Radiant
partnered with
Idaho National Laboratory

NE-21-26061, Microreactor Control Drum Failure Simulation

YEAR AWARDED: 2021

TOTAL PROJECT VALUE: $354,200 (DOE: $283,200, Radiant: $71k)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Javier Ortensi (INL), Ben Betzler (Radiant)

DESCRIPTION: Radiant is a small business in El Segundo, Calif., engaged in developing a portable High Temperature Gas Reactor (HTGR) that can fit in a shipping container, power about 1,000 homes and use TRISO fuel and a helium coolant instead of water. With plans to deploy by the end of the decade, the company has turned to the U.S. Department of Energy's Nuclear Energy Advanced Modeling and Simulation (NEAMS) suite of codes to aid in the design. To accelerate Radiant's reactor design process, a transient model to simulate "runaway" control drum motion is necessary for accident scenario simulation for engineers to finalize control drum motor sizing and control system loop stability. This can be accomplished by using Griffin, a Multiphysics Object Oriented Simulation Environment (MOOSE)-based reactor physics application, which is a subset of the NEAMS tools. Under this GAIN voucher, Radiant collaborated with INL on coupling Serpent and Griffin to enable a thermal-hydraulics and neutronics multiphysics model of the transient scenario.

BENEFIT: This rapid simulation capability will help Radiant accelerate development of an economically viable microreactor. The analysis will be adopted by Radiant and used internally, allowing for rapid reassessment of the control drum system design requirements, as subsystems or failure scenarios mature or change.

IMPACT: The completed work provides Radiant with a blueprint with to conduct modeling and simulation for future designs. Areas with inherent difficulty are emphasized to allow better understanding of the nuances of modeling and simulation with both Monte Carlo and deterministic methods.

SIGNIFICANT CONCLUSIONS: Radiant learned from INL and ensured that design parameters relevant to the reactor were used throughout the design. There were two primary objectives to this work: 1. accelerate the development of an intermediate-resolution model that captures most of the important physics in the Radiant design without compromising runtime, and 2. train Radiant staff in the nuclear engineering and applied scientific computing required to quickly reach engineering decision points using multiphysics models.

NEXT STEPS: Under another GAIN voucher, announced in December 2022, Radiant is partnering with Argonne National Laboratory to build a multiphysics coupling in the Cardinal software of the Kaleidos reactor. They will then collaborate with MOOSE framework experts at INL to extend Cardinal to optimize software links necessary to integrating core and shielding analysis tools needed for predicting decay heat sources in OpenMC.