U.S. DEPARTMENT OF ENERGY
NUCLEAR ENERGY RESEARCH INITIATIVE
ABSTRACT

PI: **Hiroshi Takahashi** **Proposal No.: 99-0164**

Institution: **Brookhaven National Laboratory**

Collaborators: **Purdue University, Hitachi Ltd.**

Title: **A Proliferation Resistant Hexagonal Tight Lattice BWR Fuel Core Design for Increased Burnup and Reduced Fuel Storage Requirements**

The objective of this proposal is to perform the research required to develop a proliferation resistant, economically competitive, high conversion, boiling water reactor (HCBWR) fueled with fissile plutonium and fertile thorium oxide fuel elements. This BWR will be characterized by a very tight lattice with relatively small water volume fraction, and will operate with a fast reactor neutron spectrum. A design objective will be to achieve a high conversion of thorium to ^{233}U and to reduce the national accumulated inventory of plutonium while producing useful energy. Through a combination of high concentration of plutonium and large rate of production of ^{233}U, it is expected that the core will be able to achieve very high fuel burnup. The consequent reduction of the required fuel reshuffling will increase the plant operating factor and lower the cost of electricity. A radially and axially segmented core design will be used, with a thin annulus of neutron moderating and absorbing materials separating core and blanket segments. This design element is an inherent safety feature of this water-cooled fast reactor, designed to provide negative reactivity feedback during accidents involving generation of very large voids in the core.

The reactor core design will be carried out using a Monte Carlo transport code, accounting for fuel burnup. Monte Carlo methods will also be used to compute reactivity coefficients for reactor safety analysis. Thermal hydraulics analysis, including the boiling flow stability problems associated with the tight lattice, will be carried out using the RELAP5, RAMONA and PARCS codes. The thorium fuel cycle will be studied, and an economics analysis will be performed.

The new reactor design incorporates features to reduce the potential for proliferation of fissionable materials, and efficiently makes use of the abundant fertile thorium resource. It satisfies the basic NERI objectives of non-proliferation, advancement of nuclear technology, and maintains the computational tools and scientific and engineering talent required for the future of nuclear engineering.