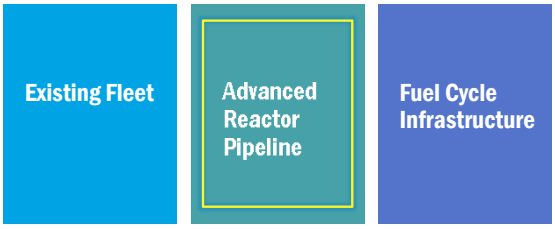
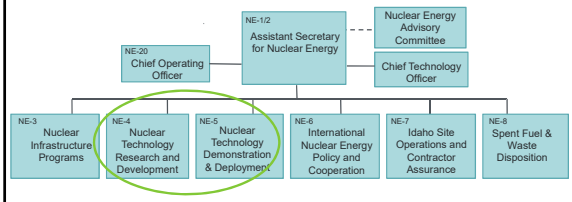
Outline

- Background, Who we are in the Office of Nuclear Energy
- Activities to support development of an advanced reactor regulatory framework
- Research and development activities to reduce regulatory risk

Office of Nuclear Energy Mission Priorities



Office of Nuclear Energy



Key organizations engaged in advanced reactor technical risk reduction activities

Advanced Reactor Technical and Regulatory Risk Reduction Efforts

R&D to Enhance Safety and Reduce Regulatory Risk

- Materials qualification and codification
- Methods development to model normal operations and severe accidents
- Scaled experiments to validate codes
- TRISO fuel qualification for HTGRs and solid-fuel MSRs

Gateway for Accelerated Innovation in Nuclear (GAIN)
gain.inl.gov

- Mechanism for industry to obtain licensing policy and process information from NRC

Advanced Reactor Regulatory Framework

- Establishing technology-inclusive General Design Criteria
- NRC draft regulatory guide DG-1330, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors"
  - Published February 3, 2017
  - Finalization under way
- Licensing Modernization Project
- Regulatory Assistance Grants

Licensing Modernization Project

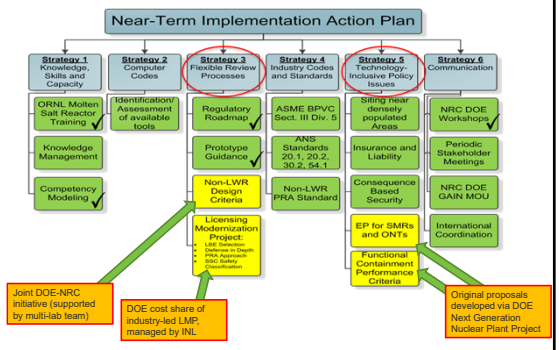
- The LMP is a utility-led/DOE cost-share collaboration that addresses significant longstanding regulatory uncertainty. It does this by:
  - Providing a technology-inclusive, risk-informed, and performance-based approach for selecting and evaluating LBEs, applying SSC safety classification, and evaluating DID adequacy for non-LWRs
  - Establishing a new (optional) NRC-endorsed methodology to address key licensing requirements (i.e., 10CFR50.34 or 52.79) in an easily referenced form
- Aligns with NRC Near-Term Implementation Action Plan Strategies 3 & 5
  - Establishes a process to generate licensing bases/accident sets for advanced technologies
- Guidance document development is now underway
  - Content based on LMP proposals and NRC public review meetings over past 18 months
  - NRC-LMP-NEI public stakeholder working meetings started in February to refine and finalize document content
  - Target date for NRC endorsement (likely via Reg. Guide): CY2019

Regulatory Assistance Grants

- For applicants in early stages of regulatory development
- Support work to resolve design regulatory issues, to develop topical reports or papers, and other efforts focused on obtaining certification and licensing approvals

Tier	Work Scope Addressed	Task Funding Range	Cost Share Requirements	Typical No. of Tasks	Length of Tasks
1	Regulatory Assistance Grants	$50K - $500K	80/20	10-20	Up to 12 months

DOE Impact on Advanced Reactor Regulatory Framework Development



Office of Advanced Reactor Technologies

Goal: Enable industry to develop and ultimately demonstrate advanced reactor concepts by the early 2030's.

