Economic Analysis of Physical Security at Nuclear Power Plants


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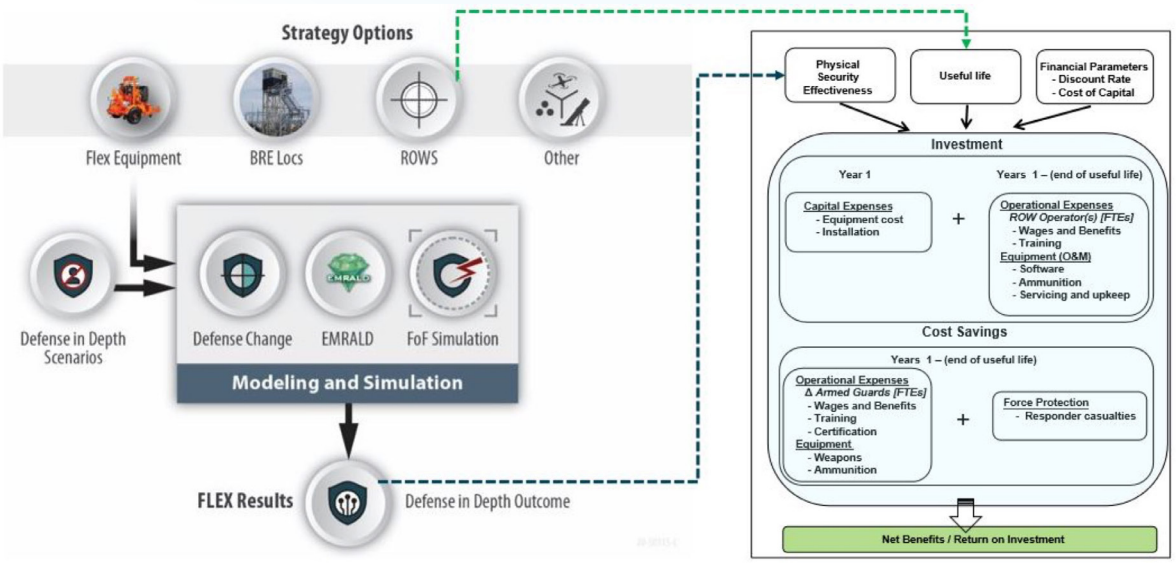
Physical Security Pathway

The requirements for U.S. nuclear power plants to maintain a large onsite physical security force contribute to their operational costs. The cost of maintaining the current physical security posture is approximately 10% of the overall operation and maintenance budget for commercial nuclear power plants [1]. The goal of the LWRS Program Physical Security Pathway is to develop tools, methods, and technologies, and to provide the technical basis for an optimized physical security posture. The conservatisms built into current security postures may be minimized to reduce security costs while still ensuring adequate security and operational safety.

This research developed a framework integrating results from Force on Force (FoF) analysis with economic assessment to achieve two closely linked objectives: (1) component effectiveness estimation of the physical security posture; and (2) investment evaluation in physical security using an estimated cash flow analysis. The economic models are developed to incorporate input from the physical security performance assessment models—such as FoF models developed using INL's EMRALD dynamic modeling framework [2], which provide the performance effectiveness of a physical security posture. When implemented together, the economic and FoF models will provide a utility with a technical basis to enable an optimized physical security program that is both cost- and performance-effective.

The current effort utilizes econometric tools to evaluate the effectiveness of physical security at a nuclear power plant. This analysis enables the identification of the relative importance of each component of the physical security posture. The objective is to evaluate tradeoffs between the components to identify potential

Figure 13. Economic analysis for including ROWS into security posture.



opportunities to optimize physical security components while maintaining a specific level of system effectiveness. Effectiveness of a physical security posture is represented as a binary variable as success or failure of the posture in protecting core assets of the nuclear power plant in the event of an adversarial attack. A logistic regression framework is used to analyze the performance data to estimate the probability of a "success" occurring given the values of the independent variables [3]. The ratio of the probability of successes over the probability of failure, commonly called the odds ratio, indicates the resulting change in odds due to a one-unit change in the predictor [4]. Odds ratio is used for determining the sensitivities of various elements of physical security posture to the performance and cost outcomes.

The investment analysis is performed based on a specified level of security posture effectiveness as determined by the FoF analysis, which determines the effectiveness of the physical security posture given a range of system components (e.g., security guards, intrusion detection system technologies, remotely operated weapon systems [ROWS], active and passive barriers, etc.). This work demonstrates the evaluation of cost-efficiencies arising from incorporating ROWS into a physical security posture. Both performance and economic characteristics of ROWS, such as acquisition costs, installation, useful life, and system performance are incorporated into the analytical framework. Figure 13 provides an illustration of the steps involved for evaluating the impact of including ROWS into the security posture. This performance- and cost-effectiveness framework can provide the utilities with an analytical tool to support informed decision-making regarding the most impactful capital investments within the physical security infrastructure. More details about the framework are published in a LWRS Program report [5].

References

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2020 Secretary of Energy Achievement Award

In January 2021, LWRS Program team members Richard Boardman, Alison Hahn, Bruce Hallbert, Jason Marcinkoski, Cristian Rabiti, and Kenneth Thomas, were recognized with a Department of Energy Secretary's Honor Award for their achievements as part of the Integrated Energy Systems Team. The team showed dedication and made enormous efforts that will allow the United States to move forward in demonstrating hydrogen generation technology at operating nuclear reactors. This step is important for meeting the Department of Energy's Integrated Energy Systems goals. This team's commitment and energy in working with a number involved parties has mitigated uncertainties that otherwise may have rendered this project impossible.