

# NEAMS Annual Review: High Temperature Gas-Cooled and Fluoride Salt-Cooled Reactors

---



U.S. DEPARTMENT  
*of* **ENERGY**

Office of  
Nuclear Energy

# Opening Remarks and Meeting Objectives

---

David Andersson, NEAMS National Technical Director, Los Alamos National Laboratory

Tanju Sofu, NEAMS Deputy National Technical Director, Argonne National Laboratory

David Henderson, Federal Program Manager, U.S. Department of Energy



U.S. DEPARTMENT  
*of* **ENERGY**

Office of  
Nuclear Energy

# Meeting Objectives

- Welcome and thank you for your interest in the DOE NEAMS (Nuclear Energy Advanced Modeling and Simulation) program!
- Reviews are performed by reactor type in virtual meetings (today's LWR meeting highlighted):
  - Light Water Reactors: May 7, 11:00 AM – 5:00 PM ET
  - **High Temperature Gas-cooled and Fluoride Salt-Cooled Reactors: May 8, 11:00 AM – 4:00 PM ET**
  - Micro-Reactors: May 12, 11:00 AM – 4:00 PM ET
  - Molten Salt Reactors: May 28, 11:00 AM – 4:15 PM ET
  - Fast Reactors: May 29, 11:00 AM – 4:15 PM ET
- The objectives of this meeting are to review the work performed by the NEAMS program during the past year, solicit feedback from stakeholders, and discuss future priorities – making sure that we are aligned with the needs of the nuclear industry, regulators and broader R&D community.
- We welcome and encourage feedback and constructive discussion.



# Meeting Logistics

- The meeting is virtual and utilizes Microsoft Teams.
- Please mute yourself when you are not speaking.
- Questions may be asked after each talk (for clarification) or during the main Q&A slot at the end of each session. We have also scheduled time at the end of the day for stakeholders to provide summary feedback and ask any final questions.
- You can ask your questions or make comments in the chat, by raising your hand or by unmuting yourself and speaking up – in that order of preference.
- Moderators will monitor the chat and call on people raising their hands in the order that they were raised to state their questions.
- We will provide email for each presenter if you would like to have a more in-depth discussion. You can also email David Andersson, [andersson@lanl.gov](mailto:andersson@lanl.gov).



# Agenda

## NEAMS Agenda

### NEAMS Annual Review High Temperature Gas-Cooled and Fluoride Salt-Cooled Reactors May 8, 2025

11:00 AM-4:00 PM (Eastern Time)

11:00	<b>Opening remarks and meeting objectives</b>	David Henderson, DOE/David Andersson, LANL
11:05	<b>NEAMS overview and Gas-Cooled and Fluoride Salt-Cooled Reactors research plan</b>	David Andersson, LANL
<b>Research presentations on High Temperature Gas-Cooled and Fluoride Salt-Cooled by NEAMS Technical Areas on Fast Reactors by NEAMS Technical Areas</b>		
11:15	<b>Multiphysics Applications</b>	
	Introduction to Multiphysics Applications Technical Area (5 min)	Emily Shemon, ANL/Cody Permann, INL
	Multi-physics simulation of PB-HTGR transients using SAM and Griffin (15 min)	Zhilee Jhia Ooi, ANL
	Review of running-in simulation and verification in PBRs (15 min)	Josh Hanophy, INL
	Q & A (10 min)	
12:00	<b>Reactor Physics</b>	
	Introduction to Reactor Physics Technical Area (5 min)	Matthew Jessee, ORNL
	Overview of Griffin and Shift R&D activities for GCR/FHR systems (15 min)	Javier Ortensi, ORNL
	Griffin cross section methodologies for GCR/FHR systems (15 min)	Rike Bostelmann, ORNL

