Introduction to Air Quality: Air Emissions 101

By John Downs

CEMTEK KVB-Enertec

Agenda

- Brief History of Regulations
- Regulatory Drivers for CEMS
- What is a CEMS?
- Quality Assurance of CEMS
- Summary & Question

CEMTEK KVB-Enertec

US Clean Air Act History

- 1963 – Clean Air Act - established funding for the study and the cleanup of air pollution
- 1969 – National Environmental Policy Act
  - Signed by Nixon 1/1/1970
- 1970 - Congress passed much stronger CAA
  - Sets NAAQS
  - Requires state to develop SIPS
- 1970 - Congress also formed the US EPA.

CEMTEK KVB-Enertec

US Clean Air Act History

- 1977 – CAA Amended to add PSD permitting
  - Implementing New Source Review (NSR)
  - Added Non-Attainment to NAAQS
- 1990 – CAA Amended - Congress dramatically revised and expanded the Act, providing EPA even broader authority to implement and enforce regulations in effort to reduce air pollutant emissions.
  - Emphasis of 1990 CAAA: acid rain, urban air pollution, and toxic air emissions.
    - Through National Permitting program – Title V
    - Establishing improved Enforcement program
- 2000's and beyond

CEMTEK KVB-Enertec

Clean Air Act Milestones

- 1990 – Amendments added Title V operating permit program and SO_2/NO_X reduction programs.

Major Sections of the Clean Air Act:	
Title I: *Air Pollution Prevention & Control* • Emissions Limits (Part A) • PSD (Part C) • Nonattainment (Part D)	**Title III**: *General*
	Title IV: *Acid Deposition Control*
	Title V: *Permits*
Title II: *Mobile Sources*	**Title VI:** *Stratospheric Ozone Protection*

CEMTEK KVB-Enertec

Agenda

- Brief History of Regulations
- Regulatory Drivers for CEMS
- What is a CEMS?
- Quality Assurance of CEMS
- Summary & Question

CEMTEK KVB-Enertec

Title IV: Acid Rain Program

- Intended to reduce both NO_X and SO_2 emissions in effort to achieve significant public health benefits.
- Includes emissions limits and allows facility's to trade emissions holdings: Cap-and-Trade
- Facilities were allocated allowances – in the form of an emissions unit.
  - One ton of SO_2 or NO_X = one allowance
  - Allowances can be banked, bought, and sold
- End of year reconciliation – a facility must hold enough allowances to cover previous years emissions

CEMTEK KVB-Enertec

ARP + Part 75

- Emissions Monitoring requirements of ARP are found in 40 CFR Part 75
- ARP generally includes Part 72 through Part 78.
- Part 75 is the primary implemented rule that the CAA set to be used for compliance demonstration
  - Definitions are found in Part 72
  - Part 73 covers SO_2 allowance system
  - Part 74 covers SO_2 opt-in facilities
  - Part 75 sets CEMS requirements
  - Part 76 – NO_X emissions reductions
  - Part 77 – Excess Emissions
  - Part 78 – Appeals process.

CEMTEK
KVB-Enertec

Acid Rain Program (cont.)

- ARP requires sources to monitor and report emissions:

SO_2	NO_X
CO_2	Heat Input
Volumetric Flow	Opacity

- Requires all emissions to be accounted for – sets up procedures for estimating missing data
- Requires monitoring equipment to have initial and on-going certification testing
- Sets up periodic Quality Assurance/Quality Control procedures

CEMTEK KVB-Enertec

Part 75 - Monitoring

- The ARP requires regulated sources to measure, record, and report emissions using continuous emission monitoring systems (CEMS) or an approved alternative measurement method:
- CEMS are the primary method
- Alternative methods use estimations based on fuel combustion.
  - Sometimes referred to as an Appendix D/G unit.
  - Some sources do not continually measure emissions, initial and periodic tests are used to extrapolate and estimate emissions data. (APPE, LME)

CEMTEK
KVB-Enertec

New Source Performance Standards: Part 60

Part 60 is the New Source Performance Standards (NSPS)

Part 60 is divided into numerous Subparts.

Each subpart is either an emissions unit specific or an industry specific standard.

Subpart A covers General Provisions of Part 60

Gas Turbines subparts found in GG and KKKK

GT Specs in Part 60

GT's constructed between 10/3/77 and 2/18/2005 , with capacity greater the 10.0 mmBtu/hr are regulated under GG 40 CFR 60.330 – 60.335, *Subpart GG Standards of Performance for Stationary Gas Turbines*

The HRSGU are subject to 40 CFR Part 60.40Da - Standards of Performance for Electric Utility Steam Generating Units

GT's constructed after 2/18/2005 , with capacity greater the 10.0 mmBtu/hr are regulated under KKKK 40 CFR 60.4300 -60.4420, *Subpart KKKK Standards of Performance for Stationary Combustion Turbines*

KKKK includes standards for HRSG, but does not include HHV contribution from HRSG in determining KKKK applicability.

Transport Rule / Cross-State Air Pollution Rule (CSAPR)

Downwind emissions are another issue EPA addressing.

