

# CEMS Training

## Presented by ALL4 for



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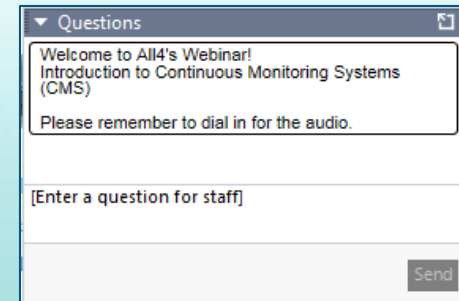
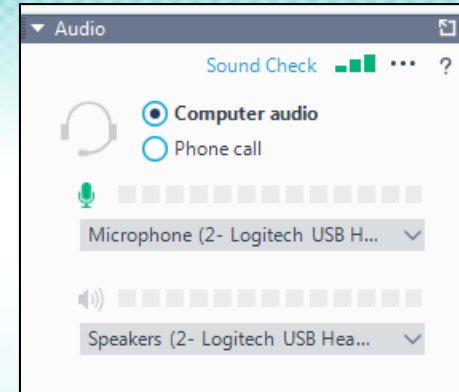
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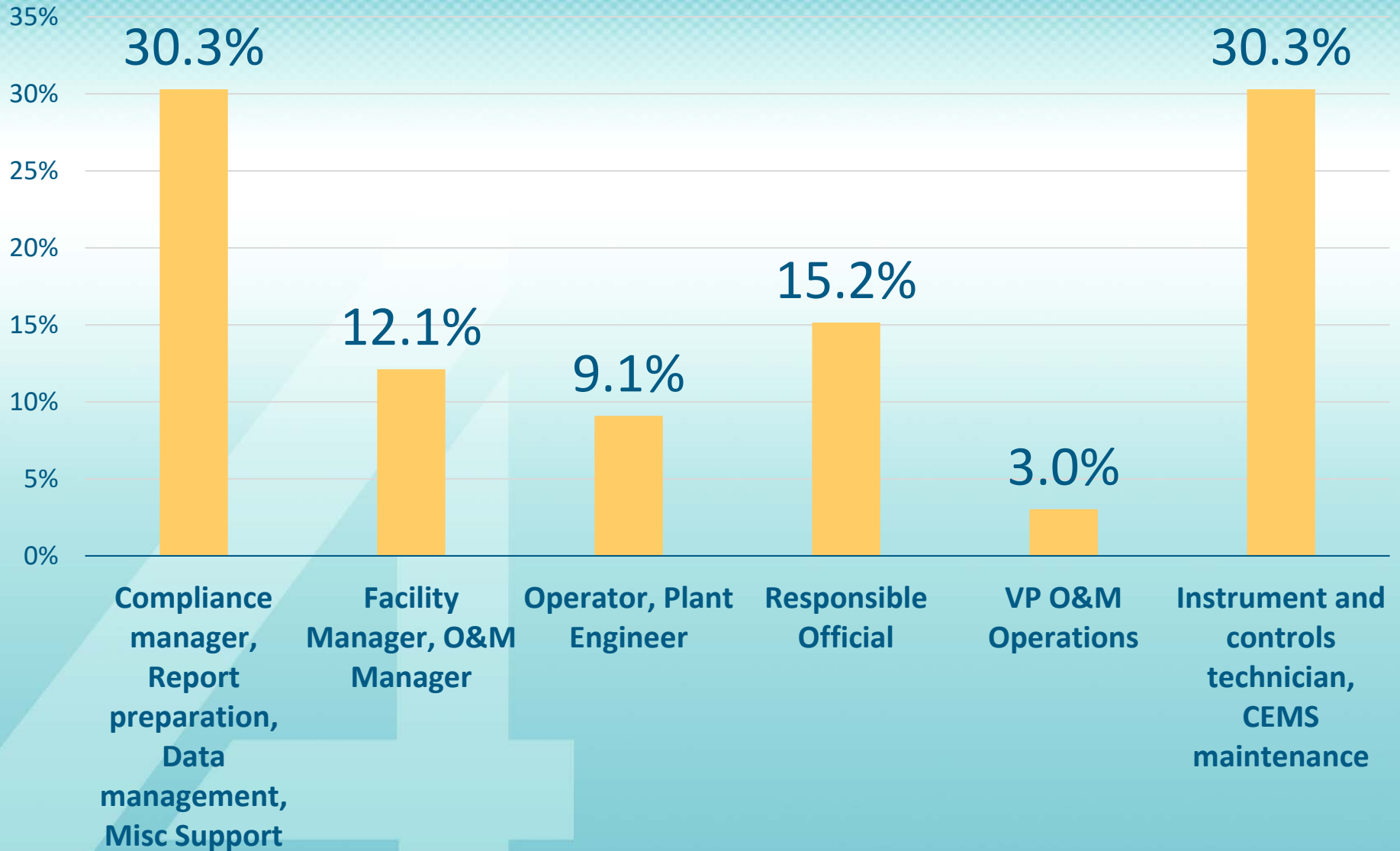


# Using GoToWebinar

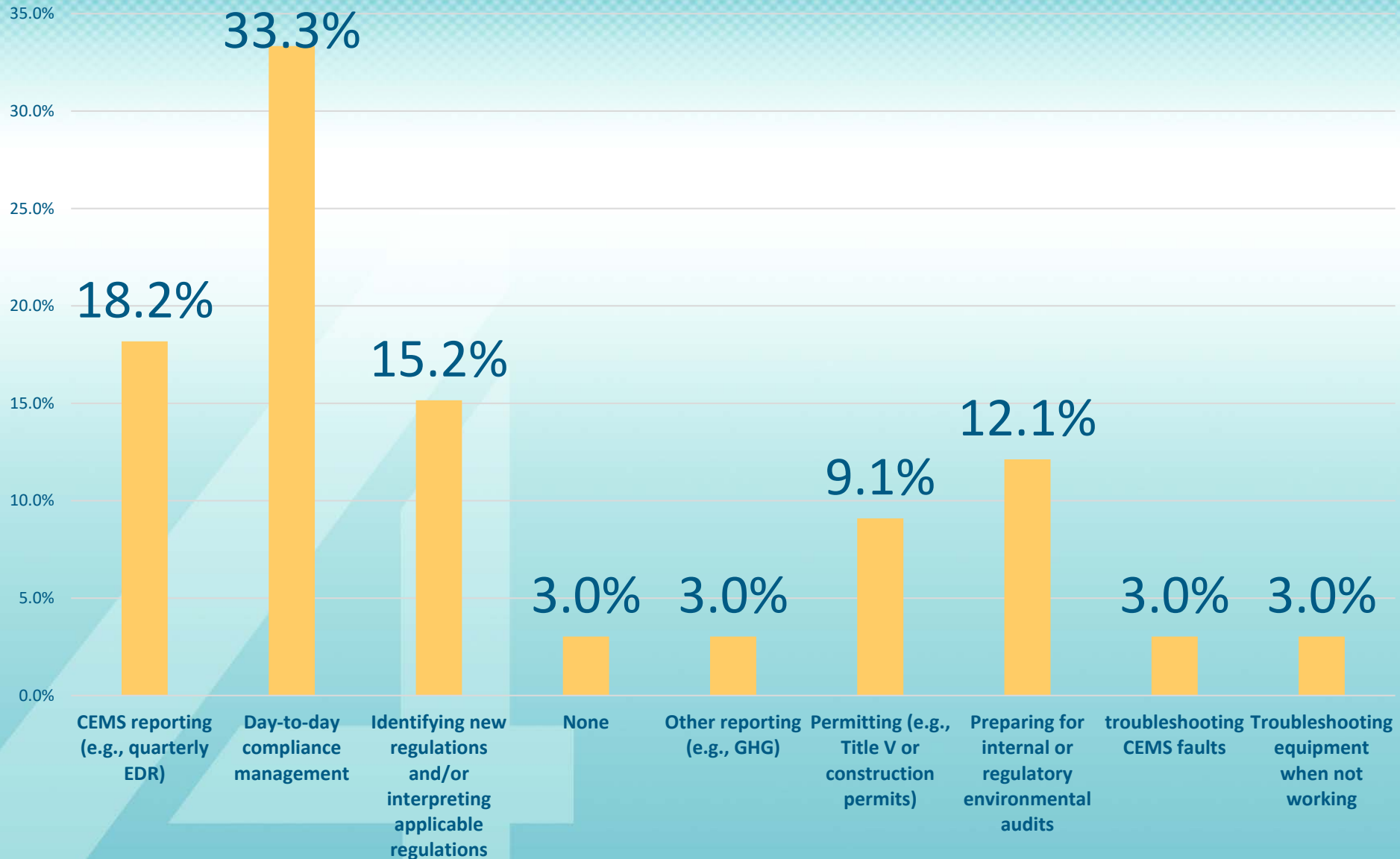
- ❑ Use computer audio or dial-in
- ❑ Use chat box for technical difficulties
- ❑ Use questions box for questions about the training
- ❑ Click the red arrow to expand the control panel



# What is your role?



# What is your biggest challenge?













Your environmental compliance is *clearly* our business.

# Agenda

- ❑ Overview
- ❑ Successful CMS Program
- ❑ Whys & Hows Monitoring
- ❑ CMS Data Flow
- ❑ Audit Tools

# Training Key

SYM	Designation	SYM	Designation
	United States of America	<b>P60</b>	40 CFR Part 60 Appendix B & F
  	<b>High (Upscale)</b>	 <b>P75</b>	80 to 100% of Span
			80 to 100% of Full Scale
		 <b>P60</b>	50 to 100% of Span
			40 to 100% of Range
			80% to 90% of Range
	New Jersey	<b>1005</b>	Air Quality Permitting Program Bureau of Technical Services – Technical Manual #1005 (June 2010)

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# Training Key

SYM	Designation
<b>NO<sub>x</sub></b>	Nitrogen Oxides

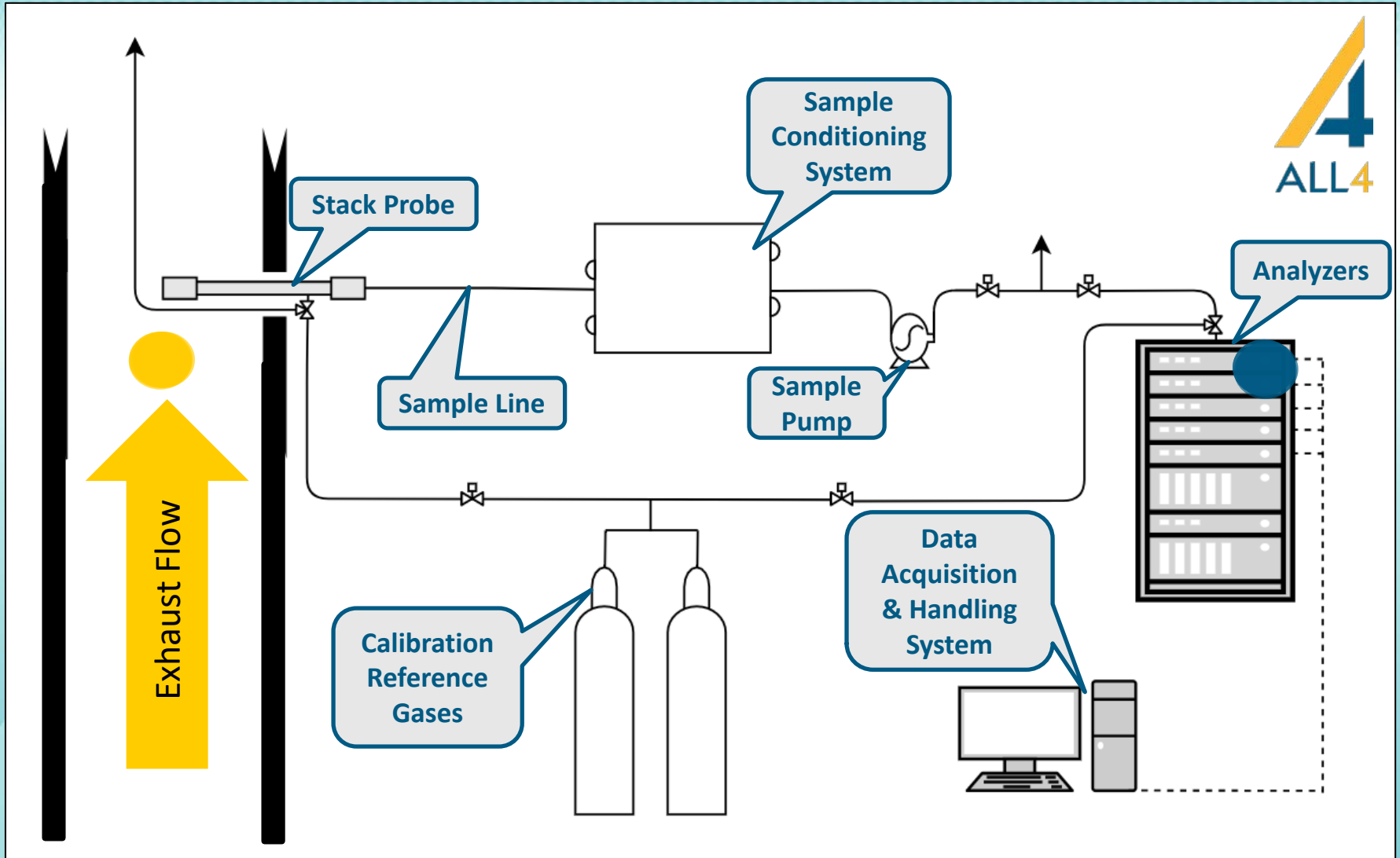
- Quality Assurance Activities
  - Annual Review **BP**

<b>FFM</b>	Fuel Flow Monitor
<b>BP</b>	Best Practice(s)

**Let's Get Started...**



# CEMS Diagram



# Poll Question #1

Which of the following analyzer components are needed to demonstrate compliance with a  $\text{NO}_x$  ppmvd @ 15%  $\text{O}_2$  emission standard? Select all that apply.

- a)  $\text{O}_2$
- b)  $\text{NO}_x$
- c) Fuel Flow
- d) CO
- e) Moisture

# Poll Question #1 – Answer

Which of the following analyzer components are needed to demonstrate compliance with a  $\text{NO}_x$  ppmvd @ 15%  $\text{O}_2$  emission standard? Select all that apply.

- a)  $\text{O}_2$
- b)  $\text{NO}_x$
- c) Fuel Flow
- d) CO
- e) Moisture

# Components vs. Systems

- ❑ Continuous emissions monitoring systems (CEMS)
  - ❑ The total equipment used to sample, condition (if applicable), analyze, calculate, and provide a record of the operating limit emissions in terms of the emissions standard.
  - ❑ CEMS are comprised of multiple components!



**Let's take a step back...**



# Why are CEMS important?

- Regulatory and legal obligation to maintain a successful program that uses data collected from CEMS for demonstrating compliance with applicable local, state, and/or Federal requirements.



# Goal of CMS Program

- The ultimate goal of a successful CMS program is to allow the Certifying Official to confidently sign the following statement as it relates to CMS data used for compliance purposes:
  - “I certify, based on information and belief formed after reasonable inquiry, that the statements and information in this report are true, accurate, and complete.”

# Successful CMS Program

- Systems, Processes, Procedures, People
  - Compliance Demonstration
  - Feedback
  - Report Generation
  - Reasonable Inquiry
  - External Scrutiny
  - Roles and Responsibilities

# “The Village”



## Environmental:

- Whys and Hows for the CEMS Monitoring
- Recordkeeping/Reporting
- Oversight
  - Processes
  - Procedures
  - Resources

## Owners:

- Reviews & Signs the Report
- Attests
  - “Reasonable Inquiry”
  - True
  - Accurate
  - Complete

## Instrumentation:

- Day-to-day operation and quality assurance of CEMS data
- Execute CEMS QA/QC Plan
- Implementing maintenance programs
- Maintaining records of corrective/preventative actions associated with invalid CMS data

## Operation:

- Operate source in compliance with emissions standards
- Verifying “reasonability” of CEMS data
- Responding to excursions
- Maintaining records of corrective/preventative actions associated with invalid data



# Poll Question #2

Do you have the resources (i.e., systems, processes, procedures, and people) in place to confidently attest that reasonable inquiry for review and reporting of the CEMS data has been met?

- a) Yes
- b) No

# Poll Question #2 – Answer

Do you have the resources (i.e., systems, processes, procedures, and people) in place to confidently attest that reasonable inquiry for review and reporting of the CEMS data has been met?

- a) Yes
- b) No

**Let's look at the Whys...**



# Some Why Basics

## □ Standards that require monitoring

- Specific Regulation
- Permit Condition

## □ Standards for conducting monitoring

### • Promulgated Regulations

- 40 CFR Part 60 Appendix B & F



**P60**

- 40 CFR Part 75 Appendices



**P75**

### • Guidance Documents

- PADEP Continuous Source Monitoring Manual – Revision 8



**CSMM8**

### • Technical Manuals

- NJ BTS – Technical Manual #1005



**1005**

### • Protocols

- Report EPS 1/PG/7



**PG7**

# Why?

## □ Operating Permit

- Federal 
  - 40 CFR 60 (NSPS)
  - 40 CFR 63 (NESHAPS)
  - 40 CFR 72 & 97 (Trading Programs)
  - 40 CFR 98 (GHG Monitoring Programs)
- State Only or State Implemented  

## □ Ontario MOECC

# Why the “Whys” are important?

- Establishes
  - Regulatory objectives of the compliance demonstration using CEMS
  - “Hows” (mostly by reference) for the operation of the CEMS

# Poll Question #3

You operate a NO<sub>x</sub> CEMS in accordance with 40 CFR Part 75. However your permit also requires the NO<sub>x</sub> CEMS to be operated in accordance with 40 CFR Part 60? How should you operated your CEMS?

