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Physical Security Pathway

2024 LWRS Program Spring Review Meeting

April 30, 2024

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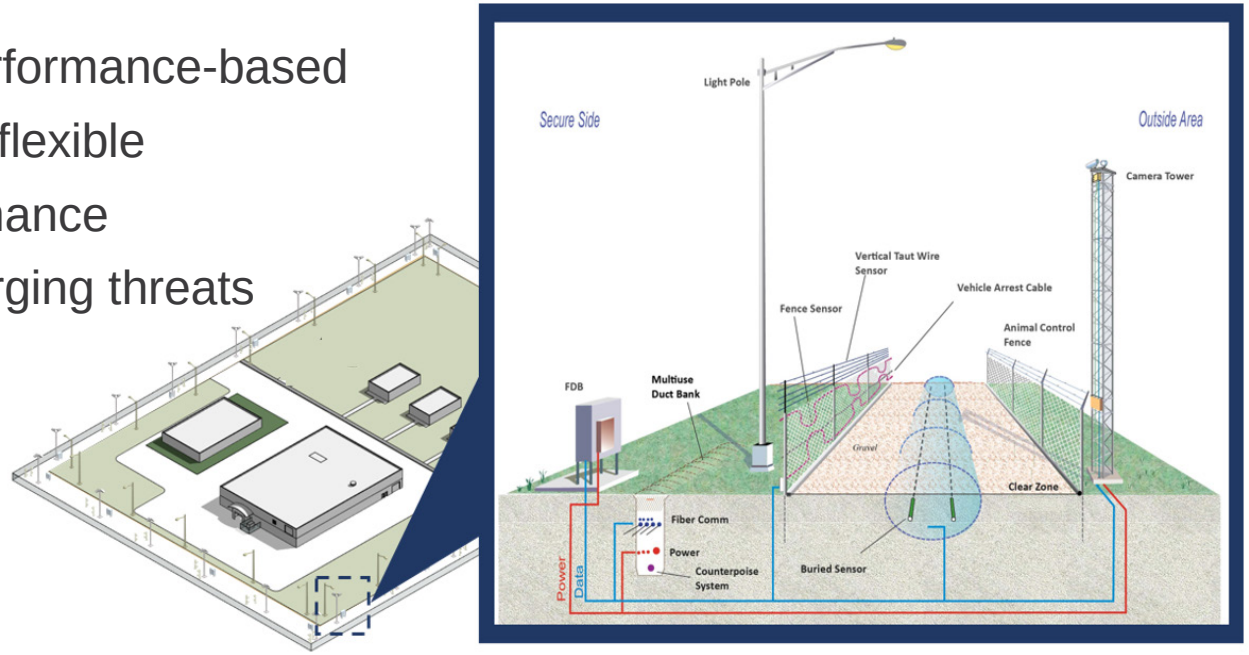
Summary – Physical Security Challenges

Fundamental architectures for physical security systems have changed little over the last 50 years

Challenges:

- Increasing labor costs
- Primarily compliance-based instead of performance-based
- Fixed infrastructure, which is costly and inflexible
- High nuisance alarm rates reduce performance
- Difficulty to adapt current systems to emerging threats
- Response relies on human variability



Perimeter intrusions detection system

Physical Security Pathway's Motivation and Overview

Why is LWRS focusing on Physical Security?

- Physical security accounts for approximately 20% of staffing at nuclear power plants
- There are many ways to reduce this percentage while maintaining security systems effectiveness

Physical Security research aims to create tools, technologies and capabilities for performance-based, risk-informed decision making with the following objectives:

- Develop mitigation strategies enhance the technical basis necessary for stakeholders to reevaluate physical security postures while meeting regulatory requirements
- Analyze the existing physical security regime and current best practices, compare/contrast insights with alternative methods that leverage advanced modeling and simulation, modern technologies, and novel techniques to address the design basis threat and regulatory requirements

Main research focus areas:

- Advanced Security Technologies
- Risk-Informed Physical Security
- Advanced Security Sensor and Barrier Systems

Force-on-force exercise

Unattended opening performance test

Summary – LWRS Physical Security Pathway Goals

Next generation security systems must leverage commercial investments integrated with advanced government technologies and methodologies to revolutionize current-day functions while addressing the 21st century evolving threats

Goals:

- Reduce need for costly infrastructure upgrades:
  - Design / Installation
  - Sustainment
  - Labor
- Leverage commercial technologies
- Threat agnostic
- Adaptable systems and technology management processes to minimize future system-wide overhauls
- Reduce nuisance alarm rates
- Increased survivability for security forces
- Common evaluation of overall physical protection system effectiveness
- Decision making based on performance-based, risk-informed security

Major Activities and Accomplishments

- Stakeholder Engagement Meetings
  - DEPO, Explosive, Adversary Timeline and Vulnerability Assessment Workshops
- Advanced Security Technologies
  - Remotely Operated Weapons System (ROWS) modeling of Riverbend and Monticello
- Risk-Informed Physical Security
  - Unattended openings – first report on performance-based risk-informed security
  - Conducted preliminary analyses for developing a dynamic risk-informed security methodology with Palo Verde
  - Expanded performance test data collection (security sensors, ballistics, and explosives)
  - Access for NRC licensees to 4 DOE Security System Desk References
- Advanced Security Sensor and Barrier Systems
  - Identified cost effective solution for microwave sensor testing
  - Completed two pilot studies of deliberate motion analytics with DC Cook and Waterford-III
  - Developed a shot detection capability for cameras and multiplexor boxes

Notional Modeling of External ROWS Placements

Aluminum and stainless-steel test spheres

Desired Impactful Outcomes within 3 years

Provide the technical basis for unattended openings (2D and 3D)
Provide access to technical documents from DOE's Office of Security and NNSA

- Fleet-wide application of risk-informed access / delay timelines for adversary and response force
- Support deployment of ROWS to at least one candidate site
- Pilot an integrated approach to dynamic force-on-force and reactor system response modeling
- Pilot the integration of human factors data and modeling for adversary and response force
- Support deployment of advanced sensor and delay technologies
  - Sensor fusion (water intakes)
  - Deliberate motion analytics (DMA)
  - Jam-resilient, cyber-hardened wireless (carbon wireless)
  - Ballistic detection for cameras and multiplexer boxes
  - Economical retrofits for added delay to vital areas

Active radar (blue) and thermal camera (yellow) fused through DMA showing both nuisance data and adversary track data; the red dots are the alarm indication.

