CEMS & Star Rating Programme

(Key Note Presentation)
One Day CEMS Workshop on13th Nov 2018

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Chief Environmental Engineer

State Pollution Control Board, Odisha

Outline

- About SPCB Odisha
- Continuous Emission Monitoring System (CEMS)
- CEMS Architecture (SPCB, Odisha)
- RT-DAS Architecture
- Online Stack Monitoring of Industries
- Capacity Building on CEMS
- CEMS Analyzers- Pre-requisites and Protocols
- Key Challenges
- Partnership with EPIC-India and CEMS Infrastructure
- Information Disclosure through Star Rating

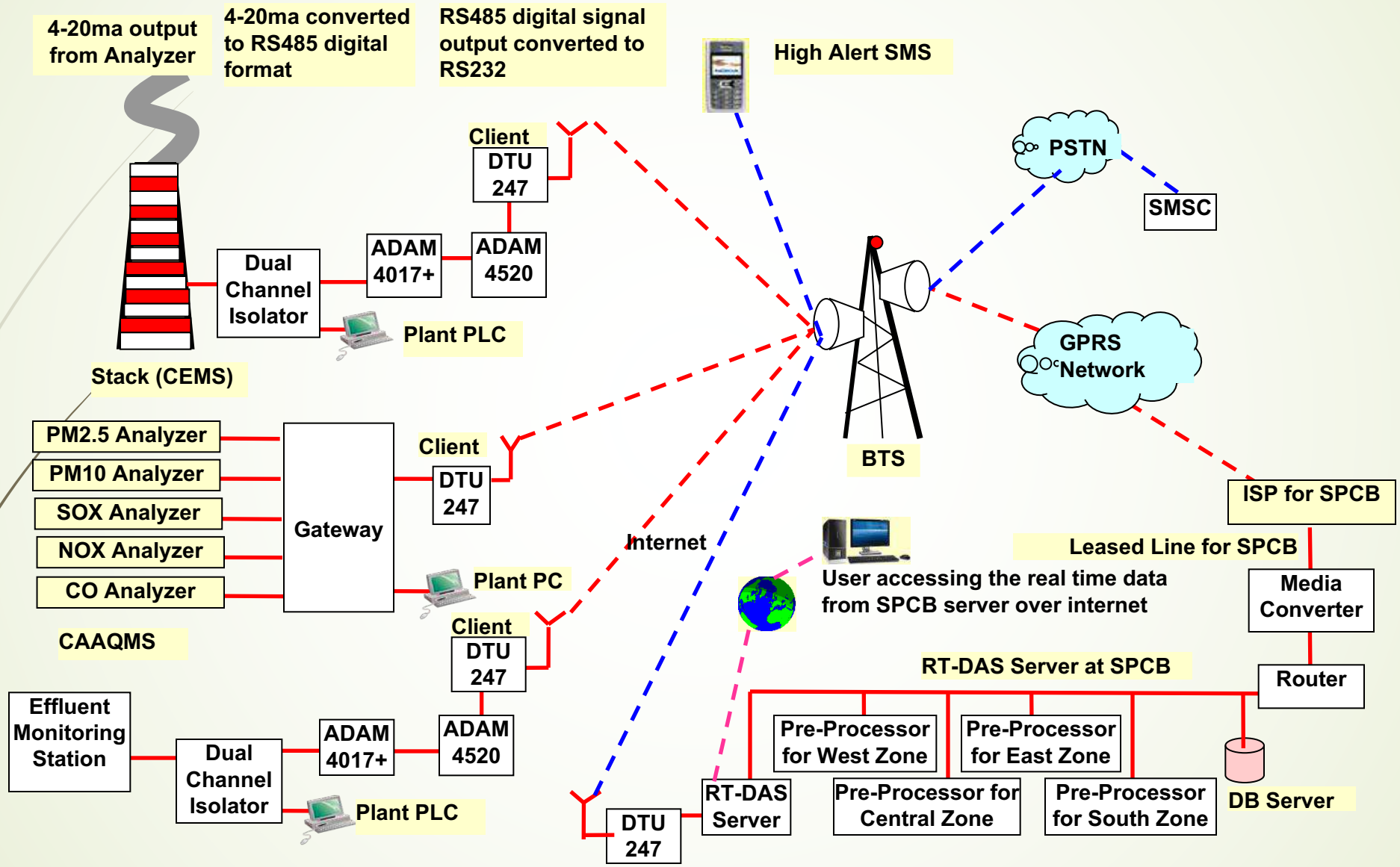
About SPCB & Indutries in Odisha

- The entire state of Odisha has been declared as Air Pollution Control Area since **18-07-2002.**
- The objective is to plan and execute a comprehensive programme for the prevention, control and abatement of air pollution.
- There are ***12 Regional Offices*** and ***1 Central Laboratory*** operating under Head Office of SPCB Odisha.
- Odisha is in the path of Industrialization and many large industries have come up in Odisha.
- A total of ***137 industries*** under 17 Categories of highly polluting industries are operating in Odisha mostly in the sector of Iron & Steel, Power, Aluminium Smelter, Cement, Pulp & Paper, Fertilizer, Refineries Unit etc. which have potential for emission of air pollutants like PM, SO2, NOx, Hg etc/ discharge of water pollutants. 100s of Industries in Large and Medium sector are also operating in the state having potential of stack emission.
- But this workshop is confined to Stack emission monitoring from the 17 Cat of Highly polluting industries, which has been prioritised at national level and closely monitored by CPCB.

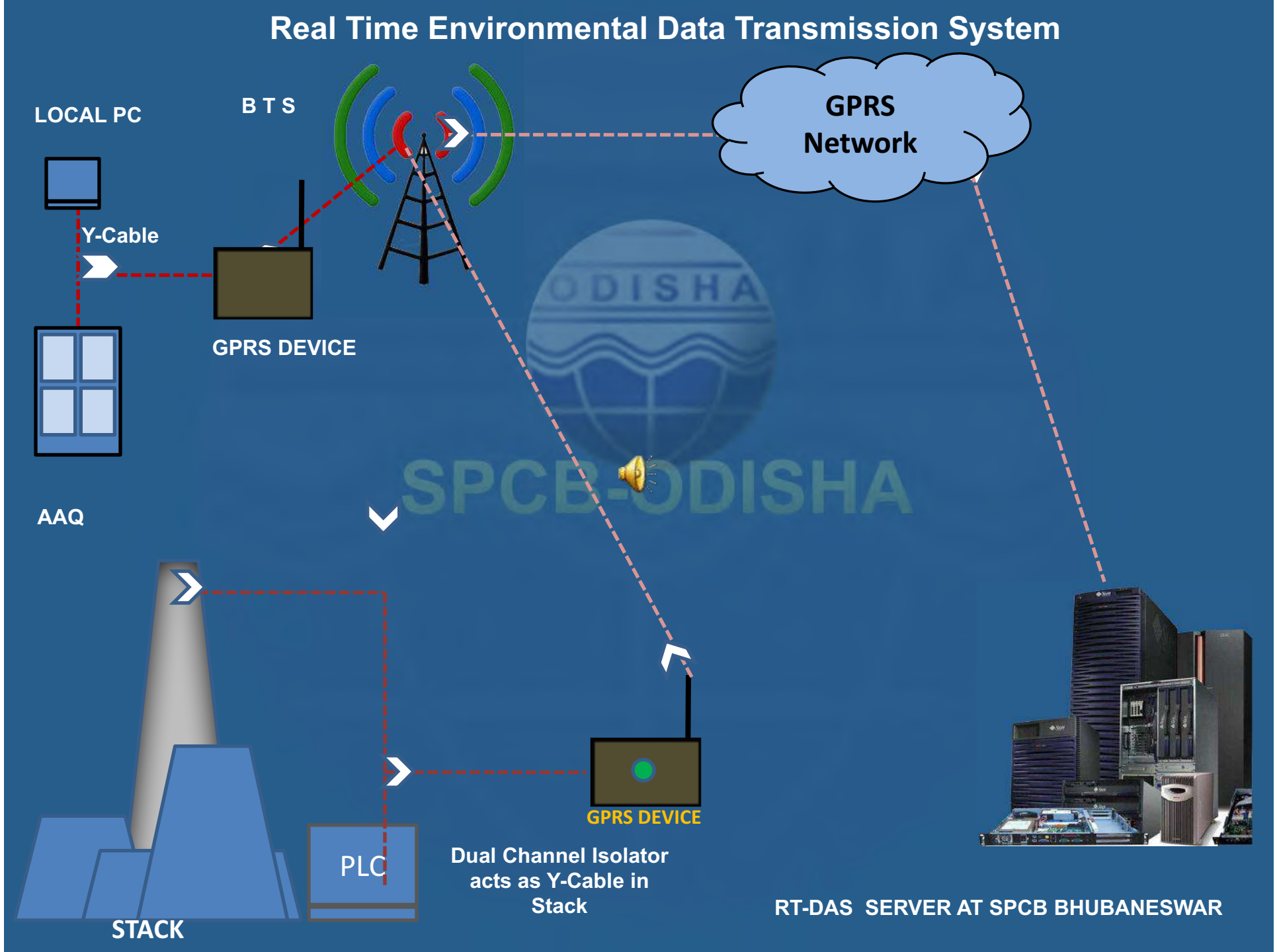
Continuous Emission Monitoring System (CEMS)

- Odisha is one of the first state in India to implement Online CEMS started in 2012 and as on date all industries under 17 categories are connected through online monitoring having 584 CEMS, 204 AAQMS, 81 EQMS.
- Real-Time Data sent though Y-Cable from industries and received at RT-DAS server of OSPCB
- CPCB has come out with CEMS guidelines in July 2017 and the revised version in August 2018 with detailed procedure for selection of CEMS, installation guidelines, calibration and data validation protocols.
- As a first step SPCB, Odisha have started calibration of PM-CEMS in April 2018 and subsequently will cover all gaseous CEMS and effluent monitoring stations for 17 category of highly polluting industries as notified by CPCB
- In this direction Capacity Building programs have been conducted by the Board in collaboration with EPIC India in industries for the Board officials.

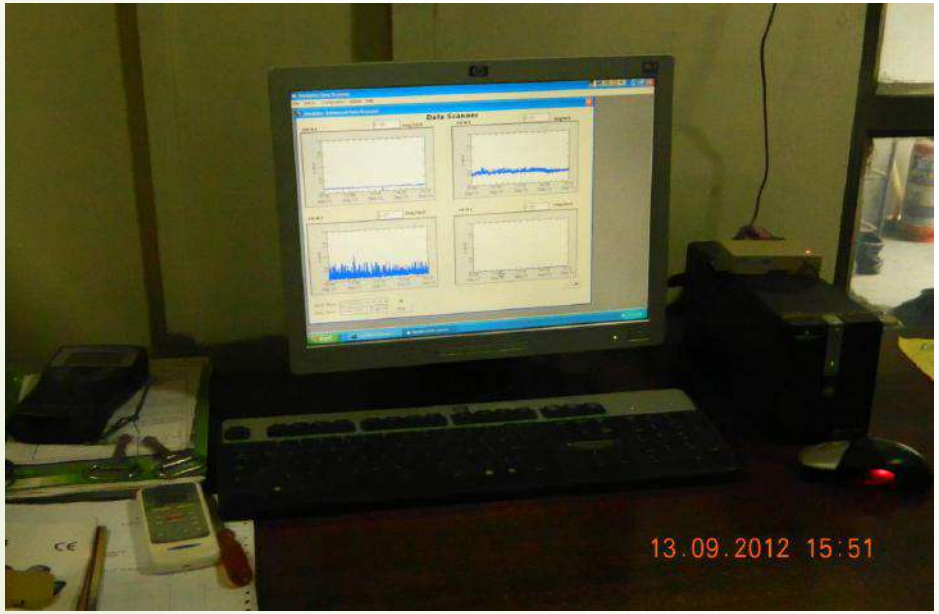
CEMS Architecture (SPCB, Odisha)



Real Time Environmental Data Transmission System



Online Stack Monitoring System in Aluminium Smelter

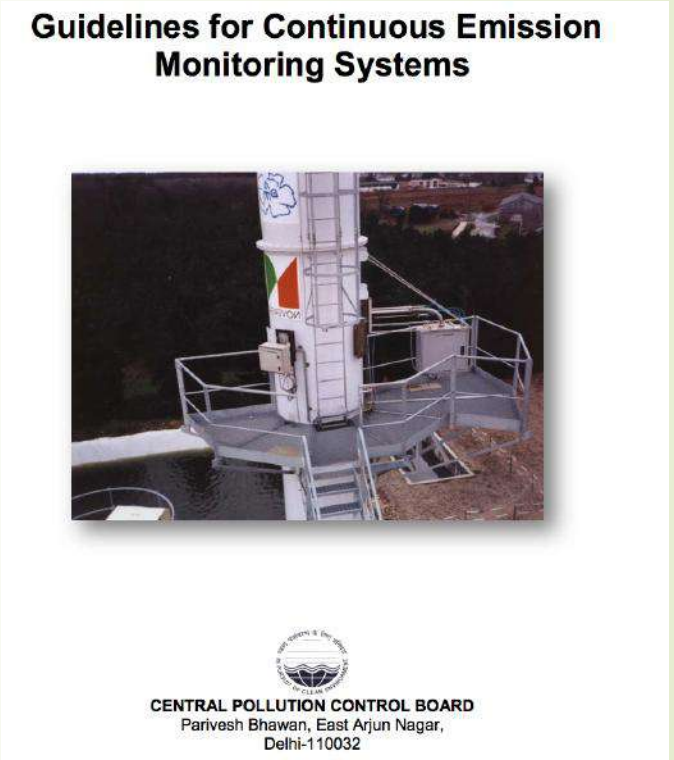


Capacity Building on CEMS

- Online monitoring of CEMS are technology intensive and require lot of capacity building to get updated about online monitoring system.
- Through OSPCB-EPIC partnership a series up workshops, field visits and classroom sessions were organized between **August 2017 to March 2018**.
- Industries, CEMS Vendors, Regional Office Staff & Officials of H.O., SPCB Odisha were part of this capacity building exercise to understand online monitoring system, calibration, validation etc.
- CPCB guidelines and OCEMS protocols were strictly adhered to monitor compliance and proper installation of analyzers.
- From **1st August 2018**, Regional Office team have been visiting each of these industries to support in calibration and validation of CEMS data.

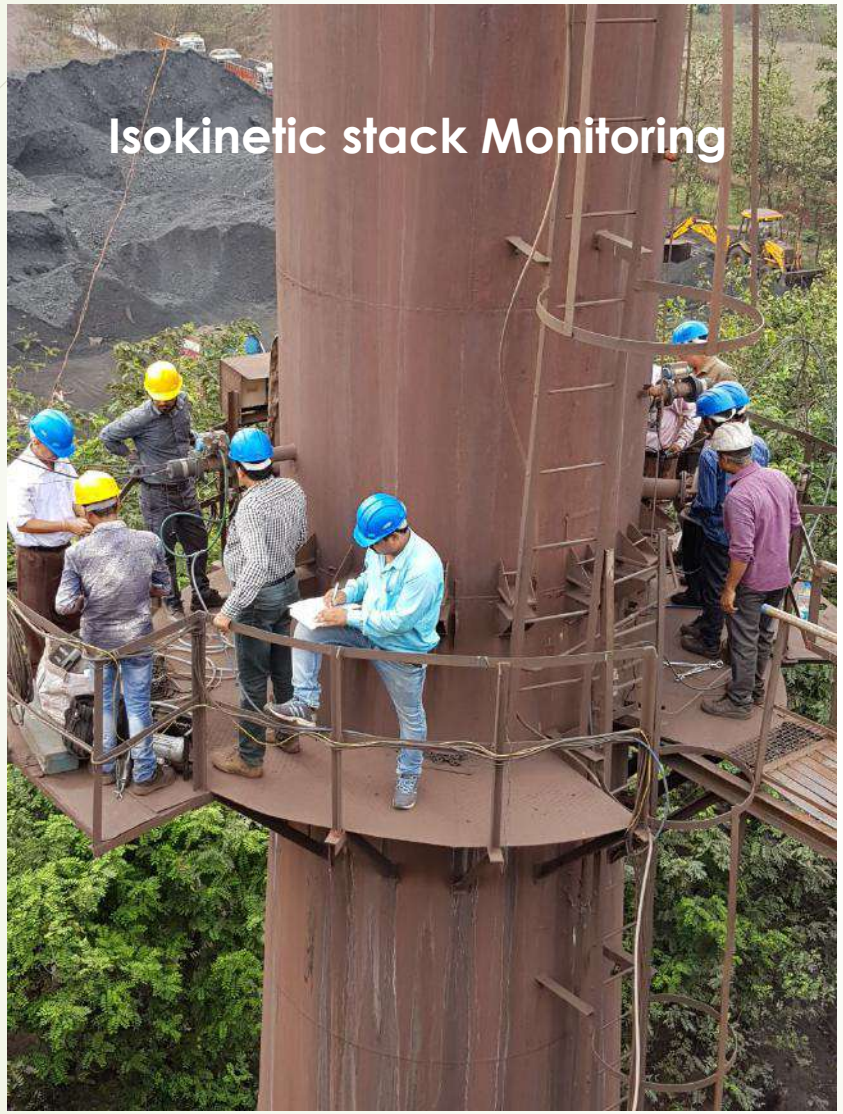
CEMS Analyzers- Pre-requisites and Protocols

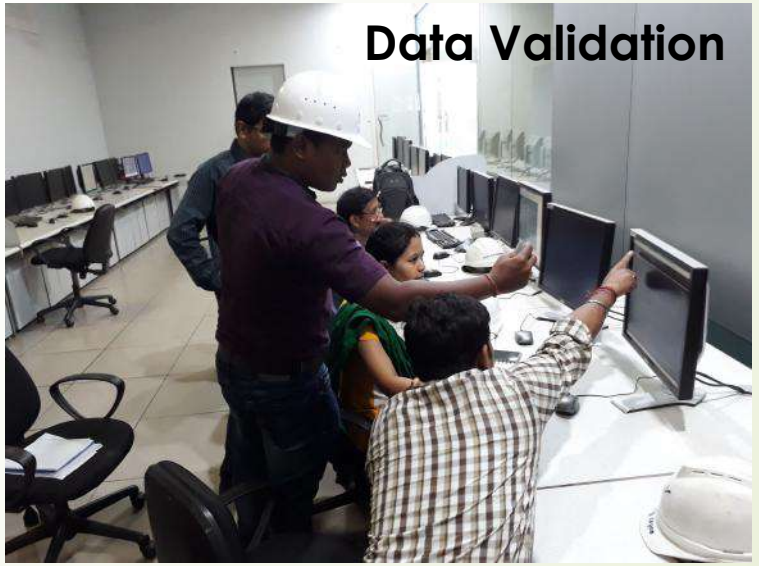
- Data transmission should be **minimum 85%.**
- CEMS analyzers need to be calibrated at different operational loads against isokinetic sampling method (triplicate samples at each load) at the time of installation and thereafter, every six months of its operation.
- In case of shut-down/ planned maintenance the industries need to intimate SPCB HO & Regional Office in advance.
- Dedicated manpower must be allocated by industries for smooth operation of CEMS and ensure regular monitoring for transmission of data to SPCB server.
- The industry should ensure **tamperproof** operation of CEMS devices to make sure analyzers working properly and real time data transmission happening seamless to SPCB server.
- Technology of Analysers-as per CPCB Guideline



Revision-1, August 2018
Link:

Calibration and Data Validation Drive





Key Challenges

- Most of the industries have shown their inability to vary the load due to operational conditions. However, variation of load at different plant load factors (25%, 50%, 75% and 100%) is a mandate from CPCB to conduct sampling for PM CEMS calibration.
- Absence of CEMS vendors during calibration resulted in delays in calibration, especially, in setting the new dust factor post manual sampling.
- Lack of accessibility to analysers installed on stack and improper location of portholes have also made it difficult for manual monitoring for some industries.
- Dust deposition on probes and leakage test show poor maintenance of analysers installed on stacks.
- Since the analysers are not sealed properly there is a possibility of tampering the calibrated dust factors (CDF) which will lead to wrong data transmission to SPCB server.

Partnership with EPIC-India and Development of CEMS Infrastructure

- SPCB, Odisha has partnered with Energy Policy Institute ate University of Chicago to develop robust CEMS Infrastructure through cutting edge research and development on CEMS for better environment compliance.
- SPCB, Odisha have introduced a centralized monitoring and IT-Cell at the Head Office of the Board to strengthen its vigil mechanism and analysis of RT-DAS data.
- Also, monitoring happens at decentralized manner at Regional Office level by creating a pool of dynamic staff through additional capacity building.
- A more robust IT-Infrastructure and Control Centre is in pipeline which will provide advanced real-time monitoring through digitization of CEMS data.

Information Disclosure through Star Rating

- A dedicated Star Rating Portal have been created in partnership with EPIC-India which will be accessed through www.oscboard.org. The Star Rating Portal was inaugurated by **Hon'ble Chief Minister of Odisha on 17th Sept'2018.**
- Ratings are given based on two parameters (i) Emission averaged over a period of time compared with permissible limit and (ii) Data availability as prescribed in CPCB guidelines
- Industries are given dedicated Ids to access their online data sent to SPCB server in addition to sms alerts.
- Only those industries who have completed calibration and validation of data by SPCB officials will be considered for the Star Rating Programme.
- As on 30th October 2018, total 50 industries are included for Star Rating Programme. SPCB, Odisha has target to cover all industries by 31st January 2019.
- Detailed deliberations on different issues will be covered in technical sessions.

Thank You

CEMS Introduction and PM CEMS

One day workshop on
"Continuous Emission Monitoring System (CEMS) and Star Rating"
13th November 2018
Hotel- Swosti Premium

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A good ENVIRONMENTAL GOVERNANCE is essential for sustainable growth of a nation. It assures equitable social and economic development, quality environment, and health & safety.

It needs

- Strong regulatory framework
- Credible disclosure, Transparency
- Standardised pollution monitoring practices
- Suitable pollution norms
- Self regulation

Good Environmental Governance

- 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

Real time monitoring can catapult environmental compliance monitoring to 21st century.

US, Europe etc. have well established CEMS framework. Between 2005 and 2015, US has achieved emission reduction of NO_X by 62% (from 3.4 to 1.3 MnMT) and SO_2 by 78% (from 9.3 to 2.0 MnMT)

Why CEMS ?

- **Pilot scale Particulate matter (PM) Emission Trading Scheme** in Gujarat, Maharashtra and Tamil Nadu - in 2011
- **CPCB direction for CEMS, CEQMS -** in Feb 2014
  17 categories of industries (2764), CETPs (192), Common bio-medical waste treatment facility (198), Common HW treatment facilities (26), MSW treatment facilities
- **CPCB direction under National Ganga River Basin Authority Mission** for installation of CEQMS in grossly polluting industries (~800) -in March 2014
- **Guidelines for CEMS-** in August 2017, revised in June 2018
- **CEMS mandated in RED category in Delhi-NCR-** in July 2018
- **Compliance reporting protocol-** March 2018
- **Notice for remote calibration-** April 2018

How CEMS started?

Parameter to be monitored (Online)		
Category	**Effluent Parameters(13)**	**Emission Parameters(7)**
Aluminium	pH, BOD, COD, TSS, Flow	PM, Fluoride
Cement	-	PM,NOx,SO_2
Distillery	pH, BOD,COD,TSS, Flow	PM
Dye and dye	pH, BOD,COD, TSS, Cr, Flow	-
Chlor Alkali	pH, TSS, Flow	Cl_2,HCl
Fertilizers	pH, flow, Ammonical Nitrogen, F	PM, Fluoride, NH3
Iron & steel	pH, Phenol, cyanide, flow	PM,SO_2
Oil refinery	pH, BOD,COD,TSS, flow	PM,CO,NOx,SO_2
Petrochemical	pH, BOD,COD,TSS, flow	PM,CO,NOx,SO_2,
Pesticides	pH, BOD, COD, TSS, Cr, As , flow	-
Pharmaceutical	pH, BOD, COD, TSS ,Cr ,As, flow	-
Power Plants	pH, TSS, Temperature	PM,NOx,SO_2
Pulp & paper	pH, BOD, COD, TSS ,AOx, flow	-
Sugar	pH, BOD,COD,TSS, flow	-
Tannery	pH, BOD, COD, TSS, Cr, flow	-
Zinc	pH, TSS, flow	PM SO_2
Copper	pH, TSS, flow	PM SO_2

Implementation Challenges

SUITABLE TECHNOLOGY SELECTION

- Multiple technology / multiple CEMS suppliers. Industries lack clarity on suitable technology selection

CORRECT INSTALLATION

- Stack or duct? Which stack? Where to install ?

QUALITY ASSURANCE AND CONTROL

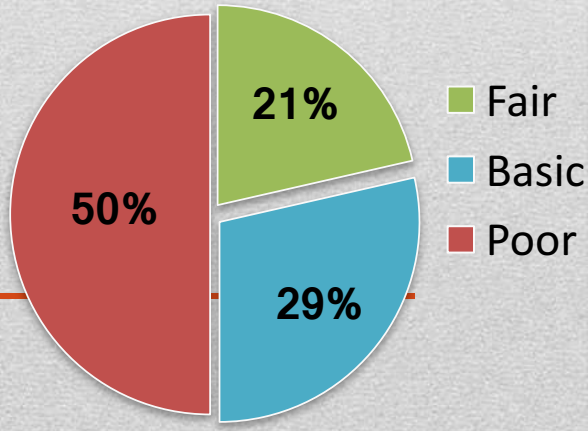
- Through device certification or performance check during installation. . None available.

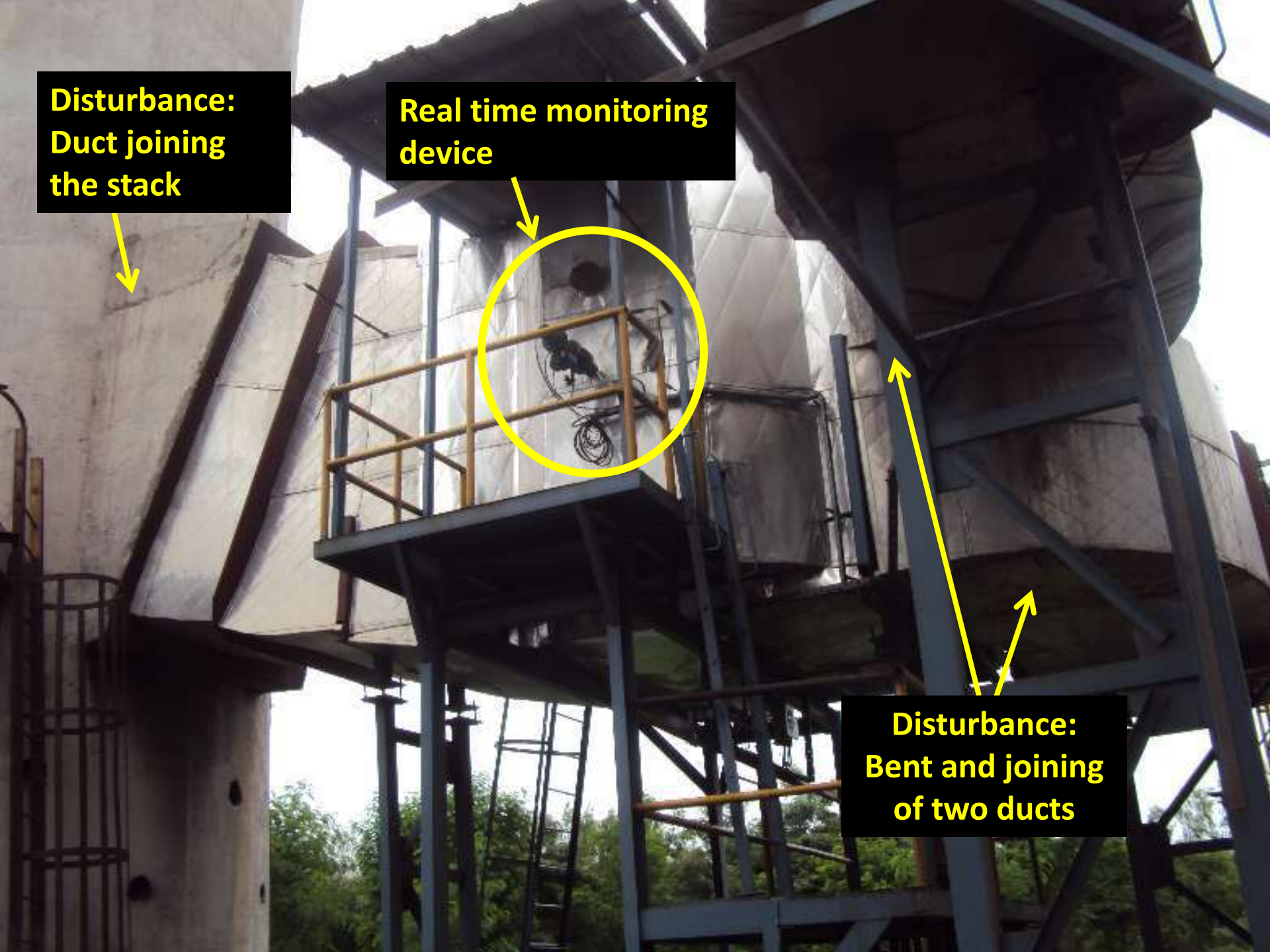
LAB EMPANELMENT SYSTEM FOR CEMS WORK

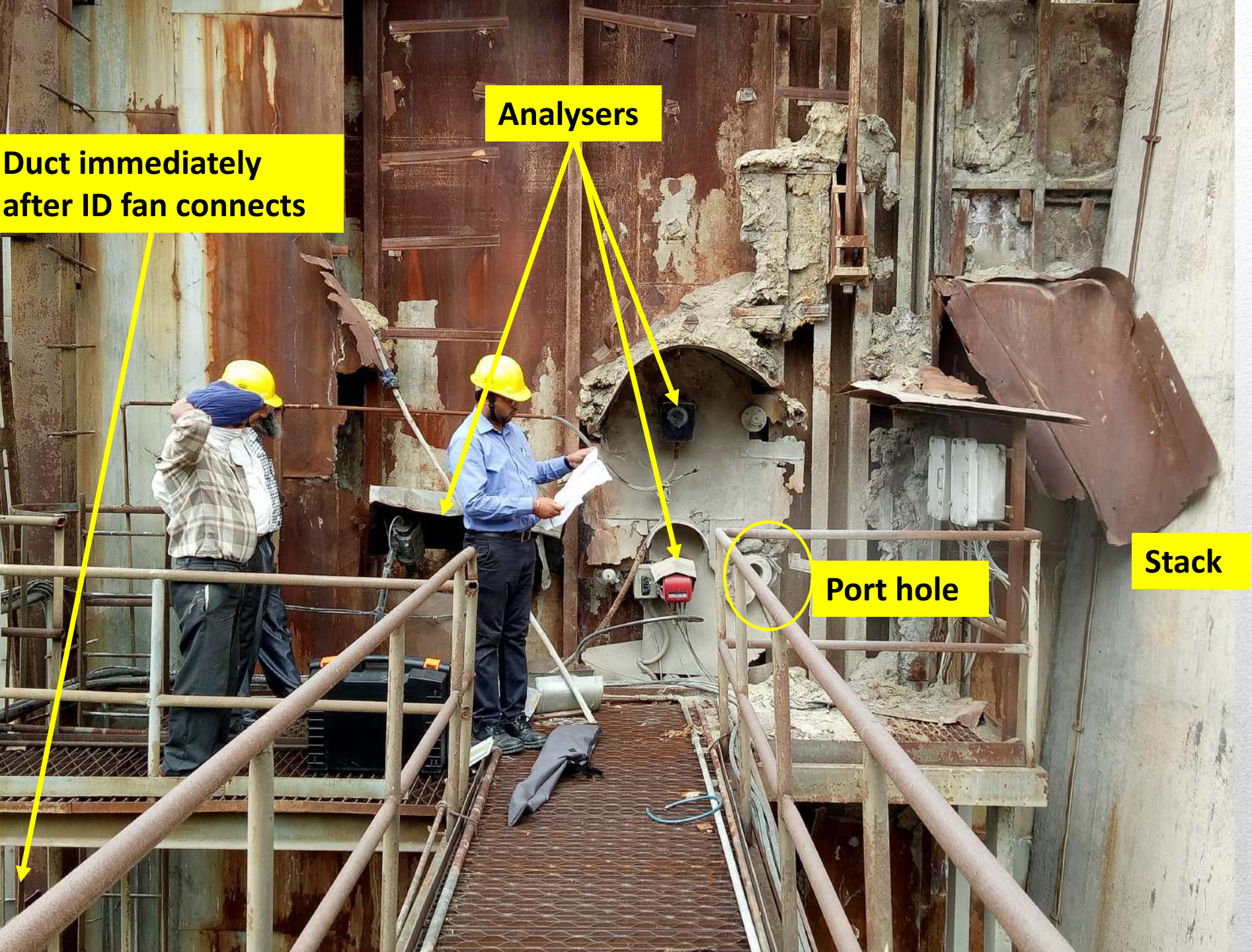
- Calibration, performance check and verification ideally should be done by empaneled labs. No labs empanelled for this.

CAPACITY BUILDING OF STAKEHOLDERS

- Essential capacity building is grossly missing




Disturbance: Duct joining the stack
Real time monitoring device
Disturbance: Bent and joining of two ducts


Duct immediately after ID fan connects
Analysers
Port hole
Stack

Indian scenario

Environment, health and safety are prime concerns for German industries.

