Comments & Recommendations
on Guideline Manual for
Continuous (Real Time) Emission Monitoring (CEM) in Industries

Submitted to:
Central Pollution Control Board (CPCB)

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About the document

Central Pollution Control Board (CPCB) has mandated installation of continuous emission monitoring system (CEMS) via letter No. B-29016/04/06PCI-1/5401 dated 05.02.2014 for 17 categories of highly polluting industries, Common Effluent Treatment Plants (CETPs) and STPs, Common Bio-Medical Waste Incinerator and Common Hazardous Waste Incinerators. To guide stakeholders on CEMS implementation, CPCB has come up with a draft guideline manual for real time pollution monitoring of pollutants.

The Centre for Science and Environment (CSE), a public interest research and advocacy organization based in New Delhi, welcomes this initiative taken by CPCB. CSE has reviewed the draft guideline document and has come-up with important comments and recommendations. CSE has also consulted European experts for suggestions to bring improvement in the CEMS guideline document. This document prepared by CSE is an effort to propose suggestions/comments on the draft guidelines and provide recommendations to CPCB for successful implementation of CEMS in India.

CSE's comments

The feedback has been organized under three headings:

A. Technical corrections,
B. Editorial corrections
C. Recommendations
D. Annexure 1

A. Technical Corrections

1. The draft guideline document has presented a number of technologies which can be used for real time pollution monitoring. For PM CEMS, two types of opacity monitors are defined namely, single pass and double pass with the help of diagrams. Since the present **diagrams doesn't represent single and double pass correctly, need to be corrected/replaced. Also, single and dual beam concept should be explained which often confuses the industry.** (page 13). Technical correction point 1 of the Annexure 1 of this document carries diagrammatic representations of single and double pass opacity meter. The explanation of single and double beam has also been provided.

2. A table for Particulate Matter (PM) technology selection has been presented which is generic. **It is advised to mention the PM concentration range instead of just saying high and low. (page 20). Similarly in the table in Annexure II should mention concentration range for PM and gases.** Technical correction point 2 of Annexure1 presents tables on PM technology selection.

3. The draft guideline document presents three charts (Figure 17, 18 and19) to define the roles and responsibilities of different stakeholders. Since these charts present the broad responsibilities, two or more parties appear responsible for the same work which leaves scope for stakeholders blaming each other. **To bring more clarity on this issue, it is suggested to include a detailed table with clear and specific responsibilities of the particular.** (page 30-31). The technical correction point 3 of Annexure 1 presents the table for stakeholder's responsibilities.

4. For indigenous CEMS without COP, performance demonstration of device equivalent to QAL 2 standard or EPA performance standard criteria has been suggested for a period extending fortnight to one. **Please note USEPA performance specification is equivalent to QAL1 and QAL2 process together. The QAL2 process alone doesn't assure the quality and reliability for longer period. Therefore, the industries should be asked to carry performance demonstration as per USEPA performance specification criteria or tests carried as per EN15267 - QAL1 and EN14181- QAL2 standard. The verification/approval of the performance demonstration by SPCB/PCC should be mandated. The standard reference method should also be mandated.**

   Tests required to be carried for performance demonstration should be clearly specified like- 7days drift tests, multi-load multi-point calibration and correlation with SRM for a week, Relative Accuracy Test Audit (RATA) for gaseous CEMS (repeating 3 or 6 monthly) and Absolute Correlation Audit (ACA) for PM CEMS (repeating 6 monthly or yearly), Response Audit for Gaseous CEMS and the Relative Response Assessment (RRA) for PM. For details, 40 CFR Part 75 Appendix B of USEPA can be referred. (Page 31)

The Technical correction point 4 of Annexure 1 presents CEMS quality assurance process in Europe and USA, and the standard reference methods (SRM) for various tests.

5. The document guides that the CEMS shall be installed at a distance at least at 8 times the stack diameter downstream and 2 times stack diameter upstream from any flow disturbance (with some exceptions). **Since there are multiple CEMS equipment needed to be installed, it is suggested to explain the installation plane, angle and location of CEMS diagrammatically for key pollutants such as PM and SO_2, NOx, HCl, HF etc.** (page 32). Please refer Technical correction point 5 of Annexure 1 for diagrammatic presentation.

