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DOE Advanced Reactor Initiatives

Workshop on Advanced Reactor Licensing

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U.S. Department of Energy

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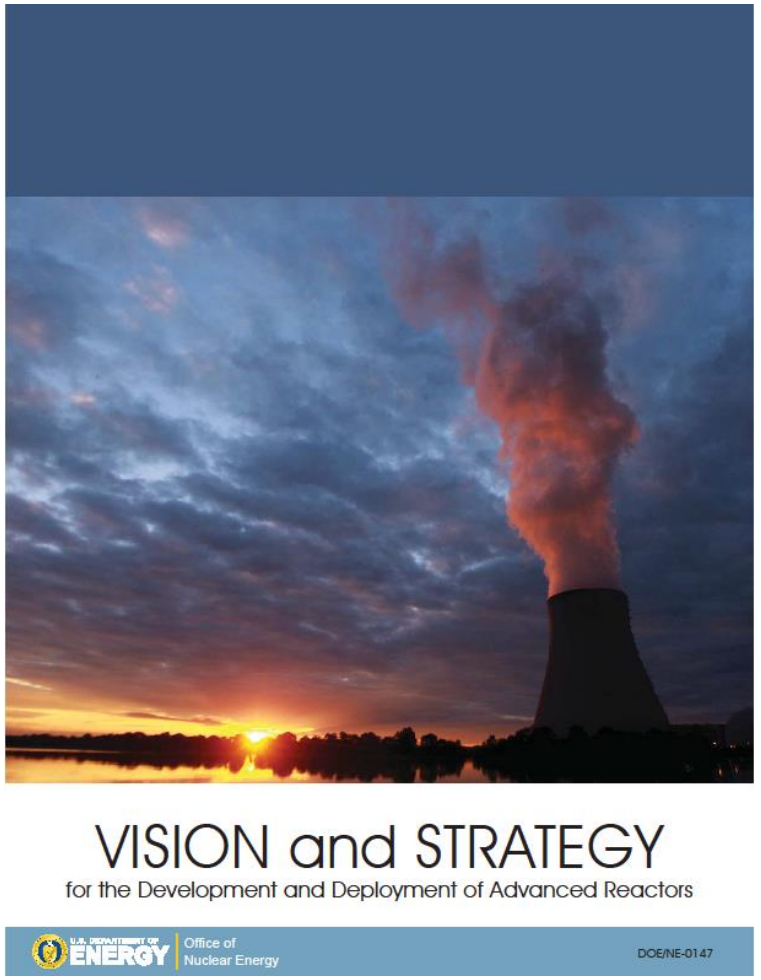
DOE Vision and Strategy

DOE issued its "VISION and STRATEGY for the Development and Deployment of Advanced Reactors"

https://energy.gov/ne/downloads/vision-and-strategy-development-and-deployment-advanced-reactors

- Complementary with NRC's Implementation Action Plan
- Includes a near term focus on an NRC regulatory framework being established for advanced non-LWRs



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Priorities for Advanced Reactors

- **Work with NRC and industry to develop a framework for advanced reactor licensing**
- **Make DOE assets and expertise available to industry and academia via the GAIN Initiative**
- **Conduct cutting edge research to enable the commercial deployment of advanced reactors by the 2030's**
- **Applying Modeling and Simulation tools suitable for analysis of advanced reactor systems**

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Establishing a Regulatory Framework for Advanced Reactors

Key constituents of a regulatory framework that will increase regulatory certainty for advanced reactors include:

- **Identify and resolve key Commission policy issues**
- **Adapt LWR-based regulatory requirements to advanced non-LWRs**
  - Informed by results of DOE's focused R&D activities
- **Establish Licensing Technical Requirements**
  - Enhanced by development of industry consensus Codes & Standards
- **Establish staged/phased review processes**

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Gateway for Accelerated Innovation in Nuclear (GAIN)

- **GAIN was created to provide access to state-of-the-art DOE capabilities for nuclear energy**
- **GAIN facilitates workshops and meetings to advance understanding of needs and abilities**
- **New round of GAIN Vouchers announced**
  - Letters of intent by **March 9, 2017** were encouraged
  - RFA submittal period **March 13 – April 10, 2017**
  - Anticipate funding as many as 20 vouchers for FY2017, subject to appropriation

https://gain.inl.gov

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Advanced Reactor Technologies Focus Areas

