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# Development of Critical Experiments to Provide Validation Data for Multiphysics Coupling Methods

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**ABSTRACT:**

The overall purpose of numerical simulation in nuclear reactor engineering is to achieve an accurate prediction of the physical phenomena and behavioral outcome of the reactor under normal (steady-state or quasi-steady-state) and/or transient/accident conditions. The complex nature of the physical processes in the reactor has lead to the development of a suite of high-fidelity codes, each specializing in particular physical processes. The interdependence of these different processes has driven an effort to couple these individual simulations together into multiphysics codes. The NEAMS toolkit couples computational codes addressing neutronics, thermal mechanics, fluid dynamics, structural mechanics, and system response with the purpose of enabling the design of future nuclear power plants and reactor cores. The physics and data coupling between these tools are facilitated through a series of supporting elements (CouPÉ, SIGMA, MOOSE). The integration of these physics codes and the coupled feedback mechanisms between the models must be addressed through experimental validation.

The purpose of this project is to develop a set of benchmark validation experiments for multiphysics coupling by taking advantage of the inherent flexibility of the reactor facility at the applicant university. This project will use targeted experiments to validate the coupling between neutronics, thermal hydraulics, and structural mechanics routines present in the NEAMS Reactor Product Line toolkit.

These experiments will be designed using the Reactor Critical Facility (RCF) at Rensselaer Polytechnic Institute, which is a low-power critical assembly using precisely controlled conditions necessary for the validation of integrated simulations. The existing capabilities for varying moderator temperature will be utilized, and a new experimental test section will be built to extend the temperature capabilities to a larger range of temperatures and a shorter time scale, as well as the introduction of simulated structural deformation.

The project will provide evaluated data providing for comparison of multiphysics experimental datasets with toolkit simulations, an analysis of uncertainty and uncertainty quantification for propagation of errors through multi-physics simulations, and the identification of gaps in available data and definition data requirements for future experiments.