or more of these indicators.

5 - Year USGS Fish Study revealed ALL mercury analyses exceeded health limits

Tekran Products and Services

- Tekran focuses solely on Mercury Measurement
- Applications - Ambient Air, Aqueous and Flue Gas
- Service, Training, Parts Support, NIST Traceability

Tekran Products, Services & Markets

Three Product Lines Serve Different Market Sectors

1 Mercury Continuous Emissions Monitor (HgCEM) for coal fired power plants to meet requirements of Federal and State Regulations and Process Performance Monitoring and Optimization.

- Electric Generating Units (EGUs)
- Mercury emissions control (i.e. abatement) technology suppliers and researchers
- Other emitting sources of Hg, e.g. Steel, Cement Kilns, Waste incinerators, Chlor-Alkali Plants, etc.

Tekran's 3300 CMM

Tekran CMMS Services

Field Tested. Field Proven. Field Ready.

Field Services
24/7 Service Availabilty
Phone Support
RATA Support
Emergency Service

System Services
System Installations
Industrywide DAS Support
Training Classes - Onsite & Remote
Custom Maintenance Agreements
Remote Diagnostics

Calibration & Maintenance
NIST Traceable Service Center
System Repairs & Scheduled Maintenance
Component Warranty Service Center
Scheduled Consumables Delivery
Spares Inventory Program
Component Exchange Programs

Mercury CEM Parts
Large Parts Inventory
Same Day Shipment on Most Orders
Afterhours Parts Availability

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WHERE MEASUREMENT BEGINS™

For North American Sales and Service, please contact us at:

Tekran Instruments Corporation
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1-888-3-TEKRAN | sales@tekran.com

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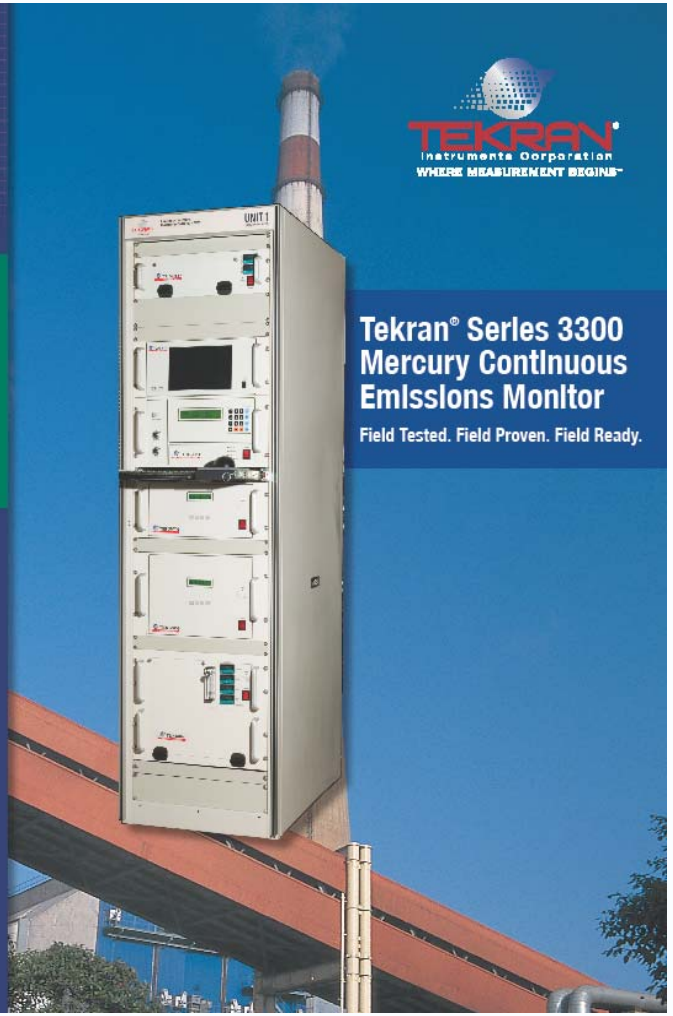
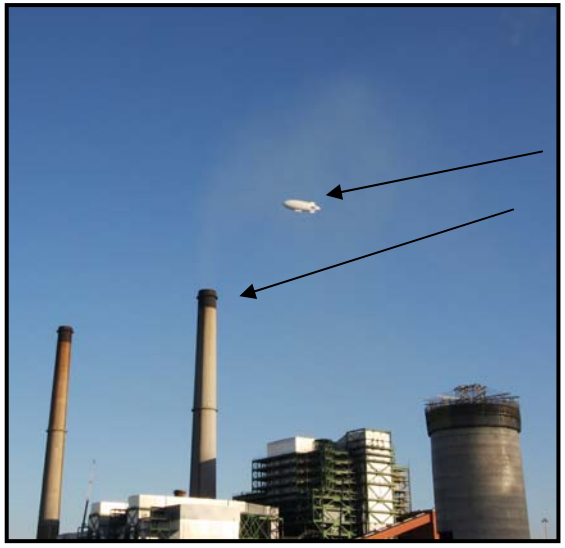


