Global shutdown dose rate maps for a DEMO conceptual design

D. Leichtle [1], P. Pereslavtsev[1]), J. Sanz [2] , J.P. Catalán [2], R. Juarez [2]

[1] Karlsruhe Institute of Technology KIT, Institute for Neutron Physics and Reactor Technology, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany,
[2] Universidad Nacional de Educación a Distancia(UNED), E.T.S. Ingenieros Industriales, C/ Juan del Rosal 12, 28040 Madrid, Spain

For the calculations of highly reliable shutdown dose rate (SDR) maps in fusion devices like a DEMO plant, the Rigorous-2-Step (R2S) method is nowadays routinely applied using high-resolution decay gamma sources from initial high-resolution neutron flux meshes activating all materials in the system. The calculation effort to produce global activation and SDR maps is tremendous and is usually tackled by splitting up the geometry for separate R2S calculations. This approach has been utilized in the present paper with the objective to provide SDR relevant for RH systems of a conceptual DEMO design developed in the EU.

The primary objective was to assess specific locations of interest for RH equipment inside the vessel and along the extension of maintenance ports. To this end, a provisional DEMO MCNP model has been used, featuring HCLL-type blankets, tungsten/copper divertor, manifolds, vacuum vessel with ports and toroidal field coils. The operational scenario assumed 2.1 GW fusion power and a life-time of 20 years with plant availability of 30%, where removable parts will be extracted after 5.2 years. Results of absorbed dose rate distributions for several relevant materials as well as equivalent dose rate maps are presented and discussed in terms of the different contributions from the various activated components.

The importance of different activated regions to SDR values at specific locations vary, depending not only on the physical boundary conditions, but also on computational parameters, most importantly on the mesh spacings of the chosen decay gamma sources. The effect of varying mesh spacings in a full-torus calculation has been studied to assess the impact on specific SDR locations. The paper will conclude with recommendations on best-practice approaches to reliable full-torus SDR calculations.

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