Data Quality Indictor Report (AMP255)

AQS Conference

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Topics

- Background – 40 CFR Part 58 Appendix A
- One Point Quality Control Check for Gases
- Annual Performance Evaluation for Gases
- Flow Rate Verification for PM and Lead
- Semi-Annual Flow Rate Audit for PM and Lead
- Collocated Audits for PM and Lead
- Performance Evaluation Program for PM and Lead
- Lead Analysis Audits

Background (1)

- 40 CFR Part 58 Appendix A contains the regulatory requirements for monitoring QA
  - The AQS Data Quality Indicator Report, AMP255, implements the assessments defined in Appendix A.
  - The report presents completeness, precision, and bias statistics for these assessments.
  - This AQS faciltiy provides both a print-formatted report and workfiles for importing into Excel (note: Currently, there is a problem with the Excel files).
  - Summarizes data reported on QA/QC transactions (RP and RA transactions) and computed for collocated monitors (from RD transactions)

Background (2)

- The report is used as part of the certification process.

- The report separately presents data for "Regulatory" monitors vs Non-Regulatory monitors. Non-Regulatory monitors are those with a monitor type set to "NON REGULATORY"

  – Non-regulatory monitors are labeled with "App A?: No"

  – All others are labeled with "App A?: Yes"

Calculations: Relative Percent Difference

- Basis for all statistical calculations
- For Gases:

$$d_i = \frac{meas - audit}{audit} \times 100$$

- For Collocated Samples (including PEP):

$$d_i = \frac{X_i - Y_i}{(X_i + Y_i)/2} \bullet 100$$

  – Where X_i is the primary sample and Y_i is the collocated sample

One Point QC Check (1)

- A one-point quality control (QC) check must be performed at least once every 2 weeks on each automated analyzer used to measure SO_2, NO_2, O_3 and CO.
- Report is organized by pollutant and regulatory/non-regulatory
- Detail data is presented by Monitor and summarized first by year then by PQAO.
- Monitor detail Begin and End dates are the intersection of report date range, Sample Period, and PQAO assignment
- Number required reflects CFR specifying assessments every 2 weeks for date range
- Number of Observation is number of Gaseous RP transactions loaded in date range

One Point QC Check (2)

- ## Coefficient of Variation (precision estimate)

$$CV = \sqrt{\frac{n \bullet \sum_{i=1}^{n} d_i^2 - (\sum_{i=1}^{n} d_i)^2}{n(n-1)}} \bullet \sqrt{\frac{n-1}{\chi_{0.1,n-1}^2}}$$

Chi-Squared Distribution

- ## Bias

$$Bias\_Estimate = \frac{1}{n} \bullet \sum_{i=1}^{n} |d_i| + t_{0.95,n-1} \bullet \frac{AS}{\sqrt{n}}$$

Student-t Distribution

Standard Error

- – Where

$$AS = \sqrt{\frac{n \bullet \sum_{i=1}^{n} |d_i|^2 - (\sum_{i=1}^{n} |d_i|)^2}{n(n-1)}}$$

One Point QC Check (3)

- Sign of Bias
  - If the 25th percentile of the relative percent difference and 75 percentile are both negative, then the sign of the bias is negative.
  - If the 25th percentile and 75th percentile are both positive, then the sign of the bias is positive.
  - If the 25th percentile is negative and the 75th percentile is positive, then the sign of the bias is undetermined (+/-)

Annual Perfomance Evaluation (1)

- Each calendar quarter (during which analyzers are operated), evaluate at least 25 percent of the SLAMS analyzers that monitor for SO_2, NO_2, O_3, or CO such that each analyzer is evaluated at least once per year.
- Report is organized by pollutant
- Detail data is presented by Monitor and summarized first by year then by PQAO.
- Monitor detail Begin and End dates are the intersection of report date range, Sample Period, and PQAO assignment
- Average Percent Difference is displayed by Audit Level (levels 1 – 10)

Annual Perfomance Evaluation (2)

- "Obs / Q" is the number of RA transactions submitted for each quarter
- "Criteria Met?" Is determined by the CFR requirement for one audit per site with 3 levels each year

