

# Continuous Emission Monitoring System (CEMS)

WHEN YOU NEED TO BE SURE



## Law and Regulation

- **Notification of Ministry of Science, Technology and Environment B.E. 2535**

**EIA Projects : Perform RATA Twice a Year**

- **Notification of Ministry of Industry B.E. 2545**

**All Industry Projects in Eastern Seaboard Area :  
Perform the accuracy of CEMS data according to US.  
EPA. Regulation and Send to DIW's data Center**

## Why to conduct PS test ?

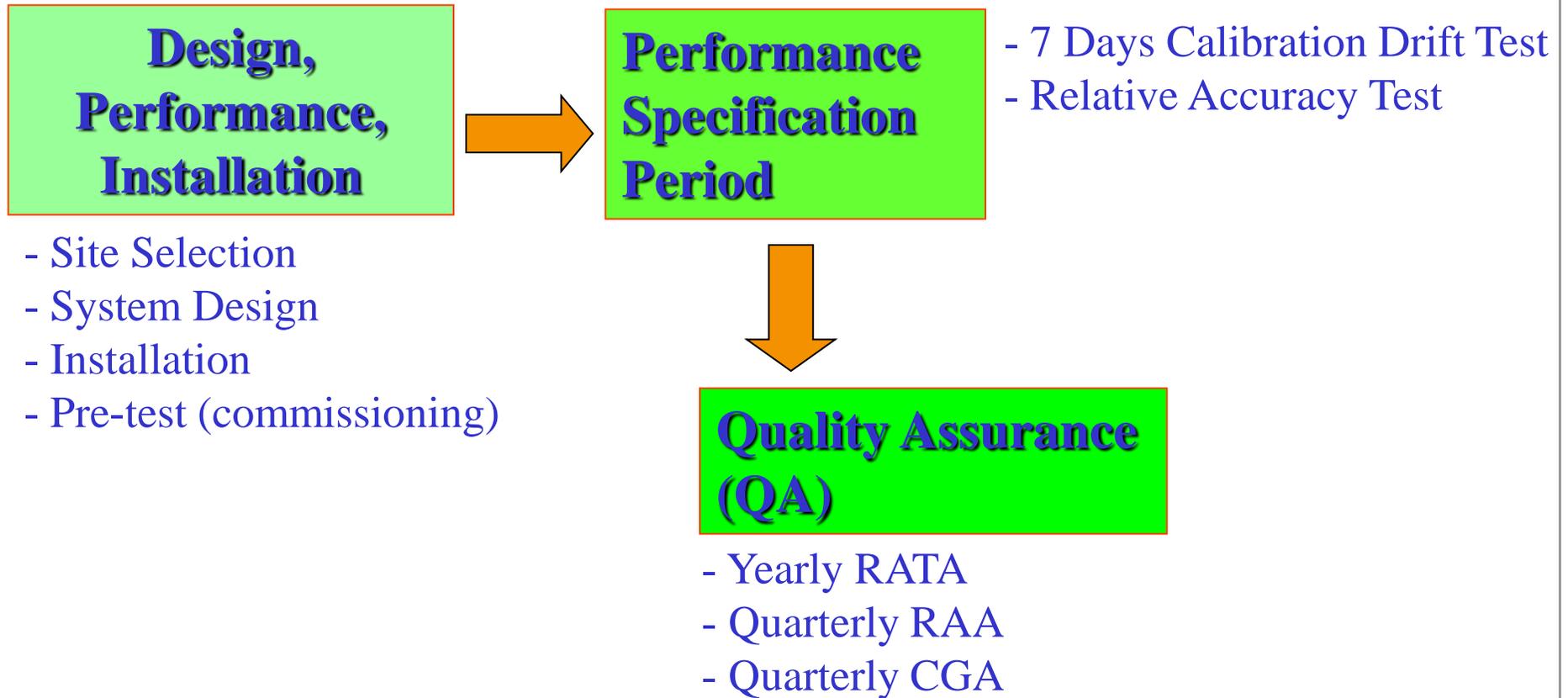
- To Verify The Accuracy & Precision of System and Data before Acceptance The Measurement Equipment / Systems
- Laws Enforcement
- Regulation Requirement from Parent / Global Company