- a) Part 75 (since it is more stringent)
- b) Part 60
- c) Part 60 and Part 75
- d) Not Sure

# Poll Question #3 - Answer

You operate a NO<sub>x</sub> CEMS in accordance with 40 CFR Part 75. However your permit also requires the NO<sub>x</sub> CEMS to be operated in accordance with 40 CFR Part 60? How should you operated your CEMS?

- a) Part 75 (since it is more stringent)
- b) Part 60
- c) Part 60 and Part 75
- d) Not Sure

# Regulatory Objectives






- The reason why CMS are used defines how the CMS are operated and quality assured.
- Example:

<b>Part 60 / Permit (Emission Standard)</b>	<b>Part 72 / Part 97 (Trading Programs)</b>
Accurate reporting	Conservative or over reporting
Older rule	Newer, better developed rule
No missing data substitution	Missing data substitution
No bias adjustment	Bias adjustment factor

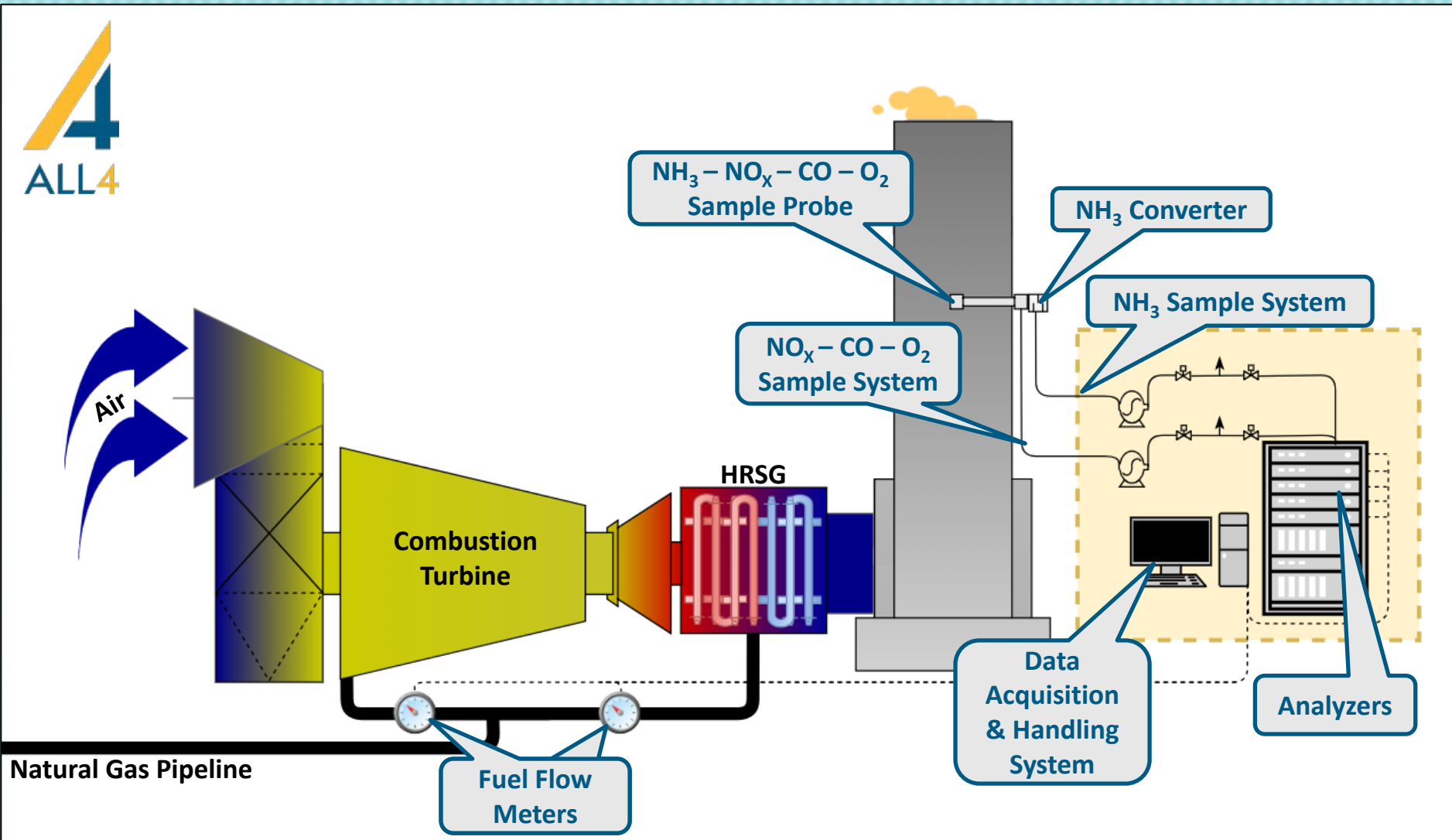
**Let's look at the Hows...**



# Hows?

- ❑ 40 CFR Part 60 Appendix B & F  **P60**
- ❑ 40 CFR Part 75 Appendices  **P75**
- ❑ PADEP Continuous Source Monitoring Manual –  
Revision 8  **CSMM8**
- ❑ NJ BTS – Technical Manual #1005  **1005**
- ❑ Report EPS 1/PG/7  **PG7**

# How am I complying?



# CMS Components

## Sample System

- Sample probes
- Sample “umbilical” lines
- Sample conditioning (e.g., heaters, condensers, gas dilution equipment)

## Analyzers

- Pollutant concentration monitors
- Diluent gas monitor
- Fuel flow monitors

**O<sub>2</sub>**

**FFM**

**NO<sub>x</sub>**

**CO**

**NH<sub>3</sub>**

## Data Handling

- Data loggers or programmable logic controllers (PLCs)
- Data Acquisition and Handling System (DAHS)

# Data Acquisition and Handling System (DAHS)

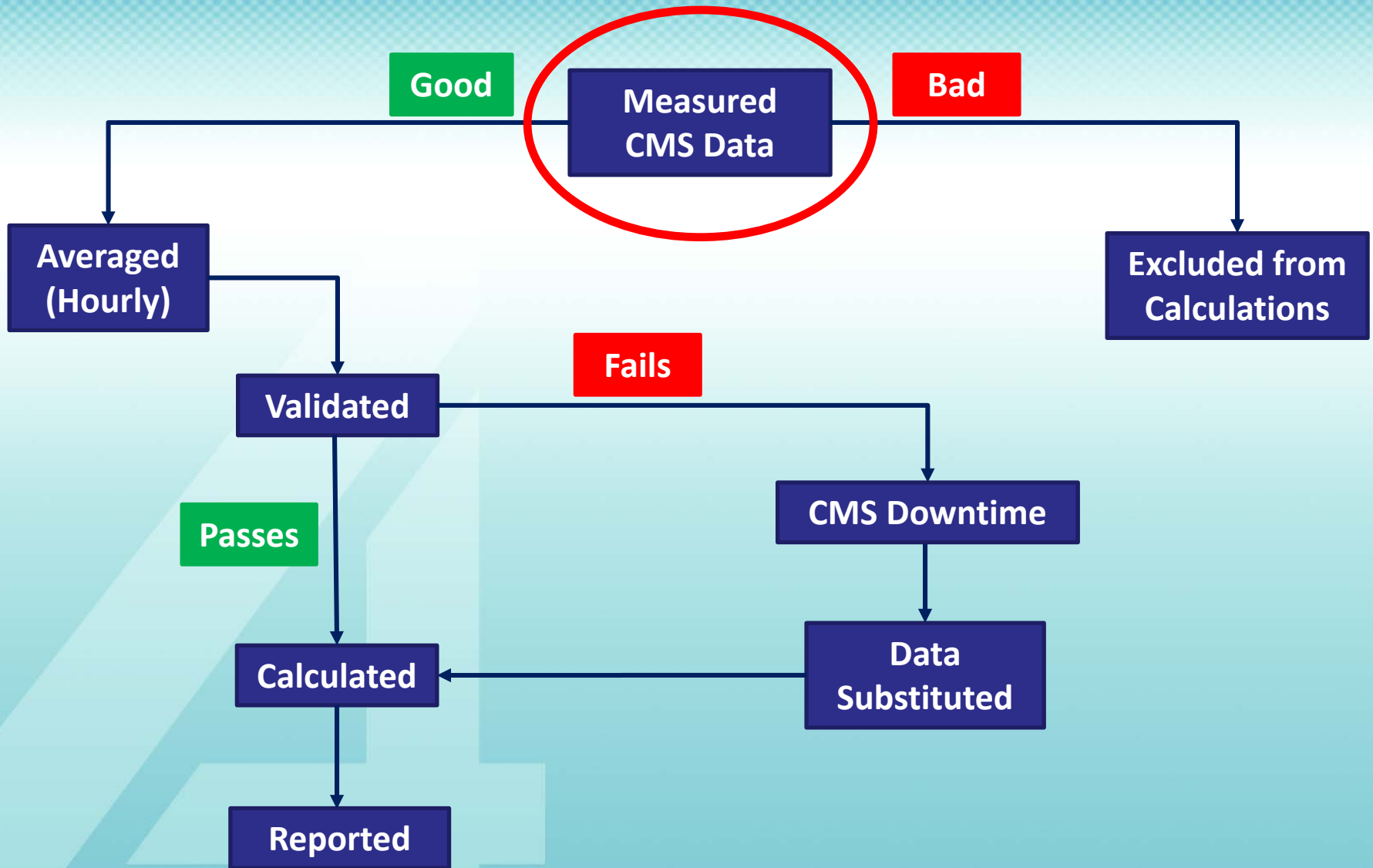
## □ Platform: The Database

Date	Time	Value	Process Code	Monitoring Code
02/19/2015	06:59	4.2	Normal	Valid
02/19/2015	07:00	0.6	Normal	Calibration
02/19/2015	07:01	0.1	Normal	Calibration
02/19/2015	07:02	42.0	Normal	Calibration
02/19/2015	07:03	56.4	Normal	Calibration
02/19/2015	07:04	35.2	Normal	Calibration
02/19/2015	07:05	8.2	Normal	Calibration
02/19/2015	07:06	4.2	Normal	Valid

**Let's get into the good  
stuff...**



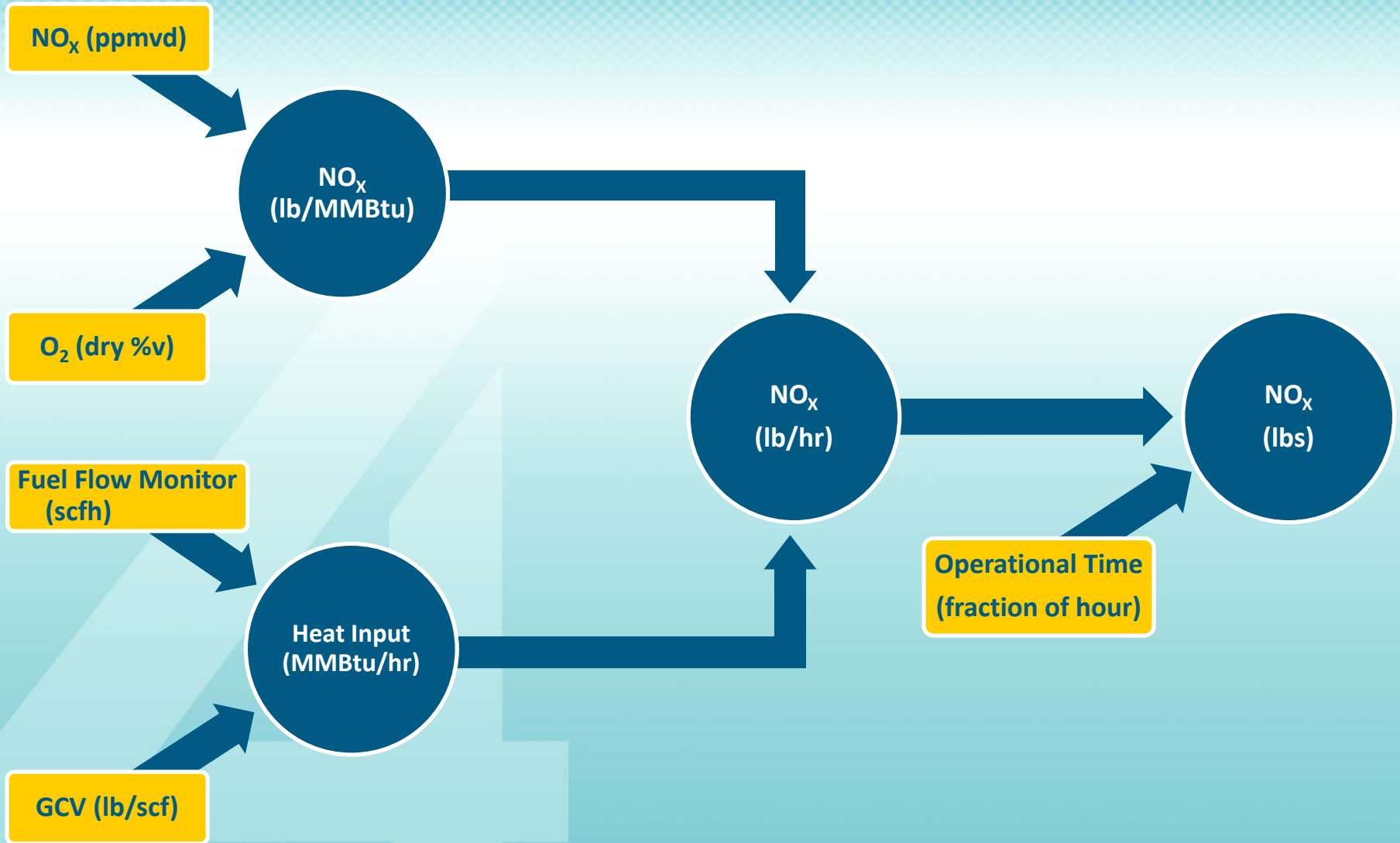
# CMS Data Schema



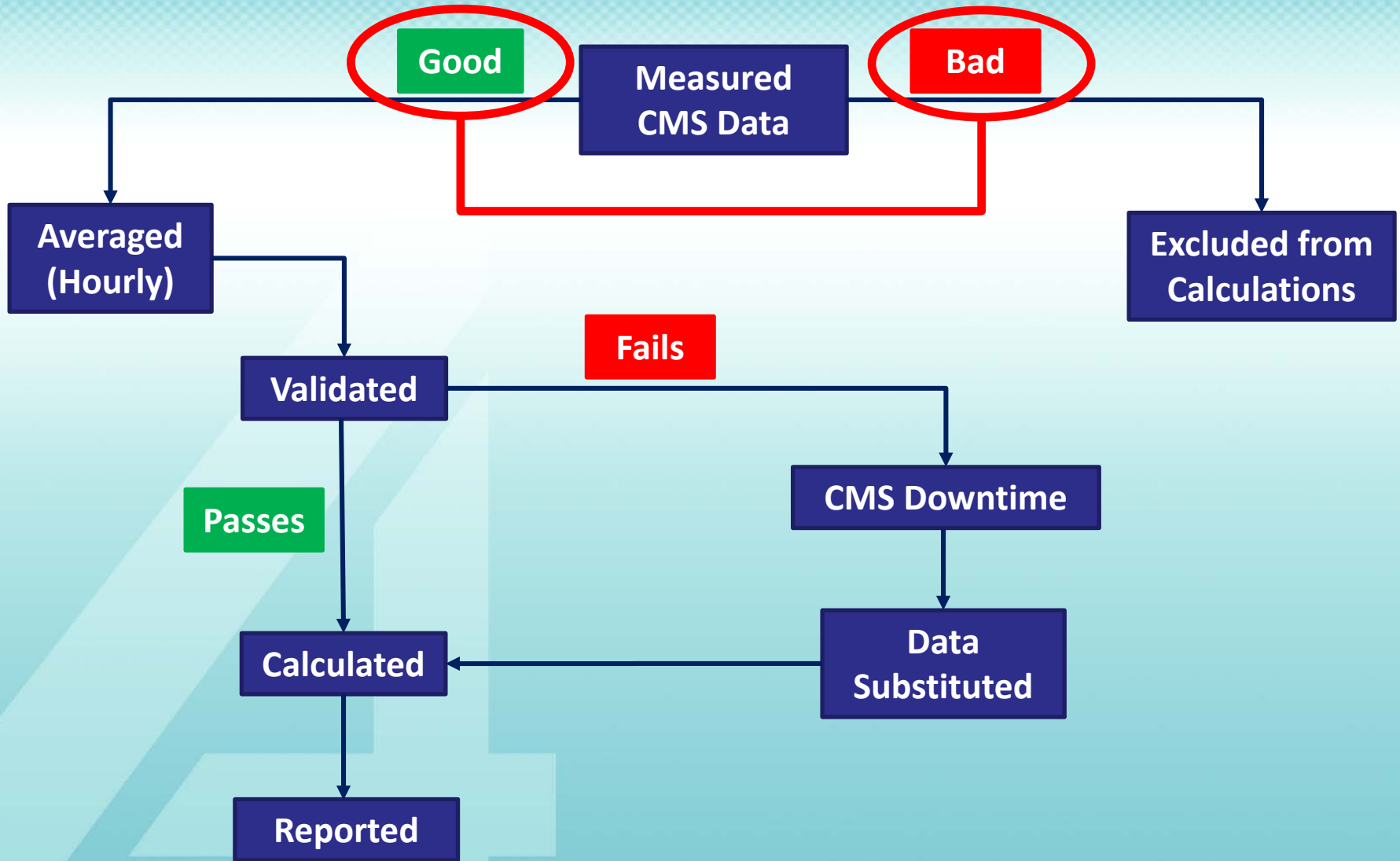
# What type of CMS are required?

