ASSESSMENT OF RADIATION DOSE RATE RESULTING FROM ACTIVATED CORROSION PRODUCTS IN THE PRIMA FACILITY COOLING LOOPS

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An important consideration in the design of the PRIMA (Padova Research Injector Megavolt Accelerated) facility is providing access to the cooling system for the purpose of maintenance and repair; beside structural material activation, impurities in the primary circuits may be present in high enough concentrations so that their activation restricts accessibility for maintenance, even after the accelerator is shut down.
PRIMA, under construction in Padua (Italy) consists in two experiments which will test at the same time the main components of the final system and the whole system. The facilities are named respectively SPIDER (Source for Production of Ion of Deuterium Extracted from Rf Plasma - ion source only) and MITICA (Megavolt ITER Injector Concept Advanced - the main system). Both injectors accelerate negative deuterium ions with a maximum energy of 1 MeV for MITICA and 100 keV for SPIDER, and a maximum beam current of 40 A for both experiments.
Thermal and epithermal neutrons produced on the calorimeter panels via D-D and D-T reactions are likely to activate materials and components around the injectors, among which the corrosion products formed in the cooling loops by the chemical reaction between metal and water; the radioactivity of the activated corrosion products (ACPs) will persist after injector shutdown for a period that depends on the half life of the induced activity of the coolant. The resulting radiation dose received by workers due to external exposure to APCs may represent a relevant issue from the radiological point of view.
In the present study, the activation level of the corrosion products coming from stainless steel (AISI 304 and 316) and copper alloys were analyzed, as a function of the neutron yield, time campaign duration and pulse duration. Corrosion data were derived from current literature. Radiation dose resulting from APCs was then assessed by mean of a dedicated software (MICROSHIELD®) in accordance with the different maintenance and repair activities and considering severe operative scenarios for radiation workers.
Our results indicate that for SPIDER, even considering the maximum workload, the contribution of APCs to external exposure is negligible. On the other hand, due to the higher neutron yield, APCs produced on MITICA cooling loops may significantly contribute to external exposure of workers. With water being used as a coolant, in a number of operative conditions, it may be necessary to remove some of the impurities by a continuous purification process to prevent a build-up of long-lived induced activity in the system.

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