U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

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Nuclear Energy University Program (NEUP)
Fiscal Year (FY) 22 Annual Planning Webinar

RC-3.1: Liquid Metal-cooled Fast Reactor Technology Development and Demonstration to Support Deployment
&
RC-3.2: Experimental Validation of Advanced Reactor Fuel Failure Modes

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Program Mission and Objectives

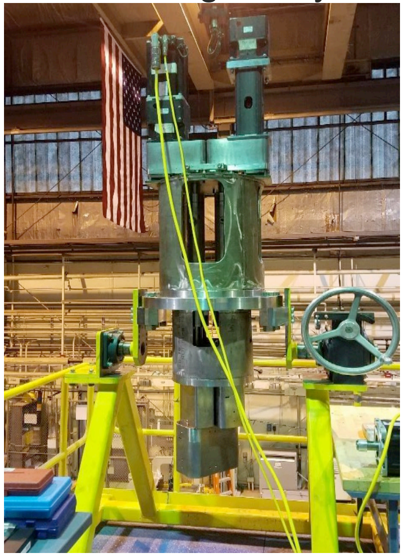
Mission:

- Perform targeted research and create sustained testing infrastructure to support demonstration of U.S. fast reactor technologies and to enable subsequent commercial deployments

Objectives:

- Research, development, and demonstration of innovative cost reduction and performance enhancing technologies (e.g., new configurations, materials, energy conversion, etc.)
- Developing and sustaining a flexible domestic infrastructure and knowledge base for research, development, and demonstration of fast spectrum systems
- Clarifying fast reactor licensing frameworks and developing science-based approaches for regulatory compliance (e.g., NRC engagement and resolution of outstanding fast reactor regulatory issues)

METL Facility - ANL



METL Test Article – Gear Test Assembly (example)

Major Program R&D Areas

For the commercial deployment of fast reactors, stakeholders have identified <u>two recurring challenges:</u>

- Capital investment in fast reactors is a dominant cost (cost reduction is vital for competitiveness)
- A pathway must be established for non-LWR licensing

To address these challenges, the program uses input from key stakeholders such as the industry-led Fast Reactor Technology Working Group to focus its efforts on the following high-priority R&D areas:

- Preserving, streamlining access to, and qualifying legacy DOE fast reactor R&D and operational data for use in industry design and licensing cases
- Industry outreach - Developing more effective R&D to support primary components, sensors, and reliability monitoring technology options
- Utilizing Mechanisms Engineering Test Loop (METL) facility to demonstrate innovative components and instrumentation in a prototypic in-sodium environment
- Improving, sustaining, benchmarking, and validating existing fast reactor design and safety analysis code suites for use in vendor design optimization and licensing cases
- Providing the technical basis to support ASME qualification of advanced structural materials for use in fast reactors

RC-3.1: Liquid Metal-cooled Fast Reactor Technology Development and Demonstration to Support Deployment

Seeking proposals to develop experiments, instrumentation, control strategies, and performance enhancing technologies that have the potential to subsequently be deployed in U.S. liquid metal fast reactor concepts and could be demonstrated in METL

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

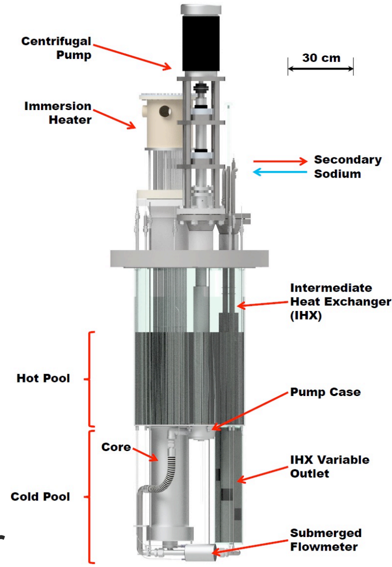
Examples of potentially beneficial work areas include:

- Development of test articles for METL. Test articles can be used to demonstrate innovative sub-components (sensors, seals, mechanisms, etc.) or validate key fast reactor behaviors under prototypic conditions
- Enhancement of advanced sensors and instrumentation required to operate in the primary liquid metal coolant (e.g., leak detection, level measurement, pressure measurement)
- Testing components for innovative liquid metal-cooled reactor self-actuated control and shutdown systems (e.g., curie point magnets, fusible linkages)
- Experiments for in-service repair technologies. These systems include visualization sensors for immersed coolant applications and technologies for the welding and repair of structures in contact with the primary coolant

RC-3.1: Liquid Metal-cooled Fast Reactor Technology Development and Demonstration to Support Deployment

Examples continued:

- Improving performance of METL sodium technologies including rugged high temperature resistance heating systems, improved insulation technology, improved sodium leak detection and identification technologies, vessel support technologies that reduce heat losses, improved clamp on flow meters, thermal monitoring, smaller and more compact refueling systems, etc.
- Development of deployable sensors and prognostic techniques for demonstration in METL that can be used to monitor the health and quantify materials degradation in liquid metal-cooled fast reactor primary systems

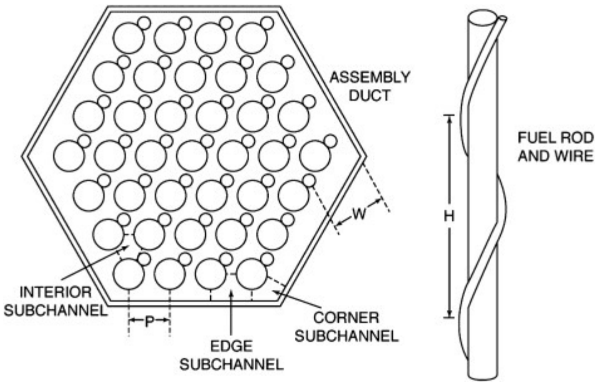


NOTE: Though proposals are not limited to the example work areas above, applicants should indicate how their proposed work will support current DOE, national laboratory, and/or U.S. nuclear industry liquid metal-cooled fast reactor deployment and commercialization R&D initiatives.

Further information on METL available at:
https://www.anl.gov/nse/mechanisms-engineering-test-loop-facility

RC-3.2: Experimental Validation of Advanced Reactor Fuel Failure Modes

Seeking proposals for university-led experiments to test the impact of cladding failure in fast reactor fuel assemblies for validation of fuel damage propagation models.



Focus on what happens when cladding fails and fission gas is released into the coolant channel under accident conditions (with both full and reduced flow).

- Assess the impact of fission gas jet penetration, including potential flow stagnation or reversal.
- Evaluate degraded heat transfer conditions due to fission gas jet impingement on neighboring fuel pins.
- Transient overpower and loss of flow accident scenarios are of interest.
- Experiments with liquid metal coolants are desirable.
  - Other surrogate coolants are acceptable if appropriate scalability of the tested configurations for the liquid-metal coolants are demonstrated.

Questions

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