6. Under "installation requirement for CEMS" the document suggests the installation of gaseous CEMS equipment at 2D &1/2D principle in exceptional cases and refers to the USEPA document- 40CFR 75. **However, it would be better to provide the brief information if any intended and refer for the detail. the USEPA document- 40CFR part 75 is very extensive, it is advisable to refer to the particular section 40CFR part 75 Appendix A if needed.**(page 32)

7. Under the heading "Calibration requirement for PM CEMS", the roles of empanelled laboratory are mentioned. (page 34)These labs will also be needed for performance demonstration during installation on uncertified device (page 31). **These provisions are not actionable since the laboratories have not been empanelled till date. It is suggested to initiate the process of laboratory empanelment/accreditation on urgent basis. The implementation of these provisions can be mandated within a defined timeline (for e.g. 3 or 6 months) from the date laboratories get empanelled**.

8. The document rightly says that no adjustment of Calibrated Dust Factor (CDF) is allowed unless full-scale calibration is performed for PM CEMS. **It can be added that change of CDF should be permitted only if it is approved by SPCB/PCC.** (page 34)

9. Under "Calibration for PM CEMS" the facility is advised to reduce the production or tune the APCD for varying the load. Since it is not always possible to change the pollution load by tuning APCD. **Therefore. it is suggested to include- In cases where it is not possible to change the dust level from the APCD, it should be acceptable to have a calibration with 5 isokinetic samples at the normal dust level and to use a calibration curve drawn through zero. The valid calibration range of the CEM shall be 200% of the maximum dust level during the Isokinetic test.** (page 34)

10. The document says that functioning, drift, linearity, detection limit, output, operating temperature and other relevant parameters should be checked before installation for obtaining calibration certificate. **It is advised to mention that calibration for certified CEMS and full performance demonstration of uncertified CEMS (which involves calibration) must be performed while being installed.** (page 34)

11. The document asks to provide only the emission data at regular intervals through Data Acquisition System (DAS). **It is suggested that the key operational parameters- plant load/capacity utilization, efficiency, fuel rate, air supply etc. should also be retrieved along with emission data. These data are readily available and can be taken as mean average (during each monitoring cycle) values. This is standard practice in Europe and helps in verification of supplied pollution data.** (page 36)

The table given as Annexure-V to retrieve average hourly CEMS data can **be modified and used to retrieve these operational data. DAS software can withdraw these data operation control room server.** (page 36)

12. After Table 13, a table for performance specification for Flow analyser should also be given. The same has been presented as Technical correction point 12 in Annexure 1 for consideration.
13. The guideline demands industry to submit monitoring data transfer report on daily as well as monthly basis. **It will unnecessarily add burden on industry and at the same time regulators will not have enough time to check these. Also, all the data is already being supplied to the regulator's server and the DAHS software can present the data in the needed format. Therefore it is advised to not to demand for daily report submission, instead monthly or quarterly submission can be mandated.** (page 40)

