U.S. DEPARTMENT OF ENERGY | Office of Nuclear Energy

Nuclear Energy University Program (NEUP) Fiscal Year (FY) 18 Annual Planning Webinar

Experimental Investigation of Radioisotope Retention Capability of Liquid Metal Coolants (Sodium and Lead) (RC-3)

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ART Fast Reactor Program Objectives

Objective: Develop advanced fast reactor technology solutions to support demonstration by 2030 and commercial deployment by 2050

- Develop scalable advanced fast reactor technologies for reducing cost, improving performance, and increasing reliability
- Preserve and manage data, knowledge, and experience related to past U.S. DOE fast reactor design, operations, tests, and component technology
- Re-establish the U.S. infrastructure to support the testing of advanced technologies for fast reactor applications
- Collaborate internationally on advanced reactors to leverage and expand fast reactor R&D investments
- **Train next generation engineers and scientists by engaging them in advanced fast reactor design and analysis**

ART Fast Reactor R&D Priorities

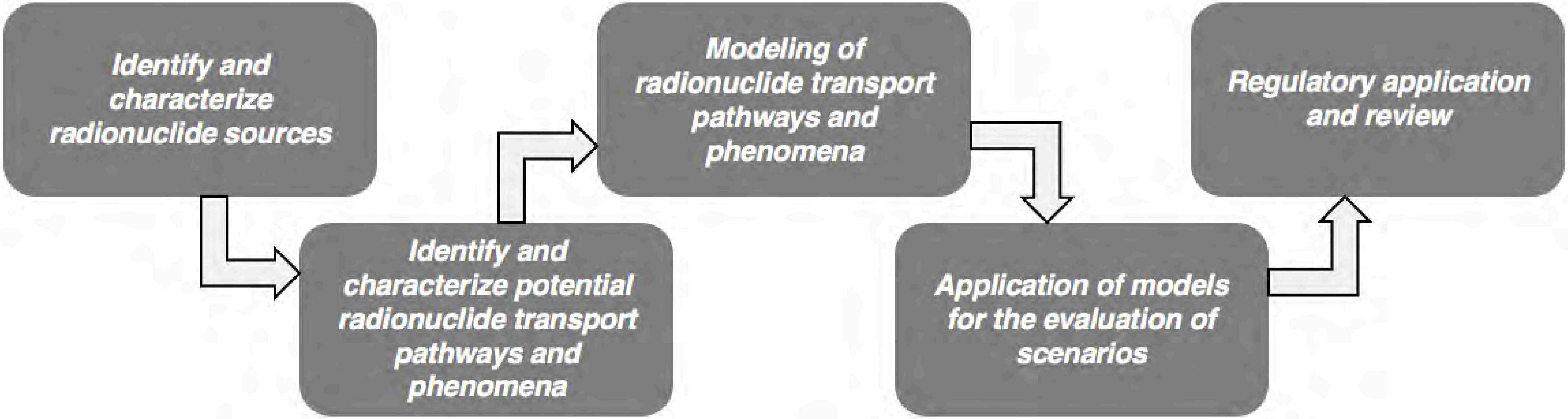
- For fast reactor commercial deployment, two recurring challenges identified
  - Large capital investment required for advanced reactors
  - Pathway needed for non-LWR licensing
- Capital cost reduction through application of innovative technology solutions
  - Improved design approach – components and maintenance
  - Advanced structural materials to reduce commodities
  - Advanced energy conversion to improve size/efficiency
  - **Advanced modeling and simulation to optimize performance**
  - Fuel development to improve fuel cycle costs
- Resolution of key licensing issues
  - Safety R&D to validate tools and assure margins
  - Qualification of fast reactor fuels

Priority R&D Requests from Industry Fast Reactor Technical Working Group

- Modeling and Simulation
  - Code validation and QA for fuels and materials performance
  - **Improved source term modeling**
  - Expand NEAMS toolkit for SFR use
  - Integrate SFR safety codes into existing safety analysis packages
  - Improved access to national lab developed M&S tools

SFR Mechanistic Source Term (MST) Assessment

- Assessment of methodologies for mechanistically estimating the "source term" from postulated accidents in the residual risk domain for metal-fueled, pool-type SFRs using best-estimate phenomenological models



SFR MST Development Goals:

- Facilitate communication
- Develop representative SFR source term model
- Describe source/barriers/transport phenomena
- Review current state-of-knowledge
- Available data, codes, etc.
- Interact with industry
- Ensure consistency with approaches
- Assure benefit to licensing needs

