Separate and Mulitphysics Effects IRPhEP Benchmark Evaluation using SNAP Experiments

PI: Dan Kotlyar, Georgia Institute of Technology

Program: MS-NE-1

Collaborators: Bojan Petrovic, Georgia Institute of Technology; Ben Lindley, University of Wisconsin-Madison; Mark DeHart, Idaho National Laboratory; Shane Stimpson, BWXT.

ABSTRACT:

The proposed project will develop an International Reactor Physics Experiment Evaluation Project (IRPhEP) mulitphysics microreactor benchmark evaluation based on data from the Systems for Nuclear Auxiliary Power (SNAP) program. The proposed work will leverage the *extensive experimental measurements* accumulated over 15 years. Utilizing the SNAP program experience is a cost-effective way to advance the technology of future microreactors, such as those being proposed for lunar surface power missions (e.g., KRUSTY), or terrestrial deployment (e.g., eVinci™). The SNAP program shares many characteristics with today's microreactors that include comparable power output, compact core design, representative physics phenomena (e.g. strong reflector effect), alkali metal heat removal working fluid and high-temperature solid moderators that are prone to hydrogen migration. While SNAP did not use heat pipes like many of today's concepts, the *neutronic* characteristics, of primary importance for the IRPhE benchmark evaluation, are well matched, and particularly valuable given the paucity of critical and at-power experiments for such systems.

The SNAP program used a design-build-test-iterate approach for reactor development. This program yielded a considerable amount of documented experimental data. This includes but is not limited to detailed measurements of profiles, fuel density analyses, hydrogen permeation testing, element categorization, failure mode analysis, high-temperature moderating elements (e.g., ZrH_x), stress analysis, mechanical design and assembly. The two main objectives pursued here are to:

1. Perform systematic assessments of the experimental data with *meticulous compilation and documentation*, with the end objective of creating *an evaluation compliant with the IRPhE evaluation guide*.
2. Validate the performance of specific *NEAMS tools* to model effects that are unique to microreactors technologies. Although the benchmark should be code agnostic, validating NEAMS tools will assist to qualify them as a design, and potentially licensing tools in the context of microreactors; as defined by the US NRC BlueCRAB program for advanced reactor analysis.

This proposal focuses on directly contributing to and expanding the IRPhEP through:

- Compilation of experimental data;
- Validation of the dry experiments;
- Validation of the wet experiments; and
- Preparation of evaluations in IRPhEP format.

Key *deliverables and outcomes* are: (1) IRPhEP evaluations with quality assurance on the data collection and reproduction covering dry- and wet-experiments from SNAP-8. (2) An SFCOMPO-styled database (including results, engineering drawings, and physical properties), and (3) Validation report demonstrating the applicability of Griffin and SAM for microreactor analysis.