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Uncertainty Quantification of EBR-II Loss of Heat Sink Simulations with SAS4A/SASSYS-1 and DAKOTA

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Argonne has developed SAS4A/SASSYS-1 models for the benchmark analyses of the Experimental Breeder Reactor II (EBR-II) Balance-of-Plant (BOP) tests that represented protected and unprotected loss of heat sink conditions. The analyses were performed to support the validation of simulation tools and models used for SFR development. Previous benchmark results for the two BOP tests were in good agreement with selected measured data. Some assumptions had to be made for the models because of uncertainties related to the cooling system. In addition, the reactivity feedback coefficients also have uncertainties due to the nuclear data. These uncertainties may contribute to discrepancies observed between the simulation results and the measured data.

The objective of this study is to apply the recently developed coupling between Dakota and SAS4A/SASSYS-1 to investigate the impact of uncertainties on the simulation results. The Dakota software is an uncertainty quantification and optimization toolkit. It was coupled with SAS4A/SASSYS-1 via a Python interface to meet an increased need to perform sensitivity analyses and uncertainty quantification in the advanced reactor domain. Dakota was used to sample user-specified parameters, drive SAS4A/SASSYS-1 transient simulations, and quantify statistical metrics as part of post processing. The studies described in this paper include the uncertainty quantification of the EBR-II simulations and the calibration between the simulation results and the experimental data. By applying Dakota for uncertainty propagation, it is found that the radial expansion, the control rod drive expansion, and the stagnant sodium mixing models have significant impacts on the benchmark results. Following the uncertainty quantification, parameters in the EBR-II model that were identified to have significant impacts were optimized by Dakota in order to improve the agreement between the simulation results and the measurements.

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