U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

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Nuclear Energy
Advanced Modeling & Simulation Program

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NE Program Briefing for SciDAC 4 Annual PI Meeting

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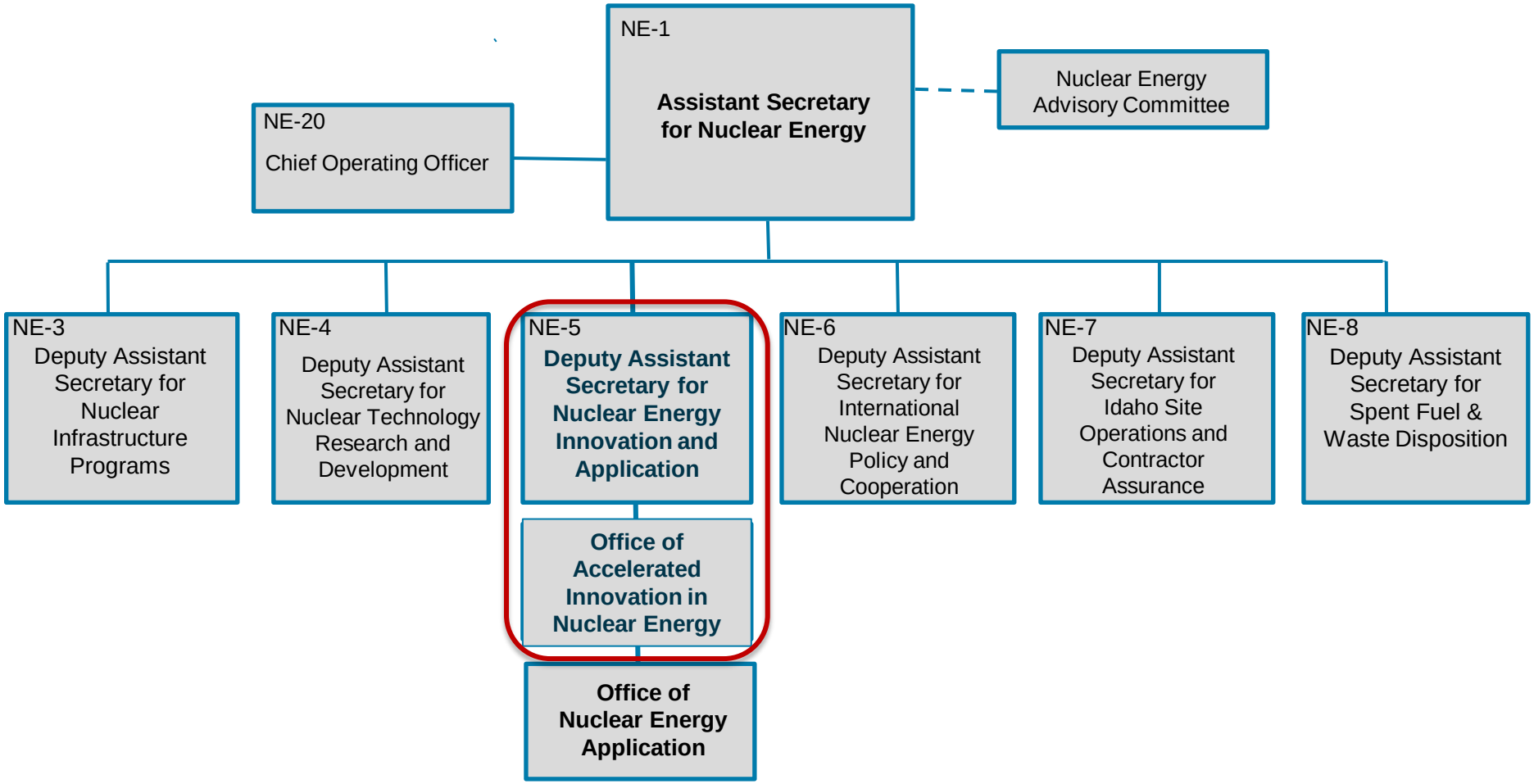
Office of Accelerated Innovation in Nuclear Energy (NE-51)

Office of Nuclear Energy Organization

Where in NE are programs for developing and deploying advanced modeling and simulation tools managed?



