



Scoping Evaluation of the IRIS Radiation Environment by Using the FW-CADIS Method and SCALE MAVRIC Code

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IRIS is an advanced pressurized water reactor of integral configuration. This integral configuration with its relatively large reactor vessel and thick downcomer (1.7 m) results in a significant reduction of radiation field and material activation. It thus enables setting up aggressive dose reduction objectives, but at the same time presents challenges for the shielding analysis which needs to be performed over a large spatial domain and include flux attenuation by many orders of magnitude.

The Monte Carlo method enables accurately representing irregular geometry and potential streaming paths, but may require significant computational efforts to reduce statistical uncertainty within the acceptable range. Variance reduction methods do exist, but they are designed to provide results for individual detectors and in limited regions, whereas in the scoping phase of IRIS shielding analysis the results are sought throughout the whole containment. To facilitate such analysis, the SCALE MAVRIC was employed. Based on the recently developed FW-CADIS method, MAVRIC uses forward and adjoint deterministic transport theory calculations to generate effective biasing parameters for Monte Carlo simulations throughout the problem. Previous studies have confirmed the potential of this method for obtaining Monte Carlo solutions with acceptable statistics over large spatial domains.

The objective of this work was to evaluate the capability of the FW-CADIS/MAVRIC to efficiently perform the required shielding analysis of IRIS. For that purpose, a representative model was prepared, retaining the main problem characteristics, i.e., a large spatial domain (over 10 m in each dimension) and significant attenuation (over 12 orders of magnitude), but geometrically rather simplified. The obtained preliminary results indicate that the FW-CADIS method implemented through the MAVRIC sequence in SCALE will enable determination of radiation field throughout the large spatial domain of the IRIS nuclear power plant within acceptable computational efforts.

Keywords: IRIS, shielding, Monte Carlo variance reduction, FW-CADIS method, MAVRIC, SCALE

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