Tekran Products, Services & Markets

2. Ambient Air Monitoring and Research

Ambient air products allow total or speciated mercury monitoring:

- State and Federal Government air quality networks - both North American & international
- Universities & Research institutions – along with USGS, DOE, EPA, EPRI etc.



Tekran CMMs in Dirigible and Coal-fired Plant Stacks

Collaborative Research Project Mercury Emissions, Transport and Fate

Arctic Air Pollutants Research Project 2007-2009

Tekran Products, Services & Markets

3. Analytical

Laboratory products provide trace mercury determinations in a variety of sample matrices:

- Private analytical service labs
- State and Federal government labs
- Wastewater utilities
- Universities & research institutions

Tekran 2700 Methyl Mercury Analyzer

2. Frequently Asked Questions

1. What will the Mercury (Hg)-Related Regulations Require – Federal and State?
2. What are the options for Mercury Monitoring and HgCEMS?
3. How much does it cost to for an HgCEMS?
4. What are the challenges with HgCEMS?

Mercury Detection - The Challenges

- ***Sensitivity***
  - Mercury is present in the low ppb or sub-ppb range

- ***Selectivity***
  - Potential interferents are present at ***1000's of times*** higher concentration than mercury
    - SO_2
    - NO_X
    - HCl

CAMR Replacement Legislation

- Maximum Achievable Control Technology (MACT)-type approach likely
- Additional focus on NIST traceability and CMM System Accuracy
- Potential renewed investigation of Hg^0, Hg^{2+}, and Hg^P
- Potential increased use of CMMs for Abatement System Control and Optimization
- Outlet Levels of Hg will be lower yet