# Continuous Emission Monitoring System (CEMS)

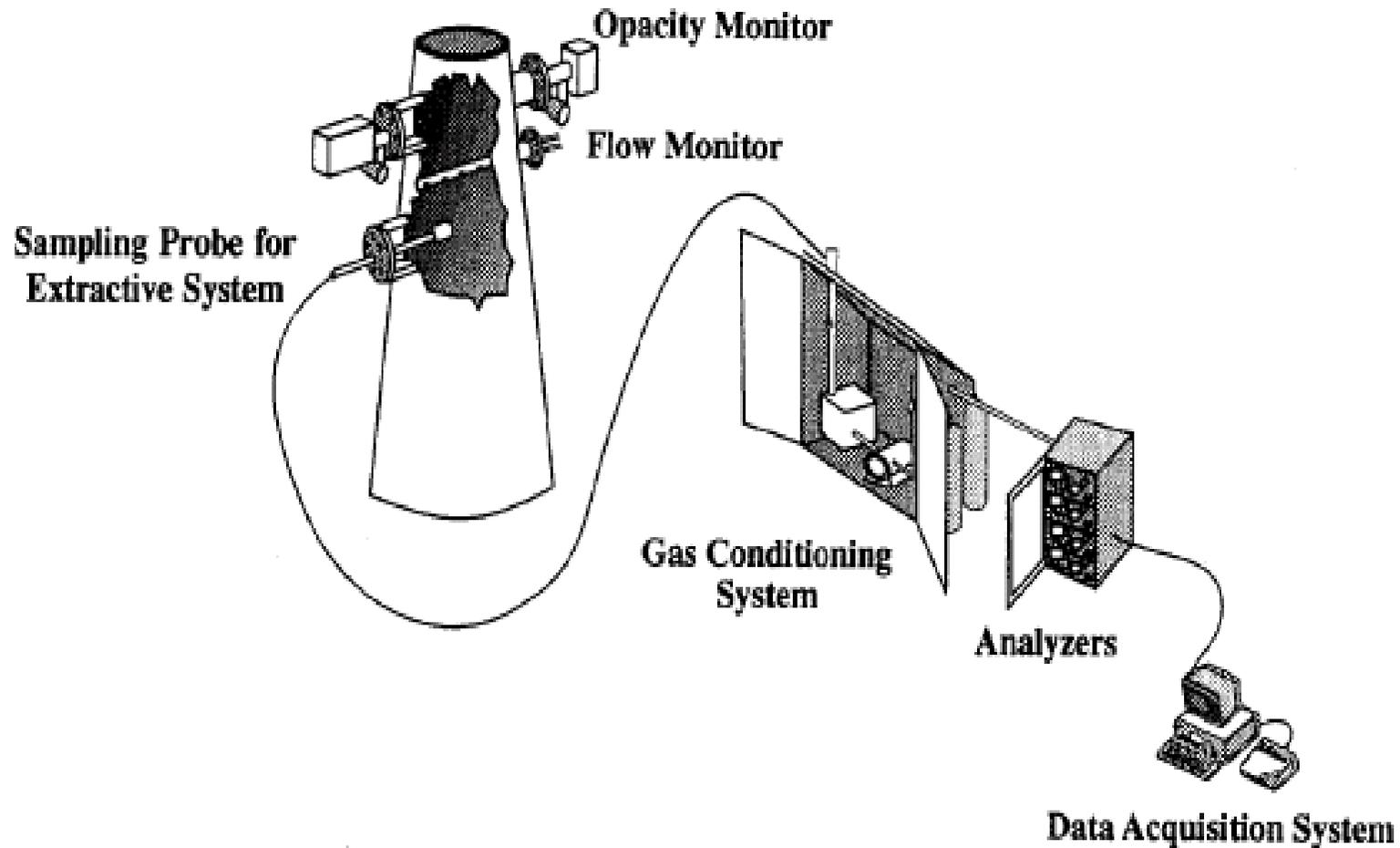
**Performance Specification Test (PST)**

40 CFR part 60

## Performance Specification Test (PST) Procedure for CEMS



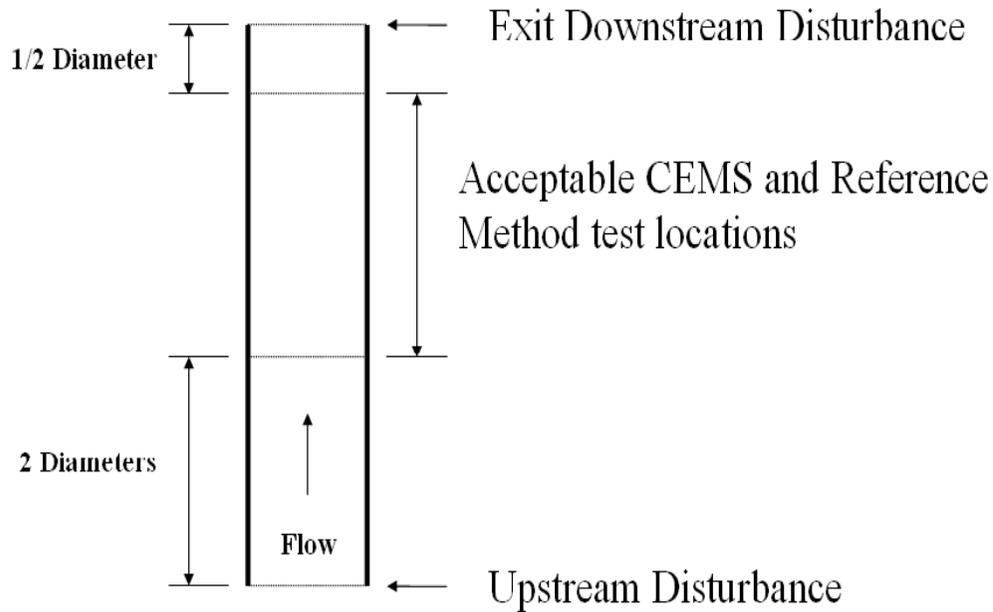
## Performance Specification Test (PST) Procedure for CEMS



