
Control Chart Methodology for Evaluating CEMS Data

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Intro

- ◆ Control charts are an effective tool for identifying unusual shifts in a parameter that should be fairly constant for a given operating condition
- ◆ One use is to detect bias from probe leaks in dilution monitoring systems. Calibrations do not necessarily detect system leaks.
- ◆ EPA reference method systems utilizing the dilution probes can have air in-leakage (harder to control-chart) – check for unexplained CO₂ shifts (see previous RATAs)



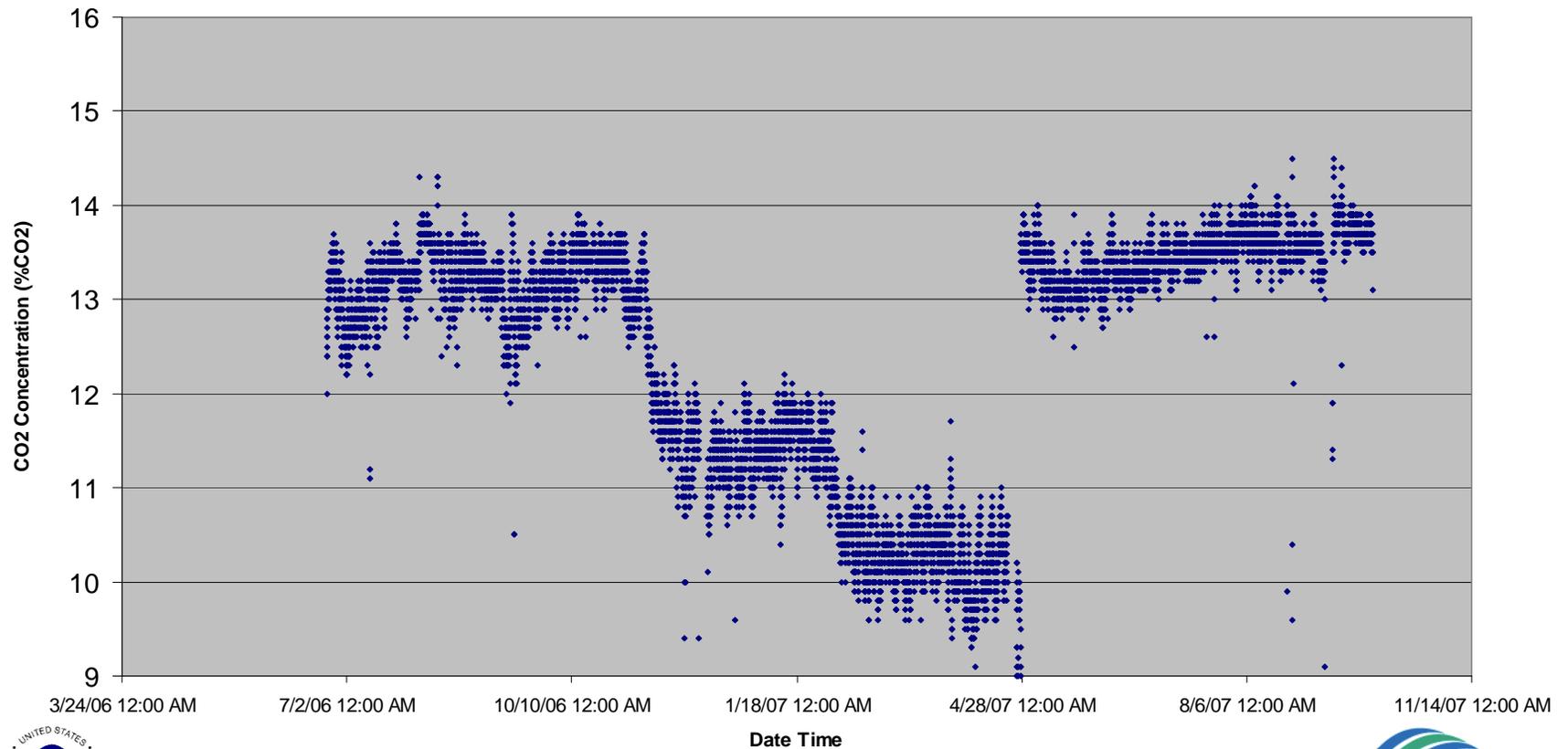
EPA CO₂ Control Chart Auditing

- ◆ EPA runs the control chart audit on CO₂ data quarterly so as to minimize in the future the amount of data that could be called into question
- ◆ This audit is run in an “ad-hoc” manner after the data has been submitted to EPA.
- ◆ EPA continues to refine this technique to “weed out” false positives.
- ◆ EPA also looks to use this sort of auditing on other parameters as appropriate to identify questionable data



Example Hourly CO₂ Data

Hourly CO₂ Concentration Data



Data Used for Analysis

- ◆ CAMD uses CO₂ concentrations used as the control parameter given its relatively low variability in any given load band
- ◆ Use normal load data – avoid start-up, shut-down, and very low loads
- ◆ Avoid substitute data (part 75 only) – use method of determination code (MODC) of “01” – measured data only
- ◆ Need date of completion for last CO₂ RATA



Data Preparation

- ◆ Identify load bin to evaluate
 - CAMD batch evaluation uses the most used load bin (load bin with highest % usage)
 - Other load bins can be evaluated as desired
- ◆ Minimum Criteria for Daily Data:
 - CAMD discards all CO₂ data for days with less than six quality assured measured values in the load bin of interest