- Whys - 40 CFR Part 97 CSAPR
  - NO<sub>x</sub> Mass Emissions (i.e., lbs in the hr)
  - NO<sub>x</sub> Mass Emissions Rate (i.e., lbs per MMBtu)
  - Heat Input (i.e., MMBtu per hr)
  
- Hows - 40 CFR Part 75
  - NO<sub>x</sub> Concentration (i.e., ppmvd)
  - O<sub>2</sub> Diluent Concentration (i.e., dry %v)
  - Fuel Flow Rate (i.e., scfh)

# What type of CMS are required?



# CMS Data Schema



Data collected by CMS (when subject to monitoring) can ONLY be:

**GOOD**  
“Valid”

Used for compliance demonstration

Quality Assured

Accurate (Representative)

**BAD**

“Invalid”

Quantified as CMS downtime

Out-of-Control (OOC)

Non-representative

# Poll Question #4

In what ways could CMS data be invalidated?

- a) Excessive calibration drift
- b) Maintenance on monitoring system
- c) Process/source downtime
- d) Data is not representative of operations
- e) Air pollution control device malfunction

# Poll Question #4 - Answer

In what ways could CMS data be invalidated?

- a) ✓ Excessive calibration drift
- b) ✓ Maintenance on monitoring system
- c) ✗ Process/source downtime
- d) ✓ Data is not representative of operations
- e) ✗ Air pollution control device malfunction

**Let's look at QA/QC...**



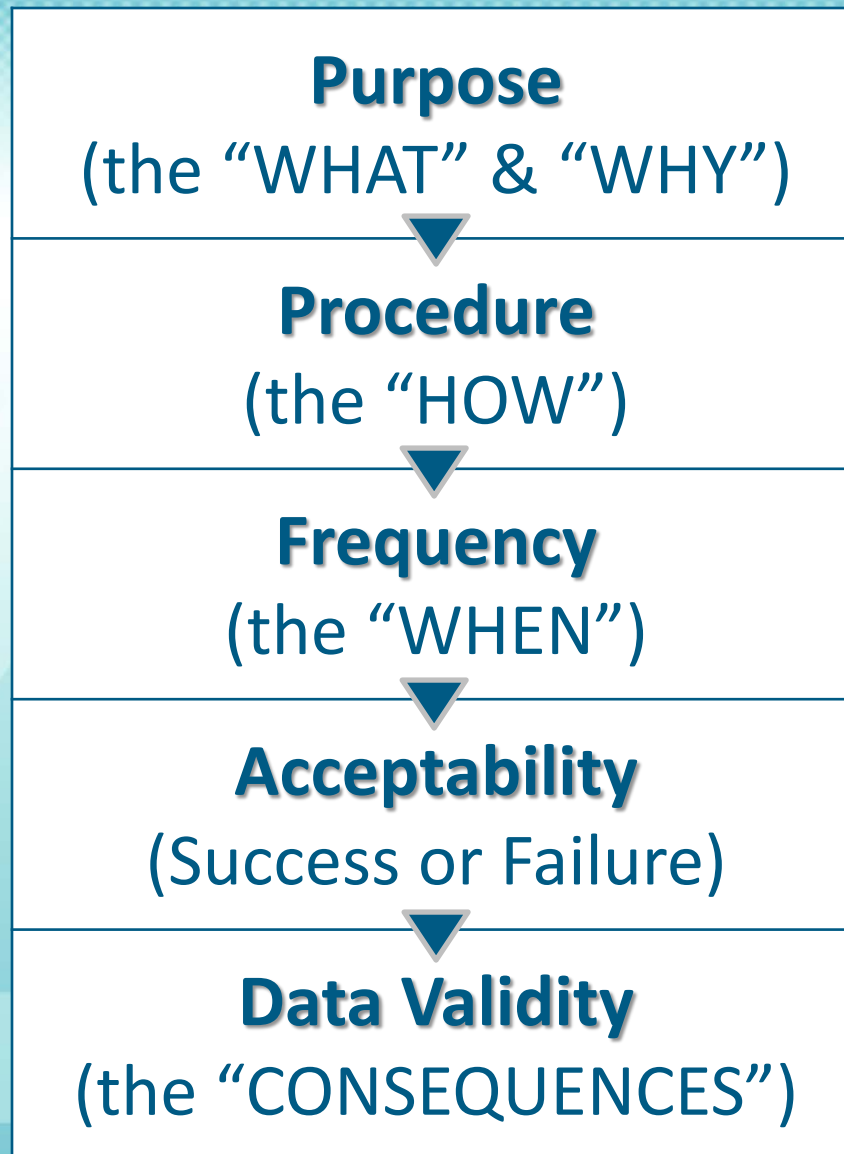
# QA/QC Definitions

- **Quality Assurance (QA)** involves external checks to confirm that the quality control (QC) procedures are adequate to meet the level of precision required for the system.
- **Quality Control (QC)** functions comprise a series of frequent internal checks, such as system inspections, periodic calibrations, and routine maintenance.

# QA/QC Plan

- ❑ A QA/QC Plan is required to be implemented and maintained.
- ❑ Provides step-by-step procedures and operations for each of the following activities:
  - Preventive and Corrective Maintenance
    - Including spare parts inventory
  - Maintenance Records
  - Recordkeeping and Reporting
  - Quality Assurance Activities
- ❑ Annual Review 

# What are the QA/QC Activities?



**Let's look at Dailys...**



# DAILY: QA/QC Test

## Calibration Drift Test (CDT)



P60



## Calibration Error Test (CET)



P75



Validates daily concentration readings by introducing a low and high level calibration gas and recording monitor's response.

### Purpose

(the "WHAT" & "WHY")



### Procedure

(the "HOW")



### Frequency

(the "WHEN")



### Acceptability

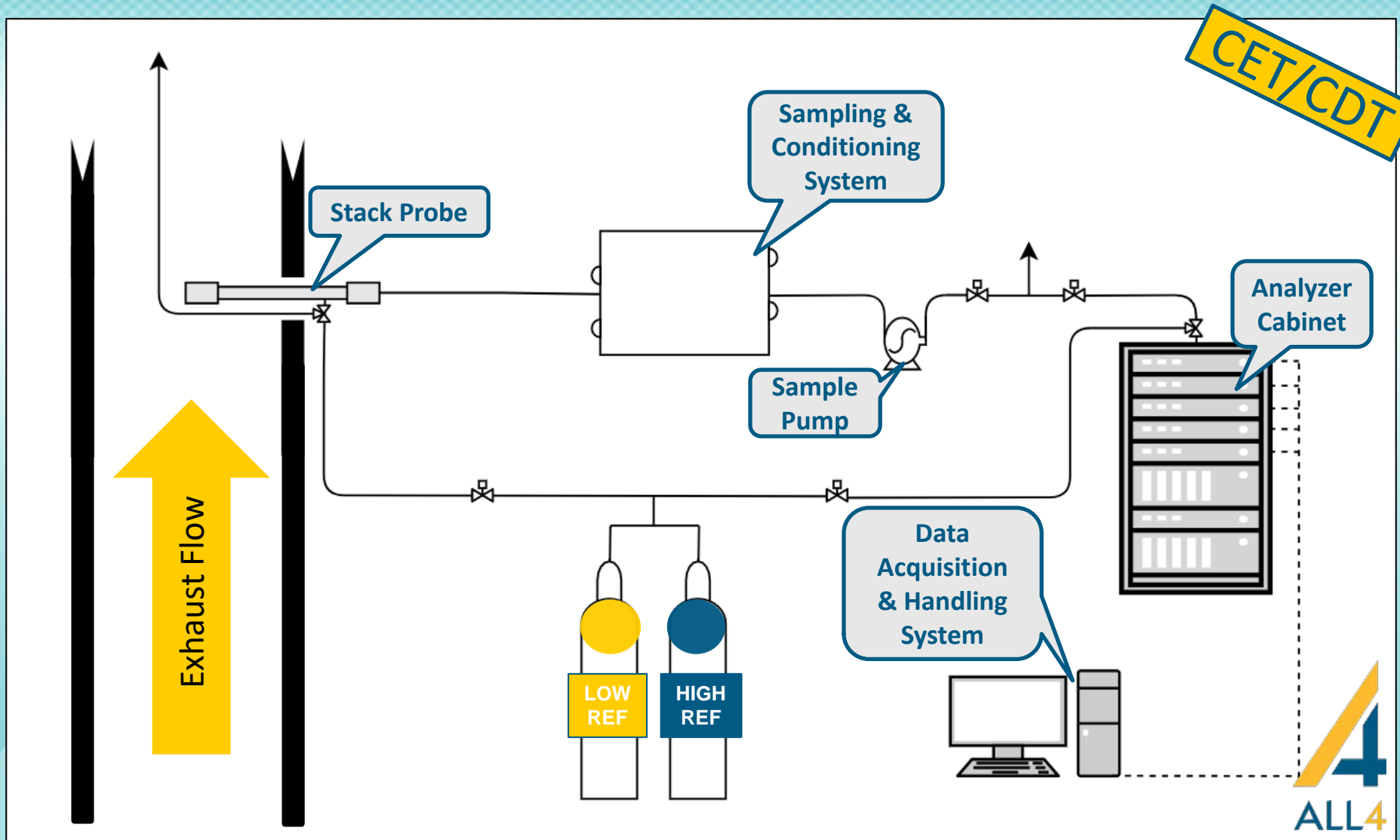
(Success or Failure)



### Data Validity

(the "CONSEQUENCES")

# DAILY: CET/CDT



# DAILY: CET/CDT

## Reference Gases

**Purpose**  
(the "WHAT" & "WHY")



**Procedure**  
(the "HOW")













**Frequency**  
(the "WHEN")



**Acceptability**  
(Success or Failure)

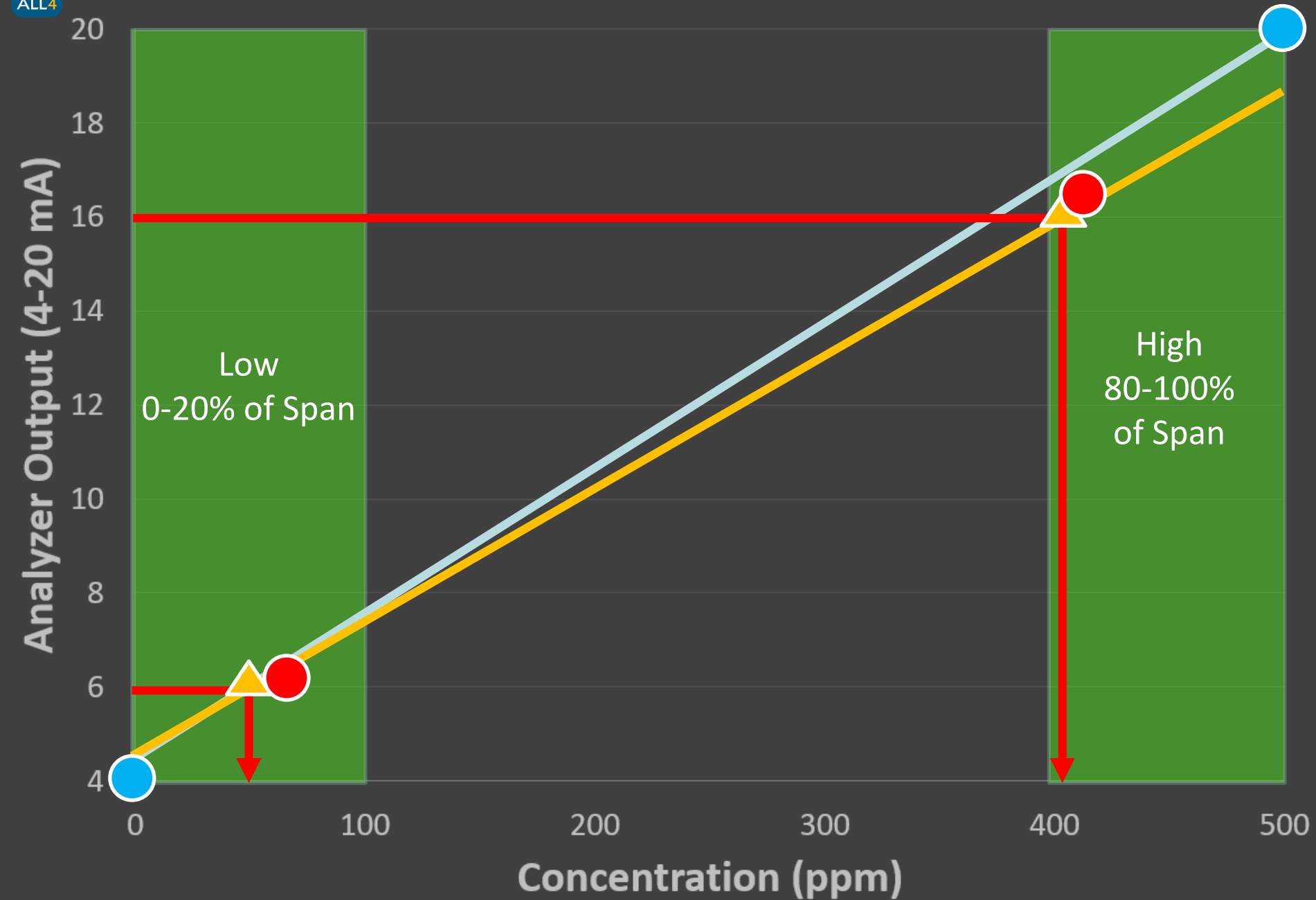


**Data Validity**  
(the "CONSEQUENCES")

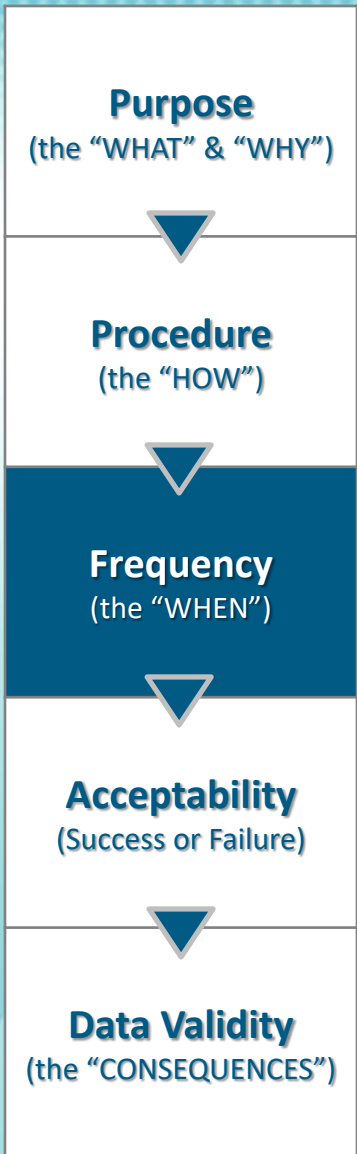
Zero	 <b>P75</b>	0 to 20% of Span
		0 to 30% of Range
Low	 <b>P60</b>	0 to 20% of Span
		0 to 20% of Full Scale
Mid	 <b>P75</b>	50 to 60% of Span (Alternative)
High (Upscale)	 <b>P75</b>	80 to 100% of Span
		80 to 100% of Full Scale
	 <b>P60</b>	50 to 100% of Span
		40 to 100% of Range
		80% to 90% of Range



# DAILY: Analyzer QC



# DAILY: CET/CDT



**P60**

1. At least once daily (approximately 24 hours)



**P75**

1. Daily (i.e., once every 26 hours when the unit is in operation)
2. 8 hours after startup
3. After specific maintenance events



**BP**

1. Immediately prior to and after Preventative Maintenance (PM)
2. Immediately after Corrective Maintenance (CM)



1. Once every 24 hours



1. Daily (i.e., once every 24 hours)
2. Immediately prior to or during startup

# DAILY: CET/CDT

**Purpose**  
(the "WHAT" & WHY")



**Procedure**  
(the "HOW")



**Frequency**  
(the "WHEN")



**Acceptability**  
(Success or Failure)



**Data Validity**  
(the "CONSEQUENCES")

$$CD = \frac{|R - A|}{SPAN} \times 100$$



P75

P60

NO<sub>x</sub>

CO

NH<sub>3</sub>

$$CE = \frac{|R - A|}{RANGE} \times 100$$



NO<sub>x</sub>

CO

NH<sub>3</sub>

$$CE = \frac{|R - A|}{LMESE} \times 100$$



NO<sub>x</sub>

CO

NH<sub>3</sub>

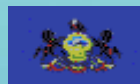
$$CE = |R - A|$$



P75

P60

O<sub>2</sub>



# Span, Range, LMESE

## □ SPAN

- Regulatory Defined
- Used to determine calibration gases and calculate calibration drift.

