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Evolution of Approaches to Calculation Justification of Long-Term Safety of Radioactive Waste Disposal Facilities in the Russian Federation

In 2004, the IAEA published the results of the international project ISAM (Safety Assessment Methodologies for Near Surface Disposal Facilities (NSDF)) [1], which was devoted to current approaches to safety assessment and the calculation tools used. In the ISAM project as a perspective approach to the NSDF long-term safety assessment the use of the compartmental modeling was considered.

Using compartmental modeling SEC NRS has carried out long-term safety assessments of Radon-type long-term storage facilities for radioactive waste, tailings and other similar nuclear legacy facilities. The experience of using compartmental modeling pointed to its fundamental drawback, which is associated with obtaining excessively conservative results due to a significant simplification of the engineered barrier systems of radioactive waste disposal facilities (RWDF) and the geological environment. In particular, when using compartmental modeling it is impossible to consider some features of engineered barrier, topographical relief, the presence of flooding factors, geological heterogeneities such as tectonic disturbances, regional hydrogeological conditions, real paths of radionuclides migration.

In accordance with the legal and regulatory acts of the Russian Federation, based on the results of the long-term safety assessment the choice of RWDF site, engineered barriers system, and radioactive waste acceptance criteria should be justified. Consequently, over conservatism can lead to mistakes in RWDF site selection, underestimation of RWDF useful capacity, excessive costs of engineered barriers system, and errors in determining doses of public exposure.

Currently, there are computer programs that can be implemented to RWDF long-term safety assessments based on a realistic approach, in which the initial data, model parameters and boundary conditions are confirmed by field data and experimental studies. In such case, it is reasonable to use modern computer programs that allow developing three-dimensional grid models based on numerical methods of finite elements, finite volumes or finite differences, allowing to consider a wide range of processes occurring in the disposal system, real paths of radionuclide migration, geological heterogeneities and exact geometry of RWDF elements. A successful example of the use of such computer programs in SEC NRS is the work carried out in 2017 - 2019, on the calculation justification of the long-term safety of unique and technically complex radioactive disposal facilities in the Russian Federation - deep well injection disposal facilities for liquid radioactive waste, as well as on the development of NSDF models for independent regulatory assessments.

References

1. INTERNATIONAL ATOMIC ENERGY AGENCY. Safety Assessment Methodologies for Near Surface Disposal Facilities. Results of a co-ordinated research project. IAEA, Vienna (2004).

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