- Facilities in 27 US states are subject to CSAPR 40 CFR Part 96/Part 97
- Reduces NO_X Mass and SO_2 mass emissions.
  Annual and O3 season reporting
- Data processed under Part 75 rules:
  Reported via ECMPS

CEMTEK KVB-Enertec

Part 75/Part 60 Harmonization

- In 2007 EPA passed Harmonization rule.
  - **Data from certified Part 75 monitors (SO_2, NO_x, CO_2, O_2, and flow rate) to be used to demonstrate compliance with the Part 60 emission limits**
  - **The QA/QC procedures in Part 75, Appendix B to be followed instead of the procedures in Part 60, Appendix F**
  - **Part 75 bias-adjusted data and substitute data are not to be used for Part 60 compliance determinations**
  - **For units subject to a lb/mmBtu SO_2 standard, the RATA of the SO_2 CEMS must be done on a lb/mmBtu basis and meet the RA specification in PS 2, in addition to meeting the Part 75 RA specification on a ppm basis**

CEMTEK KVB-Enertec

Non-Harmonized P75/P60

- In 2007 EPA passed Harmonization rule.
  - **Some Differences where units must comply with both:**
    - **If the span value of an SO_2 or NO_x monitor is < 100 ppm, the calibration drift and out-of-control provisions in section 4.3 of Appendix F must be followed for Part 60 data validation**
    - **If the span value of an SO_2 or NO_x monitor is ≤ 30 ppm, cylinder gas audits (CGAs) must be performed according to section 5.1.2 of Appendix F**
    - **Daily Calibrations:**
      - **Part 75 daily Calibration failure sets monitor OOC if result 2x perf spec;**
      - **Part 60 OOC if result for 5x days > 2x perf spec → Part 75 takes precedence**
      - **Part 60 OOC from last good cal if cal result >4x perf spec.**
        - **Result that minute data and thus hourly date for Part 60 reporting would be OOC back upto 24 hours, i.e. since last valid calibration**
      - **Part 60 does not require calibration to be online (while emissions unit in operation) / Part 75 requires online cal minimum every 26 unit process on (operating) hours.**

CEMTEK KVB-Enertec

Air Permit vs. Part 75

- *Pipeline natural gas* - "... Pipeline natural gas contains 0.5 grains or less of total sulfur per 100 standard cubic feet. Additionally, pipeline natural gas must either be composed of at least 70 percent methane by volume or have a gross calorific value between 950 and 1100 Btu per standard cubic foot." – (40 CFR 72.2)
  - *Many permits limit fuel sulfur content with limits that are higher than Part 72 defines.*
- *Natural Gas* - Maximum sulfur content of 20 grains per 100 dry standard cubic feet (dscf) … in Part 72 and other regulations, e.g. § 60.331(u).
- Example from permit: Special Condition 3: "… fuel shall contain no more than 5 grains total sulfur per 100 dscf (0.5 grains total sulfur per 100 dscf averaged over any consecutive 12-month period)." - (July 2012 PSDTX936 permit)
  - Part 75 is more restrictive: DAHS is configured to use Part 75 methods.

CEMTEK
KVB-Enertec

Regulatory Drivers

- Facilities install CEMS to satisfy:
  - Permit Conditions
  - NSPS requirements
  - NESHAP requirements
  - Acid Rain requirements
- Excess Emissions (Permit Limits)
- Annual Emissions Inventory requirements
- NBP, CSAPR, GHG reporting
- Process Controls – APC control

Agenda

- Brief History of Regulations
- Regulatory Drivers for CEMS
- What is a CEMS?
- Quality Assurance of CEMS
- Summary & Question

CEMTEK KVB-Enertec

Monitoring

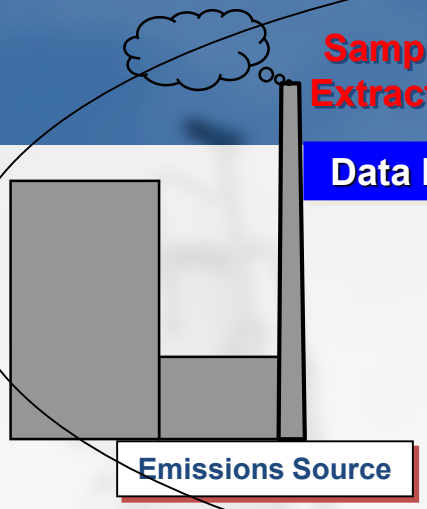
- Many Federal, State regulations and air permits require monitoring
- Type of monitoring system installed 100% dependent on what your sites processes are
- Typical CEMS:
  - *Dilution → Dilution In Stack; Dilution Out of Stack; Dry Dilution Out of Stack*
  - *Dry Extractive*
  - In Situ
  - Cross Stack In Situ
  - Wet Extractive

CEMTEK KVB-Enertec

What is a CEMS/DAHS?

What is *Emission Monitoring*?

Emission Monitoring



CEMS Hardware

Main Components Include:

Stack Sample Probe

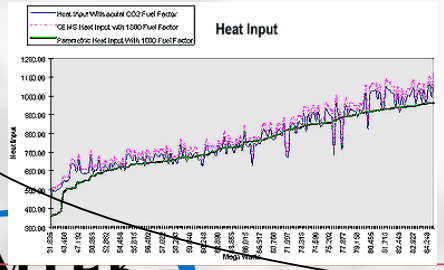
- Analyzers
- Flow meters
- Conditioning Equipment
- Programmable Logic Controller
- DAHS Software

System Design Technology

Software Technology

Data Acquisition and Handling System (DAHS)

Data Flow



- Data Recorded, Processed and EPA Report Generated
- Plant Monitoring Emissions for Site Performance
- Site Emission Report Electronically Delivered to Plant Manager

CEMTEK KVB-Enertec

Types of CEMS

- Conventional Extractive (Wet or Dry Basis Measurement)
  - Hot Wet - Wet Basis
  - Cool Dry with condenser near the CEMS Shelter - Dry Basis
  - Cool Dry with condenser at the probe - Dry Basis
- Dilution Extractive (Wet Basis Measurement)
  - In Stack Dilution
  - Out of Stack Dilution
- In-situ (Wet Basis measurement in the stack)
  - Point
  - Path

