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Calibration of a Low Background Gamma Spectrometer for the Assay of Pb-210 in Lead and Comments on Current Availability of Low Background Lead in North America

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Content

It is often the case that lead stocks considered for use as shielding in low-background radiation measurement applications are assayed for Pb-210 content to ensure the shielding will not contribute unacceptable background count rates. One traditional method for this assay is via alpha-spectroscopy of the daughter isotope, Po-210, after relatively intensive chemical processing to separate, purify, and electroplate the polonium. In order to reduce the sample processing manpower and timeline requirements, a method for evaluating Pb-210 concentrations was developed via measurement of the bremsstrahlung radiation from beta-decay of the daughter isotope, Bi-210, using a 14-crystal array of high purity germanium detectors. Ten sources of refined lead were assayed, and a selected set of these were used to calibrate the bremsstrahlung-based assay method using previously measured Pb-210 values. The original Pb-210 concentration assay values for these samples were determined through the [U+F061]gamma-spectroscopy method. This calibration was successful, and provides a method of Pb-210 assay that can extend as low as ˜ 2 Bq kg-1 with extended measurement times and limited accuracy (˜25% one sigma). For lead above ˜10 Bq kg-1, the method will provide accuracy of 5% or better, and typical "good" low-background lead (e.g. "Doe Run" lead) with ˜30 Bq kg-1 Pb-210 content can be assayed within about two days of measurement time, and no chemical processing. Subsequent to calibration of the germanium spectrometer, several samples of lead have been assayed via this method. These include both commercially available material and two batches of lead currently stored at Pacific Northwest National Laboratory. These measurements, while nowhere near exhaustive of commercial lead suppliers in the U.S., point out that the loss of lead smelting capacity in the U.S. has eliminated the traditional commercial supply of standard "low background" lead (˜30 Bq kg-1), and current commercial supplies contain roughly an order of magnitude higher Pb-210 levels.

About the Presenter

Martin Keillor is a nuclear engineer who has worked at Pacific Northwest National Laboratory (PNNL) for the past ten years, after retiring from the United States Air Force (USAF). His focus at PNNL is on low-background radiation detection for various nuclear treaty monitoring and national security applications, and he has worked primarily on germanium-based gamma spectrometry and gas proportional detectors.

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