Online Emission Monitoring—Beyond Compliance

J S KAMYOTRA
Environmental Governance

A good ENVIRONMENTAL GOVERNANCE regime paves the path for sustainable growth of a nation. It assures quality environment, equitable growth, health & safety for its people while promoting growth.

Emerging economies: Environmental Governance issues

- Weak pollution norms
- Shortage of regulatory manpower and infrastructure
- Poor monitoring and reporting practices
- Non-transparency
- Scope of action against defaulters are limited
- Lack of self regulation or market based pollution control mechanism (like emission trading).
Regulatory Regime

- Consent orders of SPCBs/PCCs specify standards to be complied by industries.
- Industries submit analysis reports to SPCBs/PCCs and invariably copies are marked to CPCB.
- Reports submitted by industries largely comply with the consent standard limits in contrast to the samples collected by SPCBs/PCCs/CPCB that by and large remain non-complying.
- Actions (based on manual monitoring methodology) against industries are not leading to improvement in treatment processes by the units besides the willingness of persistent defaulters remains non-committal.
Regulatory Regime (contd.)

- Monitoring mechanism is weak due to lack of logistics, manpower and resources among the SPCBs/PCCs/CPCB obviously due to vastness of the jurisdiction area for regional offices and Zonal offices.

- Remedy is to put in place alternate monitoring mechanism on self monitoring methodology by industries and provide online data to regulatory regime.
National Policy on Online Monitoring

In “National Environment Policy” it is envisaged to strengthen the testing infrastructure and network for monitoring ambient environmental quality and progressively ensure real-time, and online availability of the monitoring data.
What real time monitoring brings?

- Credible pollution monitoring - less manual intervention
- Transparency
- Better regulatory hand - continuous vigil
- Immediate corrective measures
- Process optimization
- Basic framework for market based pollution control
- Paves path for Self- monitoring regime
CEMS in India- regulation

• CEMS in 17 category of industries and waste incineration plants started with CPCB’s direction in Feb 2014.

• Common effluent quality monitoring system (CEQMS) started in Feb 2014 for 17 categories, CETP and grossly polluting industries (generate 100kg BOD/day).

•
- 17 highly polluting categories of industries - 3206 Units
- Common Effluent Treatment Plans - 175
- Common Hazardous Waste Incinerator-25
- Common Bio Medical Waste Incinerator- 179
- Grossly Polluting Industries (> 100kg BOD/day) - 764

### 17 highly polluting categories of industries

<table>
<thead>
<tr>
<th>No.</th>
<th>Industry</th>
<th>No.</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Aluminium Smelter</td>
<td>10.</td>
<td>Pesticides</td>
</tr>
<tr>
<td>2.</td>
<td>Caustic Soda</td>
<td>11.</td>
<td>Petrochemicals</td>
</tr>
<tr>
<td>3.</td>
<td>Cement</td>
<td>12.</td>
<td>Drugs &amp; Pharmaceuticals</td>
</tr>
<tr>
<td>5.</td>
<td>Distilleries</td>
<td>14.</td>
<td>Oil Refineries</td>
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<tr>
<td>6.</td>
<td>Dyes &amp; Dye Intermediates</td>
<td>15.</td>
<td>Sugar</td>
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<tr>
<td>7.</td>
<td>Fertilizer</td>
<td>16.</td>
<td>Thermal Power Plants</td>
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<tr>
<td>8.</td>
<td>Integrated Iron &amp; Steel</td>
<td>17.</td>
<td>Zinc Smelter</td>
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<tr>
<td>9.</td>
<td>Tanneries</td>
<td></td>
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</tbody>
</table>
Real Time Monitoring System – Why?