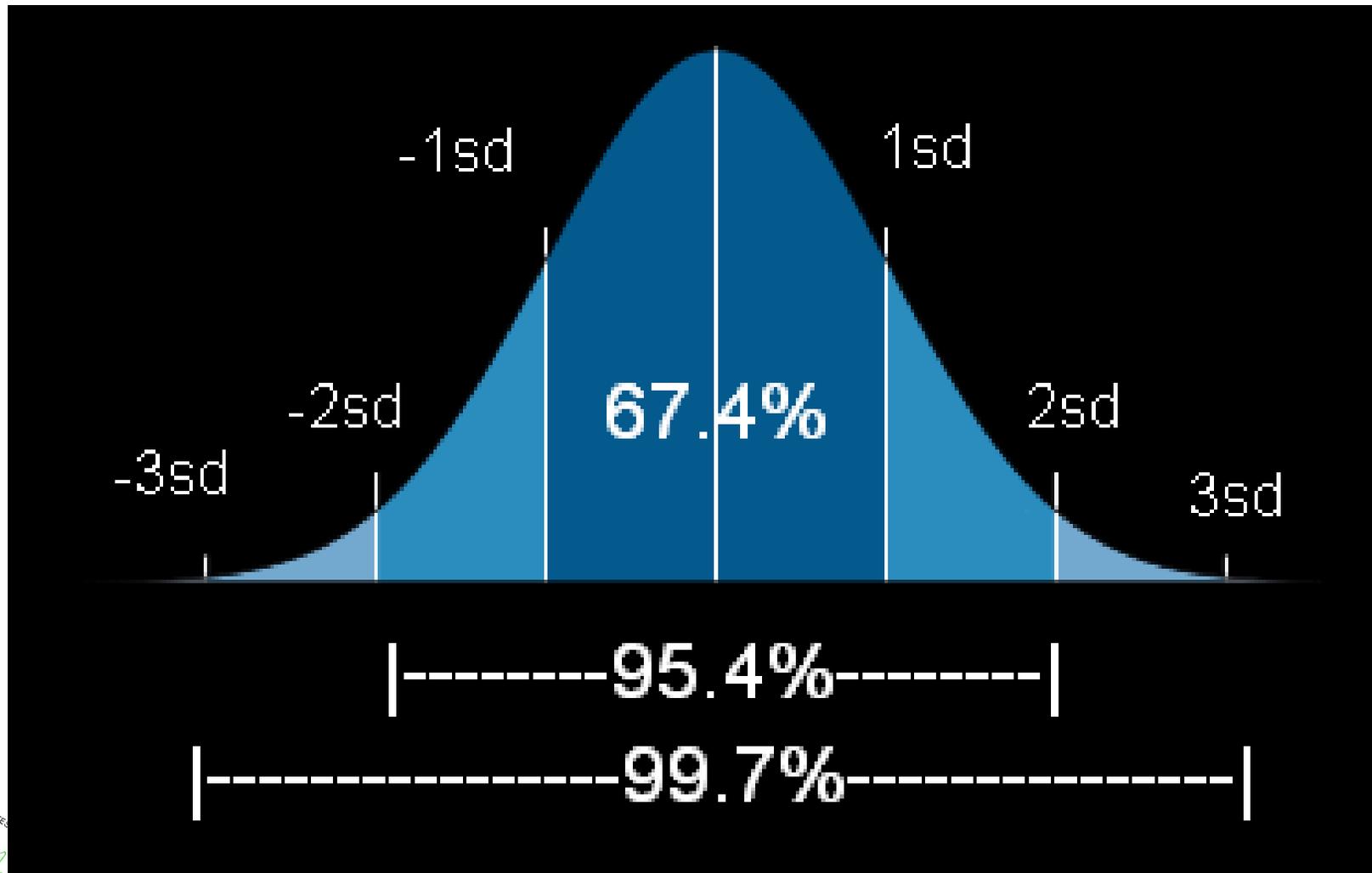


Determining Baseline Mean and Control limits

- ◆ Baseline data is compiled from the 30 calendar days following a successful CO₂ RATA (more if less than 15 days meet the minimum criteria)
- ◆ The following values are calculated for the baseline period:
 - The daily average CO₂ concentration, (AC_i);
 - The **baseline mean** CO₂ concentration, (AA_B); and
 - The standard deviation of the daily average CO₂ values over the baseline period, (SD_B)
- ◆ The control limits are set based on the standard deviation of the baseline data.



Normal Distribution



Determining Control Limits

- ◆ EPA uses $AA_B \pm 3 SD_B$ as the audit level as 99.7% of the daily averages should fall within this range.

- ◆ Therefore:

- The upper control limit is:

$$XUCL = AA_B + 3 SD_B; \text{ and}$$

- The lower control limit is:

$$XUCL = AA_B - 3 SD_B$$

- ◆ EPA recommend that sources use $AA_B \pm 2 SD_B$ as a control warning level



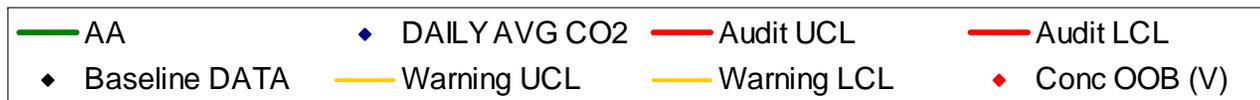
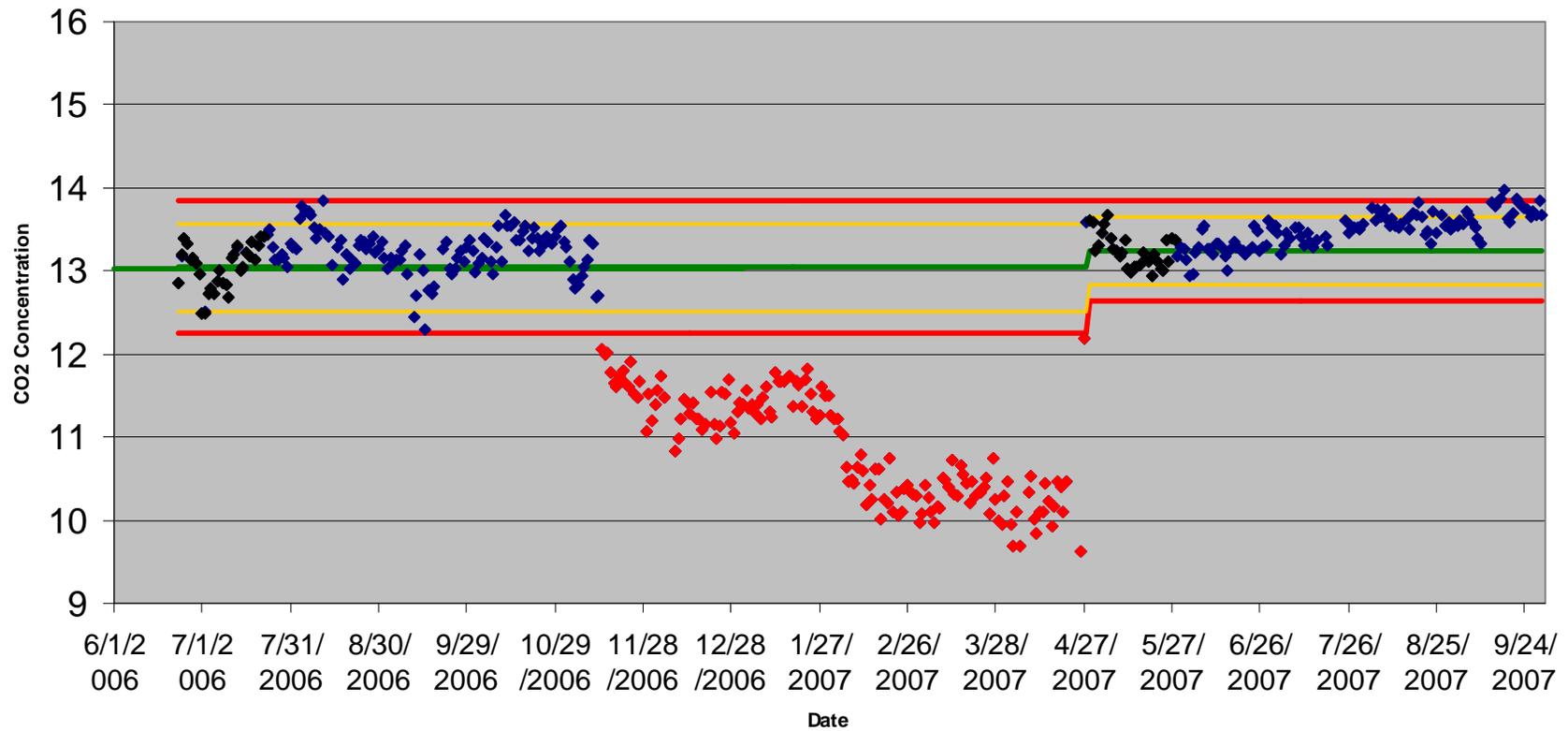
Evaluating Daily Data Against the Baseline

- ◆ Compare each daily average CO₂ concentration value to the calculated control limits.
- ◆ Flag any day where the average CO₂ value is outside of the control limits.
 - High and Low deviations are tracked separately
- ◆ Whenever 7 or more consecutive daily averages are out-of-bounds (consistently high or low) the data for the unit is flagged as having developed a potential bias, and possible sampling system leak.



Identify Data Outside of the Control Limits

Daily Average CO2 Concentration Control Chart



Leak Detection and Prevention of Data Loss (i.e., Avoiding the audit letter)

- ◆ EPA encourages all facilities with CO₂ CEMS data to follow the procedures described in this presentation to identify early any questionable data as an added QA step.
- ◆ If you see the CO₂ drop for more than a few days, investigate to find the cause and take appropriate action.
- ◆ EPA recommends investigation at the 2σ level
- ◆ In such cases, consider the data validity for other parameters that might also need to be invalidated.
- ◆ Document all findings.

