Environmental Compliance using CEMS

ERM's Exton Office March 13, 2012

Joel Millard
Environmental Regulatory Specialist

Overview

CEMS

- Why install a CEMS
- Common Analyzer Types
- MATS Compliance using CEMS

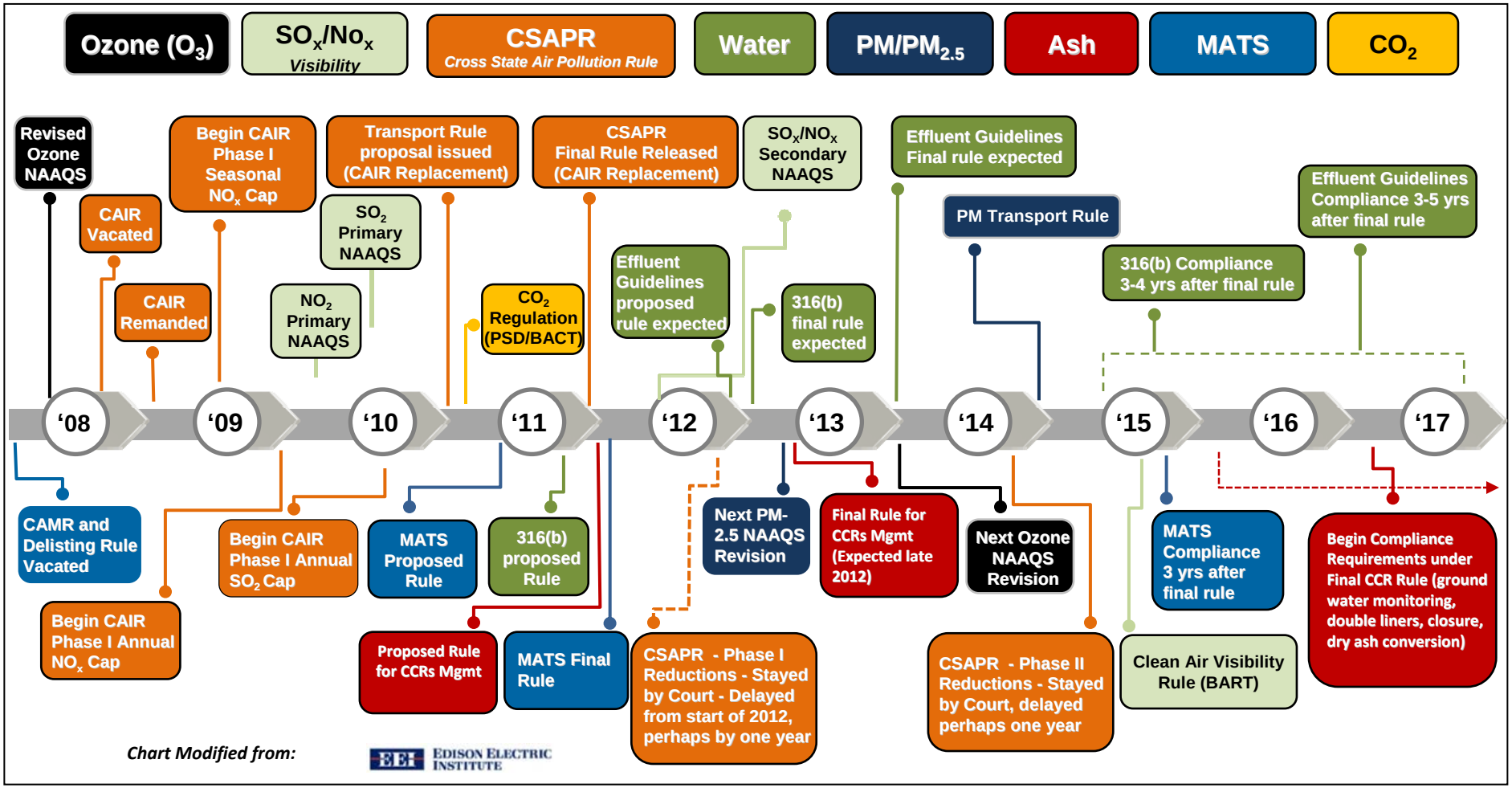
DAHS

- Compliance tool
- Reporting tool
- MATS Compliance using DAHS

Why Install CEMS?

- Permit Requirement
- New Environmental Regulations
- Real Time Data for Air Pollution Control (APC) device operation
- Closed Loop Environmental Control (CLEC)
  - NO_X analyzer at the inlet to an SCR
  - SO_2 analyzer at the inlet to an FGD
- Coal Fire Detection System
  - Monitors the CO and O_2 concentrations of coal storage piles as an early detection system for fires

Possible Timeline for Environmental Regulatory Requirements for the Utility Industry



Continuous Emission Monitoring System

US EPA Definition of a CEMS

- The total equipment used to acquire data, which includes sample extraction hardware, analyzers, data recording and processing hardware, and software.

Two Main Types of CEMS

Dry Extractive

Non corrosive gas streams

Main components

- Sample probe (usually heated)
- Heated sample line
- Sample pump
- Gas conditioner (moisture removal)
- Analyzers

Dilution Extractive

Corrosive Gas streams

Main components

- Sample probe
- Dilution orifice
- Dilution air system
- Sample line
- Sample pump
- Analyzers

Common Analyzer Types and Technologies

Oxides of Nitrogen (NO_X)
- Chemiluminescense with an NO_2 to NO converter

Sulfur Dioxide (SO_2)
- Ultraviolet (UV), Non-dispersive infrared (NDIR), Fluorescence

Diluent Gas (O_2/CO_2)
- O_2 – paramagnetic or zirconium oxide sensor
- CO_2 –infrared

Carbon Monoxide (CO)
- Gas Filter Correlation

Volatile Organic Compounds (VOC)
- Flame Ionization Detector (FID), Gas Chromatograph (GC)

Stack Flow
- Ultrasonic, Differential Pressure (ΔP)