## □ RANGE

- Physical measurement range

## □ LMESE

- Lowest concentration equivalent

# Out-of-Control Limits

Analyzer	Maintenance Level <b>BP</b>	Excessive Calibration Error (OOC)
NO <sub>x</sub>	2.5% of span	5.0% of span ABS 5.0 ppm (for span values ≤ 50 ppm) ABS 10.0 ppm (for span values > 50 ppm, but ≤ 200 ppm).
O <sub>2</sub>	0.5% O <sub>2</sub> abs. difference	1.0% O <sub>2</sub> ABS difference



Expressed in terms of FS  
Low Level OOC 4.0% FS



**P75**

# DAILY: CET/CDT

**Purpose**  
(the “WHAT” & “WHY”)



**P75**



Data is invalid from the hour in which the daily verification exceeds until the hour in which a successful daily calibration is completed and the minimum hourly data validation requirements are met.

**Procedure**  
(the “HOW”)



Data is invalid from the minute in which the daily verification exceeds until the minute in which a successful daily calibration is completed and the minimum hourly data validation requirements are met.

**Frequency**  
(the “WHEN”)

**2x Spec Limit Exceeded:**



**CET/CDT Legend**

- ◆ Good
- ◆ Bad/OOC

**Acceptability**  
(Success or Failure)

**Data Validity**  
(the “CONSEQUENCES”)

# Out-of-Control Limits

Analyzer	Calibration Drift Specification	Excessive Calibration Drift, 5 Consecutive Days (2x Specification Limit) (Analyzer OOC)	Excessive Calibration Drift, 24 Hour Criteria (4x Specification Limit) (Analyzer OOC)
NO <sub>x</sub>	2.5% of span	5.0% of span	10.0% of span
NH <sub>3</sub>	2.5% of span	5.0% of span	10.0% of span
CO	5.0% of span	10.0% of span	20.0% of span
O <sub>2</sub>	0.5% O <sub>2</sub> abs. difference	1.0% O <sub>2</sub> abs. difference	2.0% O <sub>2</sub> abs. difference



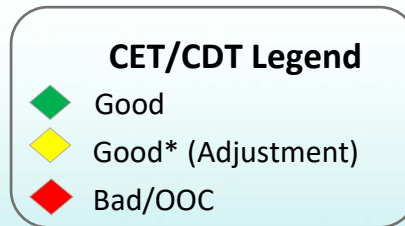
# DAILY: CET/CDT

P60

## □ Data Validity

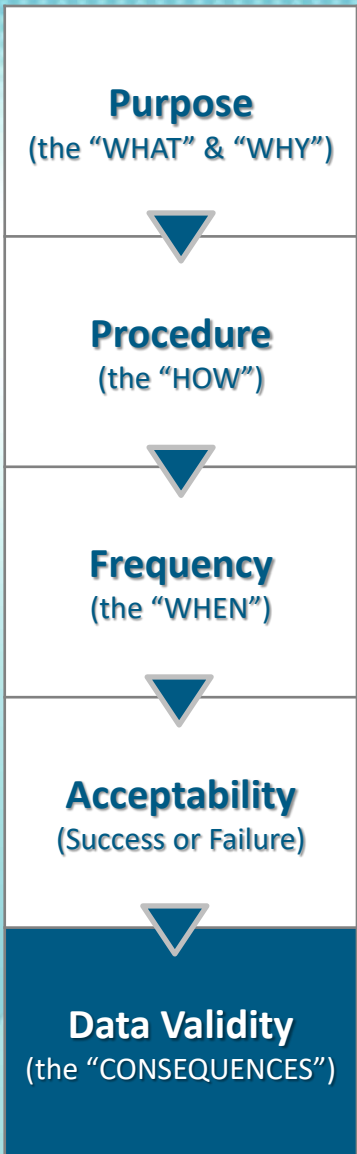
- 2x spec limit for 5 consecutive days = data invalid from the hour in which the CDT exceeds until the hour in which a successful CDT is completed and the minimum hourly data validation requirements are met.

### 2x Spec Limit Exceeded for Five Consecutive Days:



- 4x spec limit = data invalid from the time corresponding to the completion of the daily CDT preceding the daily CDT that resulted in a CD in excess of 4x the applicable drift specification (i.e., retroactive invalidation).

### 4x Spec Limit Exceeded:



**Let's take a break...**

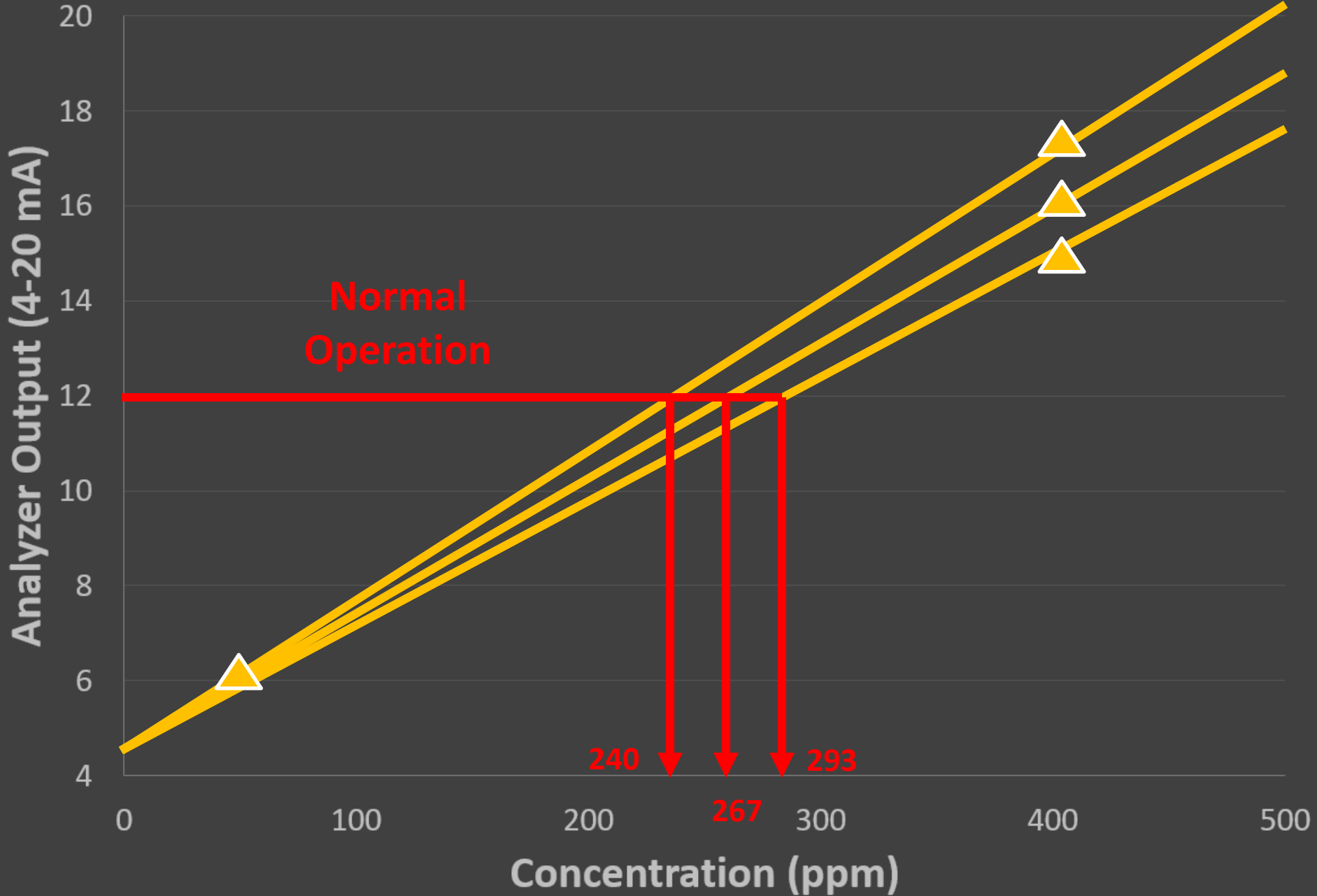


# Let's look at Quarterlies...

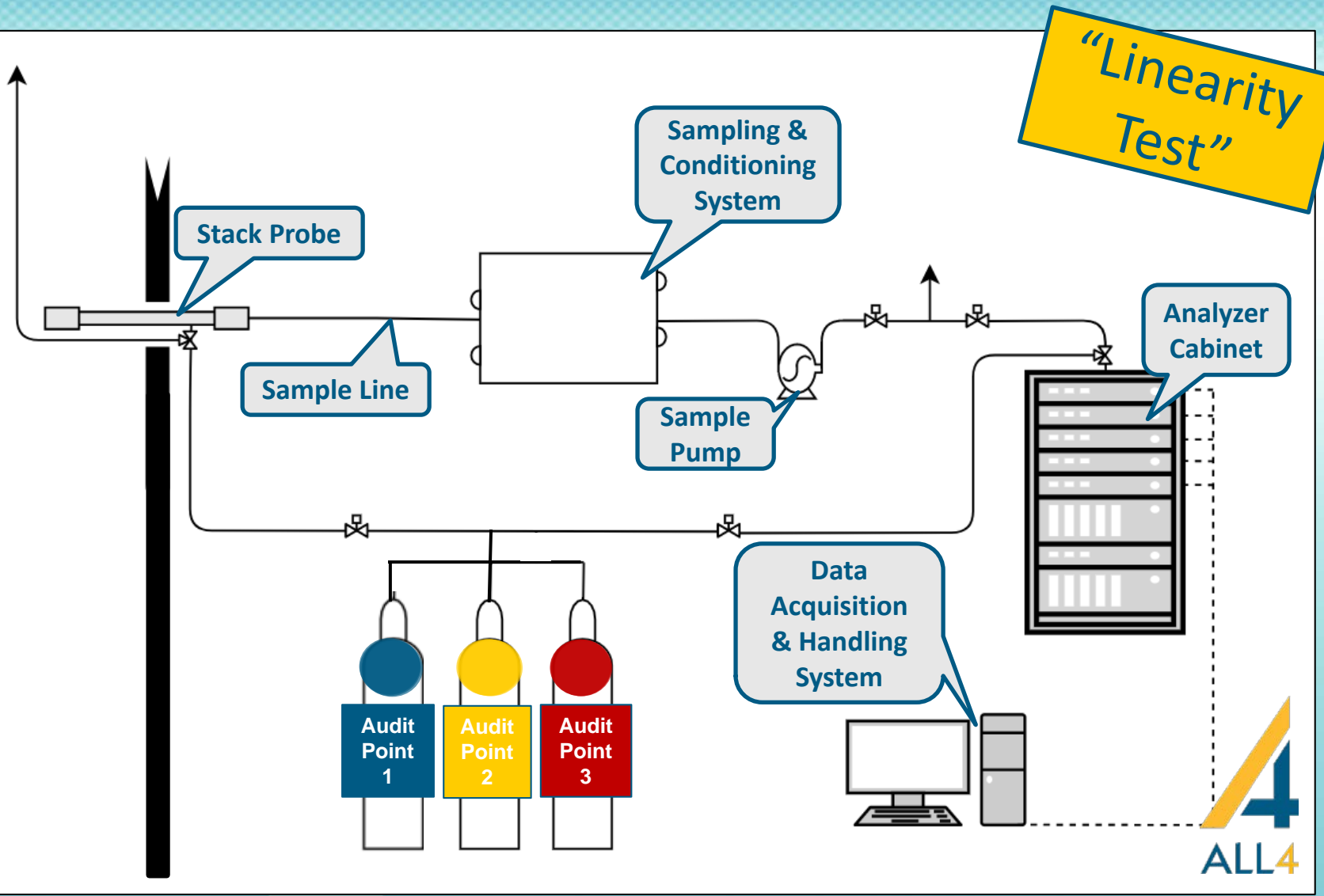




# DAILY: Analyzer QC



# QUARTERLY: Linearity Test



# QUARTERLY: Linearity Test

- Purpose
  - Verifies a linear response to 3 calibration gases throughout the monitor's operating range, 3 times at each point
- Procedure
  - 3 reference points as defined by regulation
    - Low = 20 to 30% of span
    - Mid = 50 to 60% of span
    - High = 80 to 100% of span
- Frequency
  - Could be required as part of initial or re-certification
  - Required every operating quarter, no less than 30 days apart, no less than once a year
  - Grace Period: 168 consecutive operating hours
  - Not required if NO<sub>x</sub> or SO<sub>2</sub> span is ≤ 30 ppm
  - [Recommended] Following certain PM or CM activities
    - May be done “cold”, after routine maintenance, or after corrective maintenance

## Purpose

(the “WHAT” & “WHY”)



## Procedure

(the “HOW”)



## Frequency

(the “WHEN”)



## Acceptability

(Success or Failure)

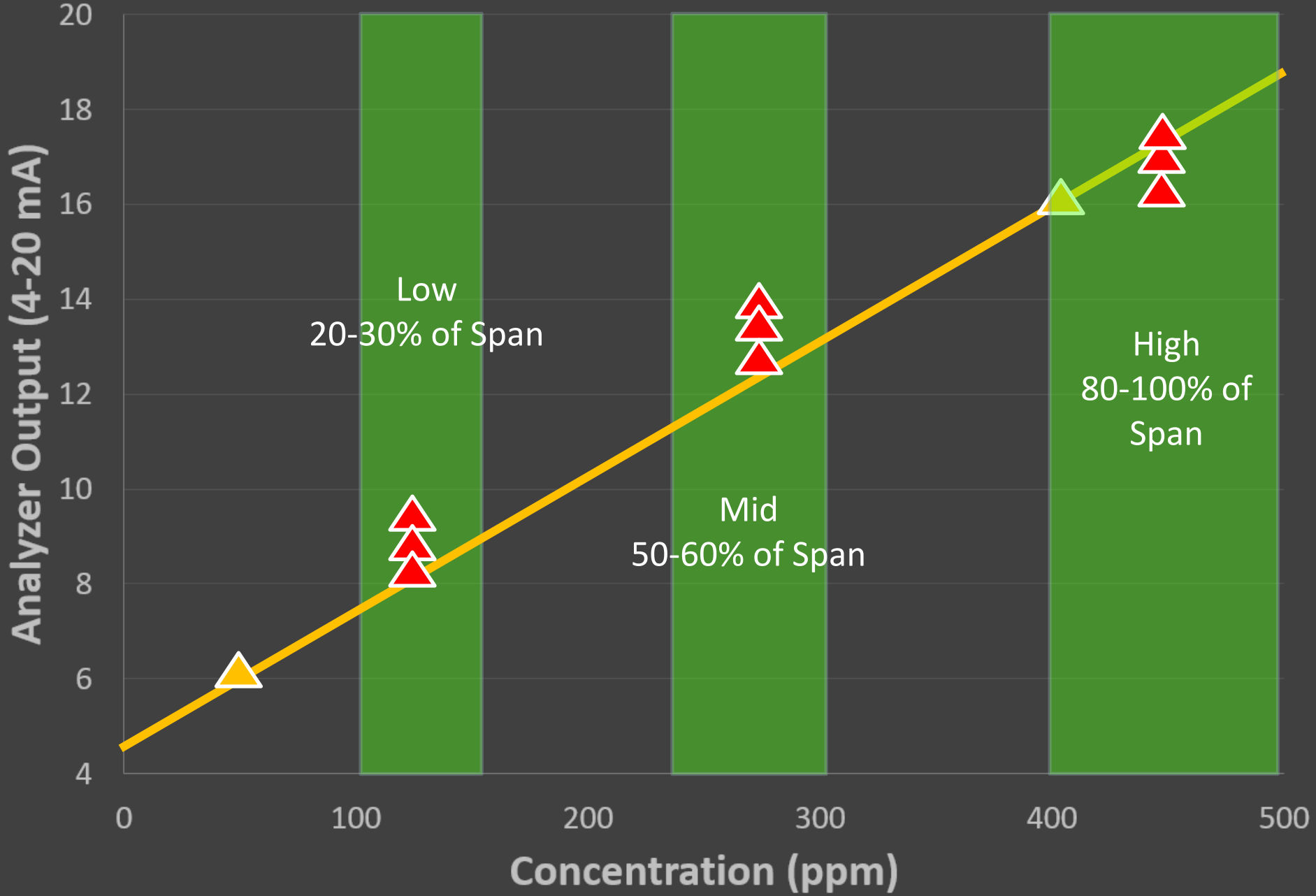


## Data Validity

(the “CONSEQUENCES”)



# QUARTERLY: Analyzer QA



# QUARTERLY: Linearity Test

## □ Acceptability

- ±5.0 % of Average Audit Value, or
- Absolute of ± 5 ppm

$$LE = \frac{|R - A|}{R} \times 100$$

LE = Percentage Linearity error, based upon the reference value.

R = Reference value of low-, mid-, or high-level calibration gas introduced into the monitoring system.

A = Average of the monitoring system responses.



Expressed in terms of FS  
Low, Mid Level OOC 4.0% FS



P75

**Purpose**  
(the “WHAT” & “WHY”)

**Procedure**  
(the “HOW”)

**Frequency**  
(the “WHEN”)

**Acceptability**  
(Success or Failure)

**Data Validity**  
(the “CONSEQUENCES”)

# QUARTERLY: Linearity Test

## □ Data Validity

- The CMS is deemed OOC the hour in which the LT failed or was aborted in anticipation of a LT failure.
- The measured data from CMS are considered valid the hour that a successful LT is completed.
- No retroactive invalidation required.