German scenario

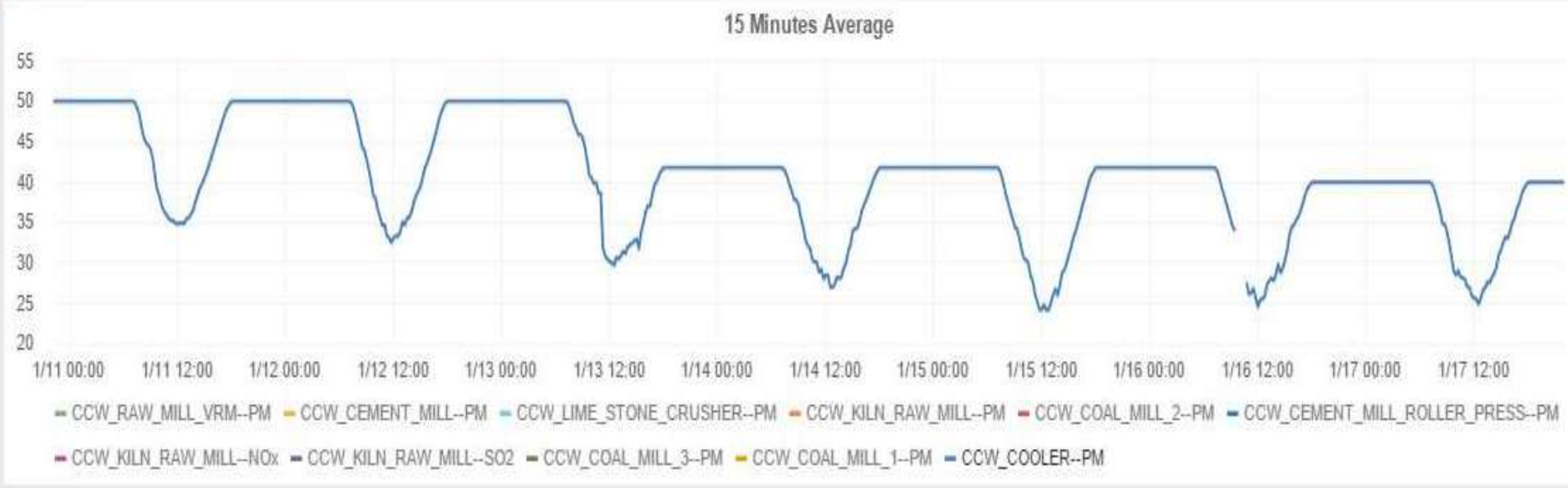
CEMS

Flue gas inlet

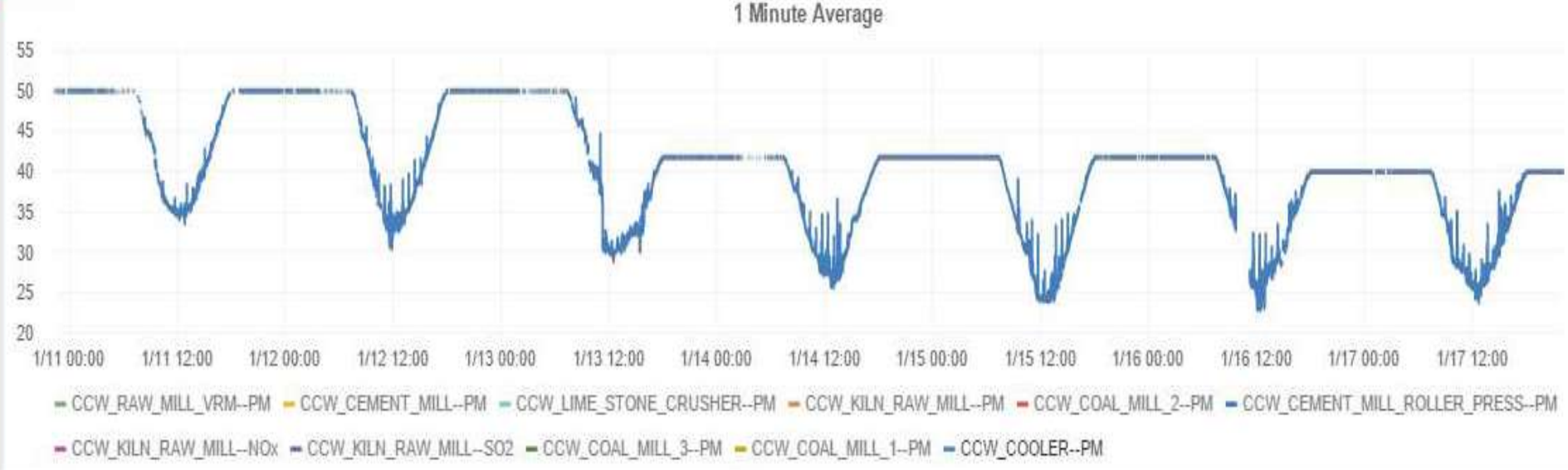
CEMS cabinet with no AC, Fan, Light

No probe

DATA PEAK JUST BELOW 50 mg/Nm3

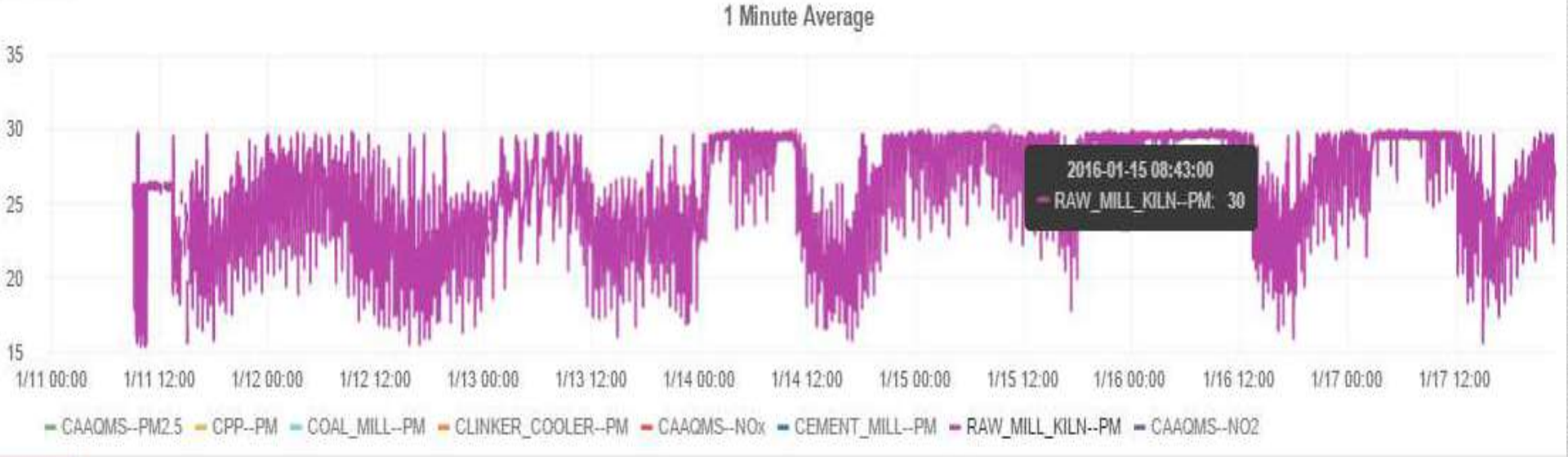


Show Table

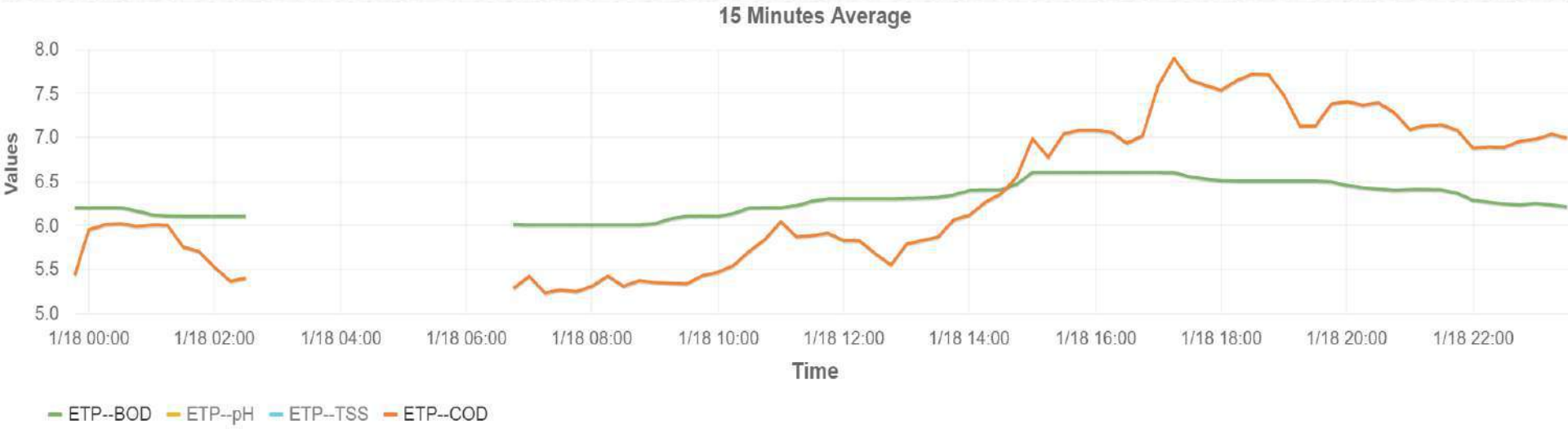


RANDOM DATA SIMULATION WITH DATA PEAK AT 30 mg/Nm3

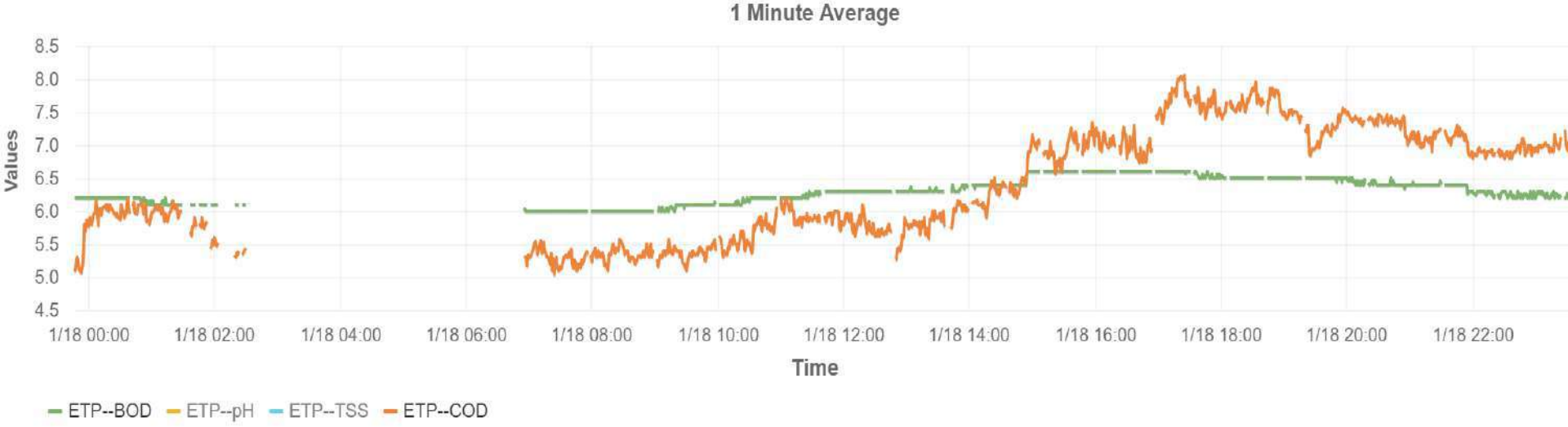
Show Table



BOD EXCEEDS COD

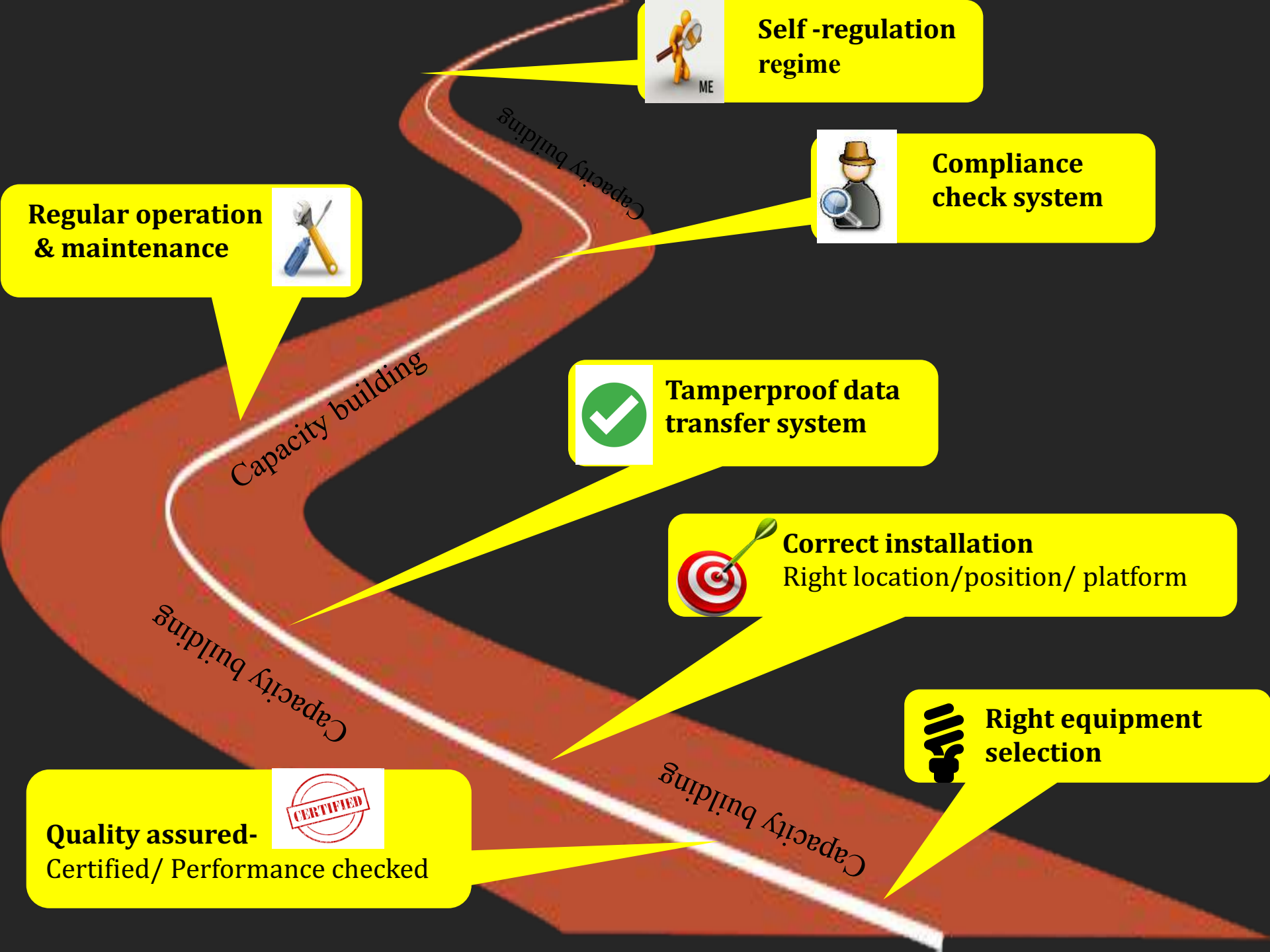


CSV Print



Successful implementation demands

- ✓Roadmap/Time-bound strategy,
- ✓Stakeholder's roles & responsibility,
- ✓Infrastructure in place,
- ✓Capacity building


Self -regulation regime
Compliance check system
Regular operation & maintenance
Capacity building
Tamperproof data transfer system
Correct installation
Right location/position/ platform
Right equipment selection
Quality assured-
Certified/ Performance checked
CERTIFIED

Guidelines

Key mounting infrastructure, utilities, safety

Acceptance of analyser

Calibration requirement

Emission monitoring requirement

Data exceedance and compliance

- Strong platform with safe approach/ladders/stair.
- If mounting location is >45mtr then proper stair case/ elevator
- Monkey ladder not preferred for height > 30 mts. from the ground.
- For vertical ladder: caged, every 10-12 mtrs- a landing platform
- Strong, maintained ladder, continued through platform to some distance above for safe landing.
- Platform railing at least reach 1.2 mtr in height
- Min. platform width: metallic stacks- 800mm, concrete stack- 1000mm.
- All the cables, instrument air tubings - properly laid & clamped
- Uninterrupted, properly earthed power supply, Lightning arrestor wire line
- Proper and quality Instrument air connection as per demand

Refer: CPCB's Emission Regulation Part III (COINDS/20/1984-85)

Key mounting infrastructure, utilities, safety

- **Quality assurance EU process- QAL1, QAL2, QAL3, AST**
- **Quality assurance using USEPA method of Performance check- RATA, RRA**
- **Certified equipment to install**
- **Post Indigenous certification system, all manufacturer to get certification with 6 months, not after 12 months**
- **Till then, non-certified ones to undergo performance check in the field-** calibration function, variability, data comparison with data quality objective, establishing calibration function with SRM
- **Performance specification of gaseous analyser, PM analyser to meet stipulated range- Zero/Span/Linearity ±1% (for PM ±2%), performance accuracy ±10% of reference measurement**

Acceptance of analyser

- **PM CEMS Calibration- against iso-kinetic method, triplicate/load-** 9 points during installation and 6 points afterward
- **Every 6 months calibration**
- **Result of PM CEMS to compare every fortnightly (Friday 10 am) against iso-kinetic (replicate)**
- **In case of O2 deviation consecutive >10%- recalibration (multi-load, replicate)**
- **No dust factor change without full calibration with prior approval from SPCB/PCC**
- **After major repair/lamp change – recalibration- multi load, triplicate sample**
- **85% data capture**
- **Intensity of lamp to check fortnightly**
- **Data comparison/calibration by empanelled lab**

Calibration- PM CEMS

- Calibration- functioning, drift, linearity, detection limit, output, operating temp etc.
- Full calibration/performance check during installation
- Multi-point (min 3 span) Calibration, data accuracy and reliability check- 6 months
- Data comparison and calibration verification using SRM- by empaneled lab- 6 months
- Zero drift check- 10am daily; if drift exceeds for continuously for 5 days- recalibrate
- Zero and Span drift check, every Friday 10am, to be recorded
- No drift check using ambient air
- DOAS, NDIR, NDUV, FTIR, laser based system- calibration revalidation once in 3 months and after lamp change
- Recalibration after any major repair and replacement
- Provision for remote calibration
- Lamp intensity to check- fortnightly
- Minimum 85% data availability

Calibration- Gaseous CEMS

- Follow 8D/2D from last disturbance for laminar flow
- In rare cases 4D in each direction from last disturbance. In this case 12 sample calibration (triplicate at 25%, 50%, 75%, 100% load)
- CEMS – 500mm below porthole
- PM CEMS installation in Horizontal plane
- Gaseous CEMS, protruding downwards facing the direction of flow

Key points- Emission monitoring

- **Compliance check not being carried as of now. But time average will be used for compliance check.**
- **Not to consider:** Spike for <1min, data during calibration/preventive maintenance, initial 30 mins data for batch process or start-up or small boilers, shut down
- **10 mins/hr data loss= one half-hourly data loss**
- **>5 half-hourly data loss= 1 days data loss**
- **>3 x hourly data loss due to malfunctioning= accounted for 85%**
- **System problem for >24hrs= operation close**
- **Any exceedance calls for SMS and immediate response**

Key points- Data exceedance and compliance

PM CEMS

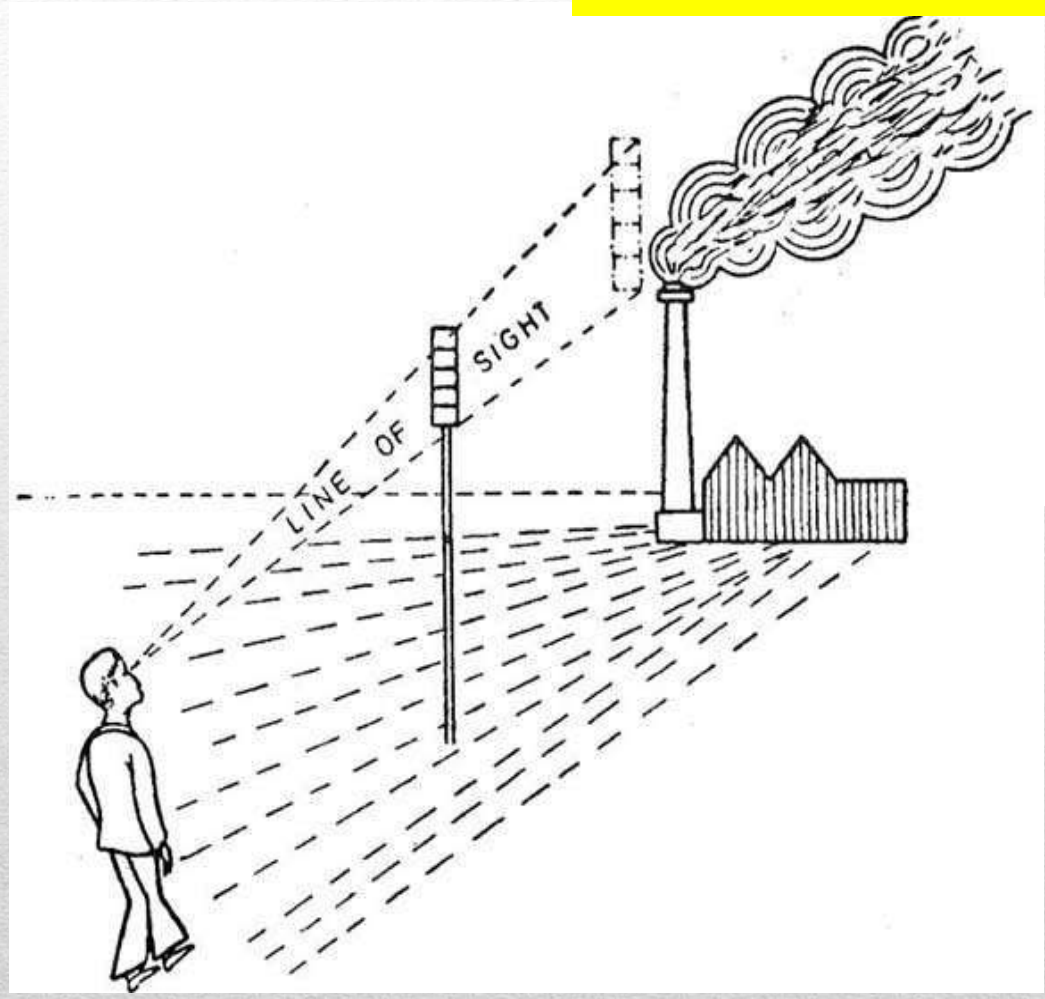
Technology basics

Technology options

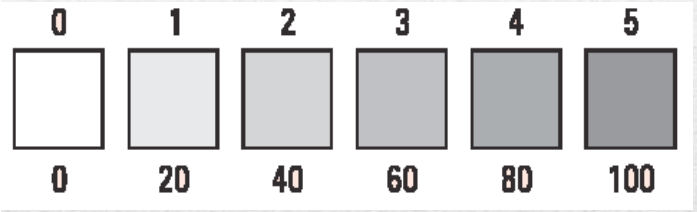
Early Air pollution control device

What do you see?

Ringelmann Scale



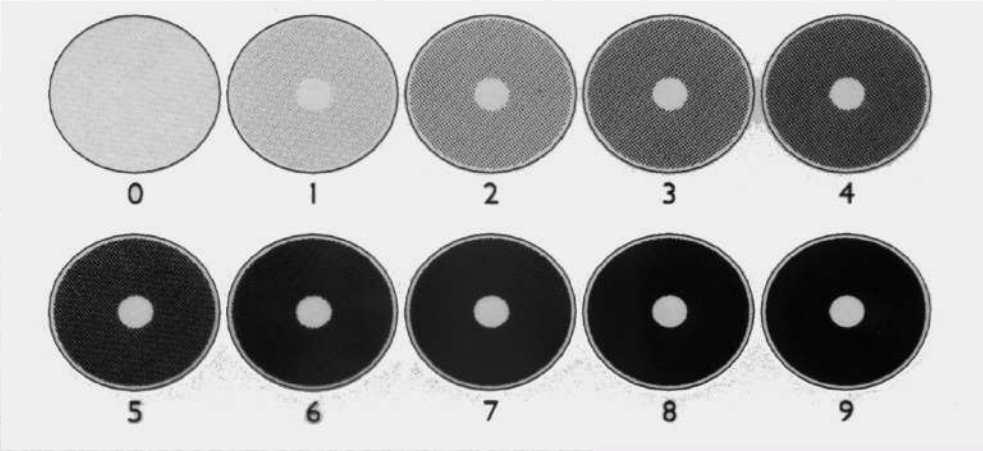
Opacity (%)

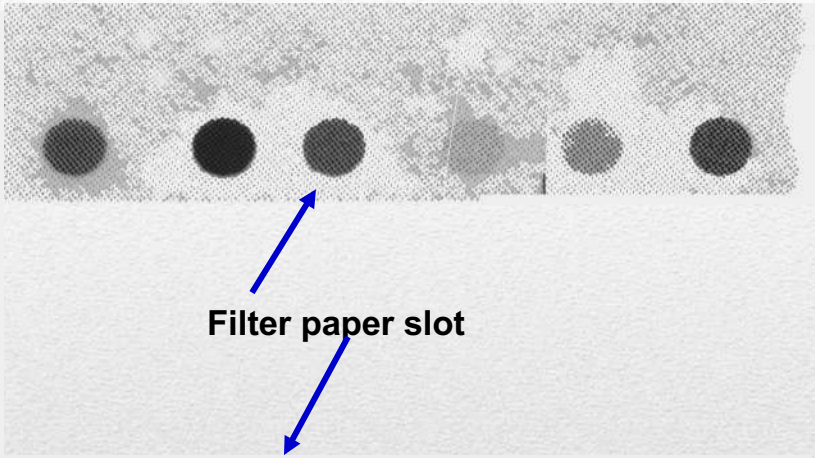


Historical approach of dust monitoring

Bacharach Scale

Reference scale





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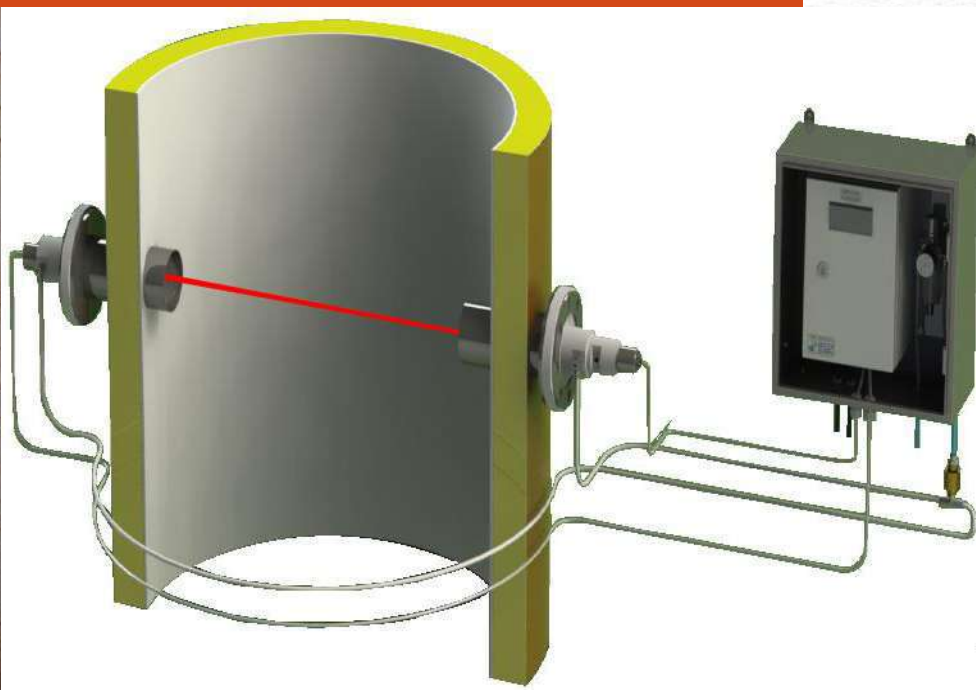
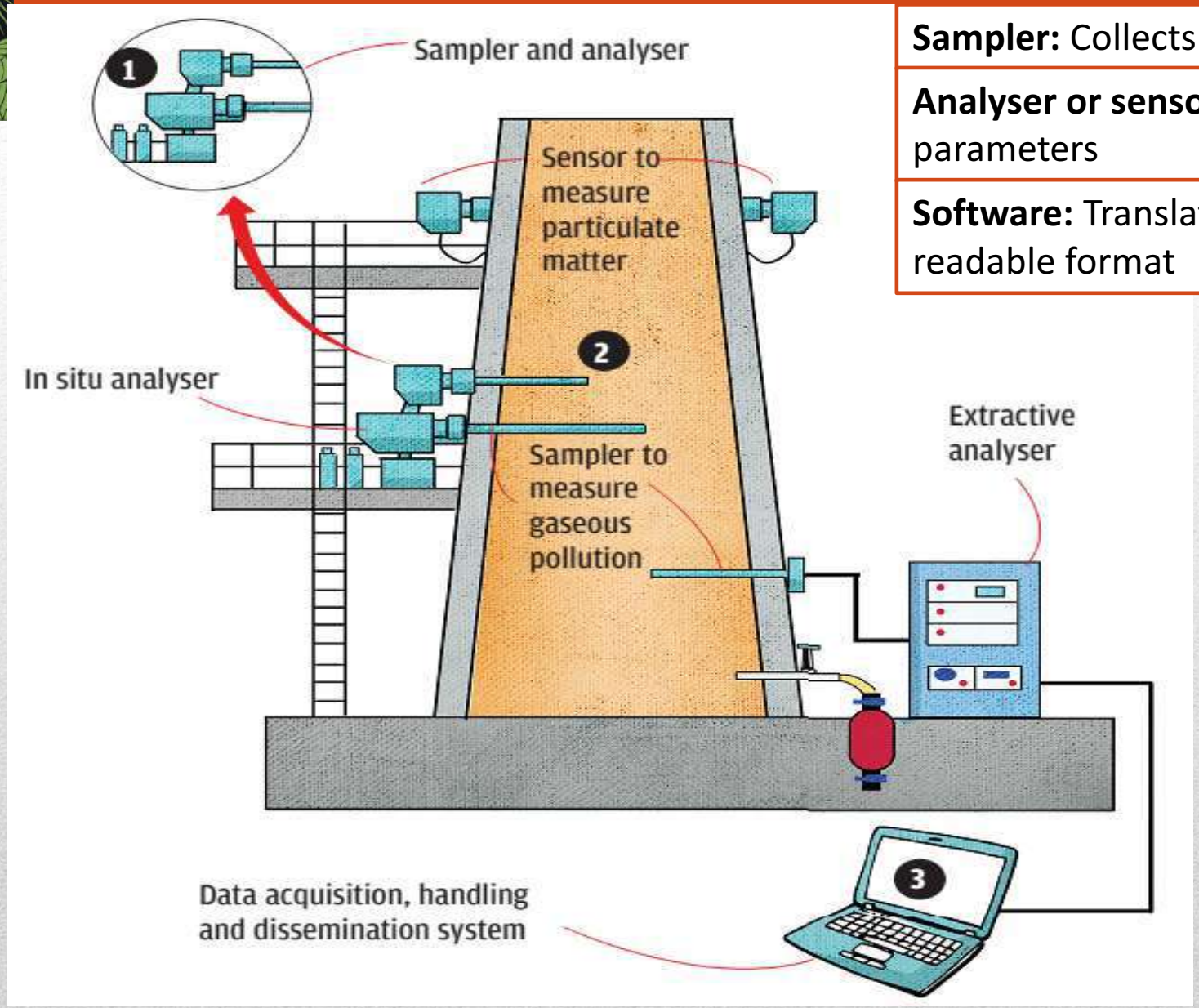


