



Continuous Emission Monitoring System (CEMS)

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- Strong pollution control regime is must
- Unlike US, EU, developing countries suffers from - weak/missing-pollution norms, standardised monitoring, market, transparency

India- inadequate existing regime

1. Manual monitoring- low frequency, prone to manipulation
2. Reported data doesn't match actual emission
3. If online monitors- no check on calibration, limited reporting
4. Real time data not accessible to regulator for verification
5. Poor transparency- no public scrutiny
6. Limited inspection- fails to ensure adequate pollution control practices

CEMS- What & Why ?

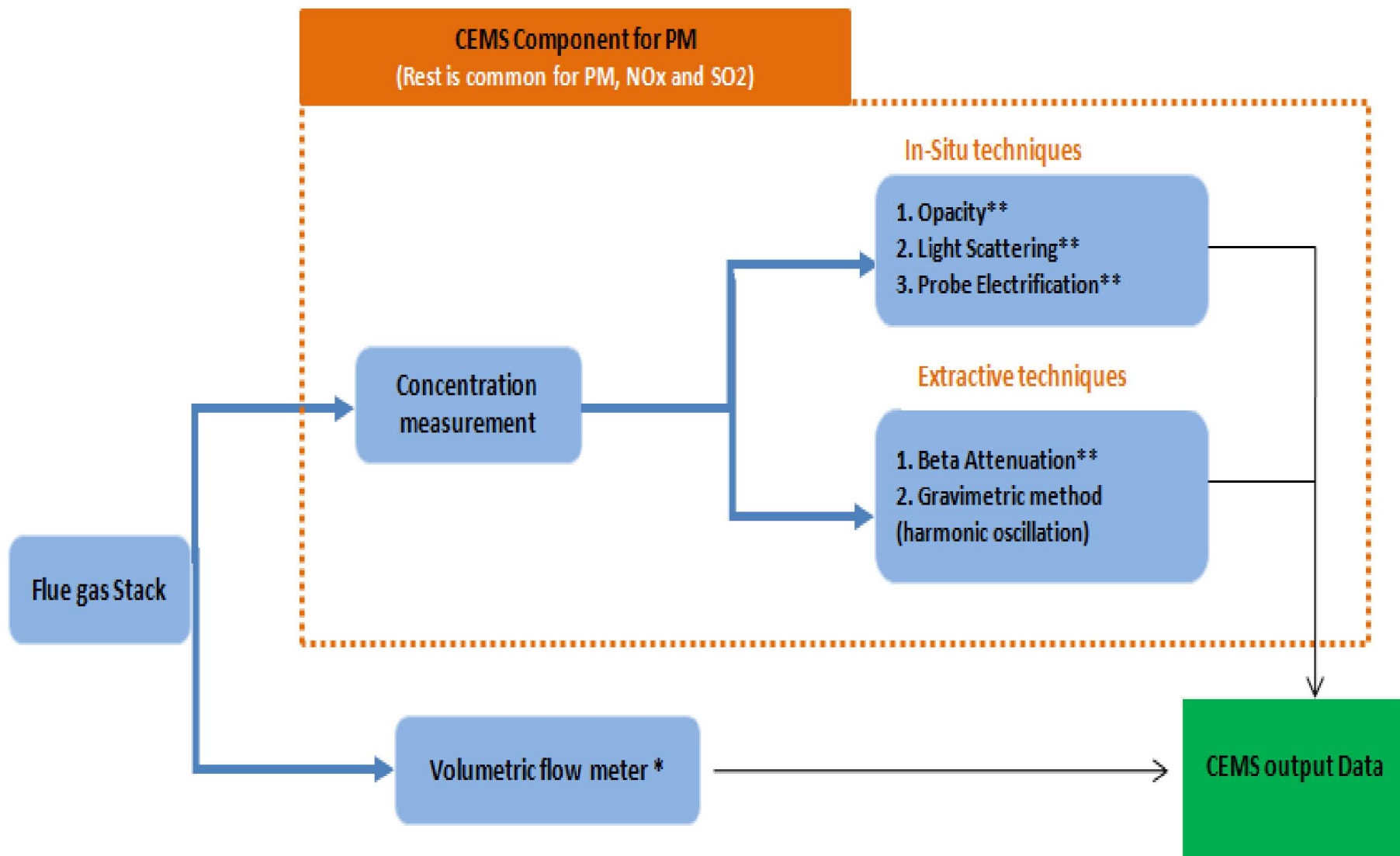
GRP experience - Even if pollution norms are tightened with time, pollution keeps growing; False compliance; poor monitoring & reporting