B. Editorial correction

Page	Title/ Section	Comments	Correction
	Cover page	The coloured diagram obviously presenting Durag and Sick instruments.	Can be presented as monochromatic diagram
v	List of Abbreviations	Full form of MCerts is not correct	**Replace with** Environment Agency of England & Wales (EA) Monitoring Certification Scheme
		Abbreviation for "percent mass by volume" is given as %m/v.	**Replace with** %v/v
1	2.0 Purpose	MoEF full form and abbreviation	**Replace with** MoEF&CC. Also the full form has not been mentioned anywhere.
10	6.0- First paragraph	The applicability of extractive PM-CEMs should be explained The 2nd to last sentence should be changed and the last one removed. It does cover BETA which are also extractive systems	**Replace sentence beginning ' the extractive PM-CEM' with** Extractive PM-CEMS are generally used in applications in which liquid droplets are present. Droplets can cause measurement issues in applications with saturated emission stacks eg after wet scrubbing systems, Wet FGD's etc and in these types applications extractive systems which condition the gas have been found to be the prime solution for measuring particulate successfully.
10	6.0- second paragraph	The words "shoot" is not correct	**Replace with** soot
12	6.1	Elaborate on Reference methods	Add reference to EN-13284-1
12		'Should use a red or near infrared light source' .....not important as technology moves forward or in relation to Opacity monitors used for PS-1 compliance in US where green wavelengths are measured for Opacity (not a requirement for PM)	**Sentence starting with 'should use a red or near infrared light source' should be replace with** A transmissometer should use an appropriate stable light source which is less affected by outside interference. Typically 500nM light (Green) or 600nm light (red) is used
14	6.2 Light scattering	The use of the **pulsed** light source limits the possibility that light from some other source (e.g., ambient Stray light) will be measured, because a reference of the source intensity is measured along with each scattered light measurement.	**Change the word** 'Pulsed' for' Modulated'
14	6.2 Light scattering	Forward scattering type instruments are probe time and have lesser representative sampling path, hence may not be suitable for higher particle concentration. It has also some maintenance issues	**Replace with** Forward scattering instruments are probe type and have a smaller measurement volume than back scatter instruments. Due to the small measurement volume of light scattering instruments in general, location of the instrument to a place where it measures a representative concentration of dust is important. Intrusive probes may need more

			maintenance at higher particle concentrations
14	6.2 Light scattering	The coloured diagram obviously presenting Durag and Sick instruments.	Can be presented as monochromatic diagram
15	6.3 Scatter-light Extractive PM - CEMS	Principle is same as earlier, but the gas is extracted isokinetically and heated to vapourise the water droplets. Delete the word isokinetically	All extractive systems don't monitor in this manner
15	6.3 Table 2: The advantages and disadvantages light Scattering	Disadvantage- Measures liquid drops as PM is only true for in-situ version (extractive system designed to deal with this application)	**Replace with** 'In-situ versions suffer interference from liquid drops. Extractive versions are designed for wet flue gas applications and are required for liquid drops'
16	6.4 Table 3: The advantages and disadvantages Optical Scintillation	Disadvantage- Measures liquid drops as PM	**Replace with** The presence of liquid droplets or vapour will cause erroneous readings due to refraction / reflection of the light beam by the moisture
16	6.5 Probe Electrification Technique	Electrostatic charges from the friction of particles contacting a probe will electrify the probe (i.e., a small current is produced in the probe Not correct.	**Replace with** Probe electrification devices utilise charge transfer methodologies where the natural electrical charge held by a dust particle interacts with a metallic rod in the gas stream.
18	Table 4: The advantages and disadvantages Probe Electrification Technique	Disadvantage: Particle sizes and velocity affect adversely Not correct.	**Replace with** 'Triboelectric instruments are affected by changes in velocity- care should be taken when using in applications with widely varying velocities. Charge induction technologies generally overcome this issue in the range of 8 -20 m/s. Care should be taken when selecting an instrument for use in applications with dampers or variable speed fans'
		Advantage- Moisture interference can be removed by using piezo-electric shield on probe. This statement is not proven by independent approvals bodies	**Replace with** 'Effects of damp particulate can be mitigated by using an insulated sensing rod'
		Advantage- Suitable for reporting either concentration of mass emission depending on the technology selected. Not correct	**Replace with** 'Suitable for measuring concentration when Calibrated against a gravimetric sample'
20	Table 6	Table needs correction. ✓ Remove trade name **Tribo-Flow** and replace with probe electrification ✓ Correct table to show probe electrification instruments may be used to stacks in 3m diameter and are suitable for low to medium concentrations ✓ Add Extractive light scatter to same column as BAM, use >500'C is Not applicable for BAM and extractive Light scatter	**Replace the table** with the Table. PM technology selection matrix attached under Annexure under point 2

