NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

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MEMORANDUM

To: CDL Engineers and Technicians

From: V. Summers V. Summers

Subject: An Approximate Calculation for Part Cleaning

How many rinses does it take to cleanse a part to specifications? Let's use an example by way of approximation.

Take a 150 ml beaker. Weigh it dry. Fill it with water and let it drip out after emptying. Weigh it with the inside, not the outside, still wet. This gives one a weight in grams of residue, for this particular case, 1.01 g. Imagine for a moment this residue is water contaminated with a species of concentration C_0 . Then, if rinsing using 5 mls water from a spray bottle without any contaminant

$$C_1 = C_0\left(\frac{1.01}{6.01}\right)^1$$

For five rinses

$$C_5 = C_0\left(\frac{1.01}{6.01}\right)^5$$

or, in other words,

$$C_n = C_0\left(\frac{1.01}{6.01}\right)^n$$

For C_0 = 0.001 molar, for example

$$C_5 = C_0\left(\frac{1.01}{6.01}\right)^5 = 0.00000013 \text{ molar} = 1.3 \times 10^{-7} \text{ molar}$$

assuming thorough mixing at each step.

This is only a crude approximation but should give order of magnitude results. Again,

$$C_n = C_0\left(\frac{\text{residual}}{\text{rinse + residual}}\right)^{\text{number of rinses}}$$

or

$$C_n = C_0\left(\frac{\text{residual per sq. cm x surface area of part}}{\text{rinse + residual}}\right)^{\text{number of rinses}}$$

To put this equation into more useful form and using

$$1.01\ \text{g}/24.5\ \text{cm}^2 = \text{residual liquid per cm}^2 = 0.04\ \text{ml}/\text{cm}^2$$

the number of rinses required for a given initial concentration of contaminant and a final desired C_n

$$\log\frac{C_n}{C_0} = n\log\left(\frac{\text{residual}}{\text{rinse + residual}}\right)$$

For example, using the original 0.001 molar contaminant, the 150-ml beaker, the 5-ml wash sizes, with a desired cleanliness to 0.00000000 molar

$$n = \log\frac{\frac{C_n}{C_0}}{\log\frac{\text{residual}}{\text{rinse + residual}}} = \frac{\log\left(10^{-6}\right)}{\log\left(1.68 \times 10^{-1}\right)} = \frac{(-6)}{(-1 + 0.225)} = 7.7\ \text{rinses}$$