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INL Alpha Radiation Background Study

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Background

During a radiological emergency, swift determination of the extent and intensity of the radiological materials that have been released to the environment are important for decision makers to correctly assess the hazards and recommend protective actions. To do this successfully, emergency management staff and field monitoring teams need a complete understanding of the data received.

Problem?

Naturally occurring radioactive material that emits alpha radiation is present in small quantities across Idaho. This natural radioactivity can be detected by instrumentation and can negatively affect information gathered by surveys. In a radiological emergency, natural background counts need to be subtracted from the total activity for the actual amount of activity present to be assessed. This study provides documented survey results of the soils in and around the INL using instrumentation utilized by field monitoring teams that support the INL.

Methodology

Using instrumentation, the field monitoring teams supporting the INL (BEA, DOE Radiological Assistance Program (RAP), and the State of Idaho Department of Environmental Quality (DEQ) (see Figure 1), select random locations on the INL site for surveillance (See Figure 2). The surveys were chosen to include areas around the major INL facilities, including the Research and Education Complex (REC), the Materials and Fuels Complex (MFC), the Idaho Nuclear Technology and Engineering Center (INTEC), the Advanced Test Reactor Complex, and the Specific Manufacturing Capability (SMC). The alpha probes were kept a quarter inch off the ground using measured spacers. This standoff distance of a quarter inch between the ground and probe is standard practice at the INL. The surveys were focused on the soil around INL. Each background count lasted for one minute and recorded the alpha baseline in counts per minute. Additionally, two soil samples were taken of the top 1 cm of soil to determine the uranium and thorium content of typical INL surface soil.

Figure 1. Ludlum 2224 Alpha/Beta meters with 100 cm^2 probe (Top View).

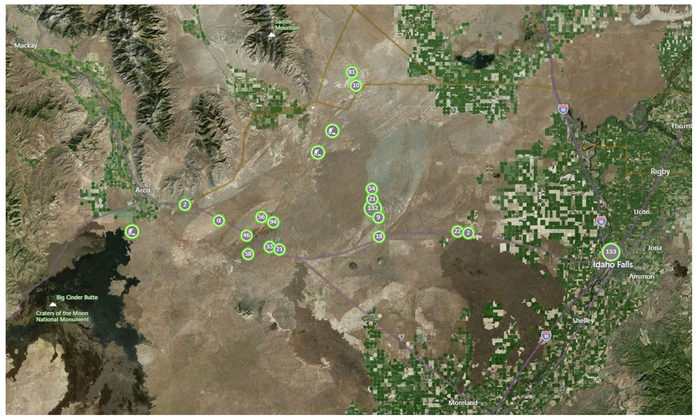

Figure 2. Map of all collected data, including surveys and soil samples.

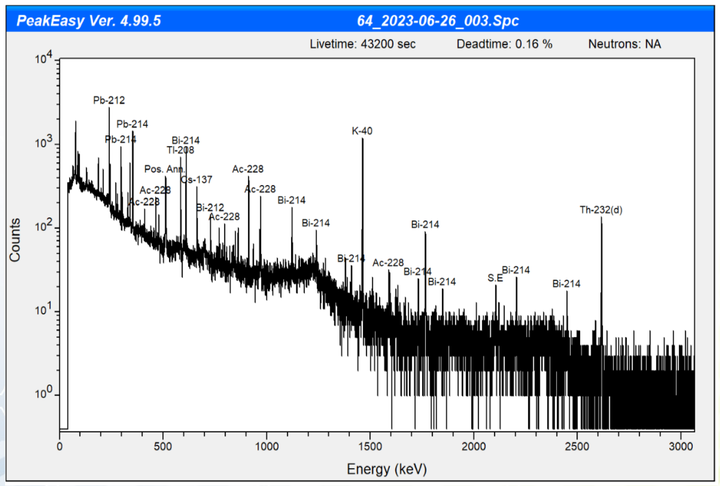

Figure 3. Graph of the spectral data from physical soil samples.

Results

Over three hundred alpha background counts were taken. A histogram of the results is provided (see Figure 4). The distribution is complex in that it is the result of using six different portable instruments from the pool of actual responder instruments taken at various times of the day over many locations at the INL. A decision level for the distribution was determined based on a 95% probability that a count above the decision level will not be background. Measured count rates on dry soil were consistent. This is not the case for soil that was recently or is being rained on. During the study, background counts of soil during and after a rainstorm were obtained. In this case, the alpha background count rate averaged 13.5 counts per minute, which was significantly higher than any other surveys of dry soil. This was most likely a result of the rain collecting radon/thoron daughter products from the air and depositing them on the ground. This adds additional alpha background counts to normal background count rate. This effect was suspected, but it is likely not consistent in its results as it would be highly dependent on atmospheric radon/thoron daughter product content and the amount and characteristics of the rain. In addition to the field surveys, two soil samples were taken to quantify the radionuclides present in the soil. Each sample underwent gamma spectroscopy (see Figure 3). Beryllium-7, Cesium-137, and Potassium-40 were detected, as well as low levels of uranium and thorium and all their daughter products. These last two are natural radioactive elements present in dirt that are the source of the alpha background counts.

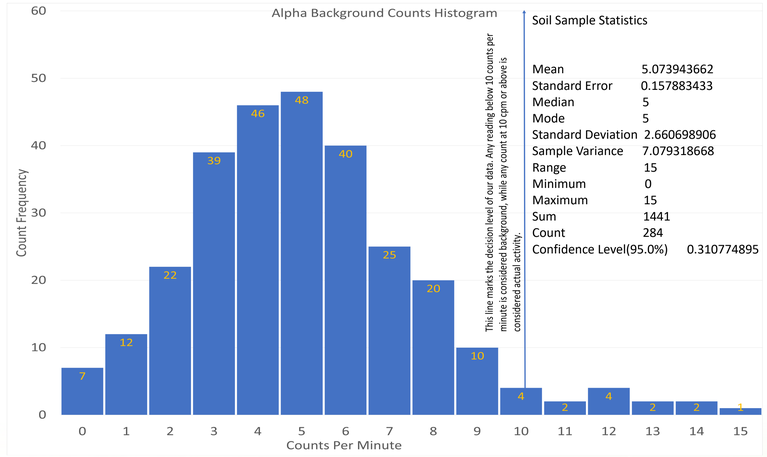

Figure 4. Histogram recording the frequency of survey counts.

Conclusions

The initial question asked was “Does the soil of the INL’s naturally occurring radioactive material elevate the alpha background radiation?” According to the data collected through this study, the answer is yes. The soil at the INL carries natural radioactivity. Why is the ground radioactive? Idaho’s soil also carries naturally occurring thorium and uranium, which have existed in the earth’s crust since its formation. The naturally occurring radioactive material does interfere with the survey data. The average alpha background count rate on portable instruments in use by field monitoring teams is 5 counts per minute and the decision level for activity that should be considered as having activity greater than background is 10 counts per minute. Rain or snow can increase the background and its effects are difficult to quantify.

Idaho State University

Battelle Energy Alliance manages INL for the U.S. Department of Energy’s Office of Nuclear Energy

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