- Self Monitoring mechanism within the industries
- Increased management responsibility for regulatory compliance
- Increased cost-effectiveness
- Fast corrective action
- Improved control over impacts on the environment
- Higher environmental awareness
- Increased public access to information (public)
CEMS device selection

Installation and calibration

Real-time pollution monitoring

Data acquisition system or Data logger

Secured Data Transfer

Data acquisition & handling at CPCB

Data acquisition & handling at SPCBs/PCCs

Display at Web-portals

- Suitable CEMS, CEQMS device selection by industry
- Device and Vendor selection
- Device installation, software and hardware setup
- Emission monitoring
- Data collection through compatible software
- Periodical calibration, zero and span drift test
- Calibration validation/audit
- Regular maintenance
- Secure data collection and storage at server or directly transfer to servers installed at regulators
- Data of stack emission, effluent monitoring and ambient air quality monitoring can be handled and transferred together
- Data from industry is stored at servers/ internet storage facility at state and central regulatory bodies
- Industry receives relevant auto response/instruction from servers

- CEMS in India: How does it work?
Issues identified in implementation

- Incomplete installation
- Wrong installations - no clear idea on where to install CEMS - which stack? Which location?
- Many non-functional - poor maintenance
- No clarity on suitable technology selection. To comply the direction many industries installed cheaper devices irrespective to their suitability
- Data supply to regulators was poor
- Data was not credible
Data reporting issues
Priority

• Compliance
• Ensuring Reliable Data
• Legal Frame Work
• Actions Proposed
Quality assured - Certified/ Performance checked

Correct installation
Right location/position/platform

Right equipment selection

Tamperproof data transfer system

Self-regulation regime

Compliance check system

Regular operation & maintenance

Capacity building
Protocol

(i) Monitoring Methodology
(ii) Calibration
(iii) Sampling Location
(iv) Exceedance
(v) Data Acquisition system
Monitoring Systems operated by Industries

Air Pollution Monitoring System
- Emission Monitoring Systems
- Ambient Air Quality Monitoring Systems

Water Pollution Monitoring System
- Effluent Monitoring Systems
Technologies available for Gaseous CEMS

Two basic types:

- **In-situ**
  - Folded Beam
  - Cross Duct

- **Extractive**
  - Hot/Wet (Using Heated Analyzers)
  - Dilution
  - Drying system:
    - Cooler
    - Dryer (Permeation)
Stack Monitoring Architecture

In-situ
Two basic types:

- Cross Stack
- Folded Beam
In-Situ Cross Stack

**Good Points**
- Fast Response time
- Reasonable cost
- Process control
- No sample Conditioning required.

**Bad Points**
- Two flanges so access to both the sides of stack required.
- Calibrated Electronically, Hence not good for Legislative applications.
- Subject to stack vibration and temperature
- Sensitivity limited due to path length
- Limited application for gases and subject to cross interference especially from Water and Particulate.
- Spectroscopy Principle – very limited reliability of measurements and accuracy
- Outside and top of stack not ideal conditions for maintenance.
In-Situ Folded Beam

**Good Points**
- Fast Response time
- Low cost
- Process control
- No sample conditioning required.

**Bad Points**
- Calibrated Electronically so not valid for Legislative applications.
- Subject to stack vibration and temperature
- Sensitivity limited due to path length
- Limited # of gases and subject to cross interference especially from Water and Particulate.
- Outside and top of stack not nice conditions for maintenance.
- No updated approval (TÜV, MCERTS)
CEMS Types - Extractive

**Cold Dry**
- Probe
- Heated line
- Cooler
- Pump
- Analyzers

**Dilution**
- Probe
- Dilution Air
- Heated Pump & Analyzers

**Hot Wet**
- Probe & Dryer
- Un-Heated line
- Heated Pump & Analyzers

**Dry**
- Probe & Dryer
- Analyzers
Extractive CEM Systems

Good Points
- Sensitivity not related to stack diameter.
- Varying stack temperature does not effect measurement.
- Can be placed in a clean, dry, temperature controlled environment so more stable and easier to maintain.
- Many analytical methods.
- Can be proven using Calibration gases suitable for legislative applications.
- TUV and Mcerts approval available.

Bad Points
- More costly.
Sample gas is extracted from the stack and transported to the analyzer using heated line and heated sampling components - filters, pumps, etc. including the analyzer measurement cell. The temperature of all components in contact with the sample gas is typically at 180°C to avoid condensation and loss of soluble gases.