- **Fast Reactor Technologies**
  - For actinide management and electricity production
  - Current focus on sodium coolant
- **Gas Reactor Technologies**
  - For electricity and process heat production
- **Molten Salt Reactor Technologies**
  - Commonalities across multiple R&D technologies
- **Advanced Reactor Demonstration and Industry Awards**
  - Continued support for ARC 15 awards
    - X-energy
    - Southern Company

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Fast Reactor Technologies

- **Demonstrate feasibility of advanced systems and component technologies**
  - Mechanisms Engineering Test Loop (METL) facility at ANL – multiple test vessels for component testing in prototypic conditions
    - In FY17, commissioning, start-up testing and introduction of first test assembly
    - Locations available for industry-defined component, materials or equipment testing
  - Development of under-sodium inspection techniques and instruments
- **Methods and code validation to support design and licensing**
  - Detailed analysis and international benchmarking of fast reactor safety tests conducted at demonstration reactors
  - Safety analysis code improvements and validation and verification
  - Thermal hydraulic and neutronic code development
- **Advanced materials qualification**
  - Qualification of alloys for anticipated operation conditions in SFRs
  - Material testing for Grade 91 and Alloy 709 for use in fast reactor development
  - Structural material testing data exchange with Japan to support code qualification
- **Fast reactor information recovery and preservation**

Na-CO2 Interaction Loop at Argonne National Laboratory

Mechanisms Engineering Test Loop (METL) facility at ANL – multiple test vessels for component testing in prototypic sodium conditions

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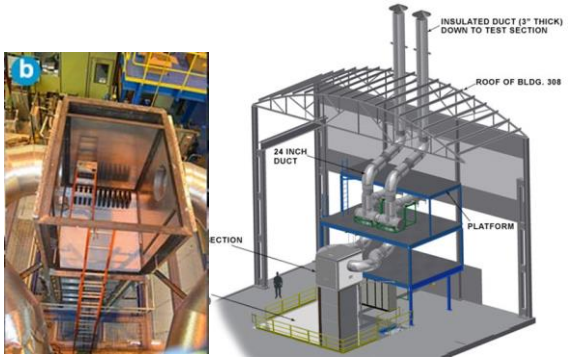
Gas Reactor Technologies R&D

- **Advanced materials qualification**
  - Graphite qualification for use in HTRs through a series of baseline characterizations, irradiation creep testing in ATR, irradiated properties testing, and model development
  - Approval of ASME code case for Alloy 617 for anticipated operation conditions in HTRs - heat exchangers and steam generators
  - Update high-temperature design methods in ASME Code
- **AGR fuel qualification program**
  - Fabrication, irradiation and PIE to verify superior TRISO fuel performance under normal operating and potential accident conditions
- **Scaled experiments to support design and licensing**
  - Simulate coolant flow and heat transport in and from HTRs during accident scenarios – code validation to support licensing
    - Natural Convection Shutdown heat removal Test Facility (NTSF) at ANL for severe accident heat removal
    - High Temperature Test Facility (HTTF) at Oregon State University for core thermal hydraulics – heated prismatic block core simulator, ¼ scale
- **High Temperature Fission Chamber development**



Natural circulation Shutdown heat removal Test Facility (NSTF) for vessel cooling studies

High Temperature Test Facility (HTTF) at Oregon State University

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Molten Salt Reactor Technologies R&D

- **Molten salt test loop at ORNL for testing tritium management technology**
- **MSR information recovery and preservation**
- **Other current work funded under university grants and Integrated Research Projects**
  - High-Temperature Salt-Cooled Reactor for Power and Process Heat (2011, MIT, Wisconsin, UC Berkeley)
  - Integrated Approach to FHR Technology and Design Challenges (2014, MIT and Georgia Tech)
- **Future work could include:**
  - Demonstrate the technology viability, component and system reliability, and safety by constructing and operating appropriate test facilities
    - Identify and establish R&D infrastructure (loops, test stands, etc.,)
  - Advanced Materials Qualification
    - ASME code case for Hastelloy N – a high nickel alloy compatible with salt-cooled reactors
    - Methods to allow use of salt-corrosion-resistant clad structural materials
  - Approaches for qualification of liquid fuels
  - Modeling and Validation to support the design, operations, and licensing

