E. Ionizing Radiation Theory

1. Definition

   Ionizing radiation has the ability to remove electrons from atoms, creating ions; hence the term “ionizing radiation.” The result of ionization is the production of negatively charged free electrons and positively charged ionized atoms.

2. Radioactive materials have an associated half-life, or decay time characteristic of that isotope. As radiation is emitted, the material becomes less radioactive over time, decaying exponentially. Some radioisotopes have long half-lives; for example, C-14 takes 5,730 years for any given quantity to decay to half the original amount of radioactivity. Other radioactive materials have short half-lives; P-32 has a two-week half-life, and Tc-99 has a half-life of six hours.

3. The equation used to calculate radioactive decay is:

$$A = A_0 e^{-kt}$$

   Where:

   A = current amount of radioactivity
   $\mathbf{A_0}$ = original amount of radioactivity
   e = base natural log (approximately 2.718)
   k = the decay constant = 0.693/t1/2 (where t1/2 = half-life)
   t = the amount of time elapsed from $\mathbf{A_0}$ to **A**

4. Knowing the radioactive decay rates/half-lives of the radioisotopes you are working with helps to eliminate outdated stocks.

5. If contamination is “non-removable,” the radioactive decay equation can help determine when radiation levels will be indistinguishable from background.