**ARTIFICIAL RADIONUCLIDES IN THE PLANT COVER OF TEST LOCATIONS OF RADIOLOGICAL WARFARE AGENTS AT THE 4 SITE**

**N.V. Larionova\*, A.V. Toporova, P.Ye. Krivitskiy, A.Ye. Kunduzbayeva, A.O. Aydarkhanov**

*Branch ‘Institute pf Radiation Safety and Ecology’ RSE NNC RK, Kurchatov, Kazakhstan*

\* *e-mail: Larionova@nnc.kz*

The Semipalatinsk Test Site (STS) was one of the largest nuclear test sites (~18,500 km2). Altogether, 340 underground nuclear explosions, 30 ground and 86 air explosions were conducted in its territory. Each type of test was characterized by a certain amount and composition of radionuclides produced during a nuclear explosion, their spread area and localization at various spots, and subsequently by radionuclide speciation in soils. The test locations of radiological warfare agents (RWA) are notable for a unique radionuclide composition. The activity concentration of strontium-90 radionuclide in the soils of this territory reaches several million Bq/kg, whereas the content of radionuclides is significantly lower than that of the rest, which is apparently attributed to the formulation of the substances used in the tests. The RWA tests implied dispersion by detonating individual warheads, bombing areas with mortar shells, dropping bombs from bombers or spraying RWA from airplanes. RWA are liquid or powdered formulations fabricated either from radiochemical waste or by irradiating specially selected substances with neutrons from an operating nuclear reactor. Their activity concentration ranged from tenths to several curies per liter. The RWA tests were carried out at 2 sites – 4 and 4a. This paper presents the findings on the accumulation of artificial radionuclides by plants at the 4 site.

The vegetation cover was studied using individual techniques of geobotanical description identifying the main ecosystems and the species composition of plants. To determine the content of artificial radionuclides in the plant cover, 16 research sites were prepared – the points of duplicate sampling of soils and plants. The aboveground parts of the plants were sampled at each site (sampling area ~1-2 m2), as well as soil samples to assess the dose rate of external radiation. A plant sample represented a mixed sample of steppe motley grasses approximately equally dominated by feather grass (*Stipa capillata*, *S. sareptana*, *S. lessingiana*), sheep fescue (*Festuca valesiaca*) and sagebrush (*Artemisia gracileccens*, *A. frigida*). The soil was sampled by ‘envelope’ to a depth of 5 cm. The weight of each sample was 200-300 g. 137Cs and 241Am were determined using a Canberra GX-2020 gamma-ray spectrometer, 90Sr and 239+240Pu – by radiochemical isolation followed by measuring with a TRI–CARB 2900 TR beta spectrometer and a Canberra alpha spectrometer (mod. 7401), respectively. A Progress beta spectrometer was also applied to determine 90Sr. The concentrations of radionuclides in plants were determined in the ash followed by converting to dry basis. The measurement error for 137Cs and 241Am did not exceed 10-20%, for 90Sr – 15-25%, 239+240Pu – 30%.

According to the findings, the territory of the 4 site was found to be basically represented by ecosystems of low hummocks, deluvial-proluvial plains and anthropogenic ecosystems with ecosystems of high hummocks occurring more seldom. The activity concentration of 137Cs in plants does not exceed 1 Bq/kg, that of 239+240Pu – 6.8 Bq/kg, for 241Am – below the detection limit of the methodological instrumentation in use, and the content of 90Sr varies from 7.6 to 18,000 Bq/kg. The excess of the maximum permissible level of radioactive contamination of forage plants was only detected for 90Sr, which was also found to make the main contribution to the overall dose rate for herbaceous vegetation. At the same time, the maximum value of the overall dose rate from all radionuclides at radioactively contaminated spots of the 4 test location is 220 µGy/day. This research was undertaken as part of special-purpose funding by the Ministry of Science and Higher Education RK (BR21882086).