## Agenda

	Q & A (10 min)	
12:45	<b>Thermal Fluids</b>	
	Introduction to Thermal Fluids Technical Area (5 min)	Elia Merzari, ANL/Rui Hu, ANL
	Enhancements in system-level T/H modeling for HTGRs and FHRs (15 min)	Ling Zou, ANL
	Enhancements in engineering-level T/H modeling for HTGRs and FHRs, including overlapping domain coupling (15 min)	David Reger, INL
	Q & A (10 min)	
13:30	<b>Break</b>	
14:15	<b>Fuel Performance</b>	
	Introduction to Fuel Performance Technical Area (5 min)	Stephen Novascone, INL/Michael Cooper, LANL
	NEAMS fuels modeling for HTGRs and FHRs- FY24 accomplishments and outlook for FY25 (30 min)	Jake Hirschhorn, INL
	Q & A (10 min)	
15:00	<b>Structural Materials and Chemistry</b>	
	Introduction to Structural Materials and Chemistry Technical Area (5 min)	Benjamin Spencer, INL/Ted Besmann, USC
	Graphite thermos/mechanical modeling capability development in Grizzly (10 min)	Parikshit Bajpai, INL
	Incorporating irradiation effects in predictive models of Grade 91 alloy (10 min)	Laurent Capolungo, LANL
	Release of NEML2 high-performance constitutive modeling library (10 min)	Gary Hu, ANL
	Q & A (10 min)	

## Agenda

15:45	<b>Feedback and conclusion</b>
16:00	<b>Adjourn</b>



# NEAMS Overview and Gas-Cooled and Fluoride Salt-Cooled Reactors research plan

---

David Andersson, NEAMS National Technical Director, Los Alamos National Laboratory

Tanju Sofu, NEAMS Deputy National Technical Director, Argonne National Laboratory

David Henderson, Federal Program Manager, U.S. Department of Energy



U.S. DEPARTMENT  
*of* **ENERGY**

Office of  
Nuclear Energy

# ***NEAMS is the DOE-NE Modeling and Simulation Program***

- Why advanced modeling simulation of nuclear reactors?
  - Predictive modeling and simulation enable innovation in design, development, licensing, deployment and operation of nuclear reactors by providing high fidelity results and enhancing the value of available, but often limited, experimental data points.
- The NEAMS program aims to address this need by:
  - Developing advanced methods, models and simulation capabilities (software) in reactor physics, thermal hydraulics, fuels, materials, chemistry and multi-physics that enhance our ability to simulate the current fleet and advanced reactors.
  - Utilizing and advancing new and evolving science and technology such as multi-scale simulations, AI/ML, in-line sensor data and digital twins, and advanced computing platforms to solve high-impact problems.
  - Supporting development, licensing, deployment and operation of nuclear reactors by stakeholders through software deployment, maintenance, baseline support, validation and verification.
  - Engaging in collaborations and partnerships to enable use of NEAMS tools for advances in reactor technology by stakeholders (industry, NRC, universities, other DOE programs – e.g., ART, AFC and AMMT, international, etc.).



# NEAMS Program Structure



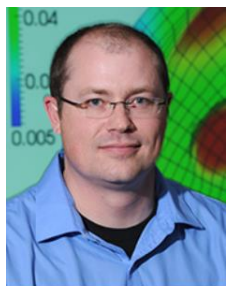
David Henderson  
DOE NE-5 Federal Program Manager



