

Recovery of Depleted Uranium Fragments from Soil

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A cost-effective method was developed for recovering depleted uranium (DU) fragments from soil piles at Sandia National Laboratories. A dirt pad of compacted clean soil was prepared adjacent to the piles. Multiple three-inch lifts of soil, taken from the contaminated piles, were applied to the pad using conventional construction equipment. Each lift was scanned with radiation detectors. The DU fragments were located, identified and removed using handheld trowels and shovels. After DU removal, the affected areas were re-scanned and the new data patched into the data base to replace the original data. This new data set was used as final status survey data.

An eight detector array was placed on a small trailer pulled by a John Deere tractor with a hydrostatic transmission. The tractor cruise control feature allows one to set a variable speed as slow as one inch per second. A scan speed of 4 to 5 inches per second and a scaler counting interval of 3 seconds were adopted in order to obtain acceptable spatial resolution of the data and reasonable productivity. The positioning and radiation detection system is similar to ERG's 3-dimensional indoor radiation survey system (3-DISS). The system automatically records radiation data along with associated detector coordinates at prescribed intervals. The positioning component of the system uses infrared fan lasers to estimate coordinates at the end of each 3-second counting interval with centimeter accuracy. Data are stored electronically on a laptop computer. Scanning and positional data are downloaded into the ArcGIS computer application for data processing and presentation. Action levels were established above the normal variation of background. When counts above the action level were encountered an investigation was conducted to locate, identify and remove the fragment. The coordinates of data above the action level were downloaded into a hand-held unit which allowed the user to navigate to those locations. A handheld detector was then used to further locate and remove the fragment. Approximately 75,000 data records per acre were generated for each 3-inch lift.

Prior to developing this method, samples of DU fragments ranging from less than a gram up to 48 grams were used for detector efficiency measurements. DU fragments were covered by various thicknesses of soil up to three inches. The net count rates per gram were measured using a 3-inch by 3-inch NaI(Tl) detector, a 2-inch by 2-inch NaI(Tl) detector and a Field Instrument for the Detection of Low Energy Radiation (FIDLER) detector. Each detector was placed four inches above the soil containing the fragment. For all measurements the FIDLER detector proved to be superior to the other detectors and therefore chosen for use in this work. The average net counts per minute per gram of DU was measured to be 9329, 2000, and 1293 when the source was buried beneath 0, 1 inch and 3 inches of local desert soils, respectively.

The detection capability of the system as a function of DU fragment mass and burial depth was modeled and determined to be sufficient to assure that the site concentration limits would be met. The results showed that a ten-gram or larger size fragments would be detected with a very high probability even if beneath 3 inches of soil; small particles (< 1-2 grams) are easily detected on the surface. While detection probabilities are easily calculated, it is necessary to measure the average DU concentration in the soil by sampling and analytical means. This will be conducted by Sandia National Laboratories.