**Good Points**
- Can be used for majority of gases including oxygen.

**Bad Points**
- Costly heated lines and components.
- Heated lines not UPS protected due to power required - risk of condensation and damage.
- More time required to maintain and heat stressed components.
- High sample flow rates to avoid condensation so uses more calibration gas.
Extractive CEM with Dilution

Sample gas is extracted from the stack at a known flow rate, mixed with a known flow rate of dry air.

**Good Points**

- Can be used to reduce moisture content so no heated sampling components are required.
- No power required at the probe so it can be used in hazardous areas. Excellent in Refineries.
- Very low maintenance as mechanical components are limited.

**Bad Points**

- Flow rates are critical and need to be controlled to avoid varying dilution ratios.
- Sample gas needs to be a high concentration to avoid analyzer sensitivity issues or use air quality analyzers.
- Cannot be used for all gases including oxygen.
- Careful consideration of probe materials for high temperature and corrosive applications.
Sample gas is passed through a cooler to take the sample gas down to a low temperature and to remove water so sample is almost dry.

**Good Points**
- Can use analyzers operating at low/ambient temperatures so components are not heat stressed.
- Analyzers are running at low temperatures, so systems tend to be cheaper than heated systems.

**Bad Points**
- Cannot be used on very soluble/corrosive gases.
- Soluble gases (HCl, SO\(_2\), NO\(_2\)) can be lost during the cooling.
Extractive CEM with Dryer

Sample gas is extracted from the stack, moisture is removed at the sampling point using Permapure dryer and transported to the analyzer using Un-heated line to the Analyser at a distance.

**Good Points**
- Can be used for majority of gases incl. oxygen.
- Removes water while in gaseous phase; no problems with solubility of SO$_2$, NO$_2$, HCl etc.
- No heated line required.
- Lower cost because non heated components.
- Low flow rate, low volume, fast response time.
- Less calibration gas required.
- Removes water, the biggest interference in NDIR
- All measurements are expressed in dry basis as requested by legislation
- Long term cost effective solution

**Bad Points**
- Cannot be used for NH$_3$
- Some maintenance required.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Technology</th>
<th>Manufacturers</th>
<th>Gases Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>In-Situ – Cross Stack</td>
<td>Opis</td>
<td>Many using IR or UV</td>
</tr>
<tr>
<td>1.1</td>
<td>In-Situ – Cross Stack</td>
<td>Siemens, Sick</td>
<td>NH&lt;sub&gt;3&lt;/sub&gt;, HCL using Laser</td>
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<tr>
<td>2.</td>
<td>In-Situ – Folded Beam</td>
<td>Codel, Procal, Forbes Marshal, Sick-Maihak</td>
<td>SO&lt;sub&gt;2&lt;/sub&gt;, NO&lt;sub&gt;x&lt;/sub&gt;, CO, CO&lt;sub&gt;2&lt;/sub&gt;</td>
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<tr>
<td>3.</td>
<td>Extractive – Cold Dry</td>
<td>Sick, ABB, Siemens, Horiba, ESA</td>
<td>SO&lt;sub&gt;2&lt;/sub&gt;, NO&lt;sub&gt;x&lt;/sub&gt;, CO, CO&lt;sub&gt;2&lt;/sub&gt;, HC</td>
</tr>
<tr>
<td>4.</td>
<td>Extractive – Dilution</td>
<td>ESA, Thermo</td>
<td>SO&lt;sub&gt;2&lt;/sub&gt;, NO&lt;sub&gt;x&lt;/sub&gt;, CO, CO&lt;sub&gt;2&lt;/sub&gt;, HC</td>
</tr>
<tr>
<td>5.</td>
<td>Extractive – Heated</td>
<td>Sick, ABB, ESA</td>
<td>Typically all Gases, specially NH&lt;sub&gt;3&lt;/sub&gt;</td>
</tr>
<tr>
<td>6.</td>
<td>Extractive – Dry</td>
<td>ESA</td>
<td>Typically all Gases</td>
</tr>
<tr>
<td>7.</td>
<td>Extractive – EC</td>
<td>Land/ Ametek</td>
<td>Typically all Gases</td>
</tr>
</tbody>
</table>
Gas detector technology using individual very low cost detection cell for each gas being measured.