David Andersson  
National Technical Director



Tanju Sofu  
NEAMS Deputy Director



Stephen Novacsone  
Lead, Fuel Performance



Michael Cooper  
Deputy Lead, Fuel Performance



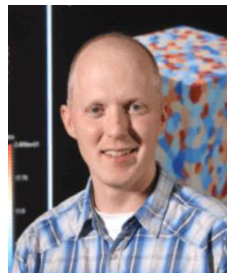
Elia Merzari  
Lead, Thermal-Hydraulics



Rui Hu  
Deputy Lead, Thermal Fluids



Emily Shemon  
Lead, Multiphysics Applications



Cody Permann  
Deputy Lead, Multiphysics Applications



Benjamin Spencer  
Lead, Structural Materials & Chemistry



Ted Besmann  
Deputy Lead, Structural Materials & Chemistry



Matthew Jessee  
Lead, Reactor Physics



Javier Ortensi  
Deputy Lead, Reactor Physics

**DOE NE-72**  
**Federal Program Manager:**  
David Henderson

**Director:** David Andersson (LANL)  
**Deputy Director:** Tanju Sofu (ANL)

## Senior Leadership

**Fuel Performance**  
*Lead:* Steve Novacsone (INL), *Deputy:* Mike Cooper (LANL)

**Reactor Physics**  
*Lead:* Matt Jessee (ORNL), *Deputy:* Javier Ortensi (INL)

**Thermal Fluids**  
*Lead:* Elia Merzari (PSU, JFA ANL), *Deputy:* Rui Hu (ANL)

**Structural Materials and Chemistry**  
*Lead:* Ben Spencer (INL), *Deputy:* Ted Besmann (USC, JFA ORNL)

**Multiphysics Applications**  
*Lead:* Emily Shemon(ANL), *Deputy:* Cody Permann (INL)

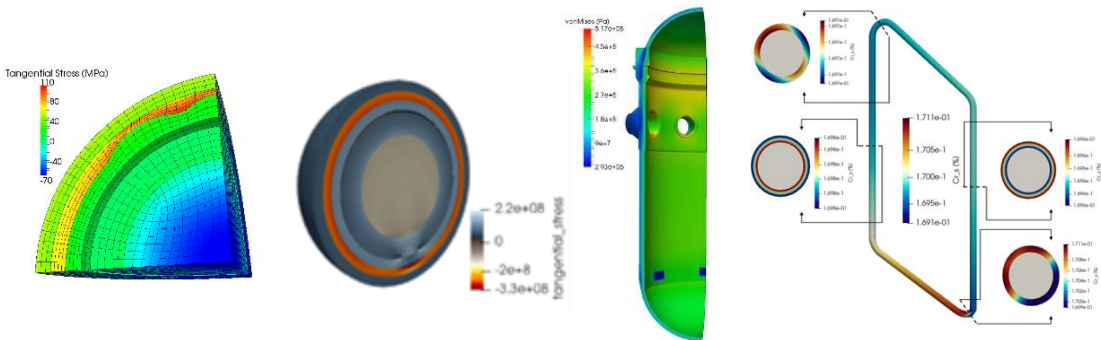
## Extended Leadership





# NEAMS Technical Areas and Code Support

## Fuel Performance

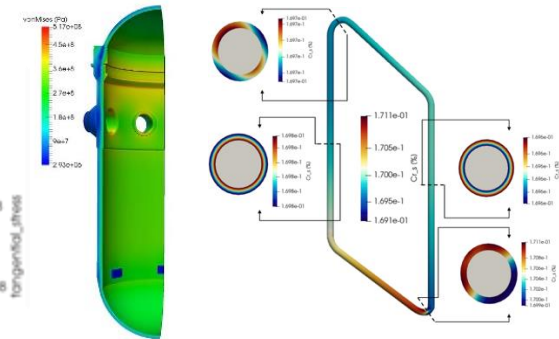


**Competencies:** Multi-scale fuel and cladding performance

**Codes:** Bison

**Lower-length-scale capabilities:** DFT, MD, phase field, crystal plasticity (LAPx), cluster dynamics, phase field

## Structural Materials and Chemistry

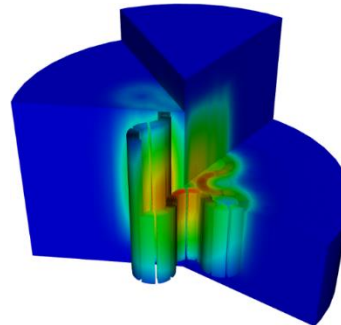


**Competencies:** Multi-scale modeling of materials degradation and chemistry (molten salts)

**Codes:** Grizzly/BlackBear, MSTDB-TC, MSTDB-TP, Mole, SWIFT, MOSCATO

**Lower-length-scale capabilities:** DFT, MD, phase field, crystal plasticity (LAPx), dislocation dynamics, cluster dynamics