PM (dust) CEMS



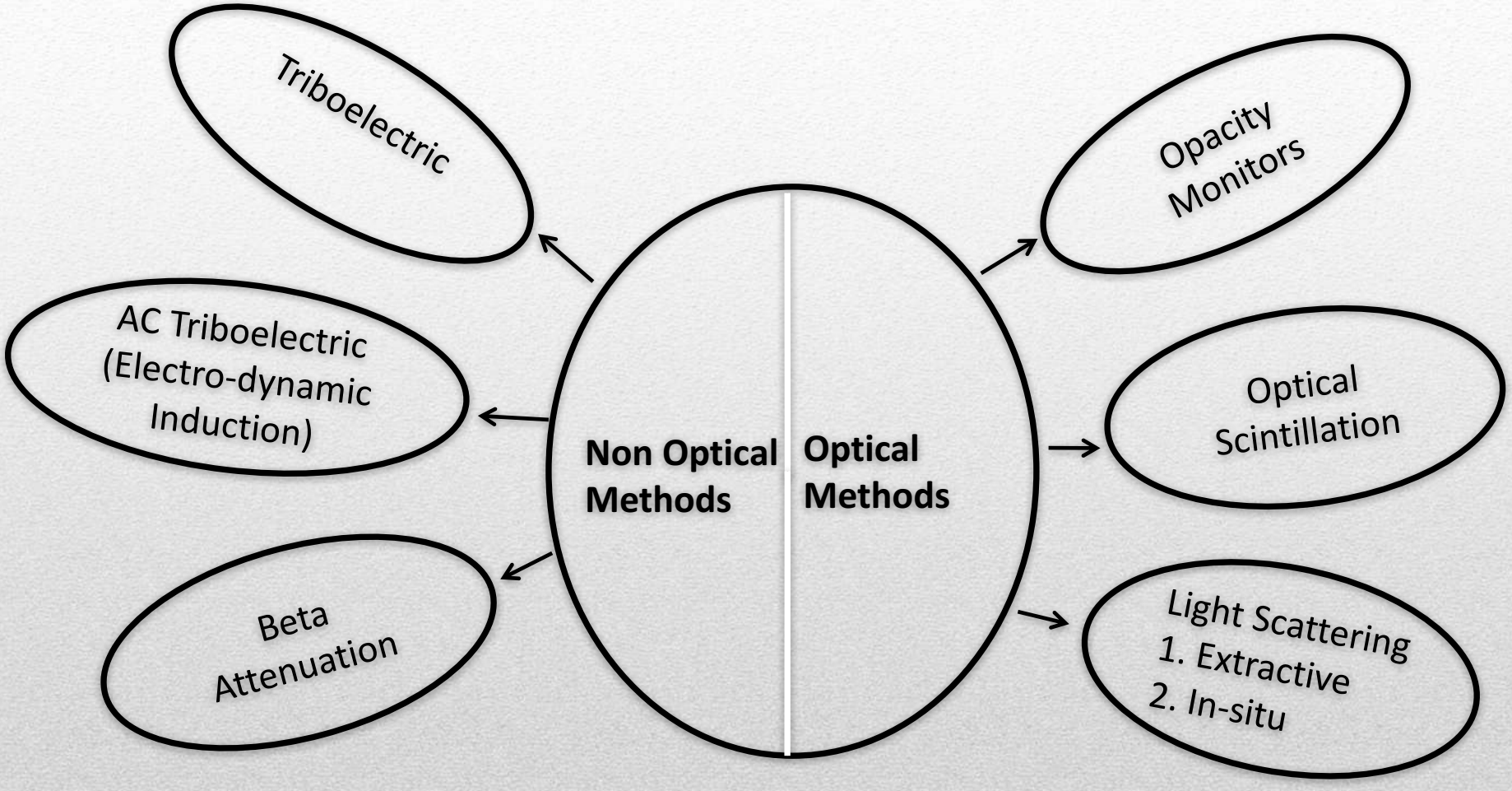
Sampler: Collects sample

Analyser or sensor : Measure parameters

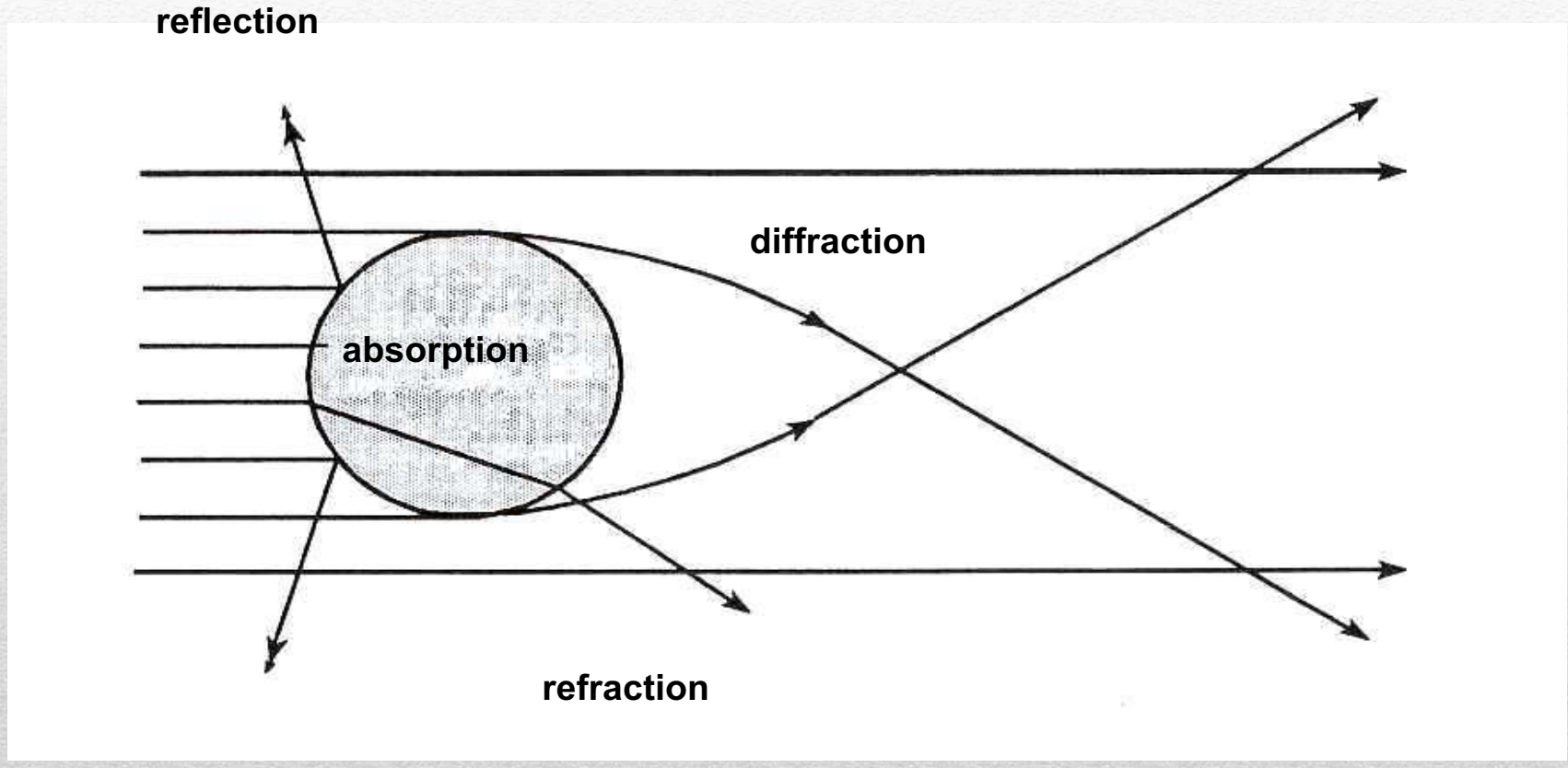
Software: Translates data into readable format

CEMS set-up

Technology options



Methods for PM CEMS



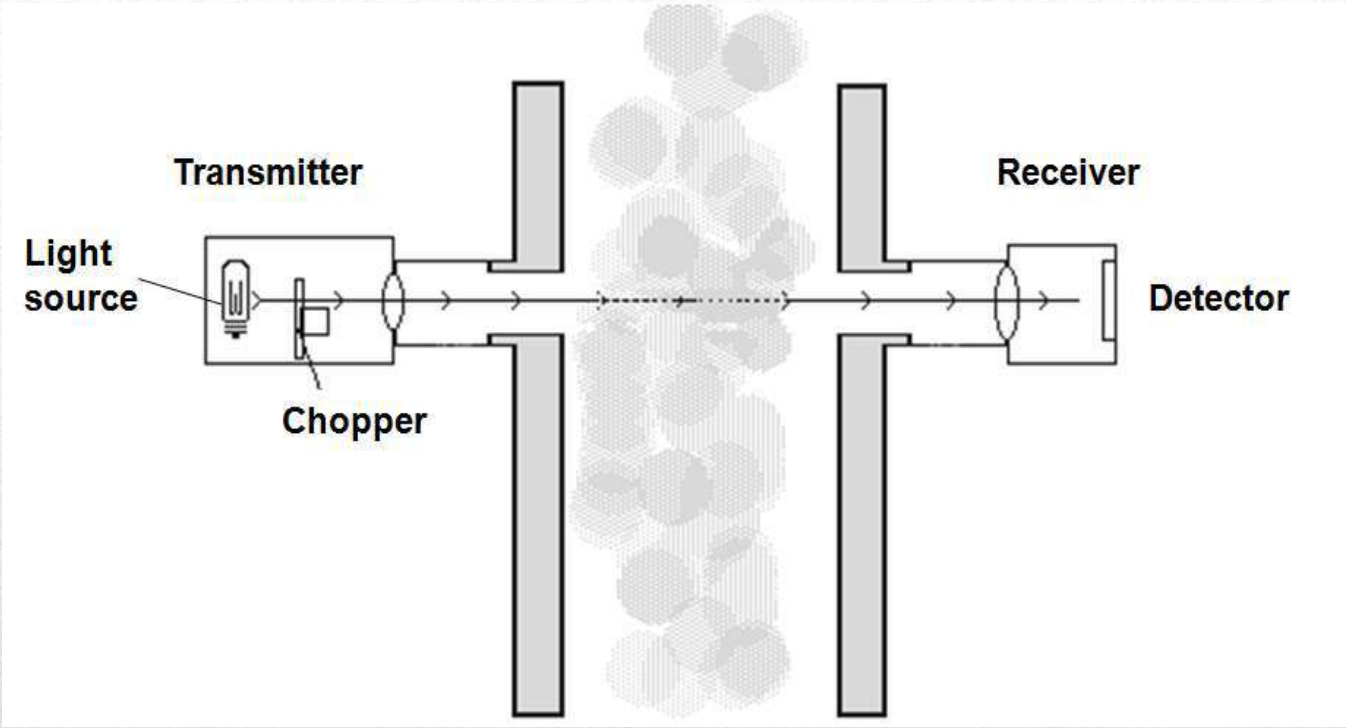
Different effects on illuminating a particle

Transmission

$$T = \frac{I}{I_o}$$

Opacity

$$Opac = 1 - \frac{I}{I_o}$$



Dust concentration is proportional to Extinction

Extinction = loge 1/T = $e^{k.n.a.L}$

I = received light;

I_o = emitted light

k = extinction coefficient

n = dust concentration

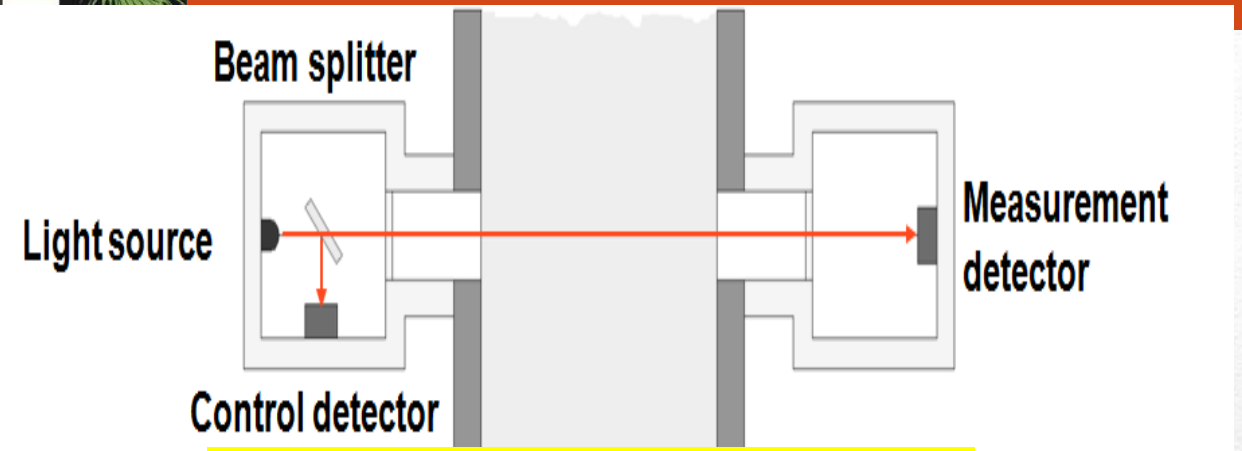
a = mean projected area of particle

L = length of optical measurement path

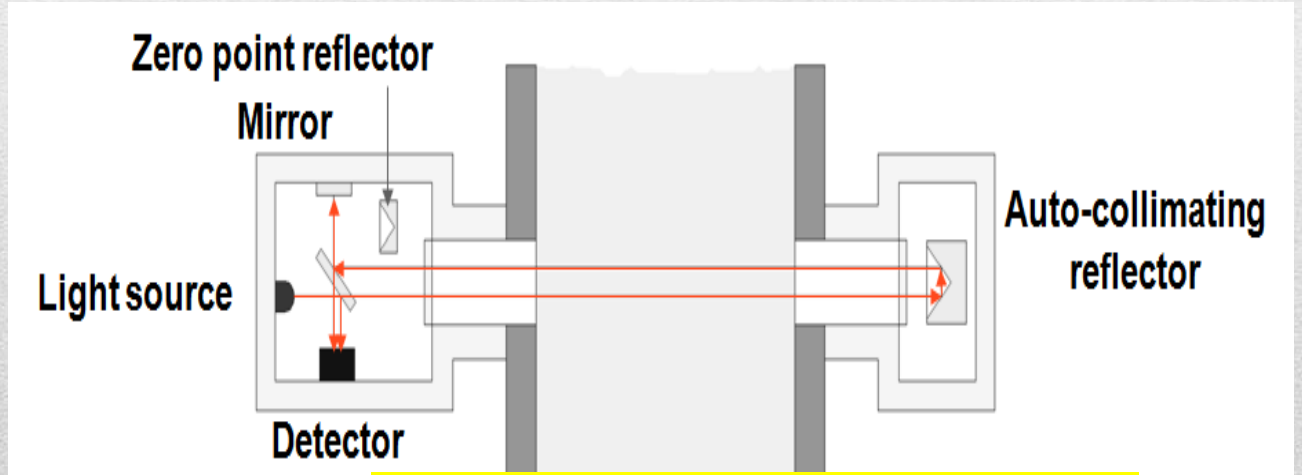
(auto-collimating: 2 x distance)

Transmittance / Opacity

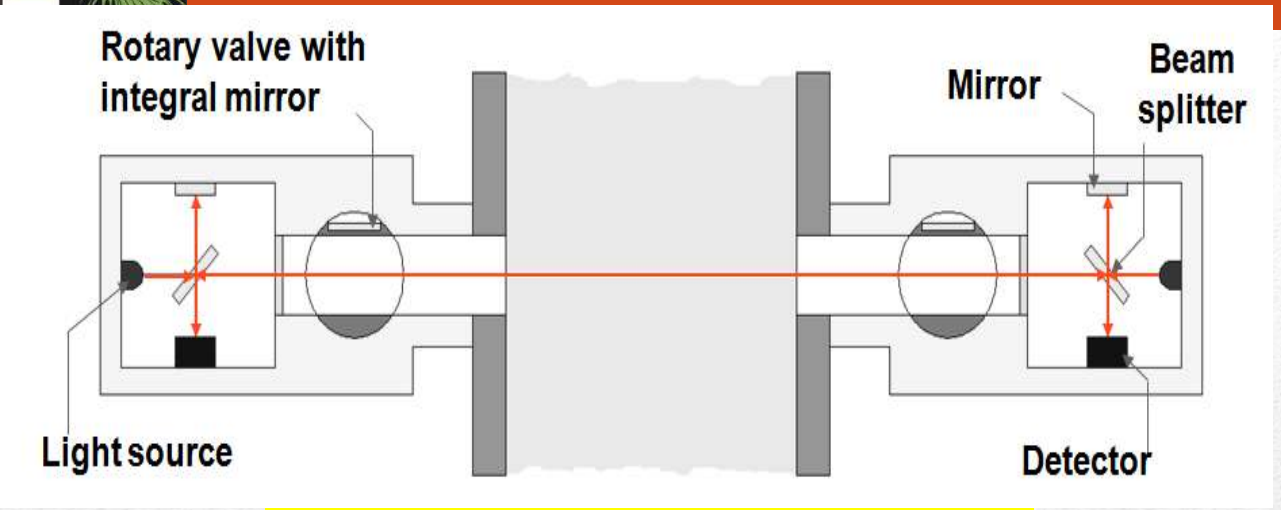
Types of Transmissometer



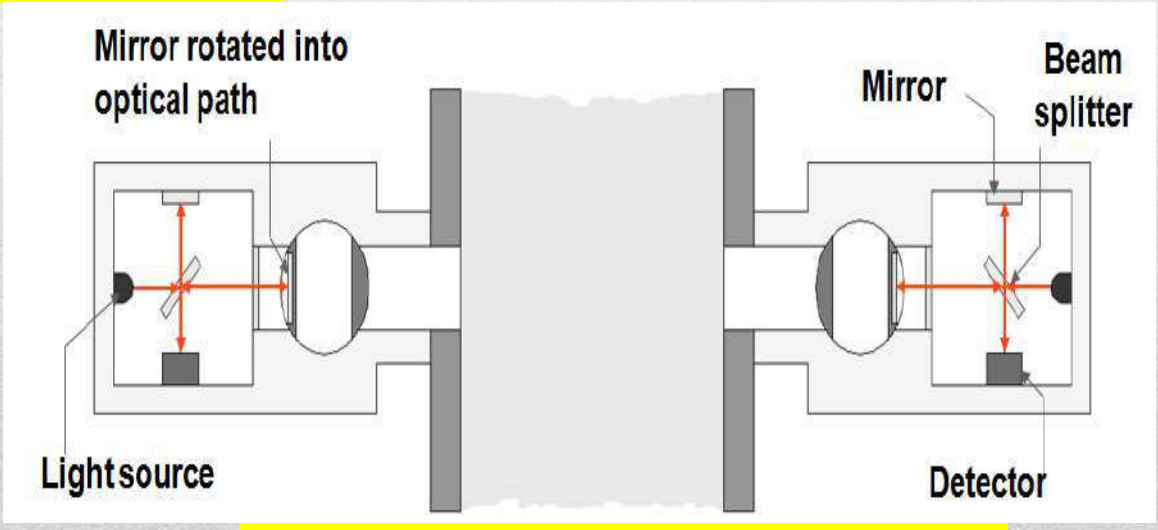
Single pass transmissometer



Double pass transmissometer



Dual beam (measurement)



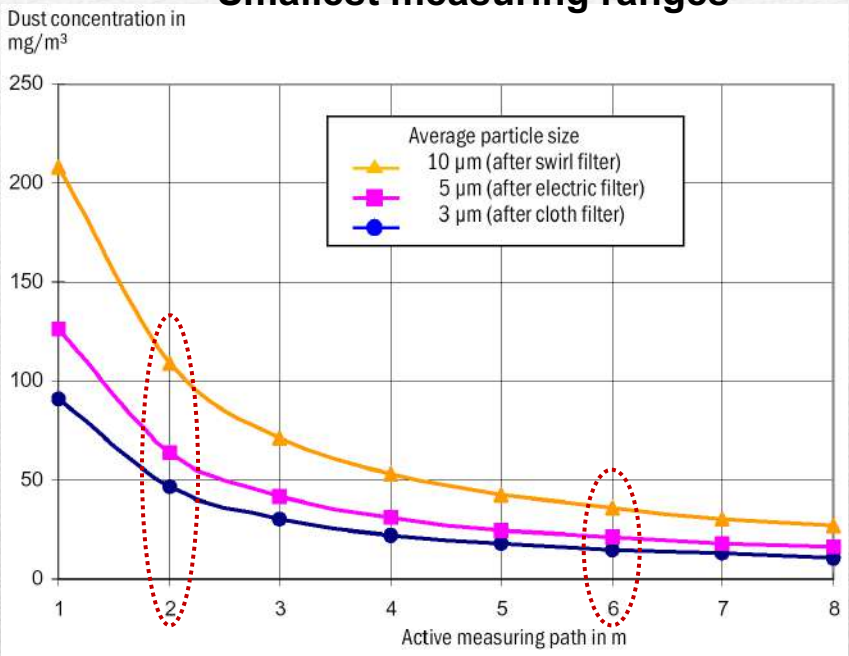
Dual beam (contamination check)

Types of Transmissometer

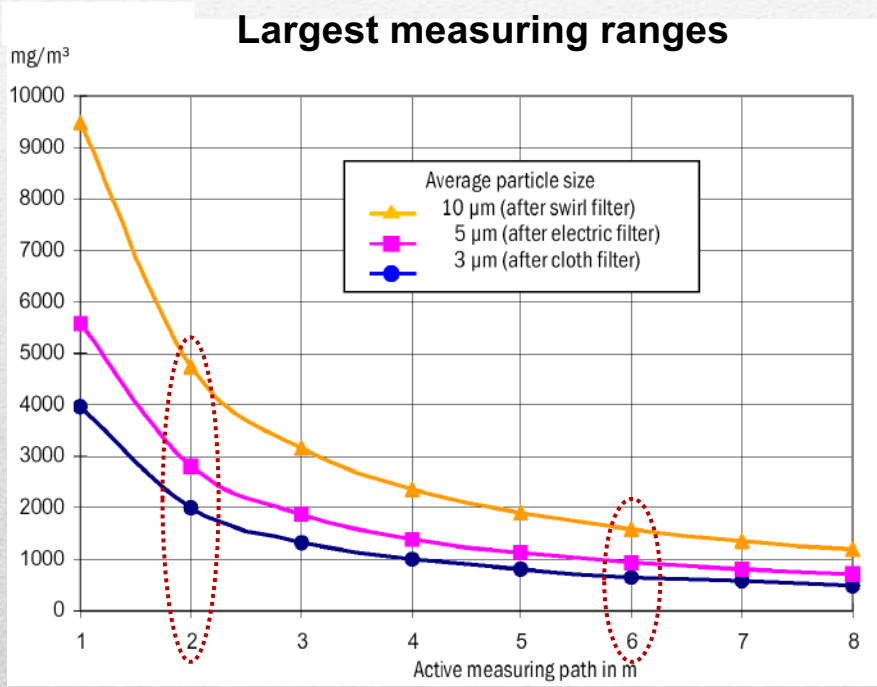
Relationship between

- path length
- particle size
- dust concentration

Smallest measuring ranges



Largest measuring ranges

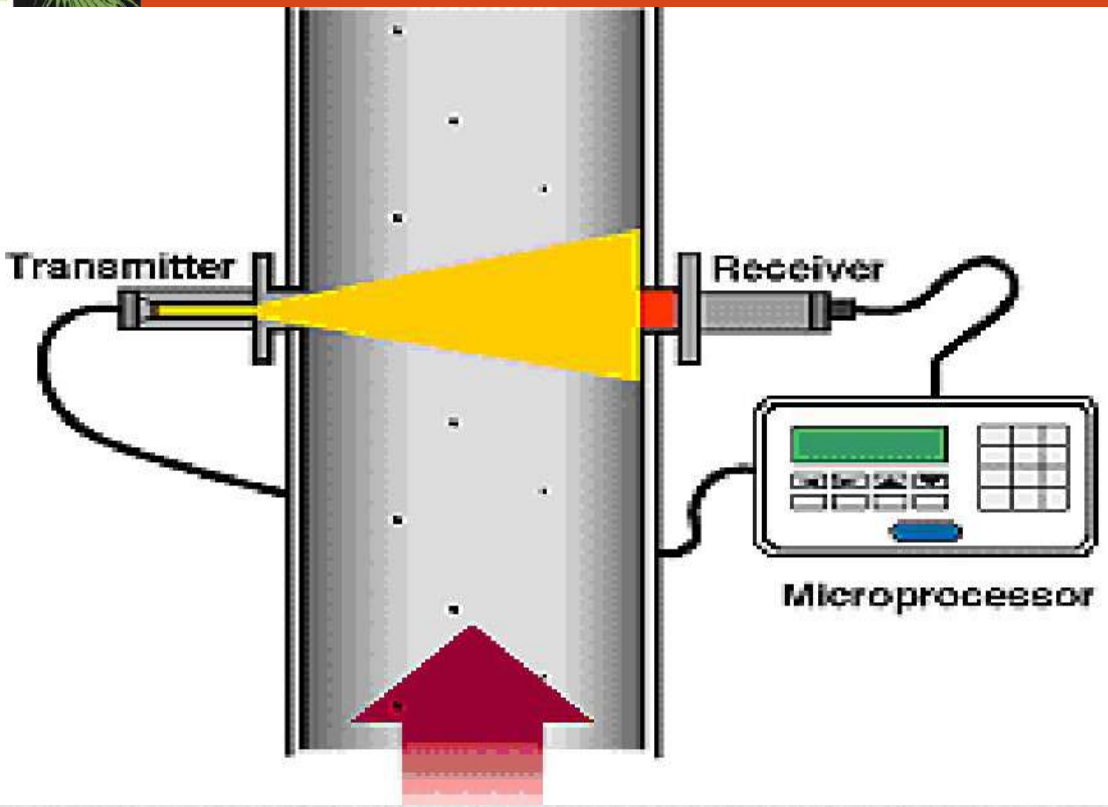


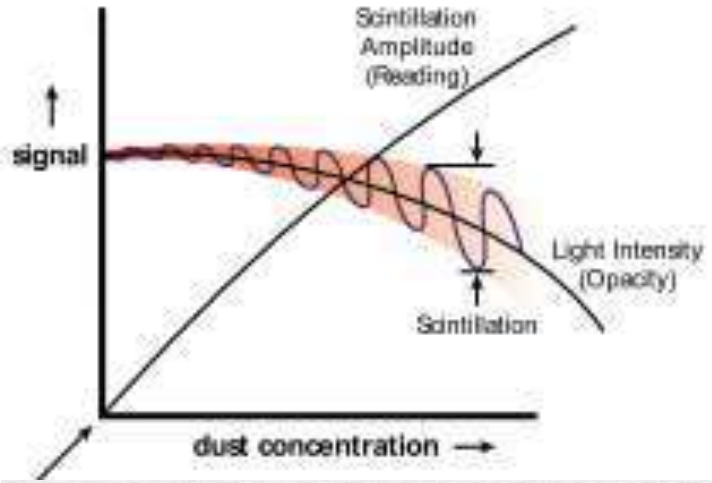
To measure low concentrations → a long measuring path is required

Measuring Limits – Transmission / Opacity

Opacity meter- Limitations

- **Suitable for medium to high concentration**. At low concentrations (<10mg/Nm3), the reduction in the light beam caused by the particles is indistinguishable from the zero drift.
- The attenuation of light is sensitive to dust contamination on the lens surfaces.
- Systems without retro-reflectors (i.e. single pass) are sensitive to misalignment between the transmitter and receiver.
- Not suitable for stacks with flue gas below dew point or containing water droplets from wet collectors.
- Calibration and response from instrument changes with
  - ✓ Particle type and refractive index
  - ✓ Particle colour
  - ✓ Particle size and shape



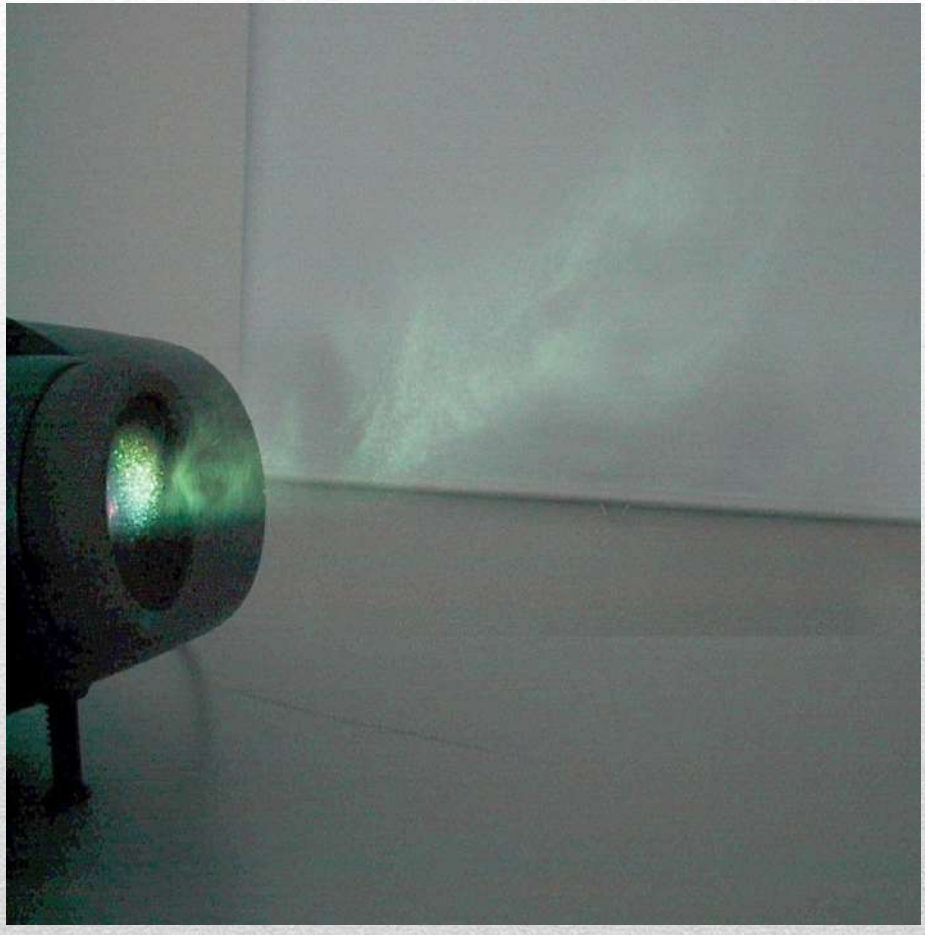


- A variation of transmissometer
- Based on Flicker of light while dust Particles pass the beam
- Dust particles passing through the light beam cause the receiver to detect a modulating signal. The ratio of the fluctuations in the received light (scintillation) to the average light intensity at the detector is used to produce a signal proportional to changes in particulate concentration.

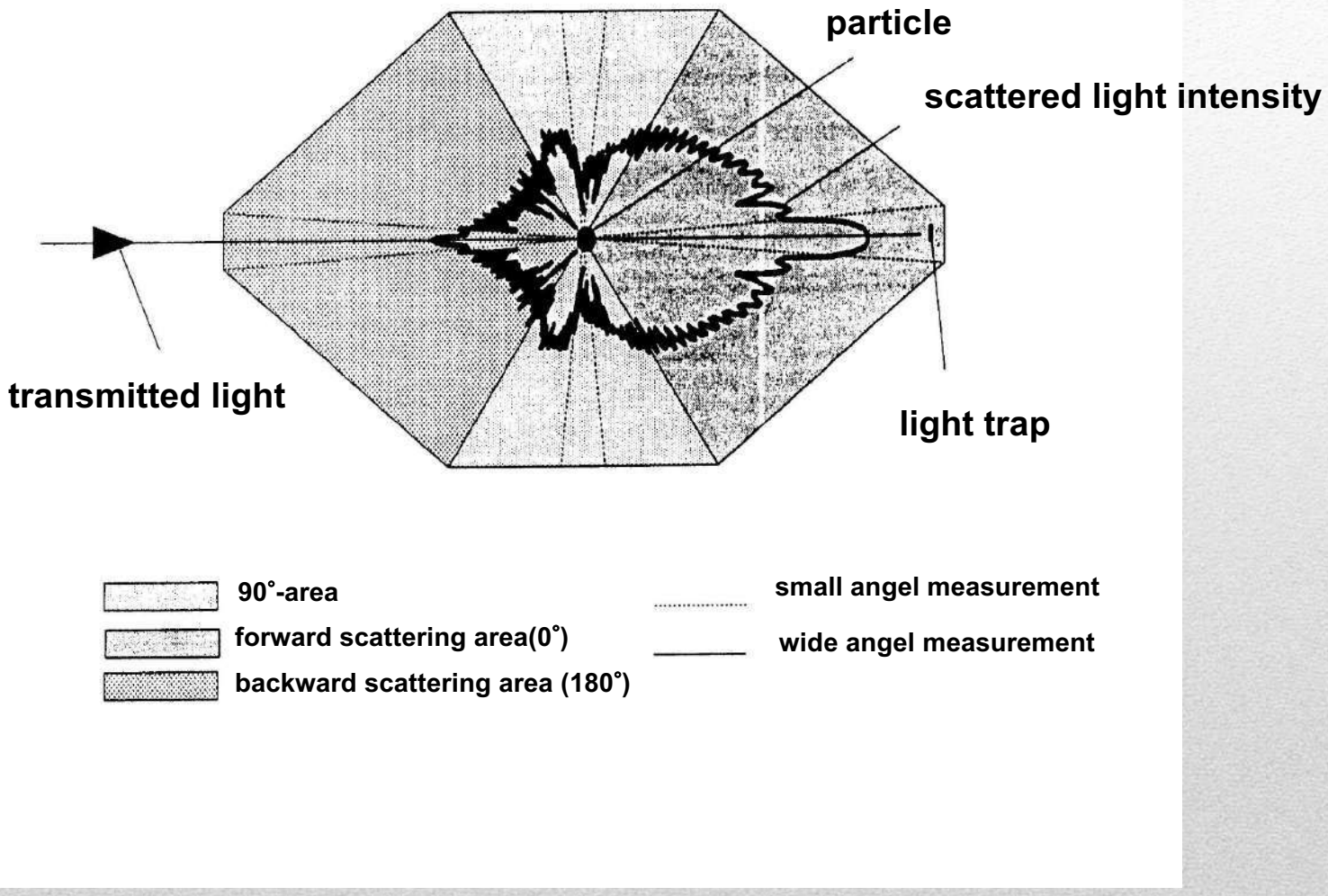
Optical scintillation

- Liquid droplets or vapour cause erroneous readings due to refraction / reflection of the light beam by the moisture.
- Not suitable for PM levels below the resolution limits of opacity instruments use to offsets created by heat haze.
- Aadversely affected by particle size, density, shape change.
- The cleaning of receiver is an issue.