Typical manufacturers: Land / Ametek.

**Good Points**

☑ Very low cost technology usually used for toxic gas monitoring.

**Bad Points**

○ Suffers from cross interferences that cannot be compensated for

○ Flow, pressure, temperature and humidity sensitive.

○ Cells can become poisoned or alter sensitivity after measuring high gas concentration.

○ Significant Drift.

○ Limited lifetime (typically 1 year per measuring cell)

○ This technique has no approval from TÜV nor from MCERTs
Infra Red Analyzers

- Wall Mount MIR 9000
- Stack Mount MIR IS
- Rack Mount MIR 9000
- Wall Mount MIR 9000-H
- Rack Mount FT-IR
Continuous Monitoring Systems

Central Server with DAS

Local Server with DAS

Flue Gas Flow Monitor

Dust Monitor

Flue Gas Analyzer

Ambient Air Quality Monitoring Station

Internet

LAN or WAN

Pollution Control Board
Various Systems used in Air Pollution Monitoring

- Multigas Analysers
- In Situ Analyzers
- Dilution Based Analyzers
- FTIR-based analyzer
- Integrated indoor cabinet
<table>
<thead>
<tr>
<th>Technique</th>
<th>Type</th>
<th>Parameter(S) Measured</th>
<th>Comments &amp; Limitations</th>
</tr>
</thead>
</table>
| Chimiluminescence     | Extractive    | NO, NO\textsubscript{x}, NO\textsubscript{2}* | *NO\textsubscript{2} calculated (NO\textsubscript{x} - NO).  
- To operate it requires additional accessories like Ozone Generator, Pumps, Dilution Probes/Assemblies, etc.  
- Quench Effect of CO\textsubscript{2}/Moisture, etc.  
- Suitable for very low concentrations of NO\textsubscript{x} applications like Ambient Quality Monitoring in cleaner environment.  
- Inability to measure other emission components like SO\textsubscript{2}, CO, CO\textsubscript{2}, etc. as compared to other techniques which can do multi gas measurements. |
| UV Fluorescence       | Extractive    | SO\textsubscript{2}, H\textsubscript{2}S*, TRS* (Total Reduced Sulphur) | *Cannot be measured simultaneously with SO\textsubscript{2}.  
- To operate it requires additional accessories Dilution Probes/Assemblies, etc.  
- Quench Effect of CO\textsubscript{2}/Moisture, etc.  
- Suitable for very low concentrations of SO\textsubscript{2} applications like Ambient Quality Monitoring in cleaner environment.  
- Inability to measure other emission components like NO\textsubscript{x}, CO, CO\textsubscript{2}, etc. compared to other techniques which can do multi gas measurements. |
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| Fourier Transformed Infra-Red (FTIR)          | Extractive      | CO, CO$_2$, SO$_2$, NO, NO$_2$, N$_2$O, (NH$_3$), (HF), (HCl), CH$_4$, Moisture (H$_2$O), VOC, etc. | - A direct method for continuous monitoring of multiple gases up to 5 - 12 gases using high end spectroscopy technique.  
- H$_2$O measurement in FTIR spectroscopy is necessary for moisture correction.  
- Uses Hot Wet Preferred technique for complex stack gas matrix like waste Incinerators or waste to power plants, alternative fuels fired Cement Plants, with high moisture and soluble gases.  
- High Price, however, with multi complex gases and integrated modules like VOC, O$_2$ makes it cost effective over all solution.  
- Ideal for very low concentration of NH$_3$, HF, HCl |
| Differential Optical Absorption Spectroscopy (DOAS) | Open Path Long Distance / Perimeter | CO, CO$_2$, SO$_2$, NO$_2$, (NH$_3$), (VOC), HCl, HF etc. | - Suitable of monitoring of multiple gases preferably more than 5, but has maintenance issues as it is suitable for open path fence line ambient quality monitoring  
- Suitable for trace measurements  
- Limitations in High Dust & Moisture applications  
- Indirect measurement technique having calibration challenges at site, as calibration needs to be done through a bench. |
| Flame Ionization                              | Extractive      | Total HC (VOC)                                                                          | - Very selective technique for Total HC/ TOC/ VOC. Requires H$_2$ gas for flame and carrier Gas.  