Opacity (COMS)
- Single or double pass Transmissometry

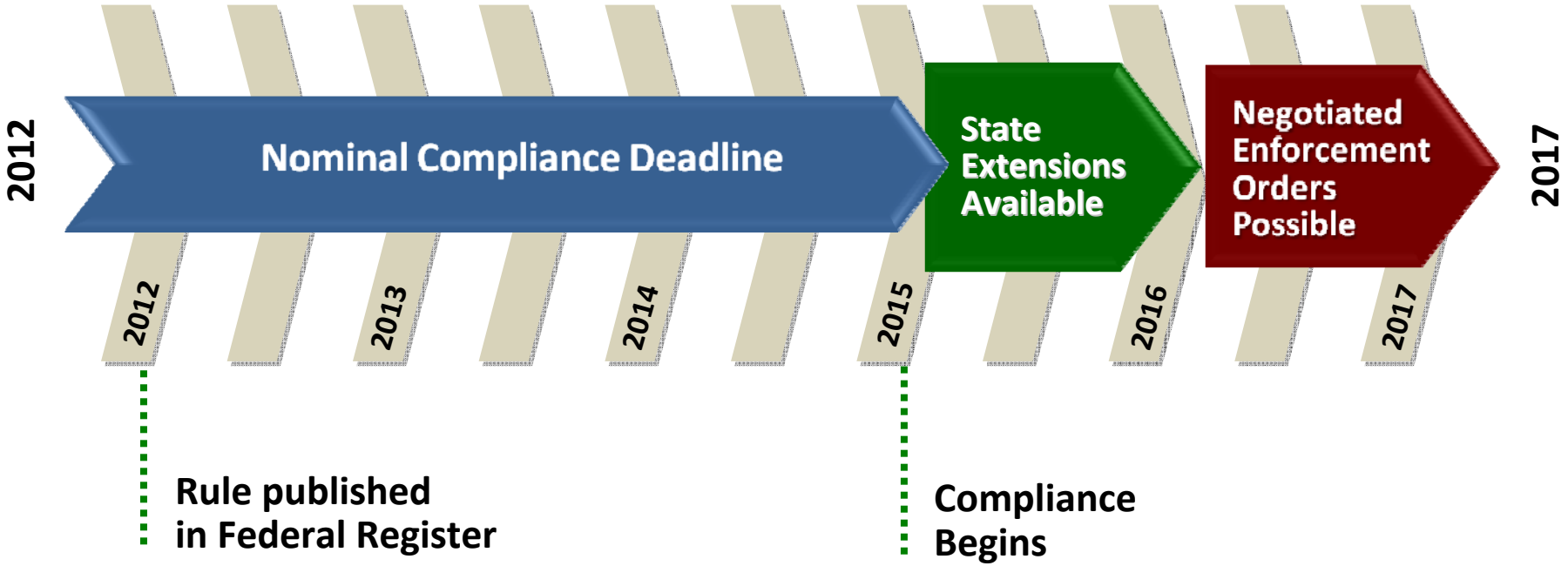
Mercury and Air Toxics Standards (MATS)

- 40 CFR Part 63, Subpart UUUUU – National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units
- Also known as the Utility MACT
- Final rule published in the Federal Register on February 16, 2012
  - Effective 60 days from publishing in FR (April 16, 2012)
  - Affected sources have 3 years from this date to become compliant*

***note: it appears that the EPA will grant a one year extension for sources that are showing an effort to achieve compliance**

Timeline for Compliance Mercury and Air Toxics Standard (MATS)

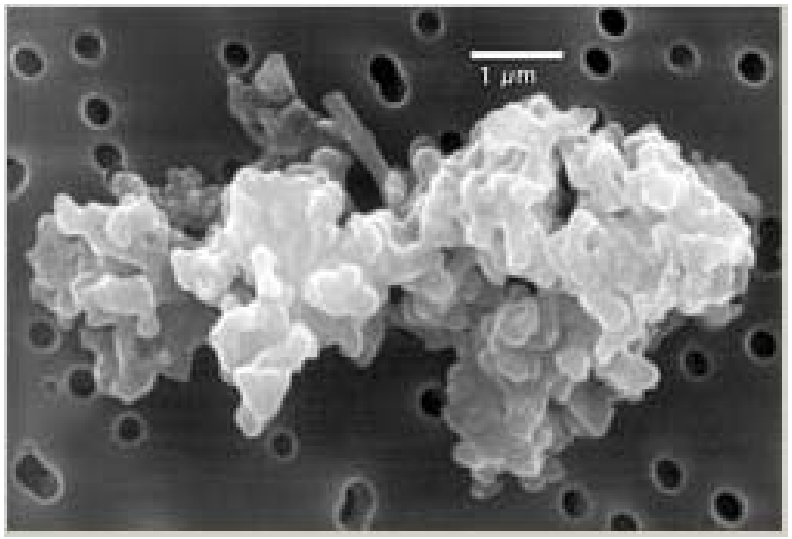
- **Covers Filterable Particulate Matter as a marker for heavy metals, HCl or SO_2 as a marker for acid gasses, and Mercury**



UMACT – CEMS Additions

Added Measurements & Data Collection

- PM CEMS- Filterable only (OR non-Hg metals)
- SO_2 – or HCl (If SO_2 does not meet limit)
- Hg – CEMS or Sorbent Traps
- Parametric Monitoring – Depends on Control device
- Limits based on 30 boiler day rolling average



Particulate Matter (PM)

UMATS – PM Limits

EGU Category	PM		Total Non-Hg HAPS Metals	
Existing Units	lbs/mmBTU	mg/Scm	lbs/mmBTU	mg/Scm
Coal (Not Low)	0.03	49.1	0.00005	0.1
Coal (Low Rank)	0.03	49.1	0.00005	0.1
IGCC	0.04	65.5	0.00006	0.1
Liquid Oil-Cont.	0.03	52.3	0.0008*	1.4
Solid Oil (Coke)	0.008	13.1	0.00004	0.1
NEW Units	Lbs/MWh	mg/Scm	Lbs/MWh	mg/Scm
Coal (Not Low)	0.007	1.1	0.00006	0.01
Coal (Low Rank)	0.007	1.1	0.00006	0.01
IGCC	0.07	11.1	0.0004	0.06
Liquid Oil-Cont.	0.07	NA	0.0002*	0.03
Solid Oil (Coke)	0.02	3.2	0.0006	0.10

* Includes Hg PM

PM Compliance Options

1. Measure using PM CEMS
2. Measure using a Continuous Parametric Monitoring System (CPMS) and perform annual compliance testing
3. Quarterly testing for PM/Non-Hg Hap Metals
   - PM filterable – Method 5 test - $14K
   - Total HAP Metals – Method 29 train - $15K/quarter
   - Individual HAP Metals (10) - More $$ than Method 29 test

NOTE:

Annual Compliance test not required for Option 3

PM CEMS

Permissible Monitor Types for UMACT Compliance

- Light Scatter
- Scintillation
- Beta Attenuation
- Mass Accumulation

Back Scatter Extractive

Back Scatter In-Situ

Beta Gauge Extractive

PM Model Types

Model	Type	Wet Stack	Capital Cost	O&M Cost	Notes
SICK SP100	Light Scatter		$	$	Insitu
SICK FWE-200	Light Scatter	X	$$	$$	Extractive
TML LaserHawk	Light Scatter		$	$	Insitu
MSI BetaGuage	Beta	X	$$$	$$$	Extractive
PCME 181	Light Scatter	X	$$	$$	Extractive
Durag D-R 300	Light Scatter		$	$	
Preciptech CPM	Scintillation		$	$	CPMS/Leak Detector

Note: Thermo hybrid PM CEMS – Not commercially available.

