SUBJECT: Ph.D. Dissertation Defense

BY: Nathanael Hudson

TIME: Thursday, May 11, 2006, 2:00 p.m.

PLACE: MRDC Building, Room 4211

TITLE: The Correction of Pebble Bed Reactor Nodal Cross Sections for the Effects of Leakage and Depletion History

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SUMMARY

A cross section methodology for the Pebble Bed Reactor (PBR) that corrects the cross sections of a spectral zone for the effects of neutron leakage and depletion is presented. This method is known as Spectral History Correction (SHC). In a recirculating PBR, graphite encased fuel pebbles flow downward through the reactor, accruing burnup. Partially burned, discharged pebbles are reloaded into the top of the core, along with fresh fuel pebbles. Because of this reloading, after a period of continuous refueling an asymptotic, steady state in the core is achieved, known as the equilibrium cycle. Pebbles of varying degrees of burnup may be present in the core at once, and the calculation of cross sections for the lattice is more difficult. The spectrum is influenced more by the zone-averaged isotopics and leakage in the zone than the state of any specific pebble. In the PBR fuel cycle code under consideration, inaccuracies in the cross section library are manifest as the fuel burnup and leakage change during the simulation. To this end, a solution is developed in which the fine group spectrum for each spectral zone of the core is computed for each change in flux and burnup. This spectrum is estimated through the solution of a slowing down balance equation. The macroscopic cross sections for this equation are estimated by coupling pre-computed microscopic cross section libraries with zone-averaged nuclide densities. The fine group cross-section library is then collapsed with the spectrum to the broad group structure. The SHC algorithm is fully developed and implemented into the PBR fuel cycle code. The benchmark problem consists of repeated calls to the cross section generator to re-compute cross-sections. The basis of comparison includes the converged core eigenvalue, fission density, flux, and the power peaking factor.