Development and Evaluation of Neutron Thermalization Integral Benchmarks for Advanced Reactor Applications

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ABSTRACT:

Integral benchmarks will be developed that aim to examine thermal neutron scattering data for graphite (ideal and nuclear), light water, and molten salt (e.g., FLiBe). These materials are expected to represent major components (i.e., neutron moderators, reflectors, and reactor coolants) in the core of modern thermal nuclear reactor concepts such as advanced light water reactors, variants of the advanced high temperature reactor (AHTR), and variants of the molten salt reactor (MSR). Neutron thermalization is quantitatively described using $S(\beta,\alpha)$, i.e., the thermal scattering law (TSL) of a given material. Recently, discussion within the nuclear reactor design community, and nuclear data and benchmark communities have indicated the need for integral benchmarks that can isolate thermalization effects and test the corresponding TSL libraries that are used in the analysis. For nuclear graphite, this proposal will develop the slowing-down-time experiment that was performed at the OREAL facility of ORNL as a benchmark. For light water, several slowing-down-time experiments have been identified and will be examined to select one for evaluation as a benchmark. For FLiBe, recent benchmarks will be reexamined to explicitly capture the impact of TSL variations. The project leverages the extensive experience at NCSU in TSL physics and the ability to develop benchmark experiments specifically designed to probe this physics. The outcome will be integral benchmark evaluations that are contributed to International Reactor Physics Experiment Evaluation Project (IRPhEP) for eventual inclusion in the International Handbook of Evaluated Reactor Physics Benchmark Experiments.