Radionuclide Characterization of Nellis Dunes Recreation Area Soils

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Every soil contains a variety of naturally occurring and man-made radionuclides. The presence of shorter-lived man-made radionuclides in the soil is the result of fallout from atmospheric nuclear weapons tests conducted between 1945 and 1963. The resulting terrestrial radiation exposure to humans makes up for about 8% of the total average annual exposure of 360 mrem. This exposure is due to the radiation field caused by gamma-emitting radionuclides present in the soil. The alpha-emitting nuclides present in the soil have a higher energy deposition associated with their decay; however their range is so small that they cannot penetrate the outer layer of the skin. Their contribution to the external radiation exposure is therefore insignificant.

This situation changes drastically if radionuclides, in particular alpha emitters, are incorporated in the human body. Such incorporation can occur either through ingestion or, more likely, through inhalation. Radionuclides entering the body through inhalation will deposit either in the nasal passages, the tracheobronchial tree or the deep lung parenchyma. These three regions have very different characteristics for retention of aerosols that are introduced.

The penetration into these regions is determined entirely by the aerodynamic properties of the particles inhaled, in particular the particle diameter. Penetration into the deep lung parenchyma is the most important process to consider. As a result of this penetration the radioactive atom is placed in the immediate vicinity of a biologically sensitive target, such as the lung tissue. The energy resulting from the radioactive decay is completely absorbed by the tissue, which gives rise to an appreciable internal dose. In particular the high-energy deposition associated with the alpha decay of the radon daughters' polonium-218 and polonium-214 is of concern.

Off-road driving at NRDA will not only cause significant dust inhalation by the driver. It also has the potential to significantly increase the amount of dust generally present in the air. This will likely affect the air quality not only in the vicinity of NRDA but also in

places that are downwind from the dunes. The goal of this preliminary study was to determine the concentration of radionuclides in soil samples from the NDRA to assess the potential health hazard associated with the dust inhalation.

A total of seventeen samples obtained from the NDRA were assayed to determine the concentration of gamma-emitting radionuclides. The samples were measured using a Canberra Model GR3519 high-purity germanium gamma detector with a relative efficiency of 35%. A certified soil reference standard in the same sample geometry was used to perform a multi-point energy and detection efficiency calibration on the detector. The calibration was carried out in accordance with ANSI Standard N42.14-1999. A certified reference material obtained by the National Institute for Standards and Technology was measured as an unknown sample to verify the calibration. Measurement and subsequent analysis of the soil samples was carried out using a modification of EPA Method 901.1. The samples, a blank and the detector background were all measured for 72 hours with the exception of one sample that was measured for 88 hours. All results were background corrected. The activities measured were corrected for sample mass to obtain the specific activity in picocurie per gram of soil.

The radioisotopes actinium-228 (Ac-228), lead-212 (Pb-212) and bismuth-212 (Bi-212) from the thorium decay series were found in all samples. The mother nuclide for this series, thorium-232 (Th-232) was found in seven samples. The members of the uranium decay series protactinium-234m (Pa-234m), lead-214 (Pb-214) and bismuth 214 (Bi-214) were also identified in all samples. Thorium-231 (Th-231) from the actinium decay series was found in all of the samples and protactinium-231 (Pa-231) from the same series was identified in five samples. The mother nuclide for this series, uranium-235 (U-235) was found in all samples except one. In addition the primordial isotope potassium-40 (K-40) was present in all samples. These radioisotopes are all naturally occurring and their presence is not unexpected. To understand the potential hazards to humans who inhale dust containing these radioisotopes, a separate study is required.

Cesium-137 (Cs-137) was also found in all samples. This isotope was deposited in the soil as a result of atmospheric testing of nuclear weapons. The Annual Limit of Intake for Inhalation of Cs-137 is 200 micro Curie. This is for a person designated as a radiation worker; for the general public this limit needs to be reduced to 4 micro Curie. The largest concentration of Cs-137 in the Nellis Dune soil samples analyzed was 2.1×10^{-7} micro Curie per gram of sample. The sample was taken at dust station 24, originating from soil type 3.3. Based on this concentration a person would have to inhale 19,046 kg (or 42,045 lbs) of soil to exceed the limit for the general public. *We can state with confidence that the Cs-137 content in these samples does not pose any health hazard.*