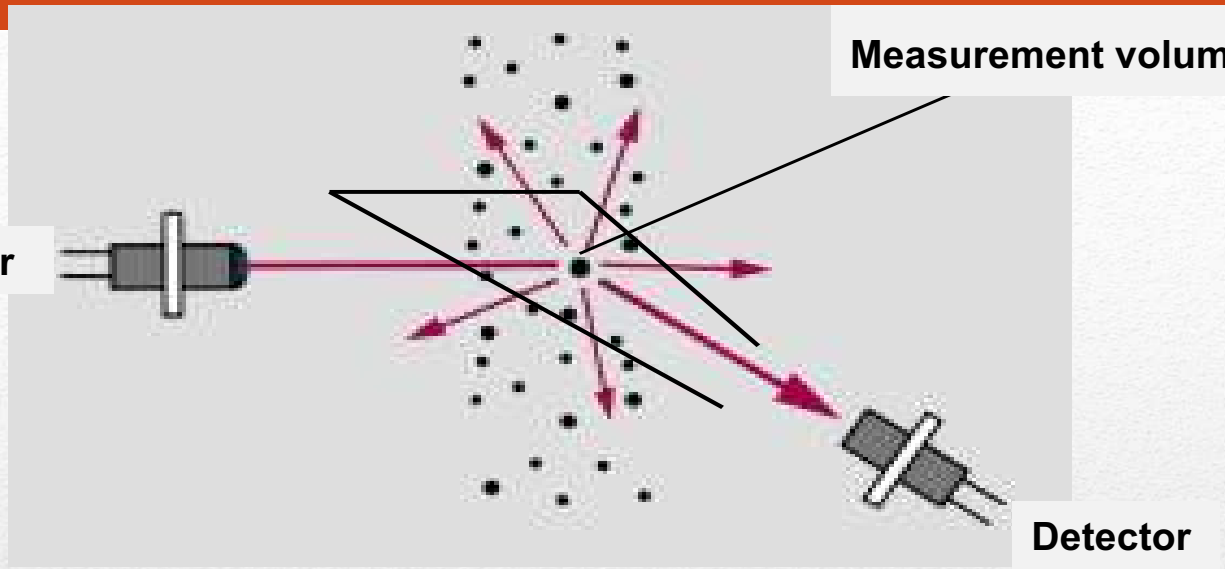
Opacity meter- Limitations



Scatter Light



Different Regions of Scattered Light

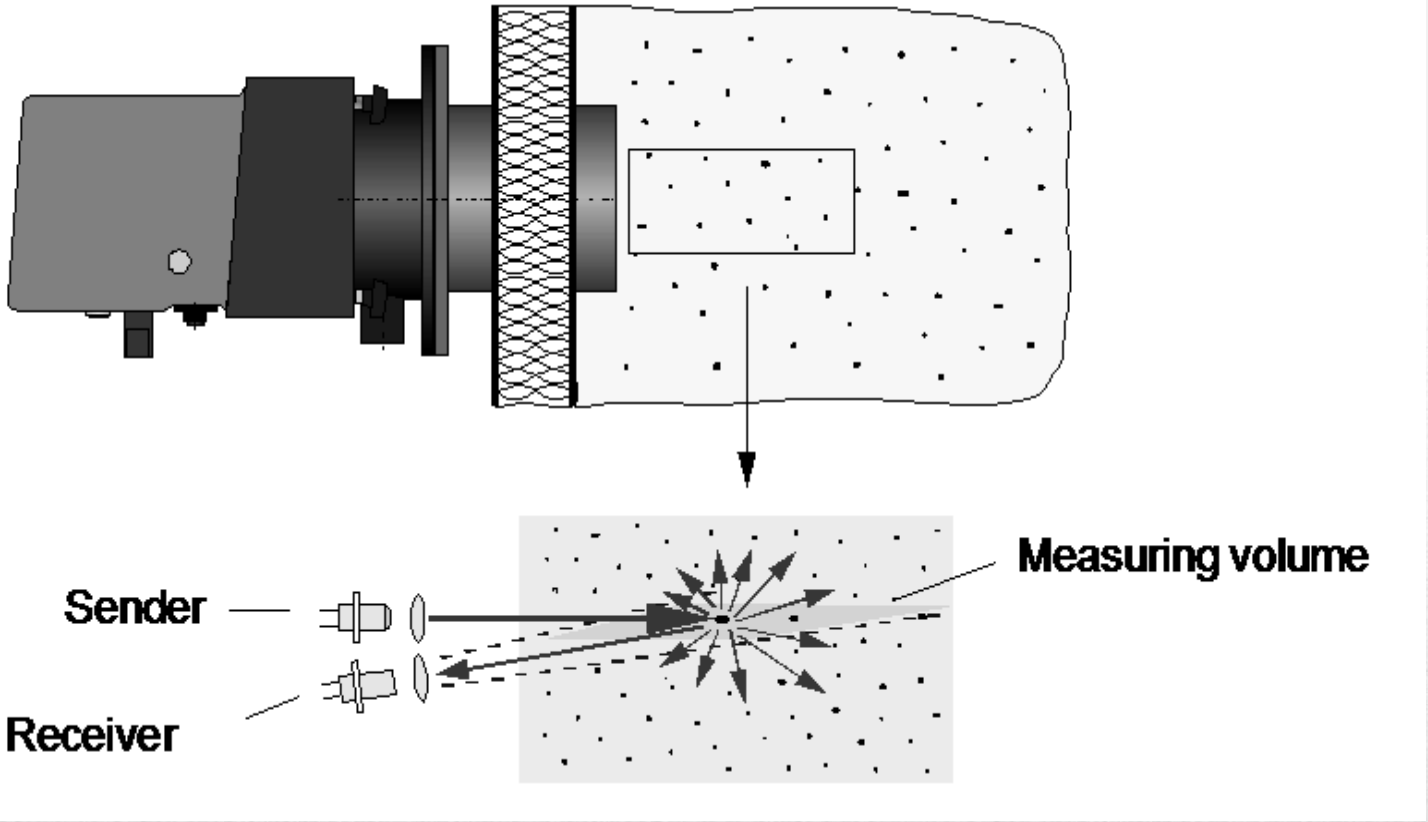


It has better sensitivity than back scatter devices. Suitable for low to medium conc.

Limitations

- Small scattered light intensity requires high measurement accuracy and occurring at small angles to the incidence, it is very important to shield the receiver properly from directly transmitted light.
- Air purges are required for optical surfaces, although compensation for dust accumulation can be made by separately measuring changes in directly transmitted light.

Forward Scatter Light

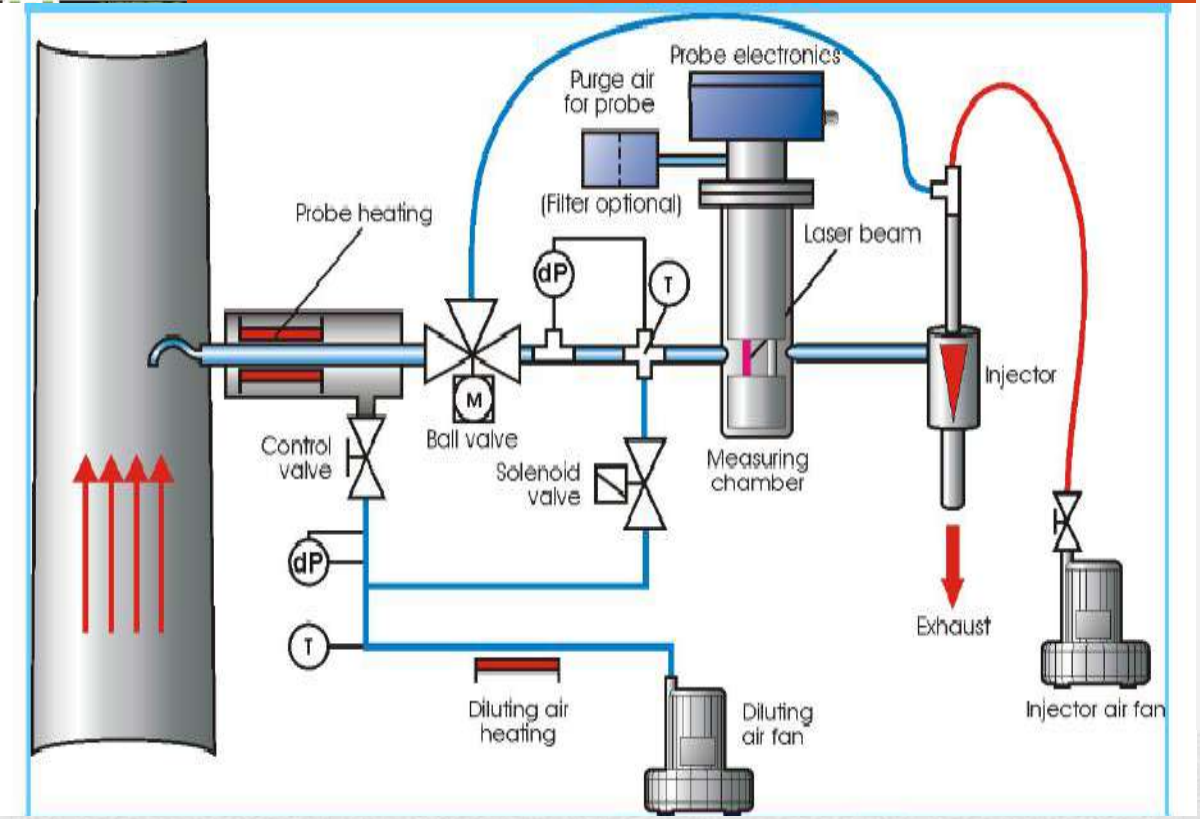


Suitable for high to medium conc.

Limitations

- Calibration is affected by changes in particle size and type of particle. Response reduces by 20% from peak if particle size changes from 0.8- 0.7µm.
- More sensitive to changes in particle composition and refractive index
- Water droplets affect the reading of In-situ instrument.

Backward Scatter Light



Extractive versions are designed for wet flue gas applications and are required for liquid droplets.

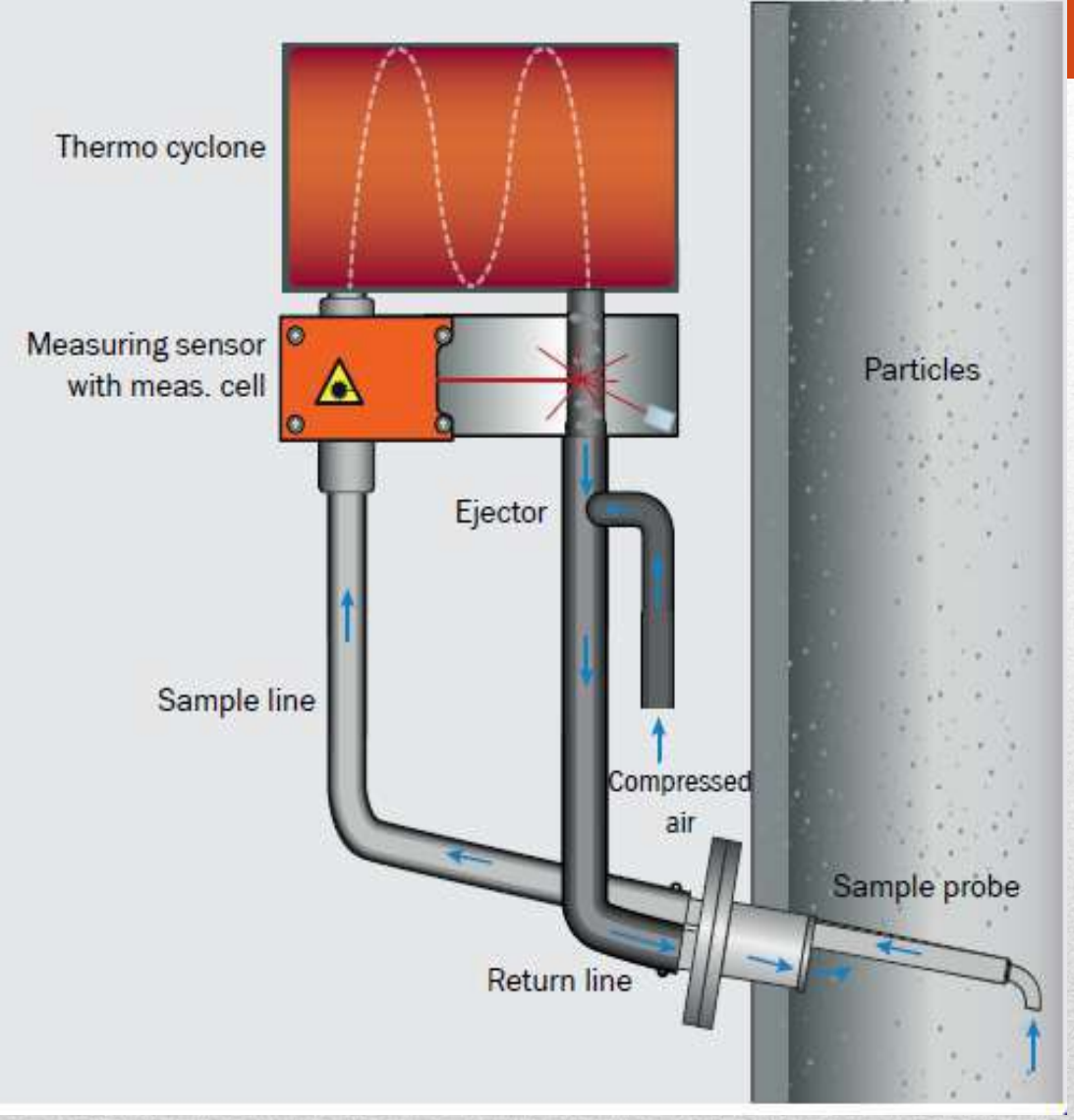
Infrared light gives better response than visible light in this instrument.

Works best after a bag filter or multi-stage APC

Limitations

- Low cost, low maintenance but high installation cost.
- Sensitive to low PM concentration.
- Performance is adversely affected by particle size, density and shape .

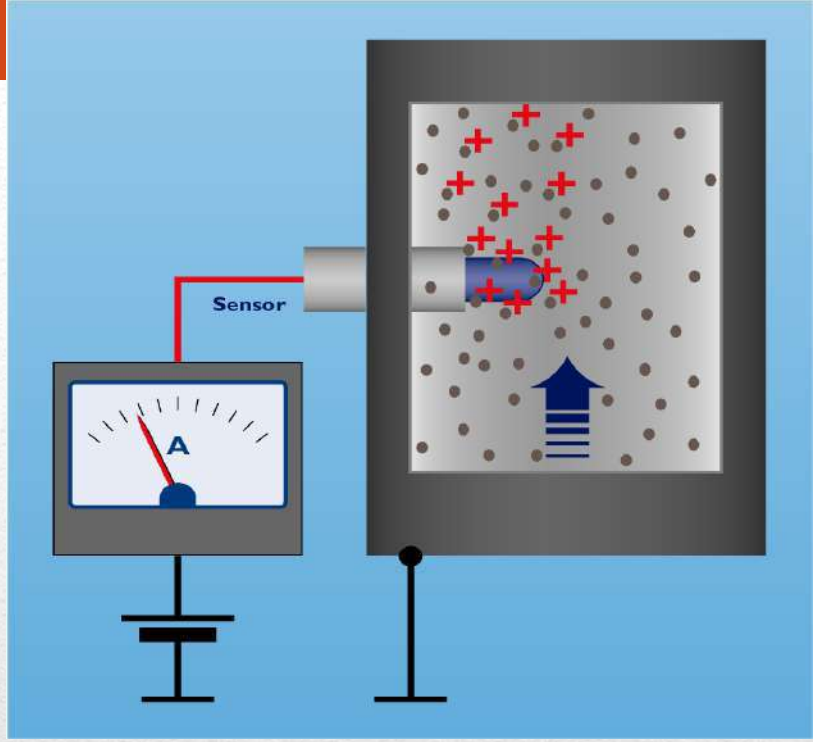
Extractive Light Scatter



PM CEMS- Wet Extractive

Colliding particles exchange their electrical charge with the measuring electrode.

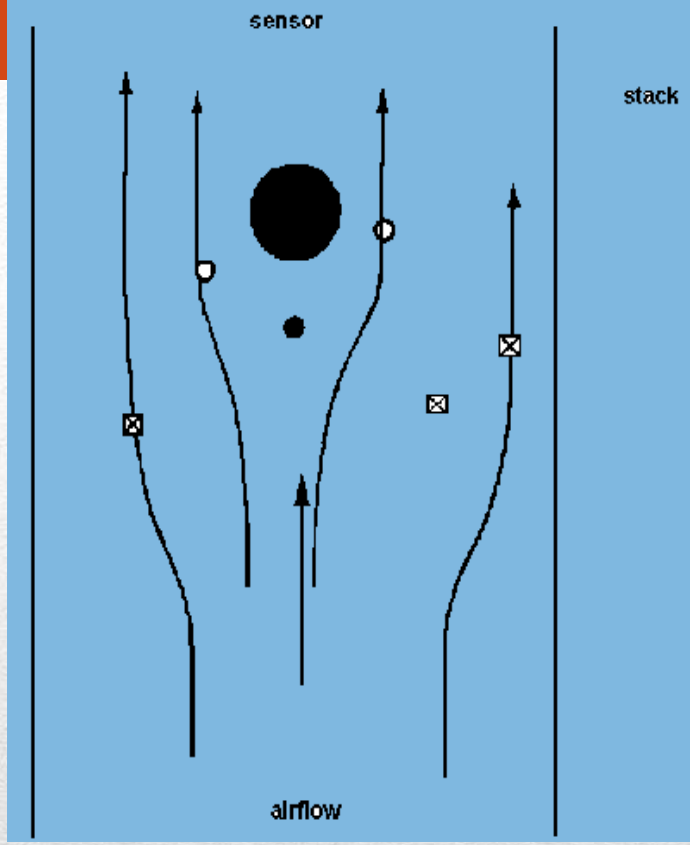
The electrical charge transfer depends on the respective mass, velocity and electric charge of the particles. This effect is used by the so-called "Tribo flow effect"



- A rod length of approximately half the stack size is used to ensure representative measurement.
- Amplification of the small Triboelectric signal (10 Pico amps) is usually performed in the sensor head to maximize the instrument signal.
- The insulator at the base of the sensor rod must be kept clean to avoid false signals from ground loops and stack currents.

Triboflow

Particles produce a AC charge movement by charge induction. Charge on the particle transfer charge in the probe as it passes.



$$I_{AC} = K_I \bullet K_M \bullet m$$

I_{AC} = measured AC-current (A)

K_I = const., function of the geometry of the stack

K_M = material-dependent

m = mass-concentration of particulates (mg/s)

Electrodynamic

Limitations

- Triboelectric / Triboflow / Electrodynamic is velocity dependent. So not suitable for any process where there is a variation in the velocity.
- Mostly suitable for mass flow measurement and not for instantaneous concentration measurement.
- Widely used as a switch for detection of filter bag rupture
- Internal Zero & Span check is not possible

- Particles in the extracted partial gas flow are collected on a filter paper in defined time intervals (approx. 5 min).
- Beta-radiation on the filter paper provides measured values directly proportional to the dust weight, not influenced by particle size and color.

- Device provides only mean values (normally 5 to 20 min), no information about actual measured values
- Radiation source needs high safety effort
- High costs for consumables

Beta Attenuation

Measuring principle	Type	Procedure
Gravimetric measurement	extractive	discontinuous
Beta Ray	extractive	discontinuous
Scatter light wet gas	extractive	continuous
Scatter light dry gas	in - situ	continuous
Triboflow	in - situ	continuous
Transmission	in - situ	continuous

Summary

Measurement Technology		Stack Diameter (m)	Concentration mg/m³		APC device	Min. certification. range	Dry	Humid	Wet	Velocity Dependant
			Min	Max						
Probe Electrification	Electrodynamic	0.1 -3 (6m with multiple probes)	< 0.1	250	Bag, Cyclone, Drier,	0 to7.5mg/m3 (QAL1 to EN-15267-3)	√	√	x	Not in 8 - 18m/s range
	AC Tribo	0.1 - 3	< 1	250	Bag, Cyclone	0 - 15mg/m3	√	x	x	Yes
	Tribo	0.1-3	< 1	250	Bag, Cyclone	qualitative bag leak	√	x	x	Yes
Transmissometry	Dynamic Opacity / Scintilation	0.5 - 10	10 10 (5m stack) 25 (2m stack)	1000	Cyclone, ESP, None	0- 150mg/m3	√	x	x	No
	Opacity/ Extinction	1 - 15	10 (at 5m) 50 (at 1m)	1000	Bag, Cyclone, ESP, None	0- 50mg/m3	√	x	x	No
		0.5-12	< 30	1000	ESP, None	None	√	x	x	No
In-situ Light Scatter	Scattered Light (Fwd)	1 - 3	< 0.1	300	Bag, ESP, None	0-15mg/m3	√	x	x	No
	Scattered Light (Back)	2 - 10	<0.5	500	Bag , ESP, None	0-7.5mg/m3	√	x	x	No
Extractive light scatter		0.5 - 10	0.1	100	Wet collector (wet FGD)		√	√	√	N/A
Extractive Beta		0.5 -10	0.5	< 150	Wet collector (wet FGD)		√	√	√	N/A

Suitability of PM- CEMS (CSE's Technical Guidance Manual)

Industries/Applications	Process conditions	Typical solution	Comments
Incinerators	0-10mg/m^3 (bagfilters after dry scrubbing)	Light scatter or Probe electrification	Cost effective solution for highly abated processes (below 1 mg/m^3)
Cement kilns	0-10 mg/m^3 (with incineration) 0-50 mg/m^3 (other)	Light scatter Opacity/ dynamic opacity	Plant networked solution extends to mill applications
Coal fired power plant	0-50 mg/m^3 (new plant) 0-150 mg/m^3 (old plant) 0-20 mg/m^3 (wet FGD)	Back or forward scatter Opacity/ Back scatter Extractive Beta or Scatter	Solution depends on dust levels
Small boilers	0-200 mg/m^3 (ESP or no controls)	Opacity/Back scatter	High dust may use opacity or back scatter
Gas turbines	<1 mg/m^3	Forward scatter	
Pulp and paper	0-50 mg/m^3 High humidity	Electrodynamic or opacity	Insulated Electrodynamic probe allows instrument to discriminate between water vapour and particulate
Refineries	0-50 mg/m^3 (Ex gas zone)	Opacity or light scatter or Electrodynamic	Category 1 device approved according to IECX

Suitability of PM- CEMS (CSE's Technical Guidance Manual)

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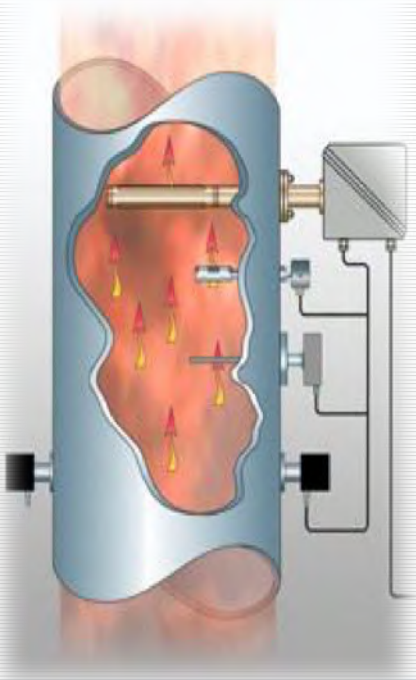

Selection of (CEMS)

Technology, Calibration, Operation & Maintenance

Date: 13.11.2018

SANJEEB KUMAR PAL

Environment Management Department

Is this the requirement for we individuals

OR

This is the job of traffic police to find out and punish us.

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Environment Management Department

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Environment Management Department

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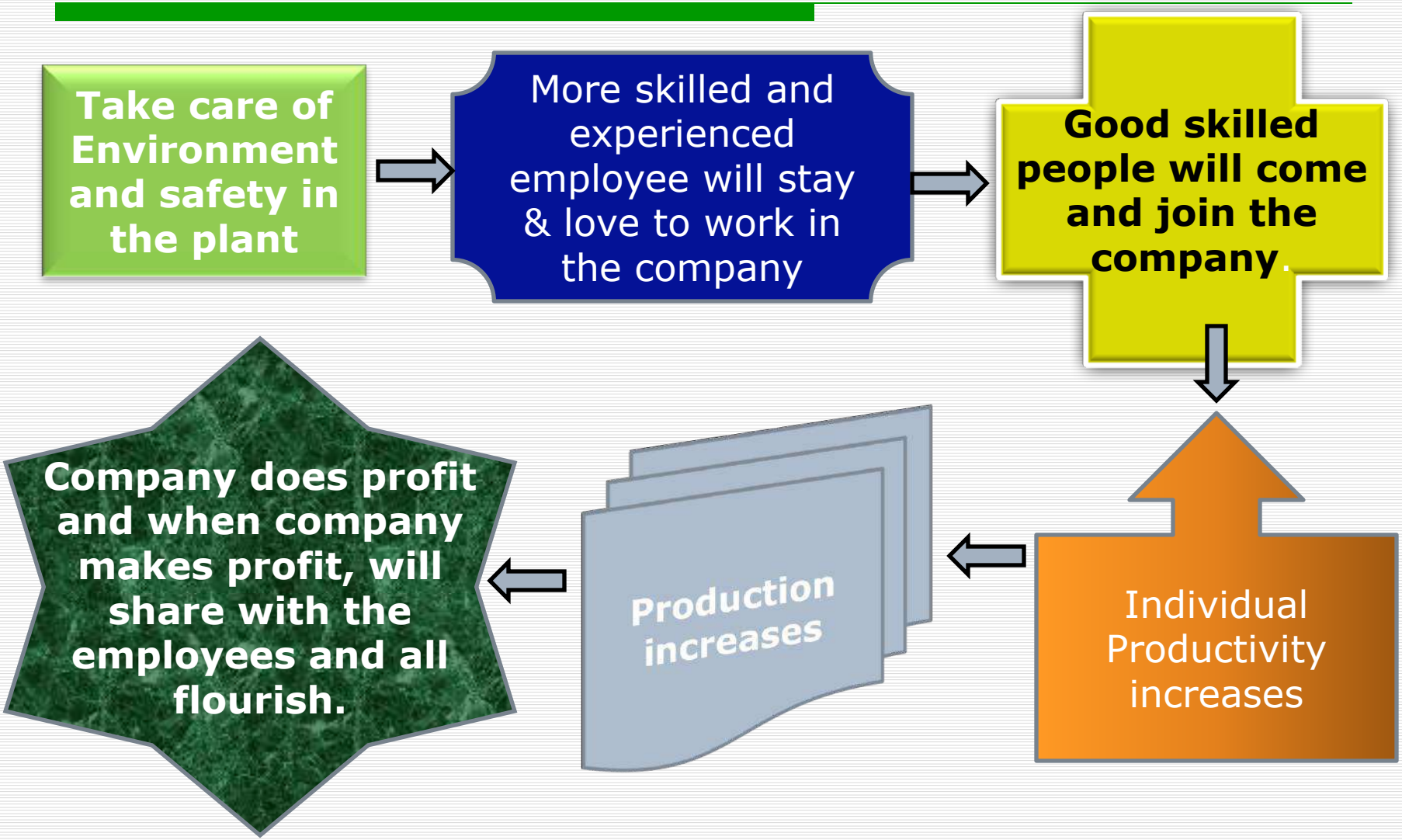


Air Monitoring

01. Source emission Monitoring (Stacks , process outlets , Vehicles etc):→

A **point source** is a single, stationary source of pollution, such as an industrial facility, that typically operates under some kind of government authorization (e.g., a permit, approval or regulation). A **nonpoint source** includes stationary and mobile sources that are individually small compared to point sources, but collectively large, such as wood stoves, motor vehicles and lawnmowers. It also includes sources whose emissions are spread out over a broad area, such as prescribed burning

02. Fugitive Emission monitoring :→

Pollutant released into air from leaks in equipment, pipe lines, seals, valves, etc., and not from the usual sources such chimneys, stacks, and vents.

"could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening." In general, the decision whether to consider emissions as fugitive is a factual determination made by the state permitting agency on a case-by-case basis.

03. Ambient Air quality Monitoring:→

Ambient air quality refers to the quality of outdoor air to which the public has access. Poor ambient air quality occurs when pollutants reach high enough concentrations to affect human health and/or the environment. Ambient air quality is typically measured near ground level, away from direct sources of pollution.

In Air Monitoring Which common Parameters We Monitor ?

1. Gaseous Pollutants

CO, CO2, SOX, NOX, O3, BTX, NH3, HCL, CL2, Mercury, O2 etc.

2. Particulate matters

Total Dust, SPM, RSPM, PM10, PM2.5, Lead , Arsenic , Nickel etc.

Standard Monitoring Equipments

On-line (short term / long term) & Manual monitoring

These are called standard monitoring equipments because these equipments follow the standards, defined by statutory authorities all over the world , they may be autonomous body or central government of the country.

We in India follow USEPA / TUV standards.

USEPA stands for **US Environmental Protection Agency**

TUV stands for (**Technischer Überwachungsverein**, English translation: Technical Inspection Association)

International Certification for CEMS

European Union	USA
QAL I - Quality assurance level I (Certification of Product, COP) QAL II - Quality assurance level II (Performance evaluation at site) QAL III - Quality assurance level III (Audit verification and validation)	US has no certification process at product quality level for sampler/analyser (USEPA) has parameter wise performance standards (PS I to PS XI), which is equivalent to QAL II and QAL III
TÜV (Germany) (Technical watch-over Association) – a Product standard	MACT (Maximum Achievable Control Technology); this is an objective oriented quality certification applicable to US only
MCERTS (UK) (Monitoring Certification Schemes) – a Product standard	

European Union / USEPA	Indian Scenario
QAL I - Quality assurance level I (Certification of Product, COP)	Does not exist as there is no certifying agency Indian agency should come up in near future
QAL II - Quality assurance level II (Performance evaluation at site)	Possible through performance evaluation; however criteria may be little relaxed
QAL III - Quality assurance level III (Audit verification and validation)	Possible but SPCBs/CPCB and empanelled Laboratories must be trained Provision for ILC shall be developed for QC requirement Availability of certified standard gases should be ensured
Performance standards (PS I to PS XI), which is equivalent to QAL II and QAL III	Implementation Possible; however criteria may be little relaxed

Measurement Location Selection for stack analyser

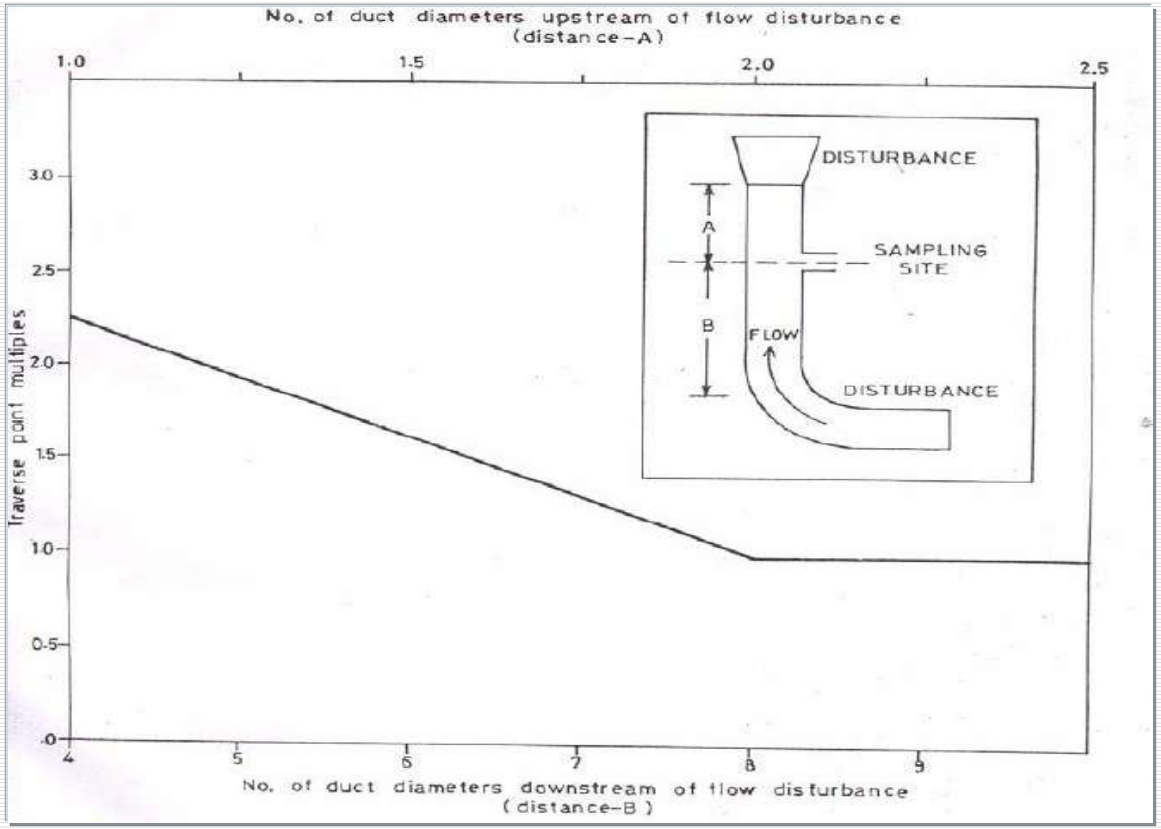
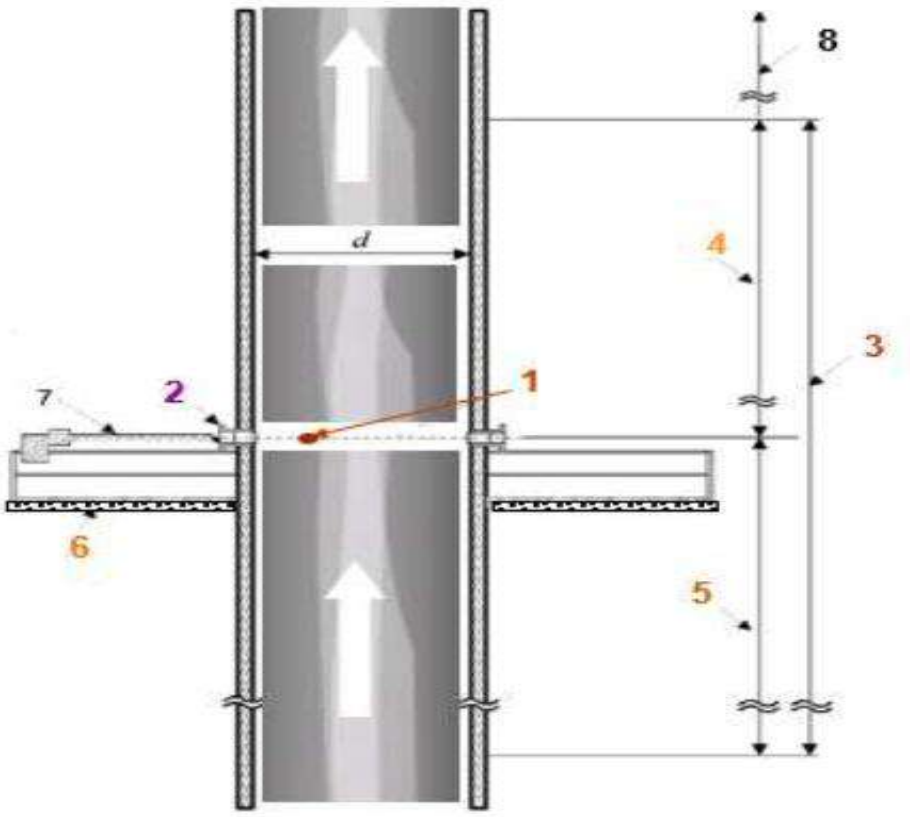


FIGURE 1.3 Travers point multiples to determine minimum number of traverse points requirement when a < 2 dia or b < 8 dia

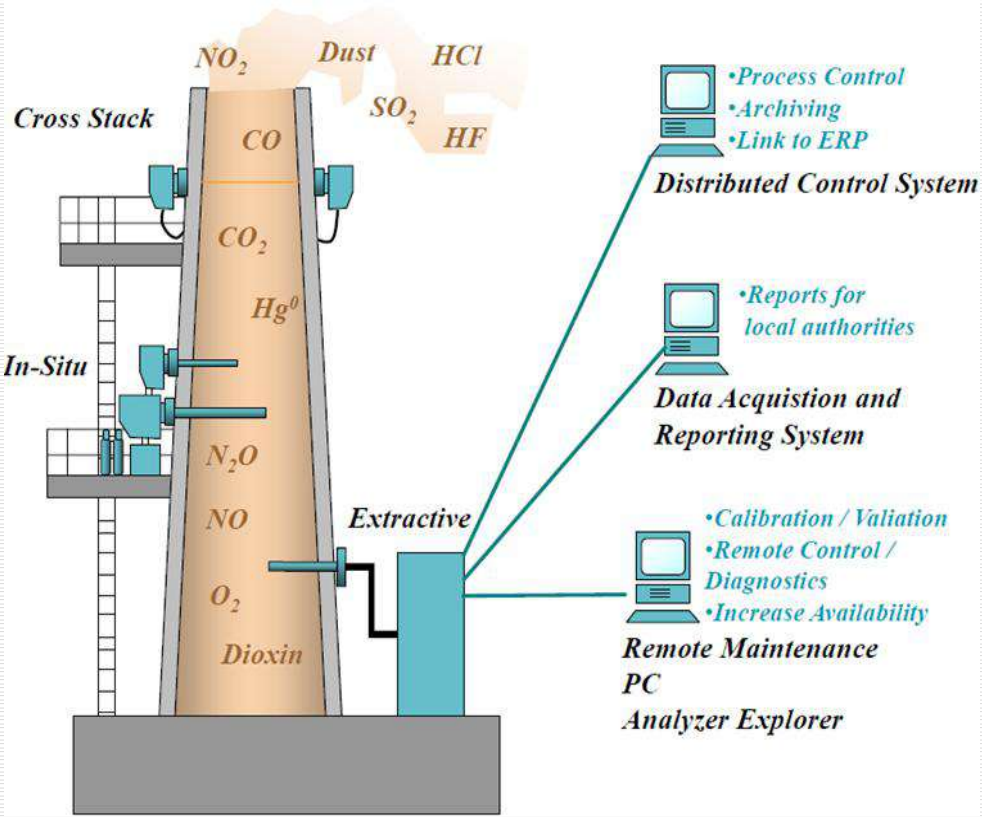


1. Measurement point
2. Measurement pot
3. Measurement section
4. Outlet (2D)
5. Inlet section (8D)
6. Working platform
7. Manual sampling train

(Note: D= Stack Diameter)

Figure 1.1: Measurement Site and Measurement Section

WHAT IS CEMS ?