CEMTEK KVB-Enertec

Full Extractive CEMS

- Representative sample of the flue gas is continuously withdrawn from the stack, transported to a CEMS shelter and analyzed
- Transported samples are done via heated sample line to a conditioner.
- Conditioner filters out particulate matter and then dries the sample to remove moisture prior to sample pump and analyzer
  - Extractive systems usually make measurements on a dry basis
- Used where emissions are generally lower
- O_2 can be measured

CEMTEK
KVB-Enertec

Dilution Extractive CEMS

- Similar to full extractive, with differences
- Flue gas is diluted with clean dry air to lower the dew-point of the sample
  - Eliminates the need for
    - Heated sample lines
    - Moisture removal system
- In Stack Dilution
  - Critical Orifice is in the probe
  - Sample Temperature is Stack Temperature
  - Quicker response than out of stack dilution
  - No temperature controls to maintain

CEMTEK KVB-Enertec

In-Situ CEMS

- In-situ CEMS differ from extractive CEMS in that they use instruments to continuously monitor the flue gas directly and do not use an extracted, conditioned sample.
- Point In-Situ CEMS
- Point in-situ CEMS continuously measure the concentrations directly from the stack gas at a single point or along a short path within the stack
- Path In-Situ CEMS
- Path or cross-stack in-situ CEMS, Continuously measure the concentrations directly from the stack gas. However, instead of measuring the concentrations at a single point, they use a light beam projected across the entire path of the stream of gas to analyze the concentrations.

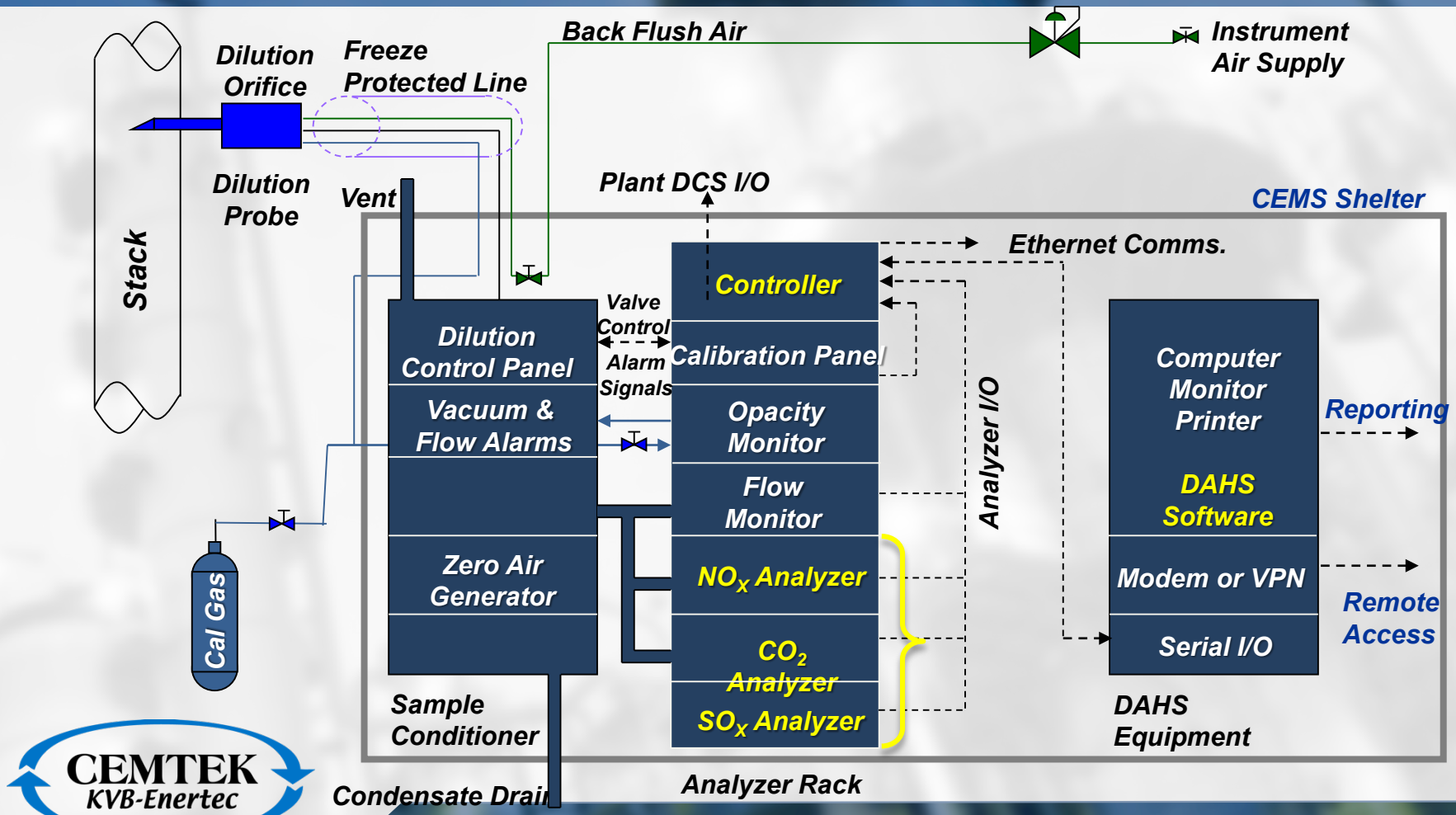
CEMTEK
KVB-Enertec

Where are Dilution CEMS Installed?