- Confidence limits are on the mean relative percent difference of the **<u>1-point QC Checks</u>**:
  - Upper 95% Confidence Limit = Mean + 1.96 * Standard_Deviation
  - Lower 95% Confidence Limit = Mean – 1.96 * Standard_Deviation
  - These are displayed only for summary rows (year and PQAO)
- The report also computes the percent of the **<u>Annual PE</u>** percent differences between the confidence limits on the **<u>1-point QC Checks</u>**

Flow Rate Verifications (1)

- A one-point flow rate verification check must be performed at least once every month on each automated analyzer used to measure PM_{10}, $PM_{10-2.5}$ and $PM_{2.5}$. (TSP is quarterly)
- Report is organized by pollutant
- Detail data is presented by Monitor and summarized first by year then by PQAO.
- Monitor detail Begin and End dates are the intersection of report date range, Sample Period, and PQAO assignment
- Number required is based on the date range (number of full months or quarters)

Flow Rate Verifications (2)

- Number of Obs: Number of Flow type RP transactions submitted in the date range

- Average %D: Arithmetic mean of relative percent differences

- %Complete: 100 X Number of Obs / Number required

Flow Rate Verifications (3)

- Bias

$$Bias\_Estimate = \frac{1}{n} \bullet \sum_{i=1}^{n} |d_i| + t_{0.95,n-1} \bullet \frac{AS}{\sqrt{n}}$$

  - Where

$$AS = \sqrt{\frac{n \bullet \sum_{i=1}^{n} |d_i|^2 - (\sum_{i=1}^{n} |d_i|)^2}{n(n-1)}}$$

Flow Rate Verifications (4)

- Sign of Bias
  - If the 25th percentile of the relative percent difference and 75 percentile are both negative, then the sign of the bias is negative.
  - If the 25th percentile and 75 percentile are both positive, then the sign of the bias is positive.
  - If the 25th percentile is negative and the 75 percentile is positive, then the sign of the bias is undetermined (+/-)

Semi Annual Flow Rate Audits (1)

- Every 6 months, audit the flow rate of the PM_{10}, $PM_{10-2.5}$ and $PM_{2.5}$ particulate analyzers.
- Report is organized by pollutant
- Detail data is presented by Monitor and summarized first by year then by PQAO.
- Monitor detail Begin and End dates are the intersection of report date range, Sample Period, and PQAO assignment
- Number required is based on the date range (number of six-month periods)

Semi Annual Flow Rate Audits (2)

- Number of Quarters with data: Number of calendar quarters in date range with Flow Audit RA transactioins

- % Completeness: 100 X number of quarters with data / number required

- Criteria Met: a) The number of required audits were performed, and b) if 2 audits are required, then they are between 5 and 7 months appart.

- Numer of Observations per Quarter: Number of Flow Audit RA transactions submitted in quarter

- Average %d: Arithmetic mean of %d

- Confidence limits on the mean relative percent difference of the **<u>Flow Rate Verifications</u>**:
  - Upper 95% Confidence Limit = Mean + 1.96 * Standard_Deviation
  - Lower 95% Confidence Limit = Mean – 1.96 * Standard_Deviation
  - These are displayed only for summary rows (year and PQAO)

- The report also computes the percent of the **<u>Flow Rate Audit</u>** percent differences between the confidence limits on the **<u>Flow Rate Verifications</u>**

Collocated Audits: Collocation Detail (1)

- The report contains a detail section (monitor level) and a summary section (by year and PQAO)

- The report is organized by pollutant (e.g. PM 10)

- Only measurement values above the following will be consdiered valid: TSP: 20 ug/m^3, Pb: 0.02 ug/m^3, PM10 hi-vol: 15 ug/m^3, PM10 low-vol: 3 ug/m^3, PM2.5: 3ug/m^3, PM10-2.5: 3ug/m^3

- The POC provided on the detail section is for the primary monitor

- Monitor detail Begin and End dates are the intersection of report date range, Sample Period, and PQAO assignment

- The number required is based on every 12 days

- Values for both Lead 12128 and 14129 will be combined

- "# Obs" is the number of precision pairs (either submitted as RP or RD transactions)

- "# Valid": This is the number of collocation pairs with concentrations above the thresholds provided above

