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 the small amounts of 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 Mutsu City were measured for 1 week in each season in FY 2012 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 43 nGy h^{-1} and higher than the value of 28 nGy h^{-1} estimated using the measurement results in the various environments with the glass dosimeters and mean spending time in each environment from the literature. Since one reason for the difference was considered to be the background of the personal electrical dosimeters, the background will be measured, and the measurement data will be corrected in FY 2013.

To estimate external radiation dose to biota in Lake Obuchi, environmental γ-ray doses in the lake water were measured with glass dosimeters placed in watertight boxes and submerged in the water. Concentrations of radionuclides in Japanese pond smelt (*Hypomesus nipponensis*) were also measured to estimate its internal dose. The environmental γ-ray dose rate at the surface of the lake water was found to be 27 nGy h^{-1}, and the dose rate decreased with the water depth. The radionuclide in the highest concentration in the pond smelt was ^{40}K, and its contribution to internal dose was about 36% using the dose conversion coefficients of a pelagic fish calculated by FASSET. A voxel phantom of the pond smelt 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. Agricultural upland field soil samples from six sites in Rokkasho were analyzed, and it was found that ^{210}Po was present in the highest concentration among natural α-emitting radionuclides. Mean concentration of ^{210}Po in the 0 – 60 cm depth of these soil samples was about 620 times larger than that of $^{238, 239, 240}$Pu possibly discharged from the plant. Polonium-210 also was found in the highest concentration in sediment samples from the Obuchi River and 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.