PM CEMS Certification

PM CEMS must initially be certified in accordance with 40 CFR Part 60, Appendix B, Performance Specification 11

- Test to generate a correlation curve between the particulate concentration and the unit load
- Requires at least 15 Paired samples
  - 3 loads, 5 runs per loading level
  - usually requires more than the minimum number of runs
- Tests are time consuming and expensive (35k-50k), and often cause problems with the state regulatory agency

Ongoing QA/QC procedures outlined in 40 CFR 60, Appendix F, Procedure 2

- Absolute Correlation Audit (ACA) – Challenge the analyzer with three filters
- Response Correlation Audit (RCA) - Basically 12 run PS -11
- Relative Response Audit (RRA) – 3 particulate tests, normal load

CPMS

MATS requires the same analyzer technology as a PM CEMS

- Analyzer does not require certification

Compliance based on annual stack test results

- Parametric data recorded during annual compliance tests
- A parameter range is determined during the annual testing
- Unit is deemed compliant as long as the CPMS is operating within this range

PM CEMS vs. CPMS

UMATS allows for EITHER PM CEMS OR CPMS

Both technologies must use Light Scatter, Scintillation, Beta Attenuation, or Mass Accumulation

<u>What is the Difference ?</u>

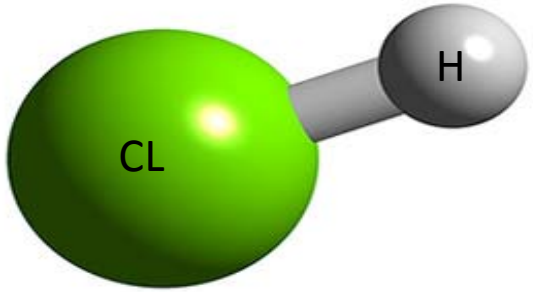
CPMS – Not a certified PM CEMS – Similar technology

- Parametric limit is determined from annual testing

PM CEMS – Initial capital cost & testing is more $$

PM CEMS – Exempt from Opacity monitoring (Pending state approval)

HCL Compliance



UMATS – HCl/SO2 Limits

EGU Category	HCl		SO2 *	
Existing Units	lbs/mmBTU	ppm@ 3% O2	lbs/mmBTU	ppm@ 3% O2
Coal (Not Low)	0.002	1.9	0.2	105.5
Coal (Low Rank)	0.002	1.9	0.2	105.5
IGCC	0.0005	4.9	NA	NA
Liquid Oil-Cont.	0.0002	2.0	NA	NA
Solid Oil (Coke)	0.005	4.6	0.3	158.3
NEW Units	Lbs/GWh		Lbs/GWh	
Coal (Not Low)	0.4	0.04	0.4	20.5
Coal (Low Rank)	0.4	0.04	0.4	20.5
IGCC	2	0.2	0.4	20.5
Liquid Oil-Cont.	0.4	0.04	NA	NA
Solid Oil (Coke)	0.4	0.04	0.4	20.5

* SO2 Limit only for units with FGD

Compliance Options

Continuously monitor HCL concentrations

Continuously monitor SO_2 concentrations

- Coal fired sources already have SO_2 analyzers installed
- Requires that the source has a wet or dry FGD
- Once a plant opts in to using SO2 as a surrogate, the 0.20 lb/MMBtu limit becomes federally enforceable
  - some clients choosing not to use this option, due to the reduction of fuel flexibility

HCL

Limit is 0.002 lbs/mmBTU (~1.9 ppm) – Coal fired units

Initial and Annual testing – Method 26 or 26A

Annual compliance tests are $14K – 3 – 1 hour runs

HCl CEMS types:

- FTIR – Hot, wet extractive
- TDL – In-situ, cross stack/duct
- Gas Filter Correlation Infra-red (GFC) – Hot, wet extractive

New probes/ports required for most applications

HCl CEMS have been in use for many years on waste incinerator applications

HCl - FTIR

Fourier Transform Infrared

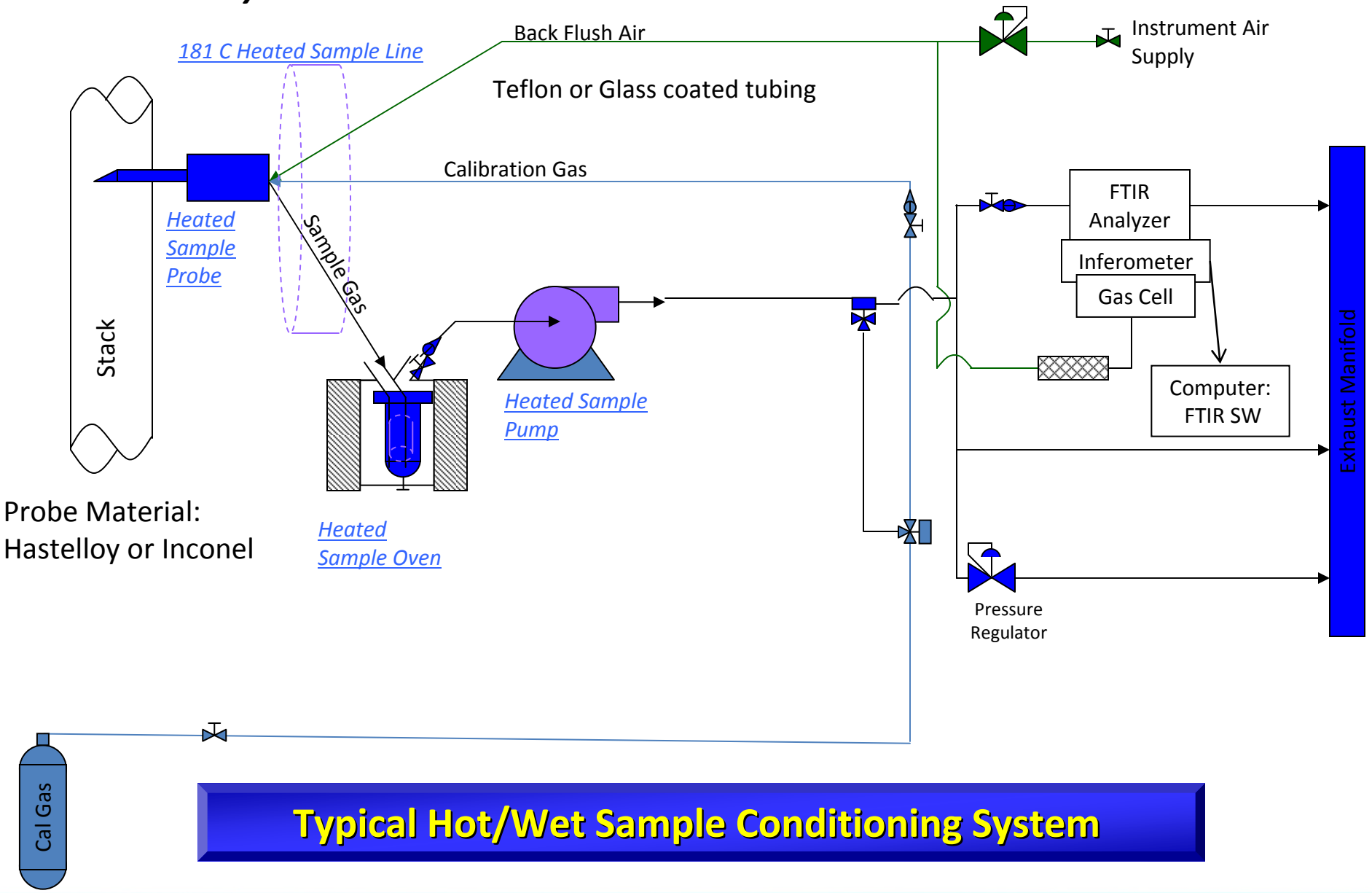
- Extractive, Hot, wet CEMS
- System consists of:
  - Rack mounted analyzer
  - Heated Sample Line
  - IR Source
  - Long path gas cell
  - Inferometer