- 55% TPPs had very high emission
- 10% TPPs with PM norms of 50-75 mg/Nm³ -visible emissions
- SO₂ –no control, reported <13mg/Nm³. Global best ~25mg/Nm³
- NOx - reported <0.1mg/Nm³. Global best ~80mg/Nm³

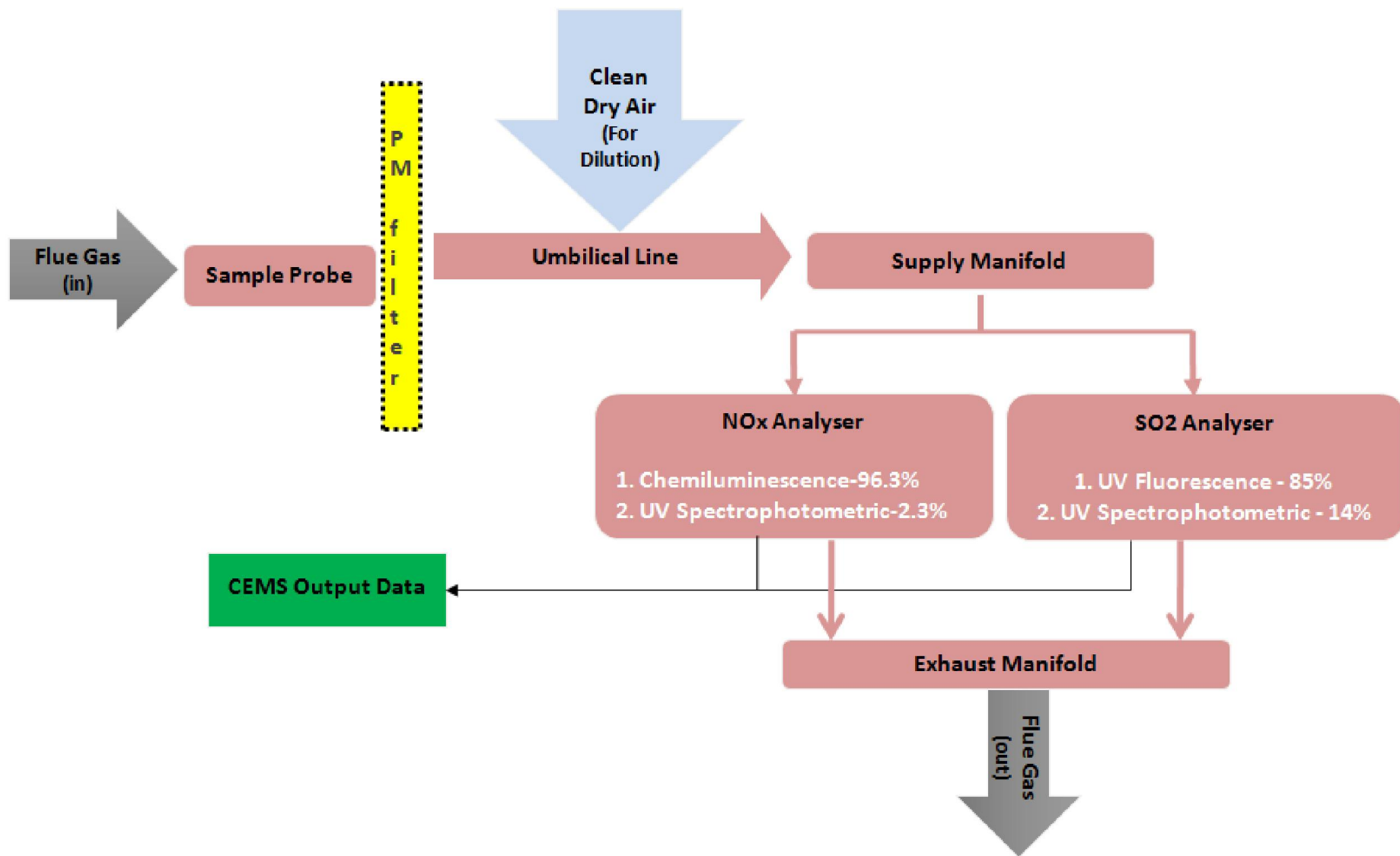
CEMS – A solution- An important tool

Ensures- data accuracy, higher monitoring frequency, minimal-manual intervention, firm regulatory monitoring, better transparency.