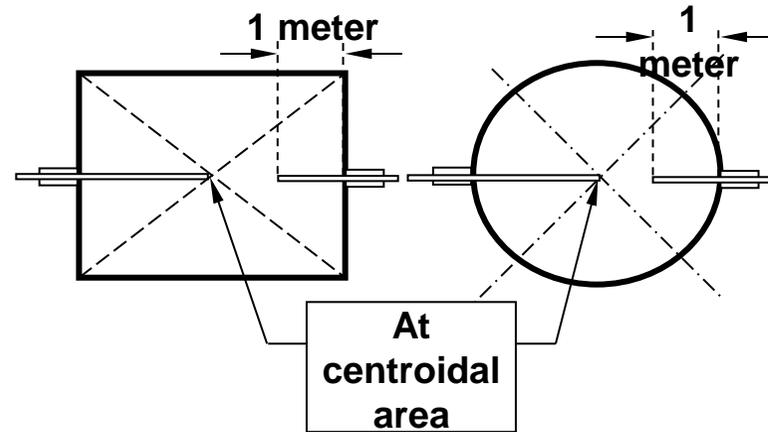
■ **Data logger scale** : The CEMs data recorder output range must include zero and high-level value. The high-level value is chosen by the source owner or operator and is defined as follows:

1. For the CEMs intended measure an uncontrolled emission (e.g. SO<sub>2</sub> measurement at the inlet of a flue gas desulfurization unit), the high-level value should be between 1.25 and 2 times of maximum potential emission level over the appropriate averaging time.
2. For the CEMs installed to measure controlled emissions or emissions that are in the compliance with an applicable regulation, the high-level value between 1.5 times the pollutant concentration corresponding to the emission standard level and the span value given in the applicable regulations is adequate.
3. Alternative high-level values may be used, provided the source can measure emissions which exceed the full-scale limit in accordance with the requirements of applicable regulation.

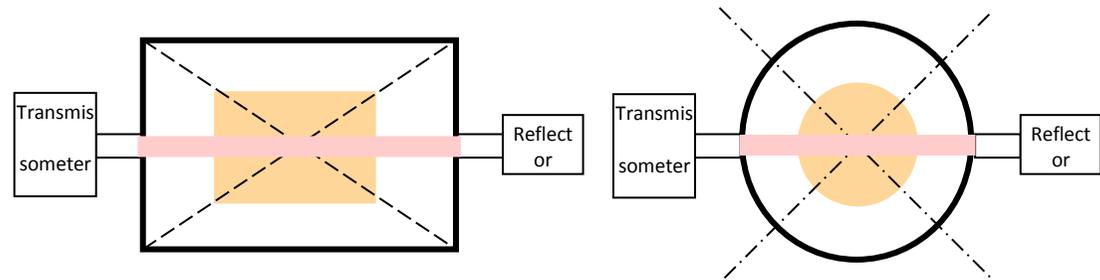
## Designation & Installation



### Point Installation



### Path Installation



### Suggestion Sampling Area



## ■ Calibration Drift Test ( CD Test )

**What is CD Test?** : The CD is the difference in the CEMS measurement values from a reference value after a period of operation during with no un-scheduled maintenance, repair, or adjustment took place.

**Purpose** : The CD Test is verification procedure to inform the ability of the CEMS to conform to the established CEMS calibration used for determining the emission concentration or emission rate within no need to maintenance, repair or adjustment took place with minimum period 168 hrs (7 consecutive days).

**Duration** : CD test is determined once each day (at 24-hour interval) for 7 Consecutive Days, at the Zero and High-level (50 – 100% of full scale) values.

**Operation Condition** : more than 50% of normal operation load.

**Responsibilities** : Plant Owner, CEMS Distributor, or Third Party

■ **Calibration Gas** : Calibration Gas cylinders are used for zero and span calibration and/or linearity check. They have 2 level of calibration gas cylinder as

