**Modeling of Neutron-Induced Air Activation in a Compartment Intended for the Installation of the HRNS Diagnostic System at ITER**

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This study presents a numerical investigation of neutron-induced activation of air within one of the compartments designated for the installation of detection systems of the High-Resolution Neutron Spectrometer (HRNS). The HRNS is one of the diagnostic systems currently in the design phase for ITER (International Thermonuclear Experimental Reactor), a large-scale nuclear fusion facility under construction in France. Neutron spectra for both deuterium-deuterium (2.45 MeV) and deuterium-tritium (14 MeV) plasma discharges were simulated using the Monte Carlo N-Particle (MCNP) code. The resulting spectra were used in activation calculations with FISPACT-II — an inventory code capable of performing modeling activation, transmutation and depletion processes induced by neutrons and other particles.

The analysis focused on dominant radionuclides such as Ar-41, Kr-83m, C-14, and H-3, with activity evaluated both per gram of air and for the total air mass (~5.74 kg) within the HRNS compartment. Ar‑41 was identified as the dominant contributor to short-term activity. In contrast, long-lived radionuclides such as tritium and carbon-14 were produced in much smaller quantities.

For the most radiologically significant of these, tritium (H-3), the maximum predicted concentration in air was approximately 44 Bq/m³. This value is over four orders of magnitude below the Derived Air Concentration (DAC) for tritium established by the International Commission on Radiological Protection (ICRP), which is 740,000 Bq/m³. It is also seven orders of magnitude below the action limit for tritium concentration in room air adopted in ITER's engineering safety approach.

These findings confirm that even under conservative operational assumptions - including no air exchange - neutron-induced activation of confined air volumes will not pose a radiological hazard. The results support environmental safety assessments for future fusion reactors and contribute to modelling-based evaluation of environmental processes in enclosed air spaces exposed to neutron radiation.

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