- Detector creates interferogram of sample stream

Issues – HCl sample stream losses

- H2O interference, probe pluggage
- Slow response
- Setup and calibration – Software ease of use
- Lack of an EPA Performance Specification

FTIR Extractive System



Typical Hot/Wet Sample Conditioning System

TDL – Tunable Diode Laser

Utilizes an in-situ IR analytical technique

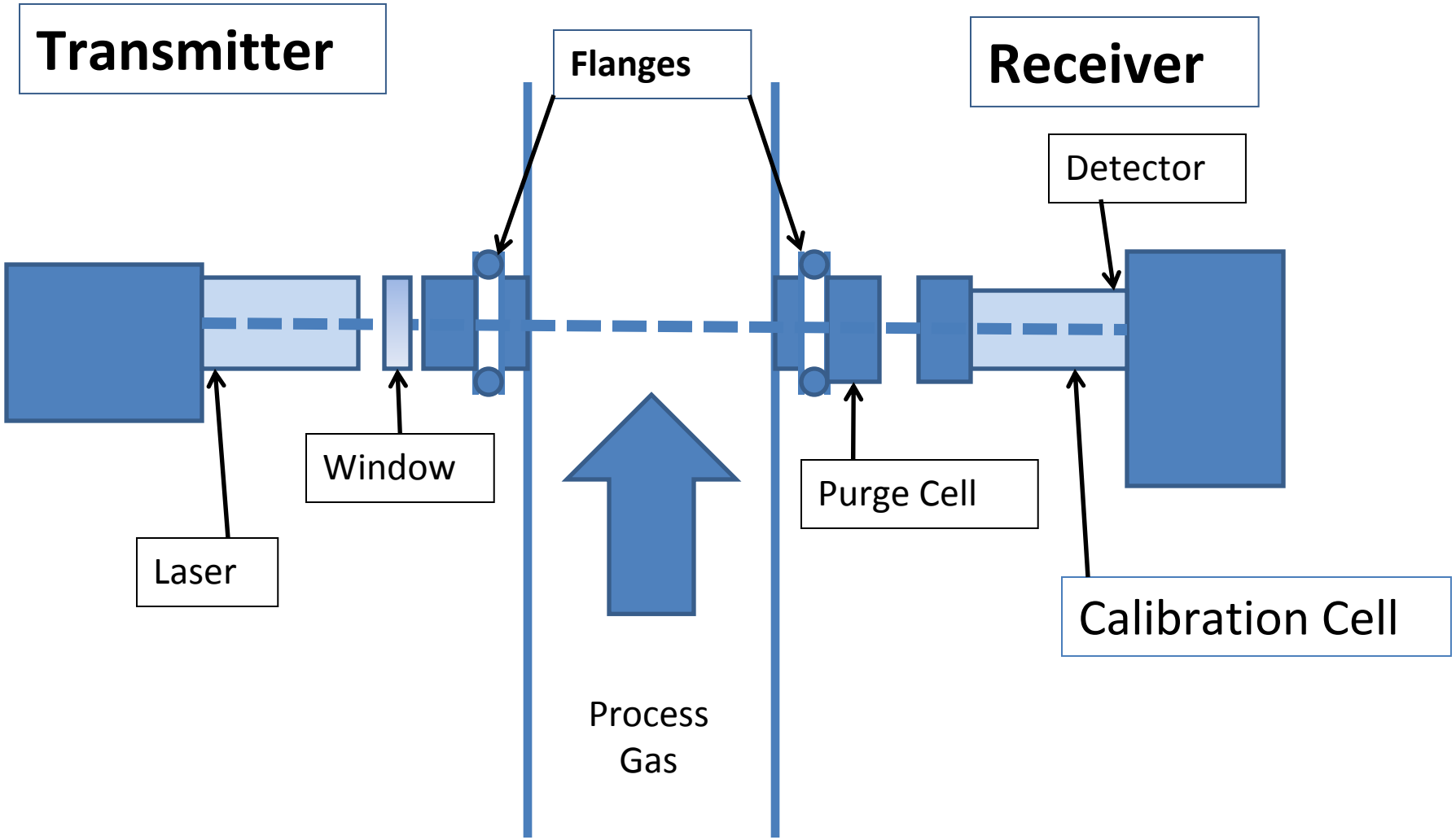
Advantages

- Highly Selective
- Measure low concentrations
- Eliminate cross-interference
- Single digit measurement
- Fast response

Disadvantages

- Can't monitor multiple parameters
- Difficult to calibrate on the stack
- Calibration standards unavailable
- Difficult to keep aligned
- Vibrations cause problems

Typical TDL Cross Stack Configuration



In-Situ Methods & Issues

Path length & particulate densities affect accuracy

Limitations on stack gas temperatures

Measurement must be temperature & path length corrected

Issues:

- Speciation and cross-interference
- Vibration, alignment high velocities
- Inability to be challenged with calibration gas

Mercury Compliance

UMATS – Hg Limits

EGU Category	Hg	
Existing Units	Lbs/tBTU	ug/Scm
Coal (Not Low)	1.2	1.97
Coal (Low Rank)	4.0	6.50
IGCC	2.5	4.81
Liquid Oil-Cont.	0.05	0.09
Solid Oil (Coke)	0.2	0.33
NEW Units	Lbs/GWh	
Coal (Not Low)	0.0002	0.03
Coal (Low Rank)	0.04	6.30
IGCC	0.003	0.56
Liquid Oil-Cont.	0.0001	0.02
Solid Oil (Coke)	0.002	0.32

Hg Compliance Options

Continuous Monitors must be installed

- Two technologies currently available
  - Hg analyzer
  - Continuous Sorbent Trap Monitoring System

