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Nuclear Energy University Program (NEUP) Fiscal Year (FY) 19 Annual Planning Webinar

RC.3 Liquid Metal-cooled Fast Reactor Technology Development and Demonstration to Support Deployment

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August 7, 2018

DOE Fast Reactor R&D – Priorities and Approach

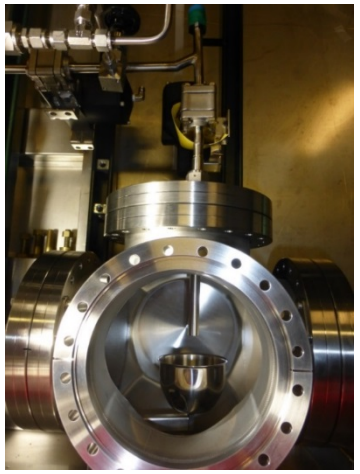
Advanced Reactor Technologies (ART) Fast Reactor Strategy:

Create sustained infrastructure and perform targeted research to enable commercial deployment of fast reactor technology in the United States

- For the commercial deployment of fast reactor technology, two recurring challenges are identified
  - Capital investment in reactors is the dominant cost (cost reduction also vital for electricity production)
  - A pathway must be established for non-LWR licensing
- To address these challenges, ART Fast Reactor work activities have focused on:
  - Research, development, and demonstration of innovative cost reduction and performance enhancing technologies (e.g., new configurations, materials, energy conversion, etc.)
  - Clarifying fast reactor licensing criteria and science-based approach for demonstration of regulatory compliance – NRC engagement and resolution of regulatory issues
  - Developing and sustaining a flexible domestic infrastructure and knowledge base for research, development, and demonstration of fast spectrum systems – both facility and human resources

Current ART Fast Reactor R&D Areas

- **Cost Reduction R&D**
  - Technology Development and Demonstration
    - Mechanisms Engineering Test Loop (METL) Facility
    - Coupling Supercritical CO_2 (S- CO_2) Systems to Sodium-Cooled Fast Reactors (SFRs)
    - Advanced Materials Development
- **Key Regulatory Issues R&D**
  - Methods, Modeling, and Validation
    - Fast Reactor Knowledge Preservation and Validation
    - Safety Analysis Tools and Techniques
    - Advanced Modeling and Simulation
  - Historical Fuel Data Qualification
- **Collaborative Efforts**
  - International, University, and Industry Collaborations



Sodium Draining and Filling Facility

METL Facility

Fast Reactor Industry Technology Working Group

- Stand-alone industry-led working group
- Consists of multiple developers with a diverse set of fast spectrum technologies:
  - **SFR:** Oklo, General Electric, TerraPower, Advanced Reactor Concepts
  - **LFR:** Westinghouse, Columbia Basin Consulting Group, Hydromine
  - **GFR:** General Atomics
  - **MCFR**: Elysium, Southern/TerraPower
  - Active participation by utilities including Duke and Exelon

- Group has met quarterly since July 2016 to discuss R&D needs that can be addressed through DOE capabilities
  - Needs generally broad in scope and identify R&D useful for multiple fast technologies
  - In February 2017, the FR TWG submitted to DOE a formal list of identified R&D needs
  - In January 2018, FR TWG reaffirmed and updated specific needs identified in the February 2017 request

FRWG Priority R&D Areas

- Fast Test Reactor
- Legacy Data Management
  - Maintain and expand historical SFR testing and operations databases
- Fuels
  - Expand fuel fabrication facilities and enhance fabrication methods
  - Develop pathways to access >5% LEU for early cores
  - Support restart of TREAT operations
- Modeling and Simulation
  - Code validation and QA for fuels and materials performance
- Nuclear Data Refinement
- Separate and Integral Effects Test Facilities

FRWG Testing and Deployment Requests

Specific FRWG recommendations relevant to this year's scope include:

- Supporting ongoing flexible liquid metal component testing capabilities
  - Enables testing of valves, seals, instrumentation, pumps, handling machines, sensors, etc.
  - Can be adapted for separate/integral effects, thermal-hydraulic performance, and mechanical and structural testing
- Optimizing opaque fluid management techniques
  - In-service inspection, on-line monitoring, etc.
- Developing testing facilities, including high-temperature corrosion testing loops, to support lead-based technologies
- Optimizing and performing validation work on innovative heat exchanger designs for use in advanced energy conversion systems
- Reducing uncertainties in fast reactor design and safety performance codes

RC.3 Scope (1 of 2)

Seeking proposals to develop and demonstrate innovative technology options for liquid metal (sodium or lead-cooled) fast reactors to support U.S. nuclear industry advanced reactor concepts

Focus on experimental and analytical work that can offer potentially significant benefits in reactor capital or operating cost reductions

Examples of potentially beneficial work areas include:

- Sensors and prognostic techniques that can survive in typical advanced liquid metal-cooled reactor environments over extended periods of time, are able to detect degradation early, and can be embedded in/on structural materials to enable structural health monitoring
- Development and application of uncertainty propagation analysis techniques to quantify impacts on key liquid metal-cooled fast reactor performance parameters (e.g., burnup) and/or safety performance

RC.3 Scope (2 of 2)

Examples continued:

- Development of test articles for the Mechanisms Engineering Test Laboratory (METL) sodium loop facility. Test articles can be used to demonstrate innovative sub-components (sensors, seals, mechanisms, etc.) or validate key fast reactor behaviors (e.g., thermal striping) under prototypic conditions
- Detailed analytical performance studies and experimental validation of compact heat exchanger options (e.g., microchannel configurations) for lead or sodium-cooled fast reactors
- Development of small-scale heavy liquid metal (lead or lead-bismuth) testing capabilities and/or test articles supporting lead-cooled fast reactor technology development and demonstration

NOTE: Though proposals are not limited to the example work areas above, applicants should indicate how their proposed work will support current DOE, national laboratory, and/or U.S. nuclear industry liquid metal-cooled fast reactor deployment and commercialization R&D initiatives.

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