- Integrated with extractive Hot wet / cold dry techniques. |
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</table>
| NDIR      | Extractive | CO, CO₂, SO₂, NOₓ etc. | - A direct method for continuous monitoring of multiple gases suitable upto 4-5 gas measurements without any dilutions.  
- Popular for low SO₂/ NOx concentrations with moisture removal.  
- Used in cold Dry extractive technique to remove moisture to avoid background interference from moisture.  
- Uses Internal optical filters for removal of interferences.  
- Inability to measure other emission components like HF, Cl₂, H₂S, etc. compared to other techniques which can do multi gas measurements.  
- Issue of dissolution and stripping of CO₂/ SO₂ can under estimate the measured concentration, in case calibration does not follow the same system of cooling. |
| NDUV      | Extractive | SO₂, NO NO₂, NH₃,Cl₂, CS₂, etc. | - A direct method for continuous monitoring of multiple gases suitable upto 2-3 gas measurements without any dilutions.  
- Popular in harsh applications in wide spectrum of Industrial process.  
- Used in cold Dry extractive technique to remove moisture to avoid background interference from moisture. Hot Wet options available for soluble gases like NH₃.  
- Inability to measure other emission components like CO, CO₂, HCl, HF, etc. compared to other techniques which can do multi gas measurements. |
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</table>
| Tunable Diode Laser        | Path     | CO, CO$_2$, NH$_3$, Moisture (H$_2$O), HCl, HF, CH$_4$ etc. O$_2$ & H$_2$S | Usually selective laser techniques are not cost effective technique for single component, very expensive, for multi gas measurement.  
- Limitation in measuring SO$_2$ and NO$_x$ due to lack of selectivity. 
- Measurement of H$_2$O for moisture correction is necessary and available in recent analysers. |
| Electrochemical            | Extractive | O$_2$, CO/CO$_2$, etc.                          | - Electrochemical sensor is a consumable and requires regular replacement and gets influenced by process stack background gas matrix.  
- Limitations Influenced by moisture, dust, temperature, etc.  
- Suitable for Ambient / LEL / Portable detection  
- Not suitable for online stack emission monitoring in Industries. |
| Zirconium Oxide / O$_2$Cell | In-situ  | O$_2$                                           | Widely used for boiler/ Stack O$_2$ correction/ Normalisation. Technology explained earlier. (both extractive and in situ) |
| Paramagnetic               | Extractive | O$_2$                                           | Stable and accurate and the technology type explained in detailed earlier. |
CALIBRATION
Calibration of Air Analysers Gaseous Parameter

a. The instruments/ analysers for real time monitoring of gaseous emissions shall be calibrated with respect to their functioning, drift, linearity detection limit, output, operating temperature and other relevant parameters before installation.
b. It is advised to mention that calibration for certified CEMS and full performance demonstration of uncertified CEMS (which involves calibration) must be performed while being installed.
c. After six months of operation, the system shall be rechecked for its health and data accuracy and reliability, following multi point calibration (at least 03 span concentrations) using standard methods and certified reference materials.
d. The data comparison and calibration verification shall be done once in 06 months by empanelled laboratories following standard procedures and using certified reference standards.
e. The health of the instruments/analysers shall be assessed on daily basis at fixed time (10.00 a.m.) by checking the zero drift. No adjustment is allowed.
f. In case the daily zero drift is more than the acceptable limit as specified in the catalogue/brochure of the instrument/analyser manufacturer and persists continuously for five days, the instrument/analyser shall be recalibrated following procedure laid down at point (d) above.