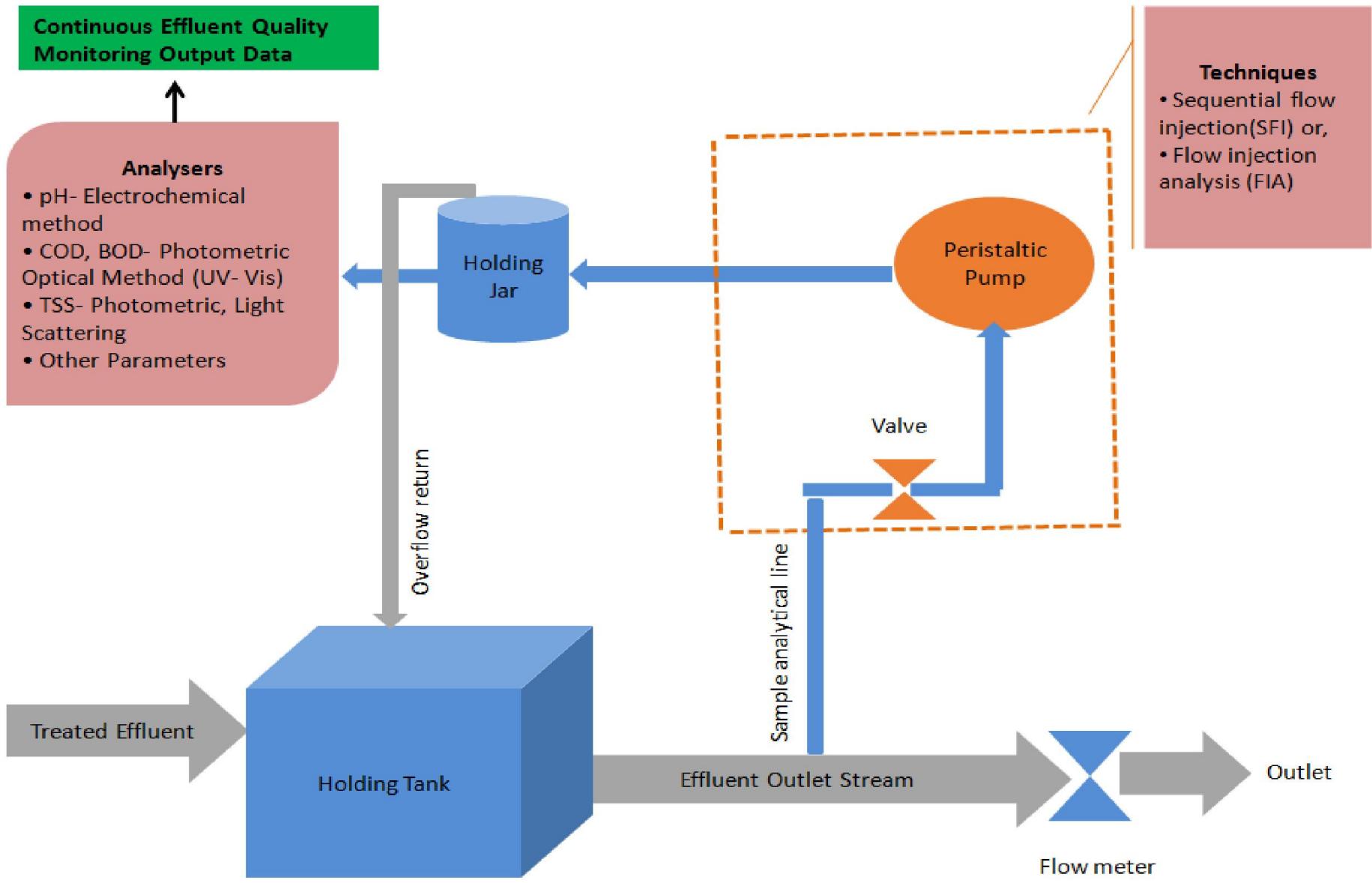
CEMS- PM



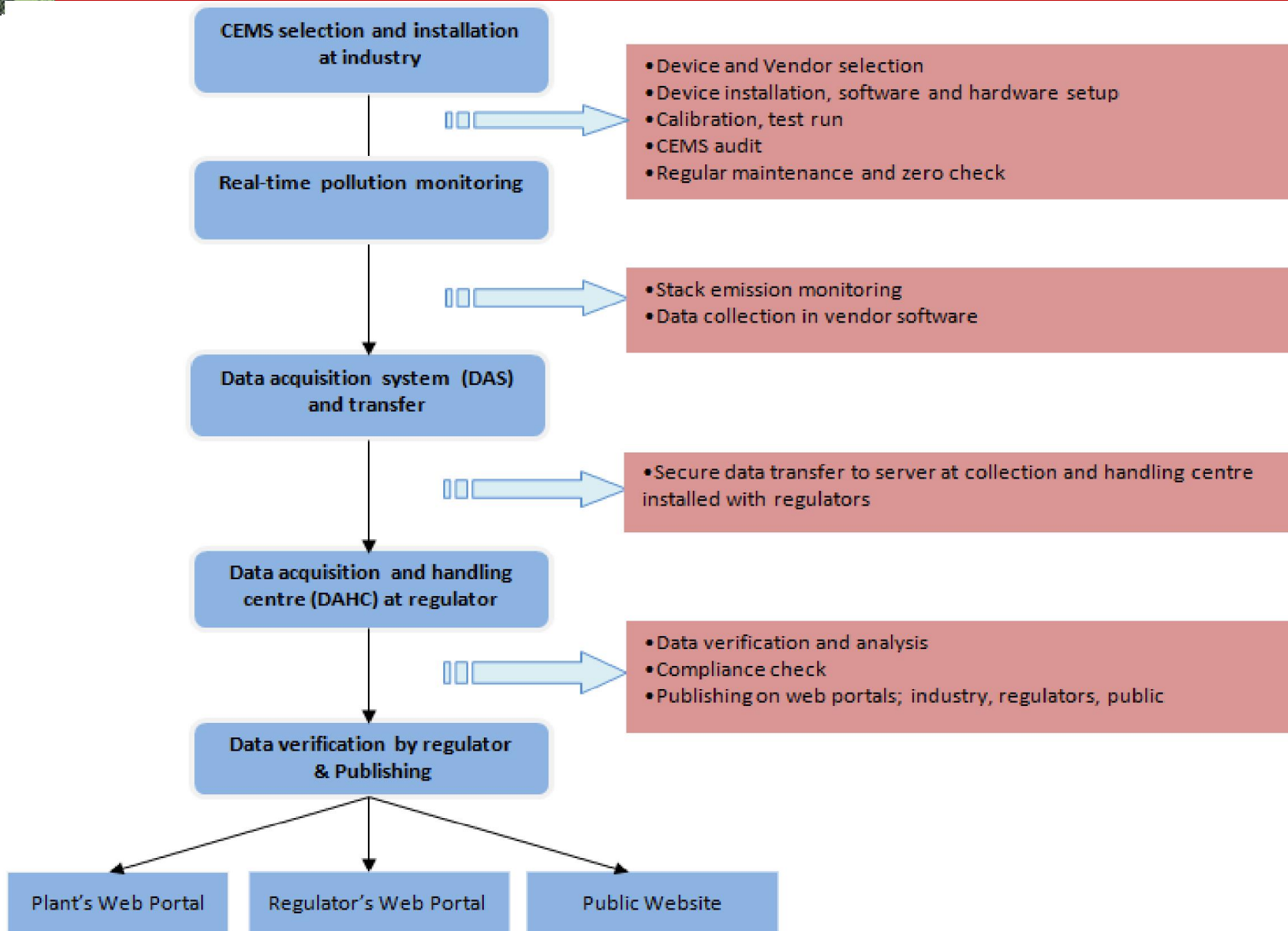
CEMS- SO2, NOx



CEMS- Effluent



CEMS- framework



1. In mid- 1970's- Federal CEMS for tracking performance of APC device under EPA's NSPS (New Source Performance Standards).
2. Under ARP (Title IV of the 1990 Clean Air Act), stringent performance requirements for CEMS
 - **Mandatory real time monitoring-** SO₂, NO_x, and CO₂
 - ✓ If 2 or more CEMS in same stack/duct- primary + back-up
 - ✓ **May choose alternative monitoring system- demonstrate alternative having same/better precision, reliability, accessibility, and timelines**
 - **Selection of device & conformance with the performance specifications**

