Integral full core multi-physics PWR benchmark with measured data

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ABSTRACT:

In recent years, the importance of modeling and simulation has been highlighted extensively in the DOE research portfolio with concrete examples in nuclear engineering with the CASL and NEAMS programs. These research efforts and similar efforts worldwide aim at the development of high-fidelity multi-physics analysis tools for the simulation of current and next-generation nuclear power reactors. Like all analysis tools, verification and validation is essential to guarantee proper functioning of the software and methods employed. The current approach relies mainly on the validation of single physic phenomena (e.g. critical experiment, flow loops, etc.) and there is a lack of relevant multiphysics benchmark measurements that are necessary to validate high-fidelity methods being developed today.

This proposal introduces BEAVRS, a new multi-cycle full-core Pressurized Water Reactor (PWR) depletion benchmark based on two operational cycles of a commercial nuclear power plant that provides a detailed description of fuel assemblies, burnable absorbers, in-core fission detectors, core loading and re-loading patterns. This benchmark enables analysts to develop extremely detailed reactor core models that can be used for testing and validation of coupled neutron transport, thermal-hydraulics, and fuel isotopic depletion. The benchmark also provides measured reactor data for Hot Zero Power (HZP) physics tests, boron letdown curves, and three-dimensional in-core flux maps from fifty-eight instrumented assemblies. The benchmark description is now available online and has been used by many groups. However, much work remains to be done on the quantification of uncertainties and modeling sensitivities. This proposal aims to address these deficiencies and make BEAVRS a true non-proprietary international benchmark for the validation of high-fidelity tools.