Objectives:

- Conduct focused research and development to **reduce technical barriers to deployment** of advanced nuclear energy systems
- Develop technologies that can enable new designs to achieve enhanced **affordability, safety, sustainability and flexibility** of use
- **Collaborate with industry** to identify and conduct essential research to reduce technical risk associated with advanced reactor technologies
- **Sustain technical expertise and capabilities** within national laboratories and universities to perform needed research
- Engage with Standards Developing Organizations (SDO's) to **address gaps in codes and standards** to support advanced reactor designs

ART Advanced Materials R&D

- Topics directly related to ASME Section III Division 5 for High Temperature Reactors
  - Alloy Qualification and High Temperature Design Methodology
  - Graphite Qualification and Codification
  - Standardization and Codification of Ceramic Composites
- Additional topics required for licensing approval
  - Corrosion effects
  - Irradiation effects
  - Flaw evaluations
- Providing inputs for NRC's internal assessment of endorsing the 2017 edition of Division 5

Fast Reactor Risk Reduction

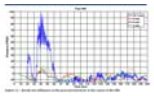
- **Demonstrate feasibility of advanced systems and component technologies**
  - Mechanisms Engineering Test Loop (METL) facility at ANL – multiple test vessels for component testing in prototypic conditions
  - Development of under-sodium inspection techniques and instruments
- **Methods and code validation to support design and licensing**
  - Detailed analysis and international benchmarking of fast reactor safety tests conducted at demonstration reactors (EBR-II, FFTF, PHENIX, Monju).
  - Safety analysis code improvements and validation and verification (V&V)
  - 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**

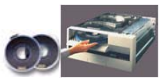
Na-CO2 Interaction Loop at Argonne National Laboratory

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

Fast Reactor Knowledge Preservation

- **Identify areas where information is at risk of being lost or destroyed**
  - Example – FFTF document preservation at PNNL
- **Collect and organize FR-related information into databases**
  - EBR-II SHRT database
  - FFTF Passive Safety Testing database
  - TREAT Database
  - EBR-II Fuels Irradiation Database
  - Fast Reactor Reliability Database (CREDO)
- **Recover lost computer codes**
  - NUBOW-3D code recovery – supports core restraint design
  - SWAAM (sodium-water interaction) code recovery (upgraded to include sodium-CO2 interactions)
  - SOFIRE – a sodium pool fire code
- **Make information accessible to U.S. Fast Reactor developers**
  - More Applied Technology documentation is being released to OSTI as it is reviewed for Export Control
  - Over 8,600 documents have been scanned and made available
  - IAEA CRP on EBR-II Passive Testing Benchmark
- **Create FFTF Lessons Learned Documents**
  - *Sodium Thermal Stratification,*
  - *Sodium Vapor Trap Design/Operation,*
  - *Thermal Transient Usage, among others*

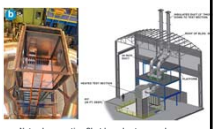




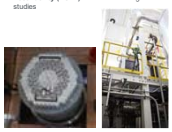
osti.gov

Gas Reactor Risk Reduction

- **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 integral 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 (NSTF) 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



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



High Temperature Test Facility (HTTF) at Oregon State University

Molten Salt Reactor Risk Reduction

New program effort beginning in FY 2018:

- 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.,)
  - Understand fundamental salt properties and chemistry
- Advanced Materials Qualification
  - Methods to allow use of salt-corrosion-resistant clad structural materials
  - ASME code case for Hastelloy N or variant – a high nickel alloy compatible with salt-cooled reactors
- Approaches for qualification of liquid fuels
- Modeling and Validation to support the design, operations, and licensing
- Molten salt test loop at ORNL for testing tritium management technology
- MSR information recovery and preservation

DOE Investment's in Advanced Reactors

- Our R&D shapes design choices, informs standards development, and influences regulatory requirements
- Our cost shared investments with industry and collaborations with NRC accelerate regulatory innovation
- We are listening, and adapting, to help ensure that the promise of advanced reactors can be realized in the near future

Happy to Take Any Questions!

U.S. DEPARTMENT OF ENERGY

Clean. Reliable. Nuclear.