**Purpose**  
(the “WHAT” & “WHY”)



**Procedure**  
(the “HOW”)



**Frequency**  
(the “WHEN”)



**Acceptability**  
(Success or Failure)

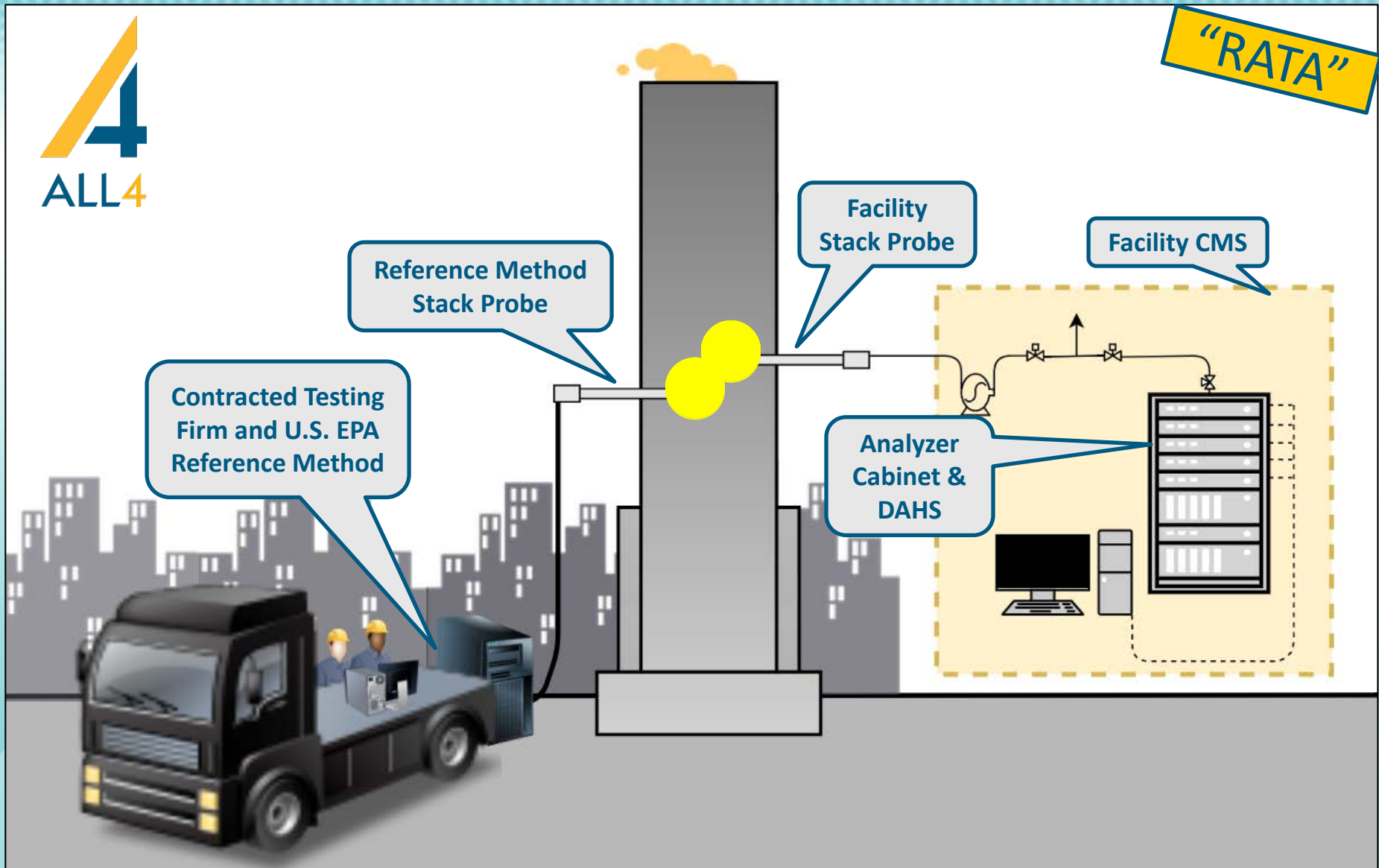


**Data Validity**  
(the “CONSEQUENCES”)

# Let's look at Annuals...



# ANNUAL: Relative Accuracy Test



# ANNUAL: Relative Accuracy Test

## Purpose

(the “WHAT” & “WHY”)



## Procedure

(the “HOW”)



## Frequency

(the “WHEN”)



## Acceptability

(Success or Failure)



## Data Validity

(the “CONSEQUENCES”)

### □ Purpose

- A RATA compares the CMS results with Reference Method (RM) results generated by a Stack Testing Firm

### □ Procedure

- Completed by Stack Testing Firm
- Compare analyzer response with independent system response

# ANNUAL: Relative Accuracy Test

**Purpose**  
(the “WHAT” & “WHY”)



**P60**



1. Once every 4 calendar quarters (with extended outage provisions)

**Procedure**  
(the “HOW”)



**P75**



1. Once every 2 successive QA operating quarters
  - a. Can be reduced to once every 4 successive QA operating quarters

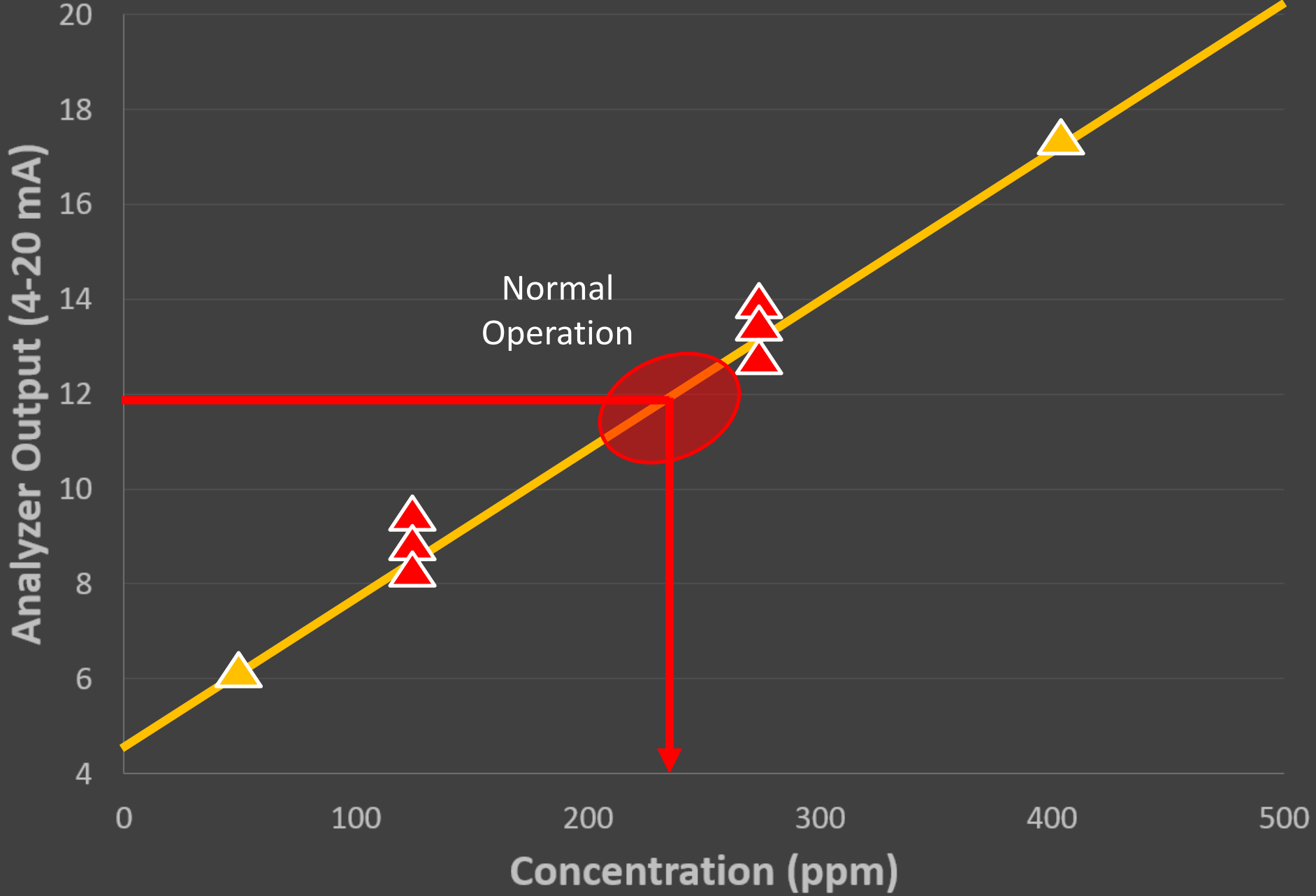
**Frequency**  
(the “WHEN”)

**Acceptability**  
(Success or Failure)

**Data Validity**  
(the “CONSEQUENCES”)



# ANNUALLY: Analyzer QA



# ANNUAL: Relative Accuracy Test

## □ Acceptability

- % Reference Method
- % of the Emissions Standard
- ABS Difference

$$RA = \frac{(|d_{avg}| + |CC|)}{RM_{avg}} \times 100$$

RA = Relative accuracy of the CMS

$d_{avg}$  = Absolute value of the mean difference between the RM and CMS values

CC = Absolute value of the confidence coefficient

$RM_{avg}$  = Average RM value.

### Purpose

(the "WHAT" & "WHY")

### Procedure

(the "HOW")

### Frequency

(the "WHEN")

### Acceptability

(Success or Failure)

### Data Validity

(the "CONSEQUENCES")

# Bias Test

- ❑ Perform a bias test on data to determine if the CMS is biased low with respect to the reference method.
- ❑ Calculate acceptability by comparing the arithmetic mean difference of the dataset ( $d_{avg}$ ) to the confidence coefficient (CC).
  - If the mean difference is less than or equal to the CMS passed the bias test
- ❑ If low bias is found (i.e., the bias test is failed), a bias adjustment factor (BAF) must be calculated and applied to hourly emissions data after the completion of the RATA.

# Poll Question #5

The purpose of a bias adjustment factor (BAF) is to ensure that the facility CEMS reports emissions no lower than the reference method.

- a) True
- b) False
- c) Not Sure

# Poll Question #5 – Answer

The purpose of a bias adjustment factor (BAF) is to ensure that the facility CEMS reports emissions no lower than the reference method.

- a) True
- b) False
- c) Not Sure

# Bias Adjustment

- Calculate the BAF using the following equation:

$$BAF = 1 + \frac{|d_{avg}|}{CEM_{avg}}$$

$d_{avg}$  = Arithmetic mean of the difference obtained during the failed bias test

$CEM_{avg}$  = Mean of the data values provided by the monitor during the failed bias test.

# Bias Adjustment Example

- Suppose you fail the Bias Test and have to apply a BAF to your data...

Raw NO <sub>x</sub> Emissions (After RATA)
0.145
0.144
0.143
0.144
0.142
0.145
0.148
0.152
0.153
0.151
0.148
0.146

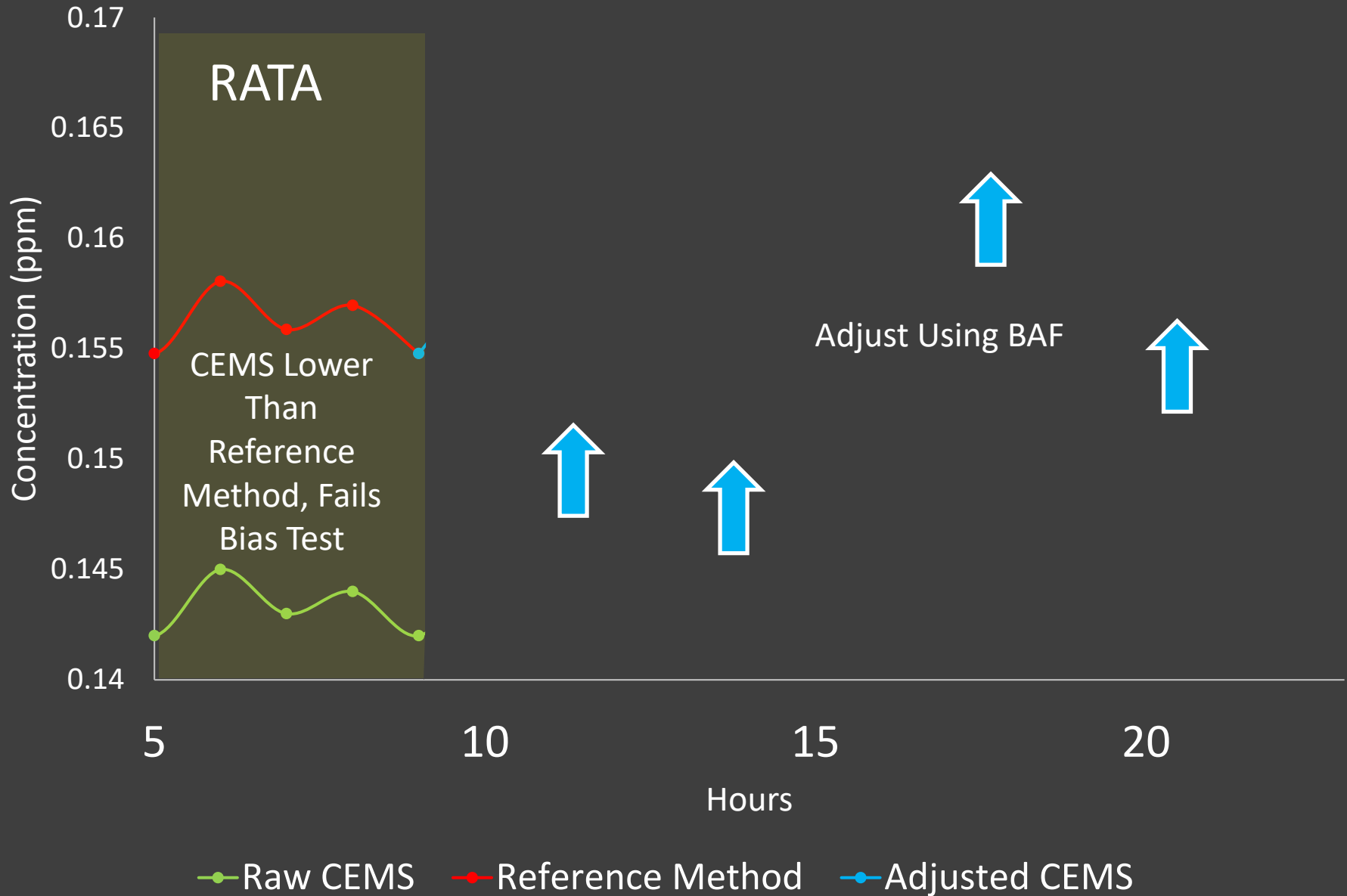


**BAF = 1.09**

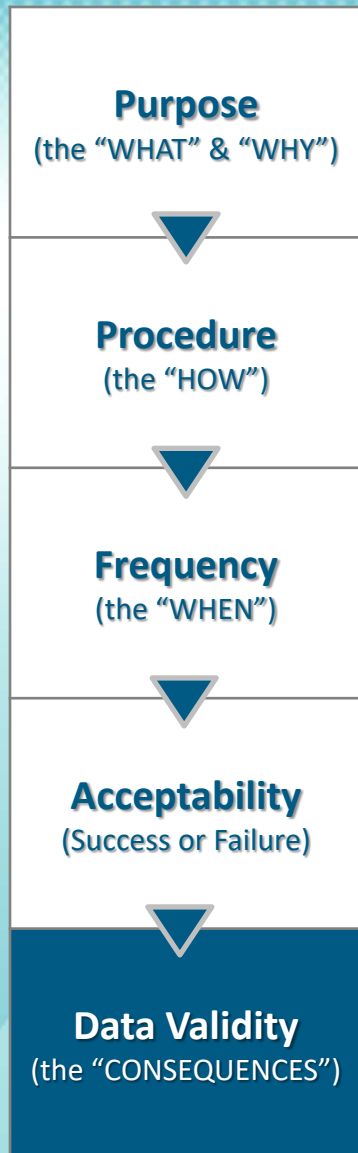
Adjusted NO <sub>x</sub> Emissions (After RATA)
0.158
0.157
0.156
0.157
0.155
0.158
0.161
0.166
0.167
0.165
0.161
0.159

Your environmental compliance is *clearly* our business.

