A novel high fidelity continuous-energy transport tool for efficient FHR transient calculations

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ABSTRACT:

Fluoride-Salt-Cooled High-Temperature Reactors (FHR) promise many benefits over traditional light water reactors. The widespread deployment of FHR technology promises benefits such as improved safety through passive safety systems and proliferation-resistant waste forms; improved economics through higher operating temperatures and higher operating efficiency; expanding the role of nuclear power beyond baseload electricity to meeting peaking electricity demand and supplying industrial process heat. One of the challenges that remain before this class of reactors can be deployed, is "a lack of a robust method in current tools for transient calculations," as identified in a recent workshop on FHR modeling and simulation." Modeling and simulation (M&S) tools are needed to support design optimization, analysis, licensing, and eventual deployment of any reactor. The current state-of-the-art of M&S is archaic and therefore inadequate for application to FHRs due to their unique complex geometry with high multiple heterogeneity. To address this issue it is proposed to develop a novel high fidelity continuous energy (CE) transport tool for efficient transient calculations in FHR with prismatic core/fuel assembly design. This will be accomplished by extending the high fidelity 3-D continuous energy coarse mesh radiation transport (COMET) code with formidable computational speed to solve transient problems in FHRs with accurate thermal hydraulic feedback. Additionally, an interface will be developed for reactor to balance of plant coupling, where the neutronics and thermal hydraulics predictions at the reactor levels will be used as inputs in iterative fashion to a system code of choice for high fidelity system level performance predictions. The new proposed tool will and can be easily shared among collaborating institutions. The models and code modules developed in this proposed project will provide data in a form that can interface with associated NEAMS toolkit tools and the NEAMS workbench user interface. The new capability will enable plant system codes to perform analyses necessary to address complex technical design, regulatory, reactor safety, and economic hurdles prior to construction. For example, this tool will enable analysis of transients during normal operating conditions as well as postulated accident/off-normal scenarios such as station blackout and simultaneous withdrawal of all control rods.