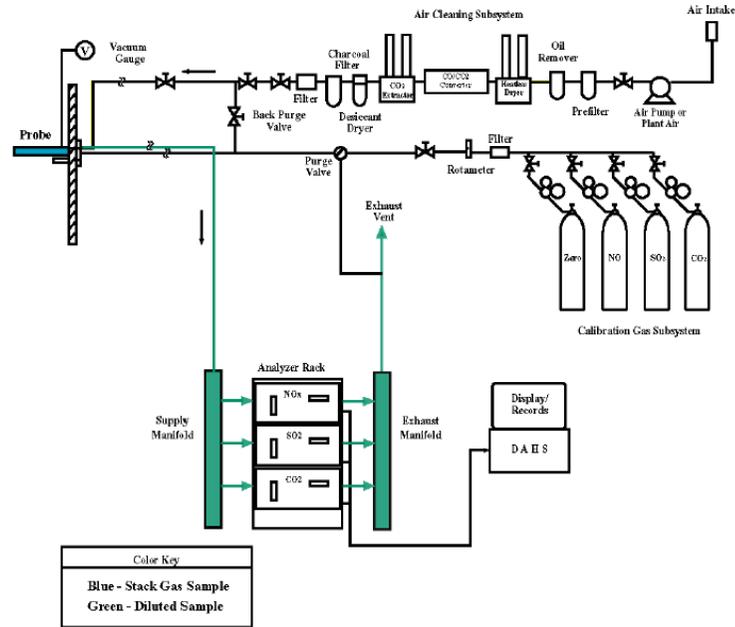
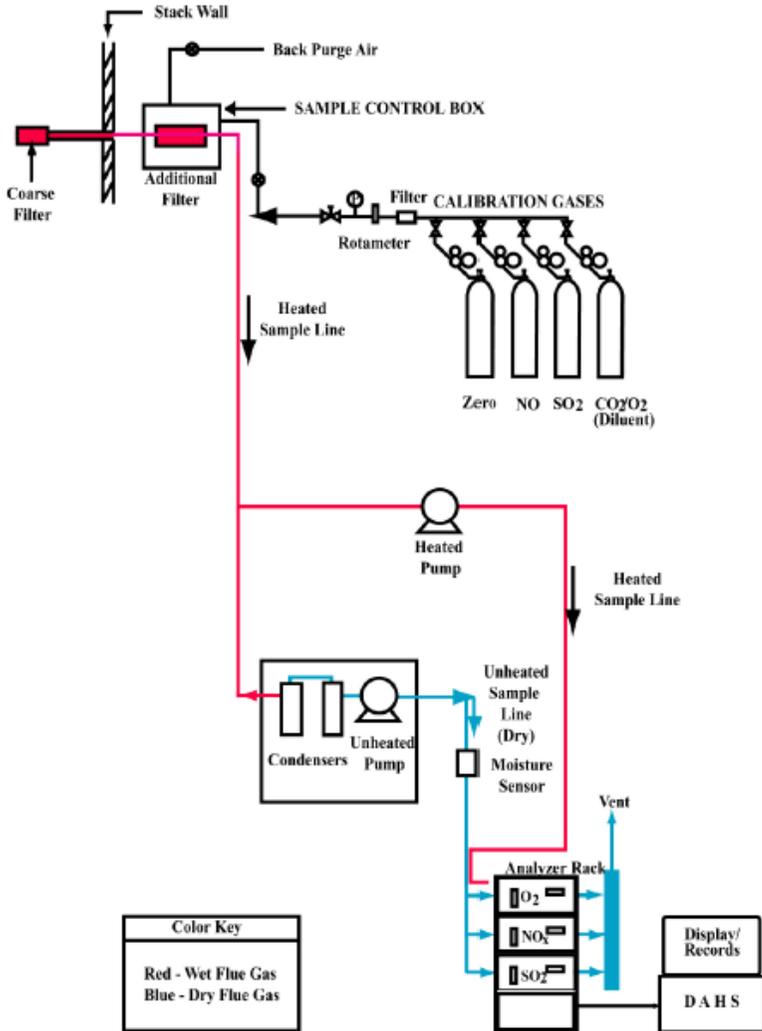
1) **Zero level gas** : Zero Air material have an effective concentration of 0.0 % of the component being zeroed ( $\text{SO}_2$ , NO, Total Hydrocarbon  $\leq 0.1$  ppm, CO  $\leq 1$  ppm and  $\text{CO}_2 \leq 400$  ppm), and is free of certain other interfering gaseous species. **and**

**2) High level gas (span gas) :** the single or mixing gaseous in gas cylinder that are separated within

Calibration Gas type	Acronym	Description
NIST-Standard Reference Material	SRM	Calibration gas obtained from the National Institute of Standard Technology
NIST-Standard Reference Material-equivalent compressed Primary Reference Material	PRM	Gas Mixtures listed in declaration of according in equivalent with section 2.1.2 of the “EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards,” September 1997, EPA-600/R-97/121 (EPA Traceability Protocol)
NIST-traceable Reference Material	NTRM	Calibration gas mixture tested and certified by NIST to have the certain specified concentration of gases
NIST/EPA-approved certified reference materials	CRM	Calibration gas mixture that has been approved by EPA and NIST as having specific known chemical or physical property values, certified by a technically valid procedure as evidenced by a certificate or other documentation issued by a certifying standard-setting body
Gas Manufacturer’s Intermediated Standard	GMIS	Compressed gas calibration standard that has been assayed and certified by direct comparison to an SRM, SRM-equivalent PRM, a CRM or NTRM, in accordance with section 2.1.2.1 of EPA Traceability Protocol
EPA protocol gas	-	Vendor-certified within 2.0 percent of the concentration specified on the cylinder label (tag values), used the uncertainty calculation procedure section 2.1.8 of the EPA Traceability Protocol

