



U.S. Department of Energy's
Office of Science

Research Agenda for Advanced Fuel Cycles

Raymond L. Orbach

Under Secretary for Science

**Nuclear Physics and Related Computational
Science R&D for Advanced Fuel Cycles Workshop**

August 10, 2006



Significance of GNEP

“Here’s where GNEP comes in. This year the Bush administration took what I believe is the correct path and proposed to close the nuclear fuel cycle and recycle spent nuclear fuel, leaving a reduced amount of material that must be disposed in Yucca. The fact is that unless we recycle, Yucca can’t contain everything. We must use the time we have before Yucca Mountain opens to look seriously at these terrific new technologies that can reduce the volume and toxicity of spent fuel. It is no great shock that I support the Global Nuclear Energy Partnership (GNEP), and it should be included as part of our nuclear waste solution.”

--**Senator Pete Domenici**, Chairman, Senate Energy and Natural Resources Committee, at a hearing on the Nuclear Fuel Management and Disposal Act, August 3, 2006



Critical Role of Basic Science in GNEP and the Expansion of the U.S. Nuclear Energy Base

- Expansion of nuclear energy is needed from the standpoint of both energy and the environment
 - Reduce nation's dependence on fossil fuels and imports
 - Reduce both toxic and carbon emissions
- Large-scale expansion will require handling waste
- Closing the fuel cycle poses major challenges in basic science
 - Materials science, chemistry, cross sections, etc.
- We need to rebuild lost expertise
- We have a major new tool with high-end computation
- SC research critical to GNEP's long-term success



Workshop 1: Basic Research Needs for Advanced Nuclear Energy Systems

Overview

- Purpose: Identify high-priority, basic research direction that address the processes and materials challenges of advanced nuclear energy utilization
- Host: BES
- July 31-August 2

Key Issues

- Materials under extreme conditions
 - Advanced structural materials to withstand higher temperatures, higher radiation, and harsher chemicals
- Chemistry under extreme conditions
 - Chemistry in high-radiation environments, corrosive environments, at interfaces, and in complex solutions
- Separations science
 - E.g., improved yield and separation factors in PUREX and UREX+ processes



Workshop 1: Basic Research Needs for Advanced Nuclear Energy Systems

Key Issues (cont'd.)

- Advanced actinide fuels
 - Development of actinide-containing fuels essential to closing nuclear fuel cycle
- Actinide containing waste forms
 - Challenge of dealing with new waste forms produced by actinide-containing fuels
- Predictive modeling and simulation
 - Predictive modeling of complex engineered systems
 - Predictive modeling of properties of fuels, structural materials
 - Improved methods for evaluation and use of nuclear data



Workshop 2: Nuclear Physics and Related Computational Science R&D for Advanced Fuel Cycles

Overview

- Purpose: Focus on experimental and computational research challenges in nuclear physics and related cross sections
- Hosts: NP, ASCR, NE
- August 10-11

Key Issues

- NP/ASCR Needs for AFC
- Nuclear Measurements (nuclear reactions, accelerator facilities, and instrumentation)
- Nuclear Data
- Nuclear Theory/Computations



Workshop 3: Simulation and Modeling for Advanced Nuclear Energy Systems

Overview

- Purpose: Focus on broader opportunities for simulation and modeling for advanced fuel cycles
- Hosts: ASCR, NE
- August 15-17

Goals

- Determine the core areas of research and development needed to advance the state of the art of modeling and simulation for nuclear energy systems
- Determine the scale and scope of a modeling and simulation activity needed to support the goals of the DOE GNEP program
- Determine the key issues that will form the basis of collaboration between the nuclear energy research community and the high-performance computing community
- Determine the requirements for access to computing capabilities and related needs for large-scale data, visualization and networking



Workshop 3: Simulation and Modeling for Advanced Nuclear Energy Systems

Key Issues

- Reactor core simulation
- Materials and Fuels
- Separations Chemistry
- Repository Modeling
- Seismic/structural/balance of plant
- Validation



FY 2007 President's Budget Request

SC Advanced Fuel Cycle Research in Support of the Global Nuclear Energy Partnership (GNEP)

- Basic Energy Sciences - \$12.4 million
- Nuclear Physics - \$2.4 million
- Advanced Scientific Computing Research - \$25 million