A continuous emission monitoring system (CEMS) is the total equipment necessary for the determination of a gas or particulate matter concentration or emission rate using pollutant analyser measurements and a conversion equation, graph, or computer program to produce results in units of the applicable emission limitation or standard

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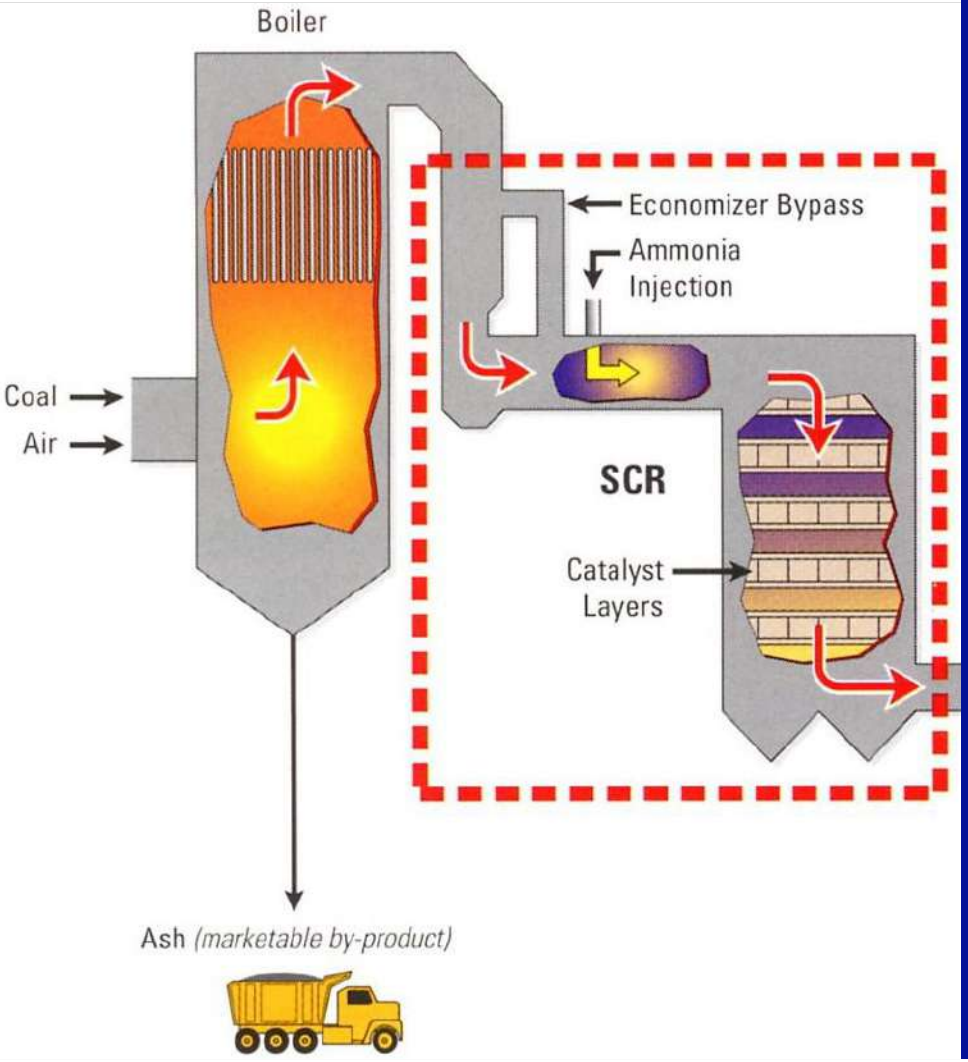
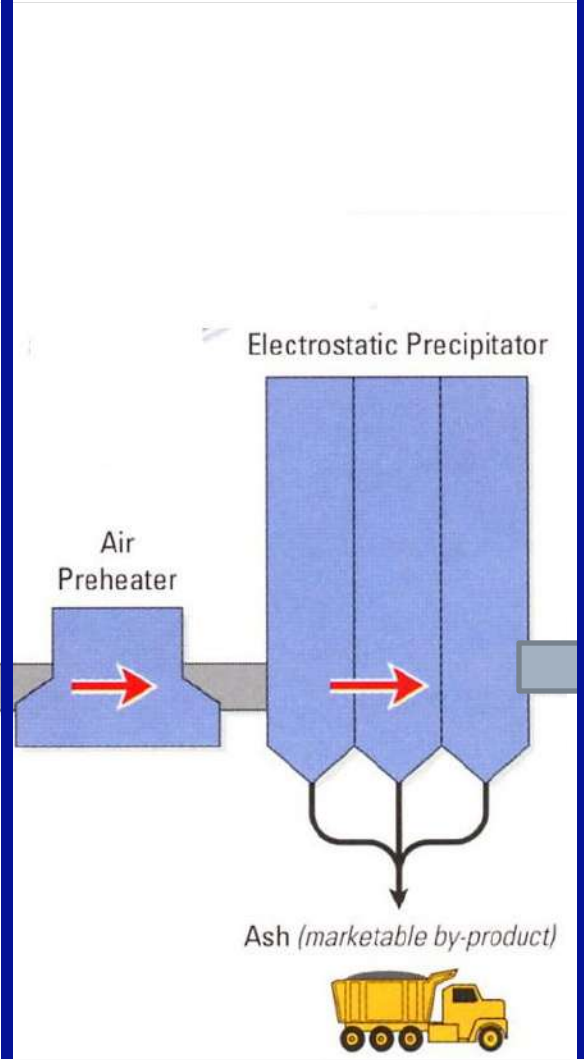
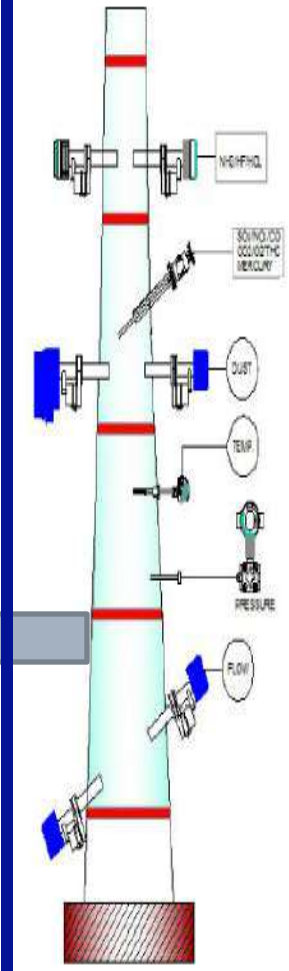
Process

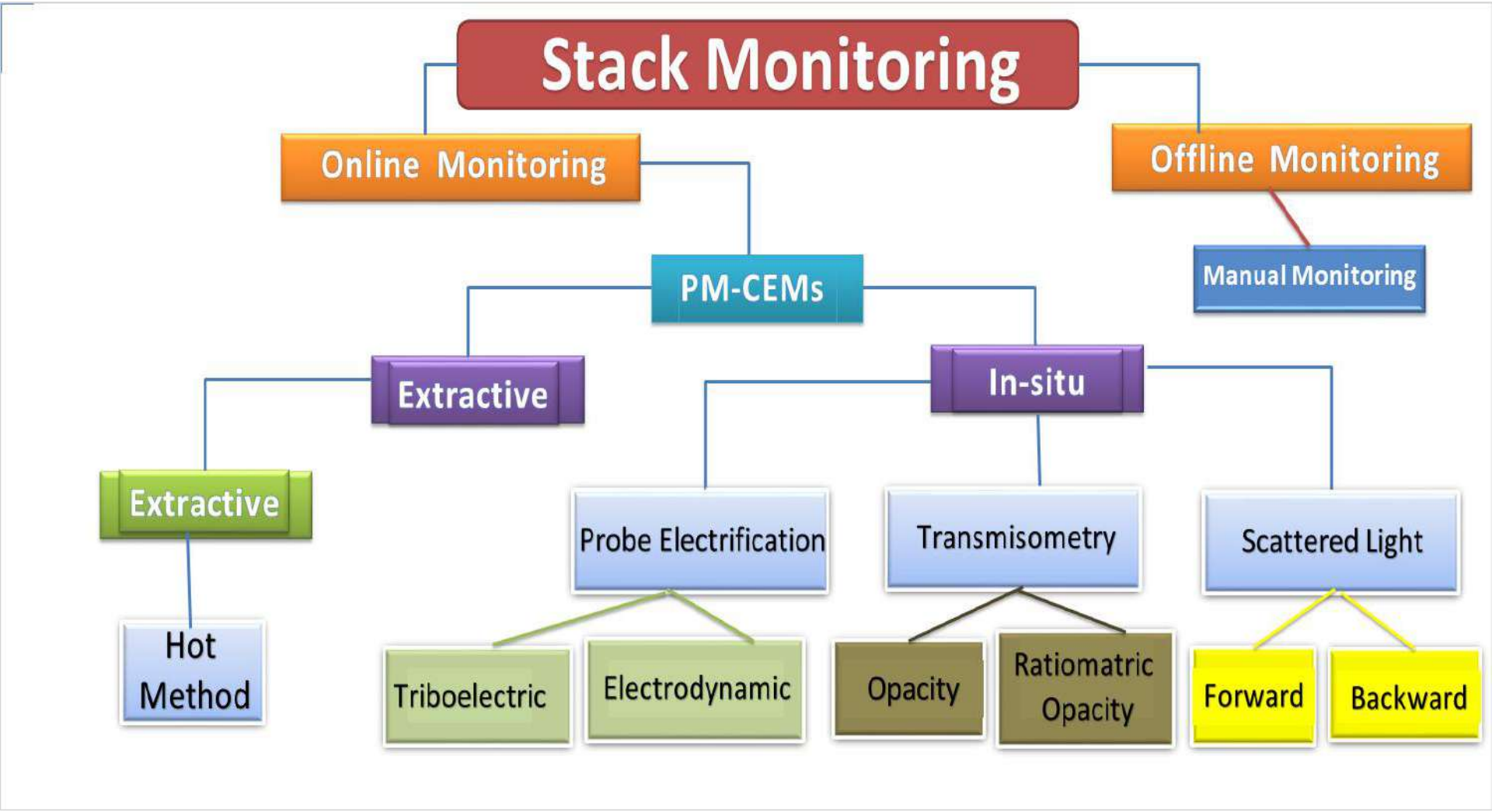


APCD



Pollution Monitoring Device

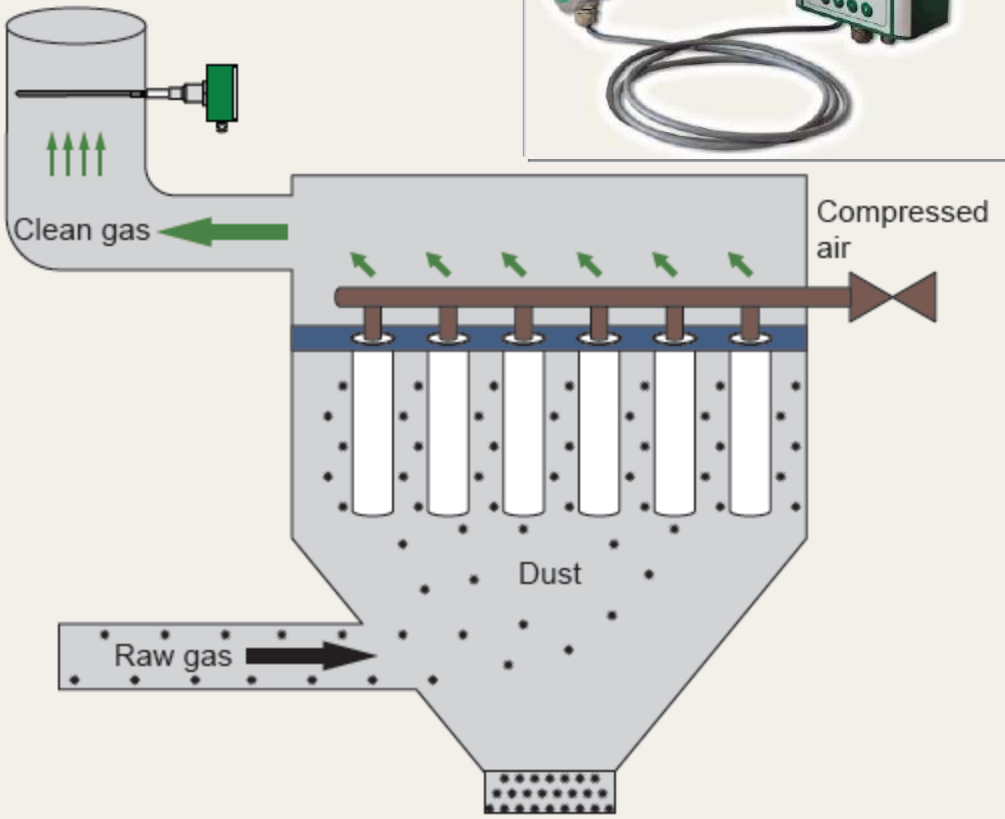



Stack Monitoring
Online Monitoring
Offline Monitoring
Manual Monitoring
PM-CEMs
Extractive
In-situ
Extractive
Hot Method
Probe Electrification
Transmisometry
Scattered Light
Triboelectric
Electrodynamic
Opacity
Ratiomatric Opacity
Forward
Backward

Stack monitoring Kit.

Method-5 and Method -17 sampling train for sampling dust from the stack.

Installation example

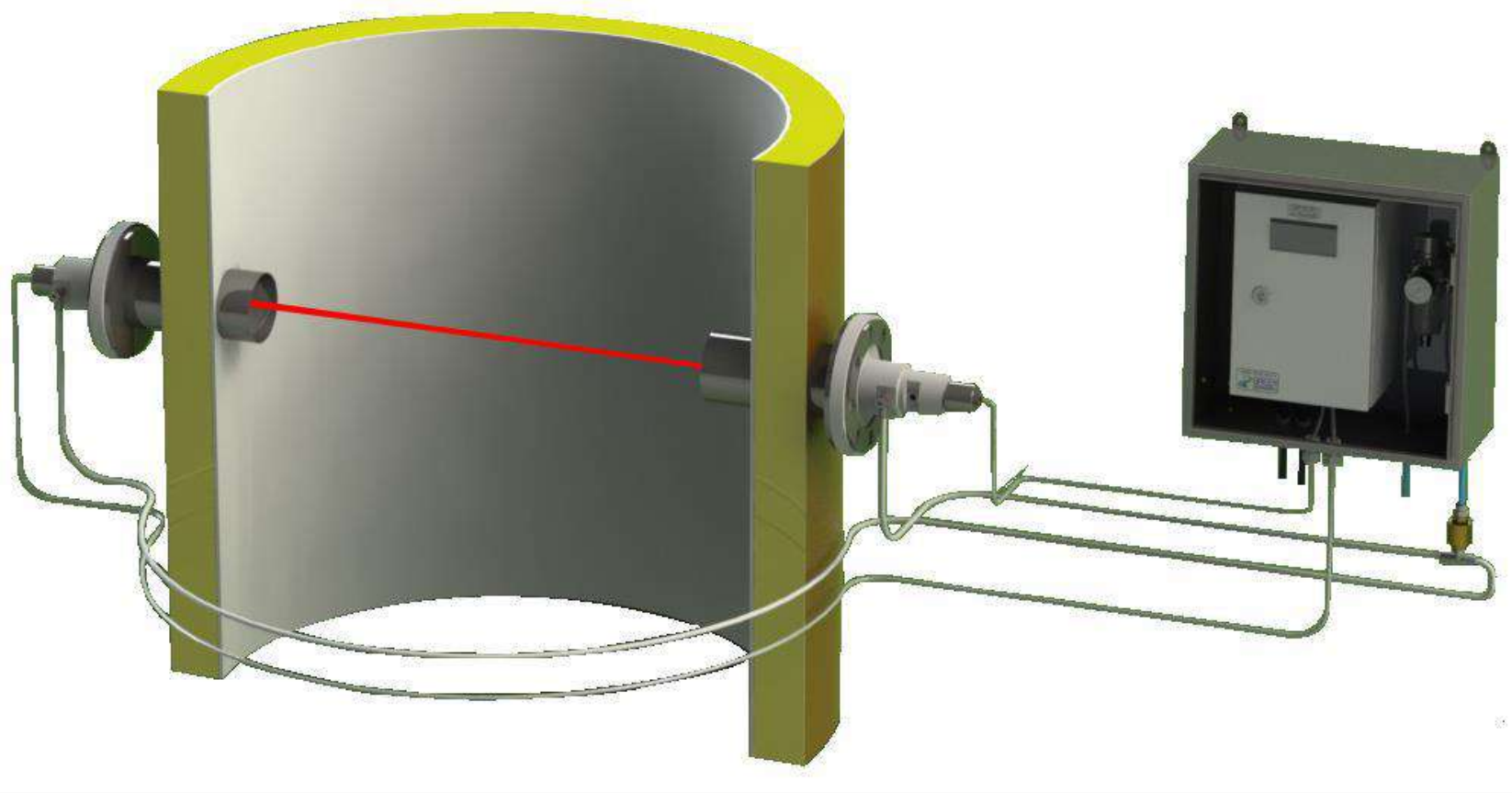


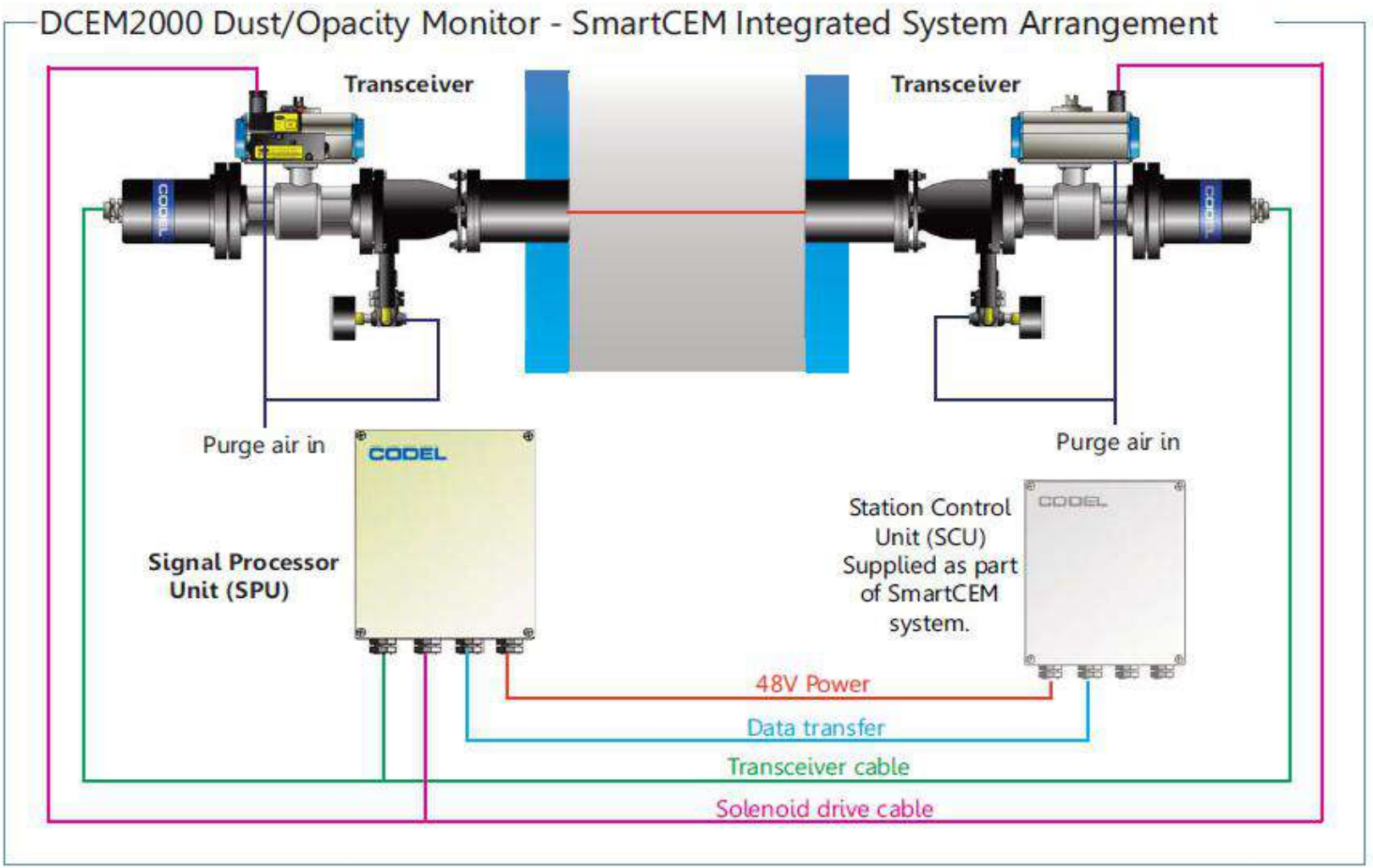
Function

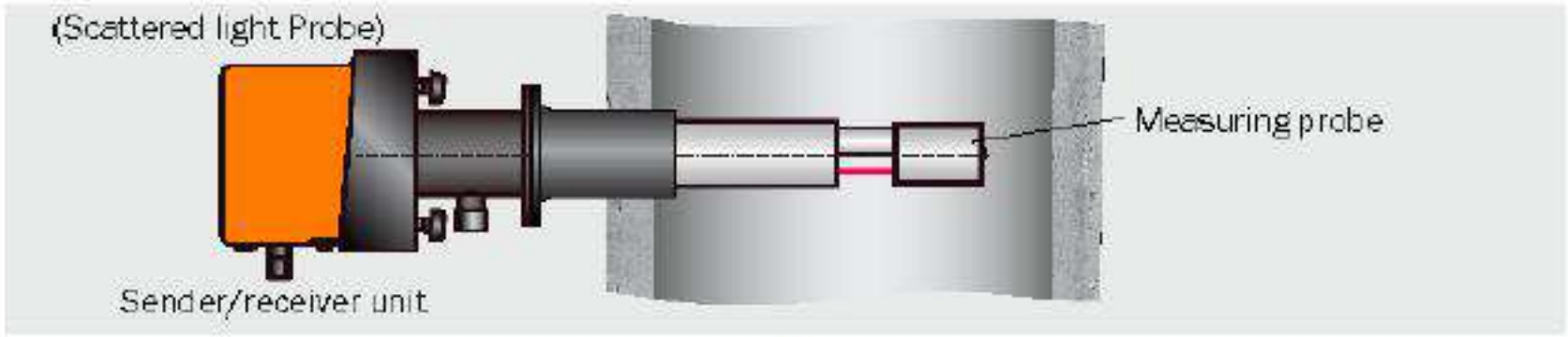
The measurement with the **Inst.** is carried out via the tribo-electric measuring method.

For that matter the measuring gas in the exhaust gas flow is gathered by means of the probe rod. By the passing as well as impinging dust particles a charge exchange takes place between these and the probe rod.

From the discharged current a signal is generated which depends on the mechanical and electrical characteristics of the dust. The dust-proportional signal which is generated by the microcontroller integrated in the device is the degree for the dust content of the exhaust.




DCEM2000 Dust/Opacity Monitor - SmartCEM Integrated System Arrangement
Transceiver
Transceiver
Purge air in
Purge air in
CODEL
Signal Processor Unit (SPU)
Station Control Unit (SCU) Supplied as part of SmartCEM system.
48V Power
Data transfer
Transceiver cable
Solenoid drive cable


(Scattered light Probe)
Measuring probe
Sender/receiver unit

(b)

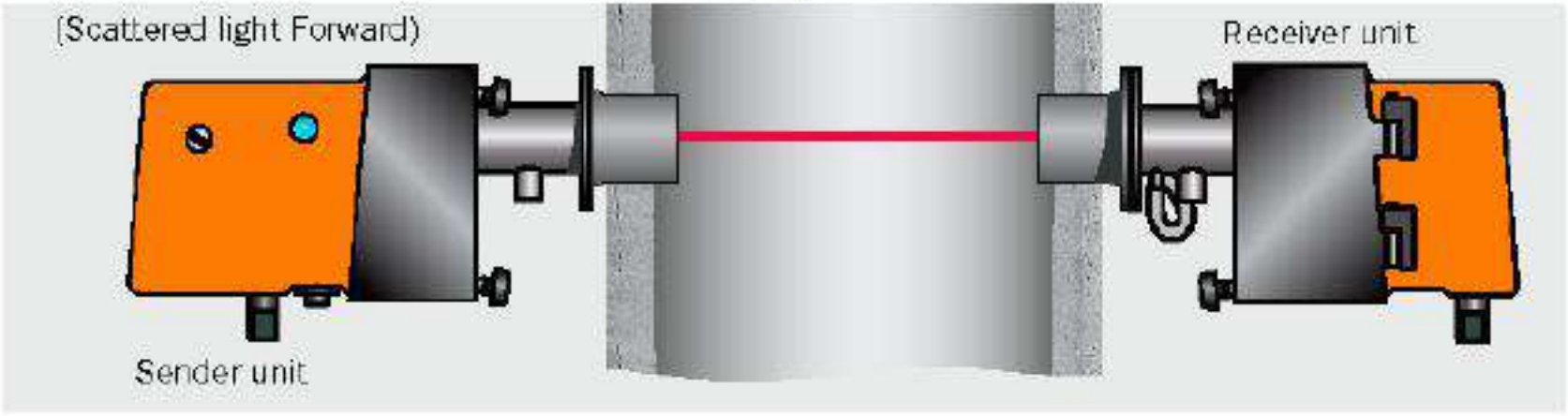
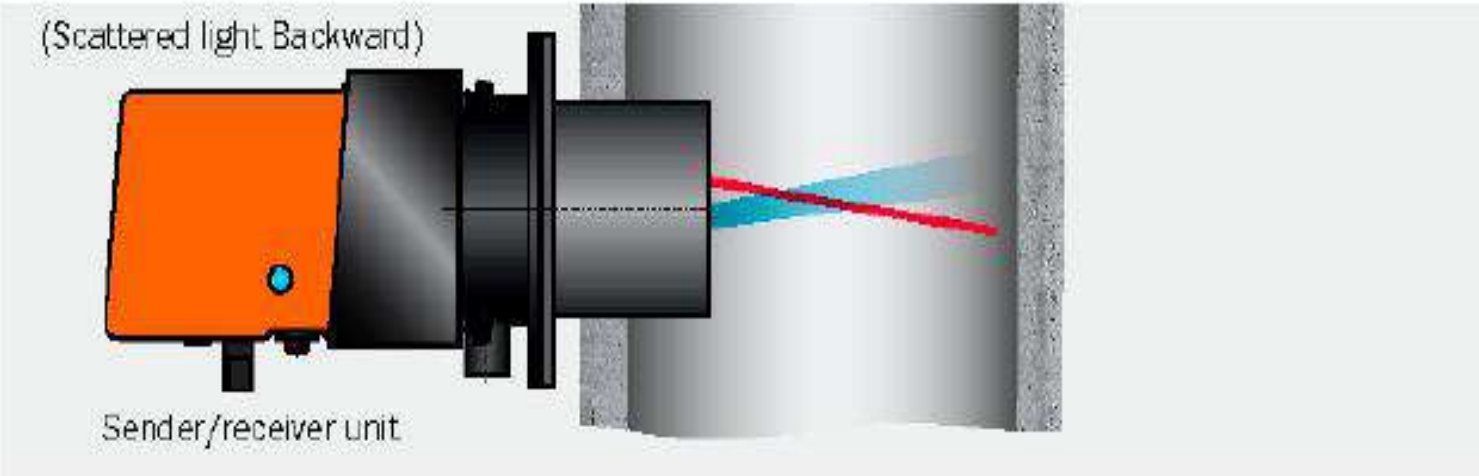

(Scattered light Forward)
Receiver unit
Sender unit

Figure 3. Light-scattering configurations: (**a**) backward scattering (**b**) probe forward scattering (**c**) cross forward scattering [36].



