U.S. DEPARTMENT OF ENERGY

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Fuel Cycle Research and Development Program

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Office of Used Nuclear Fuel Disposition Research and Development

Nuclear Regulatory Commission

Rockville, MD

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Nuclear Energy Objectives

1. Improve the reliability, sustain the safety, and extend the lives of the current reactors

2. Develop improvements in the affordability of new reactors

3. Develop sustainable nuclear fuel cycles

4. Understand and minimize the risks of nuclear proliferation and terrorism

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FY 2011 Budget Request

Nuclear Fuel Cycle R&D Appropriations

FY 2010 Appropriation: $136,000,000

FY 2011 Request: $201,000,000

This represents an increase of 48%.

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FCR&D Technical Areas

- Separations and Waste Forms
- Advanced Fuels
- Systems Analysis and Integration
- Modeling and Simulation
- Materials Protection, Accounting, and Control for Transmutation
- Used Nuclear Fuel Disposition

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FCR&D Technical Areas

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UFD FY 2011 Budget Details

Activity	Estimated Cost ($ million)
Science Programs transferred from RW to NE	12
University research related to Used Fuel Disposition	9
RW Science Program closeout costs	8
Disposal evaluations and experiments	8
Storage and transportation evaluations and experiments	6
External interactions and collaborations	1
Used Fuel Disposition Campaign Management	1
Total	45

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Used Fuel Disposition: Storage

Extend the technical basis to allow:

- **storage of LWR fuel to 100 years or more**
- **storage of high burnup LWR fuels**
- **different fuel types and waste forms**

Connecticut Yankee ISFSI

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Used Fuel Disposition: Storage

- **Evaluate concepts for distributed, regional, and centralized storage.**
- **No site-specific investigations.**

Sellafield HLW Storage

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Used Fuel Disposition: Transportation

Develop the technical basis to allow safe and secure transportation of high-burnup fuels and a variety of waste forms. (To be started in FY 2011.)

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Used Fuel Disposition: Disposal

- Geologic disposal will be required. Period.
- Establish the technical bases for a variety of potential disposal environments, including
  - Granite
  - Clay/Shale
  - Salt
  - Deep Boreholes
- No site-specific investigations.

Backup Slides

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Fuel Cycle Research and Development

Budget Summary
$ in thousands

Program Element	FY 2010 Approp	FY 2011 Request
Separations and Waste Forms	41,615	31,324
Advanced Fuels	29,651	40,000
Transmutation R&D	4,288	0
Modeling & Simulation	26,009	15,570
Systems Analysis & Integration	14,783	15,664
Materials Protection, Accountancy & Controls for Transmutation	6,826	7,814
Used Nuclear Fuel Disposition	9,124	45,000
Modified Open Cycle	0	40,000
SBIR/STTR	3,704	5,628
Total:	**136,000**	**201,000**

- **Mission**
  - Research and develop nuclear fuel and waste management technologies that will enable a safe, secure, and economic fuel cycle.
- **FY2011 Planned Accomplishments**
  - Examine 3 fuel cycle strategies: once-through, modified open, and full recycle.
  - Continue to develop advanced concepts for electrochemical processing and alternative waste forms.
  - Begin to develop innovative fuel systems that support advanced fuel cycles.
  - Provide technical expertise to inform decision-making for storage, transportation, and disposal of used nuclear fuel and radioactive waste.

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Separations and Waste Forms

Today's Technology Challenges

- Meeting current air emission requirements
- Economical recovery of transuranic elements for recycle/transmutation
- Minimal waste generation

Grand Challenges

- Near-zero radioactive off-gas emissions
- Simplified, single-step recovery of transuranic elements
- Significantly less process wastes

Development Path

- Develop fundamental understanding of separation process and waste form thermodynamics
- Understand underlying separation driving forces
- Exploit thermodynamic properties to effect separations
- Elucidate microstructural waste form corrosion mechanisms

Transformational Result

- Predictive capability for separation and waste form performance over a broad range of operational conditions
- Novel separations technologies

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Advanced Fuels

Today's Technology Challenges

- Fuels with variable compositions
- Understanding and predicting fuel behavior and performance
- Reliably fabricating fuel with zero defects and with minimal process losses