24	7.5 Tunable Diode Laser Absorption Spectroscopy (TDLAS)	TDLAS is commonly used for monitoring O_2 and H_2S, Presently not mentioned.	**Add** O_2 and H_2S list of components specifically mentioned
26	7.8 Table 9	Technique- IR gas filter correlation	**Add** ✓ 'HCl, HF, TOC' to be added to list of parameters measured ✓ NOX (both NO and NO_2 measured) ✓ Up to 10 multiple gases can be measured
		Tunable Diode Laser	**Add** 'O_2 and H_2S'
		Zirconium Oxide cell	It can be both Extractive and In –Situ
27	7.9 Paragraph 1	Ultrasonic flow monitors are available in either 'cross stack' or in ' probe' format and reference to the latter should be made	**Add** Ultrasonic flow monitors are also available in probe design with the instrument being installed on one side of the stack only, While having a shorter measurement length to cross stack instruments, these instruments have the advantage of not needing mounting and platforms at two different heights on the stack
28	Table 10: Flow meter selection matrix	Row labels in table needs correction	**Max Flue gas temperature** should be in 3rd row and **Wet Stack** row heading should be in 2nds row.
		Low velocity should be defined - The real issue is the turn down ratio Max/Min is restricted for Pitot and thermal anemometer	
33-34	8.6 Analytical Range selection of CEMS	The section is important to select the CEMS. Therefore should be shifted just following after 8.4	
34	8.7 Calibration Requirement for PM CEMS	A pass/fail criteria should be referenced for a valid calibration	The calibration shall be repeated if there is not a valid calibration against the criteria defined in table 13 of section 8.11
34	8.7 Calibration Requirement for PM CEMS (i)	Sometimes it is not possible to reduce the dust level from APCD level, there should be provision for changing the load	**Add at the end** In cases where it is not possible to change the dust level from the APCD (i.e. bagfilters) it should be acceptable to have a calibration with 5 isokinetic samples at the normal dust level and to use a calibration curve drawn through zero. The valid calibration range of the CEM shall be 200% of the maximum dust level during the Isokinetic test
34	8.8 Calibration Requirement for Gaseous CEMS (iii)	Clarify that the instrument is calibrated with 5 different gas levels by comparing the CEM output to the actual gas concentration determined in the stack by Reference Method or injection of known calibration gases	**Add** The instrument is calibrated with 5 different gas levels by comparing the CEM output to the actual gas concentration determined in the stack by Reference Method or injection of known calibration gases. In cases with multi-component analysers it is sufficient to do a 3 point calibration for all the gases measured
36	8.11 Criteria for acceptance of CEMS field Performance	For quality assurance, guidelines refer to use EN QUAL standards.	It should be QAL standards
37	8.11 Table 13	Tolerance ranges for reference point drift should be increased to 4% (as per US and EU requirements)	
39	10.0 CEM	Not applicable for PM CEMS.	

	System Test a) Calibration drift		
39	10.0 CEM System Test b) Relative Accuracy	This requirements is not useful (and is too restrictive) for PM_CEMs due to inaccuracy of reference method	Explain that the Determination coefficient (R2) should be used to understand performance vs the reference method of PM-CEMS
42	13. Reference	Reference to EN-15259 (location of sampling planes and CEMs) would be helpful	**Add reference** EN-15259 : location of sampling and CEMs
Annexure II			
Annexure II	Annexure II Aluminium	✓ Remove recommendation to Optical PM-CEMs since not valid if bagfilters are in use ✓ Correct HF for F	**Replace with** FTIR for CO and HF (costly solution)
	Cement	✓ Back scatter also applicable so remove reference to Cross stack PM –CEM ✓ NDIR applicable for SO2 and Nox	**Remove words**- Preferably cross duct **Add**- NDIR for So2 and NOx
	Chlor Alkali	Cold/dry extractive NDIR using permeation dryer also acceptable for HCl	**Add** Cold/dry extractive NDIR using permeation dryer acceptable for HCl
	Fertilizers	✓ Explain which gases can be measured by FTIR and TDLAS ✓ Also provide details of alternatives for HF and NH3	**Replace with** ✓ In-situ or Cross Duct PM CEMS ✓ FTIR, TDLAS for HF/NH3 gases ✓ Cold/dry extractive NDIR using permeation dryer acceptable for HF ✓ Hot/wet extractive NDIR acceptable for NH3
	Iron and Steel	Add reference to dilution methods	**Add** Dilution extractive CEMS acceptable for SO2, NOx, CO
	Oil Refinery	Explosion (safety) zones are common meaning that Intrinsically safe probe electrification instruments are commonly used	**Add to** approved Probe Electrification PM- CEMS
	Petrochemical	Explosion (safety) zones are common meaning that Intrinsically safe probe electrification instruments are commonly used	**Add to** approved Probe Electrification PM- CEMS
	Power plant	Add reference to NDIR for multigas	Add reference to NDIR for multigas
	Zinc and Copper		**Replace with** ✓ In-situ PM CEMS ✓ Dilution Extractive CEMS acceptable ✓ UV Fluorescence/NDIR for SO2
	Biomedical		**Replace with** ✓ In-situ PM CEMS ✓ Cold/dry extractive NDIR for HCl, NOx, CO, CO2 (permeation drying) ✓ Ideally system should be Hot wet ✓ Extractive Type or Cold/dry Extractive using permeation dryer

