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Personal and Environmental Exposure Assessment Measurements at Fernald
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Specific DOE Problem Addressed

This research provides the specific instruments required to accurately determine the dose and therefore the risk from inhaled radionuclides during D&D in any environment. Fernald is now the only site to have these data, provided by two entirely new personal exposure instruments. The first is a lightweight (20 gram) passive, badge type detector measuring both radon and thoron, the exposures of relevance at Fernald. The second is a miniature aerosol particle size sampler that can be worn with a belt pump or used for long periods of time as an area sampler.

Although the inhaled particle size is the major determinant of bronchial dose, no other DOE site is attempting to do the particle size distribution measurements. Prior to the development of this instrument, the labor intensive effort needed, and the cost, precluded the measurement.

Research Objective

The research is directed to developing state-of-the-art personal and environmental exposure assessment for inhaled radionuclides at Fernald during D&D. An additional objective is the radiochemical analyses of soil samples taken around the radium (K-65) silos before and after removal of the material. Lead-210, the long lived decay product of radon released during the removal, provides a sensitive tracer to determine the entire inventory of radon released.

Research Progress and Implications (Summarizing year 3 of a 3 year project)

Two new radiation detection instruments have been developed. The first is a lightweight (20 gram) radon (Rn-222) and thoron (Rn-220) detector, This is the only monitor of its kind. The radon and thoron detector is tri-lobed and shaped like a cloverleaf. There are 3 alpha track detection chambers , 2 chambers have a diffusion barrier to prevent short-lived thoron gas entry (55 second half life). These 2 chambers provide a duplicate measurement of radon (3.8 day halflife). The third chamber measures the total gas signal and thoron is measured by signal difference of the 2 chambers. The CloverLeaf monitor

was designed for use at Fernald but has wider application wherever radon or thoron exposures exist. It is either a personal monitor, clipped to the lapel or deployed as a field area monitor. It is presently being used both outdoors as an area monitor around the radium (K-65) silos to determine the relevant compliance dose perimeter, and indoors to determine personal exposure where thoron and/or radon concentrations are known to exist..

The second instrument is a particle size sampler for inhaled airborne particles. This newly developed particle size monitor is also the only one of its kind. It is a commercial sampler head modified with 4 added filtration stages of our design. The inlet air jets focus on an impactor stage, modified with a ZnS alpha phosphor cover. All large particles (> 2 micrometer diameter) deposit on the impactor stage. Four, very fine mesh screen filters, follow the impactor stage. The screens filter the small size particles selectively. An exit Millipore backup filter collects any residual particles. A low flow pump (4 LPM) draws air through the sampler head. We count the radioactivity from all 6 filtration elements, in our very low background (5 counts per day) alpha counters at NYU.

The long lived radon decay products, Pb,Po-210, is a unique tracer for atmospheric aerosol particles, and this is used to trace the particle size around the silos or other locations having even background concentrations of radon. During the excavation of pit3, two samplers along with the radon thoron detectors were located on either side of the removal area. In late 1999, a low level excursion at the drying facility occurred, while drying material from pit3 (mainly thorium-230 waste). Thorium-230 was the radionuclide measured by our particle size sampler at the drying facility, using alpha spectrometry in this case. Although the air concentrations were very low, this is the only particle size sampler that could accurately measure both the concentration and size distribution.

This particle size sampler measures over long periods of time without intensive labor or costly down time. The same is true for the passive, alpha track radon and thoron detector. These new instruments provide a means to measure, in a simple non-invasive way, the detailed information needed to describe the environmental and worker exposure before, during, and after remediation. The sensitivities are such that normal background environments can be measured by both instruments.

Planned Activities

We have been asked by the Radiation Control Section at Fernald to redesign both the radon thoron monitor and the particle size sampler. Measurements so far are initial to the remediation at Fernald. The major waste removal effort (silos, pits, builldings) is ready to commence. The radon thoron monitor is to be redesigned to have 4 detection chambers to provide duplicate measurement for both radon and thoron. The particle size detector is to be redesigned with fabrication material of lightweight conducting plastic rather than metal, and with more filtration elements to provide the complete range for the spectrum of inhaled particles.

Additional Information

NYU School of Medicine is seeking a patent for the personal radon and thoron detector.