Sorbent Trap System

Hg Monitoring – Technology Comparison

- Both Hg CEMS and Sorbent trap are certified using Method 30B
- Hg CEMS have continuous data – Sorbent trap gives weekly updates (5-7 days)
- Sorbent trap is lower capital cost
- O&M costs for each similar – Hg CEMS may be higher maintenance for some applications
- Control Device for Hg is a factor in deciding continuous vs. sorbent trap

Hg Monitoring - Cost Comparison

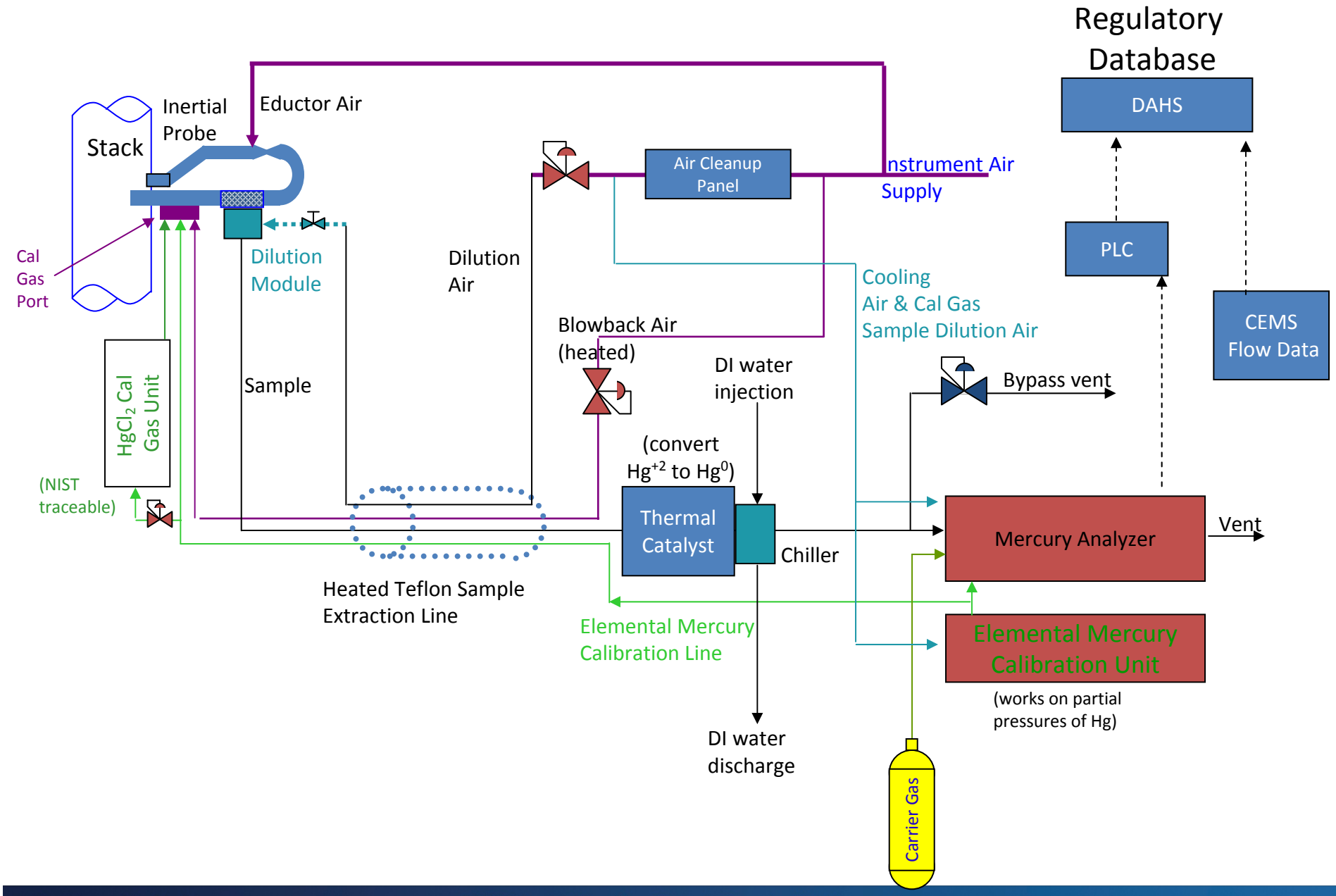
$K	Hg CEMS	Hg Sorbent Trap
Capital	220	90
Installation	100	49
1st year O&M	30	37
Total	350	177

Notes:
1. Certification costs are equivalent
2. Annual certification test costs are similiar
3. Sample Line costs are excluded
4. Cost of air compressor for Hg CEMS should also be considered
5. Sorbent trap need easy access to probe location

Hg CEMS

- Typical design is a dilution extractive system
- Analyzer measures elemental Hg
- Measurement levels are extremely low - ppt
- Ionic Hg is converted to elemental Hg
- Hg CEMS are more complex than conventional CEMS
- Capital, installation, and O&M costs are higher
- Alternative to Hg CEMS is Sorbent Trap System (non-continuous)