Advanced Modeling & Simulation

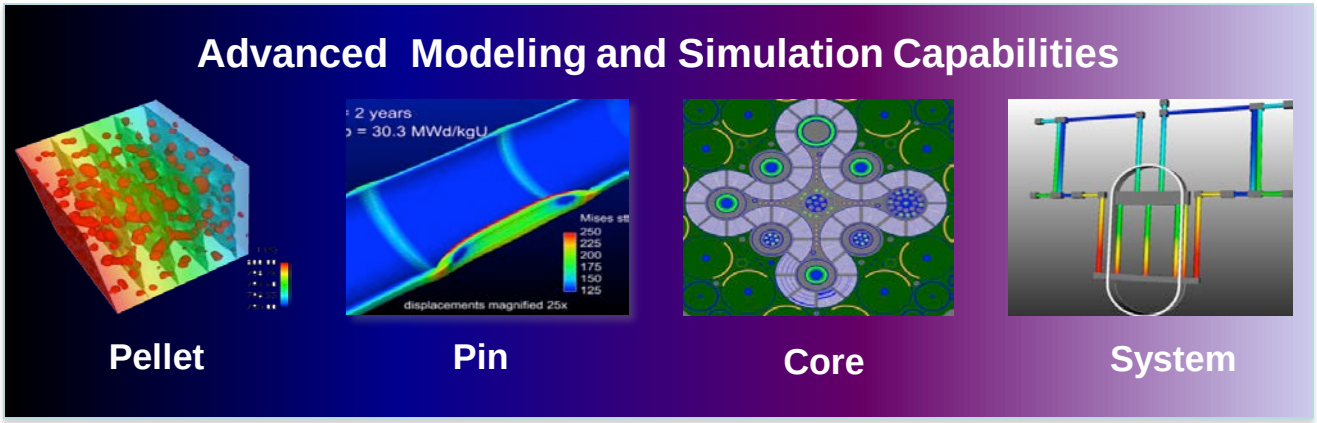
NE currently executes two complementary advanced M&S programs, each tailored to focus on a particular reactor technology area using computational tools uniquely suited to the particular reactor moderator(s) and fuel(s).

Energy Innovation Hub for Modeling and Simulation (Hub)

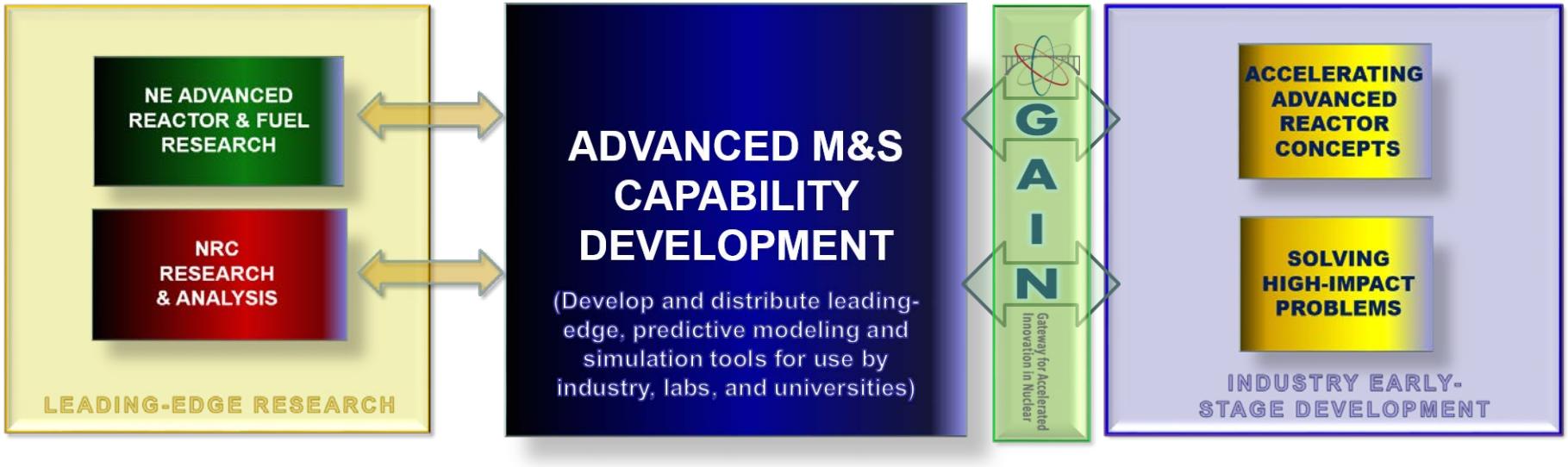
Objective: Develop and apply Virtual Environment for Reactor Applications (VERA) M&S tools for an improved understanding of operational/safety issues important to the sustainability and expansion of the existing fleet, and for regulatory acceptance, focused on LWR technologies

Nuclear Energy Advanced Modeling & Simulation (NEAMS)

Objective: Develop and deploy predictive M&S tools and methods (NEAMS ToolKit) for the analysis, design and regulatory acceptance of advanced reactor and fuel cycle systems focused on non-LWR technologies



Advanced Modeling & Simulation



Advanced Modeling & Simulation:
Tools to Solve Industry's Priority Problems

		LWRs (and water based SMRs)	Advanced Reactors
Integration		VERA	Workbench
System Analysis	Plant	RELAP-7	SAM
Core Analysis	Neutronics-Pin Resolved	MPACT	Proteus
	Neutronics-Monte Carlo	Shift/External Codes	External codes
	Neutronics-Kinetics/Depletion	MPACT	
	Neutronics-Cross Sections	AMPX/SCALE - MC2-3	MC2-3
	T-H Low Res	Cobra-TF (CTF)	SAM
	T-H Hi Res (CFD)	External codes/Nek5000	Nek5000
	Structural Mechanics	External codes	Diablo
Fuel Analysis	Continuum	BISON	BISON
	Microstructure	Marmot	Marmot
	Component Aging	Grizzly	Grizzly
	Chemistry	MAMBA	MAMBA