- Dilution CEMS are installed at locations where the flue gas is:
  - Too Wet
  - Too Hot or
  - Too dirty for analyzers to handle
- Around 90% of the SO_2 measurements use dilution CEMS
- A little less than 50% of all NO_X analyzers installed are dilution CEMS.

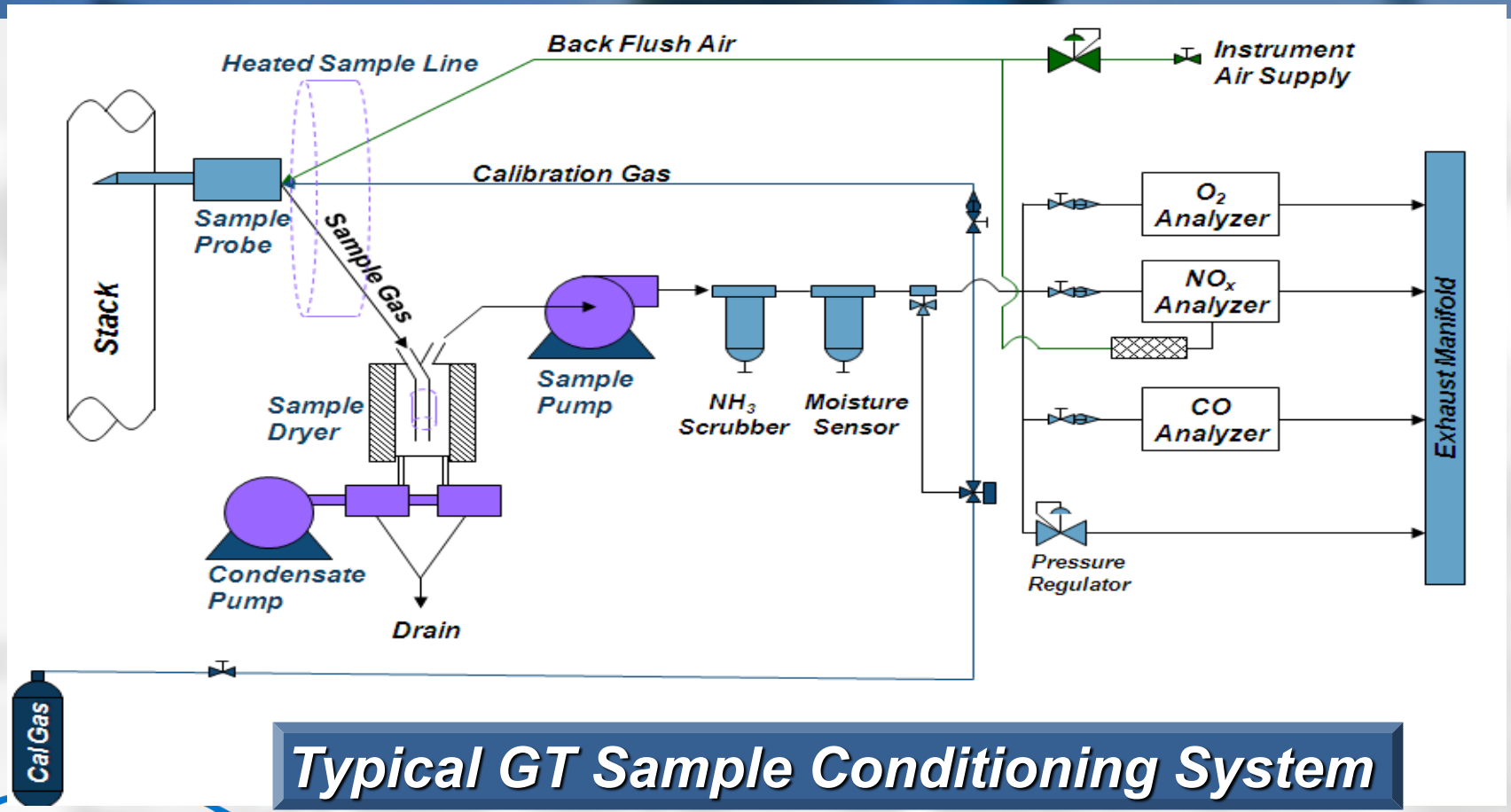
CEMTEK KVB-Enertec

Typical Dilution CEMS



CEMTEK KVB-Enertec

Typical Extractive System



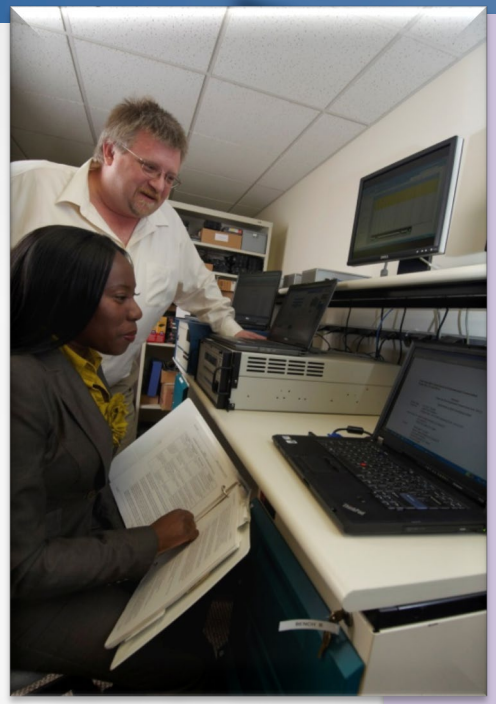
Typical GT Sample Conditioning System

CEMTEK KVB-Enertec

Continuous Emissions Monitoring Systems (CEMS)