Source : 40 CFR 60 Appendix B

## Calibration Drift Test



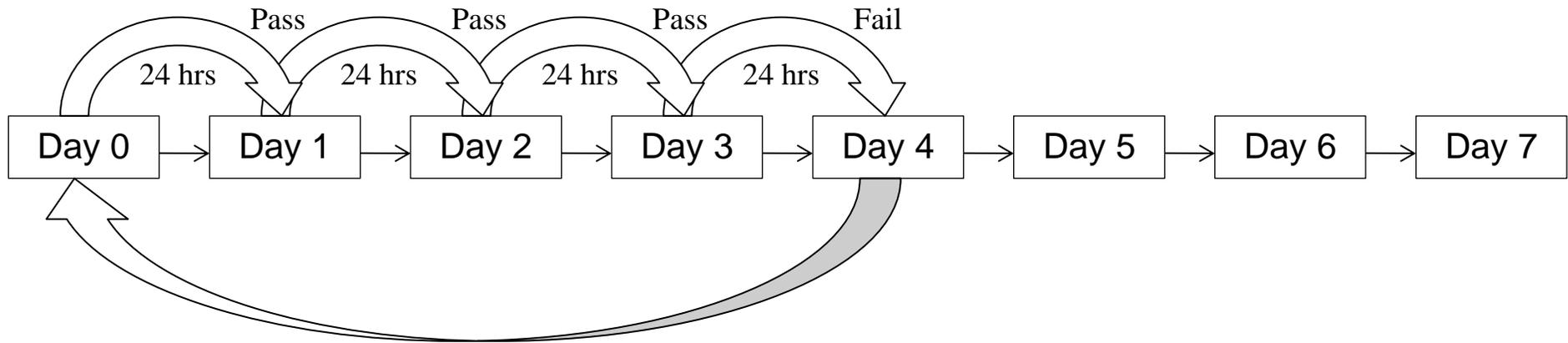
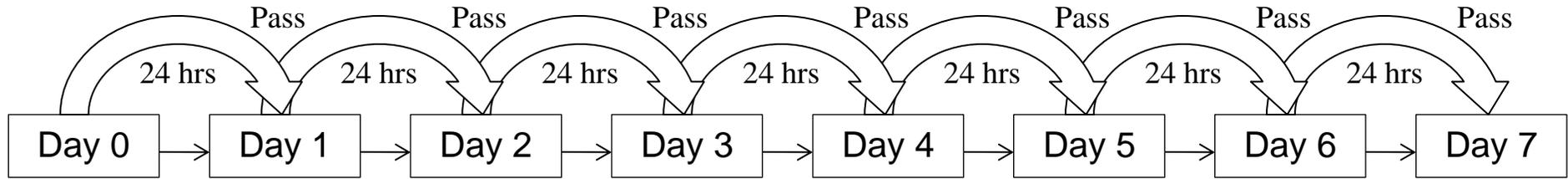
### Calibration Drift Formula:

$$A = \left( \frac{C_s - C_m}{Span} \right) \times 100$$

### When

- A** = Accuracy of the CEMS, percent
- C<sub>s</sub>** = Average audit value of applicable standard or appropriate concentration
- C<sub>m</sub>** = Average CEMS response in unit of applicable standard or appropriate concentration

## Calibration Drift Test





## Performance Specification Criteria for Calibration Drift Test

Parameter	Performance Specification	CD Test Criteria
Sulfur Dioxide (SO <sub>2</sub> )	PS-2	± 2.5 % of span
Nitrogen Oxide (NO)	PS-2	± 2.5 % of span
Nitrogen Dioxide (NO <sub>2</sub> )	PS-2	± 2.5 % of span
Oxygen (O <sub>2</sub> )	PS-3	± 0.5 % by vol.
Carbon Dioxide (CO <sub>2</sub> )	PS-3	± 0.5 % by vol.
Carbon Monoxide (CO)	PS-4	± 5.0 % of span
Total Reduce Sulfur (TRS)	PS-5	± 5.0 % of span
Emission Rate (Flow Rate)	PS-6	± 3.0 % of span
Hydrogen Sulfide (H <sub>2</sub> S)	PS-7	± 5.0 % of span
Volatile Organic Compounds (VOCs)	PS-8	± 2.5 % of span
Total Hydrocarbon (THC)	PS-8a	± 3.0 % of span

Source : 40 CFR 60 Appendix B

## ■ Relative Accuracy ( RA )

**What is RA?** The RA is basically the absolute mean difference between the gas concentration by the CEMS and the value determined by Reference Method (RM), plus the 2.5 percent error confidence coefficient of a series of tests, divide by the mean of RM tests or the applicable of emission limit.

**What's RM?** The RM means the measurement results of stack emission which be conducted by Promulgated Method for Determination of Air Emission from Stationary Sources according to 40 CFR 60 Appendix A, US. EPA. Regulation.

**Duration :** The RA test may be conducted after during the 7-days CD Test period. Testing Period for RA test are 6-8 hrs (need 12 sample data, by 1 sample data is collected with in 30 minutes).

**Operation Condition :** more than 50% of normal operation load.

**Responsibilities :** Third Party



# Performance Test Procedure

## SGS's Reference Method

Parameter	40 CFR 60 Appendix A	
	Method No.	Method Principle
Sulfur Dioxide (SO <sub>2</sub> )	6C	UV Fluorescent
Nitrogen Oxide (NO)	7E	Chemiluminescent
Nitrogen Dioxide (NO <sub>2</sub> )	7E	Chemiluminescent
Oxygen (O <sub>2</sub> )	3B	Paramagnetic
Carbon Dioxide (CO <sub>2</sub> )	10	Non-Dispersive Infrared
Carbon Monoxide (CO)	10	Non-Dispersive Infrared
Emission Rate (Flow Rate)	2	S-type Pitot tube
Hydrogen Sulfide (H <sub>2</sub> S)	11	Titration
Total Hydrocarbon (THC)	25	Flame Ionization Detector