(**a**)

Table 4: PM CEMS Technol

Measurement Technology		Technology	Stack Diameter (m)	Concentration (mg/m³)		Filter Type
				Min	Max	
Probe Electrification	Charge Induction (AC)	ElectroDynamic	0.2-4	0.05	1000	Bag,Cyclone, Drier,Scrubber[5], None[6]
	Contact Charge Transfer (DC)	DC Triboelectric	0.2-2	1	1000	Bag,Cyclone, None[6],ESP[10]
	Combination AC & DC	Combination AC & DC/ Tribo	0.2-2	1	1000	Bag,Cyclone, None[6]
Transmisometry	Ratiometric Opacity	Dynamic Opacity	1-15[1][2][7]	10[3]	1000	Bag[1],Cyclone,EP,None
		Dyanamic Detection Principle	1-10[1][2]	20	1000	Bag[1],Cyclone,EP,None
	Opacity	Opacity	2-10[1][2]	30[4]	1000	EP,None
		Non Comliance Transmittance	2-10[1][2]	30[4]	1000	EP,None
Scattered Light	Light Scattering	Forward Scatter	1-3[2]	0.1	200	Bag,Cyclone,EP,None
	Light Scattering	Backward / Side Scatter	1-4[1][2]	25	500	Bag[1],Cyclone,EP,None

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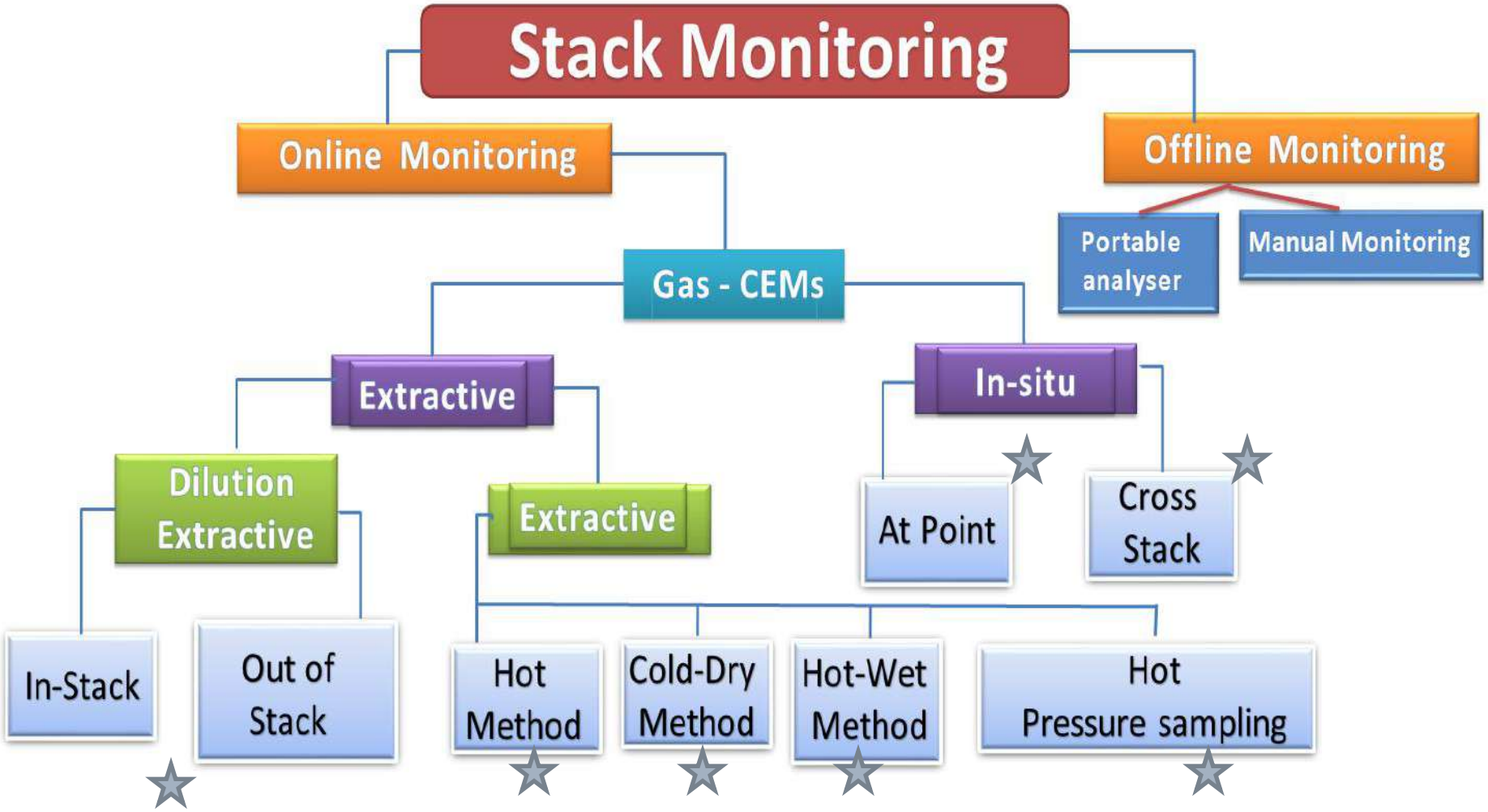
1st Revised Guidelines for Continuous Emission Monitoring Systems June 2018

Table 4: PM CEMS Technology Applications and Limitations

Measurement Technology		Technology	Stack Diameter (m)	Concentration (mg/m³)		Filter Type	Self-checks		Dry	Humid	Wet	Type of dust		Velocity Dependant
				Min	Max		Sensor contamination check	Zero & span				Same	Changing	
Probe Electrification	Charge Induction (AC)	ElectroDynamic	0.2-4	0.05	1000	Bag,Cyclone, Drier,Scrubber[5], None[6]	✓ (7)	✓ (7)	✓	√	x	√	x	No [8]
	Contact Charge Transfer (DC)	DC Triboelectric	0.2-2	1	1000	Bag,Cyclone, None[6],ESP[10]	x	x	✓	x	x	√	x	Yes
	Combination AC & DC	Combination AC & DC/ Tribo	0.2-2	1	1000	Bag,Cyclone, None[6]	x	✓ (7)	✓	x	x	√	x	Yes
Transmisometry	Ratiometric Opacity	Dynamic Opacity	1-15[1][2][7]	10[3]	1000	Bag[1],Cyclone,EP,None	✓	✓ (7)	✓	x	x	√	x	No
		Dyanamic Detection Principle	1-10[1][2]	20	1000	Bag[1],Cyclone,EP,None	✓	x	✓	x	x	√	x	No
	Opacity	Opacity	2-10[1][2]	30[4]	1000	EP,None	✓	✓	✓	x	x	√	x	No
		Non Comliance Transmittance	2-10[1][2]	30[4]	1000	EP,None	x	x	✓	x	x	√	x	No
Scattered Light	Light Scattering	Forward Scatter	1-3[2]	0.1	200	Bag,Cyclone,EP,None	✓	✓	✓	x	√ (9)	√	X	No
	Light Scattering	Backward / Side Scatter	1-4[1][2]	25	500	Bag[1],Cyclone,EP,None	✓	✓	✓	x	x	√	X	No


Stack Monitoring
Online Monitoring
Offline Monitoring
Portable analyser
Manual Monitoring
Gas - CEMs
Extractive
In-situ
Dilution Extractive
Extractive
At Point
Cross Stack
In-Stack
Out of Stack
Hot Method
Cold-Dry Method
Hot-Wet Method
Hot Pressure sampling

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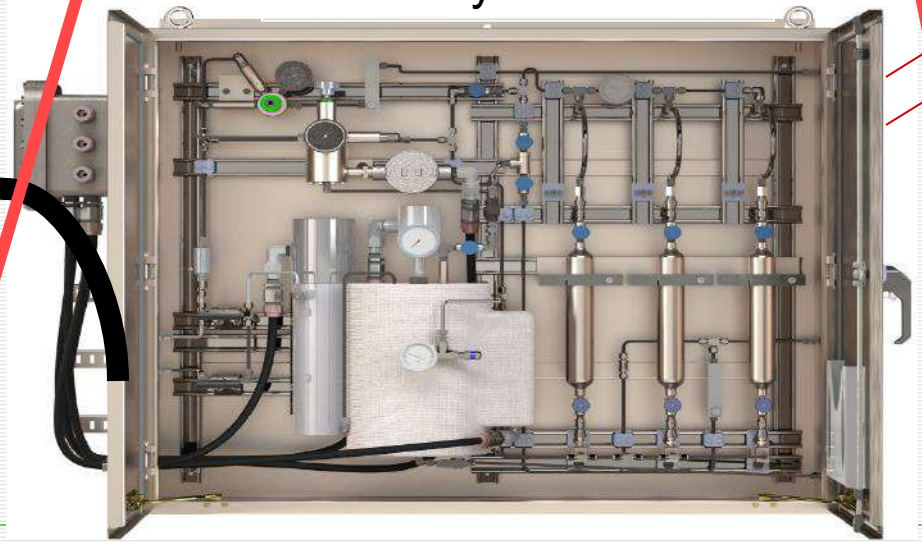
Sampling Probe

Sample Conditioning System



Gas Analyser

MAIN POINTS IN A HOT EXTRACTION METHOD

a. The Heated Probe should be located as per the guidelines. Which should 2 times the stack diameter downstream and 1/2 times stack diameter upstream. However the Probe is to be located at a location where maintenance can done and there is proper approach to the Probe.

b. The Heated Tune is to start from the Probe and continue till the Analyser Panel. There should be no Cold Spots.

c. The Gradient of the Heated line should be downwards.

d. Line should be checked and Leakage free Line should be ensured

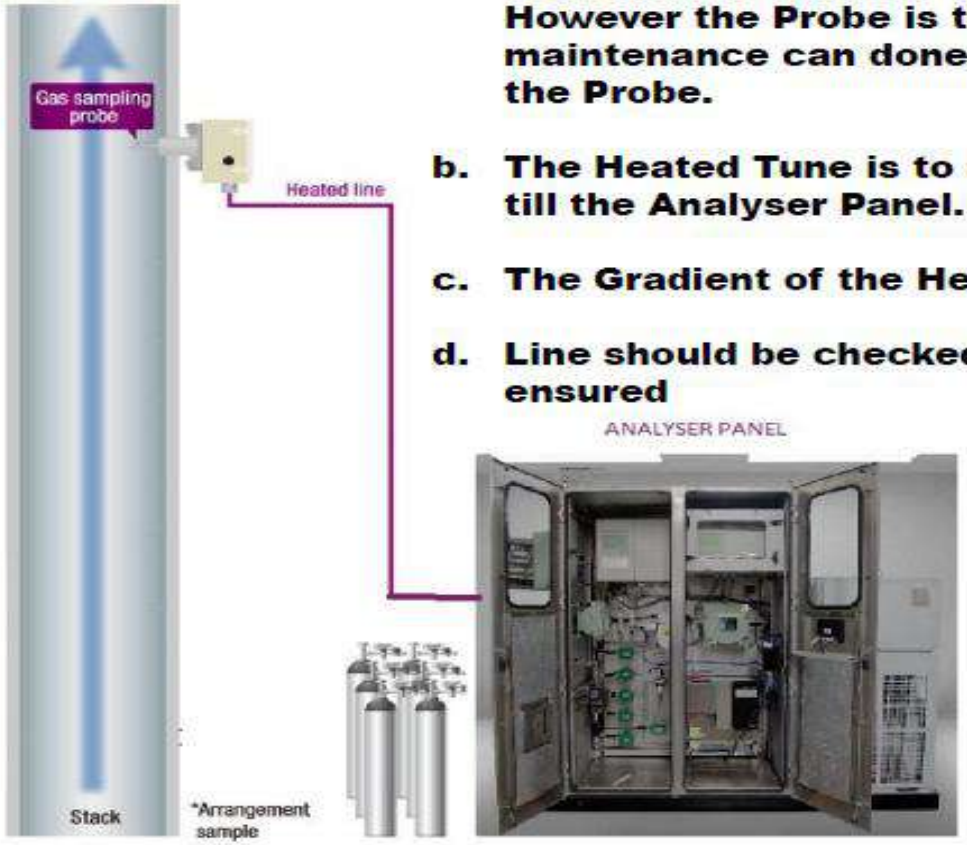


Figure 2: full extractive system

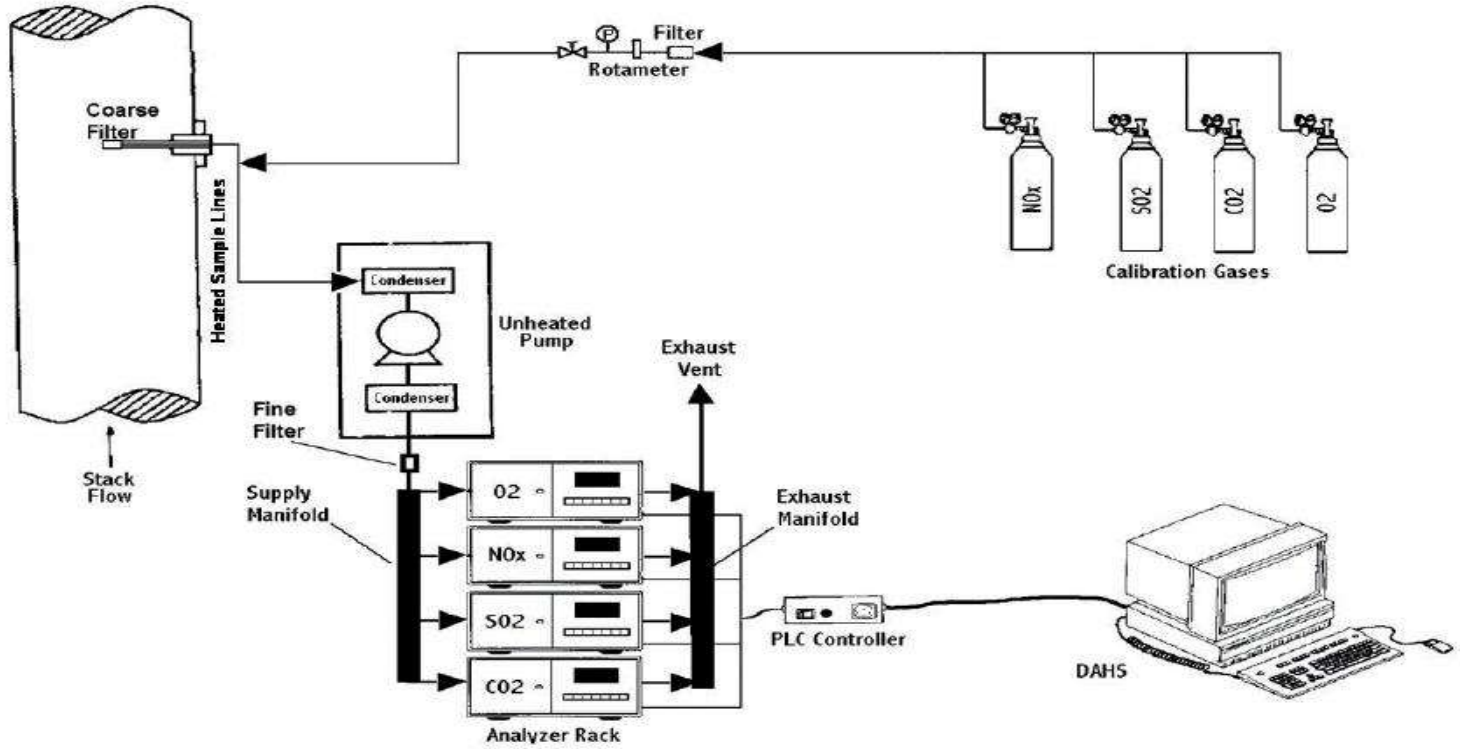
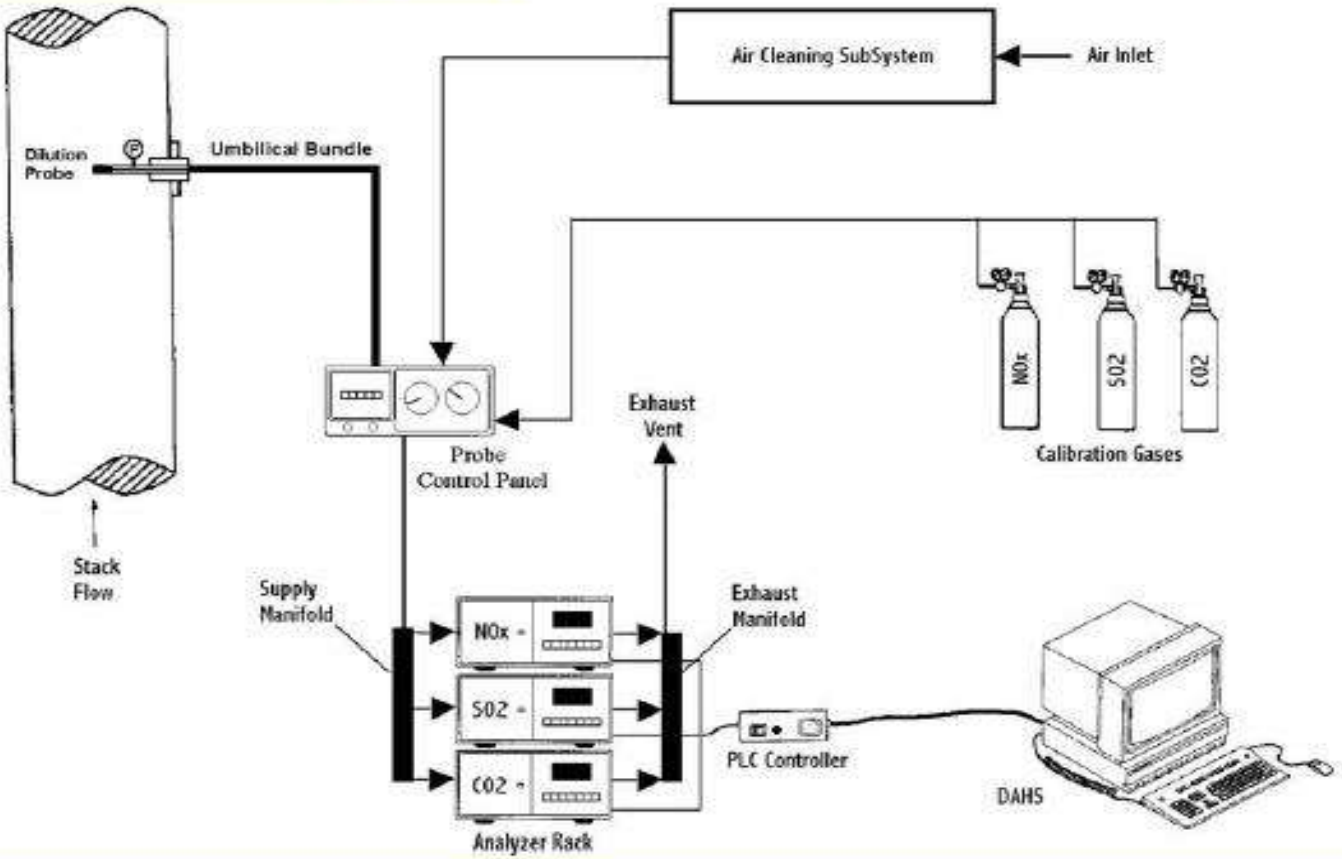
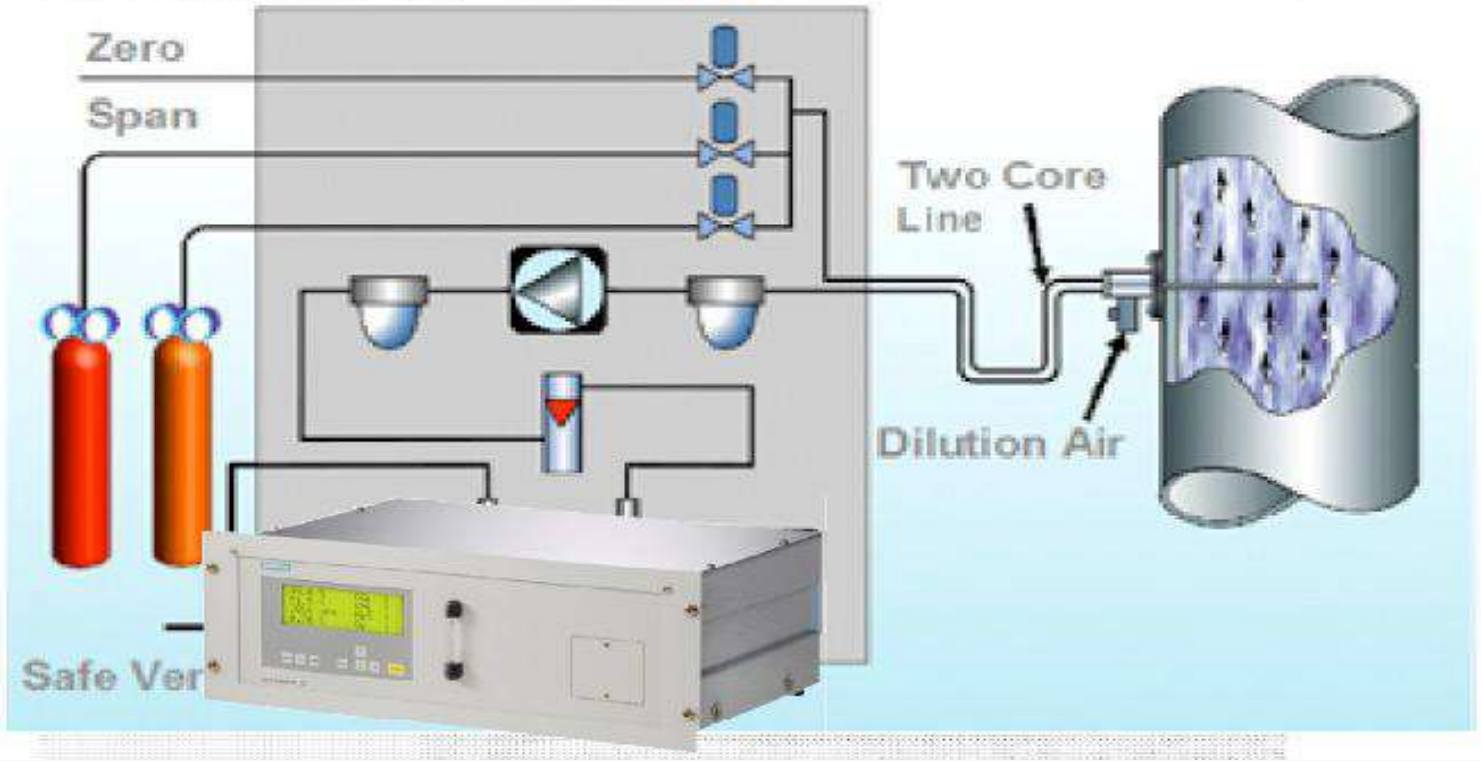


Figure 3: Dilution Extractive System



MEASUREMENT BASED ON DILUTION TECHNIQUE



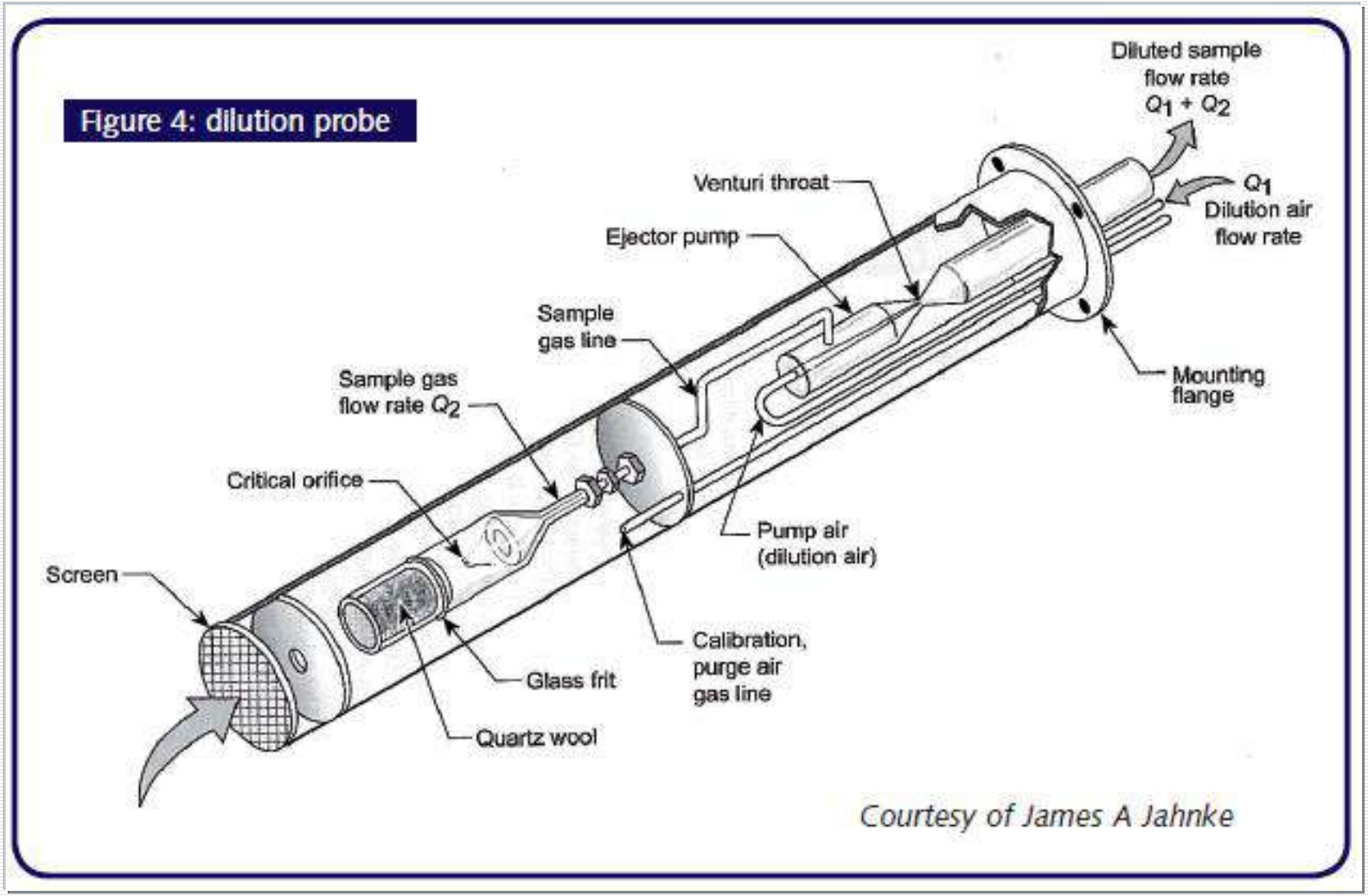
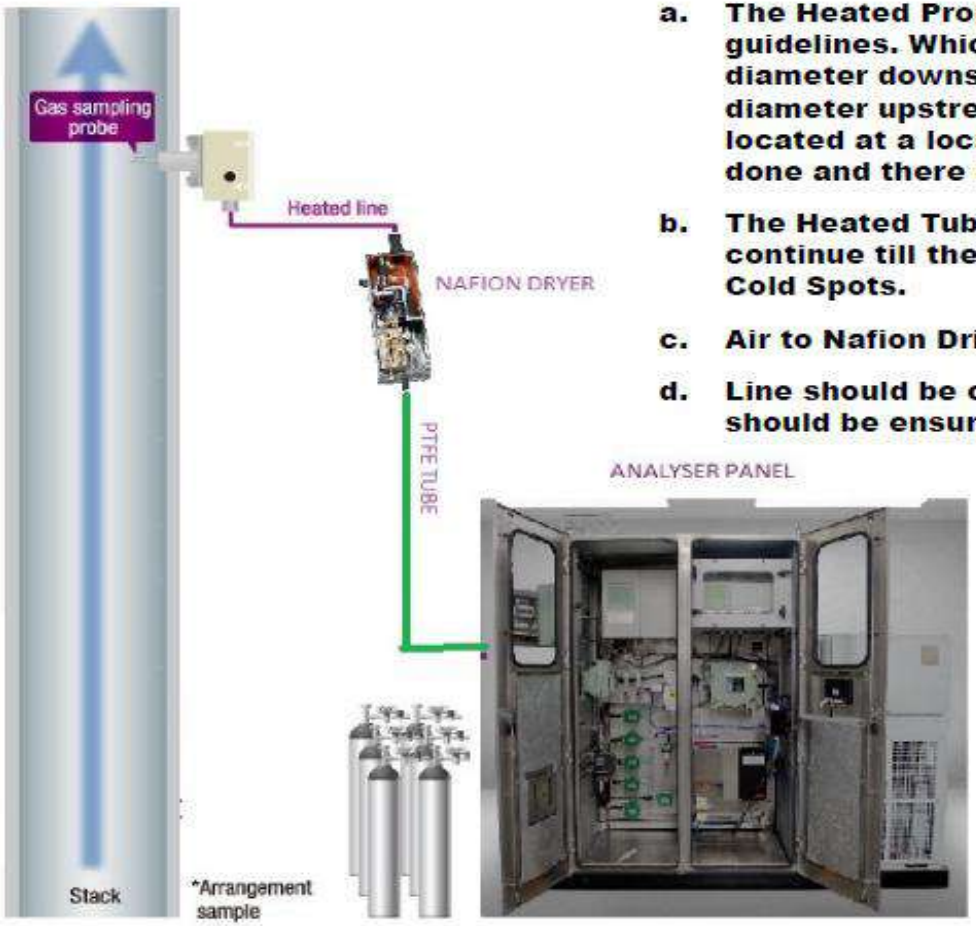


Figure 4: dilution probe
Diluted sample flow rate $Q_1 + Q_2$
Q_1 Dilution air flow rate
Venturi throat
Ejector pump
Sample gas line
Sample gas flow rate Q_2
Critical orifice
Screen
Pump air (dilution air)
Mounting flange
Calibration, purge air gas line
Glass frit
Quartz wool
Courtesy of James A Jahnke

MAIN POINTS IN A COLD DRY EXTRACTION METHOD



a. The Heated Probe should be located as per the guidelines. Which should 2 times the stack diameter downstream and 1/2 times stack diameter upstream. However the Probe is to be located at a location where maintenance can done and there is proper approach to the Probe.

b. The Heated Tube is to start from the Probe and continue till the Nafion Dryer. There should be no Cold Spots.

c. Air to Nafion Drier should be moisture free – Dry.

d. Line should be checked and Leakage free Line should be ensured

Hot-Wet Extractive Systems

No moisture removal - Moisture remains in the system throughout the sampling and measurement process.

Sampling line, pump, and analytical chamber are heated to keep wet sample gas above its dew point. Sample is analyzed hot and wet.

Low Pressure Sampling

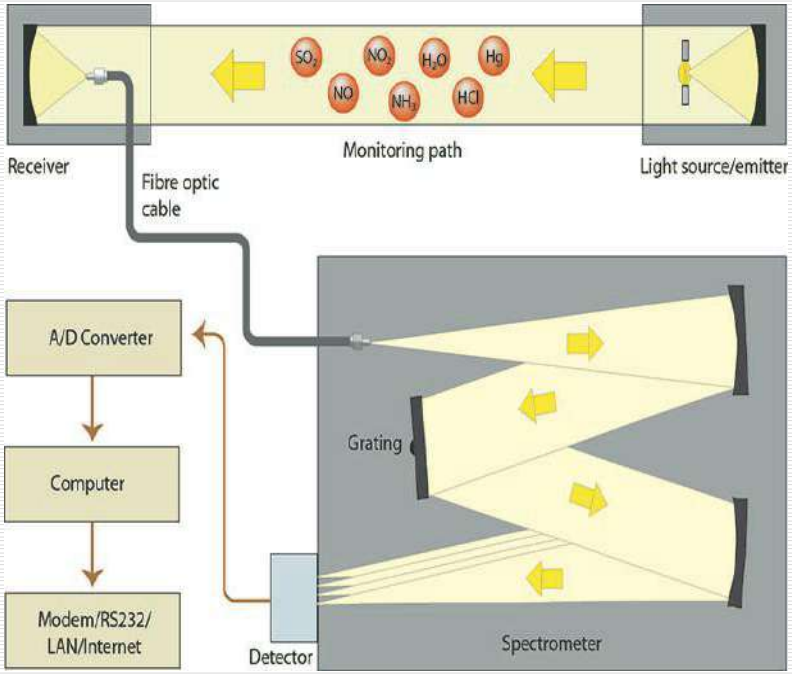
- The measuring principle works on a low pressure sample (LPS). The sampling system consists of a SONIC NOZZLE. It is an original system which can collect and convey the sample from 50 to 200 mbar abs from the sampling point to the analyzer.
- The sample is taken at a very low pressure (50 to 200 mbar absolute). This feature enables us to reduce the vapor pressure of the sample at the level of the sampling point. At the pressure of the sampling, the ambient temperature is almost always above the dew point. There is no risk of condensation, which eliminates the need for a heated line and a cooler. Thanks to this technique, we do not distort the sample.
- The sample is taken with a flow rate of 1 to 24 l/h. However, since the pressure of the sample in the duct is 10 times lower than the atmospheric pressure (100 mbar abs), the transfer speed is multiplied by 10. The transfer rate of the sample ranges therefore between 10 to 240 l/h.
- Since only a little flow amount is collected, the system hardly gets dirty, requiring limited maintenance of the analysis chain.

Differential Optical Absorption Spectroscopy (DOAS), which is based on Beer-Lambert's absorption law. It states the relationship between the quantity of light absorbed and the number of molecules in the light path.

Because every type of molecule, every gas, has its own unique absorption spectrum properties, or "fingerprint", it is possible to identify and determine the concentrations of several different gases in the light path at the same time.

DOAS is based on transferring a beam of light from a special source – a high-pressure xenon lamp – over a chosen path and then using advanced computer calculations to evaluate and analyse the light losses from molecular absorption along the path. The light from the xenon lamp is very intense, and includes both the visible spectrum and ultraviolet and infrared wavelengths.

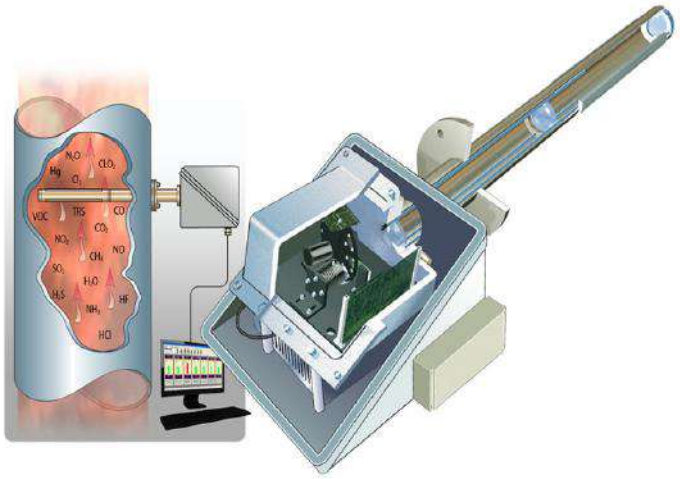
The light is captured by a receiver and conducted through an optical fibre to the analyser. The fibre allows the analyser to be installed away from potentially aggressive environments.



In-situ single point analyzer

An infra-red (IR) or UV, duct or stack-mounted gas analyser designed to provide in-stack analysis of, gas-phase emission components.