CEMTEK
KVB-Enertec

Different Types of CEMS



- Dilution CEMS – Used when emissions are higher or sticky
- Extractive CEMS – Regulatory & Process Control
- CFDS – Coal Fired Detection Systems
- Opacity, particulates and stack flow monitoring
- Closed loop and remote emissions control
- DAHS – USA Part 60, 63, & Part 75, State, Local & International
  (Data Acquisition and Reporting system/software)
- Predictive emissions monitoring systems
- Mercury CEMS; HCl CEMS, others

CEMTEK
KVB-Enertec

Specialized CEMS

- In-Situ CEMS
- Laser
- Fence-line
- Over time, CEMS have evolved to meet specific drivers

• Hg	• PM
• TDL	• HCL
• FTIR	• Metals + other needs

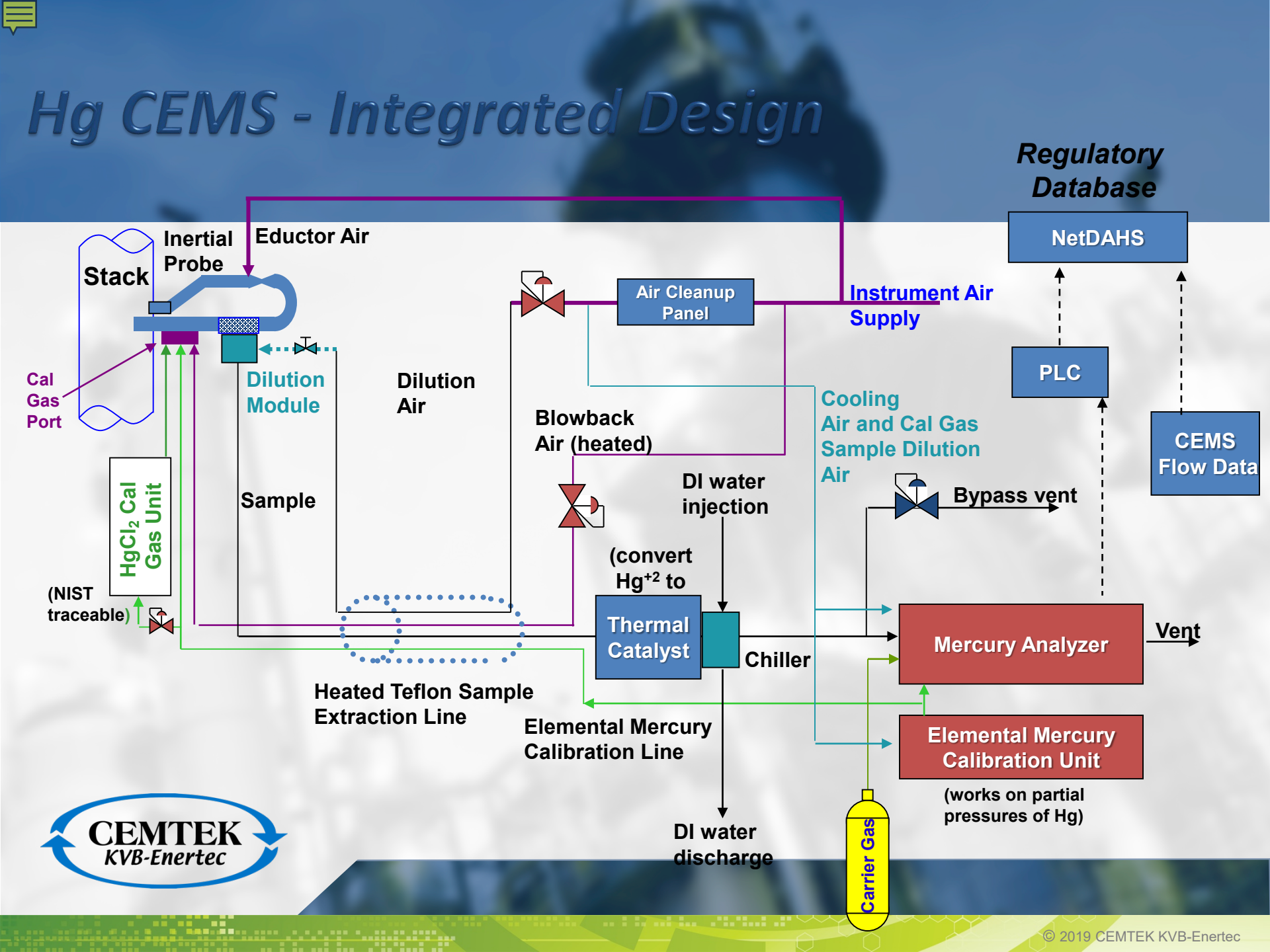
CEMTEK KVB-Enertec

Hg CEMS vs. Hg Sorbent Trap

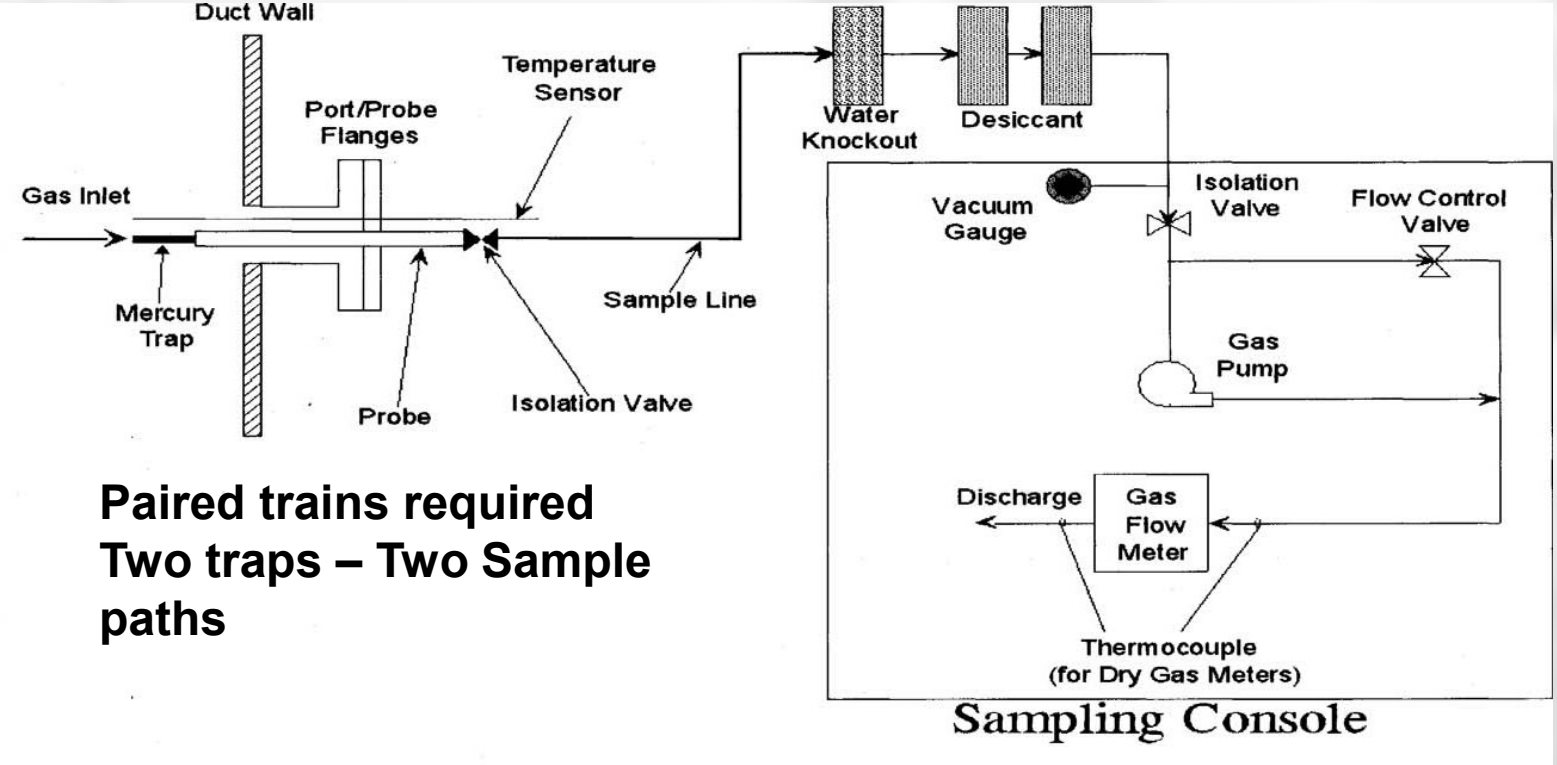
- Facilities subject to MATS, PCMACT, etc. are required to meet Hg emissions limits
- Methods for demonstrating compliance include:
  1. Qualifying as a Low Emissions EGU
  2. Installation of a Hg CEMS or
  3. Install and certify Hg Sorbent trap monitoring system

