

Topic Area 6 – Licensing and Safety

Up to 3 years and up to \$1,000,000

LS-1: Risk Informed System Analysis/Probabilistic Risk Assessment| *William Walsh, Federal POC*

LS-2: Safety Implications of Utilizing Process Heat| *Jason Marcinkoski, Federal POC*

LS-3: Advanced Reactors and Fuel Cycle Facilities Material Accountancy, Control, and Physical Protection| *Savannah Fitzwater & Tansel Selekler, Federal POCs*

LS-4: Advanced Reactor Licensing Topics| *Janelle Eddins, Federal POC*

LS-5: Other Licensing and Safety Topics

Licensing and Safety Overview

- Continued need for enhancing understanding of licensing and safety requirements as they apply to the safe and secure operations of reactors and all fuel cycle related facilities.
- This area focuses on better understanding:
 - Nuclear reactor and recycling plant safety and safeguards margins,
 - Physical security system response and materials accountancy system response using risk-informed frameworks,
 - Probabilistic risk assessment,
 - Reliability of passive systems and components,
 - Integration with materials accountancy and physical protection measures, and the
 - Advancement of modeling and simulation capabilities to develop, verify and validate next-generation safety systems codes.
- This topic covers additional aspects of licensing and safety including:
 - Flexible plant design
 - Operations
 - Cyber security
 - Physical security and material control and accountancy
 - Plant automation and modernization
 - Human/machine interface challenges
 - Other relevant topics

Risk Informed Systems Analysis/Probabilistic Risk Assessment (LS-1)

Light Water Reactor Sustainability (LWRS) Program

- Sustain the long-term operation of commercial light water reactors by lowering O&M costs, diversifying revenue, and ensuring safe operation of the physical components of the plant

Background

- Probabilistic risk assessment (PRA) serves as a fundamental element of nuclear plant operations and regulatory infrastructure
- Complexity, high modeling resource requirements, and lengthy analysis times limit the potential application of this technology
- Proposals are sought to enhance the applicability, usability, and efficiency of PRA tools

Major areas of interest

1. Quantification speed and memory limitations to process large PRA models
2. Human Reliability Analysis (HRA) dependency analysis
3. Quantification and result output from the combined hazard PRA models where external hazards are included in a single model

Contacts,

Federal, William Walsh, william.walsh@nuclear.energy.gov
Idaho National Laboratory, Svetlana Lawrence, svetlana.lawrence@inl.gov

On-Going NE Work Relevant to LS-1

The Office of Nuclear energy, through the **LWRS Program**, conducts R&D in the area of risk informed systems analysis, for the commercial fleet, of which PRA is a key focus area

Current ongoing related R&D

- Risk informed maintenance strategy
- Digital I&C Risk Assessment
- Fire Modeling and Simulation for Risk Assessment
- Dynamic PRA
- Static and dynamic human reliability analysis

Applicants are encouraged to propose novel approaches to PRA analysis, with the goal of eventual use by operating plants to streamline processes for which PRA is a key feature, including but not limited to regulatory compliance

Contacts,

Federal, William Walsh, william.walsh@nuclear.energy.gov

Idaho National Laboratory, Svetlana Lawrence, svetlana.lawrence@inl.gov

Areas Not of Interest

Applications should focus on research that support the **DOE-NE mission**

Applications with the following focuses would be considered not relevant to this topic:

Identifying and reducing unnecessary conservative assumptions, see Topic Area 1 RDO-2

Topics concerning improvements to plant economics beyond PRAs and licensing, see Topic Area 1 RDO-2

PRA techniques for any of the following applications

- Nuclear non-proliferation purposes
- Technologies solely for nuclear fusion applications
- Personnel dose monitoring
- Nuclear weapons R&D
- Nuclear medical isotope production
- Nuclear medicine related technologies

Contacts,

Federal, William Walsh, william.walsh@nuclear.energy.gov

Idaho National Laboratory, Svetlana Lawrence, svetlana.lawrence@inl.gov

Safety Implications of Using Process Heat (LS-2)

This topic focuses on the use of reliable, low-cost thermal and electrical energy from nuclear reactors to decarbonize industrial processes. (e.g. refineries, chemicals, minerals production, district heating)

The Office of Nuclear Energy is seeking projects that evaluate the feasibility of directly using energy from a nuclear power plant (NPP) for decarbonizing off-grid industrial processes to include:

- Physical placement of chemical plants with existing LWRs;
- Colocation of advanced reactors at industrial sites;
- Regulatory research and review for licensing and permitting.