Advanced Modeling & Simulation
Underpins NE's Mission Focus Areas

Existing Fleet

- **Address core performance issues that increase operational costs**
- **Assure the long-term availability and market competitiveness of nuclear energy**

Advanced Reactor Pipeline

- **Accelerate concept development and commercialization**
- **Meet otherwise cost-prohibitive data needs**
- **Support NRC confirmatory analyses**

Fuel Cycle Infrastructure

- **Confirm higher burn-up fuel strategies to slow production of used nuclear fuel (UNF) – VERA**
- **Support UNF R&D with high-fidelity analysis and prediction of fuel and cladding performance- NEAMS**

Advanced Modeling & Simulation:
Supporting NE's Mission Focus Areas

Existing Fleet | Advanced Reactor Pipeline | Fuel Cycle Infrastructure

- **Allows the LWR vendors and utilities to develop innovative solutions to important fuel and core performance issues**
  - *Issues* – include power shifts, corrosion, fuel damage, and thermal performance, which add cost and limit affordability
  - *Solutions* – will help achieve significant reductions in reactor operational costs, which is an important component in the industry-wide initiative, "Delivering the Nuclear Promise"

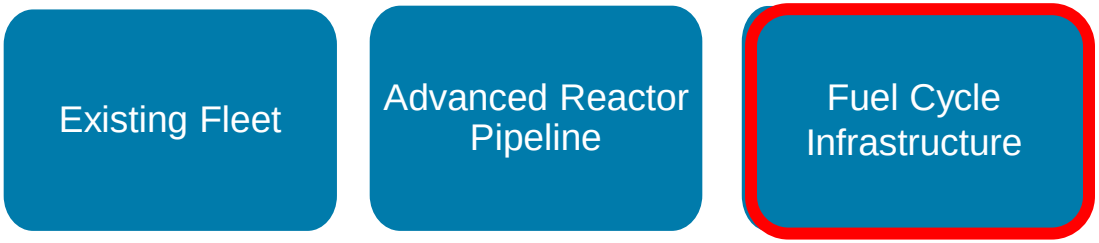
- **Empowers the LWR community to take advantage of accident tolerant fuels (ATF), and implement load-following strategies for enhanced safety, improved economics, and greater versatility on the grid**
  - Accelerate development and approval of new ATF concepts (in fact, advanced M&S researchers have identified a promising new fuel, patent-pending)
  - Confirm viability of load-following with LWRs, to allow greater flexibility in meeting electrical demand, especially in combination with other renewable energy sources

Advanced Modeling & Simulation
Supporting NE's Mission Focus Areas

Existing Fleet | **Advanced Reactor Pipeline** | Fuel Cycle Infrastructure

- **Critical role in accelerating design and deployment of advanced reactors**
  - Design optimization is required to fully realize the economic and technological advantages of advanced concepts
  - Advanced M&S tools will help the NRC expand capabilities as needed to perform confirmatory analysis on advanced reactor concepts
- **Only way for vendors to economically address data needs, which otherwise could require cost-prohibitive experimentation**
  - Reduce the amount of experimental testing needed
  - Identify, design, execute, and analyze more effective high-value experiments
- **The advanced reactor industry is already using our Advanced M&S tools to:**
  - Reduce cost and time for license applications to the NRC
  - Enhance potential for successful commercialization - accelerated development crucial to economic viability

Advanced Modeling & Simulation:
Supporting NE's Mission Focus Areas



- **Contribute to nuclear fuel cycle sustainability, and address the integrity and confidence of spent fuel management over future decades**
  - Help extend fuel life and produce less used nuclear fuel (UNF) through higher fuel burnup strategies, developed and implemented with advanced M&S tools
  - Support future UNF disposition R&D with predictive analyses of fuel and cladding performance and conditions, from removal from the reactor through dry storage in a canister

Advanced Modeling & Simulation:
Tools to Solve Industry's Priority Problems

- **Reducing operational costs and improving market competitiveness are crucial for existing LWRs**
  - Without cost reductions and versatility of operation enabled by Advanced M&S, efforts to maintain and expand the existing LWR fleet may not succeed

- **Accelerating concept development for timely commercialization is absolutely critical to the future success of advanced reactors**
  - Without acceleration enabled by Advanced M&S, commercialization of promising advanced reactor concepts may not be possible, which could have a long-range adverse impact on the energy sector; certainly a major opportunity lost

Advanced Modeling & Simulation:
Tools to Solve Industry's Priority Problems

"*Advanced modeling and simulation capabilities are crucial to advanced reactor commercialization. Oklo has been using NEAMS tools to support design and licensing activities, which have helped Oklo* ***accelerate*** *its design and licensing timeframes. Oklo intends to use NEAMS* ***tools now under development*** *to directly support part of its license application, which are enabling Oklo to pursue a faster timeline.*

The U.S. holds a global advantage in its modeling and simulation capabilities thanks to advances made in NEAMS tools, including legacy tools. These tools give U.S. developers an advantage over international competitors, but ***these capabilities need to be expanded and enhanced*** *to maintain this lead*."

– Dr. Jacob DeWitt
CEO, Oklo, Inc.

Thanks for Listening!

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