ADVANCED REACTOR SAFEGUARDS

Fall 2021 Working Group Meeting

PRESENTED BY

Ben Cipiti, NTD & Alison Hahn, DOE-NE

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ARS Program Goals

- The ARS program applies laboratory R&D to address near term challenges that advanced reactor vendors face in meeting domestic materials accountancy and physical protection requirements for U.S. construction.
- We want to reduce roadblocks in the deployment of new and advanced reactors by solving regulatory challenges and reducing safeguards and security costs while utilizing the latest technologies and approaches for plant monitoring and protection.
- Our $5 million funding level has remained flat.
- We’re pushing for near-term deliverables and so will be rotating into new challenges frequently.

Current Thrust Areas

Physical Protection Systems

- **Reduce number of on-site responders**
- **Reduce upfront costs**
- **Evaluate enhanced safety systems**
- **Evaluate unique sabotage targets**

Pebble Bed Reactor MC&A

- **Evaluate regulatory approach**
- **Determine driving requirements**
- **Evaluate new monitoring technologies**

Microreactor PPS and MC&A

- **Develop a licensing framework**
- **Develop approaches appropriate to the very small scale**
- **Evaluate new monitoring technologies**

Liquid Fueled MC&A

- **Evaluate regulatory approach**
- **Develop baseline accountancy approaches**
- **Evaluate new measurement and monitoring technologies**

International Considerations

- **Consider international safeguards requirements**
- **Interface with international safeguards and security programs**
- **Support the Gen-IV PR&PP working group**

Major Activities and Outcomes (FY22-FY25)

- Design, analyze, and verify (through performance modeling) Physical Protection System (PPS) design alternatives that significantly reduce or eliminate the need for on-site responders for generic SMR, pebble bed, and microreactor designs. **(September 2021)**
- Develop the tools necessary for sabotage, timeline progression, and uncertainty quantification for advanced reactors to help vendors with new physical security rulemaking (joint SNL-INL report). **(September 2022)**
- Complete the design, cost estimate, and testing for the Deliberate Motion Algorithm system for SMRs and microreactors. **(September 2022)**
- Determine the feasibility of optical spectroscopy and voltametric measurements for actinide quantification in molten salt reactors. **(September 2022)**
- Finalize the MC&A regulatory approach (including pebble handling system, fresh and spent pebble storage, burnup, and batch identification measurements) for pebble bed reactors. **(FY23)**
- Complete the MC&A regulatory approach for molten salt reactors. **(FY23)**
- Develop a microreactor regulatory approach that ties in remote operations and cyber security. **(FY24)**
- Complete sabotage analysis for multiple reactor classes tying in timeline progression with force on force adversary modeling in order to fully prove PPS designs for advanced reactors. **(FY25)**

FY22 Integrated Priority List Summary

	FY22
Project Management	$ 250K
Direct funded research	$ 3190K
Physical Protection Modeling and Approaches (3 projects)	*$ 750K*
Physical Protection, Safety Interface (2 projects)	*$ 535K*
MC&A PBR (2 projects)	*$ 465K*
MC&A MSRs (5 projects)	*$ 1270K*
MC&A International Interfaces (2 projects)	*$ 170K*
Total	**$ 3440K**

FY22 Work Packages

Control Account	Work Package Title	Scope	Lead Org.	FY22 $
Physical Protection	Security by Design Vulnerability Analysis for Advanced Reactors	Expand previous alternative PPS arrangements for iPWRs, PBRs, Microreactors to examine cost-benefit of upgrades and use of ROWS. Expand work into SFRs. Perform detailed review of delay times	SNL	$350K
	Fused Radar and Video Analytics	Collect 4 weeks of alarm data from the DMA demo at SNL, develop a design and layout for SMR and microreactor PPS's with cost estimate	SNL	$250K
	Application of Scenario Exploration for Security Design	Develop sabotage scenarios and timelines for different classes of reactors, along with uncertainty quantification, examine interface with consequence modeling work in parallel DOE NE program areas	INL	$285K
	Unique Sabotage Targets for Advanced Reactors	Study targets and sabotage impacts for microreactors and SFRs, determine which may be credible, begin to determine accident progression timelines	SNL	$250K
	Procedural Framework for Microreactor Safeguards and Security	Work with 3 vendors to revise the licensing framework, expand framework beyond microreactors	ANL	$150K
Total				**$1285K**

FY22 Work Packages

Control Account	Work Package Title	Scope	Lead Organization	FY22 $
Material Control and Accounting	MC&A for Pebble Bed Reactors	Deeper dive into MC&A requirements for fresh and spent fuel storage, pebble handling system, reactor inventory, and burnup measurements	ORNL	$225K
	Pebble Accountancy for Pebble Bed Reactors	Refine the concept for testing at TAMU, examine integration into the pebble monitoring system, work with fuel manufacturers to determine feasibility	ANL	$240K
	Gen-IV PR&PP Working Group Support	Continue to lead the PR&PP working group as one of the co-chairs, complete 6 system white papers, and complete crosscut white paper	BNL	$140K
	International Safeguards Interface	Coordinate work with NNSA program areas and work with vendors to take international safeguards into account when designing domestic MC&A systems	PNNL	$30K
Total				**$635K**

FY22 Work Packages

Control Account	Work Package Title	Scope	Lead Organization	FY22 $
Material Control and Accounting	MC&A for Molten Salt Reactors	Determine inventories as a function of time for various MSR designs, continue to develop a quasi-process monitoring approach, and work in results from related work packages	ORNL	$250K
	MSR Safeguards Modeling	Examine limitations of measurement uncertainty and develop new MC&A approaches.	SNL	$100K
	Spectroscopy, Online Monitoring for MSRs	Collect training data of U species and determine impact of chemical contaminants as well as fission products, build chemometric models.	PNNL	$320K
	Flow Enhanced Sensors for MSRs	Complete assessment of the voltametric-based sensor using a variety of fission product surrogates, integrate sensor into the Modular Flow Instrument Test Bed.	ANL	$300K
	Experimental Validation for nondestructive analysis of MSRs	Complete measurement campaign at ORNL to develop a baseline on spent fuel, and begin measurements of molten salts at INL, using microcal, gamma spec, and neutron meas.	LANL	$300K
Total				**$1270K**

Milestones

- Our program has had an extensive number of late milestones.
- Most of the labs have been changing their review and approval processes over the past few years in ways that only increase the time it takes.
- **If you know your lab's review process takes 4 weeks, then you need to have your report complete 1 month before the milestone due date.**
- Delays due to COVID, supply chain issues, or facility problems are understandable, but waiting on review and approval is not a valid reason.

FY22 Planning

- As opposed to holding another large stakeholder review meeting, I will be working to set up one-on-one meetings with advanced reactor vendors.
- I will be sending pertinent FY21 milestones out to vendors to solicit feedback and set up followup meetings.
- We will use those meetings to determine relevancy, identify any further gaps, and discuss ways the labs can help.
- I may be calling on you to provide overviews (like those prepared here) for those meetings. It’s usually a chance to have a more open conversation about their challenges.