NUCLEAR ENERGY RESEARCH INITIATIVE

An Advanced Neutronic Analysis Toolkit with In-line Monte Carlo Capability for VHTR Analysis

PI: William R. Martin and John C. Lee, University of Michigan

Collaborators: Studsvik of America, Idaho National Laboratory, Los Alamos National Laboratory, General Atomics, Oak Ridge National Laboratory, and TransWare Enterprises, Inc.

Project Number: 06-068

Program Area: Generation IV

Project Description

The goal of this project is to develop, implement, and test a lattice physics code for very high temperature reactor (VHTR) neutronic design and analysis. This code is based on a production-quality lattice physics code used in LWR analysis and is augmented by Monte Carlo capability to treat resonance absorption in pebble bed TRISO particle fuel. The approach takes advantage of the highly developed capabilities available for light water reactor neutronic analysis, in which lattice physics codes generate effective cross sections at the assembly level. These cross sections can be used in nodal codes to allow efficient calculation of global flux/power distributions and k_{eff} as a function of fuel depletion and temperature.

This project will incorporate the capability of the nodal Monte Carlo code, MCNP5, directly into the lattice code, CPM-3, to establish "proof-of-principle." Code linking will be accomplished through an interface that will enable the MCNP5 capability to be extensible to other cross-section generation codes as well. This capability will be demonstrated by linking MCNP5 to CASMO-4. The resultant package will inherit the substantial downstream capabilities of CASMO-SIMULATE, including cross-section generation for global nodal analysis and depletion, systematic preparation of cross-section sets for accident analysis, and efficient fuel cycle analyses and assessment of alternative fuel management schemes. The final result will be a validated neutronics methodology for VHTR design and analysis, including cross-section generation, global reactor analysis, depletion, and fuel management.

Workscope

Tasks associated with this project are listed below:

- Design the interface (API) and modify CPM-3 code
- Develop VHTR test suite and verify CPM-3/MCNP5 methodology
- Specify VHTR design parameters
- Port CPM5 to CASMO-4
- Determine low-lying resonances and depletion
- Develop validation test suite and validate coupled methodology

- Generate cross sections for nominal VHTR design
- Assess potential for analyzing pebble bed fuel