QUALITY CONTROL IN COUNTING RADIOACTIVE NUCLIDES

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Thomas A. Kelley Prepared By	26-Oct-83 Date
[illegible] Technical Approval	26-Oct-83 Date
[illegible] Technical Project Officer	12-29-83 Date
Ron Michels Quality Assurance Approval	1/3/84 Date

QUALITY CONTROL IN COUNTING RADIOACTIVE NUCLUDES

1. PURPOSE

The following procedures are designed to control the precision of the measurements made on radioactive samples. They insure that the various detectors behave consistently from day to day.

2. SCOPE

The following procedures apply to the personnel in the counting room. They dictate how often standards are to be counted, in what manner they are to be counted, and under what conditions the results are to be interpreted as an indication of acceptable quality.

3. PROCEDURES

3.1 Plateaus

Once a week a "plateau" is run on the simple alpha and beta counting systems. This is a determination of counting rate vs. voltage to the central wire anode of the gas detector. This is used to determine where to set the voltage. Then a standard is to be run to determine the acceptability of the level of counts for the given detector.

3.2 Standards

Standards are to be run on every counter each working day unless the counting system is being used for a very long count and this is not practical or unless the counter is currently being repaired. This is done by counting a specified standard on each counter for at least 10 minutes.

The following types of standards are used:

a) ^{239}Pu on the simple alpha counting systems,

b) ^{234}Pa from a U_3O_8 source on the simple beta counting systems,

c) ^{137}Cs on the NaI gamma spectrometry systems,

d) ^{152}Eu on the Ge(Li) gamma spectrometry systems, and

e) a mixture of ^{238}Pu and ^{239}Pu on the alpha spectrometry systems.

One or more statistics are then calculated and compared against "historical" values (see Section 4. below). The statistics corresponding to the above types of standards are:

a) the total counts from the sample,
b) the total counts from the sample,
c) the total counts per minute across a fixed number of channels whose midpoint is chosen to coincide with the centroid of the Cs-137 peak,
d) the total counts per minute across a fixed number of channels whose midpoints are chosen to coincide with the centroids of 7 prominent peaks in the ^{152}Eu spectrum (those at energies of 122, 245, 344, 779, 964, 1112, and 1408 keV),
e) the total counts per minute across a fixed number of channels whose midpoints are chosen to coincide with the centroids of the ^{238}Pu and ^{239}Pu peaks and the ratio of these two counts.

The comparisons are to be made according to our QA acceptance rules.

3.3 QA Acceptance Rules

When a single statistic is calculated, the counting system will be accepted only if that statistic is within 1.5 standard deviations of the "historical" value. If it is not, a second run of the same standard must be made. This time, the counting system will be accepted only if that statistic is within 3.0 standard deviations of the "historical" value. If it is not, counting must stop on that system until the problem causing the abnormal deviation is isolated and repaired, and it can be shown that the system is back to normal (usually by running the same standard again after repairs).

When multiple statistics are calculated, the acceptance is to depend on that statistic which deviates from its "historical" value by the greatest amount. In other words, acceptance is to be based on the worst case.

4. QUALITY ASSURANCE

The QA acceptance rules were established many years ago for the purpose of monitoring the behavior of our alpha and beta counting systems. They have since been extended and expanded for use with our gamma-ray spectrometry systems.

The "historical" values alluded to above are arrived at by running a standard on a counting system a large number of times when it is known to be in a stable condition. The average and standard deviation of these counts are then recorded for future comparisons.

Calculations have been made to determine the quantitative behavior of these rules from a statistical point of view. The probability of rejecting a perfectly acceptable counter when using a single statistic is .0004 and when using the worst of seven statistics is .01; these are acceptably low for us.

The probability of the other type of error; namely accepting a counter which has "drifted", depends on how much the counter has gotten off. These probabilities have been tabulated as a function of the bias which is defined as the number of standard deviations from the "historical" average. When converted back to actual counts, it appears that for all of our standards, a 3% change in the overall counting rate will be detected with an error probability less than .01; again this is acceptable to us.

Trained personnel shall do all counts relating to the NNWSI project and this training shall be documented in the form of Personnel Certifications.

5. RECORDS

The printed results from the measurement of radioactivity in the samples given to us are returned to the individual chemist. The results of the daily standards are recorded manually for future reference. At a very minimum, the values of each statistic are recorded.