

**Custom Instrumentation Services Corporation** 

#### 2016 USERS GROUP PRESENTATION: Calibration Checks

### **Calibration Topics**

#### Basics of Calibration Checks:

- ► Validate Analyzer Data per 24 hour cycle
- Sequencing Calibration Gases
- ➢Nitrogen Versus Oxygen Zero Gas
- ➢ Part 60 Versus Part 75 Regulations
  - Other Regulations may apply, but not discussed here (PADEP, SQAQMD, CANADIAN)
- ➢ Part 60 Warning Terminology
- Online Versus Offline Calibration Checks

## Validation of Data

- An Analyzer's response to the gas it is designed to measure is an electronic signal. Calibration Gas provides reference points for the detector output, and allows us to give assign the output concentration values in terms of ppm or %.
- The accuracy of an analyzer's output signal is entirely attributed to the concept that the Calibration Gas Concentration value is true.
- Daily Calibration Checks are required to verify that the analyzer is providing true values.
- Therefore, the method of delivering, timing and sequencing of the calibration gases is one of the most important aspects of an automated CEMS.

### **Calibration Gas Sequence**

#### Sequencing is not regulated, based on best practice

#### Zero is usually first.

- Normal Emissions rates are low, close to zero, so purging out the process pollutant concentrations will happen quickly
- > Can use Nitrogen or Oxygen, this choice is discussed later
- Low Analyzer Range Spans for NOx, CO, SO2. The jump from zero is significant, so do the low range spans first
- ➢ High Analyzer Range Spans for NOx, CO, SO2.
- Oxygen Span: When not using O2 for the zero gas, run the Oxygen as the last gas since this will flush out the high concentrations of Span gas from the previous span check.
- If ending the cal sequence using a High Range Span gas, be sure to supply enough end-of-cal purge time to flush out the high concentrations

## **Cal Gas Selection**

#### Use O2 for Zero gas or Nitrogen?

- > Nitrogen is very cheap and provides excellent zero capability
- CEMS Zero Nitrogen is readily stocked by suppliers and so can be delivered quickly
- Oxygen performs dual purpose of providing a zero for Non-oxygen analyzers, and spanning the Oxygen analyzer. This decreases the Calibration Check Duration.
- Use Instrument Air for O2 Span or Cal Cylinder?
  - Part 75 Policy Manual has clarified that Instrument Air may be used for as the high gas for Daily Calibration Checks and Linearity Checks.
    - They do require that the air be free from contaminants, how can this be proven?
  - Using Instrument air extends the calibration sequence (refer to O2 Zero gas above). This might cause invalid hour data under some circumstances or if multiple cals are run in an hour

### **Cal Gas Selection**

#### Compatible Gas Combinations

- Blending Gases allows multiple analyzers to be Calibration Checked at the same time. This helps reduce the calibration period, which might help prevent CEMS downtime.
- Not all gasses may be mixed. Here are some combinations we know will work:
  - NOx & CO
  - CO & O2
  - ➤ CO2 & O2
  - > SO2 & NOx & CO2
- NOx and O2 do NOT blend well together.

#### Some things CiSCO has learned about gas Blends

- When a system has an NH3-Nox determination method analyzer. We avoid mixing NO and CO into the same cylinder. This is because of the presence of the NH3 converter required by this method. The converter operates at 1200-1500 °F. When NO & CO are present in the NH3 converter, the high temperature causes a reaction between NO & CO to produce N2 & CO2. Thus, the NOx analyzer will not see much NO. Note that this affect does not occur when process gas is present as oxygen in the process gas will react quicker with the CO and leave the NO intact.
- Pulsed fluorescent SO<sub>2</sub> analyzers (Teledyne for example), will allow interference between NOx and SO<sub>2</sub>, i.e. the NOx will 'pulse' similarly to SO2 and result in erroneously high readings. This only happens when NOx and SO2 are present in the nitrogen based calibration gas, not when process gas is present. This is believed to be due to a quenching affect that CO2 and other process gasses have upon the NOx molecule. Therefore, we find that Blending NO & SO2 in Nitrogen **does not work** but blending NO & SO2 & CO2 in Nitrogen does work.

# **Calibration Timing Settings**

- Standard settings for CiSCO systems:
  - <u>4 minutes of Purge Time</u> for each Gas. Purging is performed with the calibration gas that is used to challenge the analyzer.
    - > Purge Times are User Settings in the OIT panel or Realview.
    - Setting Purge times lower, saves gas, but raises possibilities of unstable results, especially during times of high emissions; startup, shutdown, process variations.
  - 1 Minute of Sample Time for Each Gas. Once the purge time is completed, the CEMS Datasystem begins averaging data for a period of one minute, the end result, being the cal check response.

➤ Sample Time is not changeable.

- End-of-Cal Purge Time. Once the last Cal result is calculated, the last cal gas is shutoff, and process gas begins to enter the system. The End Of Cal purge time should be set long enough to allow the process gas to travel to the analyzer, and the analyzer stabilize on the process values.
  - > Typically set to 2 minutes, this is a user changeable setting.

# **Calibration Timing Settings**

- Notes on Purging:
  - Longer Purge times are required when NH3 injection not working.
    - Without NH3 injection, NOx emissions rates may be as high as 20-40 ppm.
    - NOx can get hung up in the system, especially in the Probe Filter, Sample Filter, and membrane dryer.
    - Although Nox response on the analyzer may seem to react quickly, cleaning out the residual Nox of 0.5 ppm or less can take an extensive period of time.
    - For systems that are trying to perform a 7-Day drift test before NH3 injection is functioning, we have to set purge times to 6-10 minutes.
  - > <u>Alternate to Purging with Cal Gas</u>: Use Instrument Air
    - Most systems we design have instrument air plumbed to the Calibration Manifold of the system. Air may be used for Calibrating the O2 Span, but also is a cheaper alternative for extended purge times. Adding Air to the Calibration Manifold is easy to do even if the Air is not required for calibration of the O2 Analyzer.