A typical system comprises an in-situ mounted analyser, an integral calibration function and a Control Unit with options which include a powerful in-situ Heater and calibration gas cyinders



Measuring Principle: →

CO and CO2	→ NDIR method / Electro Chemical, DOAS
SO2	→ UV fluorescence method , NDIR, EC, DOAS
NO,NO2, NOX	→ Chemiluminescence Method , EC , NDIR,DOAS
O2	→ EC, Paramagnetic, Zirconium

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Overview of Technologies

Method	Technique	Technology	Gases Measured
Non-Dispersive Infrared (NDIR)	Hot Extraction Cold dry Extraction In-situ	Beer Lambert Law Filter photometer	SO2, NOx, CO, CO2
Non-Dispersive Ultraviolet	Hot Extraction Cold dry Extraction In-situ	Beer Lambert Law Filter Photometer	H2S, SO2,
UV Fluorescence	Cold Dry Extractive Dilution Extractive	Excitation (214nm) and Fluorescence (300 nm)	H2S, SO2
Chemiluminescence	Dilution Extractive	Converter	Oxides of Nitrogen
Dispersive Ultraviolet	In-Situ	Beer Lambert Dispersive	SO2, NH3, H2S
Enhanced Laser	Extractive	OFCEAS (Optical feedback cavity-enhanced absorption spectroscopy)	H2S, HF, NH3, HCl, HCN, SO2, SO3, NO,NO2,CO, CO2, O2
TDLS	Insitu	Wavelength Modulation Spectroscopy	H2S, HF, NH3, HCl, O2, CO,CO2, H2O
Flame Ionization Detector (FID)	Hot Wet Extractive	Hydrogen flame and measure hydrocarbon	THC, VOC

Method	Technique	Technology	Gases Measured
Fourier Transform Infra Red (FTIR)	Hot Wet Extractive	Beer Lambert Law Filter photometer	H2S, HF, NH3, HCl, HCN, SO2, NO,NO2,CO, CO2, O2, H2O
Gas Chromatography	Hot Wet Extractive Hot Extraction Cold Dry Extraction	GC separation and FID detection	VOC, THC, H2S, HF, NH3, HCl, HCN, SO2, NO,NO2,CO, CO2, O2, H2O
Mass Spectrometry	Hot Wet Extractive Hot Extraction Cold Dry Extraction	Ionisation	VOC, THC, H2S, HF, NH3, HCl, HCN, SO2, NO,NO2,CO, CO2, O2, H2O
Atomic Absorption	Hot Wet ex-situ Cold Dry ex-situ	Resonance Mercury emission/absorption	Hg
Atomic Fluorescence	Hot Wet ex-situ	fluorescence analyzer	Hg
Paramagnetic	Hot Extraction Cold dry Extraction	Measures unique magnetic effect of oxygen	O2
Zirconium Oxide	Hot Extraction Cold dry Extraction In-Situ	Transport of oxygen ions (Nernst Eqn)	O2
Electrochemical	Hot Extraction Cold dry Extraction	Chemical reaction	O2

Out Target:>

We need to measure the pollutants emitted out from the stack .

1. All stacks are different and the nature of the industry or process are different.
2. Some are steel, concrete, and different industry like , power, cement, steel, fertilizer petrochemical etc.
3. The ultimate measuring components are same , but the back ground gas compositions are different.
4. Technology should be chosen keeping the application and gas components in mind. in mind

When you are choosing a analyser what are the points needs to be considered.

1. The Temperature of the Stack.
2. The Moisture Content in the Stack.
3. Dew Point Of Sample Gas
4. The Dust Content in the Stack.
5. The Presence of Corrosive Components in the Gas.
6. The Range of the Analyser.
7. The Area Classification, (Safe Area or in Zone)
8. What is the maintenance requirement of the Analyser.

Calibration of CEMS

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

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. 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)

e. The data capture rate of more than 85% shall be ensured.

f. The intensity of lamp shall be checked once every fortnight.

g. The data comparison/calibration verification shall be done by laboratories empanelled by CPCB using standard reference methods and at a frequency specified.

Gaseous Parameter

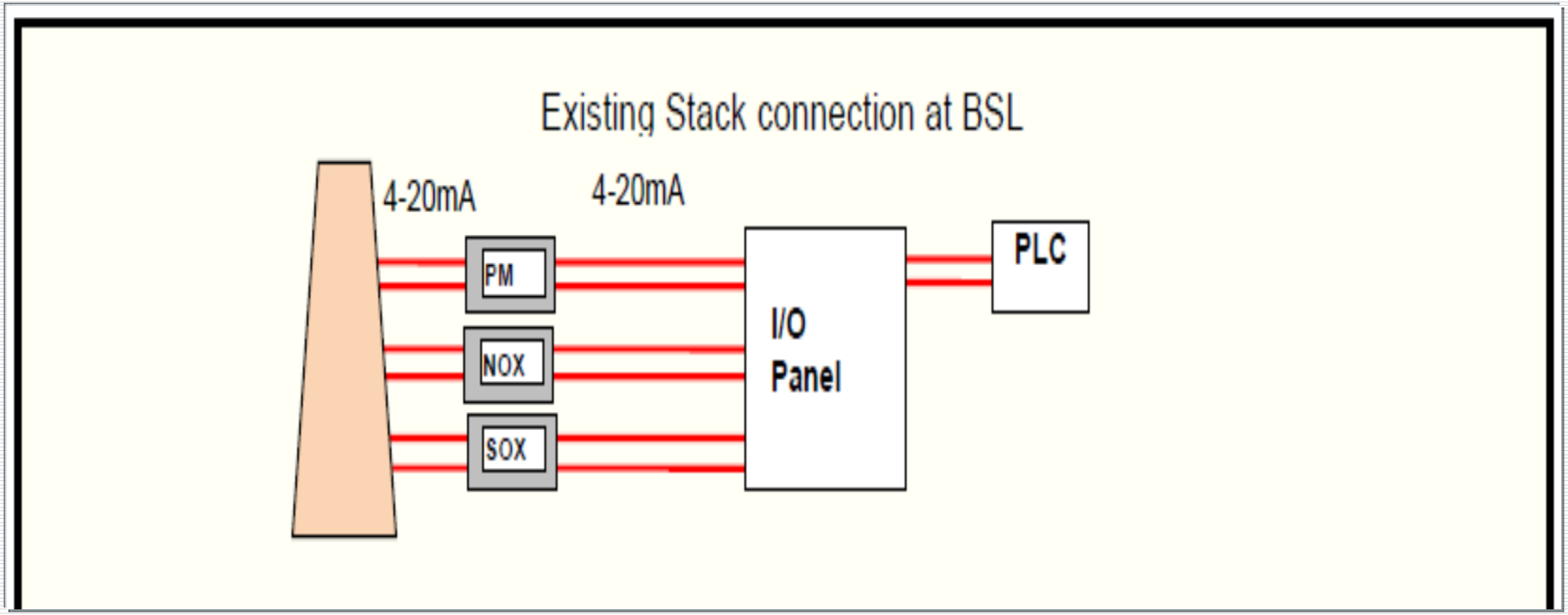
- The instruments/ analysers for real time monitoring of gaseous emissions shall be calibrated with respect to their functioning, drift, linearity detection limit, output, operating temperature and other relevant parameters before installation.
- After six months of operation, the system shall be rechecked for its health and data accuracy and reliability, following multi point calibration (at least 02 span concentrations 20% and 80% of the range) using standard methods and certified reference materials.
- **The data comparison and calibration verification shall be done once in 06 months by empanelled laboratories following standard procedures and using certified reference standards.**
- At any point of time in between it we are doing calibration check and found that, the drift is more we need to recalibrate the analyser.

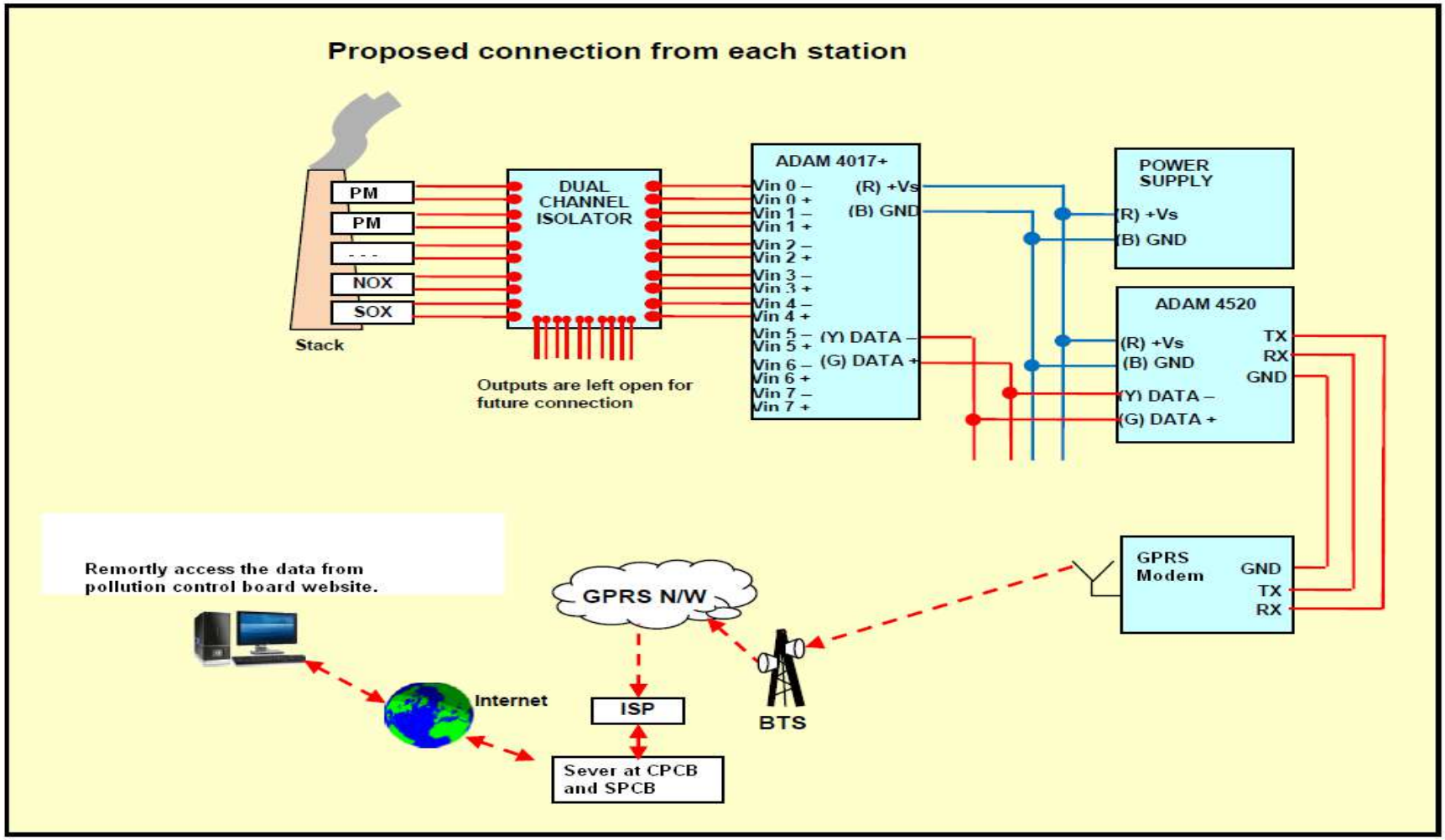
- For Differential Optical Absorption Spectroscopy (DOAS), Non Dispersive Ultra Violet (NDUV)/Non Dispersive Infra-Red lamp based systems, the calibration shall be revalidated once in 03 months, and after replacement of lamp. In-situ based TDLS/ DOAS needs to be brought down to lab for calibration.
- 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.
- Using Air for Zero/Span calibration is not acceptable, Zero / Span Gas / Gas filled Cuvette to be used with required certifications.
- Should have valid NABL or NIST traceable gas cylinder, with valid certificate.
- Calibration also can be done automatically using Permeation tube with NIST traceability certificate and are costlier.

Maintenance of analysers

1. If you are capable enough, then maintain your analyser by your own.
2. Else keep the analysers on AMC.
3. In above two cases , you need to keep minimum spares in stock.
4. Else give CAMC to the supplying vendor.
5. In all the above cases keep SOP to maintain the analysers.
6. The SOP should be as per the nature of the analyser and the process. It should be prepared in consultation with supplier.
6. Every analyser component has self life and running life , we need to make sure that , to get accurate result they need to be changed as per the supplier maintenance manual recommendations.
7. When the analyser sensor get older the level of drift increases , to get good result , you need to do frequent calibration check followed by calibrations.

Data Connectivity to Pollution Control Board Server And Data Validation


Existing Stack connection at BSL
4-20mA
4-20mA
PM
NOX
SOX
I/O
Panel
PLC


Proposed connection from each station
PM
PM
- - -
NOX
SOX
Stack
DUAL CHANNEL ISOLATOR
Outputs are left open for future connection
ADAM 4017+
Vin 0 –
Vin 0 +
Vin 1 –
Vin 1 +
Vin 2 –
Vin 2 +
Vin 3 –
Vin 3 +
Vin 4 –
Vin 4 +
Vin 5 –
Vin 5 +
Vin 6 –
Vin 6 +
Vin 7 –
Vin 7 +
(R) +Vs
(B) GND
(Y) DATA –
(G) DATA +
POWER SUPPLY
(R) +Vs
(B) GND
ADAM 4520
(R) +Vs
(B) GND
(Y) DATA –
(G) DATA +
TX
RX
GND
GPRS Modem
GND
TX
RX
Remortly access the data from pollution control board website.
GPRS N/W
BTS
Internet
ISP
Sever at CPCB and SPCB

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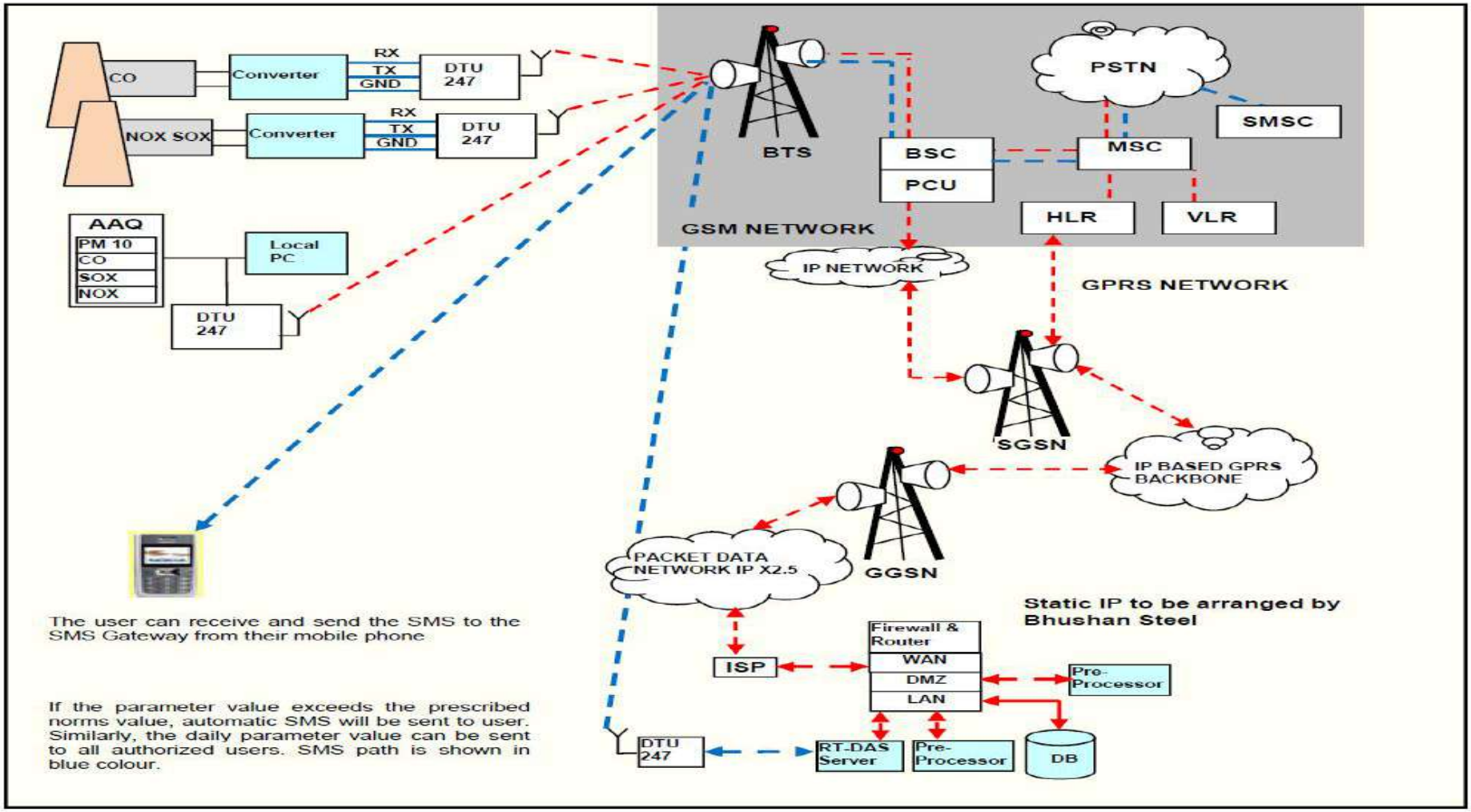


- The Y-cable data transmission adapted by OSPCB is a near to tamper proof technology.

- The problems faced in the above system.

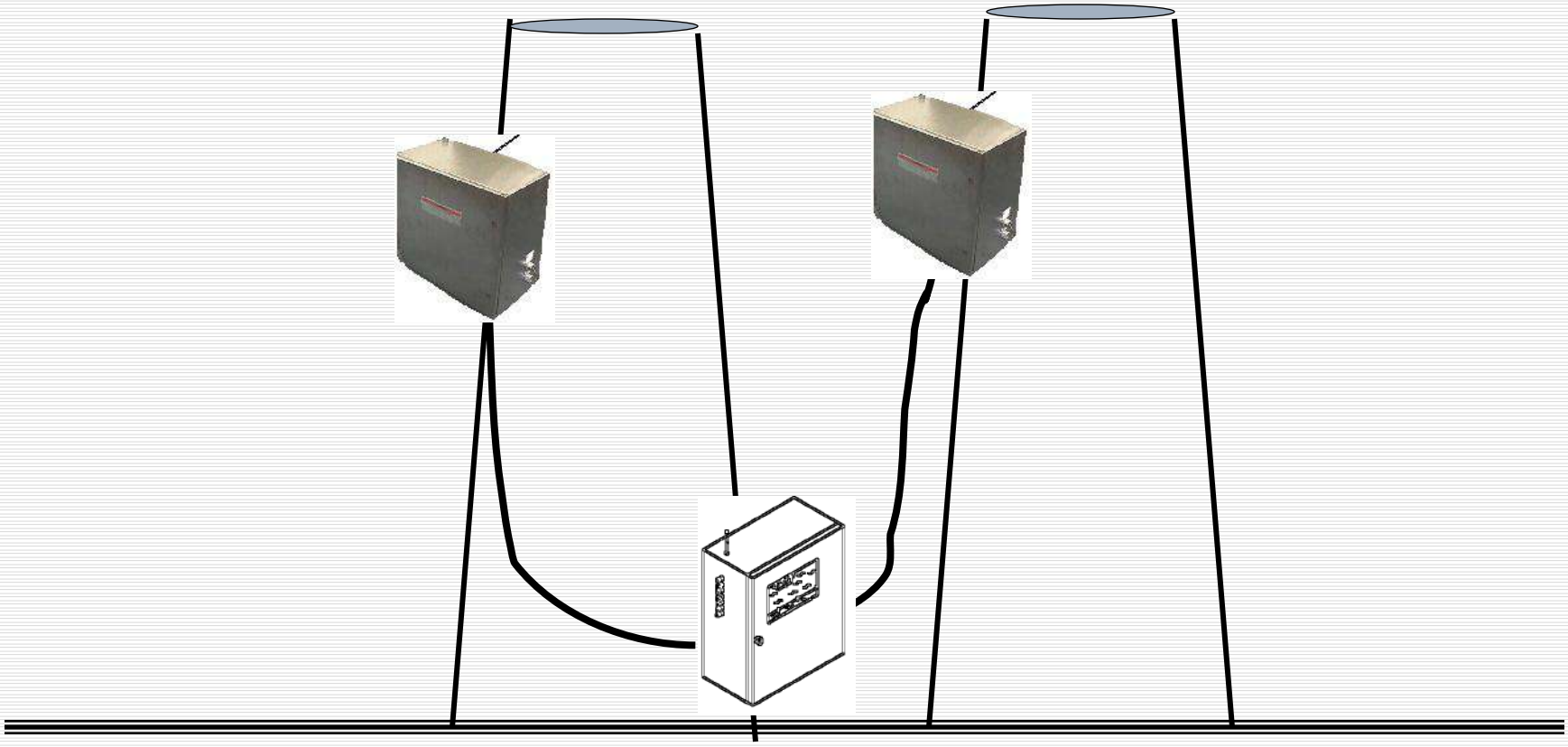
1. If in between any unwanted spike comes for a second, it records and my average value indicates me a bad record.
2. CPCB is sending 15 minutes average alarm, it is requested to provide the data in the SPCB server in the interval of 15 minutes instead of one hour average data.
3. Should have in between data logger, without manual intervention , to collect and transfer the data with the rate 100%.
4. If my plant is not running, the analysers shows 4mA , then we get non compliance that, data not received from a particular date. This issue need to be discussed and solved.
5. OSPCB should have a mobile App for all the analysers data going to their server.

Questions OR Ambiguities

1. Turboelectric Analyzer use after the ESP
2. Can we use Electrochemical sensors for the CEMS
3. Why we are not able to achieve 100% data transmission to pollution control board server.
4. Pollution control Board is asking for
    a. Remote Calibration
    b. Remote Calibration Checking.
5. Is it possible to calibrate the cross dust (DOAS) analyzer without removing from the stack.
6. If for remote calibration check, we will take option to give the order to different vendor other than the existing data transmitting vendor , what will be the issues.
7. As per the new protocol industry need to install O2 / CO2 analyser, Moisture analyser, temp and flow measurement analyser. What to do for this.

8. All the data has to be corrected to mass/volume at STP (760mm Hg Pressure and 298 K temperature in dry condition).
9. It is possible to install time share gas analyser.
10. To do Zero Calibration for the CEMS Gas analyser can we use ambient air.
11. Whether we need to have individual cylinder for individual gas or I cal use mixed gas cylinder.
12. Location of installation of gas analyser.
13. Dust measurement corrected to CO2.
14. In the CEMs document CPCB has suggested to represent NOx in terms of NO2. Why?

Is it possible to install Time Share Option for gas analysers



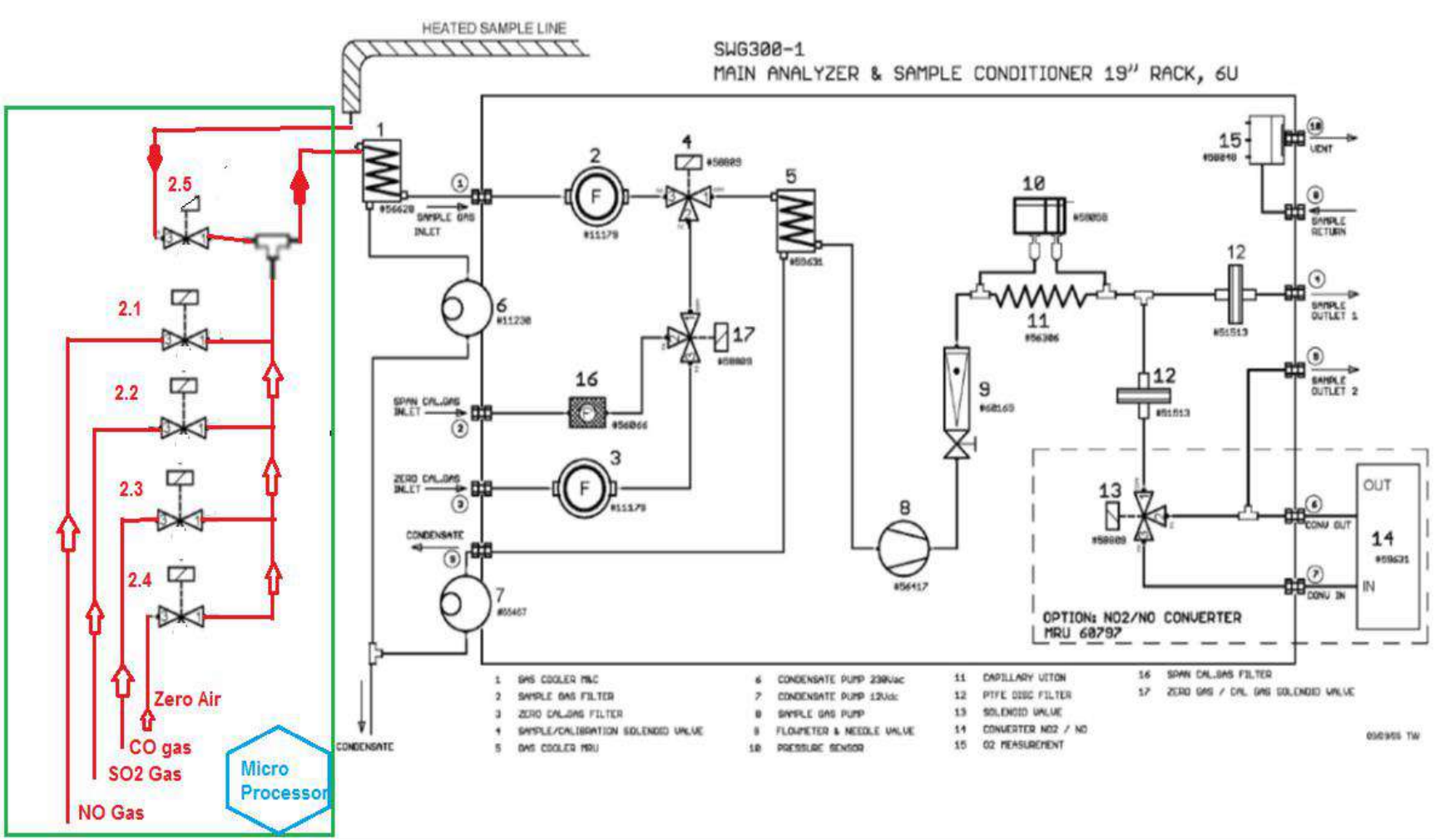

HEATED SAMPLE LINE
SWG300-1
MAIN ANALYZER & SAMPLE CONDITIONER 19" RACK, 6U
2.5
2.1
2.2
2.3
2.4
Zero Air
CO gas
SO2 Gas
NO Gas
Micro Processor
SAMPLE GAS INLET
SPAN CAL.GAS INLET
ZERO CAL.GAS INLET
CONDENSATE
VENT
SAMPLE RETURN
SAMPLE OUTLET 1
SAMPLE OUTLET 2
CONV OUT
CONV IN
OUT
IN
OPTION: NO2/NO CONVERTER
MRU 60797
1 GAS COOLER M&C
2 SAMPLE GAS FILTER
3 ZERO CAL.GAS FILTER
4 SAMPLE/CALIBRATION SOLENOID VALVE
5 GAS COOLER MRU
6 CONDENSATE PUMP 230Vac
7 CONDENSATE PUMP 12Vdc
8 SAMPLE GAS PUMP
9 FLOWMETER & NEEDLE VALVE
10 PRESSURE SENSOR
11 CAPILLARY VITON
12 PTFE DISC FILTER
13 SOLENOID VALVE
14 CONVERTER NO2 / NO
15 O2 MEASUREMENT
16 SPAN CAL.GAS FILTER
17 ZERO GAS / CAL GAS SOLENOID VALVE

Table 1: Minimum Detection Limit of FTIR Method for different compounds

Sl. No	Compound	Frequency (cm^{-1})	MDL (PPB)	Remarks
1.	Carbon Dioxide (CO_2)	2363	0.4	MDL is 0.4 ppb if no other CO_2 is present. In air, the minimum detectable change in CO_2 would be about 50 ppb
2.	Carbon Monoxide (CO)	2200-2100	2.0	Array of lines
3.	Hydrogen Chloride (HCl)	3050-2700	1.5	Array of lines
4.	Nitric Oxide (NO)	1920-1870	4.0	Array of lines
5.	Nitrogen Dioxide (NO_2)	2210	1.0	Array of Lines
6.	Sulfur Dioxide (SO_2)	1361	2.0	Spike; water must be carefully subtracted
7.	Water (H_2O)	1700-1400	5.0	MDL is 5 ppb if no other water is present. In Humid air, the minimum detectable change in water content would be 1000 ppb.


Presentation
Finished.
Any questions?


Thank you!


Invest in the
ENVIRONMENT

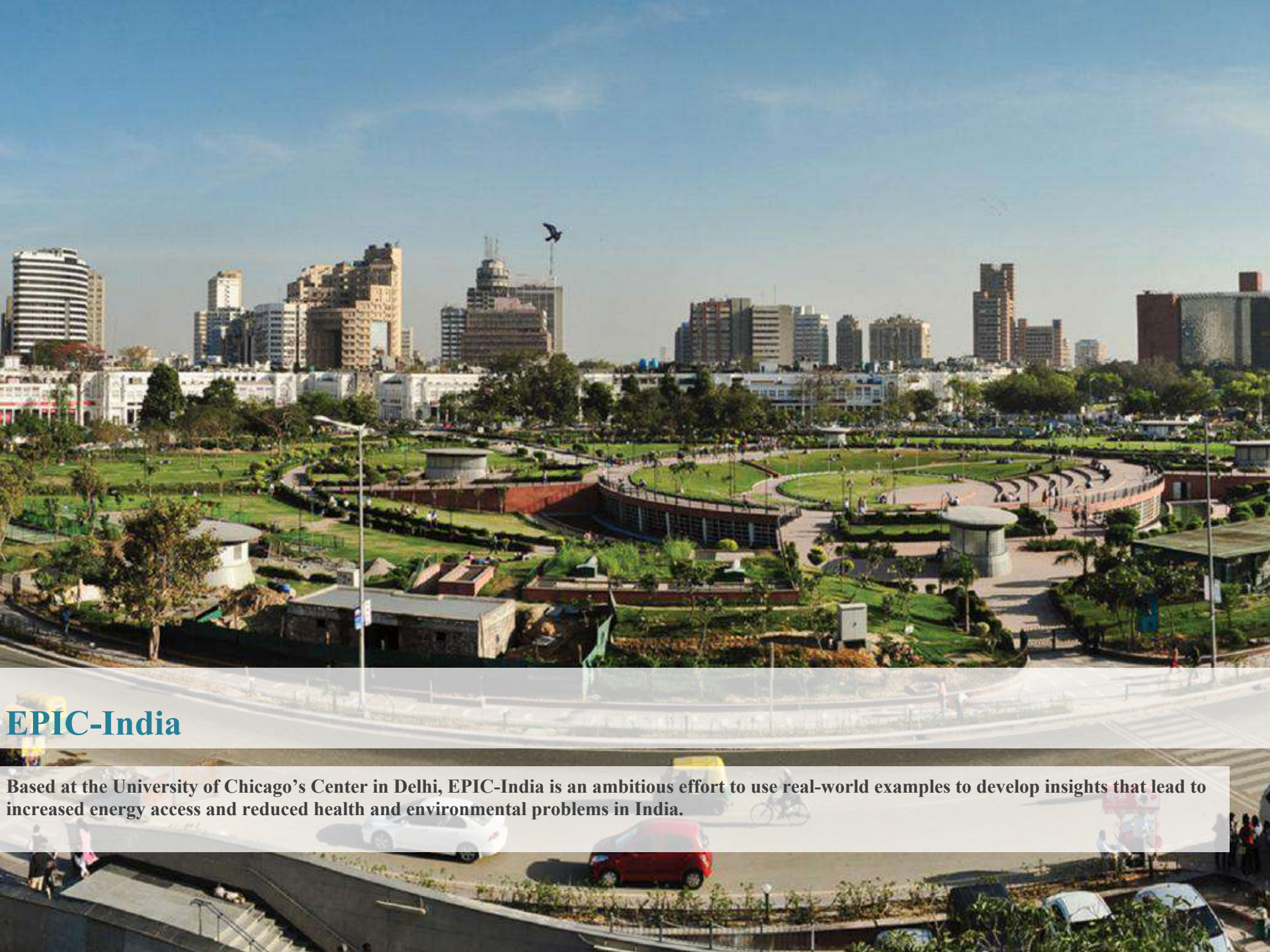
EPIC INDIA
ENERGY POLICY INSTITUTE
AT THE UNIVERSITY OF CHICAGO

INTERPRETATION OF CEMS DATA & STAR RATING OF INDUSTRIES IN ODISHA

By EPIC India Team

13th Nov 2018

ABOUT EPIC-India & EPIC- Cell, Odisha

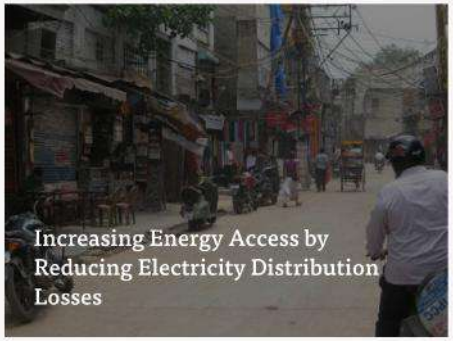


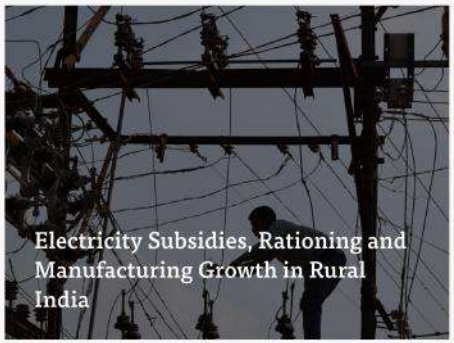
EPIC-India

Based at the University of Chicago's Center in Delhi, EPIC-India is an ambitious effort to use real-world examples to develop insights that lead to increased energy access and reduced health and environmental problems in India.

Our growing portfolio of Indian projects

EPIC-India is working with government partners in 5 states across India.