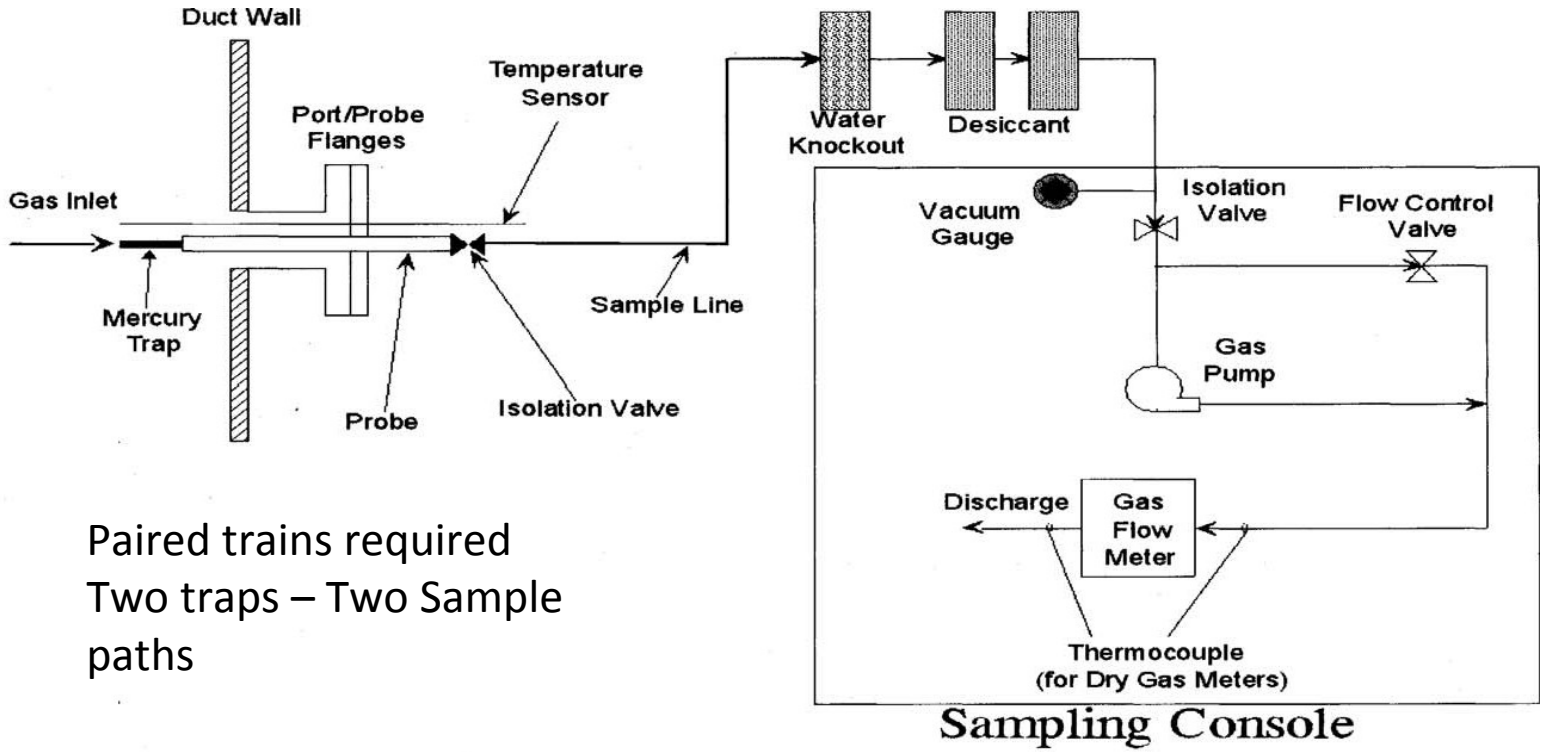
Hg CEMS - Integrated Design



Hg Sorbent traps

- Can be used instead of CEMS measurement & also for ref. Method stack tester
- Uses dual train carbon traps mounted in tip of probe in stack
- Hg is collected on carbon traps and sent to lab for Hg analysis (every 5-7 days)
- Must measure sample flow, stack flow, and stack conditions
- Issues: Loose 5-7 days of data if traps fail QA tests
- Hg reading are batch sample – I.e. Non-Continuous

Typical Sorbent Trap Monitoring System



Paired trains required
Two traps – Two Sample paths

Summary

Particulate Matter

- PM CEMS
- CPMS and Annual Testing
- Quarterly testing for PM or Non-Hg HAP Metals

Hydrogen Chloride

- FTIR - More accurate but more expensive
- TDL- Cheaper and easier to integrate, may have some issues with data accuracy

Mercury

- Mercury CEMS - Costlier method, however real time data is available
- Sorbent Trap System - Cheaper method, however data is not available and it is more labor intensive for the plant personnel

CEMS Questions?

Data Acquisition and Handling System

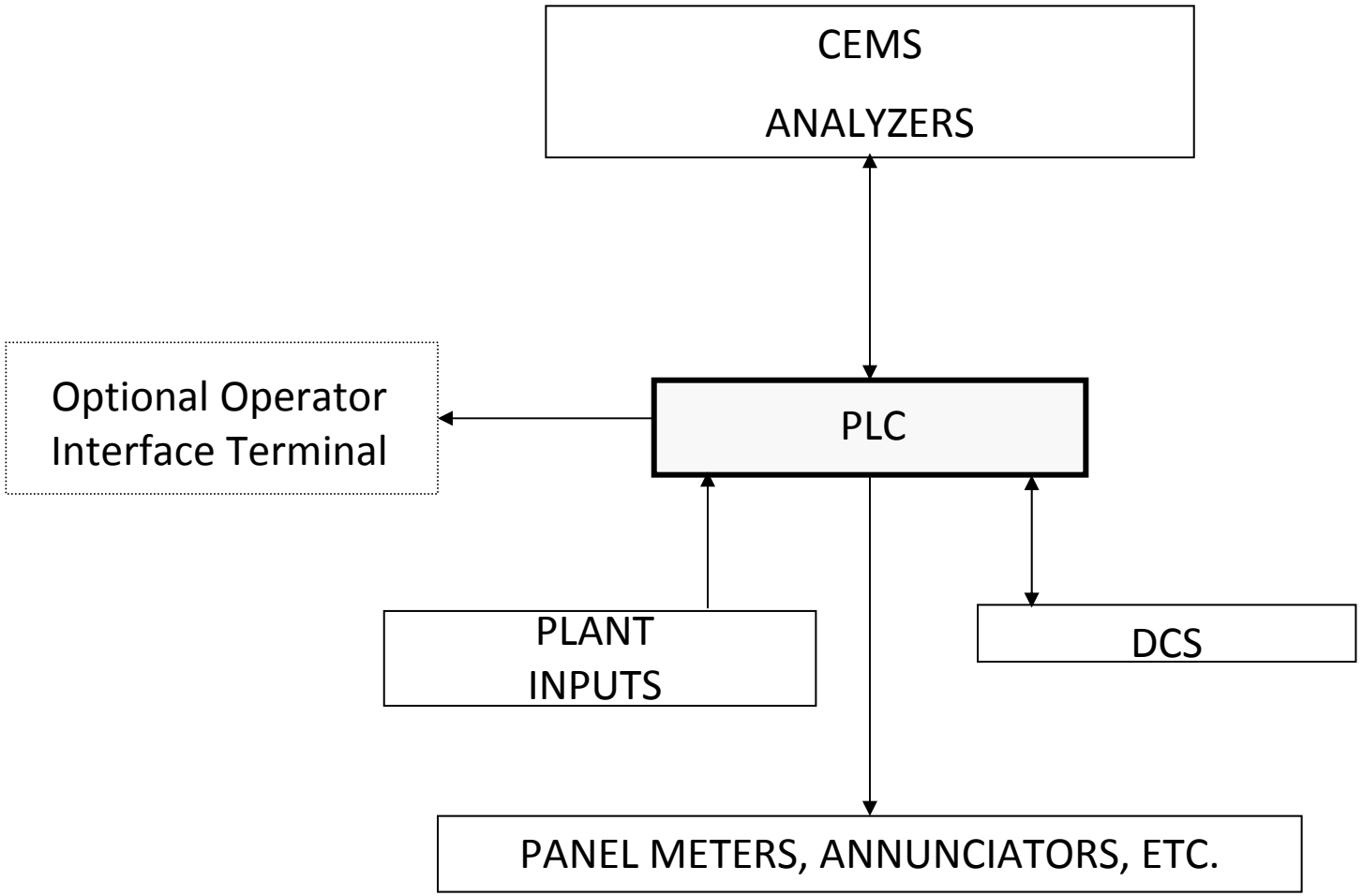
Place to view, store, and reduce data from the CEMS

Can receive data directly from the analyzers serially, by ethernet, or via analog 4-20ma signals