	Waste Incinerator		**Replace with** ✓ Ideally system must be Hot wet Extractive ✓ Type or Cold/dry Extractive using permeation dryer ✓ QAL 1 approved PM CEMS (o- 15mg.m3 certification range) ✓ FTIR Type Multigas analysis is best Suitable (but costly solution) ✓ Cold/dry extractive NDIR for HCl,HF,SO2, NOx, CO, CO2, TOC (using permeation drying) ✓ FID based instrument or NDIR for TOC Paramagnetic or Zirconum cell Type Oxygen sensor

C. CSE's Recommendations

1. System for Indigenous CEMS device certification

The guideline document mentions about device certification which assures quality control and quality assurance for CEMS. An indigenous system for complete device (analyzer and other accessories) certification needs to be developed urgently.

- The MoEF&CC or CPCB needs to take initiative and approach the competent agencies and develop strategy for developing such a system in India. Keeping the timeline in mind, mandating the certification for domestically produced CEMS within a given timeframe will be required.
- BIS appears to be one of the most suitable Indian organization for developing certification system for CEMS. It functions in line with international standards ISO/IEC 17021 that assures the competence, consistency and impartiality of bodies providing audit and certification of all types of management systems. Other competent agencies like TUV Rheinland, TUV SUD, TUV Nord etc. available in India have been successfully carrying this task in Europe and other countries for many decades. They have expertise and set-ups in India which can be upgraded if required. MoEF&CC or CPCB can approach them and develop the strategy.
- A set of performance standards needs to be developed for certification against which the CEMS will be tested. These performance standards are well established for decades in Europe and have been followed in many countries.

2. System for CEMS quality control and quality assurance

The CEMS device performance check is an important tool for quality control and quality assurance. The document suggests carrying performance check of indigenous CEMS device during installation at site. This would be a costly measure however can be used as temporary quality assurance and quality control system until the certification system is established. However, the provisions have been mentioned in the draft guideline document, it requires following to be clarified:

- CPCB should clarify what all tests need to be carried out for performance testing which can assure the quality of the device.
- CPCB has to identify and authorize the laboratories which are eligible to carry these performance tests.

3. Lab accreditation/empanelment system

The guideline documents require laboratories to carry performance tests, certification tests and calibration tasks for CEMS. This would require accreditation or empanelment of such laboratories. No efforts have been made in this direction so far. Setting up such a system is the immediate need of time.

- The MoEF&CC or CPCB should approach the competent agencies and develop strategy for developing such a system within six months. NABL appears to be most suitable organization for developing the CEMS certification system. It already follows the international standard- ISO/IEC 17025 for laboratory accreditation for testing and calibration. CEMS can be included in the scope of accreditation. However, NABL may require government's support to develop the additional infrastructure for this purpose. Other expert laboratories such as TUV Rheinland, TUV SUD etc. which have been successfully carrying this task in Europe and other countries for many decades can be approached. They have expertise and set-ups in India which can be upgraded for this purpose.