Projects will evaluate the safety implications of utilizing heat from both existing NPPs and future advanced NPPs for industrial applications. This work will:

- Develop requirements for mutual protection from industrial and nuclear plant hazards.
- Engineer conceptual systems to address the requirements as a basis for safety analysis.
- Assess the impacts of both nuclear and industrial system maintenance and operations on the integrated nuclear-industrial system.

On-Going NE Work Relevant to LS-2

The Light Water Reactor Sustainability Program (LWRS) Flexible Plant Operation and Generation pathway (FPOG) work includes:

- Exploring the safety of hydrogen electrolysis systems at a 1 km distance from a nuclear plant.
- Probably risk assessments for initiating events associated with hydrogen integration into light water reactors.
- Industry engagement for regulatory research and review pertaining to use 20 MW_{th} for 100 MW_e electrolysis applications.

Areas Not of Interest

Hydrogen Safety topics for the current fleet of light water reactors
(currently covered by the LWRS program)

Advanced Reactors and Fuel Cycle Facilities Materials Accountancy, Control and Physical Protection (LS-3)

Advanced Reactors and Fuel Cycle Facilities Materials Accountancy, Control, and Physical Protection (LS-3)

- The ARS Program is addressing near-term challenges that advanced reactor vendors face in meeting domestic material control and accounting (MC&A) and physical protection system (PPS) requirements for U.S. construction.
- Applications should:
 - Identify the MC&A or PPS approach to be developed or expanded
 - Consider system response using risk-informed frameworks, probabilistic risk assessment, the reliability of passive systems and components, and integration with MC&A and PPS measures.
 - Consider advancement of modeling and simulation capabilities to develop, verify and validate next-generation safety, materials accountancy, and physical protection systems codes.
 - Specify crosscutting or interfaces with other topics of interest include licensing interfaces between safety including flexible plant operations, cyber security, and physical security, MC&A accountancy, plant automation and modernization, human/machine interface challenges, etc

On-Going NE Work Relevant to LS-3

The Advanced Reactor Safeguards (ARS) program has on-going research through many avenues of funding including directed research, NEUP, and SBIR/STTR.

Previous or on-going research includes :

- PPS to reduce number of on-site responders
- Pebble Bed Reactor MC&A regulatory framework approach
- Microreactor PPS and MC&A appropriate for the very small scale
- Liquid Fueled MC&A measurement techniques and technologies
- International safeguards interfaces

The above list of R&D examples is not exhaustive, and it is provided to assist applicants in identifying research that is not duplicative of previous or on-going research. Recent reports are available on the ARS website - <https://energy.sandia.gov/ars/>

Applicants are encouraged to propose technologies beyond traditional MC&A and physical security approaches for advanced reactors, SMRs, and microreactors.