Grand Challenge

- Light water reactor fuels with significant performance improvements related to uranium utilization
- Fast reactor fuels with multi-fold increases in performance over previous generation fuels, with very low fabrication losses, and that permit high transmutation of radiotoxic elements

Development Path

- Develop a microstructural understanding of fuels and materials
- Closure of combined transport and phase-field equations
- Separate effect testing and properties measurement at sub-grain scale to support modeling development
- Advanced irradiation techniques
- Innovative clean and reliable fabrication techniques with tightly controlled microstructures tailored to desired performance

Transformational Result

- Predictive capability for fuel process and in-pile behavior for a variety of initial and boundary conditions
- Novel fuel forms qualified for commercial use

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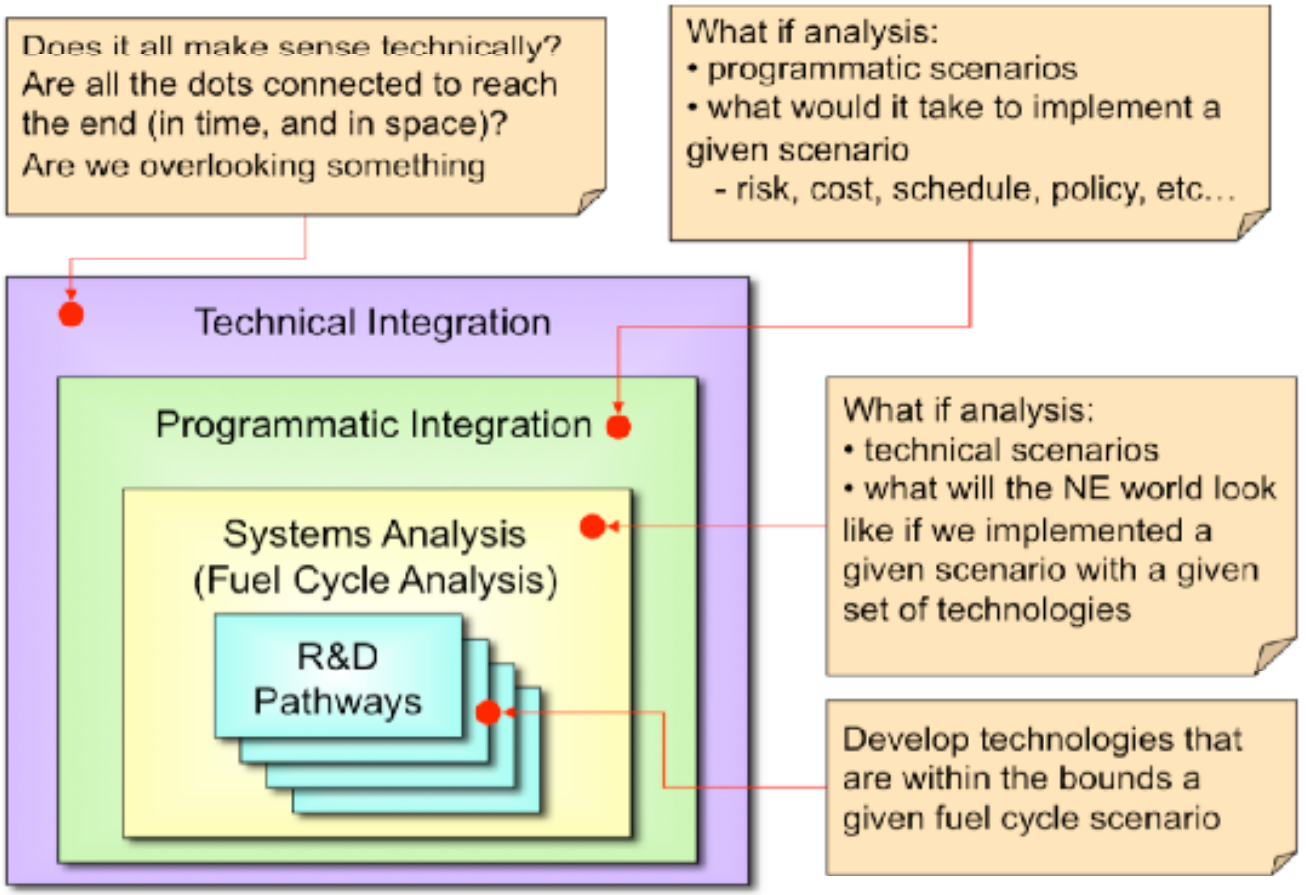
SA, SE, and TI – How do they fit together?



