INTERNATIONAL NUCLEAR ENERGY RESEARCH INITIATIVE

Improvement of the Decay Heat Removal System for VHTR

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Project Abstract

The objective of this project is to improve the performance of the reactor cavity cooling system (RCCS) of the Very-High Temperature Reactor (VHTR) design. The RCCS is a major component in safely and passively removing decay heat. Improving this system is an important step in licensing the VHTR. A beyond-design basis accident involving depressurization of the primary coolant system, accompanied by a loss of station electric power, is accommodated by passive conduction-radiation heat transfer from the reactor core to the vessel boundary, and then primarily by radiation from the vessel wall to the RCCS. Water-cooled and air-cooled RCCS concepts have been proposed that rely either on natural convection or gravity drain to discharge decay heat to the environment. The preliminary Phenomena Identification Ranking Tables (PIRTs) developed by Argonne National Laboratory (ANL), Idaho National Laboratory (INL), and the Korea Atomic Energy Research Institute (KAERI) under a separate I-NERI project have identified various phenomena that are important for these decay heat removal accident scenarios, and particularly to the RCCS.

Based on these findings, this cooperative project is aimed at the following three goals: 1) improving RCCS performance through a combination of well-focused experiments that provide data for model validation and design performance testing, 2) improving and validating the analysis methodology, and 3) improving the designs of innovative heat transfer concepts. Upon DOE approval, the ANL Natural Convection Shutdown Heat Removal Test Facility (NSTF) will be refurbished specifically for both the VHTR water- and air-cooled RCCS options in order to conduct experiments that can validate and improve the RCCS analysis tools. The coupled Fluent-RELAP analysis tool developed by INL will be used to analyze various RCCS design concepts. A radiation-enhanced heat transfer mechanism will be developed by KAERI. Validation studies will be carried out during the course of the project as the experiments are conducted. The integrated partnership between the U.S. and Korea could lead to a comprehensive validation program of these innovative design concepts, which will benefit both countries' VHTR programs.