Areas Not of Interest

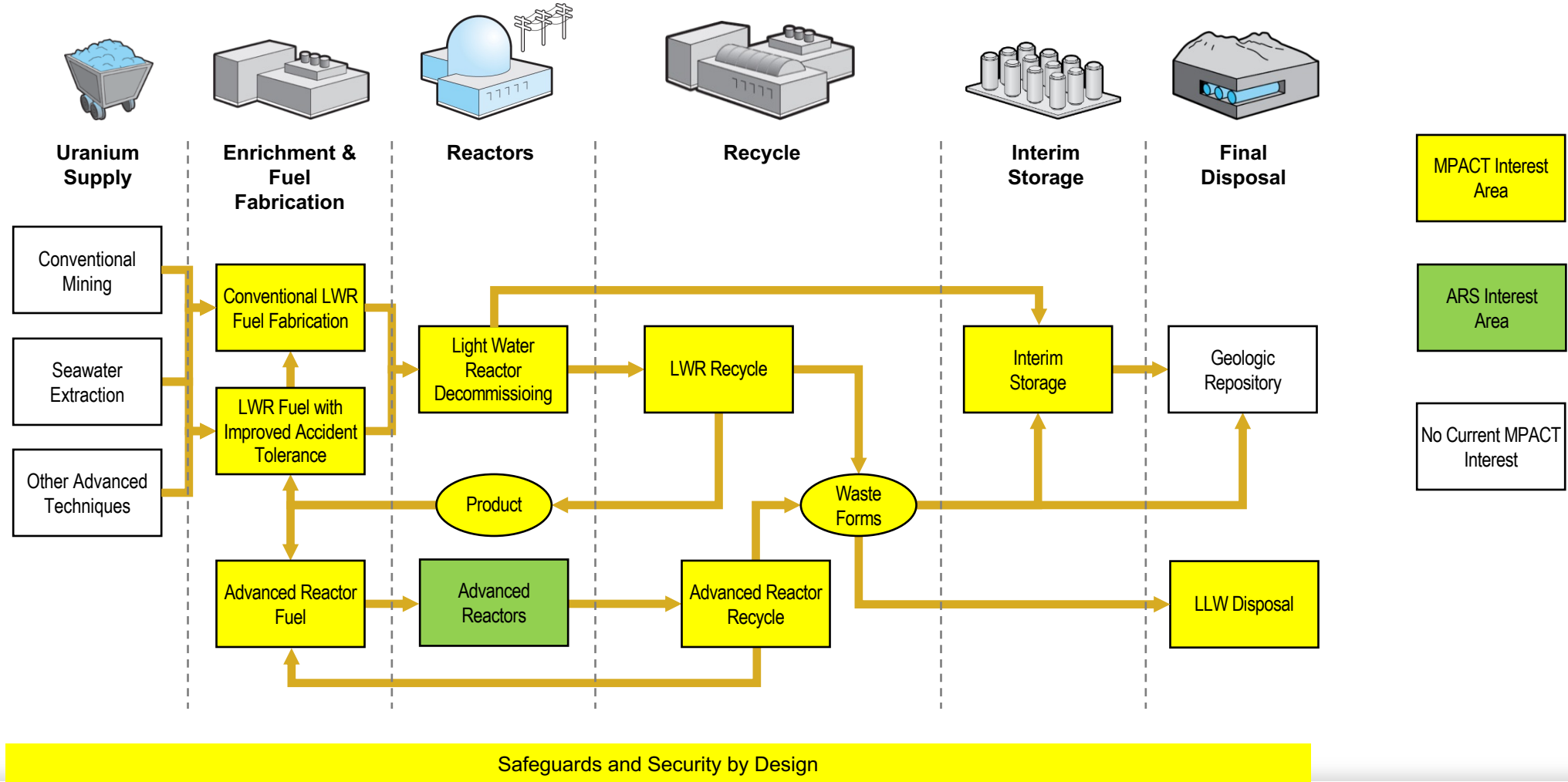
Applications should focus on research that support the **DOE-NE mission**

Applications with the following focuses would be considered not relevant to this topic:

- International safeguards and international security
- Nuclear non-proliferation purposes
- Nuclear forensics
- Technologies solely for nuclear fusion applications
- Personnel dose monitoring
- Nuclear weapons R&D
- Nuclear medical isotope production
- Nuclear medicine related technologies

Applications on technologies that crosscut any of these areas could be considered responsive if proposal clearly demonstrates the application to nuclear energy.

Licensing and Safety (LS-3)



Licensing and Safety (LS-3)

Advanced Reactors and **Fuel Cycle Facilities** Materials Accountancy, Control, and Physical Protection (LS-3)

- Support advanced fuel cycle technology developers to address and meet domestic Materials Control and Accountability (MC&A) requirements for the front and back-end of the U.S. nuclear fuel cycle and emerging nuclear fuel cycle technologies
- Applications should:
 - Identify the type of MC&A to be developed or enhanced.
 - Specify all potential fuel cycle facility applications as well as operational constraints.
 - Propose new and novel approaches to improve the efficiency and effectiveness of safeguards and security systems.
 - Develop new and innovative MC&A technologies, methods and tools to increase the accuracy, reliability, and efficiency of nuclear materials quantification, nuclear material tracking capability in nuclear fuel cycle facilities and processes, and process monitoring tools.

