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Estimate of Air Activation at the ITER Neutral Beam Test Facility

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In the framework of the safety analyses for the PRIMA (Padua Research on ITER Megavolt Accelerator) ITER Neutral Beam Test Facility (NBTF), activation of the atmosphere in the main experimental hall may represent a major radiation protection concern. The primary goal of this study was to assess radionuclide production in air due to neutron activation. For this purpose, all available input data were considered, including characteristics of the neutron field, air composition, room volume and functional parameters of the ventilation system. PRIMA comprises two independent test-stands: i) the negative ion source SPIDER (Source for the Production of Ions of Deuterium Extracted from an RF plasma) that will produce hydrogen and deuterium ions and accelerates them up to 100 kV, and ii) MITICA (Megavolt ITER Injector and Concept Advancement) a first full-size and full performance ITER injector, that will accelerate the same ions up to 1 MeV.
The high neutron yield (an average of about 2·1012 n s-1 has been evaluated for MITICA) due to D-D reactions in the components of the NBI experiments, has the potential to produce an important inventory of radionuclides in the air of the accelerator vault. The analysis presented in this work shows that, in this context, the main safety concern is related to the production of 41Ar during D2 operations of the MITICA facility. The concentration of the 41Ar in the atmosphere of the main vault has been assessed for the different operational scenarios defined in the design of the PRIMA experiment. Preliminary results indicate that the highest saturation activity of 41Ar, obtained considering the worst-case scenario, is about 5 GBq. However, due to air changes, the relatively short pulse duration and the 41Ar half-life, saturation activity is never reached inside the vault. Considering the minimum expected ventilation rate, our preliminary analysis indicates that the actual activity of 41Ar stabilizes at about 1.5 GBq. The estimated occupational effective dose rate evaluated immediately after shutdown is about 80 μSv/h, with radiation level dropping in time. On the basis of the data from this study, we conclude that both ventilation rate and waiting time before accessing the experimental hall need to be carefully assessed to prevent undue personnel radiation exposure.

Eligible for student paper award?

No

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