### Regulations Related to Calibration Checks

#### • 40 CFR Part 60, Part 75

- Both Regulations are applicable to most Gas Turbine Power Producers
- There are multiple regulations regarding the Quality Assurance standards of gas analyzers. For Part 60 and Part 75 their respective Appendix B sections describe the requirements for Calibration Check Tolerances
- Because the limits are somewhat different, CiSCO reports show the tolerance level for each regulation, and are labeled accordingly.
- CiSCO Software also evaluates the calibration result based on both regulations and will flag a Calibration Check fail as either per Part 60, Part 75 or both, as appropriate.

## Regulations Related to Calibration Checks Continued

#### Performance Specifications:

- These are the minimum Calibration Check Tolerances for Calibration Accuracy. An analyzer must only meet the Performance Specification at initial Certification during the 7-Day Drift Test.
- Performance Specifications are written for each Type of gas Measurement, and so Nox, CO and O2 have different specifications.

#### Twice the Performance Specification:

- Part 60 provides a warning drift limit for Daily Calibration Checks which is equal to the Performance Specification x 2 (see Chart)
- Part 60 Goes on to say that if the analyzer were to exceed the warning limit for 5 consecutive days, the analyzer data would then be flagged as **Out of Control and analyzer data is** invalidated retroactively for the entire period starting with the first warning limit exceedance.
- Part 75 does not provide a warning limit, instead 2 x the Part 75 Performance Specification results in an Out of Control Fail and analyzer data is invalidated.

#### • Four Times the Performance Specification:

Part 60 Regulations require that an analyzer is Out of Control if it fails to meet the tolerance limit equal to 4 x the Performance Specification. Data is Invalidated.

# Cal Fail Terminology

#### Twice the Performance Specification for Part 60:

- The Part 60 warning drift exceedance has been flagged in CISCO Calibration Reports as "Cal Fail Above" or "Cal Fail Below". Recently this has been changed in CeDAR 5 to "Cal Drift Warning"
- Labeling it as "Cal Fail Above/Below" Caused some confusion/dissatisfaction among our customers as it implies the analyzer data must be invalidated, even though it would not actually be invalidated. We claimed that the use of the word 'Fail' was better since it prompted a stronger response to correct the issue. It is our belief that that analyzer should never exceed 2 x the performance specification unless a serious problem exists.
- Calibration Check results that result in "Out of Control" Status causes analyzer data to be invalidated. Data will remain invalid until a passing calibration check occurs.
- Part 75 States that for dual range analyzers where only one of the two ranges fails calibration, the result will be that both ranges will be flagged as Out of Control. Part 60 does not specify how to handle this case, but we adopted the Part 75 Rule as our standard.

#### **Calibration Check Tolerance Limits**

		Part 60 Limits		_ Part 75 Limits
	Performance Spec/ 7- Day Drift Limit	Daily Warning Limit (X2) **	Daily Out of Control Fail (X4)	Fail
Nox, SO <sub>2</sub> *	2.5% / Part 60 5 ppm/Part 75	5.00%	10.00%	5 ppm or 5% of span (Span <u>&lt;</u> 50 ppm). 10 ppm or 5% of span (Span > 50 ppm).
CO *	5.00%	10.00%	20.00%	N/A
O <sub>2</sub> Limit in %	0.50%	1.00%	2.00%	1.00%

\* NO<sub>x</sub> CFR Part 60 Limits are based upon percentage for the Analyzer Range, while CFR Part 75 Limits are based upon Analyzer Span (not always the same).

\*\* Five consecutive daily warnings results in an out-of-control fail.

## Regulations Related to Calibration Checks Continued

- Does Process Online / Offline Status Affect Calibration Checks?
  - If a process is down, a calibration check is not required. South Coast Air Quality Management District sites are an exception.
  - If a Process goes online at a time when the analyzer has not performed a successful calibration check in 24 hours, the system will create a "No Calibration in 24 Hours" Alarm.
  - Part 60 does not specifically say what happens if the 24hour clock for a valid calibration check is exceeded, so we only invalidate data based on Part 75 Rules.

### Regulations Related to Calibration Checks Continued

#### Does Process Online / Offline Status Affect Calibration Checks?

- > Part 75 has a few scenarios for how to deal with a missing calibration:
  - If the site has been down for an extended period, greater than 1 hour, and has not performed a valid Calibration Check in 24-hours, then it is given an 8-hour grace period before data is invalidated.
  - If the site has only been down for a brief trip, less than 1 hour, then the grace period is only 2-hours beyond the 24-hour period since the last valid cal.
  - Part 75 requires Online Calibrations for Validating data. However, the site may conduct an Online/Offline comparison test. If difference between and online/offline cal are within the allowed tolerances, then data may be validated during Off-line Calibrations. It is standard for CISCO to include this test during certification for our sites.
  - If an analyzer Fails a calibration check due to a non-system, non-analyzer problem, such as a Power Outage, Incorrect Cal Cylinder, or Other human error, data will not be invalidated due to the fail, however, the condition for a valid calibration has not been met. So the site is still on the standard cal clock, which might result in a 2 or 8 hour grace period to perform a valid cal. The CEMS Datasystem will not understand the conditions, and so will flag data as invalid at the time of the cal fail, it Is up to the user to edit the monitoring code to validate data in this case.
- CiSCO recommends performing cal checks everyday unless an extended downtime is expected.

## Questions?

• Thanks –

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