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Health Risk Assessment from Potable Water Containing Tritium and Heavy Metals

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Abstract : Obninsk is situated in the Kaluga region 100 km southwest of Moscow on the left bank of the Protva River. Several enterprises utilizing nuclear energy are operating in the town. A special attention in the region where radiation-hazardous facilities are located has traditionally been paid to radioactive gas and aerosol releases into the atmosphere; liquid waste discharges into the Protva river and groundwater pollution. Municipal intakes involve 34 wells arranged 15 km apart in a sequence north-south along the foot of the left slope of the Protva river valley. Northern and southern water intakes are upstream and downstream of the town, respectively. They belong to river valley intakes with mixed feeding, i.e. precipitation infiltration is responsible for a smaller part of groundwater, and a greater amount is being formed by overflowing from Protva. Water intakes are maintained by the Protva river runoff, the volume of which depends on the precipitation fallen out and watershed area. Groundwater contamination with tritium was first detected in a sanitary-protective zone of the Institute of Physics and Power Engineering (SRC-IPPE) by Roshydromet researchers when realizing the “Program of radiological monitoring in the territory of nuclear industry enterprises”. A comprehensive survey of the SRC-IPPE’s industrial site and adjacent territories has revealed that research nuclear reactors and accelerators where tritium targets are applied as well as radioactive waste storages could be considered as potential sources of technogenic tritium. All the above sources are located within the sanitary controlled area of intakes. Tritium activity in water of springs and wells near the SRC-IPPE is about 17.4 – 3200 Bq/l. The observed values of tritium activity are below the intervention levels (7600 Bq/l for inorganic compounds and 3300 Bq/l for organically bound tritium). The risk has being assessed to estimate possible effect of considered tritium concentrations on human health. Data on tritium concentrations in pipe-line drinking water were used for calculations. The activity of 3H amounted to 10.6 Bq/l and corresponded to the risk of such water consumption of ~ 3·10-7 year-1. The risk value given in magnitude is close to the individual annual death risk for population living near a NPP – 1.6·10-8 year-1 and at the same time corresponds to the level of tolerable risk (10-6) and falls within “risk optimization”, i.e. in the sphere for planning the economically sound measures on exposure risk reduction. To estimate the chemical risk, physical and chemical analysis was made of waters from all springs and wells near the SRC-IPPE. Chemical risk from groundwater contamination was estimated according to the EPA US guidance. The risk of carcinogenic diseases at a drinking water consumption amounts to 5·10-5. According to the classification accepted the health risk in case of spring water consumption is inadmissible. The compared assessments of risk associated with tritium exposure, on the one hand, and the dangerous chemical (e.g. heavy metals) contamination of Obninsk drinking water, on the other hand, have confirmed that just these chemical pollutants are responsible for health risk.

Keywords : radiation-hazardous facilities, water intakes, tritium, heavy metal, health risk
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