NEUP Nuclear Energy University Program
U.S. Department of Energy

Extending the HMF71 Benchmark Series for Graphite Reflector Thickness up to 18 Inches

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Program: MS-NE-1
Integral Benchmark Evaluations

ABSTRACT:

The objective of this proposal is to extend the HEU-MET-FAST-071 (HMF-71) experiment benchmark series in ICSBEP by evaluating the historical (existing) experimental data for critical experiments with graphite reflector thickness from 3 inches up to 18 inches. The current evaluations in ICSBEP HMF-71 only consider the conducted experiments with 1- and 2-inch graphite reflectors. There were an additional 62 critical experiments conducted as part of the same measurement campaign as HMF-71. In this application, we argue that there is significant value in evaluating those additional experiments in support of the deployment and operation of graphite-moderated and/or -reflected nuclear reactors. These experiments will have relevance to these types of reactors due to the specifics of the nuclear data evaluation for ^{12}C, despite the fact that they were conducted with a fast-neutron spectrum.

One of the objectives of this application is to preserve legacy experimental data that is in jeopardy of being lost. Reproducing these experiments may not be possible or would incur enormous cost. The Co-PI on this application was the original experimentalist for this series of measurements. His knowledge and expertise are invaluable for careful data evaluation and documentation. The original logbooks for the experiments are in his possession and will be made available as part of this project. Furthermore, being a university-led project, this is an opportunity for graduate students to learn from someone who has planned, designed, and executed hundreds of critical and subcritical experiments.

This work will produce complete benchmark evaluations of historical experimental data for HEU cylinders with graphite reflectors that will be submitted for inclusion in the ICSBEP handbook. The scope covers an updated version of the HMF-71 experiment evaluation to include the additional 62 configurations. The evaluations draft will be submitted for ICSBEP review at the end of Year 2 to allow time for review and revisions. It is anticipated that the evaluations will be accepted for publication by ICSBEP before the end of this project.

The proposed project will also computationally demonstrate how fast-spectrum, graphite-reflected integral benchmarks can contribute to reducing the uncertainty on thermal-spectrum, graphite-moderated and/or reflected advanced nuclear reactors through the unique nuclear physics of ^{12}C. This demonstration will occur in Year 1, and the results will be published in a peer-reviewed journal. Once the draft benchmark evaluations are complete, Year 3 will involve work with industrial partners Kairos Power and X-Energy to demonstrate how the extended series of HMF-71 benchmarks can be used to reduce the uncertainty propagated to reactor calculations from ^{12}C in graphite. The analysis of generic versions of the reactor designs will be published. Uncertainty analysis specific to our partners reactor licensing applications will be conducted in collaboration with those partners.