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Nuclear Energy University Programs (NEUP)
Fuel Cycle Technologies Program Overview

Dr. John Herczeg
Office of Nuclear Energy
Associate Deputy Assistant Secretary
Fuel Cycle Technologies

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Outline

- **Organizational Structure of Fuel Cycle Technologies**
- **Where We Are Today in FCT**
- **Current Fuel Cycle R&D Portfolio**
  - Near-Term Needs
  - Long-Term Needs
- **Concluding Remarks**

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How We Are Organized

NE-5
Deputy Assistant Secretary for Fuel Cycle Technologies

Robert Price NE-51 Systems Engineering and Integration	Andrew Griffith NE-52 Fuel Cycle Research and Development	Bill Boyle NE-53 Used Nuclear Fuel Disposition Research and Development	Bill Szymanski NE-54 Uranium Management and Policy
• Fuel Cycle Option Analysis (FC-5)	• Sep/ Waste Forms (FC-1) • Advanced Fuels (FC-2) • Nuclear Materials Control and Instrumentation (FC-3)	• Used Nuclear Fuel Disposition (FC-4)	

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Where We Are Today

Global demand for energy and concerns about climate change has accelerated deployment of reactor and fuel cycle facilities worldwide.

Recognition that there is a need for a waste management strategy.

- **Interim Storage**
- **Fuel Cycle Alternatives**
- **Disposal Options**

A Blue Ribbon Commission conducting a comprehensive evaluation of policies for managing the back end of the nuclear fuel cycle, including advanced fuel cycle technologies.

The Fuel Cycle Technology Program seeks to develop innovative technologies that represent significant advantages in terms of economics, proliferation resistance, resource utilization and waste management.

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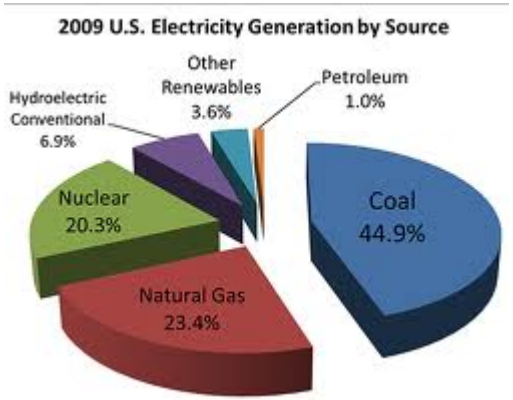
Nuclear Energy in the United States

Nuclear energy already provides approximately one-fifth of electricity used to power factories, homes, and schools.

- 104 operating nuclear power plants, located at 65 sites in 31 states.
- Two combined license (COLs) were recently issued for 2 reactors in South Carolina and 2 reactors in Georgia.



In some states nuclear energy provides a greater role compared to the national average.

- **For example, sources of electricity in Illinois (October 1, 2009 to September 30, 2010 ComEd):**
  - 53% from Nuclear Power
  - 36% from Coal Fired Power
  - 7% from Natural Gas
  - 3% from Wind, Biomass, or Hydro Power
  - 1% Other
- **Chicago receives about 75% of its electricity from nuclear power.**

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Fuel Cycle R&D Is Science-Based, Engineering-Driven

By the middle of the next decade, engineering scale experiments on a new generation of advanced technologies will enable their deployment by the middle of the century.

- **Defining and considering a broad range of fuel cycle technologies against a set of criteria:**
  - **Nuclear waste management**
  - **Resources**
  - **Proliferation risk**
  - **Safety**
  - **Security**
  - **Economics**
  - **Environmental impacts**

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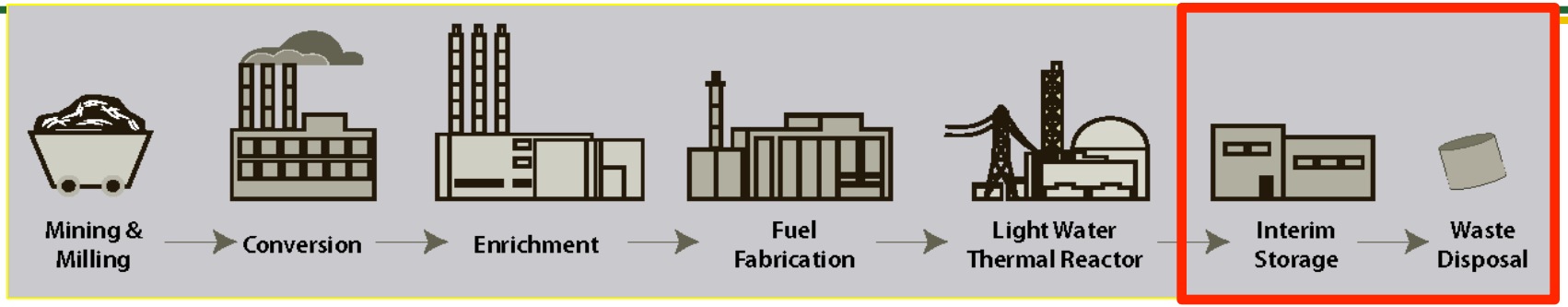
The U.S. Open Fuel Cycle is Still Incomplete – Missing Two Facilities



R&D considerations

- Are there ways to isolate used fuel or its constituents for the very long term?
- Are there proliferation issues associated either with long-term accumulation or treatment and recycle of used fuel?

