Regulation and control of radioactive airborne discharges from light-water nuclear power plants under normal operation based on the concept of nuclide vector and benchmark radionuclides

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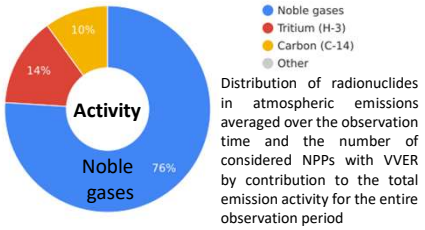
Controlling and limiting emissions of radioactive substances is crucial for maintaining ecological well-being. Here in Russia, we achieve this by setting a list of radionuclides and establishing permissible and maximum permissible activity levels for each nuclide on the list.

Emissions from light water NPPs with VVER (7 NPPs), PWR (40 NPPs) and BWR (15 NPPs) reactors during normal operation were examined and lists of radionuclides recorded in their emissions were compiled.

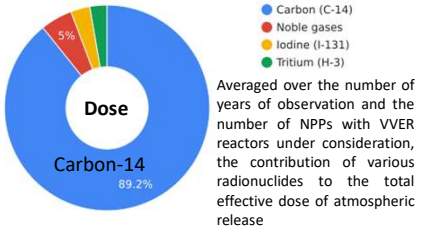
According to IAEA SRS-19 there are 803 radionuclides with established atmospheric emissions' activity. The RF has reduced the number of rationed radionuclides to 94, as per the Order of the Government of RF N 1316-r. The list of rationed radionuclides, as specified in RB-106-15, includes only those radionuclides that contribute to 99% of the total annual effective dose from all registered radionuclides in the release.



Distribution of radionuclides in atmospheric emissions averaged over the observation time and the number of considered NPPs with VVER by contribution to the total emission activity for the entire observation period

Controlling and normalizing a large number of radionuclides causes significant technical and economic challenges. The method outlined in the report, which is based on the concept of a nuclide vector and reference radionuclides, is a viable alternative.

The radionuclide vector method (the scaling factor method) successfully characterizes a radioactive waste. It detects correlations between gamma-emitting nuclides (known as reference nuclides) and more complexly detectable alpha- and beta-emitting nuclides. The report demonstrates that the radionuclide vector method is a highly promising technology for normalizing and controlling radioactive materials in NPP atmospheric emissions during normal operation thought it has never been used before with this aim. Its implementation can significantly simplify the normalization and control processes of NPP atmospheric emissions.



Averaged over the number of years of observation and the number of NPPs with VVER reactors under consideration, the contribution of various radionuclides to the total effective dose of atmospheric release

This document successfully tests the hypothesis on the stability of the emission characteristics of light-water NPPs and establishes a theoretical basis for normalizing and controlling radionuclide mixtures in NPP emissions during normal operation, utilizing the concept of nuclide vector and reference nuclides. It proves the feasibility of establishing requirements for the lower measurement limit (LML) of radionuclide activity during radiation technical surveys of NPPs. These surveys are conducted to determine the radionuclide composition of annual NPP discharge during normal operation.

The report justifies the use of a minimal number of radionuclides for rationing and control. The concept described here has significant practical implications for improving the efficiency of radioactive substance release rationing and control systems at nuclear power plants. By utilizing the nuclide vector and reference nuclides, the number of radionuclides that need to be rationed and controlled can be minimized, resulting in a more effective system. The proposed minimization simplifies the processes of rationing and release control, saving money on continuous monitoring by reducing time and labor costs for taking and processing samples. It is achieved by controlling fewer radionuclides and taking fewer measurements.