# Bias Adjustment



# ANNUAL: Relative Accuracy Test



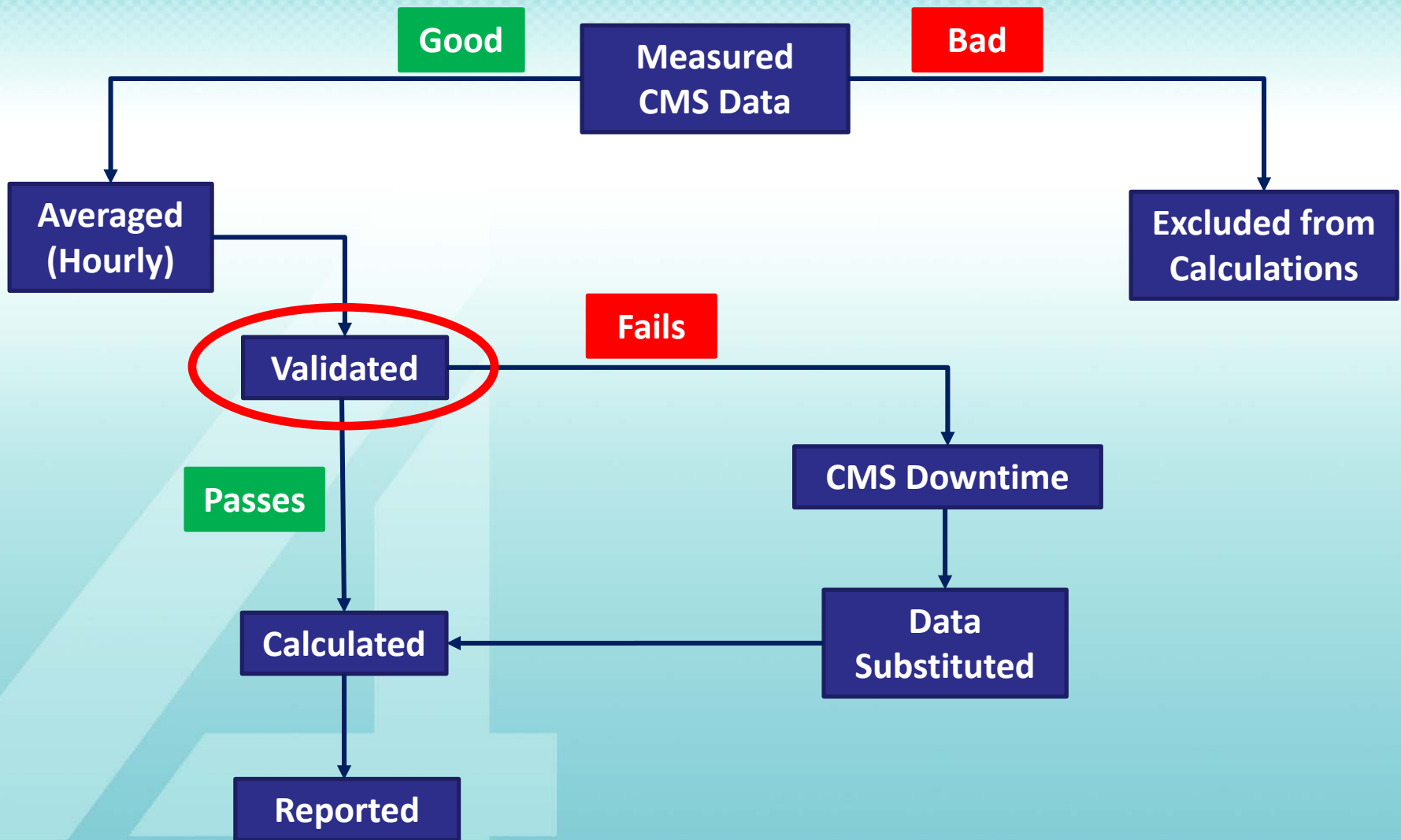
## □ Data Validity

- The RATA exceeds the tolerance in the applicable Performance Specification.
- The data are considered invalid and OOC beginning the time corresponding to the completion of the sampling for the RATA that exceeds the tolerance.
- The end of the OOC period is the time corresponding to the completion of the sampling of the subsequent successful RATA.
- \*Important to know if RATA passes/fails ASAP.

# Let's look at Validation...



# CMS Data Schema



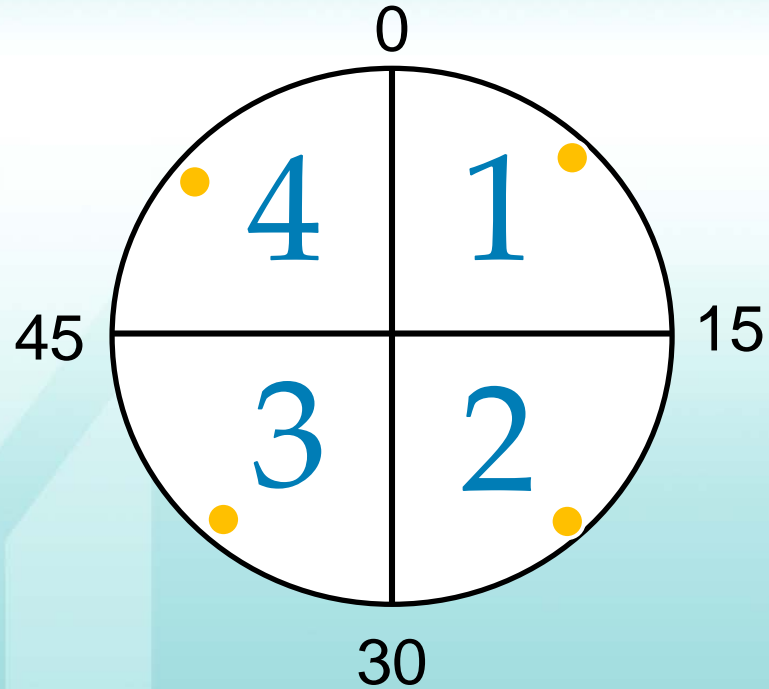
# What is Validation?

- How much and what kind of measured data is needed to build a valid average used to demonstrate compliance with an emission, parametric, or work practice standard?

# Valid Hourly Average

- Hourly averages must contain at least one data point in each 15 minute quadrant of an hour (where the unit combusted fuel during that quadrant of an hour).
- Hourly average may contain at least two data points separated by a minimum of 15 minutes (where the unit operates for more than one quadrant of an hour) if data are unavailable as a result of the performance of calibration, quality assurance, or preventive maintenance activities.

# Full Operating Hour

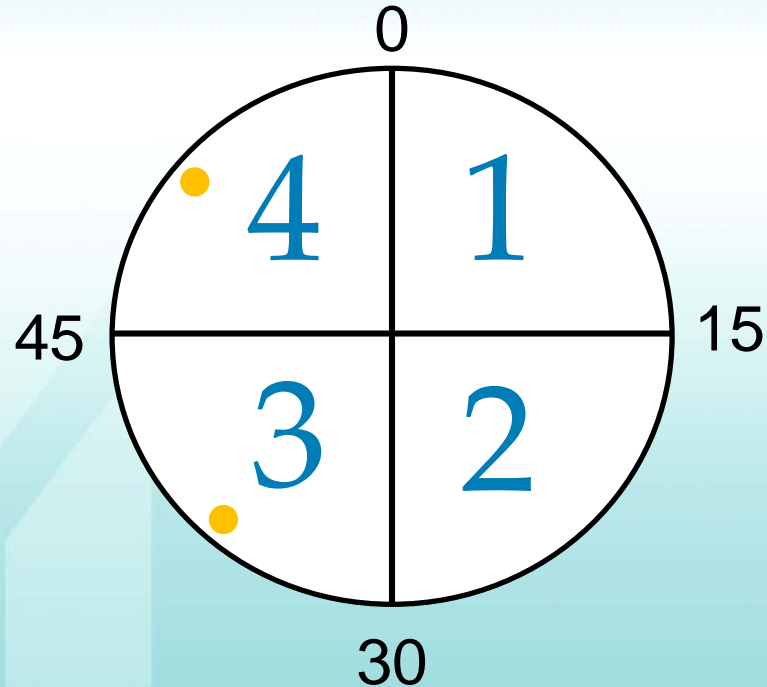


P60



P75

# QA & Maintenance Hour



P60



P75

# Example

- Determine whether this hour is valid or invalid
  - During an hour in which a quality assurance activity is completed, a valid hour consists of two data points, separated by at least 15 minutes. The unit operated the entire hour. A quarterly linearity test was performed and passed.

36 Invalid Minutes

①

Minute	Value
0	7.0
1	6.0
2	6.0
3	7.0
4	5.0
5	LT
6	LT
7	LT
8	LT
9	LT
10	LT
11	LT
12	LT
13	LT
14	LT

②

Minute	Value
15	LT
16	LT
17	LT
18	LT
19	LT
20	LT
21	LT
22	LT
23	LT
24	LT
25	LT
26	LT
27	LT
28	LT
29	LT

③

Minute	Value
30	LT
31	LT
32	LT
33	LT
34	LT
35	LT
36	LT
37	LT
38	LT
39	LT
40	LT
41	6.0
42	6.0
43	6.0
44	7.0

④

Minute	Value
45	7.0
46	6.0
47	6.0
48	7.0
49	5.0
50	7.0
51	6.0
52	6.0
53	7.0
54	6.0
55	7.0
56	6.0
57	7.0
58	6.0
59	7.0

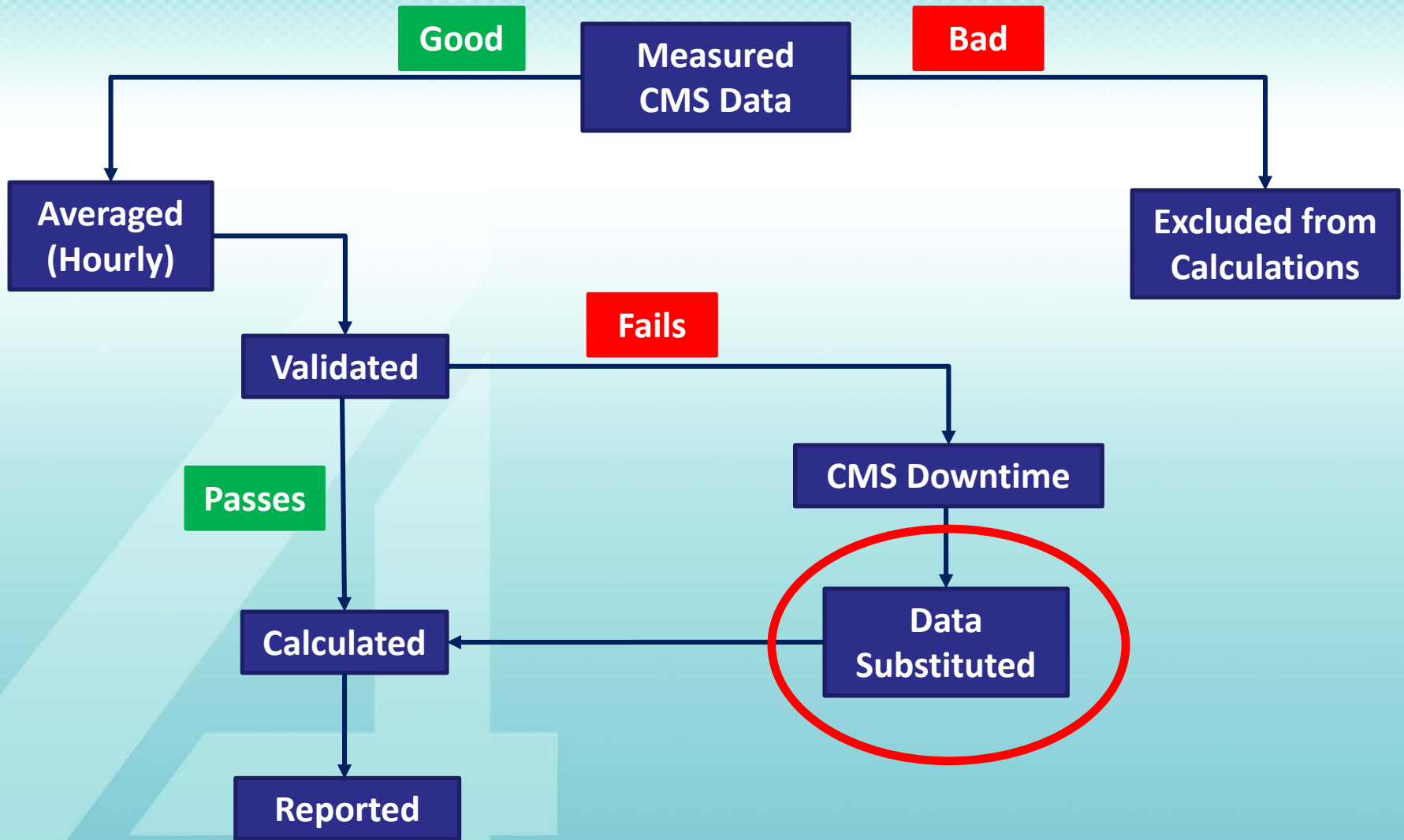
VALID HOUR

Why: 1. Two readings separated by 15 minutes in a quality assurance hour  
2. Linearity Test Passed

# Let's look at Data Substitution...



# CMS Data Schema



# Data Substitution

- Required mass related emission standard (i.e., tpy), annual emission fees, and trading programs when unit is operating and when valid CEMS data is not available.
- Data substitution methodology based on:
  - Percent Monitor Availability (PMA)
  - Duration of CMS outage



P75

# Data Substitution Load Bins

Load Bin	% of Max. Load	Measured Value
1	0-10	
2	>10-20	● ●
3	>20-30	●
4	>30-40	●
5	>40-50	●
6	>50-60	● ● ● ● ●
7	>60-70	● ● ●
8	>70-80	●
9	>80-90	●
10	>90	● ● ●



**P75**

# Data Substitution Load Bins

TABLE 2—LOAD-BASED MISSING DATA PROCEDURE FOR NO<sub>x</sub>-DILUENT CEMS, NO<sub>x</sub> CONCENTRATION CEMS AND FLOW RATE CEMS

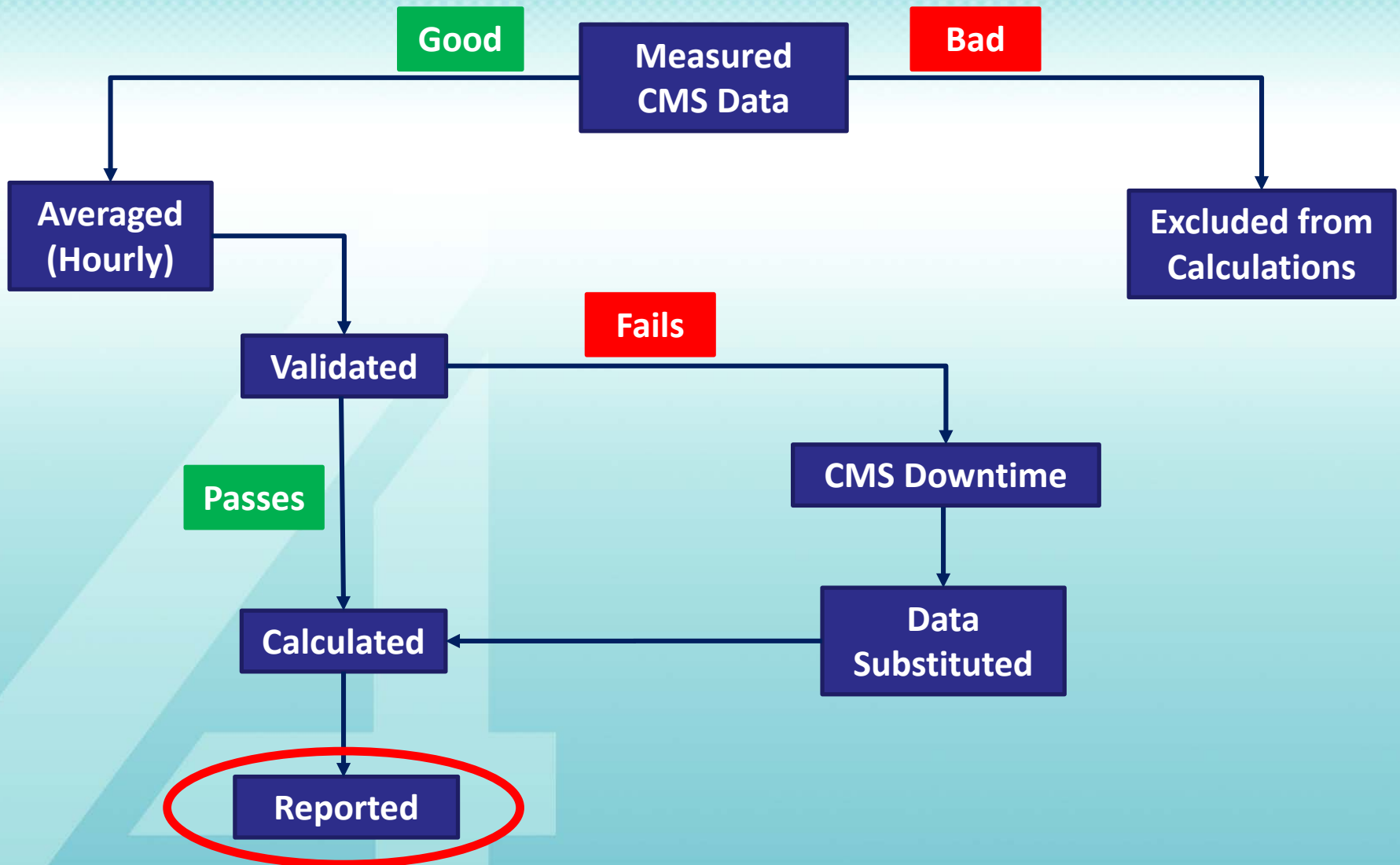
Trigger conditions		Calculation routines		
Monitor data availability (percent)	Duration (N) of CEMS outage (hours) <sup>2</sup>	Method	Lookback period	Load ranges
95 or more	N ≤ 24	Average	2,160 hours*	Yes.
	N > 24	The greater of:		
		Average	HB/HA	No.
		90th percentile	2,160 hours*	Yes.
90 or more, but below 95	N ≤ 8	Average	2,160 hours*	Yes.
	N > 8	The greater of:		
		Average	HB/HA	No.
		95th percentile	2,160 hours*	Yes.
80 or more, but below 90	N > 0	Maximum value <sup>1</sup>	2,160 hours*	Yes.
Below 80	N > 0	Maximum potential NO <sub>x</sub> emission rate <sup>3</sup> ; or maximum potential NO <sub>x</sub> concentration <sup>3</sup> ; or maximum potential flow rate	None	No.



