

Dose Assessment of Natural Radiation and Distribution of Natural α -emitting Radionuclides in the Environment

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Abstract

Natural background radiation doses for residents and the ecosystem in Rokkasho, Japan are important for evaluating the significance of the dose from radionuclides discharged from the first commercial spent nuclear fuel reprocessing plant located there. The aims of this study were to establish methods for measuring the environmental γ -ray radiation dose to people in their actual living environment and the natural radiation dose to biota in the aquatic environment of Lake Obuchi neighboring the plant. Since the background level of natural α -emitting radionuclides is also useful as a reference for such radionuclides as Pu assumed to be discharged from the plant, this study also had another purpose of obtaining the concentration level of natural α -emitting radionuclides in various environmental samples.

Environmental γ -ray dose rates to people living in Aomori City were measured for 1 week in each season in FY 2013 by using personal electrical dosimeters that were able to log data. Dose rates in various working and living environments were also measured for a year with glass dosimeters. The mean personal radiation dose for 10 volunteers was 38 nGy h⁻¹ and higher than the value of 32 nGy h⁻¹ estimated using measurement results in various environments obtained with glass dosimeters and the mean spending time in each environment from the literature. The values of this study were measured by personal dosimeters which had been calibrated by ²²⁶Ra absorbed dose in air. Self-dose of the detectors and the cosmic ray dose were corrected by using data from control detectors in a box shielded with 5-cm-thick lead.

To estimate external radiation dose to biota in Lake Obuchi, radiation dose in the lake water and its out flow, Obuchi River, were measured with glass dosimeters placed in watertight boxes and submerged in the water. Concentrations of radionuclides in Pacific herring (*Clupea pallasii*) were also measured to estimate internal dose to the fish. The radiation dose rate at the surface of the lake water was found to be 27 nGy h⁻¹, and the dose rate exponentially decreased with depth until a point 1 m above the bottom sediment. Dose rate in the Obuchi River was measured as 30 nGy h⁻¹ which was slightly higher than the value in the lake surface due to gamma-rays from bottom sediment. The radionuclide in the highest concentration in the Pacific herring was ⁴⁰K. The fish internal dose rate was evaluated to be 75 nGy h⁻¹ using dose conversion coefficients of pelagic fish calculated by FASSET with ~50% contribution by ²¹⁰Po to the dose rate. A voxel phantom of the Pacific herring was constructed by using a three-dimensional scanner for future dose calculations.

Natural α -emitting radionuclides were determined for samples of various environmental media in Rokkasho: soil, sediment, lake water, precipitation, and aerosol samples. Rice paddy soil samples from five sites in Rokkasho were analyzed, and it was found that ²¹⁰Po was present in the highest concentration among natural α -emitting radionuclides. Mean concentration of ²¹⁰Po in the 0 – 60 cm depth of these soil samples was about 650 times larger than the assumed ²³⁸, ²³⁹, ²⁴⁰Pu concentrations discharged from the plant. Polonium-210 also was found in the highest concentration of alpha-emitters in sediment samples in Lake

Obuchi, and atmospheric deposition and aerosol samples collected in IES, while ^{238}U originating from seawater was the highest in lake water samples from Lake Obuchi.