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

PI: **Philip E. MacDonald** **Proposal No.: 99-0153**

Institution: **Idaho National Engineerng and Environmental Laboratory**

Collaborators: **Argonne National Laboratory, University of Florida, Purdue University, Massachusetts Institute of Technology, ABB-Combustion Engineering, Westinghouse Electric Company, Framatome Technologies, Siemens Power Corporation**

Title: **Advanced Proliferation Resistant, Lower Cost, Uranium-Thorium Dioxide Fuels for Light Water Reactors**

The goal of this project is to develop mixed thorium-uranium (Th/U) dioxide fuels that can be operated to a relatively high burnup in current and future commercial light water reactors (LWRs). The areas of nuclear technology that apply to the research proposed are "proliferation-resistant reactor and fuel" with "higher performance efficiency" that will enhance the "management of nuclear waste". The related engineering research involves "fuel systems/cycle development" and "radioactive waste".

This project is led by The Idaho National Engineering and Environmental Laboratory (INEEL), with the collaboration of three universities (University of Florida, Massachusetts Institute of Technology, and Purdue University), and includes the participation of all of the pressurized-water-reactor and fuel vendors in the United States. Framatome Technologies and Westinghouse will be active task participants. The other vendors will participate in the evaluation of the findings of this team.

In the 1950s and early 1960s, Indian Point I, one of the first commercial nuclear power plants, was designed and started up using Th/U fuels. Although this fuel was only used in the first cycle of operation, the Shippingport reactor used Th/U fuels for several cycles. At various times since, interest in thorium was renewed for various applications, including the use of thorium as an anti-proliferation fuel. However, none of these activities led to applications. These previous programs had three shortcomings relative to present needs: (1) The previous work presumed fuel reprocessing and re-cycle, (2) start up fissile needs were provided using high enriched U-235, and (3) state-of-the-art fuel burnup for LWRs was approximately half of today's best capability.

Preliminary work performed at INEEL indicates potentially significant advantages for Th/U dioxide fuels when utilized under the projected higher burnup conditions. Th/U could lead to fuel cost advantages over the current uranium cycles, is more proliferation resistant than uranium cycles, and could provide benefits to DOE's high-level nuclear waste program.

This project spans three years and is organized into four tasks. Task 1 will consist of fuel cycle neutronics and economics analysis to determine the economic viability of a Th/U fuel cycle in

PWRs. Task 2 will determine whether or not Th/U fuel can be manufactured economically. Task 3 will evaluate the behavior of Th/U fuel during normal, off-normal, and accident conditions and compare the results with the results of previous uranium fuel evaluations and the U.S. Nuclear Regulatory Commission licensing standards. Task 4 will determine the long-term stability of Th/U waste. The product of this project is a conceptual design and attendant report that establishes the feasibility of using Th/U fuels in current commercial pressurized water reactors.