g. The instruments/analysers shall be rechecked for zero and span drift every Friday at fixed time (10:00 a.m.) using standard methods and standard reference materials. The drift needs to be recorded and suitably incorporated in the data collected over the period.

h. For Differential Optical Absorption Spectroscopy (DOAS), Non Dispersive Ultra Violet (NDUV)/Non Dispersive Infra-Red lamp based systems, the calibration shall be revalidated once in 03 months, and after replacement of lamp. In-situ based TDLS/DOAS needs to be brought down to lab for calibration.

i. The values of NDUV / NDIR based system will be compared with the standard methods using Standard Reference Material every Friday at fixed time (10.00 am) and Zero drift checked daily at fixed time (10.00 am).

j. The instrument/analyser shall be recalibrated after any major repair/replacement of parts/lamps or readjustment of the alignment using standard methods and certified reference materials.
k. The instrument/analyser system shall have provision of remote calibration, for verification of the system performance by SPCBs/PCCs whenever, felt necessary.

l. The intensity of the lamp shall be checked once every fortnight.

m. Data capture rate of more than 85% shall be ensured.

n. For FTIR Spectroscopy calibration once a year checks are acceptable or when major over haul as change in Lazer / Spectrometer.

o. Using Air for Zero/Span calibration is not acceptable, Zero / Span Gas / Gas filled Cuvette to be used with required certifications.
Particulate Matter
The PM CEMS device is ready for calibration only after performing all of the required installation, registration, and configuration steps. Details of Particulate Matter CEMS calibration are given below.

a. The continuous Particulate Matter monitoring system (PM-CEMS) shall be calibrated at different operational loads against isokinetic sampling method (triplicate samples at each load) at the time of installation and thereafter, every six months of its operation.

b. The results from the Particulate Matter monitoring system shall be compared on fortnightly basis i.e. second Friday of the fortnight, at fixed time (replicate sample) starting 10.00 am. with standard isokinetic sampling method.

c. In case, deviation of the comparison values for 02 consecutive monitoring is more than 10%, the system shall be recalibrated at variable loads against isokinetic sampling method (replicate samples).

d. No adjustment of Calibrated Dust Factor (CDF) is allowed unless full-scale calibration is performed for PM CEMS. Change of CDF should be permitted only if it is approved by SPCB/ PCC.
e. After any major repair to the system, change of lamp, readjustment of the alignment, change in fuel quality, the system shall be recalibrated against isokinetic sampling method. (triplicate samples at each load)
f. The data capture rate of more than 85% shall be ensured.
g. The intensity of lamp shall be checked once every fortnight.
h. The data comparison/calibration verification shall be done by laboratories empanelled by CPCB using standard reference methods and at a frequency specified.

**General parameters**
The following parameters shall also be monitored:-
(i) Carbon Dioxide (CO2) (for normalising the values)
(ii) Stack gas velocity
(iii) Flue Gas Volumetric Flow Rate
(iv) Flue Gas Temperature
(v) Stack Gas Parameters(Flue gas pressure)
(vi) Oxygen (O2)
(vii) Carbon Monoxide (CO)
(viii) H2O/Moisture in in-situ/ Hot Water Measurement
Criteria for Empanelment of Laboratories

(i) Laboratories recognised under the Environmental (Protection) Act, shall only be considered for empanelment.

(ii) The EPA recognised Laboratory having achieved robust statistical Z score more than 70% in the laboratory proficiency testing shall only qualify for empanelment.

(iii) The empanelled Laboratory shall participate in the proficiency testing programmes organised by CPCB twice a year.

(iv) The empanelment of Laboratories, failing to achieve the required Z score in the proficiency testing shall be kept in abeyance, till their performance in the next round of proficiency testing meets the prescribed score.

(v) Laboratories failing consecutively twice in achieving the desired Z score in proficiency testing shall not be considered for empanelment and/or their empanelment withdrawn.