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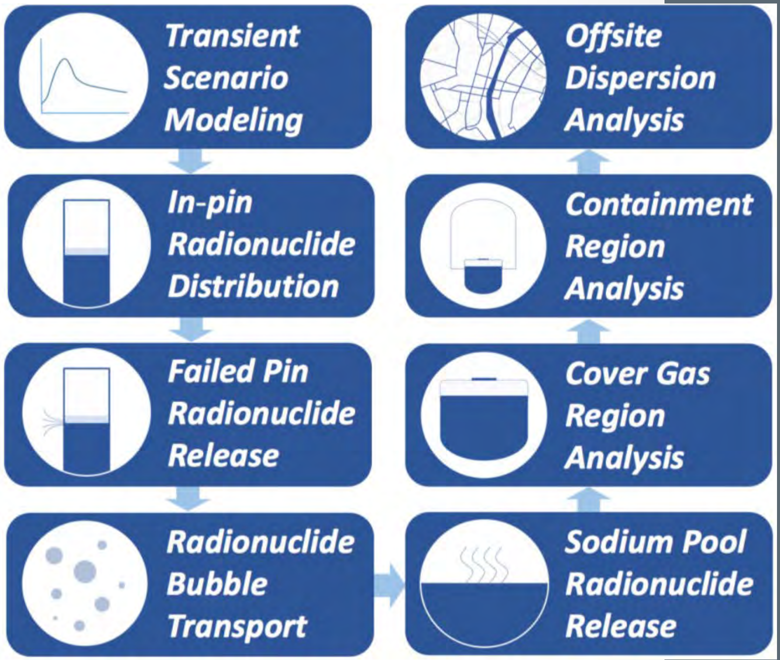
SFR Mechanistic Source Term (MST) Assessment

- Estimating the "source term" from postulated accidents for metal-fueled, pool-type SFRs using best-estimate models

Phenomena	Importance
Pool Bypass (Bubble Transport)	Very High
Fuel Release Fractions (Actinide/Lanthanide)	High
Aerosol Deposition/Removal	Medium
Reactor Head/Containment Leak Rate	Medium
Pool Vaporization	Low
Noble Gas Decay Chains	Low



Key Project Point

A SFR mechanistic source term calculation is possible, with certain limitations, utilizing currently available tools and models. Gaps in models and data regarding some phenomena result in uncertainties, or the use of conservative assumptions, which could make the process of justifying reduced emergency planning zones or plant sites difficult for vendors and also potentially impact design decisions that are dependent on source term analyses.

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FY18 Scope Background

- The NRC has indicated that advanced reactor vendors use a mechanistic source term (MST) assessment as an integral part of their licensing efforts.
- Using best-estimate models and tools, MST analyses may provide a realistic representation of potentially reduced offsite consequences associated with advanced reactor transients
- **For liquid metal-cooled reactors, the radionuclide retention characteristics of the coolant may be a vital mechanism to lessen the offsite consequences of core damage accidents**
- The use of an MST analysis as part of licensing will likely require substantial data and a high level of confidence in the radionuclide transport models employed
- Recent DOE efforts have acknowledged a potential inadequacy in the current knowledgebase and have sought to identify and characterize gaps

FY18 Scope

The FY18 scope seeks experimental programs to provide the data necessary to achieve adequate confidence in sodium- and lead-cooled fast reactor MST analyses

Specifically of interest are the data required to properly model the following phenomena for metal-fueled sodium fast reactors and oxide-fueled lead fast reactors:

- Radionuclide interactions with the coolant (compounds formed, solubility, etc.)
- Radionuclide behavior within the coolant (mixing, surface effects, plate-out, etc.)
- Vaporization of radionuclides from the coolant
- The transport of radionuclide gas/vapor bubbles through the coolant

DOE facilities exist that may be leveraged for the experimental program, such as the SNAKE sodium loop at Argonne National Laboratory

- Since the phenomena of interest are chemical in nature, it is assumed that non-radioactive isotopes can be utilized for the experiments

NOTE: It is important for applicants to properly characterize how their experimental program will resolve gaps in the knowledgebase while not repeating past efforts. Reports on recent DOE fast reactor MST efforts (ANL-ART-3, ANL-ART-38, ANL-ART-49) are available at https://www.osti.gov/src/fielded_search

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