•Certification :

- ✓ Once installed, **initial certification**- within 30 days performance tests
- ✓ Report of initial certification within 60 days- **Apply for certification**
- ✓ Administrator's approval/disapproval within 120 days; otherwise deemed certified
- ✓ **On disapproval**- monitored data invalid- **certification retest**

•Re-certification : *series of tests required*

- ✓ Any replacement/modification/change in a certified device, flue gas handling, operations **that may affect device's performance**
- ✓ After modification/change, a probationary calibration error test
- ✓ During re-certification- data conditionally valid
- ✓ **In case of failure**- data to be flagged missing- get substituted

- **Quality Assurance (QA) Testing:** Regular, verifies accurate operation of equipment. E.g. for COMS – zero, upscale calibration drift test etc.
- **Data monitoring & collection cycle:**
 - ✓ CEMS minimum **one cycle in 15-mins. 4 cycles estimate hourly avg.**
 - ✓ COMS- every 10 sec data (sampling & analysis) to average for every 6 mins cycle - **10 cycles estimate hourly avg.** (state may permit differently)
 - ✓ Plant to report the data **hourly, daily, quarterly, and annually**
 - ✓ No cycle time (pollutant conc. monitors like O₂, moisture etc.)- exceeds 15 mins

USEPA Experience

- **Compliance check:**

- ✓ **Check for PM emission compliance (for LCP) -**

- **Min. total time of observations- 3 hours** (30 six-minute averages)
- **Not to exceed 20 % opacity** except one 6 minute period/hr (max 27 %)

- ✓ **Check for SO₂, NO_x emission compliance (LCP)**

- **30 days rolling avg. basis**

- ✓ **Special condition**

- Plants -construction/modification/reconstruction before **May 4, 2011**, norms do not apply during startup, shutdown, or malfunction
- **Applicable for those commenced after May 3, 2011**

- ✓ **Relative accuracy test audits at any time.** If fails device is considered out-of-control till the next successful audit test

- **Monitoring data availability and Substitution of invalid data:**
 - ✓ Need to monitor **% valid data availability/ year**
 - ✓ To maintain record of hourly avg. data for **at least 3 years**
 - ✓ Certification, qlty control and assurance data- recorded daily
 - ✓ **Invalid data to be substituted-** If valid, quality assured data not provided by a certified equipment, missing/invalid data is substituted by estimating from valid data recorded in last 3 years.

- **Plants are **required to submit Excess Emission Reports (EERs):**** include excess emissions and excess monitoring system down time, quarterly and sometimes monthly

Real-time effluents monitoring in USA

Regulated by the National Pollutant Discharge Elimination System (NPDES) established under the Federal Water Pollution Control Act Amendments of 1972.

- Both **sequential and continuous monitoring allowed**
- **If higher monitoring frequency** needed- continuous samplers
- To establish continuous monitoring requirement- env. significance of effluent parameters and cost implications are assessed
- Limited parameters- *flow, TOC, temp., pH, conductivity, residual Cl, F, DO etc.*
- Monitoring and reporting requirements are decided on case-to-case basis. Requirements may be reduced based excellent historical performance
 - ✓ **Effluent Limits:** *by comparing BAT -based effluent with water quality-based effluent limits*
 - ✓ **Monitoring Frequency:** *based on flow, pollutant type & concentration, treatment capacity & method, compliance history, permittee's capabilities, discharge location & frequency etc.*

Called as Automated Measuring System (AMS). European Standard (EN 14181) specifies 3 quality assurance levels and an annual surveillance test.

- **Quality assurance level 1 (QAL1):** Suitability of CEMS

- ✓ Before installation
- ✓ MCERTS certification for compliance with QAL1
- ✓ Plant to do required tests- zero span, linearity, leak detection etc.