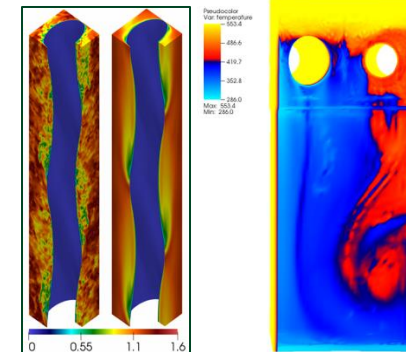
## Reactor Physics



**Competencies:** Deterministic and stochastic methods for simulating neutron transport and nuclide depletion/decay

**Codes:** GRIFFIN, Shift, MPACT

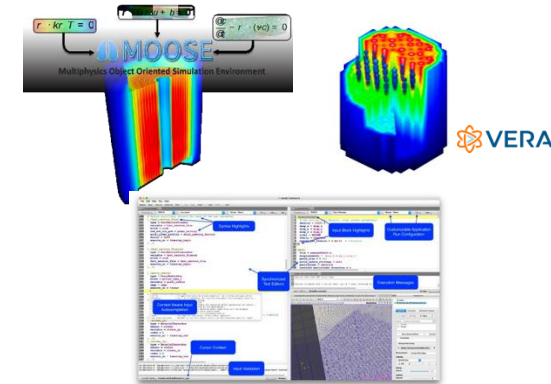
## Thermal Fluids



**Competencies:** Multi-scale simulations of thermal fluids and heat transfer in reactor systems

**Codes:** CTF, SAM, PRONGHORN, Sockeye, Nek5000/NekRS, Cardinal

## Multiphysics Applications



**Competencies:** Computational frameworks, multiphysics simulations, reactor specific applications, user interfaces and workflows.

**Codes and frameworks:** MOOSE, VERA, Workbench

**Capabilities are developed for all major reactor types – Light Water Reactors, Gas-Cooled Reactors, Molten Salt Reactors, Metal Cooled Fast Reactors and Microreactors. The reactor specific applications cross-cut the technical areas.**

**Key success metric: Use of NEAMS technology (either software or R&D) by stakeholder to improve how they “do business.”**



U.S. DEPARTMENT  
of ENERGY | Office of  
Nuclear Energy

# ***Gas- and Fluoride Salt-Cooled Reactors Research Plan***

- Research plan is driven by the needs of our stakeholders (PBRs, prismatic reactors, FHRs).
- Develop, V&V and benchmark/demonstrate advanced capabilities for reactor operational states:
  - Normal Operation and Anticipated Operational Occurrences
    - Reactor physics improvements for transients, cross-sections, reactivity control mechanisms, etc.
    - Multi-scale TH modeling to improve ability to describe PBRs, including overlapping domain coupling.
    - Develop and deploy advanced models for high-temperature alloy response.
    - Develop models for thermal and mechanical behavior of graphite grades and graphite components.
    - Multiphysics capabilities for running-in and transient simulations using, e.g., coupled SAM and Griffin simulations.
  - Accidents scenarios (Design Basis Accidents and Beyond Design Basis Accidents)
    - Capabilities to simulate the reactor system after breaks, two-phase gas mixtures, component oxidation, freeze-thaw.
    - Control system capabilities to simulate components such as relief valves, or to control the reactor operation.
    - Develop TRISO and TRISO-pebble fuel performance simulation capabilities for high and low fidelity simulations.
    - Integrate existing tools or develop new capabilities for fission product transport at the system level.
- Coordination of activities with DOE ART Gas-Cooled Reactors and AFC programs.