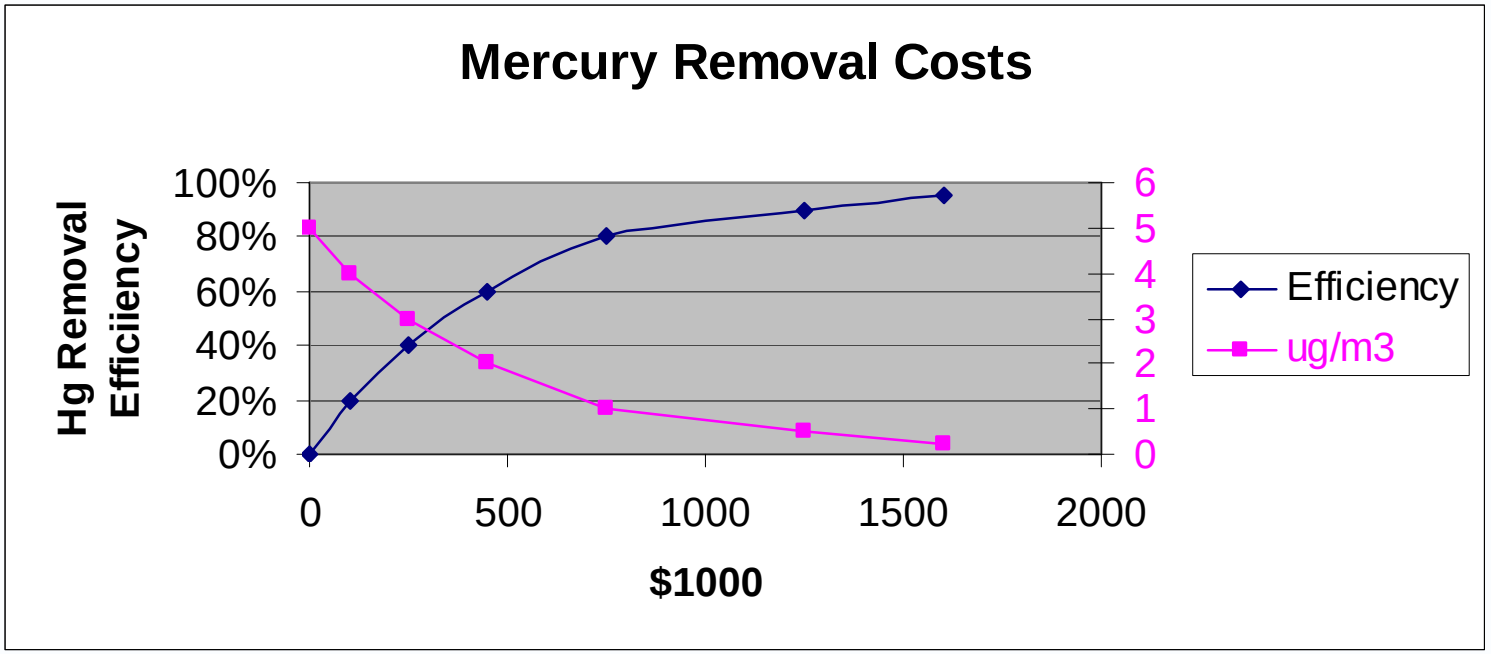
3. Monitoring Approaches/Solutions

Option	Comments
Do Nothing	Wait for Definitive Regulatory Guidance
Sorbent Traps	Less Expensive Capital Costs No real-time view of process
Electronic CEMS	Higher Capital Costs Real-time view of process and abatement/regulatory performance

Mercury Abatement Systems Status

1. Substantial testing and evaluation completed to date
2. New technologies being developed and demonstrated
3. Hg removal rates are Unit specific and can often exceed 90%
4. Unit, Plant and Fleet-wide Hg monitoring and optimization will likely be implemented
5. If MACT type rules get traction, utilities will need:
   - Low-level measurements capability
   - NIST Traceability and ongoing verification
   - Fleet-wide optimization program for mercury abatement

Example Mercury Abatement Using Sorbent Injection



Stack Concentrations will be lower than current levels,
The last 10% removal may cost an additional 50%
Low-level measurement accuracy more important than ever !

4. Constituents of an Electronic HgCEMS

- **Tekran 3300**
- Installation
- Maintenance
- The Results
- What's Next

Series 3300 - Capabilities

- Speciating
  - Hg^T and Hg^0 measured directly
  - Hg^{2+} determined by subtraction

- Typical detection limit (< 0.05 µg/m^3) or *(~0.005 ppb v/v)*
  - MDL limited by system blanks, ***not*** instrumentation
  - Lower MDL (< 0.01 µg/m^3) possible for low Hg applications
  - Update rate: one sample every 2.5 minutes

- No reagent mixing required

System Data Interchange

- High level data exchange
  - OPC, TCP/IP, Modbus, CSV data files
  - Can act as either Modbus/OPC master or slave
  - Allow over 160 internal system parameters to be accessed
  - Last resort: 4-20 mA or 0-5V analog outputs
- Remote access, operation, data transfer and troubleshooting via dial-up or network link

Model 3310 – Hg^0 and 3315-Hg^{2+} Calibration Unit

- Based on fundamental physical properties
  - Long term stability
  - High delivery rate (up to 30 l/m)
  - Precisely known delivery rate
  - Provides Zero gas
  - Span gas available at multiple levels
- Traceability protocols are developed by NIST for both gas generators and for cylinders

