DOE-NE Modeling and Simulation in Support of Advanced Reactor Development

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NEAMS (Nuclear Energy Advanced Modeling and Simulation) Program

**Aim:** Develop, apply, deploy, and support a predictive modeling and simulation toolkit for the design and analysis of current and future nuclear energy systems using computing architectures from laptops to leadership class facilities.

**Fuels Product Line**

MOOSE-BISON-MARMOT toolset provides an advanced, multiscale fuel performance capability.

- Mesoscale Material Model Development Tool
  - Simulates microstructure evolution in fuels under irradiation
  - Used with atomistic methods to develop multiscale materials models

- Engineering-scale Fuel Performance Tool
  - Models LWR, TRISO and metallic fuels in 2D, 3D
  - Steady-state and transient reactor operations

- Simulation framework enabling rapid development of FEM-based applications

**Reactor Product Line**

- Nek5000 - Thermal-Hydraulics
  - Highly-scalable solvers for multidimensional heat transfer and fluid dynamics

- PROTEUS - Neutronics
  - Can be used to analyze a fast reactor’s entire fuel cycle, including cross section generation, radiation transport and fuel cycle modeling

**Integration Product Line**

Text Input Preferred by Expert Users with Highlighting and Error Detection

Optional Component Input Preferred by Novice Users

Geometry Visualization

Date Visualization

Mesh Results Overlay
NEAMS Role in GAIN (Gateway for Accelerated Innovation in Nuclear)

What is GAIN?
Through GAIN, DOE is making its state-of-the-art and continuously improving RD&D infrastructure available to stakeholders to achieve faster and cost-effective development of innovative nuclear energy technologies toward commercial readiness. The capabilities accessible through GAIN include:

- Experimental capabilities with primary emphasis on nuclear and radiological facilities but also including other testing capabilities (e.g. thermal-hydraulic loops, control systems testing, etc.).
- Computational capabilities along with state-of-the-art modeling and simulation tools.
- Information and data through knowledge and validation center.
- Land use and site information for demonstration facilities.
- Assistance through the regulatory process. The Nuclear Regulatory Commission (NRC) will provide regulatory expertise and guidance through GAIN.


Emphasis of NEAMS program on proactive customer engagement is consistent with GAIN.
Sen. Joe Manchin: “I’m interested to hear, what you will do, if confirmed, to work with the bipartisan group of Senators to continue to ensure that DOE is equipped with adequate funding to continue researching and developing these advanced reactor designs.”

Gov. Rick Perry: “Nuclear energy is a critical component of America’s energy future, and entrepreneurs are developing promising new technologies that could truly spur a renaissance in the United States and around the world. DOE, through the National Labs complex, maintains unique government facilities that can assist in the development of advanced nuclear energy technologies. The GAIN initiative provides the potential for public-private partnerships to thrive in the future. If I am confirmed, I look forward to learning more about how DOE can support advanced nuclear reactor development.”
GAIN Mod-Sim Workshops

Goal of workshop was to connect DOE mod-sim capabilities, with GAIN advanced reactor working group needs.

Initial advertisement of DOE-NE mod-sim capabilities. Continued interaction is critical to achieve successful public-private partnership.
When considering advanced mod-sim for advanced reactor designs, unlike for LWRs, licensing is understandably the highest priority (compared to e.g. reactor operation/margin).

Advanced mod-sim tools may not obviously lend themselves to licensing. So GAIN provides important mechanism to match advanced mod-sim capabilities with vendor needs – whether licensing, or otherwise.

Future may include use of some DOE-NE advanced mod-sim tools for NRC confirmatory calculations. If those codes maintain independence, potential exists for their use also in license application.

Apart from licensing, many R&D issues exist where advanced mod-sim can assist, by e.g. revealing governing phenomena, targeting experiments, etc.
NEAMS: High Impact Problems (HIPs)

- High impact program concept introduced as a mechanism by which to direct NEAMS tools to address problem of applied relevance.
  - Core program is the “chassis” upon which HIP is built
- 3-year, ~$3M projects with a defined customer.
- Two HIPs initiated in FY15:
  - Evaluation of Representative Accident Tolerant Fuel (ATF) Candidates for the Advanced Fuels Campaign
    - Customer = DOE Advanced Fuels Campaign (and by extension, ATF vendors)
  - Numerical Evaluation of Advanced Steam Generators for SMRs
    - Customer = NuScale

NEAMS is currently designing FY18 HIP program to center around GAIN-relevant topics.
Summary

- Relative maturity of DOE-NE advanced mod-sim tools is coinciding with surge in advanced reactor start ups.

- A particular “critical path” issue (though there are many, e.g. validation) of immediate interest relevant to advanced mod-sim: connecting mod-sim capability with industrial need.

- GAIN initiative is catalyzing necessary interactions between NEAMS (and other DOE-NE programs) and industry community that will enable productive use of advanced mod-sim tools.

- The NEAMS program is eager to play an important role in the GAIN mod-sim effort and help industry address problems of relevance.