On-going NE Work Relevant to LS-3

The Materials Protection Accounting and Control Technologies (MPACT) program has on-going research through many avenues of funding including directed research, NEUP, and SBIR/STTR.

Previous or on-going research includes :

- Process Monitoring for MC&A
- Radiation Detector Development
- Nuclear Material Accountancy Modeling
- Physical Protection System Modeling
- Data Analysis & Integration
- Molten Salt Elemental and/or Isotopic Composition Measurement Systems
- Optical Analysis Methods for Elemental and/or Isotopic Composition
- Argon Hot Cell Gamma Spectroscopy

The above list of R&D examples is not exhaustive, and it is provided to assist applicants in identifying research that is not duplicative of previous or on-going research.

Applicants are encouraged to propose technologies beyond traditional MC&A methods or techniques for application to fuel cycle nuclear material accountancy challenges.

Areas Not Of Interest

Applications should focus on research that support the **DOE-NE mission**

Applications with the following focuses would be considered not relevant to this topic:

- Nuclear non-proliferation purposes
- Nuclear forensics
- Technologies solely for nuclear fusion applications
- Personnel dose monitoring
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Applications on technologies that crosscut any of these areas could be considered responsive if proposal clearly demonstrates the application to nuclear energy.

Advanced Reactor Licensing Topics (LS-4)

- Successful licensing of advanced reactors will require establishment of an advanced reactor regulatory framework, including the R&D necessary to establish the associated licensing technical requirements.
- Proposals are sought for:
 - Activities that address technology specific gaps in licensing technical requirements for advanced reactors
 - Activities that reduce the regulatory risks associated with advanced reactor designs
- Activities should support advanced reactors including microreactors, fast reactors, molten salt reactors, gas-cooled reactors and light water small modular reactors

On-Going NE Work Relevant to LS-4

- Advanced Reactor Regulatory Development Program
 - Activities directly reduce technical and regulatory risks by providing the bases for the establishment of advanced reactor technology licensing technical requirements
 - Establish technical insights and tools regarding radionuclide transport and release from advanced reactors, including fast reactors, gas-cooled reactors, and molten salt reactors
 - Support NRC endorsement of codes and standards important for manufacture of advanced reactor components
 - Validation and access to priority material property data to be used in safety codes and models
- Advanced Reactor Technologies (ART) Program
 - Supports activities to reduce technical risks for fast reactors, molten salt reactors, gas-cooled reactors and microreactors
- Cost-shared Partnerships with Industry
 - Demonstration of a high temperature gas-cooled reactor and a sodium fast reactor, including NRC licensing, through the Advanced Reactor Demonstration Program (ARDP) Demonstration awards
 - Demonstration of a light water SMR technology, including NRC licensing, through cost-shared awards to NuScale Power and Carbon Free Power Project, LLC
 - Support activities that reduce the technical and regulatory risks associated with a broad set of designs through the ARDP Risk Reduction awards and Advanced Reactor Concepts-2020 awards

The above list of examples is not exhaustive, and it is provided to assist applicants in identifying research that is not duplicative of previous or on-going research.

Areas Not of Interest

Applications should focus on research that support the **DOE-NE mission**

Applications with the following focuses would be considered not relevant to this topic:

- Activities solely for nuclear fusion applications
- Activities solely focused on the existing fleet

Applications on technologies that crosscut any of these areas could be considered responsive if proposal clearly demonstrates the application to nuclear energy.

Other Licensing and Safety Topics (LS-5)

Proposals that are relevant to Licensing and Safety as described in the Topic Area 6 overview but are not covered by the previous topic categories can be submitted to LS-5 for consideration.

It is important to note that any submission to this category can be crosscutting, but must reinforce the Office of Nuclear Energy's mission and the following supporting goals:

“Advance nuclear energy science and technology to meet U.S. energy, environmental, and economic needs.”

1. Enable continued operation of existing U.S. nuclear reactors.
2. Enable deployment of advanced nuclear reactors.
3. Develop advanced nuclear fuel cycles.
4. Maintain U.S. leadership in nuclear energy technology.

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Questions?