(vi) CPCB shall arrange for Analytical Quality Control Proficiency Testing programmes for Air Pollutants along with the Water Quality parameters.

(vii) The Head Quarter/ Zonal Office laboratories of CPCB shall verify performance of at least 2% of the installed real time monitoring systems every year.

(viii) The data comparison/calibration shall be done by empanelled laboratories at frequency specified under para-“Calibration”.
QUALITY CONTROL OF EMPANELLED LABORATORIES

- Laboratories Recognized Under E(P) Act, 1986 Will Only Be Empanelled
- CPCB Will Arrange Analytical Quality Control Exercise For Air Pollutants
- Participation In AQC For Both Air And Water Is Mandatory For All The Empanelled Laboratories
- The Qualifying Criteria Will Be Decided On Robust Statistic (Z) Score
- Quality Control Exercise Will Be Conducted On Six Monthly Basis
CONTINUOUS EMISSION MEASUREMENT SYSTEM (CEMS)

LEGISLATIVE BACK UP

- Amendment May Be Needed To Make Real Time Monitoring A Legal Proposition
- Data Obtained From Real Time Monitoring Shall Be Used For Regulatory Purposes
- Industry Submitting Wrong Information/Data Is Liable For Action
Data Logger connected to Sensors
Data use as of now

Industries had connected these CMS instrument’s output to their control rooms through PLC (Programmable Logic Controllers) to check on emission levels (Every process-wise, parameter-wise Limits are already prescribed by SPCBs/CPCB), to check the performance of plant and if required, change the combustion element ratios.
Safe System Requirement

The system should be capable of

1. Data collection on Real Time basis without human intervention.
2. Data Collection from any REAL TIME SYSTEM.
3. Providing data to all stake holders without delay.
5. Providing tamper proof mechanism.
6. Providing facility for online calibration of systems.
7. Providing a system of change request management with recording mechanism for data validation purpose.
8. Having Dashboards for facilitating SPCBs/PCCs/CPCB intelligent surveillance display for meaningful application of data.
10. Accommodating existing technology based Systems (Digital) with minimum variation.

11. Accommodating any new requirements of additional parameter monitoring in future.

12. Continuous Transfer of Real Time data for display on industry website & Industry main gate.


15. Creating a National Database for Policy & Decision Makers at a single GIS map.
Functioning of the system

Records
1. Continuous Data
2. Validation events
3. Calibration
4. Cross verification issues

Existing Systems

New Systems

INDUSTRIES

SPCBs/PCCs

Data Transmission

Data Synchro nization

CPCB

Data on Website

WEB

Data available for Policy makers/Public

Delayed Checks

Scrutiny
Data Transmission

- **Transmission Medium**: Preferential order

1. Leased Circuit of 512 Kbps or 1Mbps
2. Broadband telephone connection
3. GSM/GPRS

Leased Line
Broadband
Wireless connection
Data Viewing

- Data received from real-time monitoring systems viewed regularly
- Dedicated teams of experts monitor the data 24X7
- Daily, Weekly, Monthly and Yearly data trends viewed to ensure correct data is being generated and transmitted
- In case of irregularities in the data verification of the monitoring systems is done.
System Verification

Checking the diagnostics of the instrument

SO₂ diagnostics is ok....
Online Remote Calibration
Online Remote Calibration
Remote Calibration of CO Analyser

ZERO CALIBRATION
Span Gas (2 mg/m$^3$)
Span 2: (5 mg/m³)
Normalization of Analyser with “A”-correct data after Calibration

“A” – CORRECT DATA
## Report on Calibration

### ZERO (PHASE I)

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Standard value mg/m³</th>
<th>Measured value mg/m³</th>
<th>min mg/m³</th>
<th>max mg/m³</th>
<th>st-dev mg/m³</th>
<th>st-dev dr mg/m³</th>
<th>abs dr lo mg/m³</th>
<th>abs dr hi mg/m³</th>
<th>rel drift mg/m³</th>
<th>IPD1 mg/m³</th>
<th>IPD2 mg/m³</th>
<th>IPD3 mg/m³</th>
<th>IPD4 mg/m³</th>
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</tr>
</tbody>
</table>