Can also get an already calculated concentration/rate that is calculated externally (PLC)

Helps to ensure compliance through a series of alarms and episodes

General Data Acquisition Diagram

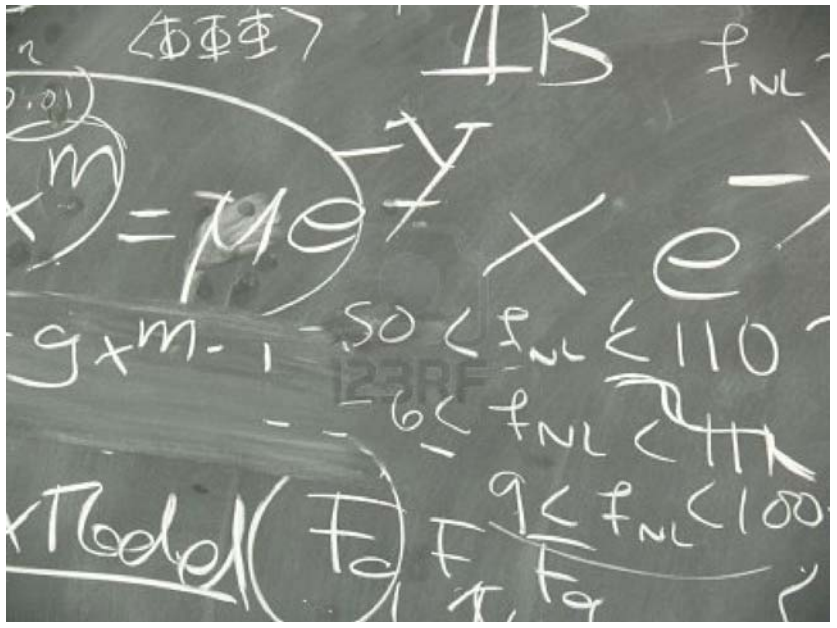


DAHS Functions

Data Validation

Data Reduction

- uses pre-programmed formulas to reduce the data to the proper engineering units
  - ppm @ 15% O2
  - lb/hr
  - lb/MMBtu
  - TPY
  - lb/MWhr
  - lb/tons of clinker



Compliance Tool

Data Reporting

Data Validation

Determines if a valid hourly average can be calculated based on:

- Calibrations – did they pass, has one been performed?
- Number of valid minutes in the hour
- Faults
- Operating mode of the Unit - SUSDMALF

Calibration Criteria Part 60 vs. Part 75

Part 60

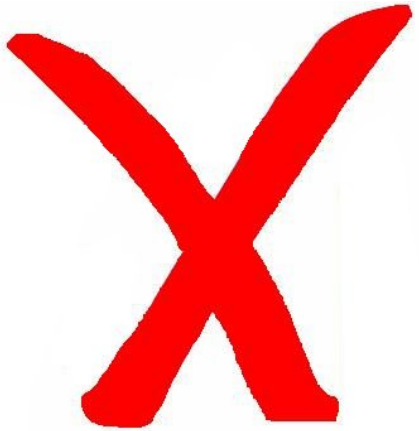
- Pass/Fail
  - >5% of span for 5 consecutive days
  - > 10% of span once
- Frequency
  - Must be performed daily(24 hours)

Part 75

- Pass/Fail
  - >2.5% of span for gaseous analyzers
  - > 3.0% of span for flow monitors
- Frequency
  - must be performed once every 26 online hours

Using Your DAHS to Track Compliance

- Each permit limit set up as an episode
- Alarms can be configured to warn users of an episode
- Real time display and historical trending screens
- Most DAHS packages are able to apply the required data substitution for periods of missing data