Model 3320 - Sample Conditioner

- Dual channel for speciation
  - ***Hg^T*** - Thermal conversion of diluted sample
  - ***Hg^0*** - Hg^{2+} removal
  - Sample conditioning
  - Acid gas scrubbing
  - No chemical reagents
  - Does *not* use impingers

Model 2537S Mercury Analyzer

- Originally designed as an ambient air mercury analyzer
  - MDL is < 0.1 *ng/m^3*
  - Update rate: every 2.5 minutes
- Proven reliability under extreme conditions
  - Has been used in the high Arctic, Antarctica and everywhere in between
- Demonstrated long term stability and accuracy
- Capable of continuous unattended operation

Principles of Operation

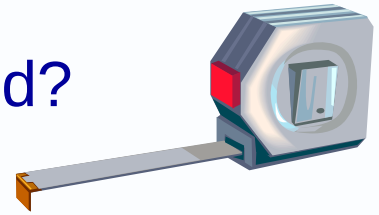
- Mercury in sample gas is preconcentrated onto (pat'd) pure gold cartridge
- Adsorbed mercury is thermally desorbed
- Detected by atomic fluorescence detector
- Two cartridges are used to alternately sample and desorb
  - No gaps in data stream
  - Provides *continuous* monitoring of inlet stream
  - Each reading is a true 2.5 minute average concentration

Continuous Emissions Mercury Monitors

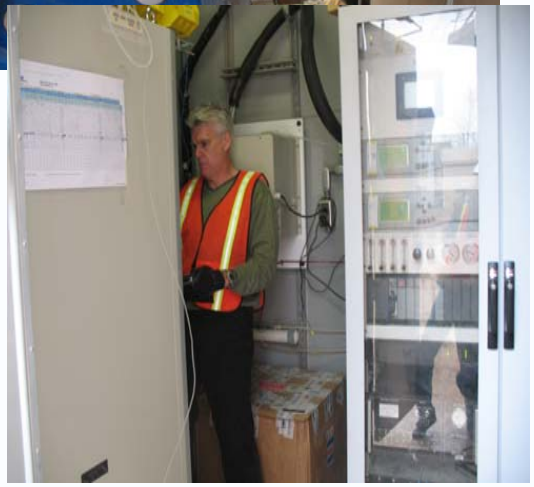
- Tekran 3300
- **Installation**
- Maintenance
- The Results
- What's Next

What do we need to know?

- The ***Series 3300*** CEM does not require tailoring to each site
  - No customization typically required
- We *do* need to know:
  - How long is the heated line you will need?
  - Probe stinger length and material? *(custom fabricated per site)*
  - Our one page site questionnaire asks for the above
    - ➢Stack composition data is for reference only



Typical Installation



Site Requirements and Questionnaire

- Full Site Pre-delivery Checklist is available
  - Explains in detail all utility and space requirements
- Requirements at CEM shelter
  - Electrical-instruments: 3 x 115 VAC, 15A
  - Heated line: 20 W/ft. 115 or 230 VAC
  - Compressed air: 80-120 PSI, max 3 CFM
  - Argon: 4.8 grade. (99.998%) 5-6 tanks/year (Approx. $18 to $40 per tank)
  - Water: 3 L (approx. ¾ gallon) per day
  - Vent to outdoors
  - Communications: Telco or Internet link
- Requirements at Probe
  - Mounting: 4” ANSI flange
  - Electrical: 2 x 115 VAC

Emissions Monitoring Options

- Out Right Purchase
- Rental/Purchase
- Lease
- Try/Buy
- Buy the Data

Some items related to rental such as umbilical's are site specific and must be purchased. Tekran has a few lengths we can include in the rental program.

