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# Risk-Informed Consequence-Driven Hybrid Cyber-Physical Protection System Security Optimization for Advanced Reactor Sites

**PI**: Shaheen Azim Dewji,
Georgia Institute of Technology

**Collaborators**: Fan Zhang, Georgia Institute of Technology; Karen Vierow Kirkland, Texas A&M University; Chris Faucett, John Fulton, Michael Rowland, Sandia National Laboratories

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**ABSTRACT:**

The proposed project aims to develop a novel methodology for designing a risk-informed cybersecurity-integrated physical protection system (PPS) framework for advanced reactor (AR) concepts that serves to reduce the operational costs for the life of a reactor against that of a traditional light water reactor (LWR) PPS design. To assess the merit of the newly proposed methodology, a reactor-agnostic hybrid cyber-PPS framework for an AR concept will be compared to current U.S. federal regulation requirements for the commercial LWR fleet and evaluated vis-à-vis proposed regulatory requirements.

The objectives of this project are to:

- Assess fundamental systems-level correlations between sabotage-based security events in the traditional PPS-security space and those in a newly integrated hybrid cyber-PPS space.
- Demonstrate the new risk-informed approach on a molten salt research reactor (MSRR) concept with uncertainty analyses to satisfy licensing requirements under proposed language of 10 CFR 53.
- Pursue a cost-savings evaluation for licensing and operating lifetime by benchmarking against the current policy-driven reactor PPS requirements as specified by 10 CFR 73 for the same site layout.

Project tasks include modeling a MSRR concept into accident and consequence analysis code; developing and validating a cyber-PPS design concept into the accident analysis code using system theoretic process analysis and fault tree analysis of digital instrumentation and control; generating inventory source terms; and conducting siting boundary, health, and economic consequence analyses. The success of this methodology will be evaluated by comparison of the footprint and economic cost compared to current LWR approaches, as well as against PPS-based approaches. Key technical innovations will include will be the coupling of consequence modeling with a newly developed risk-informed hybrid cyber-PPS security design in an integrated safety-security and consequence assessment framework. Simultaneous consideration of core behavior and cyber-PPS security risk assessment will enable an optimized design with respect to security, public health and safety, and economics.

This project will provide the following outcomes and impacts:

- An enhanced methodology framework for a cyber-PPS informed design optimization that will reduce upfront and operational security costs;
- A framework for incorporating consequence analysis into cyber-security regulations required by new regulatory licensing language;
- A means to define the level of risk for MSRs, as a framework, which is based on an integrated analysis of security and safety effects; and
- Uncertainty estimates for health/economic consequence analyses from dose-based siting boundaries.

Deliverables include:

- A new, optimized risk-informed methodology framework utilizing hybrid cyber-PPS design for optimized AR licensing requirements; and
- An expanded module including cyber-PPS integration in MELCOR for use by the broader AR licensing communities.