Is used fuel a waste or a resource?

Used fuel contains:

- Fissile isotopes that could be recovered and re-used in nuclear fuel.
- Isotopes that are radioactive for long time periods that would cause environmental and health impacts if released.

U.S. path forward

- Used fuel can be stored safely for decades.
- BRC provided recommendations that help guide management of used fuel and fuel cycle R&D.
- BRC affirms the need for R&D on advanced fuel cycles that represent advantages over today's technologies.

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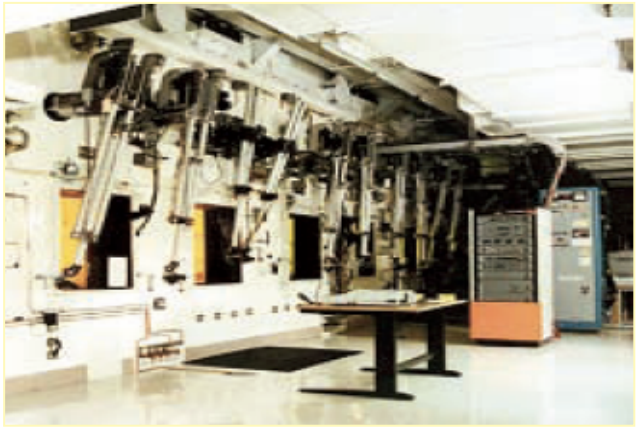
Fuel Cycle Technology Program Seeks University Research Proposals

Fuel Cycle Technology Program seeks university proposals that advance:

1. **Near term improvements to LWR safety such as accident tolerant fuels as it relates to the once through fuel cycle and recycling.**
2. **Longer term efforts to advance potential "game changing" technologies that can achieve large benefits over today's fuel cycle technologies, e.g., nanotechnology related to fuel cladding.**



Consider potential teaming arrangements that enable universities to utilize their unique capabilities and facilities as well as those potentially accessible at laboratories and industry.

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Separations and Waste Form Development

Goals: Developing the next generation of fuel cycle (including advanced fuels) and waste management technologies that enable a sustainable fuel cycle, with minimal processing, waste generation, and potential for materials diversion.

Key technology challenges:

- **Economic recovery of transuranic elements for recycle/transmutation.**
- **Minimizing low-level and high-level waste.**

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Separations and Waste Form Focus Areas for University Proposals

- **Key university research needs for separations includes:**
  - ***Fundamental understanding for electrochemical separation of transuranic elements;***
  - ***Advanced separation methods, including application of the unique properties of nanomaterials.***

- **Key university research needs for waste forms includes:**
  - ***Capture/immobilization of gaseous fission products;***
  - ***Innovative waste forms that have the potential of significantly increased waste loading and durability;***
  - ***Fundamental understanding of waste form performance over geologic time scales.***

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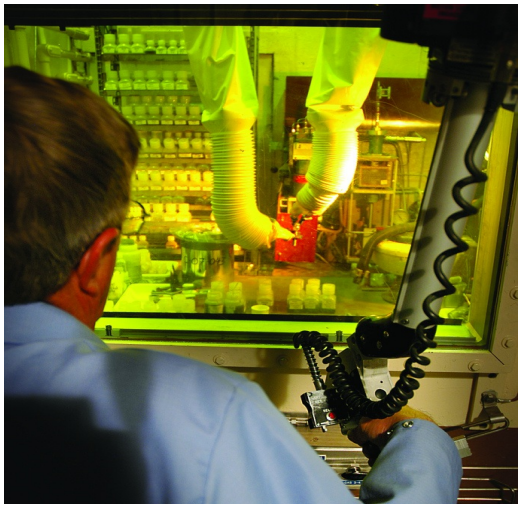
Advanced Fuel Development

Goals:

- Develop next generation LWR fuels and cladding whose characteristics include improved operating margin, accident tolerance and high burnup.
- Develop transmutation metal fuels with a high degree of tolerance to accident conditions and that represent advancements in resource utilization and reduced waste.



- Focus Areas for University Research
  - Characterization, Instrumentation and Testing
  - Advanced LWR materials