Continuous Emissions Mercury Monitors

- Tekran 3300
- Installation
- **Maintenance**
- The Results
- What's Next

CMM Maintenance

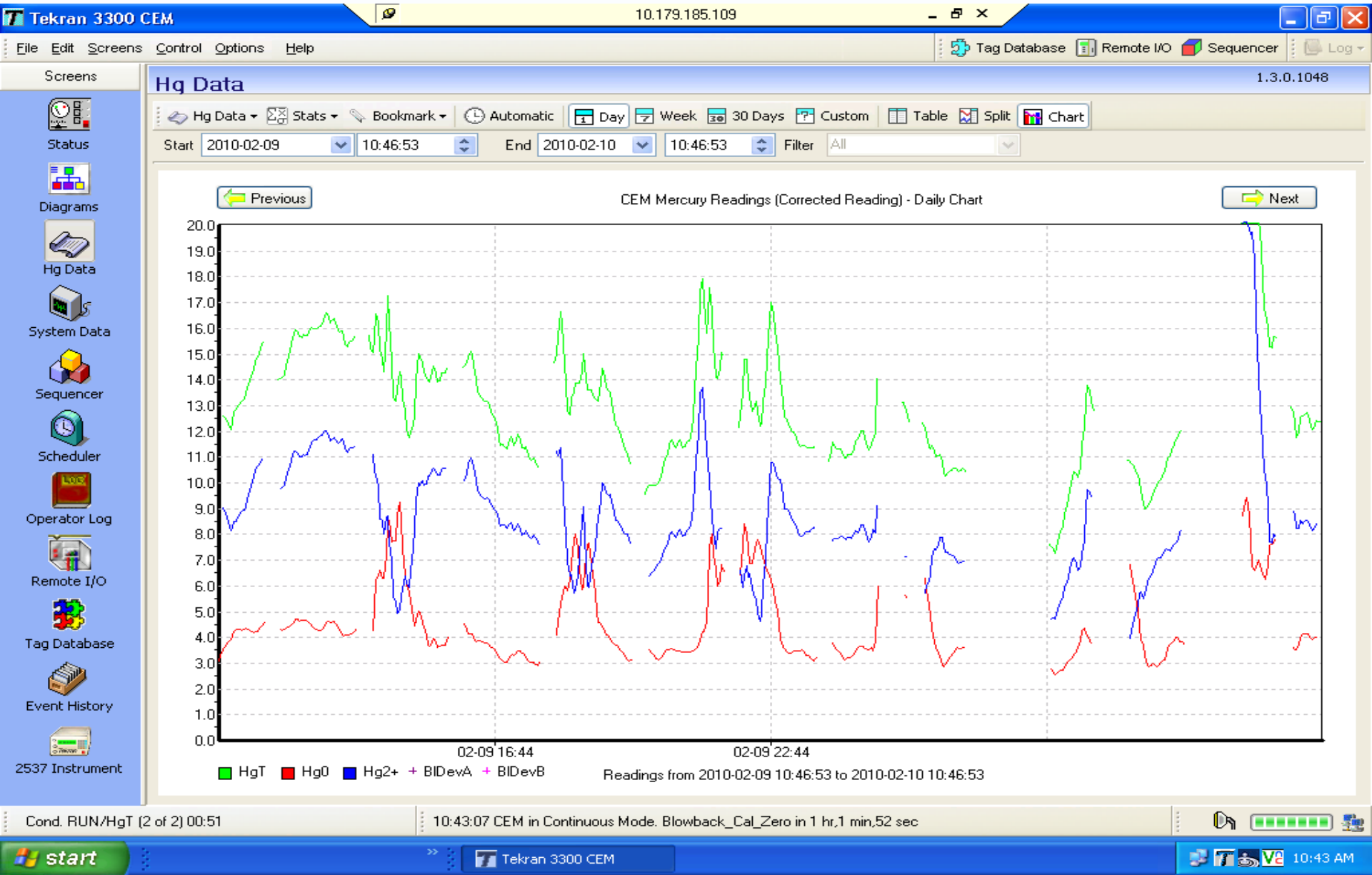
- More than a Criteria CEM
- Much Lower Detection limits
- Heated Umbilical's (350 F)
- CMM’s Use Gas Generators versus Bottles
- RATA’s are difficult (No IRM) - the Utility Industry Generally Uses 30B – Sorbent Trap – or in some cases Ontario Hydro Method used