# Let's look at Reporting...



# CMS Data Schema



# Electronic Reporting

- *Mechanism* of reporting
- Two examples:
  - Pennsylvania CEMDPS
    - Compliance
  - Clean Air Markets eCMPS
    - Reporting and QA

# PA Report Upload

- Automatic validation results
- Generation of “errors” and “warnings”
- Automatic generation of penalty fees

**QUARTERLY CONTINUOUS SOURCE MONITORING REPORT**  
 Department of Environmental Protection  
 Bureau of Air Quality  
 Harrisburg, PA 17105-8468

The Bureau prepared this report based on the Continuous Source Monitoring System (CSMS) data submitted by the company. The Facility Summary appears below. The individual Continuous Source Monitoring System Reports contain summary and daily data and appear on the remaining pages.

**FACILITY SUMMARY**

Company: \_\_\_\_\_ Year: 2017 Quarter: 1  
 Facility: \_\_\_\_\_  
 Municipality: \_\_\_\_\_  
 Region: \_\_\_\_\_

Monitored Parameter	Quarterly Average	Time Subject to Monitoring	Emission Violation Days	Excess Invalid Averages	Report Penalties			Emission Result ID
					Emission	Data Availability	Late	
Source: Clinker Cooler 1								
Opacity	2.71128 %	27.08 %	0	0	\$ 0	\$ 0	\$ 0	ABC
Source Summary:		27.08 %	0	0	\$ 0	\$ 0	\$ 0	1
Source: Clinker Cooler 2								
Opacity	1.52800 %	61.02 %	0	0	\$ 0	\$ 0	\$ 0	ABC
Source Summary:		61.02 %	0	0	\$ 0	\$ 0	\$ 0	1
Source: Kiln 1								
Opacity	1.92212 %	27.08 %	0	0	\$ 0	\$ 0	\$ 0	ABC
NOx	189.743006 lbs/hr	27.08 %	0	0	\$ 0	\$ 0	\$ 0	ABC
SO2	51.8878 ppm	27.08 %	0	0	\$ 0	\$ 0	\$ 0	ABC
SO2	45.418 lbs/hr	27.08 %	0	0	\$ 0	\$ 0	\$ 0	ABC
CO	46.811 lbs/hr	27.08 %	0	0	\$ 0	\$ 0	\$ 0	ABC
Source Summary:		27.08 %	0	0	\$ 0	\$ 0	\$ 0	5
Source: Kiln 2								
Opacity	1.72421 %	61.02 %	3	0	\$ 320	\$ 0	\$ 0	ABC
NOx	133.094749 lbs/hr	61.02 %	0	0	\$ 0	\$ 0	\$ 0	ABC
SO2	57.8976 ppm	61.02 %	2	0	\$ 600	\$ 0	\$ 0	ABC
SO2	51.680 lbs/hr	61.02 %	0	0	\$ 0	\$ 0	\$ 0	ABC
CO	46.589 lbs/hr	61.02 %	0	0	\$ 0	\$ 0	\$ 0	ABC
Source Summary:		61.02 %	5	0	\$ 920	\$ 0	\$ 0	5
Location Summary:		44.05 %	5	0	\$ 920	\$ 0	\$ 0	12
Total Penalty:					\$ 920			

# Clean Air Markets Division ECMPS

## Emissions Data

Heat Input for Unit/Stack		NOx Rate CEMS		Heat Input Appendix D		Daily Calibration Tests			Combined Parameters		
Component ID	Component Type	Span Scale	End Date/Time	Rpt. Test Result	Calc. Test Result	Upscale Gas Level	Upscale Injection Date	Upscale Injection Time	Upscale Measured Value	Upscale Reference Value	Rpt. Upscale CE or Mean Diff.
NX2	NOX	L	05/01/2016 08:01	PASSED	PASSED	HIGH	05/01/2016	08:01	8.3	8.2	1.0
NX2	NOX	H	05/01/2016 08:06	PASSED	PASSED	HIGH	05/01/2016	08:06	177.8	177.0	0.4
O22	O2	H	05/01/2016 08:16	PASSED	PASSED	HIGH	05/01/2016	08:16	22.4	22.5	0.1
NX2	NOX	L	05/02/2016 08:01	PASSED	PASSED	HIGH	05/02/2016	08:01	8.2	8.2	0.0

## RATA

### ⊙ RATA (NOX-7NS-201703018)

- ⊙ Summary (High)
  - Run (1)
  - Run (2)
  - Run (3)
  - Run (4)
  - Run (5)
  - Run (6)
  - Run (7)
  - Run (8)
  - Run (9)
  - Run (10)
  - Run (11)
- Protocol Gas (HIGH)
- Protocol Gas (HIGH)
- Protocol Gas (MID)
- Protocol Gas (MID)
- Protocol Gas (LOW)
- Air Emission Testing (Walker)

Monitoring System ID	<input type="text" value="7NS"/>	NOX	<u>Recalculated Values</u>
Test Number	<input type="text" value="NOX-7NS-201703018"/>		
Test Reason Code	<input type="text" value="INITIAL"/>	Initial Certification	
Test Result Code	<input type="text" value="PASSED"/>	Test Passed	<input type="text"/>
Begin Date	<input checked="" type="checkbox"/> 03/01/2017		
Begin Hour	<input type="text" value="8"/>		
Begin Minute	<input type="text" value="30"/>		
End Date	<input checked="" type="checkbox"/> 03/01/2017		
End Hour	<input type="text" value="13"/>		
End Minute	<input type="text" value="50"/>		
Grace Period Indicator	<input type="text" value="0 - No"/>		

**Let's look at FFM...**



# Fuel Flowmeter QA/QC

**Purpose**  
(the “WHAT” & “WHY”)



**Procedure**  
(the “HOW”)



**Frequency**  
(the “WHEN”)



**Acceptability**  
(Success or Failure)

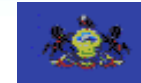


**Data Validity**  
(the “CONSEQUENCES”)

FFM Accuracy Test



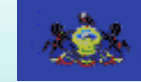
P75



Fuel Flow-to-Load  
Ratio Test



P75



F-Factor System  
Test



PG7



Manufacturer  
Accuracy Test  
(as applicable)



PG7



# Fuel Flowmeter QA/QC

## FFM QA/QC activities:

### □ Defined in

- 40 CFR Part 75, Appendix D



- Report EPS 1/PG/7



### □ Depend on the type/measurement method of FFM chosen and initial certification activities performed after installation

- “Orifice, Nozzle, and Venturi-type”
- “Coriolis” and other

# FFM Accuracy Test



P75

## □ Purpose

- Verifies the quality of the flow data the FFM is measuring and recording.
- Dependent upon initial certification activity
- Dependent upon FFM type/technology

### **Purpose**

(the “WHAT” & “WHY”)

### **Procedure**

(the “HOW”)

### **Frequency**

(the “WHEN”)

### **Acceptability**

(Success or Failure)

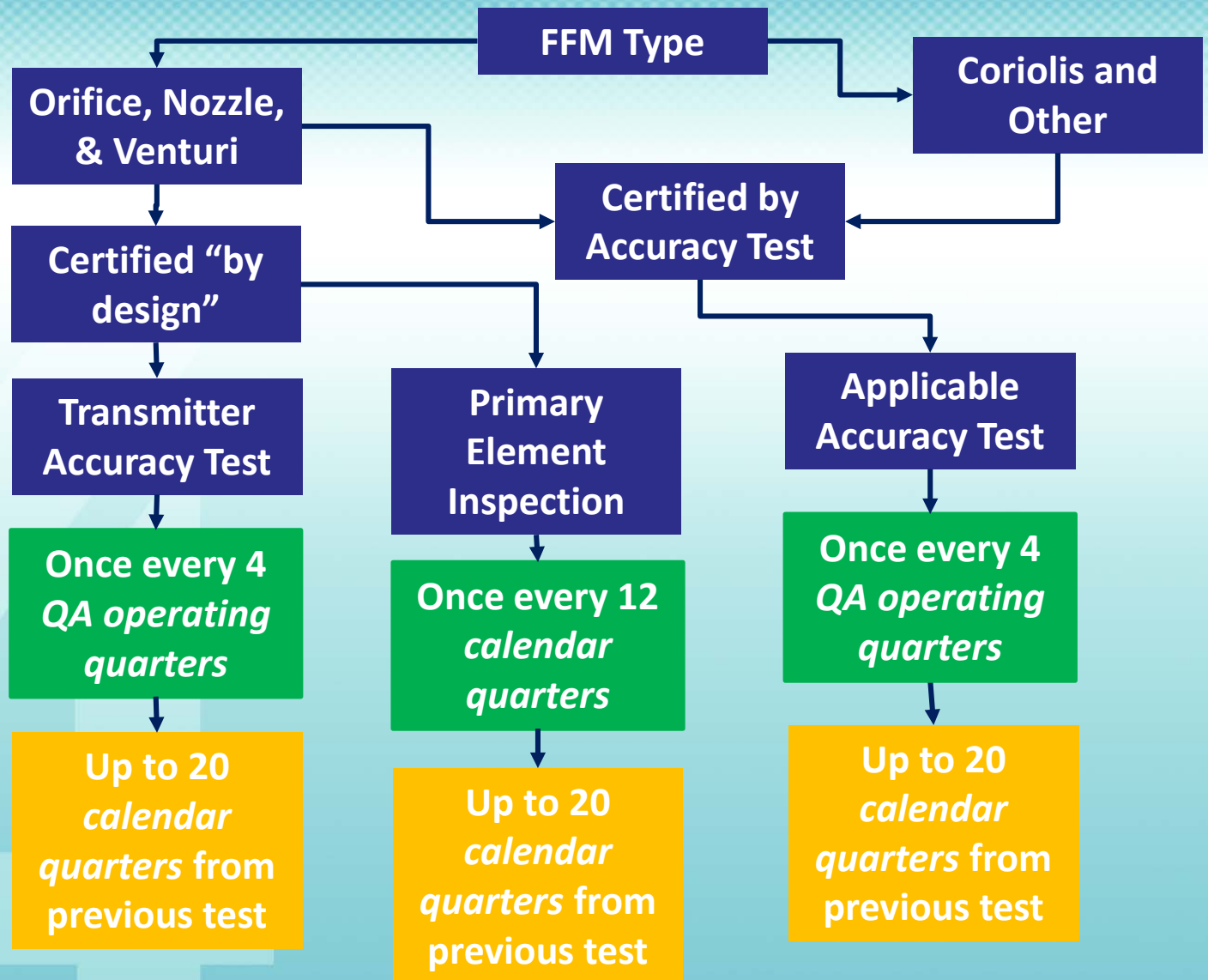
### **Consequences**

# FFM Accuracy Test



P75

<b>Purpose</b> (the "WHAT" & "WHY")
<b>Procedure</b> (the "HOW")
<b>Frequency</b> (the "WHEN")
<b>Acceptability</b> (Success or Failure)
<b>Consequences</b>



# FFM Accuracy Test



P75

- **Acceptability**
  - Shall meet a fuel flowmeter accuracy of 2.0 percent of the upper range value (i.e., the maximum fuel flowrate measurable by the flowmeter) across the range of fuel flowrate to be measured at the unit.
- **Consequences**
  - Data are considered invalid from the date and hour of the failed accuracy test and continuing until the date and hour of completion of a successful accuracy test at all levels.

## Purpose

(the “WHAT” & “WHY”)

## Procedure

(the “HOW”)

## Frequency

(the “WHEN”)

## Acceptability

(Success or Failure)

## Consequences

# Flow-to-Load Ratio Test



P75

## Purpose

(the “WHAT” & “WHY”)

## Procedure

(the “HOW”)

## Frequency

(the “WHEN”)

## Acceptability

(Success or Failure)

## Consequences

### □ Purpose

- A fuel flow-to-load test compares the hourly ratio of fuel flowrate to unit load for a period of quarterly flow data. The hourly ratios are compared to a “reference” flow-to-load to determine accuracy.

### □ Procedure

- The “reference” flow-to-load ratio is the ratio of the average RM flowrate to the average unit load from the last normal-load RATA.

### □ Frequency

- Quarterly (optional)

# Flow-to-Load Ratio Test



P75

## □ Acceptability

- The fuel flow-to-load test is passed if either of these conditions is met:
  - When the quarterly average load value is greater than 50 Megawatts electric (MWe) [or 500 thousand pounds of steam per hour (klb steam/hr)] the results of a quarterly fuel flow rate-to-load evaluation are acceptable if the Ef is no greater than 10%.
  - When the quarterly average load value is less than or equal to 50 MWe (or 500 klb steam/hr) the results of a quarterly fuel flow rate-to-load evaluation are acceptable if the Ef is no greater than 15%.

## □ Consequences

- Data are considered invalid from the date and hour of the failed flow-to-load test and continuing until the date and hour of completion of a successful accuracy test at all levels.

### Purpose

(the “WHAT” & “WHY”)

### Procedure

(the “HOW”)

### Frequency

(the “WHEN”)

### Acceptability

(Success or Failure)

### Consequences

# F-Factor System Test



PG7

## Purpose

(the “WHAT” & “WHY”)

## Procedure

(the “HOW”)

## Frequency

(the “WHEN”)

## Acceptability

(Success or Failure)

## Consequences

### □ Purpose

- To audit FFMs that are relied upon by CEMS to calculate contaminant emissions in terms of mass per unit time.

### □ Procedure

1. Evaluate heat-to-output quarterly data
2. Perform abbreviated heat-to-output data
3. Evaluate hourly heat input to commercial fuel billing

### □ Frequency

- Each calendar quarter

# F-Factor System Test



PG7

## □ Acceptability

- Heat input-to-output ratio  $\leq 10\%$  for input levels  $\geq 171$  MJ/s.
- Heat input-to-output ratio  $\leq 15\%$  for input levels  $< 171$  MJ/s.

## □ Consequences

- Data are considered invalid from the date and minute of the F-Factor System Test and continuing until the minute after corrective action has been taken and that the system has demonstrated it is operating satisfactorily.

### Purpose

(the “WHAT” & “WHY”)

### Procedure

(the “HOW”)

### Frequency

(the “WHEN”)

### Acceptability

(Success or Failure)

### Consequences

# Manufacturer's Test



PG7

## Purpose

(the "WHAT" & "WHY")

## Procedure

(the "HOW")

## Frequency

(the "WHEN")

## Acceptability

(Success or Failure)

## Consequences

- Purpose
  - To calibrate the FFM by the supplier to maintain the accuracy of the instrument within specifications.
- Procedure, Frequency, and Acceptability
  - Manufacturer indicated
- Consequences
  - Data are considered invalid from the date and minute of the test and continuing until the minute after corrective action has been taken and that the system has demonstrated it is operating satisfactorily.

# Let's look at Recertification...



# Poll Question #6

Performing various types of maintenance on a CMS can trigger specific recertification or diagnostic activities that could include the successful completion of QA test (i.e., calibration, linearity, RATA, etc.) prior to the CMS data becoming quality assured.

- a) True
- b) False
- c) Not Sure

# Poll Question #6

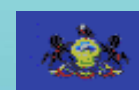
Performing various types of maintenance on a CMS can trigger specific recertification or diagnostic activities that could include the successful completion of QA test (i.e., calibration, linearity, RATA, etc.) prior to the CMS data becoming quality assured.