## Relative Accuracy Test

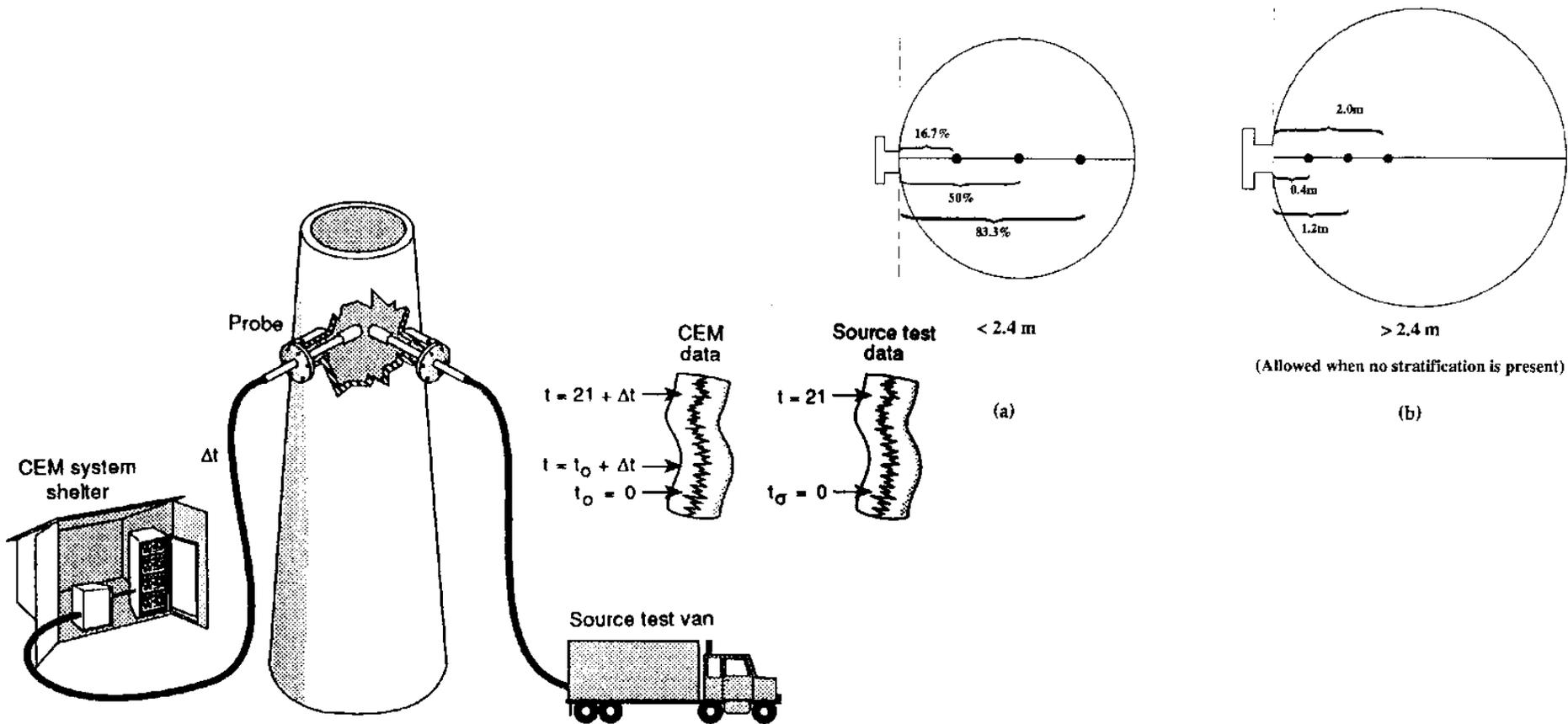


FIGURE 9-5. Correlation of reference method data and CEM data in response time.

## Relative Accuracy Test

## Other requirement & description

- ❑ Operating of process at more than 50% of normal load
- ❑ RM Test (Reference Method) means the other sampling system that according with 40 CFR 60 Appendix A (e.g. method 3A, 6C, 7E or 10 etc.)
- ❑ Three traverses sampling must be conducted at 0.4, 1.2, 2.0 meter from stack or duct wall (inside wall) when stack or duct diameter longer than 2.4 m. (normal must be conducted at 16.7%, 50% and 83.3% of Measurement Line)
- ❑ The sampling time for each RM is about 21-30 min/Run
- ❑ Minimum of 9 sets of all necessary RM Test runs
- ❑ The relative difference between the mean of the RM values and the mean of the CEMS responses will be used to assess the accuracy of the CEMS

# Performance Specification Criteria

Parameter	Performance Specification	RA Test Criteria
Sulfur Dioxide (SO <sub>2</sub> )	PS-2	± 20 % of RM
Nitrogen Oxide (NO)	PS-2	± 20 % of RM
Nitrogen Dioxide (NO <sub>2</sub> )	PS-2	± 20 % of RM
Oxygen (O <sub>2</sub> )	PS-3	± 1.0 % by vol. of RM
Carbon Dioxide (CO <sub>2</sub> )	PS-3	± 1.0 % by vol. of RM
Carbon Monoxide (CO)	PS-4	± 10 % of RM
Total Reduce Sulfur (TRS)	PS-5	± 20 % of RM
Emission Rate (Flow Rate)	PS-6	± 20 % of RM
Hydrogen Sulfide (H <sub>2</sub> S)	PS-7	± 20 % of RM
Volatile Organic Compounds (VOCs)	PS-8	± 20 % of RM
Total Hydrocarbon (THC)	PS-8a	± 20 % of RM