Continuous Emissions Mercury Monitors

- Tekran 3300
- Installation
- Maintenance
- **The Results**
- What's Next

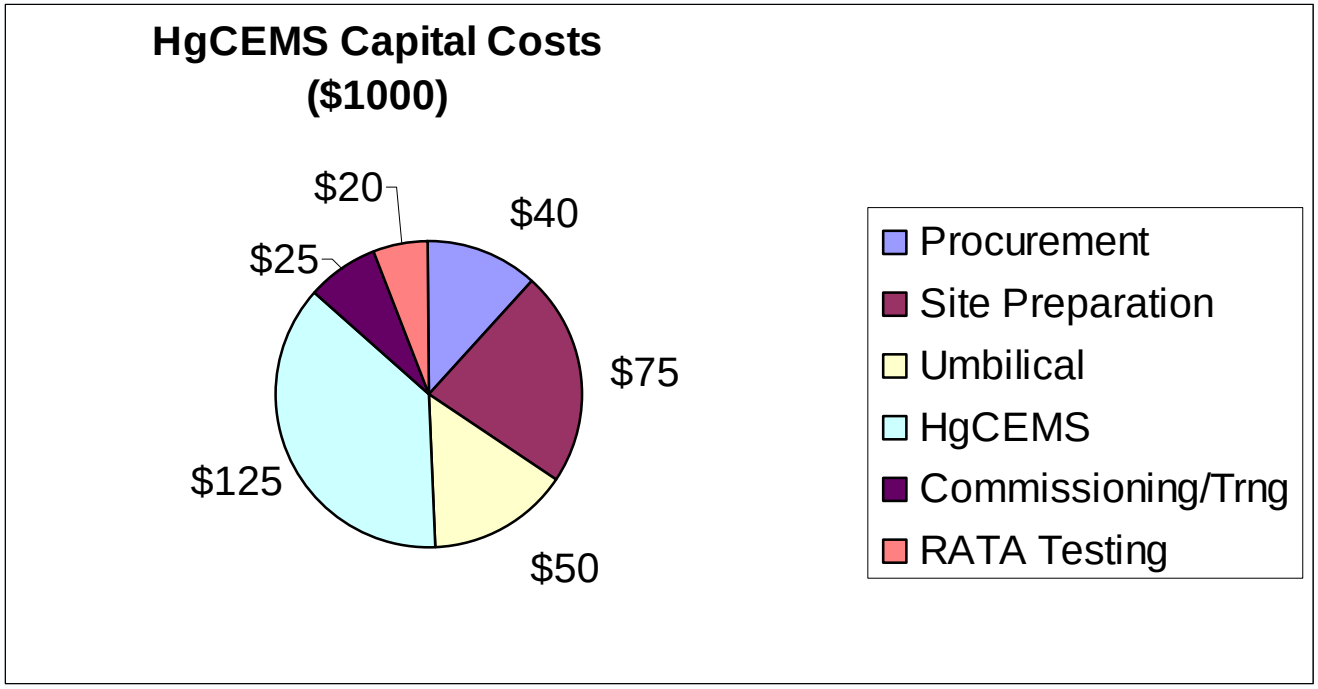
Example Hg Excursions from Cement Process

Example Speciation Results



5. Hg CEMS – Total Cost of Ownership

Capital Costs ($300-$400K)



O&M Costs

1. Service $25K
2. Parts & Repairs $15K
3. NIST Traceability $10-20K

6. Example Applications and Challenges

Example Applications

- **Process** – Coal-fired EGUs, Steel, Waste and Weapons Incineration, Cement,
- **Abatement** Systems Research – ACI, Scrubbers, Catalyst, etc.

Example Challenges

- Umbilical Failures
  - Sample transport – loss of Hg^{2+}
  - Reliability / difficult operation
  - Interferences - (AA or direct AF)
  - Verification of low-level (i.e. <1.0 µg/m^3) accuracies
  - EPA/NIST Traceability Compliance

7. Group Discussion

1. Did we accomplish objectives?
2. Additional Questions ?
3. Action Items and Follow Up?