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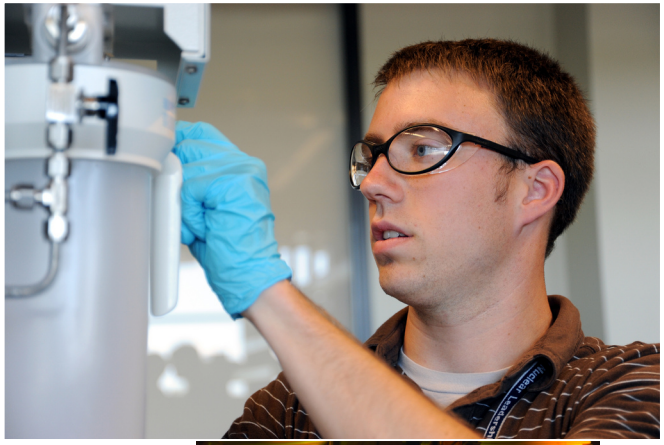
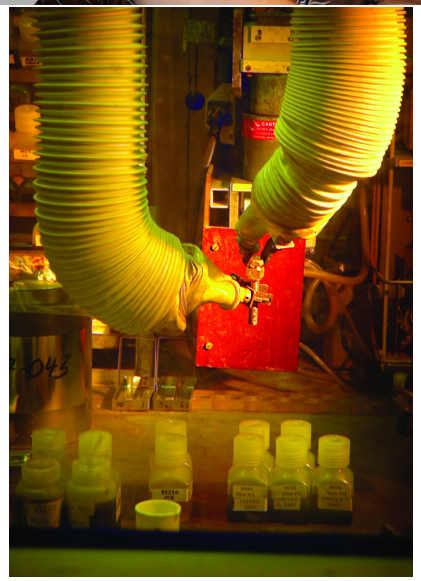
Advanced Fuels Focus Areas for University Proposals

- **Key university research needs for advanced fuels include:**
  - ***Development of material characterization techniques and in-pile instrumentation;***
  - ***Separate effects tests to support performance model development;***
  - ***LWR core materials with enhanced tolerance to accidents***
  - ***Improved nuclear data***





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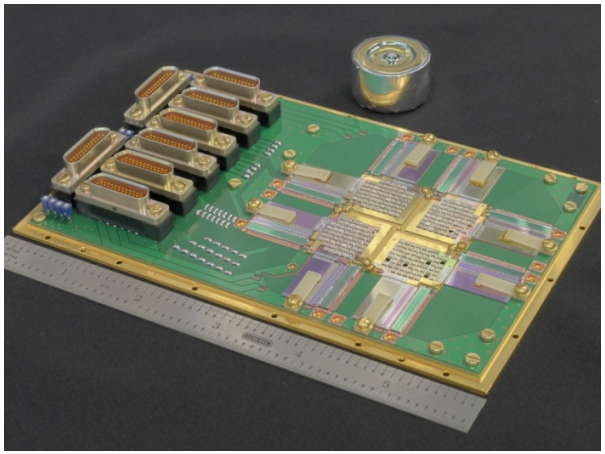
Nuclear Materials Control and Instrumentation

Goals:

- **Development of technologies and analysis to support next-generation safeguards for future U.S. fuel cycles.**
- **New and improved detector systems and sensor materials.**
- **Methods for data integration and analysis.**



- **Focus of the research:**
  - **Sensors and Instrumentation**
  - **Analysis Tools**

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Used Nuclear Fuel Disposition Focus Areas for University Proposals

- **Storage**
  - Innovative approaches to evaluate degradation and aging.
  - Data and risk informed assessment methods for high-burnup fuel.
  - Development of a superior concrete.
  - Non-destructive techniques to monitor long-term effects.
  - Innovative research in developing poison materials.
- **Transportation**
  - Materials research.
  - Structural integrity assessment.
  - Advanced modeling approaches for radiological analyses.
  - Data relevant to high-burnup and advanced fuels.

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Used Nuclear Fuel Disposition Focus Areas for University Proposals, continued

- **Disposal**
  - Degradation processes for waste forms and engineered barriers.
  - Coupled thermal-mechanical-hydrological-chemical processes.
  - Large-scale hydrologic and radionuclide transport.
  - New techniques for in-situ field characterization.
  - Aqueous speciation and surface sorption.
  - Waste form performance in different disposal environments.
  - Effects of radiolysis on used fuel, high-level waste, and barrier material.

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Fuel Cycle Options Analysis

Goals:

- By 2013, complete a "system engineering" evaluation of the three fuel cycle options:
  - Once through
  - Modified open
  - Full recycle
- BRC recommendations regarding comprehensive evaluation of a complete fuel cycle risk.

Key university research needs for fuel cycle options analysis includes:

- Develop fuel cycle data packages.
- Develop modules for the fuel cycle simulator.
- Develop capabilities for whole system optimization and economic analyses.
- Assist in building libraries of historic/infrastructure information.

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Concluding Remarks

Nuclear energy will play an important role in the future national energy portfolio.

FCT seeks to:

- Maintain advanced technology capabilities to develop next generation light water reactor fuels and cladding to improve operating margin, accident tolerance, and high burnup.
- Develop comprehensive strategy for managing the back end of the fuel cycle.
- Maintain and expand the base of highly qualified engineers and scientists.

20 percent of NE's budget aimed at funding collaborative work on specific R&D projects: FCT needs you in order to achieve its goals.

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Contact Information

Robert Price, NE-51
Office of Systems Engineering and Integration
301-903-2533

Andrew Griffith, NE-52
Office of Fuel Cycle Research and Development
301-903-7120

Bill Boyle, NE-53
Office of Used Nuclear Fuel Disposition Research and Development
702-794-5506

Blue Ribbon Commission on America's Nuclear Future:

www.brc.gov

Nuclear Energy University Program:

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