CEMTEK KVB-Enertec

Hg CEMS - Integrated Design



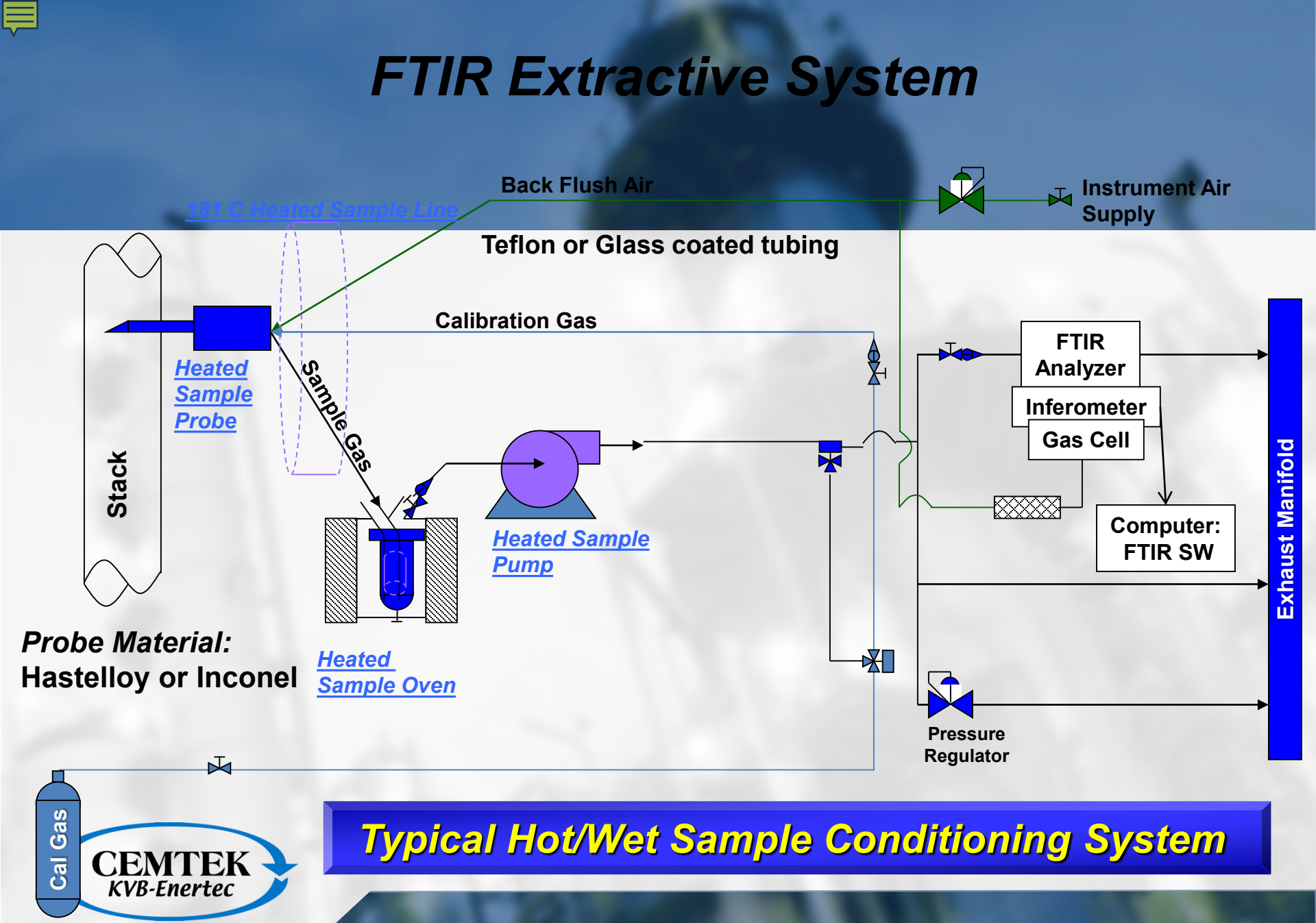
Typical Sorbent Trap Monitoring System



Paired trains required
Two traps – Two Sample paths

CEMTEK KVB-Enertec

FTIR Extractive System



Typical Hot/Wet Sample Conditioning System

Particulate Matter (PM) CEMS – Analyzer Techniques and Suppliers

Popular Techniques:

- Light Scattering (TML, Durag, Sick-Maihak, PCME)
- BETA Gauge (Durag, MSI)