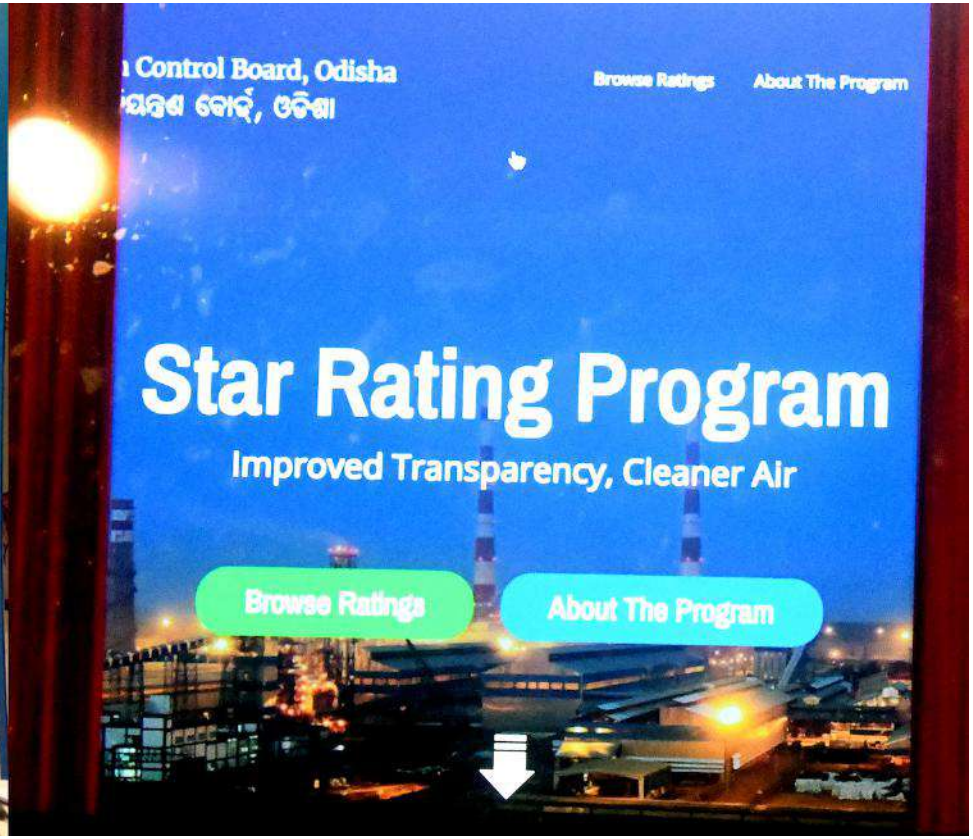


Collaboration on Research, Knowledge Sharing, and Capacity Building

April 2017 – Government of Odisha and University of Chicago statement of intent signing

Star Rating: An Information Disclosure Program

Launch of Odisha Star Rating Program (17th Sept 2018)



What is the objective of Star-Rating?

- Recognize high-achieving industries with 5-Star rating
- Increase competitiveness among industries to be environmentally friendly
- Incentivize industries to mitigate further

Star Rating is a public disclosure of emission data, not certification

Overall Design of Star-Rating

- Based on particulate matter emissions
- Relies on CEMS data
- Captures average emissions and data availability
  - » Emissions relative to consent levels
- Updated monthly
- By plant, not by stack
  - » Plant represented by its worst stack

- Star Rating Program is restricted to industries whose PM-CEMS are calibrated and online data have been validated by SPCB officials.

Design principles

- Star-rating logic should be as simple to understand as possible
  - » 1-2 star: Non-compliant/ Polluting industries
  - » 3 star: Moderate/ Acceptable level
  - » 4-5 star: Very good compliance

- Minimize subjectivity
  - » Subjective choices such as weights, inconsistent criteria ranges avoided

- Should encourage improvements even among compliant plants
  - » 5 star should be exceptional, 3 star the norm

Methodologies for Star Rating

The star-rating is based on two factors:

1. Emission averaged over a period of time compared with permissible limit and
2. Data availability as prescribed by CPCB guidelines.

The table below shows how industries are allocated to their star-rating category.

The **worst performing stack** of the selected plant is used to categorize that plant from 1 to 5 stars.

Rating	Range of mean PM emissions compared to prescribed standard	Data Availability	Rating key	Representation
5 star	<=50%	--	Very Good	
4 star	50%- 75%	--	Good	
3 star	75%- 100%	--	Moderate	
2 star	100%- 125%	--	Poor	
1 star	>125%	<85%	Very Poor	

Dhanyavaad

Data Validation and Calibration Drive by SPCB, Odisha

Presented by

Er. D.K. Dash, EE

(RO, Sambalpur)

STATE POLLUTION CONTROL BOARD, ODISHA

November 13, 2018

Outline

- Inspection protocol
- Action on CPCB direction on CEMS
- Star rating programme
- Calibration and Data validation drive
- Practical problems and challenges

17 Cat of Industries and Inspection Protocol

❖ Distillery and Fermentation ❖ Sugar ❖ Fertiliser ❖ Pulp & Paper ❖ Chloro Alkali ❖ Pharmaceuticals ❖ Dyes and Intermediates ❖ Pesticides ❖ Oil Refinery ❖ Tanneries ❖ Petrochemcials ❖ Cement ❖ Thermal Power Plants ❖ Iron & Steel ❖ Zinc Smelter ❖ Copper Smelter ❖ Aluminum Smelter	❖ Quarterly Inspection ❖ Manual monitoring and sample collection ❖ Laboratory analysis and reporting ❖ Action as and when required

Direction of CPCB for CEMS

- CPCB direction on 05.02.2014 to install CEMS and CEQMS. It was also directed to impose BG equivalent to 25% of installation cost

- Before such direction OSPCB has already installed its GPRS based RT-DAS server and CEMS data was received from certain large scale industries.
- 137 industries were identified
- Directions issued to install CEMS
- Clubbed with CTO order
- Target date extended as per CPCB direction
- Beyond the target date, bank guarantee was forfeited and CTO was not considered or revoked
- No new industry was allowed operate without CEMS

- There was no protocol
- No knowledge base
- No certification agency in India
- Limited RT-DAS vendors for connection to Board's server

Star Rating programme & Data Validation

- OSPCB is the first Board in the country to start such programme
- To create an atmosphere of competitiveness among industries for better performances
- Collaborated with University of Chicago and EPIC (India) and a centre was opened in the board
- The programme has multiple domains out of which CEMS performance is one
- CEMS data is to be used for evaluating compliance performance

- Online data needs to be tamper proof and correct.
- Therefore, such data has to be validated before using in star rating programme

Calibration
&
Data validation

Calibration and Data Validation Drive

- Training programmes were conducted for industries, Board officials at various places and levels to educate them about Star rating, Calibration and Data validation.
- PM was considered as the environmental parameter to start with
- Protocol of CPCB was followed
- Information formats were distributed among the industries
- All information have been entered online
- For calibration, Board officials, Industry representatives, CEMS vendors, NABL accredited laboratory were involved
- Manual isokinetic sampling method was adopted for data validation
- Data transmission check was done during the process

Calibration and Data Validation Drive *(Contd…)*

- Industries were selected from the jurisdiction of most of the Regional offices
- 25 industries were selected to start with-
  - Large scale industries
  - Organizations of repute
  - Well developed monitoring protocol and laboratories
  - Availability of technical man power
  - Maintenance contracts with vendors
- Calibration and data validation work was finished for 25 industries. Based on the experience, it is being extended to other industries
- Star rating programme for the 25 industries launched on 17.09.2018

Calibration Method Adopted (Field Experience)

- All the CEMS were calibrated in presence of the stakeholders
- NABL accredited laboratory conducted manual isokinetic sampling for PM- 3 sets of monitoring conducted
- CEMS vendor recorded the online PM data during the manual sampling sitting at the analyser- 3 sets of online data recorded
- Isokinetic monitoring data was taken as reference and calibration curve was prepared
- From the calibration curve equation, adjustment factors were estimated
- Adjustment factors were fed to the analyser
- Post calibration isokinetic sampling and online data recording was done to validate the data

Calibration and Data Validation Drive *(Contd…)*

- Visual observation of the stack emission
- Isokinetic sampling and observation of process parameters in control room simultaneously
- Filling up of the prescribed formats with instrumentation department / vendor
- Measurement of CO_2 emission in thermal power plants
- Verification of the data transmission system
- ON-OFF test of CEMS and checking at analyzer and control room

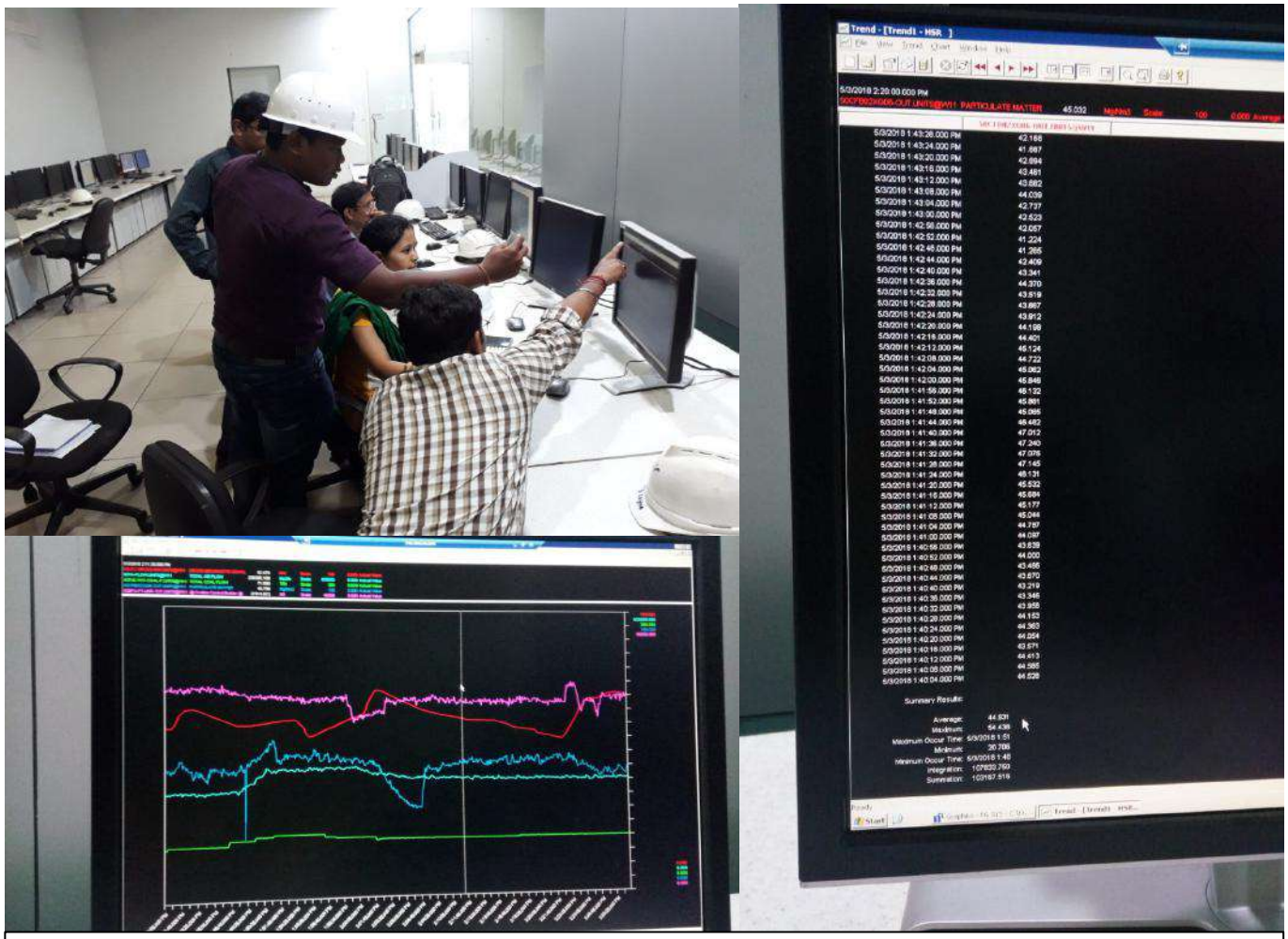
Photographs (Field Experience)

Training and sensitization meetings among Board officers and Industry representatives

Photographs (Field Experience)

Visual observation of stack and isokinetic monitoring thereof

Photographs (Field Experience)



Observations in plant control rooms

Issues and Challenges

- Isokinetic sampling Points- fool proof and error free?
  - Sampling needs to be done in laminar flow region only
  - Sampling points in some industries do not confirm to 8D/2D standard
  - Relocation of the sampling points is not possible in the old plants. Entire ducting network needs to be rebuild to avoid the problem
- Isokinetic sampling at ducts while CEMS in stacks
  - Many stack are made of concrete with unsafe monkey ladders and the sampling platforms are unsafe
  - New port hole can not be drilled in concrete stacks
  - Installation of CEMS at all the ducts is expensive
- Multiple sources connected to one stack
- Monitoring at variable load conditions

Issues and Challenges *(Contd…)*

- NABL accredited laboratories are
  - Limited in number- not available on desired dates even with prior intimation
  - Charge high price
  - Limited trained manpower
  - Stack samplers are not in good condition
- Industries involvement needs to improve
  - They do it not as a requirement, but because of the enforcement. A lot of follow up is required
  - Not keen for better performance of CEMS and RT-DAS of fear. Find some ways to manipulate and manage
  - Lack of separate environment cell with technical man power and expertise
  - Availability of data is below expectation

Issues and Challenges *(Contd…)*

- Board officers
  - Lack instrumentation expert
  - Lack statistical experts
  - Have other local issues to handle
  - Calibration and data analysis work in large industries engaged the entire offices in one industry for almost a week
- CEMS Vendors Vs. Industries
  - Low cost CEMS and RT-DAS system
  - Selection of vendor, who can extend certain advantage
  - Lack of maintenance contract
  - Only Span calibration practices

Way Forward

- Calibration work by industries and Data validation by Board officers
- Up-gradation/ replacement of low quality CEMS
- Relocation of iso-kinetic sampling points- Study and implementation
- Transparent information flow system
- Separate environment cells with environmental and instrumentation experts
- Instrumentation and statisticians in Board
- Improved protocol for comparing environmental performance in Star- rating
- Self monitoring protocol and performance beyond standards

Thank You

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Lowering Particulate Matter Emissions through improved information: the Gujarat Story

Gargee Goswami

November 13, 2018

Central Pollution Control Board
Gujarat

Ministry of Environment, Forests & Climate Change
Government of India

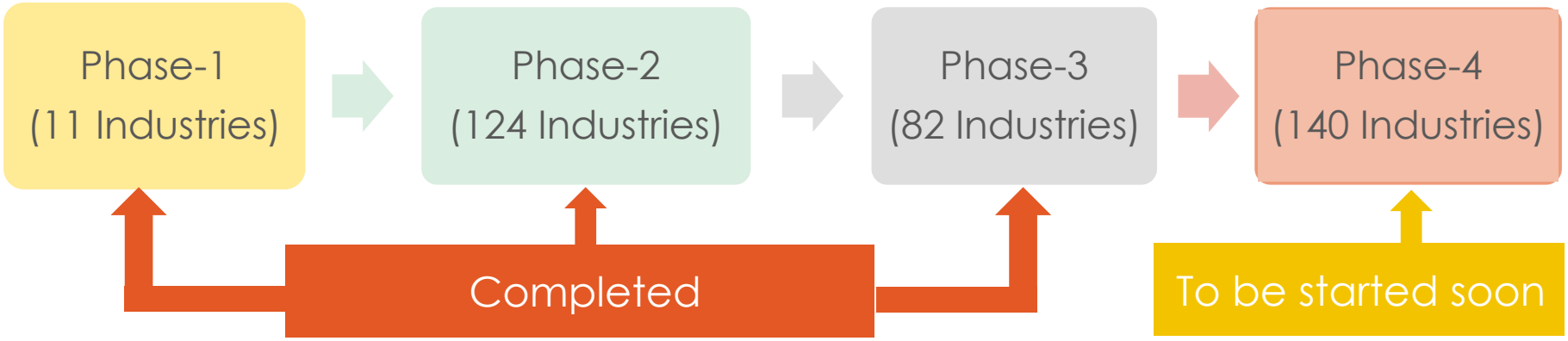
Gujarat Pollution Control Board
ISO-14001 Certified Organization

Outline

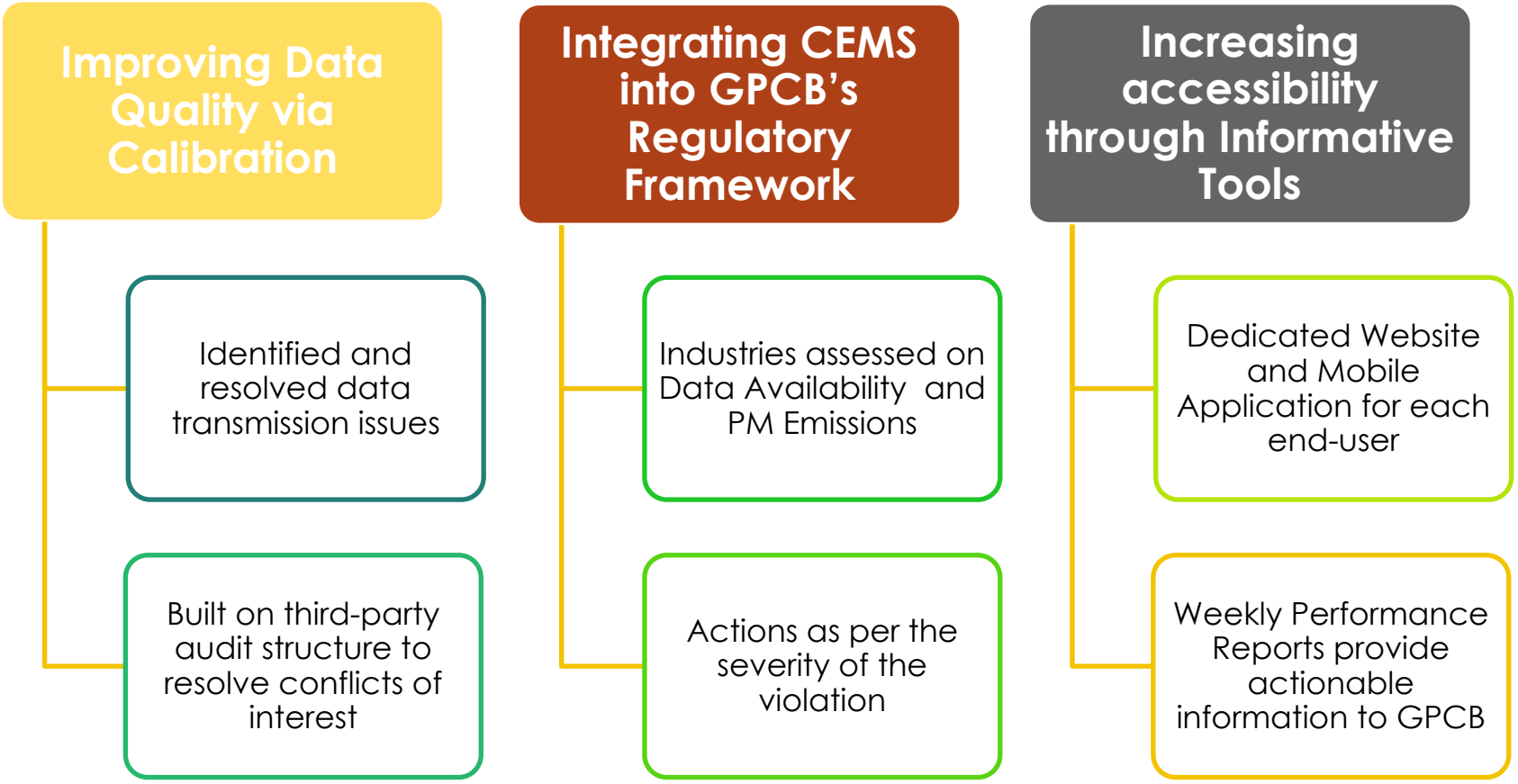
- Provide an overview of CEMS implementation in Surat:
  - Foundations for Success in Gujarat
  - CEMS Data for Decision Making
  - Impact of the GPCB Action Framework
- Discuss best practices for high data availability from CEMS:
  - Why is Data Availability important?
  - Best Practices to ensure High Data Availability
  - Vendors and Contract Structures
  - CEMS Calibration Best Practices

CEMS in Surat

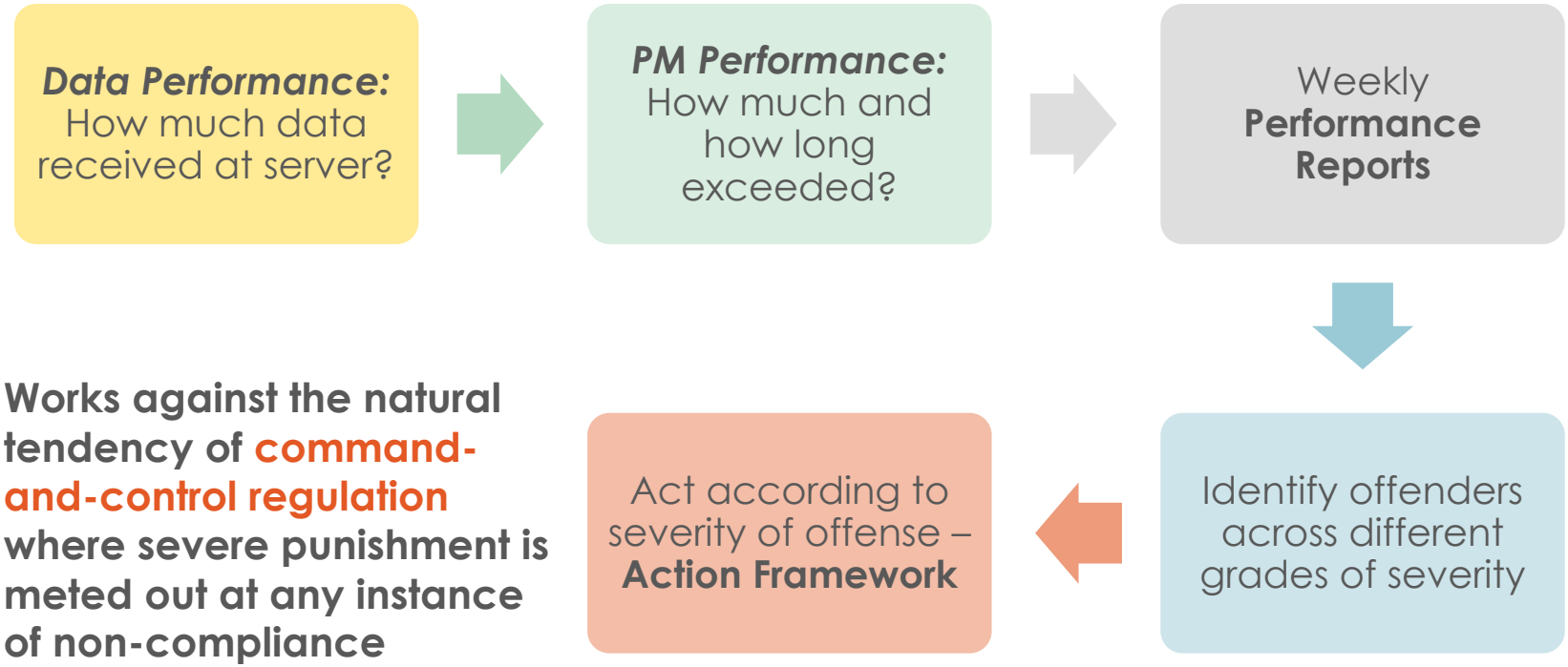
- *Surat was selected for the Pilot ETS project in Gujarat – 373 Industries participated*
- *PM CEMS installed in 176 of these Industries, 90% sending data*
- *Intended roll-out to 350+ Industries to test pilot emissions market*



Foundations for Success in Gujarat



Use of CEMS Data for Regulatory Action



Works against the natural tendency of command-and-control regulation where severe punishment is meted out at any instance of non-compliance

GPCB Framework Effects: Higher Industry Accountability

Date	Action-1 (SMS/Emails)	Action-2 (Emails/Letters)	Action-3 (Meetings with Industries)	Action-4 (Site-inspection/stack sampling)
March	58	-	-	-
April	33	-	-	-
May	33	10	-	-
June	62	46	-	-
July	67	82	20	-
August	53	28	0	-
September	75	39	21	7
October	60	54	35	5

The Surat Regional Officer has conducted 4 meetings on CEMS since July:

- 18 Industries have renewed maintenance contracts with their vendors.
- 72 Industries have called their vendors for site-visits.
- 7 Industries have calibrated their devices.

GPCB Framework effects: Sustained Increase in Data Availability

- Sustained increase in Data Availability over the past 7 months, since the implementation of the GPCB Framework in April
- During the week of Oct 14, 77% of the Industries were sending GPCB data 86% of the time

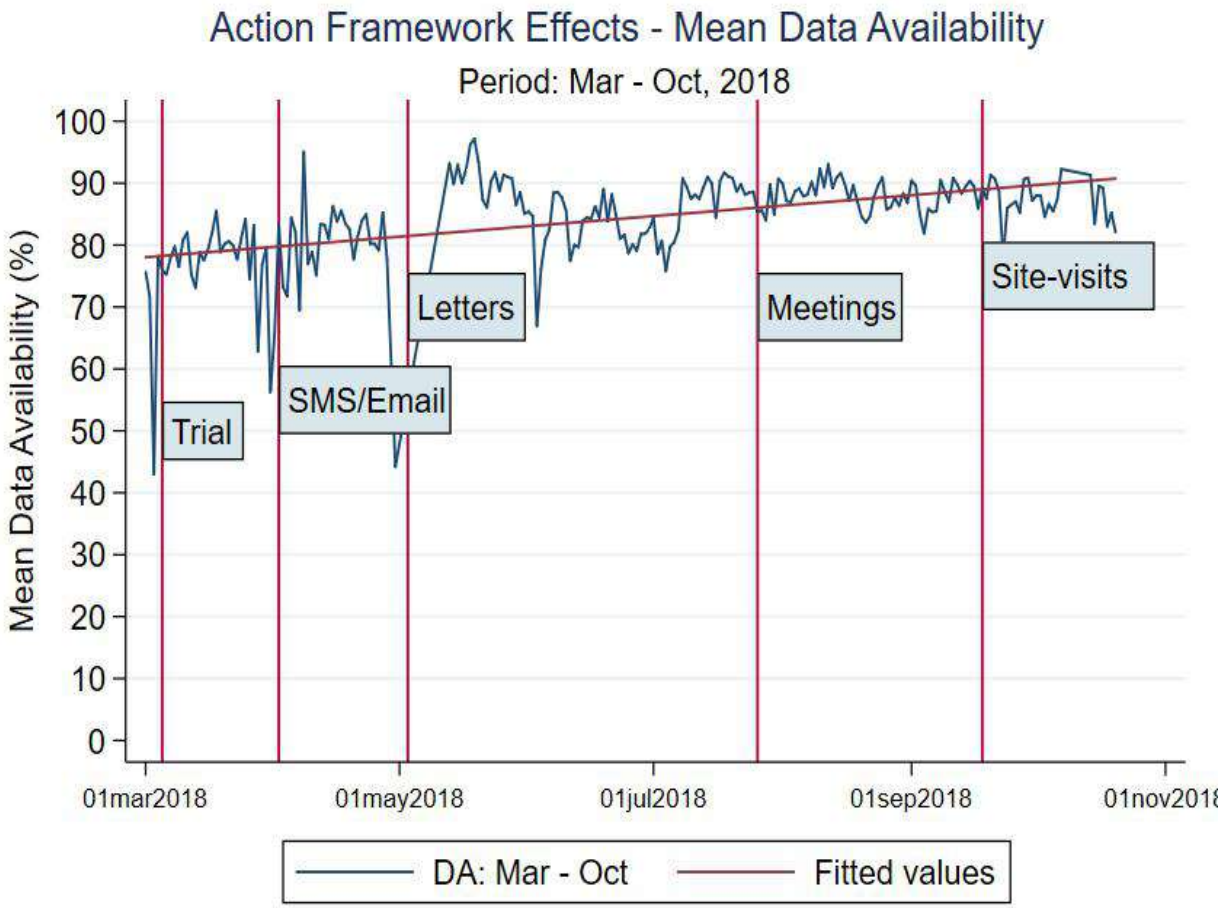


Figure 2. Plot of percentage data availability from CEMS over the course of Action Framework implementation

GPCB Framework Effects: Reduced and Stable PM Emission Levels

- As evident from the Line graph, we observe that the mean PM Conc. Levels have reduced in the month of June and July, since Letters were sent out to non-compliant Industries.

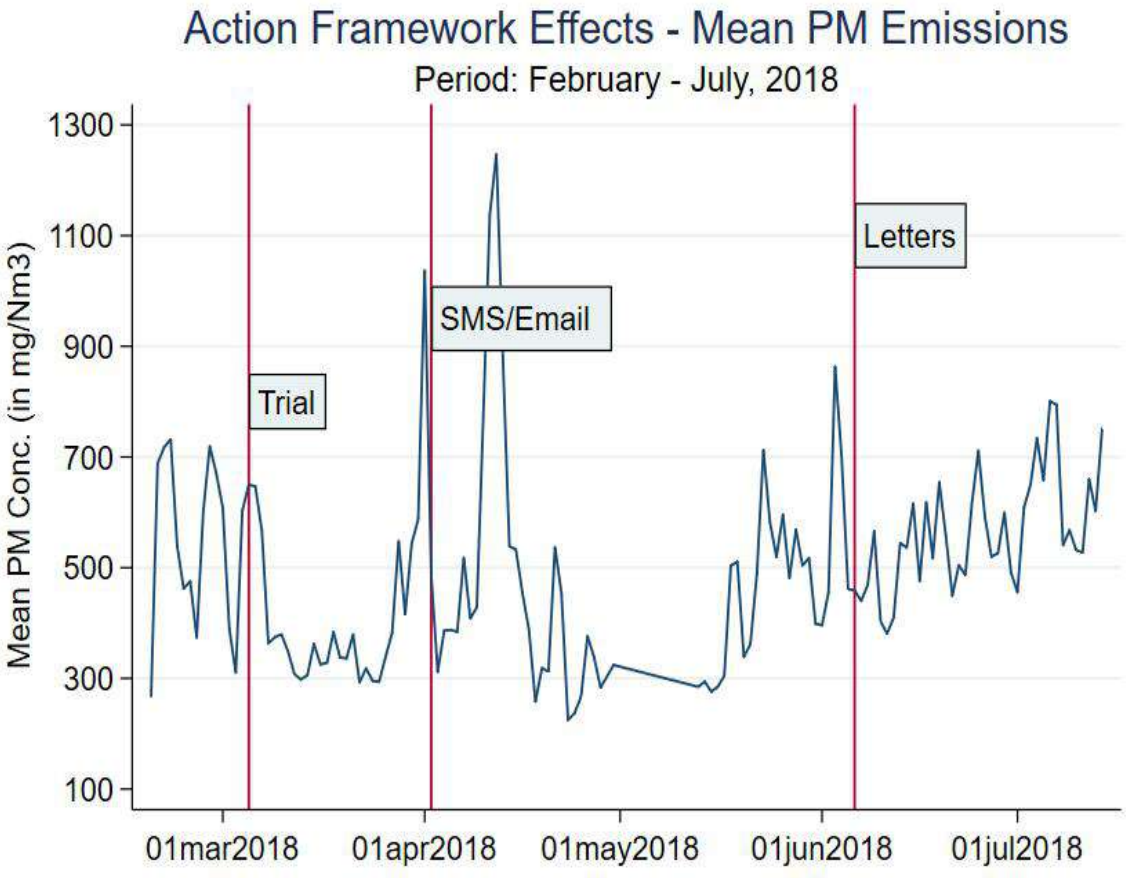


Figure 3. Plot of PM Emissions from CEMS over the course of Action Framework implementation

Best Practices for High Data Availability from CEMS

Setting-up the Data Acquisition and Handling Centre (DAHC)

- Hardware Set-up:
  - Dedicated PC on site. It should have fast internet connection
  - Industries hire a dedicated CEMS personnel to monitor DAHC
- CEMS Registration:
  - Industry registers stack and device by filling the CEMS Registration form available at the GPCB website
  - Composite ID (a unique ID) is generated for each CEMS device that is registered
- Software Set-up:
  - Install CEMS Software and G-Lens software - CEMS software reads data into a standard CPCB format. G-Lens software transfers the data to the GPCB server
  - Configure CEMS Software – Vendor sets composite ID and starts data transfer from CEMS to GPCB server
  - Vendor fills the Installation and Functional checklist, Industry sends scanned copy to GPCB server

Causes for Data Unavailability

Data unavailable at	Technological problems	Frequency of occurrence	Behavioural problems	Frequency of occurrence	Organizational problems	Frequency of occurrence
Site	CEMS software malfunction	Occasional	Disconne-cting CEMS software	Very common	Poorly structured maintenance contract	Common
	IT Vendor software malfunction	Occasional	Switching off PC	Occasional	Unavailability of skilled labour	Rare
	Hardware problems	Very common				
Server	Server malfunction	Very rare				
	Data retrieval issues	Common				

Best Practices to ensure High Data Availability

PC is ON	✓
Vendor software is running	✓
G-Lens software is running	✓
Probe is clean and not corroded	✓
Consistent internet connectivity	✓
Wiring is OK	✓
Licensed version of Windows 7	✓
Earthing is proper	✓
Readings on Hardware Vendor software OK	✓
File reading status OK	✓
Data sending status OK	✓
CSV files are generating locally	✓
Data being sent to server	✓
Comparing data at the PC and Server (Dashboard)	✓
Industry online on ETS Website	✓
Data logger memory is available	✓
Firewall settings are OK	✓

Contract Structures: Benefits of Comprehensive Maintenance Contract (CMC) over Annual Contract (AMC)

KEY FEATURES	**CMC**	**AMC**
Preventive Maintenance provided	✓	×
Breakdown Maintenance provided	✓	✓
Fixed Maximum Duration for Maintenance and Repairs	✓	×
Vendors maintain spare parts in Surat for quick repairs	✓	×
Software and DAHC Maintenance included	✓	×
Vendor conducts Monthly Review of CEMS device	✓	×
The Vendor will maintain service report for all CMC & Breakdown visits	✓	×
No-cost replacement of parts	✓	×

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Reference Slide: Action Framework

Action	***Period of Observation (No of week = X)***	***Criteria based on Data Performance***	***Criteria based on PM Performance***
Regional Office sends auto-generated SMS and email to industry	1 week	Industry is one of 5 with lowest positive data availability and mean data availability is <85% (OR) Industry has zero data availability for at-least X weeks in the past 4 weeks	Industry is one of 5 with worst PM Performance and exceedance duration > 0 hours
Regional Office sends auto-generated email and letter to industry	2 weeks		
Regional Office meets with industry and CEMS vendor	3 weeks		
Regional Offices conducts site visit and collects stack sample	4 weeks		