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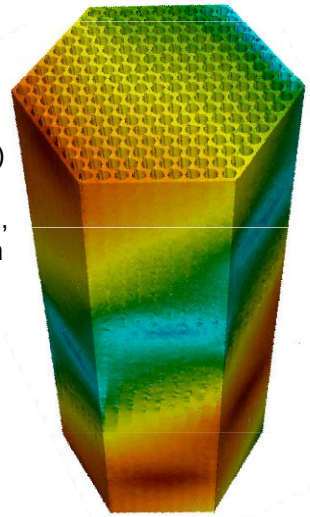
Modeling and Simulation

Today's Technology Challenges

- Current generation of nuclear modeling and simulation tools are empirically based
- Limited to use only for conditions very close to those experiments

Grand Challenge

Rapidly create and deploy "science" (first principles) verified and validated modeling and simulation capabilities essential for the design, implementation, and operation of future nuclear energy systems with the goal of improving U.S. energy security.



Development Path

- Create teams focused on developing Integrated Performance and Safety Codes
- Support smaller projects developing atomistic scale models and methods for upscaling to integrated codes
- Develop and implement methodologies for verification, validation and uncertainty quantification
- Ensure capability transfer pathways to users of modeling and simulation capabilities (labs, industry and regulatory agencies
- Provide supporting computational technologies

Transformational Result

Develop modeling and simulation that is on par with theory and experiment to implement a modern science based approach for fuel cycle technologies.

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Materials Protection, Accounting, and Control for Transmutation
(Fuel cycle systems and reactors)

Today's Technology Challenges

- Large throughput facilities require shutdown for periodic inventory
- New reactor designs require new nuclear material management approach – safeguards by design
- Move from reactive to preventive systems approach

Grand Challenge

Develop online, real-time, continuous, accountability instruments and techniques that permit an order of magnitude improvement in the ability to inventory fissile materials in domestic fuel cycle systems, in order to detect diversion and prevent misuse.

Development Path

- **Next generation instrumentation**
  - High sensitivity and specificity
  - Enabled by new physics data
  - New sensor materials
- **Integration of disparate data in quantitative manner**
  - Real time assessments
  - Probability basis with uncertainties
- **Predictive modeling and simulation at atomistic and plant level**

Transformational Result

Real time nuclear materials management with continuous inventory in fuel cycle facilities

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Used Nuclear Fuel Disposition

Today's Technology Challenges

- Storing and disposing UNF, HLW, GTCC, and LLW from a range of fuel cycles
- Understanding and predicting geologic repository performance
- Safe, secure, and cost effective storage, transportation and disposal

Grand Challenge

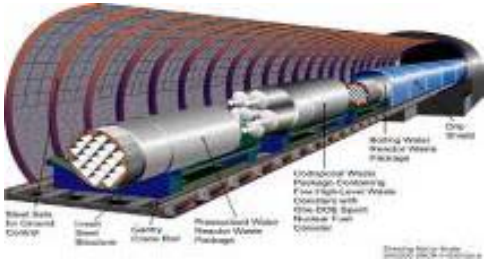
Integrated waste management with near zero radionuclide release from storage and disposal system

Development Path (with RW, EM)

- Develop an understanding of geologic repository performance
- Review extensive technical basis developed in the U.S. and internationally over the past several decades including recent work by SNL and LANL on a generic salt repository
- Explore a range of potential geologic settings, including granite, salt, clay, and tuff, and range of disposal concepts, including shaft-room, ramp-drift, and deep boreholes
- Investigate storage concepts for UNF and a range of waste streams
- Develop an integrated waste management strategy applicable to a range of fuel cycle options

Transformational Result

Predictive capability for performance of storage and disposal options for a range of fuel cycles



