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P4.232 Neutron flux uncertainty propagation in R2S-based shutdown dose rate calculations

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Rigorous-Two-Steps (R2S) is one of the most important methodologies to estimate Shutdown Dose Rate (SDR) in relevant fusion facilities. This method is based on three calculations: first, a neutron transport calculation is performed to estimate the neutron flux in the facility during the irradiation phase; then, this neutron flux is used as input data for activation calculations, primary to enable the decay gamma source to be produced; finally, a gamma transport calculation is carried out in order to obtain the final SDR and radiological responses associated to decay gammas.

One of the critical issues of most R2S-based tools is that uncertainties of intermediate results (neutron flux estimations, isotopic inventory) can be significant but are not taken into account in the final SDR evaluation. In these conditions, it is very difficult to estimate the accuracy of the results obtained with the R2S methodology.

The principal aim of this work is the development and implementation of a methodology to enable the neutron flux uncertainty to be propagated to the final SDR, and consequently to allow the accuracy of R2S calculations to be estimated.

The propagation of the uncertainty is carried out explicitly in each calculation step using the standard error propagation law. The neutron flux uncertainty, assumed as known, is propagated to nuclear neutron induced reaction rates. Afterwards, the uncertainty of the decay gamma source is obtained, in a first approach, considering only direct parent-daughter reactions, although the gamma source is built taking into account all possible reactions. Finally, the gamma source uncertainty is combined with the gamma transport uncertainty to calculate the uncertainty of the final SDR estimated.

In this work, the methodology was implemented in R2S mesh-based tool R2SUNED, which couples MCNP5 and ACAB codes, and tested in ITER port plug shutdown dose rate benchmarking exercise.

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