# *INTERNATIONAL NUCLEAR ENERGY RESEARCH INITIATIVE*

## Advanced Multi-Physics Simulation Capability for Very High Temperature Gas-cooled Reactors (VHTRs)

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**Project Abstract**

The objective of this project is to develop a suite of advanced multi-physics simulation methods and codes for high-fidelity, spatially detailed analysis of the coupled neutronic and thermo-fluid behavior of VHTRs. The focus is on reactors with prismatic block fuels. The research scope includes 1) the generation of neutronic and thermo-fluid models that accurately account for important physical phenomena in VHTRs and 2) coupling these models to obtain detailed, highly accurate multi-physics solutions.

The neutronics analysis capabilities to be developed include methods for generating fine-level multi-group cross sections that account for the double heterogeneity of coated particle fuels, plutonium resonances in the thermal energy range, and the thermal scattering kernel of graphite. Adaptive neutron transport solution methods will be developed for whole-core calculations ranging from homogenized assembly calculations with an in-line homogenization approach to detailed, three-dimensional (3-D) whole-core transport calculations with explicit geometry modeling of fuel compacts and coolant holes.

The thermo-fluid analysis methods to be developed will accurately predict convective heat removal by the coolant flowing through the block and multi-dimensional conduction within the block. Bypass coolant flow effects in the gap regions between blocks and radiative heat transfer will also be predicted. Various modeling strategies ranging from lower-order lumped-parameter models to higher-order large eddy simulations will be investigated, and a practical multi-resolution approach will be developed in which the local flow characteristics of “sub-domains” will be simulated using higher-order models; those results will be used to provide lower-order model calculations for the larger solution domain.