- a) True
- b) False
- c) Not Sure

# Part 75 Policy Manual, Question 12.10

## Recertification and Diagnostic Test Policy for Dry-Extractive and Hot-Wet Extractive CEMS<sup>(1)</sup>

Description of Event	Event Status <sup>(2)</sup>	RATA	7 Day Cal Error <sup>(3)</sup>	Cycle Time Test	Linearity Check	Calibration Error Test <sup>(4)</sup>	Submit an Event Record	Comments
Permanently replace NO <sub>x</sub> , SO <sub>2</sub> , O <sub>2</sub> or CO <sub>2</sub> analyzer with like-kind analyzer as defined in Question 7.13 ⌘	R	X	X		X	X	X	The rule indicates that the permanent replacement of an analyzer is a recertification event. EPA does not require the cycle time test in this case, since the analyzer is like-kind and the rest of the system is the same.  Modify the Monitoring Plan as necessary.
Permanently replace NO <sub>x</sub> , SO <sub>2</sub> , O <sub>2</sub> or CO <sub>2</sub> analyzer with new analyzer which does not qualify as a like-kind analyzer	R	X	X	X	X	X	X	Modify the Monitoring Plan as necessary.  The rule indicates that the permanent replacement of an analyzer is a recertification event. Thus, all tests are required.
Replace or repair any of the following components:								EPA will conditionally allow the abbreviated linearity check and the alternative system response check (see footnotes (5) and (6)).  For repair or replacement of other major components that are not listed here (e.g., major components of new monitoring technologies or monitoring technology not addressed in this policy), contact EPA for a case-by case ruling.
Photomultiplier	D				(5)	X	A	
Lamp	D				(5)	X	A	
Internal analyzer particulate filter	D			(6)		X	A	
Analyzer vacuum pump	D			(6)	(5)	X	A	
Capillary tube	D			(6)	(5)	X	A	
Ozone generator	D				(5)	X	A	



P75

BP

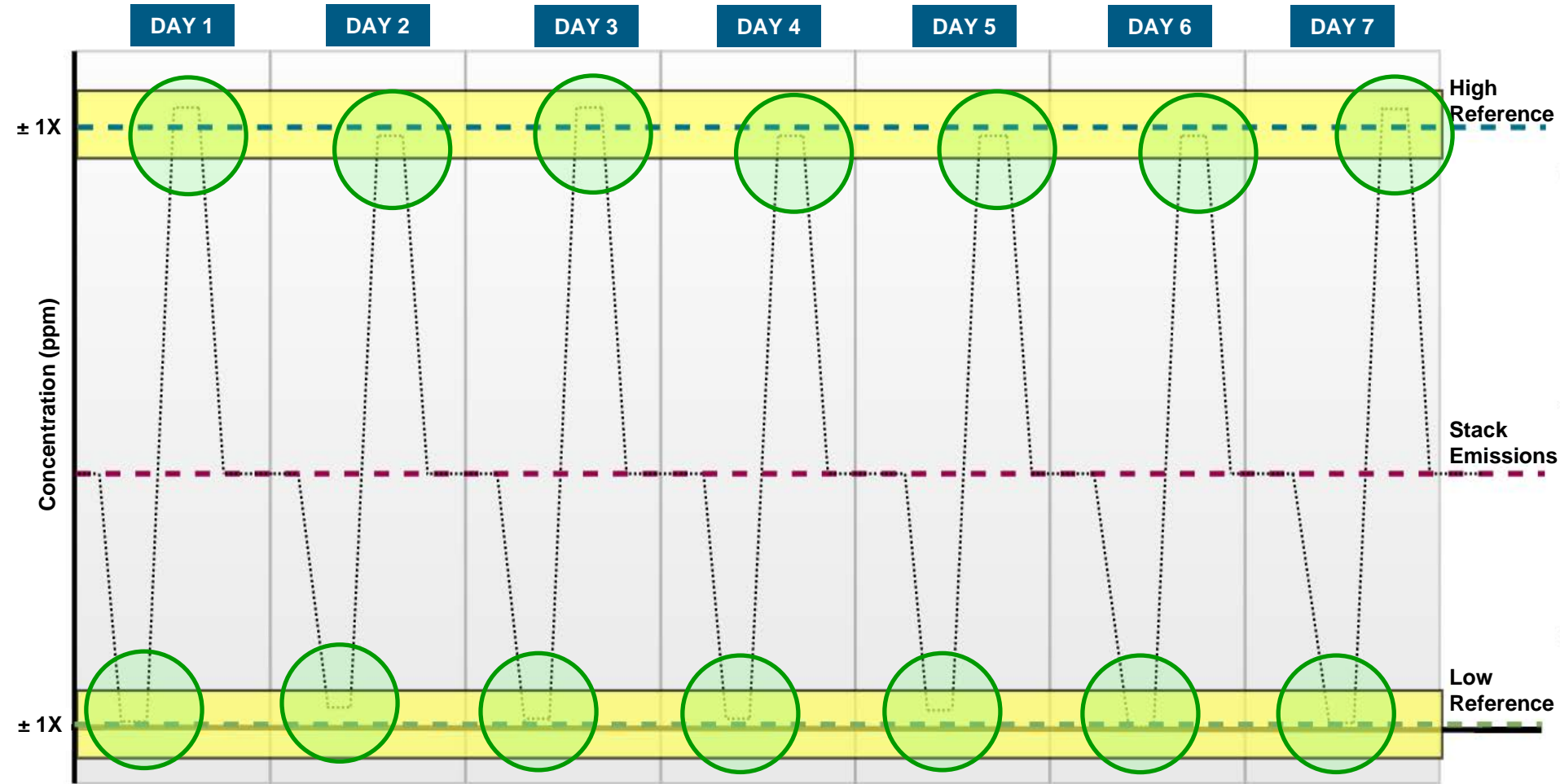
# CMS Recertification

- Defined by
  - 40 CFR Part 75
    - ...replacement, modification, or change in a certified continuous emission monitoring system...that may significantly affect the ability of the system to accurately measure...
  - QA/QC Plan

# Recertification Activities

- To evaluate the acceptability of CMS after installation and ongoing, the following procedures are examples that may be required as part of initial certification (defined by the rule).
  - Calibration Error Test
  - 7-Day Drift Test
  - Linearity Test (LT)
  - Cycle Time Test
  - Relative Accuracy Test Audit (RATA)
  - DAHS Verification

# 7-Day Calibration Drift Test



# 7-Day Calibration Drift Test

## Purpose

(the “WHAT” & “WHY”)

## Procedure

(the “HOW”)

## Frequency

(the “WHEN”)

## Acceptability

(Success or Failure)

## Consequences

- Purpose
  - Verifies CMS does not exhibit excessive calibration drift over a 7-calendar day/operating day period. Calibration drift is measured as the monitor’s response to a low and high level calibration gas.
- Procedure
  - Conduct calibration drift test (CDT) for seven consecutive calendar/operating days.
- Frequency
  - Initial or re-certification

# Cycle Time Test

## Purpose

(the “WHAT” & “WHY”)

## Procedure

(the “HOW”)

## Frequency

(the “WHEN”)

## Acceptability

(Success or Failure)

## Consequences

### □ Purpose

- Verifies system’s response time is acceptable by measuring the time it takes to cycle from a stable low concentration to a stable high concentration and back

### □ Procedure

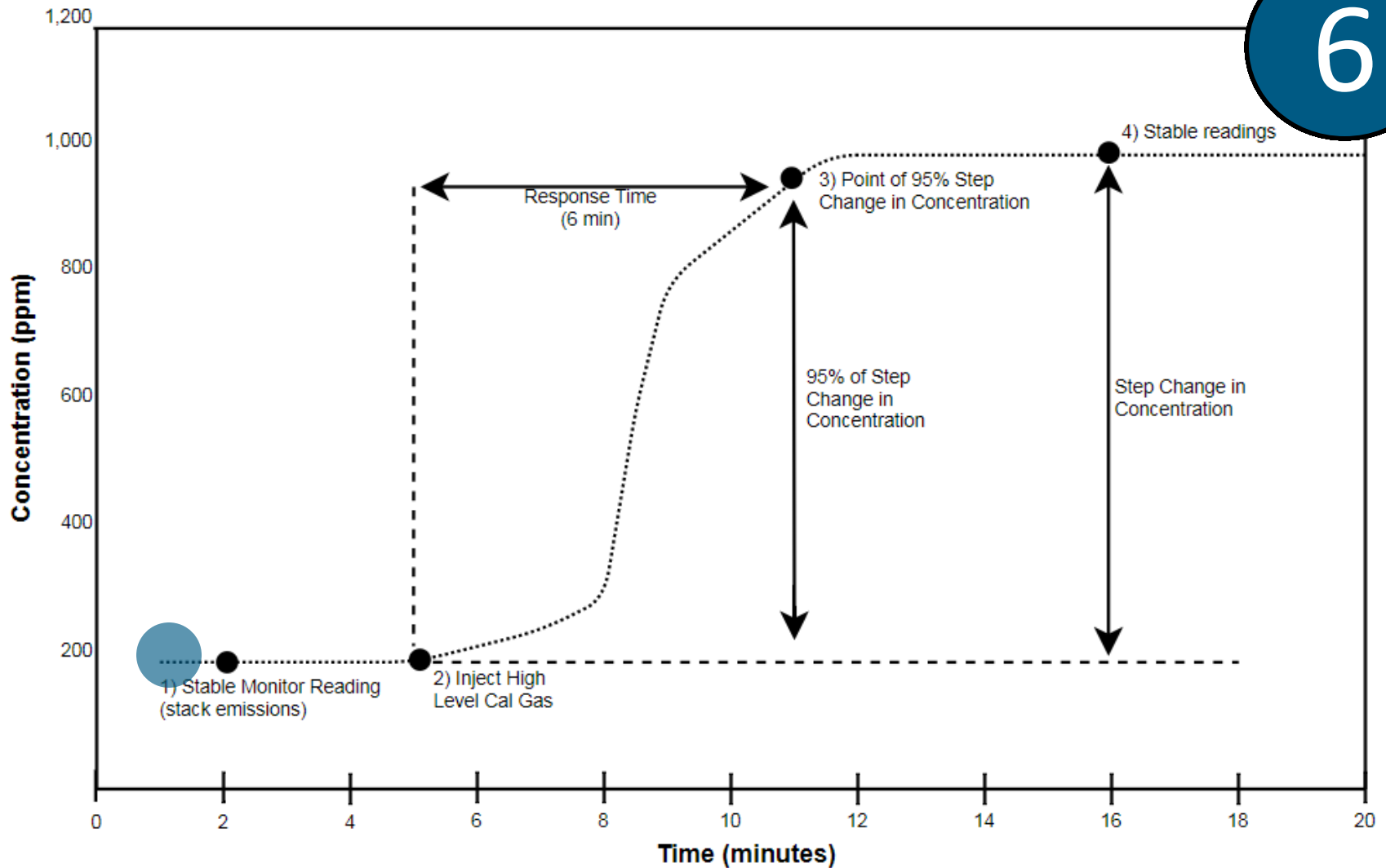
- Introduce zero gas into the system and wait for stable value. Introduce upscale calibration gas and wait for stable value.
- Record time (upscale response time) required to reach 95% of final stable value
- Reintroduce zero gas and wait for stable value before recording response time (downscale response time)
- Repeat three times to determine the mean upscale and downscale response time.

### □ Frequency

- Could be required as part of initial or re-certification

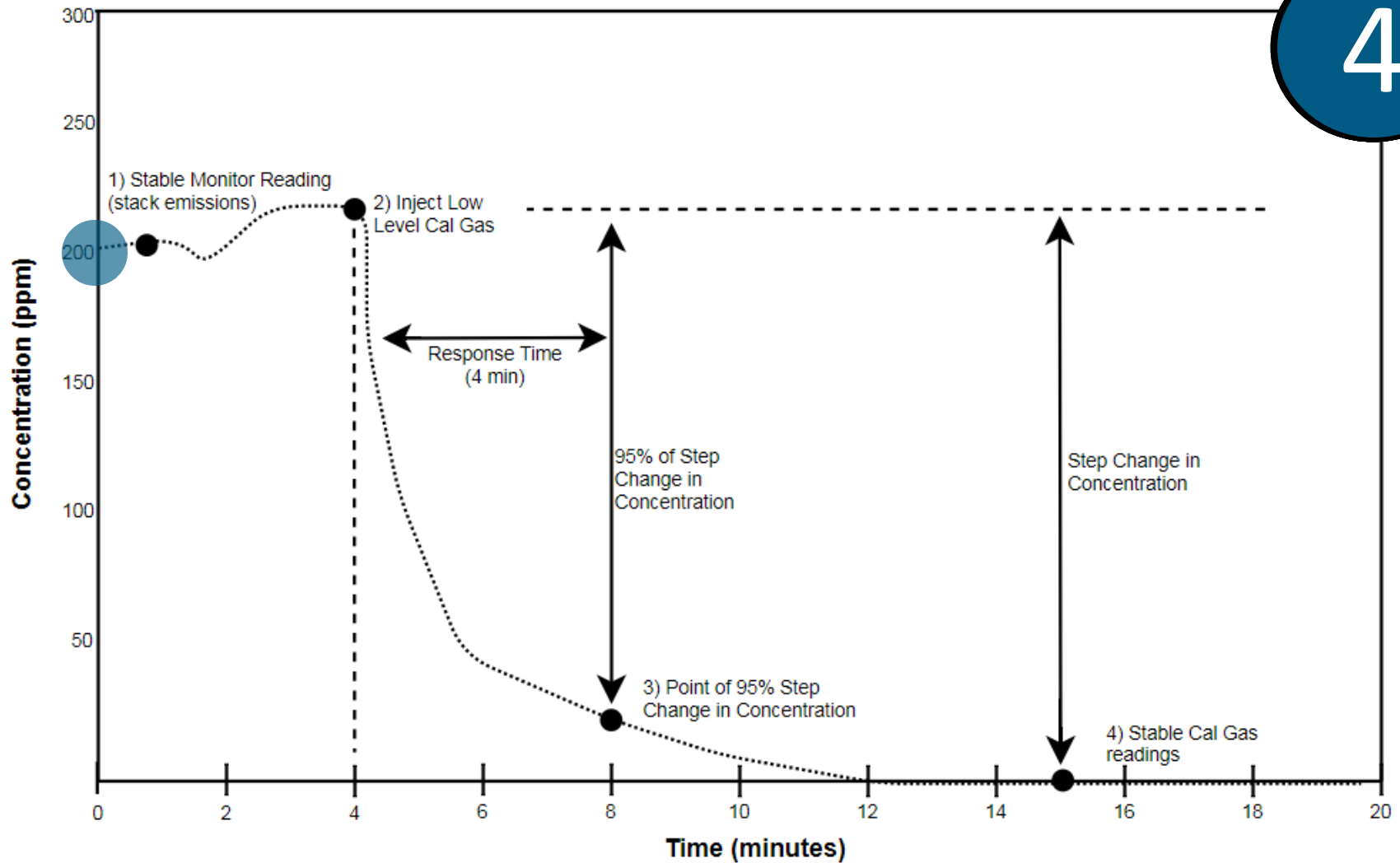
# Upscale Cycle Time Test

6



# Downscale Cycle Time Test

4



# Cycle Time Test

## □ Acceptability

- Performance specification-specific
  - Example: §4.5 of PS-4B for CO and O<sub>2</sub> CMS
    - *“The response time for the CO or O<sub>2</sub> monitor must not exceed 2 minutes.”*
- To demonstrate compliance with minimal sampling frequency requirements (i.e., once every 15 minutes)

## □ Consequences

- Potentially not certified
- System redesign

### **Purpose**

(the “WHAT” & “WHY”)

### **Procedure**

(the “HOW”)

### **Frequency**

(the “WHEN”)

### **Acceptability**

(Success or Failure)

### **Consequences**

# Let's look at Auditing...



# Auditing

## 6.5.2 Independent Inspection

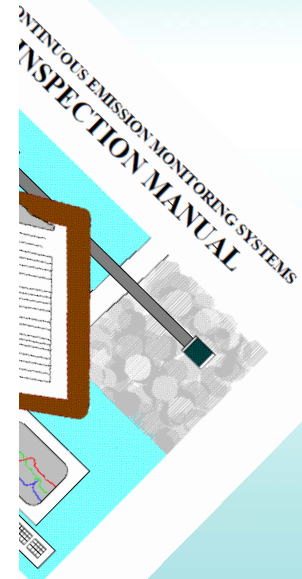
The CEM system and the QA/QC program must be evaluated by an independent inspector every 12 months  $\pm$  1 month.

The inspector must review the QA/QC manual, the CEM system operation, reports, and other associated records to determine if the procedures in the QA/QC manual are being followed. The inspector must also note any changes in the system or the procedures since the last yearly evaluation and ensure that these have been included in the QA/QC manual.

The inspector must report the findings and observations to the CEM system management and the appropriate agency within 30 days after the evaluation is completed. This report may include recommendations for improvements in the CEM system or its operation.






Part 75 CEMS



# Auditing

## 9. Optional Control Equipment Parameter Monitoring (§ 75.34)

What to Check	Observations
<p>Check the QA/QC Plan which will identify add-on SO<sub>2</sub> or NO<sub>x</sub> control equipment parameters and acceptable ranges if the source is using add-on control equipment missing data options. Parameters and acceptable ranges are required by App B, § 1.1.1.</p>	
<p>Review control equipment parameter monitoring records for a number of missing data periods. Compare the parameter data to the acceptable ranges in the QA/QC Plan. Identify any periods when the range is exceeded and how the missing data period was flagged in the DAHS (control operating properly or not operating properly).</p>	
<p>Ask the source how it enters proper control equipment operation for missing data periods into the DAHS. Manual entry of missing data period information is allowed by Part 75.</p>	  



# Logbook Comments

- ❑ Comments are the most important component of alarm acknowledgment
- ❑ Elements of a great comment – Answer the 4 WHATs
  - What happened?
  - What did you find?
  - What did you do to resolve the problem?
  - What QA activities did you perform after the resolution occurs?

# Reference Material

- **Ethos Energy One Pagers**
  - [Span and Range Evaluation checklist](#)
  - [New Jersey CEMS QA/QC](#)
  
- **Ethos Energy Environmental Bulletin Topics**
  - [Missed diagnostic linearity implication](#)
  - [CEMS maintenance](#)
  
- **EPA References**
  - [EPA Clean Air Markets Division Contacts](#)
  - [EPA Regional CEMS Contacts \(for RATA notices\)](#)
  - [Part 75 Emissions Monitoring Policy Manual \(8-2013\)](#)
  - [ECMPS Reporting Instructions \(3-2017\)](#)
    - [Quality Assurance and Certification \(9-14-2016\)](#)
  - [Plain English Guide to Part 75](#)
  - [EPA AIR Emission Measurement Center \(EMC\)](#)

**Let's talk...**



# Thanks for watching this session!

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