- The existing laboratories recognized by NABL and EPA, can be invited to build the required infrastructure and given opportunity for easy recognition or empanelment for CEMS tasks if they meet the criteria. They can be trained to carry these tasks.
- The laboratory accreditation system should be financially self-sustainable. A constitutional/legal set-up, group of experts for assessment and evaluation of laboratories, guidelines, protocols, standard operating procedure to be followed and roles & responsibilities of every stakeholders etc. need to be defined. The regulations/standards mandating tasks/tests for CEMS, similar to EN 14181 of Europe and for CEMS performance tests similar to USA, as mentioned under 40CFR part 75, need to be laid down. These can be customized as per the competency, suitability and need in India.

4. Finalization of draft guideline document and capacity building

The CPCB should hold stakeholders consultation and feedback to improve the guideline document. The implementation of the guideline will be next challenge. It would require CPCB to organize training sessions for regulators and industries.

D. Annexure 1

- **Technical corrections, Point 1**

  ✓ **Diagram for single and double pass opacity monitor**

  Transmissometers may be single-pass or double-pass design. Single pass design carries light source on one side of the duct and the detector on other side. Some modern single-pass designs use two identical senders and receivers on each side of the stack to transmit and receive alternatively in order to increase sensitivity and reduce the effects of fouling of the optical surfaces. Double-pass design incorporates both a light source and a detector on the transceiver side of the stack, and it provides a retroreflector on the opposite side.