**Source :** 40 CFR 60 Appendix B

## Measurement Equipment

### Gas Analyzer for CEMS Audit



CEMS Mobile Station



**Wind Tunnel**



**Wet Test Meter**



**Standard Pitot Tube**



**Source Simulator**



**Bios Flow Cal.**

# Continuous Emission Monitoring System (CEMS)

**Quality Assurance & Quality Control Requirement**

40 CFR part 60 Appendix F

## Quality Assurance & Quality Control Procedure

### Calibration

- Zero & high-level calibration
- Frequency (1/month or Manufacturing recommend)

### Maintenance & Repair

- Preventive Maintenance
- Un-schedule repair

### Auditing Program

CGA

OR

RAA

RATA

- Calibration Drift Check
- RATA

QA & QC Report

## ■ Cylinder Gas Audit (CGA)

**What is CGA?** : The CGA is the difference in the CEMS output reading from a reference value after a period of operation during with no un-scheduled maintenance, repair, or adjustment took place.

**Performance** : challenge the CEMS three times at each audit point, and used the average of the three responses in determining accuracy.

**Frequency** : may be conducted in three of four calendar quarters.

**Standard Reference** : Certified gases by National Bureau of Standards (NBS) gaseous Standard Reference Materials (SRM's) or NBS/EPA approved gas manufacturer's Certified Reference Materials (CRM's) follow EPA Traceability Protocol No. 1.

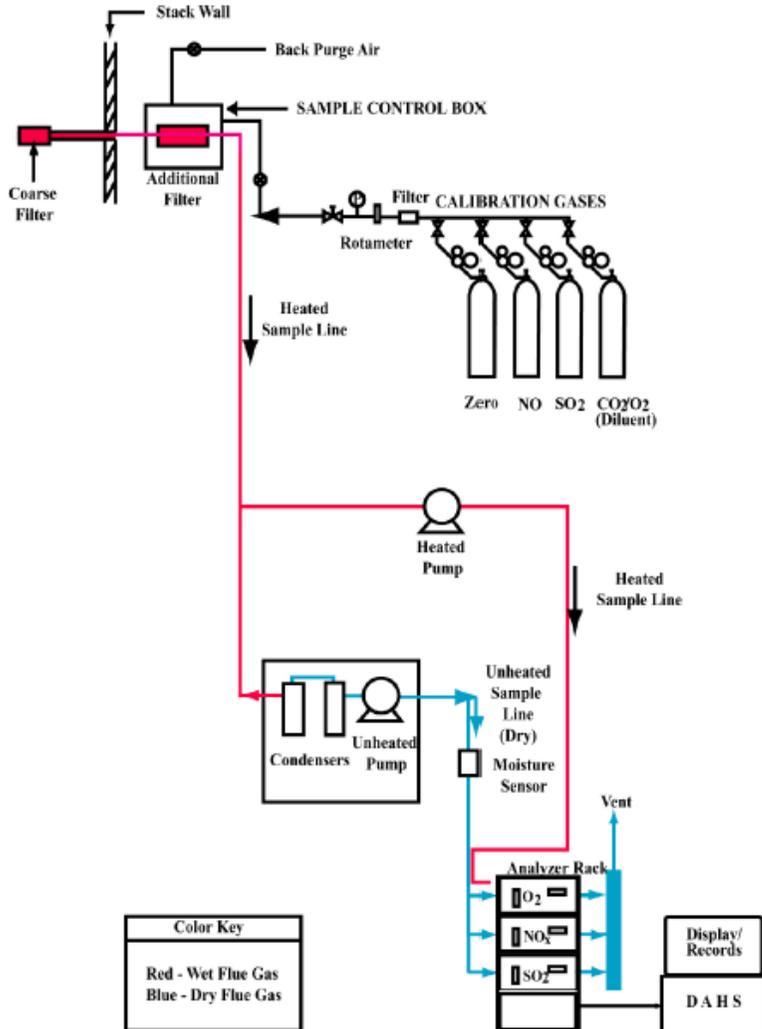
**Operation Condition** : normal operation load.

**Responsibilities** : Plant Owner, CEMS Distributor, or Third Party

**Remarks** : Do not dilute gas from audit cylinder when challenging the CEMS.



## Cylinder Gas Audit (CGA)



### Calibration Drift Formula:

$$A = \left( \frac{C_s - C_m}{Span} \right) \times 100$$

### When

- A** = Accuracy of the CEMS, percent
- C<sub>s</sub>** = Average audit value of applicable standard or appropriate concentration
- C<sub>m</sub>** = Average CEMS response in unit of applicable standard or appropriate concentration

## Audit Gas for Cylinder Gas Audit

Audit point	Audit range		
	Pollutant monitors	Diluent monitors for—	
		CO <sub>2</sub>	O <sub>2</sub>
1 .....	20 to 30% of span value.	5 to 8% by volume.	4 to 6% by volume.
2 .....	50 to 60% of span value.	10 to 14% by volume.	8 to 12% by volume.