- **Quality assurance level 2 (QAL2):** Calibration and Validation

- ✓ Post installation
- ✓ Verifies- through inspection and set of functional tests
- ✓ Frequency –
 - *After installation,*
 - *Every 5 year for LCP/ 3 year for waste incinerators,*
 - *Significant change in plant operations, significant upgrade or change in device*

• System for uncertainty of CEMS

Table. Allowable uncertainties of CEMS for coal-based LCP in EU

	Limits mg/m ³	Certification range, mg/m ³	Allowable uncertainty, %	Allowable uncertainty, mg/m ³
NO _x	200-600	500-1500	20%	40-120
SO ₂	200-850	500-2125	20%	40-170
PM (LCP)	30-50	75-125	30%	9-15

• Quality assurance level 3 (QAL3):

- ✓ During operation
- ✓ Detects drift and changes in precision- **zero and span readings**
- ✓ Frequency- **weekly or shorter based on method** (CUSUM; cumulative sum control, Stewart chart etc.)
- ✓ Mandatory recording of all activities- *CEMS details & changes, manufacturers' service visit, call out records, routine maintenance, corrective actions, zero and span drift plots and tabulation etc.*

- **Annual surveillance test (AST):**

- ✓ Check that **calibration function** carried under QAL2 is valid
- ✓ Same functional tests as in QAL2, but less repetitions
- ✓ If the AST shows calibration invalid,- then a full QAL2 is required

- **Sampling frequency and duration:** *decided in management plan*

- ✓ Commonly **duration is 30 minutes**, but may vary depending on the pollutant (e.g. for PCDD/F duration is 6 hours), expected conc., detection limit and emission profile of the process.

- **Compliance:** Vary among EU members, sector wise. For LCP :

- ✓ **95 % of all hourly avg (yearly) - not to exceed 200 %** of the norm
- ✓ **Daily average – not to exceed 110 %** of the norm
- ✓ **Monthly average – not to exceed the norm**
- ✓ **For <50 MW, daily average – not to exceed 150 %** of the norm

No established regulatory framework for CEMS till now

- A pilot project for continuous PM monitoring and ETS initiated in Gujarat, Maharashtra and Tamil Nadu-22.11.2013
- A direction by CPCB for installation of CEMS for air pollution monitoring and effluent quality monitoring from stationary sources. 05.02.2014
- CPCB guidelines for online continuous monitoring systems for effluents. 07.11.2014

CEMS guidelines for PM with special reference to pilot scale ETS

- ✓ **Selection of suitable certified device-**
 - *Mass flow or, concentration based*
 - *=<10mg/Nm³ detection level, <1 % drift , < 5% measurement deviation*
 - *Flow metre with 1 m/s min detection, < 1% zero and span drift, < 2% measurement deviation*
 - *Hardware & software - to record every 1 min data, 90% or higher data availability*
- ✓ **Certification from recognized agency-** USEPA-PSII, MCERT, TUV etc.
- ✓ Initial calibration required before installation
- ✓ Device performance test after calibration
- ✓ Periodical quality control test
- ✓ **CEMS audit at-least every 12 months**

• Standard operating procedure

- ✓ Device installation, registration, configuration- *industry to do*
- ✓ Calibration- **Accredited lab (by NABL/MoEF/CPCB/SPCB)**
 - *Sampling under various operational conditions (load, efficiency of APC device etc.)*
 - *95% data availability*
 - **Calibration at-least every 6 months** after initial calibration
- ✓ Post-calibration performance test- *to measure avg. deviation between raw readings and iso-kinetic readings and fix calibration equation*
- ✓ CEMS audit and CEMS audit performance test- *by accredited labs at fixed calibration equation, sample points and at different load*
- ✓ Recalibration-
 - **if operating out of range-** *10% or more in a week for 5 weeks or more/ 40% or more in a week for 01 week or more (45 mins moving average),*
 - *device hardware changed, changes in fuel/process, major change in APC device*
 - *every 06 months,*
 - *failure of CEMS audit*



Real-time effluent monitoring in India

- **Selection of equipment** by industries
- **Device calibration** (weekly for most parameters) by manufacturer
- At-least **85% data availability**
- **1 min. data average - every 30 minutes** transfer
- Allows **10% exceedance of norm**; Regular exceedance- action
- Relative **difference between online and laboratory measurement**-
±10% allowed for BOD, COD, TSS and ±0.2 for pH
- **ZLD plants to install camera with night vision and flow meter**
- **Plants ZLD by utilizing treated water in irrigation-** to install continuous monitor at the outlet of ETP
- **Bank guarantee** (of 25 % of device cost) **from manufacturer** to ensure optimal performance of device, and 85% data availability.
- **Cost of effluent monitoring-** 1.5 lakh to 60.5 lakh across sectors