RADIATION DOSE STRUCTURE FOR RESIDENTS EXPOSED TO DUE TO MAYAK PLANT OPERATION AND NATURAL FACTORS IN THE URALS REGION; METHODS FOR OPTIMIZATION OF RADIATION PROTECTION

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The studies interpreting the impacts of radiation accidents in the South Urals are mainly focused on the doses due to industrial sources of contamination of the territory. There is a lack of works dealing with assessment of total population exposure doses from all sources of ionizing radiation including natural, medical industrial and other types of uses of man-made radiation.

With the purpose of determining the structure of exposure doses for residents of 30 villages located in contaminated areas of Chelyabinsk, Sverdlovsk and Kurgan Regions the current doses from the following sources were analyzed:

- background (natural) external and internal radiation;
- medical radiation exposure of population due to roentgenologic diagnostic procedures;
- environmental exposure due to releases of Sr-90, Cs-137 and Pu isotopes in the environment.

The method described in [1] was applied to assess the gamma-background levels differentiated according to radiation sources.

Estimation of contents of radon, radon daughter products (RDP) and thoron daughter products (TDP) aerosols in the air inside dwellings and communal buildings was made on the basis of the routine schematic combining instant volumetric activity (VA) measurements of RDP and TDP aerosols with the use of aerosol radiometers [2], and measurements of radon VA in the air using integral radon track detectors (IRTD). This approach allowed a prompt yield of results, which is of special importance in screenings, on the one hand, and, on the other hand, it allowed a correct assessment of average annual values of the equivalent balanced volume activity (EEVA) of radon in the air inside dwellings in the surveyed area. The latter circumstance is very significant

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for decision-making on the necessity of undertaking a comprehensive radiation investigation based on the data of screening studies.

The dose coefficients applied for calculating doses due to radon and thoron included those listed in the Report of UN SCEAR: the average annual equivalent balanced volume activity of radon equal to 1 Bq/cu m results in an effective doses (ED) equal to 0.061 mSv/yr inside dwellings, and 0.025 mSv/yr inside production buildings (at an 8-hour working day). Average annual EEVA for thoron equal to 1 Bq/cu m results in ED = 0.29 mSv/yr inside dwellings and ED = 0.11 mSv/yr inside production buildings. ED resulting from inhalation pathways of RDP was calculated on the basis of the radon volume activity measured using IRTD, and ED due to inhalation intakes of TDP was estimated on the basis of instant thoron EEVA values.

To estimate the external exposure due to environmental sources it was necessary to study the intakes of artificial radionuclides with foods. For the purpose of estimating the content of radionuclides in foodstuffs and vegetation the recommendations given in [3] were used. The estimation of Sr-90 was effected by selective extraction using monoisoactilic methylphosphonate (MIOMPK) of yttrium-90 balanced with Sr-90 from 0.3-0.4 of normal nitric-acid solutions of food ashes with a subsequent measurement of Y-90 activity on NRR-610 TESLA radiometer. The background counting rate of NRR-610 radiometer is 0.04 impulses/sec which ensures measuring activity of the order of 0.06 Bq/test, with an error restricted to a maximum of 30%.

Cs-137 estimation was conducted according to the same method [3]. The method is based on Cs-137 concentrations in the sediment of nickel ferrocyanide and its subsequent separation in the form of antimonous iodide or X-chlortelluric salts. Cs-137 measurements were performed using NRR-610 radiometer.

Assessment of external exposure was made using a differentiated approach with respect to natural and artificial radionuclides [1]. Current effective doses of man-made radiation exposure were estimated according to the method described in [4]. The values of average annual effective doses from medical exposure were calculated on the basis of the roentgenologic data collected on the surveyed territory, and averaged dose parameters of the most common roentgenologic procedures. The information obtained was processed using the software "Region-At1U.K" elaborated by V.V. Nikitin

(Saint-Petersburg Research Institute for Radiation Hygiene).

The analysis of the results obtained has shown that the contribution of natural radiation sources to the structure of current doses to population constitutes 94%, it particularly applies to products of radium and thorium. It follows from the data presented in the paper that this contribution is especially significant for rural residents. This fact can be explained by the peculiarities of the construction of rural dwellings. In contrast to armored concrete floors built in multi-storeyed town dwellings the wooden floors in rural houses do not prevent radon from penetrating from the rocks into the room air. Besides, a rather severe climate of the Urals region makes the residents try to keep warmth inside the houses which results in inadequate ventilation and exchange of air in dwellings. The latter feature is typical of private houses. On the average, exposure doses due to radon and thoron are 3-4 times higher for rural than for urban dwellers. A higher contribution of thoron should be noted (9-10% vs the commonly observed 1-2%). The doses due to radon and thoron correlate well with the rates of natural radioactive mineralization of the underlyinbg rock in the surveyed area; thus, particularly high doses of natural exposure were registered in the villages Allaki and Tatarsky Karabolka located within the bounds of South Konevsky zone of elevated radon potential.

Doses due to medical exposure proved to be near the average values for developed countries, and under the conditions of the Urals region contributed up to 18% of the total dose. The task of minimization of doses resulting from medical procedures for exposed population persists as very urgent in the Urals region. It particularly applies to Sverdlovsk region where the average effective dose from roentgenologic procedures amounts to over 1.0 mSv/man vs the respective all-Russia value of 0.9 mSv/man.

The contribution to the total dose made by current average individual effective doses resulting from environmental radiation sources is the lowest. In 18% of the villages studied this exposure source contributed up to 2.5% of the total dose. In the critical population group this contribution amounts to 25% of the total dose. The table presents information on the dose structure in villages which were studied in a most thorough way.