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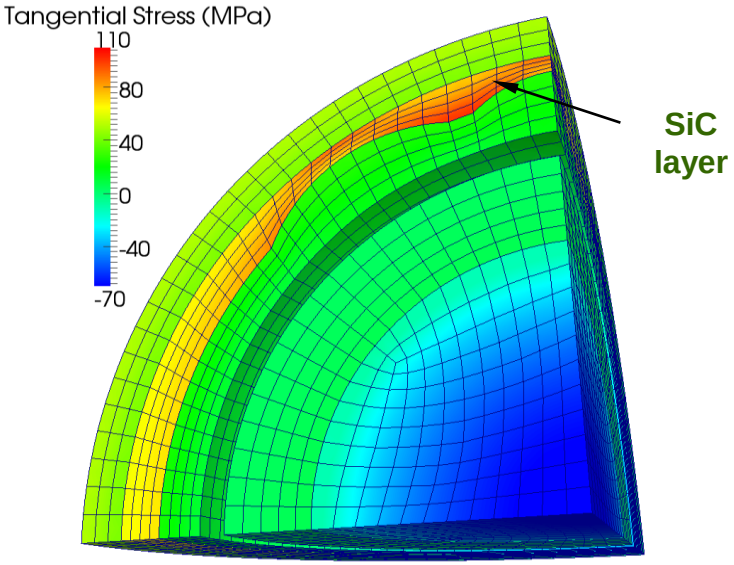
Modeling and Simulation

- NEAMS and CASL are major DOE investments in new and improved modeling tools and methods
- Validated modeling and simulation tools hold the potential for accelerating the design and licensing of advanced reactors
- Dr. Stanek will talk to the specifics of modeling and simulation later today



BISON 3D capability demonstrated on an eighth-of-a-particle with localized thinning of the SiC layer at random locations

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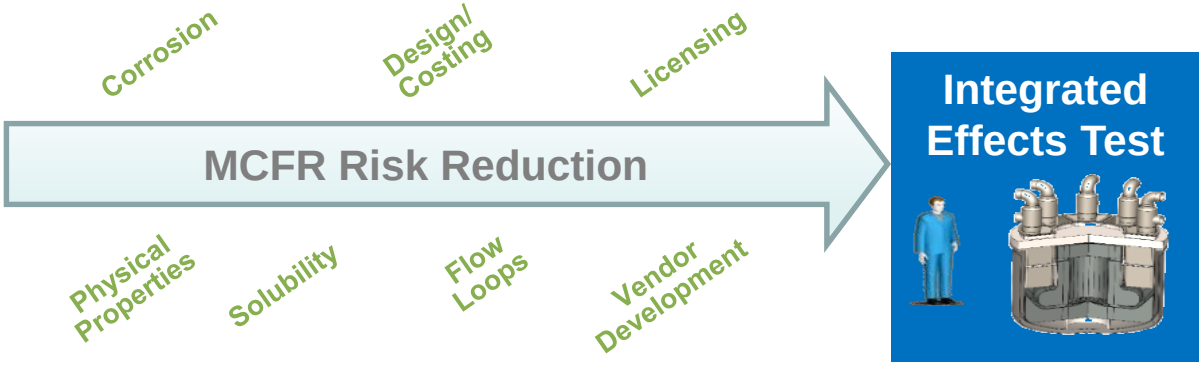
ARC-15 Awards

- **The X-energy ARC15 project has three main thrusts**
  - Further the Xe-100 HTGR pebble bed design
  - Establish pebble fuel manufacturing capability
  - Engage the NRC through white papers and topical reports

- **The Southern Company MCFR Risk Reduction Activities**
  - R&D in key areas of salt studies, material development and reactor licensing.
  - Year 1 develop Separate Effects Test (SET) and conceptual design of the Integrated Effects Test (IET), which will be constructed in Year 3
  - IET operations (Years 4-5) will validate the behavior of fuel salt (using depleted uranium) at temperature and with relevant materials.



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Summary

DOE Advanced Reactor Initiatives:

- **Work with industry and NRC on licensing framework**
- **Leverage GAIN to align advanced reactor R&D with U.S. industry needs**
- **Fund the labs, universities and industry to conduct cutting edge research to close the knowledge gaps**
- **Applying modeling and simulation tools of the future**

Collectively – DOE initiatives are enabling the future of nuclear energy