Differences in Efficiencies for I-125 and I-129

by Dru Carson, 22 October 2010

Ludlum Measurements, Inc. uses I-129 to ensure that our low energy gamma scintillators detect low gamma energies in accordance with our specifications. We chose I-129 because it has a long half-life of 15.7 million years while I-125 has a relatively short half-life of 60 days. In the medical physics market, I-125 is a radioisotope of iodine which has uses in biological assays, nuclear medicine imaging, and in radiation therapy as brachytherapy to treat prostate cancer and brain tumors.

Using I-129 to determine the optimum high voltage setting is acceptable because the energies of I-125 and I-129 are very similar. There is a misconception that the stated efficiency for I-129 is the same as the efficiency for I-125. There are important differences why this should not be done.

The numbers of photons emitted per nuclear transformation from the two isotopes are different. Below is a chart of the energy and probability of an emission of a photon with a specific energy with each transformation (i.e. disintegration).

| Photon Emission Products: I-125 | | Photon Emission Products: I-129 | |
|---------------------------------|----------|---------------------------------|----------|
| Energy(keV) | Fraction | Energy(keV) | Fraction |
| 3.770 | 15.4% | 4.110 | 8.2% |
| 27.202 | 39.2% | 29.458 | 20% |
| 27.472 | 73.2% | 29.779 | 37% |
| 31.000 | 25.4% | 33.600 | 13.2% |
| 35.492 | 6.4% | 39.581 | 7.5% |

We can ignore the 3.77 keV from I-125 and 4.11 keV from I-129 because they are so weak that they are essentially undetectable. So, you end up with about 86% more photons per transformation with I-125 than I-129. Therefore, the efficiency for I-129 can be multiplied by 1.86 to approximate the efficiency of I-125:

Model 44-3 I-125 efficiency is 33% based on I-129 efficiency of 18% Model 44-17 I-125 efficiency is 38% based on I-129 efficiency of 22%

Ludlum Measurements acquired an I-125 source and obtained the following data that seems to confirm this correction factor:

Predicted vs. Actual 4 pi Efficiencies

| Detector Model No | I-125 Predicted Efficiency | I-125 Actual Efficiency |
|-------------------|----------------------------|-------------------------|
| 44-3 | 33.5% | 34.5% |
| 44-17 | 41% | 40% |