- % Complete: 100 X #Obs / #Req (i.e. ignores validity)

- Coefficient of Variation: (precision estimate)

$$CV = \sqrt{\frac{n \cdot \sum_{i=1}^{n} d_i^2 - (\sum_{i=1}^{n} d_i)^2}{2n(n-1)}} \cdot \sqrt{\frac{n-1}{\chi^2_{0.1,n-1}}}$$

Collocated Audits: Collocation Summary (1)

- The summary section provides summaries by year and PQAO
- The report is organized by pollutant, year, and method
- Values for both Lead TSP parameters (12128 and 14129) will be combined.
- # Sites: Number of distinct sites reporting with that method.
- # Collocated Required: 15% of the sites for the pollutant must have collocated monitors
- #Actually Collocated: Number of collocated monitors actually reporting data in the date range

Collocated Audits: Collocation Summary (2)

- # Required Sites Collocated: 100 X Sites collocated / collocated sites requred

- # Required: Number of collocation audits (i.e. precision data pairs) based on number of collocated monitors and 1 in 12 collocated sampling schedule

- # Obs: Number of precision data pairs reported.

- # Valid Obs: Number of collocation pairs with concentrations above the threshold in table 4 (c) of Appendix A

- % Complete: 100 X #Obs / #Req (i.e. ignores validity)

- Coefficient of Variation:

$$CV = \sqrt{\frac{n \bullet \sum_{i=1}^{n} d_i^2 - (\sum_{i=1}^{n} d_i)^2}{2n(n-1)}} \bullet \sqrt{\frac{n-1}{\chi_{0.1,n-1}^2}}$$

  – Note: Only valid collocated pairs will be used for the CV calculation.

Performance Evaluation Program (PEP): (1)

- The PEP is an independent assessment used to estimate the total measurement system bias

- The Report presents summaries by Pollutant and PQAO (monitor level detail is not presented)

- For completeness of PM, the report displays the number of sites, the number of PEP audits required, and the number of PEP audits collected.

- For completeness of Lead, the report displays the above and the number of Collocated PEP audits required and collected

- Bias:

$$Bias\_Estimate = \frac{1}{n} \bullet \sum_{i=1}^{n} |d_i| + t_{0.95,n-1} \bullet \frac{AS}{\sqrt{n}}$$

– Where

$$AS = \sqrt{\frac{n \bullet \sum_{i=1}^{n} |d_i|^2 - (\sum_{i=1}^{n} |d_i|)^2}{n(n-1)}}$$

Performance Evaluation Program: (3)

- Confidence limits on the mean relative percent difference of the PEP audits (PM 2.5 only):
  - Upper 90% Confidence Limit

$$UpperLimit = \frac{1}{n} \bullet \sum_{i=1}^{n} d_i + t_{0.95,n} \bullet \frac{s}{\sqrt{n}}$$

  - Lower 90% Confidence Limit

$$LowerLimit = \frac{1}{n} \bullet \sum_{i=1}^{n} d_i + t_{0.95,n} \bullet \frac{s}{\sqrt{n}}$$

  - Where

$$s = \sqrt{\frac{\sum_{i=1}^{n}(d_i - Mean)^2}{n-1}}$$

Lead Analysis Audits (1)

- The lead analysis audits are an assessment of the bias of the analytical procedure (i.e. the procedure used by the analysis lab/agency)

- Three audit samples at each of two levels are requred each quarter

- The report is organized by PQAO and presents results by year and quarter

- % Complteness per quarter: 100 X Number of audit-level analyses / 6 (with no more than 3 per level counting toward total)

Lead Analysis Audits (2)

- The Lab Id on the report is the "Analysis Agency" for the monitor that is submitted on the RA transaction.

- Bias

$$Bias\_Estimate = \frac{1}{n} \bullet \sum_{i=1}^{n} | d_i | + t_{0.95, n-1} \bullet \frac{AS}{\sqrt{n}}$$

– Where

$$AS = \sqrt{\frac{n \bullet \sum_{i=1}^{n} | d_i |^2 - (\sum_{i=1}^{n} | d_i |)^2}{n(n-1)}}$$

Questions?