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Subject:
Clarification of Criteria for Removal of Data Points in the CADR Regression Calculations in ANSI/AHAM AC-1-2006.

Summary:
Section 8.1 of ANSI/AHAM AC-1-2006 provides a list of criteria for elimination of data points from an AC-1 run. The following criteria are specified in the standard:

Criterion 1.
Any noted operator error results in the elimination of the data point whether or not the data point (corresponding to the time the error is noted) is found within acceptable or anticipated concentration ranges.

Criterion 2.
Any noted equipment error will result in the elimination of the data point (corresponding to the time the error is noted) whether or not the data point is found within acceptable or anticipated concentrations ranges.

Criterion 3.
Any data points found to be outside the 95% prediction limits of the regression slope line will result in the elimination of the data point. The cause of the outlier data may or may not be due to chamber instrumentation, air cleaner inconsistency, or other chamber effects.

Criterion 4.
Any data point resulting in a reported concentration below the instrument measurability limit will be eliminated along with all subsequent data points in the run. Subsequent data points are eliminated based on the anticipated theoretical reduction of concentration with time. Any data point taken after one rejected for Criterion 4 would be theoretically expected to also be eliminated by Criterion 4.

Question:
In what order should the criteria for data point removal be applied?

Answer:
Data points that have potential for instrument (Criterion 2) or operator error (Criterion 1), and data points that are less than the minimum measurability limit (Criterion 4), should be removed prior to calculating the final slope and the resulting 95% prediction limits.

Technically, it does not make a difference in what order Criteria 1, 2 and 4 are applied. Data points that are not considered sound due to instrument error are not usable and must be rejected. Data points resulting from operator error are not usable and must be rejected. Data points that are less than the minimum measurability limit are not statistically acceptable and must be rejected. These three criteria are mutually exclusive and the same data point would be eliminated regardless of the order in which the criteria are applied.

In practice, either operator error (Criterion 1) or instrument error (Criteria 2) would be first noticed by the operator and it is realistic that these criteria be applied first.

Therefore, criteria should be applied in the following order:

Criterion 1:	Operator error
Criterion 2:	Equipment error
Criterion 4:	Measurements less than the minimum measurability limits
Criterion 3:	Points outside the 95% prediction limits

Question:
What is the process for determining if points outside the 95% prediction limits of the regression are removed?

Answer:

1. By definition, prediction limits are forward looking and are calculated per individual data points.

2. Evaluation is to be considered as follows:

    - Data points within the data set have been considered to be acceptable based on Criteria 1, 2, and 4.
    - A sufficient number of data points must still be present following the Criteria check to perform a regression for slope (nine (9) for smoke and dust, and five (5) for pollen).
    - Determine the 95% prediction limits for the modified data set (criteria 1, 2 and 4 have been applied).
    - Each data point outside the 95% prediction limits is individually subjected to analysis. Only one data point is analyzed at a time:

1. The suspect data point is temporarily removed from the data set.
2. The 95% prediction limit is recalculated without the suspect data point in the data set.
3. If the suspect data point is still found to exist outside the recalculated 95% prediction limits it is tagged for removal from the data set; however, the tagged data point is not yet removed from the data set.
4. The next data point (if any) outside the original 95% prediction limit is individually subjected to analysis according to this same procedure (return to step 1 directly above).
5. Continue this process for all data points outside the original 95% prediction limits.
6. All data points tagged for removal are eliminated from the data set.

- A sufficient number of data points must still be present to perform a regression for slope (nine (9) for smoke and dust, and five (5) for pollen).
- If a sufficient number of data points are not present the slope calculation cannot be performed and the test must be re-run.

Question:
What are the minimum measurability limits for tobacco smoke, dust and pollen and how are minimum measurability limits defined?

Answer:

1. The minimum measurability limits for tobacco smoke, dust and pollen are stated below:

Tobacco smoke:	400 particles
Dust:	400 particles
Pollen:	300 particles

   These limits should be used when applying Criterion 4, above.

2. The number of particles can be perceived in two ways – either the number of particles actually present in the room or the number of particles observed by the particle counter. These are two different values.

   The Minimum Measurability Limit (MML) is defined as the minimum point at which the particle counter can reliably count particles and does not necessarily correlate with the number of particles in the room.

   The values stated in ANSI/AHAM AC-1-2006, Section 4.4.1 (20 particles/cc for smoke and 0.03 particles/cc for dust and pollen), define the requirement for background cleaning of the room, not the MML.

   The MML for smoke and dust is 400 particles, based on the 95% counting standard deviation. In particle counting, the standard deviation of the number counted is the square root of the number. Therefore, for 100 particles counted, the standard deviation

is 10 or 10%, for 1000 particles it is 32 or 3.2%, and for 400 particles it is 20 or 5%, providing a 95% mean ratio to the count.

MML for pollen will be 300 particles, which is slightly less than the 95% counting standard deviation (94.2%). The MML value for pollen is lower to increase the probability that the minimum number of data points required for regression (5) are obtained. Utilizing a historical value for the mean pollen natural decay slope (0.120), the maximum unit decay slope (0.450), and the theoretical maximum particle concentration in the chamber, the fifth data point will be collected at 324 particles. This value was rounded to 300 to define the pollen MML.