## Cylinder Gas Audit Formula:

$$A = \left( \frac{C_a - C_m}{C_a} \right) \times 100$$

### When

**A** = Accuracy of the CEMS, percent.

**C<sub>a</sub>** = Average audit value (CGA certified value or three-run average for RAA) in units of applicable standard or appropriate concentration.

**C<sub>m</sub>** = Average CEMS response during audit in units of applicable standard or appropriate concentration.

## Cylinder Gas Audit Criteria:

For the CGA,

- ± 15 % of the average audit value or
- ± 5 ppm, whichever is greater.

## ■ Relative Accuracy Audit (RAA)

**What is RAA?** : The RAA is the difference between the gas concentration by the CEMS and the value determined by Reference Method (RM).

**Performance** : collected for only 3 set of measurement data of the CEMS and the Reference Method.

**Frequency** : may be conducted in three of four calendar quarters, but in no more than three quarters in succession.

**Standard Reference** : Reference Method that described in the applicable Performance Specification Test procedure, 40 CFR 60 Appendix B for the relative accuracy test.

**Operation Condition** : > 50 % normal operation load.

**Responsibilities** : Plant Owner, CEMS Distributor, or Third Party

### Relative Accuracy Audit Formula:

$$A = \left( \frac{C_a - C_m}{C_a} \right) \times 100$$

### When

- A** = Accuracy of the CEMS, percent.
- C<sub>a</sub>** = Average audit value (CGA certified value or three-run average for RAA) in units of applicable standard or appropriate concentration.
- C<sub>m</sub>** = Average CEMS response during audit in units of applicable standard or appropriate concentration.

### Relative Accuracy Audit Criteria:

- For the RAA,
1.  $\pm 15\%$  of the average audit value or
  2.  $\pm 7.5\%$  of the applicable standard, whichever is greater.

## ■ Relative Accuracy Test Audit (RATA)

**What is RATA?** : The RATA is the difference between the gas concentration by the CEMS and the value determined by Reference Method (RM).

**Performance** : collected for 12 set of measurement data of the CEMS and the Reference Method.

**Frequency** : must be conducted at least once every four calendar quarters.

**Standard Reference** : Reference Method that described in the applicable Performance Specification Test procedure, 40 CFR 60 Appendix B for the relative accuracy test.

**Operation Condition** : > 50 % normal operation load.

**Responsibilities** : Plant Owner, CEMS Distributor, or Third Party



## Quality Control and Assurance

### SGS's Reference Method in CEMS mobile

Parameter	40 CFR 60 Appendix A	
	Method No.	Method Principle
Sulfur Dioxide (SO <sub>2</sub> )	6C	UV Fluorescent
Nitrogen Oxide (NO)	7E	Chemiluminescent
Nitrogen Dioxide (NO <sub>2</sub> )	7E	Chemiluminescent
Oxygen (O <sub>2</sub> )	3B	Paramagnetic
Carbon Dioxide (CO <sub>2</sub> )	10	Non-Dispersive Infrared
Carbon Monoxide (CO)	10	Non-Dispersive Infrared
Total Reduce Sulfur (TRS)	15A	Titration
Emission Rate (Flow Rate)	2	S-type Pitot tube
Hydrogen Sulfide (H <sub>2</sub> S)	11	Titration
Total Hydrocarbon (THC)	25	Flame Ionization Detector

### Other requirement & description

- ❑ Operating of process at more than 50% of normal load
- ❑ RM Test (Reference Method) means the other sampling system that according with 40 CFR 60 Appendix A (e.g. method 3A, 6C, 7E or 10 etc.)
- ❑ Three traverses sampling must be conducted at 0.4, 1.2, 2.0 meter from stack or duct wall (inside wall) when stack or duct diameter longer than 2.4 m. (normal must be conducted at 16.7%, 50% and 83.3% of Measurement Line)
- ❑ The sampling time for each RM is about 21-30 min/Run
- ❑ Minimum of 9 sets of all necessary RM Test runs
- ❑ The relative difference between the mean of the RM values and the mean of the CEMS responses will be used to assess the accuracy of the CEMS

# Quality Control and Assurance

Parameter	Performance Specification	RATA Criteria
Sulfur Dioxide (SO <sub>2</sub> )	PS-2	± 20 % of RM
Nitrogen Oxide (NO)	PS-2	± 20 % of RM
Nitrogen Dioxide (NO <sub>2</sub> )	PS-2	± 20 % of RM
Oxygen (O <sub>2</sub> )	PS-3	± 1.0 % by vol. of RM
Carbon Dioxide (CO <sub>2</sub> )	PS-3	± 1.0 % by vol. of RM
Carbon Monoxide (CO)	PS-4	± 10 % of RM
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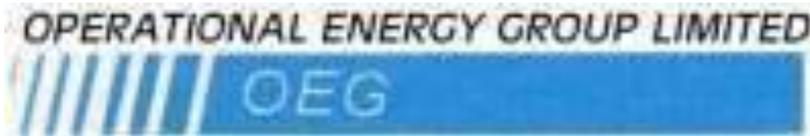
**Source : 40 CFR 60 Appendix B**



SITHIPORN  
associates



Sri Lanka



ADVANCE AGRO