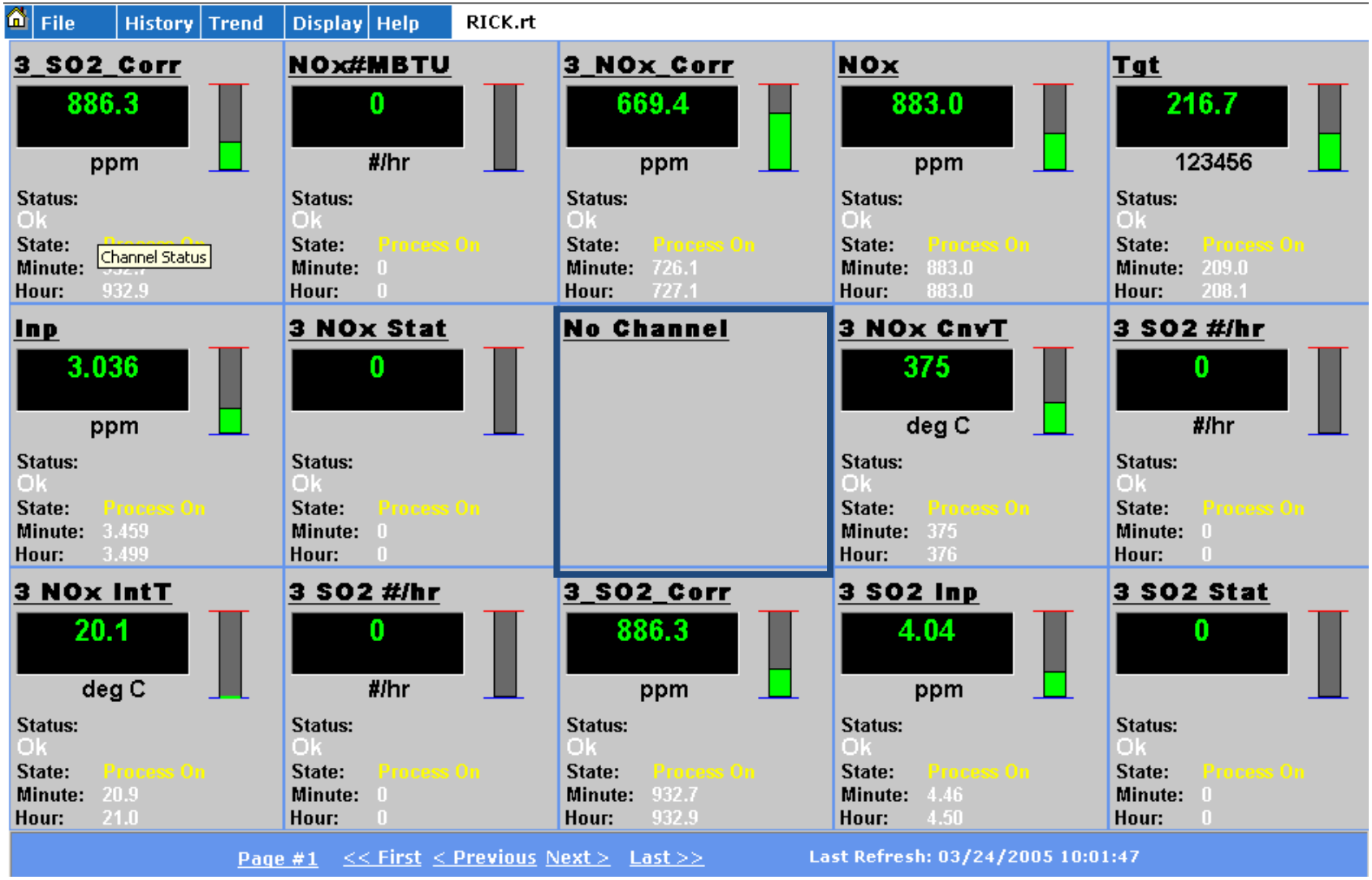
Alarms History

Select | Options | Statistics | Filter | Silence | Acknowledge | Legend | Help

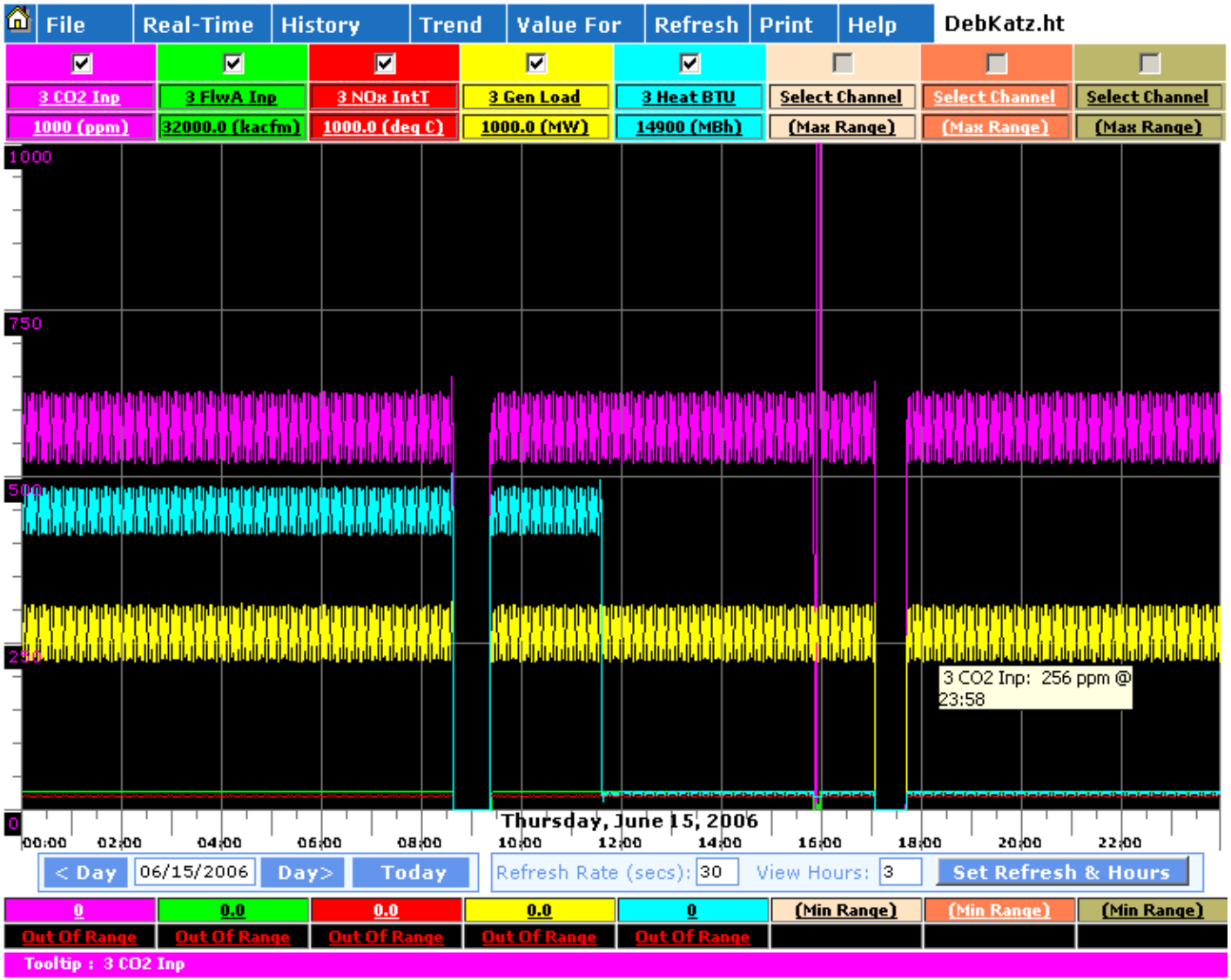
Page# 1

All	In Alarm	Out Alarm	Ack Alarm	By	Alarm ID	Description
☐	01/10/2004 07:37:16				3 SO2 Corr LO	SO2 Corr Exceeds limit - 0
☐	01/10/2004 07:37:05	07:37:15			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	01/09/2004 07:37:23	07:37:34			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	01/08/2004 07:37:14	07:37:24			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	01/07/2004 07:37:24	07:37:35			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	01/05/2004 07:37:04	07:37:15			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	01/04/2004 07:37:14	07:37:24			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	01/03/2004 07:37:24	07:37:33			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	01/02/2004 07:37:15	07:37:25			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/30/2003 07:37:01	07:37:11			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/29/2003 07:37:11	07:37:21			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/28/2003 07:37:12	07:37:21			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/26/2003 07:37:14	07:37:23			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/22/2003 07:37:12	07:37:21			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/21/2003 07:37:09	07:37:19			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/18/2003 07:37:10	07:37:20			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/15/2003 07:37:00	07:37:10			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/13/2003 07:36:53	07:37:03			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/12/2003 07:37:09	07:37:20			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/10/2003 07:37:10	07:37:19			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/08/2003 07:37:03	07:37:12			3 SO2 Corr High	SO2 Corr Exceeds limit - 840
☐	12/06/2003 07:37:11	07:37:21			3 SO2 Corr High	SO2 Corr Exceeds limit - 840

Real Time *(Display)*



Trending Screen *(Historical Trend Screen)*



DAHS Reporting

Various Types of Reports Can be Configured on a DAHS

- QA/QC Audit reports – calibration drift, CGA, Linearity, RATA
- Episode list report – list of all permit limit exceedances
- CEMSUM report – report that lists online time, periods of unit start up/ shut down and the % availability for each analyzer
- State specific reports that are configured on a project by project basis
- Federally Required Electronic Data Reports (EDR)
  - Some DAHS packages can automatically create Part 75 required EDR files for the user to upload the EPA's Emission Compliance and Monitoring Plan System (ECMPS)

MATS Data Reporting

- Sources will be required to submit HCL/SO2 and Hg CEMS data to the EPA via ECMPS
- DAHS should be able to add these data and certification elements to the sources XML EDR file for upload

Thank You
Questions?

jkmillard@babcock.com
215-997-4212