SHUTDOWN DOSE RATE ANALYSES FOR THE IFMIF HFTM

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The engineering design of the IFMIF maintenance and remote handling systems is significantly affected by the radiation doses originating from radioactive materials generated during operation in the High Flux Test Module (HFTM). In this work, shutdown dose rate assessments were performed for different materials subjected to the radiation by decay photons emitted from the HFTM. Three different decay radiation sources were considered in the analyses: a simple HFTM irradiation specimen of the "thick Charpy" type made of Eurofer steel, a single HFTM irradiation rig packed with Eurofer samples, and a HFTM assembly consisting of 12 irradiation rigs.

These dose rate calculations were performed with the assumption that the rig can be modeled as homogenized mixture of Eurofer and the eutectic NaK-78 alloy used as stagnant heat transfer medium. The human biological dose equivalent rate and the absorbed dose rate were calculated for silicon and different other optical and insulating materials of the IFMIF diagnostic, remote handling, and maintenance systems such as SiO_2, MgO, and Al_2O_3.

The shutdown dose rate calculations included the following steps: (1) neutron energy spectra calculation with the McDeLicious code using the full 3D IFMIF model; (2) calculation of the decay photon sources with the FISPACT-2007 inventory code; and (3) calculation of the absorbed dose and dose equivalent rates with the MCNP5 code using only the irradiated HFTM components. The time behaviour of the shutdown dose rates was investigated and the dominant radio-nuclides were identified. High values of the doses exemplified in the dose maps in Figs. 1 and 2 are quite noticeable. It is revealed that even after 1 month of shutdown the dose equivalent rate decreases only to 0.5 Sv/hr at 1 m distance from one rig, see Fig. 1. For the reliable operation of silicon electronics the accumulated photon dose should be well below 100 Gy. As shown in Fig. 2, at 1 m from the 12-rig assembly the absorbed dose rate in silicon reaches 5 Gy/hr, hence the electronics will withstand no more than 20 hours.

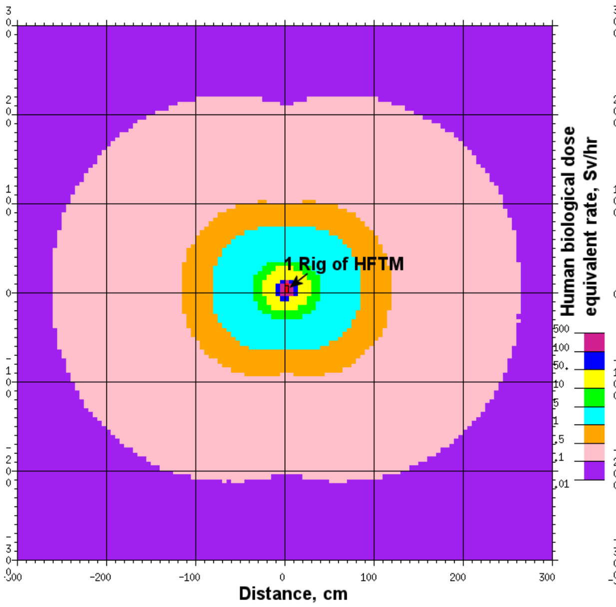

Figure 1: Map of human biological dose equivalent rate (Sv/hr) around 1 Rig after 30 cooling days.

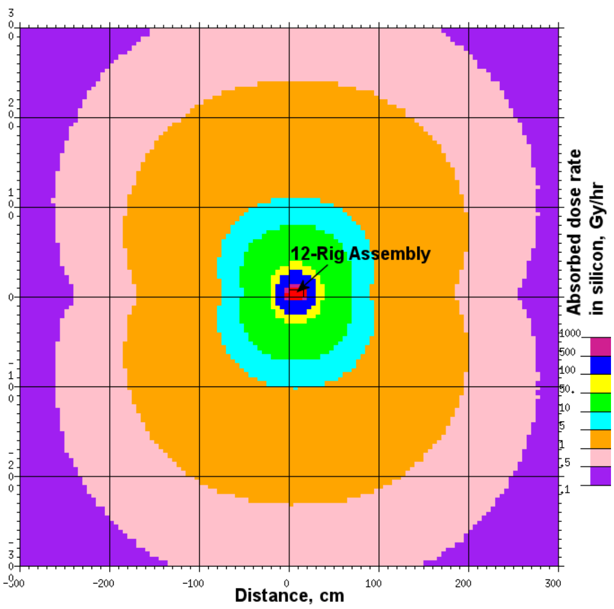

Figure 2: Map of absorbed dose rate (Gy/hr) in silicon around 12-Rig Assembly after 1 cooling day.