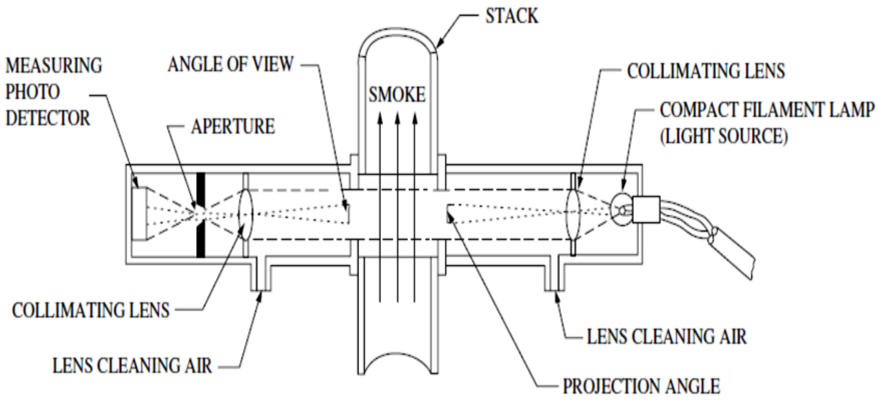


Figure1. Single pass transmissometer /opacity monitor

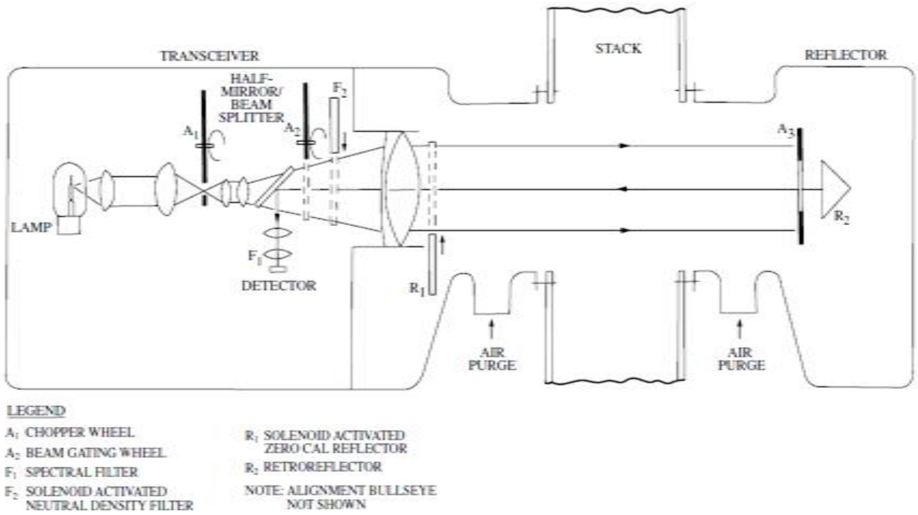


Figure 2. Double pass transmissometer /opacity monitor

  ✓ **Single beam and double beam principle-** Single-beam configuration is simplest where one light beam from source is passed to receiver. Dual or double-beam configurations internally split the light emitted from the source into two beams – one becomes measurement beam and another becomes reference beam. The measurement beam is projected through the optical medium of interest and is referenced to the second (reference) beam, which is totally contained within the instrument. There can be common or separate detectors for both the beam.

- **Technical corrections, Point 2**

Table. PM technology selection matrix

Measurement Technology		Stack Diameter (m)	Concentration (mg/m^3)		APC device	Minimum 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 Triboelectric	0.1 - 3	< 1	250	Bag, Cyclone	0 - 15mg/m3	√	x	x	Yes
	Triboelectric	0.1-3	< 1	250	Bag, Cyclone	qualitative bag leak	√	x	x	Yes
Transmissometry	Dynamic Opacity / Scintillation	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 (Forward)	1 - 3	< 0.1	300	Bag, ESP, None	0-15mg/m3	√	x	x	No
	Scattered Light (Back/Side)	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

- **Technical corrections, Point 3**

Table. Responsibilities of stakeholders

Application	Responsibilities	Responsible stakeholder
Suitability of equipment CEMS certification (QAL1)/ USEPA performance demonstration)	• Certification • Device selection • Performance evaluations process • Performance demonstration- cost • Performance demonstration approval	• Equipment Supplier • Industry • Industry • Equipment supplier • Regulator
Correct Installation, Calibration and functionality (QAL2)	• Correct installation • Setting up tamper proof data transfer system • Correct data supply	• CEMS Vendor • Data service provider • Industry
	• Tests - *Reference Tests, Calibration checks, Variability test, Uncertainty calculations etc.* • Test reports • Functionality checks	• Test Laboratory • Test laboratory • Equipment supplier
Stability performance QAL3	• Operation and maintenance of CEMS • Tests- Zero drift, Span drift	• Industry • industry
Continued calibration and functionality	• Same as QAL2 • Remote calibration	• As QAL2 • SPCB/PCC/CPCB
Inspection /Surveillance tests/ Review of data & reports, Compliance	• Correct data supply, reporting & compliance • Periodical/intermittent inspection/verification /Alerts/action • Data validation • Performance criteria setting	• Industry • SPCB/PCC/CPCB • SPCB/PCC • CPCB

- **Technical corrections, Point 4**

Table. Performance demonstration required by indigenous CEMS with COP

	Selection of CEM	Correct Installation as per	Stability before calibration	Valid calibration	Ongoing instrumental stability	Ongoing calibration stability
EU	QAL1 with appropriate certification range	EN15259	QAL3	Functional test and QAL2	QAL3 plus annual linearity	Functional test and annual surveillance tests (AST)
USA	None but legal onus on the operator to provide valid data	40 CFR part 75, Appendix	7-day drift test	Correlation tests over 3 days	Zero and Span plus quarterly linearity test	Annual correlation test and Relative Accuracy Test Audits (RATA) for gases and Relative Response Assessment (RRA) for particulate

