NUCLEAR ENERGY UNIVERSITY PROGRAMS

Integral and Separate Effects Tests for Thermal Hydraulics Code Validation for Liquid-Salt Cooled Nuclear Reactors

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Collaborators:
None

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Abstract

This project will collect integral effects test (IET) data to validate RELAP5-3D and other thermal hydraulics codes for use in predicting the transient thermal hydraulic response of liquid salt-cooled reactor systems, including the integral transient response for forced and natural circulation operation. The reference system for the project is a modular, 900 MWth pebble-bed advanced high-temperature reactor (PB-AHTR). A major goal of this research is to develop and experimentally validate the code for modeling the coupled transient response of the PB-AHTR primary loop, intermediate loop, and direct reactor auxiliary cooling system (DRACS) for design basis transients.

To accomplish this, the research team is constructing a 10-kW prototype loop capable of testing heaters, equipment, and instruments; reproducing forced and natural circulation transient response phenomena; and verifying the predicted natural circulation passive heat removal capability to a simulated DRACS heat exchanger. This project involves the following key activities:

1. Install electrical and cooling water connections, and perform initial proof testing for an initial 10-kW test loop
2. Conduct a Phenomena Identification and Ranking Table (PIRT) exercise to identify dominant phenomena for key AHTR and NGNP intermediate loop design basis events
3. Run initial shake-down tests and compare results to RELAP5-3D predictions
4. Increase test loop power to 20kW and upgrade instrumentation
5. Conduct initial proof test experiments with upgraded system
6. Perform a comprehensive set of IET experiments
7. Use resulting test data to validate RELAP5-3D for use in PB-AHTR transient analysis and licensing.

The IET results will also be applicable for validating models for the liquid-salt variant of the intermediate loop of the Next Generation Nuclear Plant, in which liquid salt coolants would enable the long-distance transport of heat in the 500°C to 800°C range needed for common process heat applications in refineries and chemical plants.