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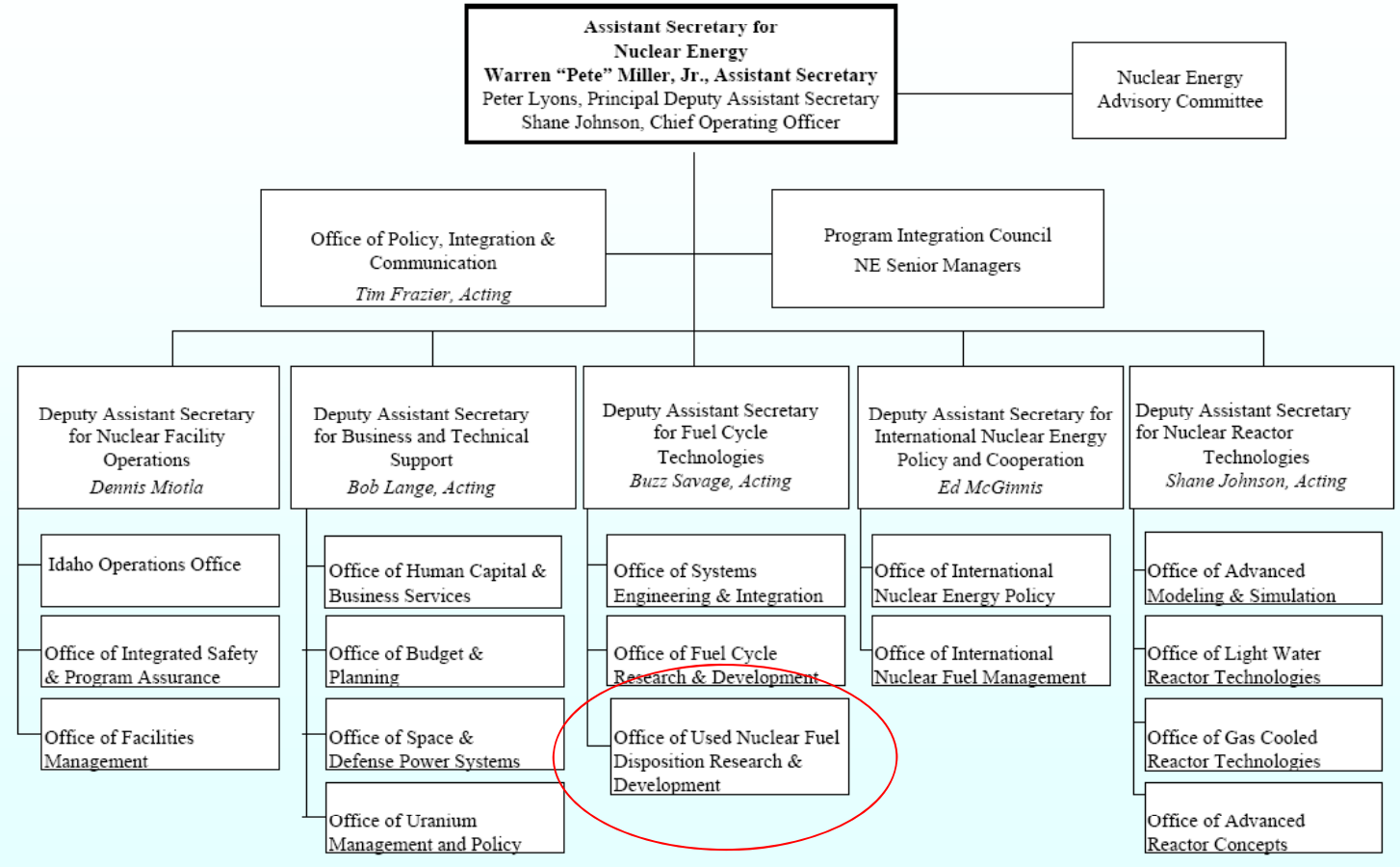
Office of Nuclear Energy: New Organization



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Transfers of RW functions

- Technical work from RW to NE
- Standard Contracts from RW to GC
- Fee Adequacy Report from RW to GC
- Litigation Support from RW to GC
- Records Retention from RW probably to LM, with funding from NE