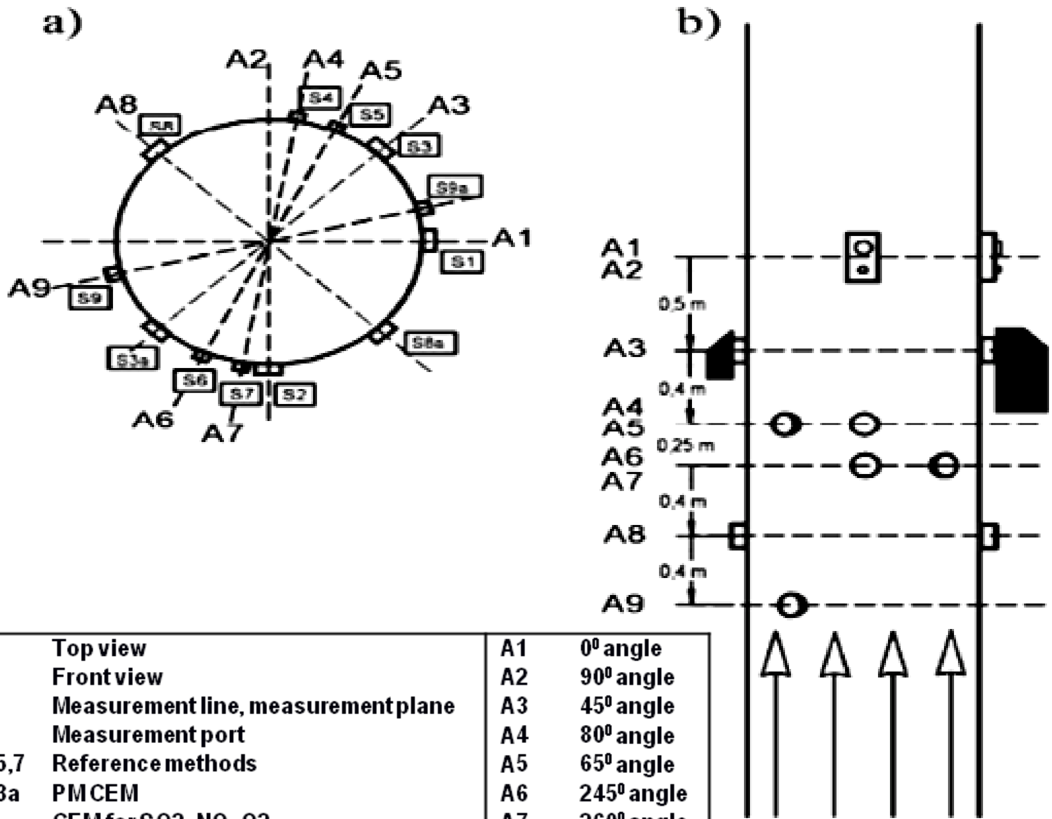
Table 5. Standard Reference Methods for CEMS

Pollutants	Reference method	Reference standard
Low range dust	Manually, plane filter	DIN EN 13284-1
Sulphur oxides	Manually, H2O2- absolute	DIN EN 14791
Nitrogen Oxides	Cont. (Chemiluminescence	DIN EN 14792
Carbon Monoxide	Cont. NDIR	DIN EN 15058

Chlorides, HCl	Manually, H2O- absolute	DIN EN 1911
Total Organic Carbon	Cont. (Flame ionization detector)	DIN EN 12619
Total Mercury	Manually, Oxid acids- absolute	DINE EN 13211
Fluorine compounds	Manually, H2O/NaOH- absolute	VDI 2470
Ammonium compounds	Manually, Saure- Absolute	preVDI 3878
Oxygen	Cont. (Paramagenetism)	DIN EN 14789
Water vapour	Manually, SiO2- Ads/Kondens	DIN EN 14790
Volume flow	Differential pressure, Anemometer, Calculation	DIN EN16911-1

- ## Technical corrections, Point 5

Diagrammatic representation of mounting CEMS in stack



a	Top view	A1	0^0 angle
b	Front view	A2	90^0 angle
A	Measurement line, measurement plane	A3	45^0 angle
S	Measurement port	A4	80^0 angle
S1,2,5,7	Reference methods	A5	65^0 angle
S3, S3a	PM CEM	A6	245^0 angle
S4	CEM for SO2, NO, O2	A7	260^0 angle
S6	CEM for HCl, total Carbon, water vapour	A8	135^0 angle
S8,S8a	Volume flow meter	A9	195^0 angle
S9	Temperature monitor		
S9a	Pressure monitor		

- ## Technical corrections, Point 12

Table. Flow analysers specification

Zero drift	<4%
Span drift	<4%
Linearity	<2% of full scale
Performance accuracy	≤ ± 10 % of compared Reference measurement