### SPAN GAS- 2 mg/m³ (PHASE II)

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Standard value mg/m³</th>
<th>Measured value mg/m³</th>
<th>min mg/m³</th>
<th>max mg/m³</th>
<th>st-dev mg/m³</th>
<th>st-dev dr mg/m³</th>
<th>abs dr lo mg/m³</th>
<th>abs dr hi mg/m³</th>
<th>rel drift mg/m³</th>
<th>IPD1 mg/m³</th>
<th>IPD2 mg/m³</th>
<th>IPD3 mg/m³</th>
<th>IPD4 mg/m³</th>
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</thead>
<tbody>
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<td>1.89</td>
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</tbody>
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### ZERO (PHASE III)

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Standard value mg/m³</th>
<th>Measured value mg/m³</th>
<th>min mg/m³</th>
<th>max mg/m³</th>
<th>st-dev mg/m³</th>
<th>st-dev dr mg/m³</th>
<th>abs dr lo mg/m³</th>
<th>abs dr hi mg/m³</th>
<th>rel drift mg/m³</th>
<th>IPD1 mg/m³</th>
<th>IPD2 mg/m³</th>
<th>IPD3 mg/m³</th>
<th>IPD4 mg/m³</th>
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</thead>
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### SPAN GAS-5 mg/m³ (PHASE IV)

<table>
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<th>Date and Time</th>
<th>Standard value mg/m³</th>
<th>Measured value mg/m³</th>
<th>min mg/m³</th>
<th>max mg/m³</th>
<th>st-dev mg/m³</th>
<th>st-dev dr mg/m³</th>
<th>abs dr lo mg/m³</th>
<th>abs dr hi mg/m³</th>
<th>rel drift mg/m³</th>
<th>IPD1 mg/m³</th>
<th>IPD2 mg/m³</th>
<th>IPD3 mg/m³</th>
<th>IPD4 mg/m³</th>
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<tbody>
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<td>0.00</td>
</tr>
</tbody>
</table>
Data Presentation

- By Geo-referencing monitoring stations on GIS Platform
- Different layers on map as per type of monitoring stations, sector & category of the industries
- Dash Board – summary of data of all monitoring stations
- Report Generation
  - Station Report (Hourly, Weekly, Monthly, Yearly, Periodic)
  - Multi station reports
  - Diurnal reports
  - Wind Rose
  - Pollution rose etc.

•
Flow of Information

- Summarizing, Analysis and Interpretation
- Use of Real-time Environmental Data
Summarizing

Analysis

Interpretation
Use of Real-time Environmental Data

- By Regulators
- By Industries
- Others Uses
Use of Real-time Environmental Data

By Regulators

A
- Regulatory Compliance
- Pollution Prevention and Control

B
- Policy Designing, Planning and Siting
- Mitigation and Response

C
- To Keep Track of Project / Program Success
- Cleanup and Remediation Science
Use of Real-time Environmental Data

By Industries

- To Avoid Non-Compliance
  Real-time Data Acquisition & Analysis Tools

- Market Trading Systems
  Responsible Corporate Citizenship

- Leveraging Enterprise + ERP Systems
Use of Real-time Environmental Data

Other Uses

Integration of Real-time Environmental Data with GIS

Study Impact of Pollution and Benefits and Costs of Pollution Control Measures

Use by Common People to know Environmental Impacts and Awareness
Whatsoever way the data may be gathered and analyzed, the data itself reflects processes that are occurring in the real world.

Factors such as pesticide in drinking water or changes in ambient air quality may be represented by numbers or charts, but in reality they represent impacts on individual organisms, on human and biological communities, and on entire ecosystems.

Scientists, policy makers and the public should do well to realize that decisions based on data, however arcane, ultimately translate back to the real world as actions and outcomes.
Thank You