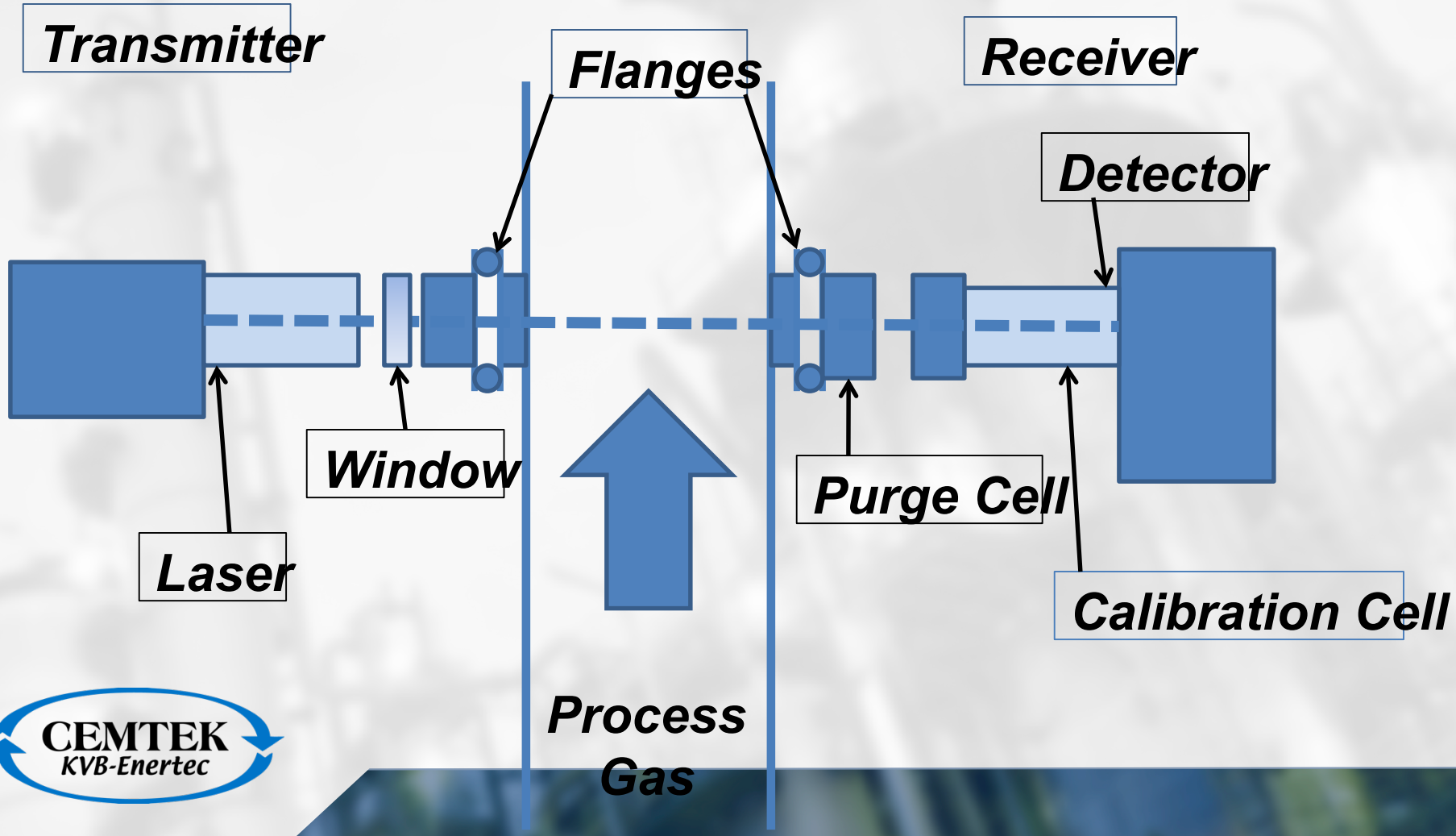
Other Technologies

- Optical Scintillation (PCME)
  (Commonly used for bag house leak detection)
- Electrification or Triboelectric (Codel, Auburn, PCME)
  – Cannot be used for MATS
- Opacity monitors – Optical Density
  (does not meet US EPA PS-11) – Cannot monitor PM mass and low PM levels
- **Opacity Monitors are adversely affected by changes in Particle size, shape, density changes**

PM Measurement Methods

CEMTEK
KVB-Enertec

Typical TDL Cross Stack Configuration



CEMTEK KVB-Enertec

Monitored Emissions means Information

Continuous Emissions Monitoring …the Hardware

Utilities, refineries, many other Industry

Sample Flow

Signal Flow

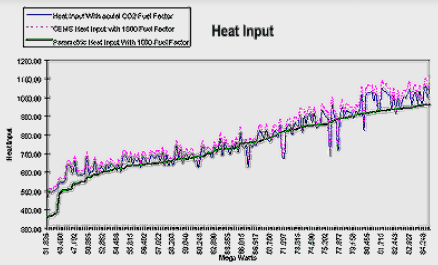
System Design

Stack Sample Probe

- Analyzers
- Flow meters
- Conditioning Equipment
- Programmable Logic Controller

Information Flow

Software Technology



- Data Recorded, Processed and EPA Report Generated
- Plant Monitoring Emissions for Site Performance
- Site Emission Report Electronically Delivered to Plant Manager

Agenda

- Brief History of Regulations
- Regulatory Drivers for CEMS
- What is a CEMS?
- Quality Assurance of CEMS
- Summary & Question

CEMTEK KVB-Enertec

CEMS Quality Assurance

- Quality assurance (QA) is defined as an integrated system of management activities involving planning, training, quality control, assessment, data review, reporting, and quality improvement to ensure that a process, item or service is of the type and quality needed and expected by the user.

- QA is a management function that deals with setting policy and running an administrative system of controls to ensure the usability of the product (e.g., data).

CEMTEK KVB-Enertec

CEMS Quality Control

- Quality control (QC) is defined as a system of technical activities that measures the performance of a process, item, or service against a defined set of criteria or standards established by QA requirements.
- QC is a technical function that includes activities such as calibrations and analyses of check samples (performance evaluation samples, duplicates, spikes, blanks, etc.) to assess the bias and precision associated with sample results.

Objective of the QA Plan

- The objective of the QAP is to establish a series of QA and QC activities that will provide a high level of confidence in the data reported by the monitoring system.
- A QAP is typically implemented per the monitoring and reporting requirements for 40 CFR 75 and 40 CFR 60.
- A QAP my intentionally provide overlap and redundancy with the plant activities to ensure the highest quality data validity and availability.
- A QAP provides guidelines for implementing QA and QC activities.

CEMTEK
KVB-Enertec

QA Plan Contents

- QA plan is a contract
- Site owns the plan and is stating that this is how they (the site) will maintain and ensure that their CEMS data is valid.
- So what is in the plan?
  - Descriptions of the QA requirements
  - Document control
  - Schedule of activities
  - Procedures for conducting activities
  - Manufactures maintenance schedules

Performance Specifications

- 40 CFR 60, Appendix B
- Each CEMS type has specifications that the system must be designed to meet and demonstrate that it meets the specifications:
  - PS-1 – Opacity
  - PS-2 NOX and SO2
  - PS-3 O2 and CO2
  - PS-4, 4A, 4B – CO
  - PS-11 – PM
  - PS-12A & 12B – Hg CEMS, Hg STS
  - PS-18 – HCL

CEMTEK KVB-Enertec

On-going QA

- Part 60 and Part 75 specify QA requirements
- Limiting the QA plan to exactly what is stated in these two regulations may not result in an adequate QA Plan.
  - Facilities must design their QA plan to meet the site conditions
  - To meet the site regulatory drivers
  - To ensure compliance with these drivers

Agenda

- Brief History of Regulations
- Regulatory Drivers for CEMS
- What is a CEMS?
- Quality Assurance of CEMS
- Summary & Question

CEMTEK KVB-Enertec

Questions?

Pennsylvania Office	California Office
CEMTEK KVB-Enertec	CEMTEK KVB- Enertec
2849 Sterling Drive	3041 S. Orange Ave.
Hatfield, PA 19440	Santa Ana, CA 92707-4247
Ph.: 215-996-9200	Ph.: 714-437-7100
Fax: 330-860-8982	Fax: 714-437-7177

NetDAHS software service help line: 1-800-582-1670
NetDAHS Software service email: netDAHS@cemteks.com
Website: www.cemteks.com www.netdahs.com

CEMTEK KVB-Enertec