# Additional Resources

- We have a newsletter - contact David Andersson, [andersson@lanl.gov](mailto:andersson@lanl.gov), if you are not on the distribution list and would like to be.
- We have a website – [neams.inl.gov](https://neams.inl.gov) – where you can find information about the program, newsletters, and soon link to technical reports.
- Request access to NEAMS codes through <https://inl.gov/ncrc/>.
- NRIC-NEAMS collaboration on the Virtual Test Bed (VTB) - [https://mooseframework.inl.gov/virtual\\_test\\_bed/](https://mooseframework.inl.gov/virtual_test_bed/) - where open models can be accessed.

**Nuclear Energy Advanced Modeling and Simulation**  
**NEWSLETTER**  
April | 2025

**A MESSAGE FROM NEAMS Senior Leadership**

Recently, we have heard exciting news about the role of nuclear energy in supporting increasing demand for electricity driven by the expansion of data centers to advance Artificial Intelligence (AI) technology. This highlights the opportunity to produce more electricity from the current fleet of reactors by uprating the power and extending the lifetime and to deploy new advanced reactors that provide additional opportunities and potential benefits. The NEAMS (Nuclear Energy Advanced Modeling and Simulation) program has an important role to play in making this opportunity a reality. Our vision is that predictive modeling and simulation enable innovation in design, development, licensing, deployment and operation of nuclear reactors. To achieve this vision the program develops advanced methods, models and simulation software for existing Light Water Reactors (LWRs), new LWR designs, and next-generation reactors (High Temperature Gas Reactors, Fluoride Salt-cooled Reactors, Liquid Metal Fast Reactors, Molten Salt Reactors, and Micro-Reactors). The computational tools we develop are intended to support industry stakeholders in their efforts to develop, license, deploy and operate nuclear reactors. They also cater to regulatory applications by the U.S. Nuclear Regulatory Commission (NRC) and research and development performed by other Department of Energy (DOE) programs. The NEAMS program is eager to work with industry and other collaborators to see the benefits of advanced modeling and simulation, including the use of AIML (Machine Learning), come to fruition in this critical time for nuclear energy.

**NEAMS**  
Nuclear Energy Advanced Modeling and Simulation

**What does the NEAMS program do?**  
The Nuclear Energy Advanced Modeling and Simulation (NEAMS) program is a U.S. Department of Energy Office of Nuclear Energy (DOE-NE) program developing advanced modeling and simulation tools and capabilities to accelerate the deployment of advanced nuclear energy technologies, including light water reactors (LWRs), next light water reactors (nLWRs), and advanced fuels.

**Learn More**

**What codes are available?**

**NEAMS** Argonne **INL** National Laboratory  
**NRIC – Virtual Test Bed (VTB)** Reactor Demonstrations

**What is it?**

- Central location for reactor developers/stakeholders to access & leverage state-of-the-art ModSim models of advanced reactors to evaluate performance & safety
- Cross-laboratory and cross-program collaboration between NRIC and DOE Nuclear Energy Advanced Modeling and Simulation (NEAMS) program
- Repository/library of simulations for: sodium, gas, lead, micro, and molten salt reactors (continuously tested)
- Continuous Software QA linking repository to software development to avoid legacy issues while enabling rapid code development

**VTB So Far**

- Currently hosting 35+ distinct models with 12 NEAMS codes showcases... **More coming soon!**
- Averaging ~250 visits/month (period between July-Sep 2023) – representation from Industry/Regulators/Academia

**VTB Link** [https://mooseframework.inl.gov/virtual\\_test\\_bed/](https://mooseframework.inl.gov/virtual_test_bed/)  
NRIC Tech Talk: [ncrc@inl.gov](mailto:ncrc@inl.gov) Tech Talk: [ncrc@inl.gov](mailto:ncrc@inl.gov)

**NRIC** **INL**



U.S. DEPARTMENT  
of **ENERGY**

Office of  
Nuclear Energy



U.S. DEPARTMENT  
*of* **ENERGY**

Office of  
Nuclear Energy