NUCLEAR ENERGY RESEARCH INITIATIVE

Development and Utilization of Mathematical Optimization in Advanced Fuel Cycle Systems Analysis

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Collaborators: Argonne National Laboratory

Project Number: 06-047

Program Area: Advanced Fuel Cycle Initiative

Project Description

This project will develop a model with the capability to mathematically optimize deployment strategies for reactor and fuel cycle facilities. The model will consider economic, energy, environmental, and nonproliferation resistance metrics of the fuel cycle based on a stochastic optimization approach.

The DANESS code will be employed to model various fuel cycle scenarios of interest. Optimization will be completed over a user-specified planning horizon to allow proper treatment of the future impact of current decisions. The system will be capable of optimizing such factors as fuel enrichment, fabrication, power generation, interim fuel storage, and reprocessing/separation, subject to constraints such as isotopic mass availability and energy generation demand. These capabilities will assure objectivity with minimal human intervention, thereby providing higher confidence when utilizing the results in policy decision making.

The goal of this work is to develop a multi-objective mathematical optimization approach that will provide quantitative data to decision makers on such items as the cost of margin, (for example, the relationship of repository thermal margin to energy costs). Decision makers can use this data to establish policies concerning incentives and requirements to encourage the evolution of the preferred commercial nuclear power reactor, fuel, and fuel cycle facilities.

Workscope

This project will encompass the following primary tasks:

- Specify objective functions, constraints, and decision variables to be considered
- Assess coupling approaches to add optimization capability to DANESS
- Modify DANESS as required to support the optimization engine
- Develop single-objective optimization capability using Simulated Annealing approach
- Exercise the optimization capabilities that have been developed
- Develop single- and multi-objective optimization capability using the Genetic Algorithm approach
- Introduce parallel processing capability for the Genetic Algorithm approach and integrate the optimization engine within DANESS, if possible.