NUCLEAR ENERGY RESEARCH INITIATIVE

Experimental and CFD Analysis of Advanced Convective Cooling Systems

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Project Number: 07-058

Program Area: Generation IV

Collaborators: None

Project Description

The objective of this proposed work is to study the fundamental physical phenomena in the Reactor Cavity Cooling Systems (RCCS) of very high temperature reactors (VHTR). One of the design objectives is to assure that RCCS is the ultimate heat sink capable of maintaining thermal integrity of the fuel, vessel, and equipment within the reactor cavity for the entire spectrum of postulated accident scenarios. Researchers will perform a series of experiments to obtain the complex flow patterns in the cavity volume using state-of-the-art particle image velocimetry and laser induced fluorescence techniques. Accurate numerical simulation of the flow and temperature in the cavity will be performed using advanced turbulence models to simulate the complex conditions of flows in critical zones of the cavity. These turbulence models will be validated and verified and implemented into commercially available computational fluid dynamics (CFD) codes.

A key outcome of this work will be to establish a versatile platform for the experimental and computational characterization of RCCS designs that will significantly advance the state of knowledge in both liquid-cooled and gas-cooled (e.g., sodium fast reactor) reactor technology. This study will extend the measurement to the micro-scale levels not obtainable in large-scale test facilities, thereby complementing the existing infrastructure.

Workscope

The proposed project will have the following products and deliverables:

1) Computer Codes
   - Develop improved turbulence model to predict behavior of the complex RCCS flow structure
   - Deliver details of the LES subgrid model and implement in commercial codes through user-defined subroutines

2) Experimental Data
   - Scaling, preliminary analysis, test plan, calibration, and initial measurements
   - Temperature measurement under various flow conditions
   - Fluorescence seeding for air flow
   - Measurements for various flow and geometry in key convective zones