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Impact of Nuclear Data on Decay Heat Uncertainty Quantification

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In the context of a nuclear power reactor operation, decay heat is a thermal power which continues to be generated after shut down. This is due to the radioactive decay of fission products, minor actinides, and delayed fission of fissile nuclide. Hence, a proper characterization of decay heat and is essential for reactor safety system design, spent fuel transportation, and repository management.
Decay heat can be calculated using reactor codes that have the capability to simulate nuclide depletion by solving the Bateman equation coupled to the summation method. As the name indicates, the summation method is the sum of decay power contributions from the above-mentioned depleted fuel components at a given time. Since the data required for this calculation, i.e., decay constants, fission yield data, and mean decay energies are evaluated from experimental data, they have a certain level of uncertainty which propagates to the decay heat calculation.
To this end, the objective is to analyze the impact of these uncertainties on decay heat calculation, and a Monte Carlo method is chosen to propagate the decay heat uncertainties through the fuel depletion. As a first step, a benchmarking work on a sample from a PWR assembly is done to estimate the spent fuel nuclide inventory at different cooling times. The benchmarking was done as a participation for the NEA working group of criticality safety related to uncertainty on nuclide inventory. The sample chosen for this purpose is the ARIANE GU3 sample. Two Monte Carlo codes (Serpent and OpenMC) and two nuclear data libraries (JEFF3.2 and ENDF7.1) were used for the depletion calculation. The results are compared with experimental values and with other participants'results. It has been shown that for most of the nuclide, the simulation results are in agreement within the error margins with the experimental values and other computational outputs. The subsequent steps will be to develop a code which is capable of sampling on the decay data uncertainties (fission yields, decay constants, mean decay energies) and calculate decay heat uncertainties. It will be first applied to the ARIANE GU3 sample and fission pulse calculations and later on the molten salt fast reactor concept.

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