Nuclear Industry Engagement

ROWS	UAO Unattended Openings	DMA Deliberate Motion Analytics	Water Intake Sensors	Dynamic Risk Framework	DOE VA Method Vulnerability Assessment	CARBON Wireless	Delay	DOE SBIR Small Business Innovative Research	DOE NEUP Nuclear Energy University Program
Entergy	Entergy	Entergy	TVA	APS	Constellation	Xcel Energy	APS	ARES	Ohio State
Xcel Energy	Xcel Energy	AEP	Xcel Energy	Southern Nuclear	Xcel Energy	NRC	Constellation	RhinoCorps	
Constellation	Constellation	Xcel Energy	Constellation	PWROG	NextEra/FPL				
NRC	NEI	NRC	PSEG	RhinoCorps	NEI				
	Stars Alliance			NRC	RhinoCorps				
	Dominion								
	SNC								
	NextEra								
	NRC								

Examples of tactical breaching and attack tools

Updates to DOE Security System Design References (SSDRs)

- DOE Environment, Health, Safety and Security (EHSS) EHSS-50 review of SSDRs
- Access Delay Volume 1 and 2
- Vulnerability assessment
- Entry control and contraband detection

- All SSDRs are limited distribution Unclassified Controlled Nuclear Information (UCNI)
- Available upon request after NRC review and approval of SSDRs:
  - NRC-approved data sources
  - NRC public notification process

- Remote Weapons System Safety Standard
  - Work in progress

Sustaining National Nuclear Assets

lwrs.inl.gov

Physical Security Pathway Milestone Reports

Research Thrust Area	Report Name	Report Number
Advanced Security Technologies	*Enhanced force-on-force modeling to support the technical basis of an advanced remote operated weapons technology for use at a candidate nuclear power plant site*	-
	Technical Basis for Remote Operated Weapon System Deployment at Nuclear Power Plants	Sandia R&A: 1197224
	Remote Operated Weapon System Deployment at Nuclear Power Plants – Excerpt for Commercial Nuclear Power Plants	Sandia R&A: 1208137
	ROWS Tower Structural Response to Bulk Explosive Attacks	SAND2020-12697 PE
	Force-on-force Modeling of Remote Operated Weapon Systems for use at a Candidate Nuclear Power Plant Site	-
	Continued Dante Study of Physical Security Upgrades at Nuclear Power Plant Sites	-
	Technical Basis for Remote Operated Weapon System Deployment at Nuclear Power Plants – Revision 1	Sandia R&A: 1630475
	FY23 Mid-Year Update of ROWS Modeling Physical Security Updates	Sandia R&A: 1630477
	Technical Basis for Remote Operated Weapon System Deployment at Nuclear Power Plants – Revision 2	Sandia R&A: 1701849
	Model-based Solution for the use in a Remote Operated Weapon System Simulator using a Formal Deployment Strategy Plan	Sandia R&A: 1710377
	Technical Basis for Remote Operated Weapon System Deployment at Nuclear Power Plants – Revision 3	Sandia R&A: 1722289

Research Thrust Area	Report Name	Report Number
Advanced Security Sensor and Barrier Systems	*Research Roadmap for Advanced Physical Security Sensor/Barrier Technology*	SAND2021-9771
	Microwave Responses for Varied Stimuli	SAND2022-4078
	Analog Microwaves and Target Velocity	SAND2022-3543
	Pilot Deployment of the Deliberate Motion Analytics Sensor System at the Donald C. Cook Nuclear Plant	SAND2022-7758 O
	Preliminary Study for Detection of Swimmers at Water Intakes for Nuclear Power Plants	Sandia R&A: 1630070
	Physical Security Meetings at Site 362	SAND2022-3542
	Analog Microwaves and Target Velocity	SAND2022-3543
	Microwave Response for Varied Stimuli	SAND2022-4078
	Pilot Deployment of the Deliberate Motion Analytics Sensor System at the Waterford III Nuclear Plant	SAND2022-14815 R
	Microwave Sensor Performance at "Slow" Setting and Alternate Stainless Steel Test Target for Microwaves	SAND2022-15618 R
	Deliberate Motion Analytics Commercialization and Technology Transfer	Sandia R&A: 1664515
	Access Delay Concepts to Enhance Security for Domestic Nuclear Power Plant Sites	Sandia R&A: 1675952
	Preliminary Study for Detection of Swimmers at Water Intakes for Nuclear Power Plants – Update	Sandia R&A: 1709040
	Deliberate Motion Analytics Commercialization and Technology Transfer – Revision 1	SAND2023-09100 R
	Pilot Deployment of the CARBON Wireless Networking System for Nuclear Power Plants	Sandia R&A: 1722279
	Access Delay Technologies to Vital Areas for Domestic Nuclear Power Plant Sites	Sandia R&A: 1722335

Physical Security Pathway Milestone Reports – continued

Research Thrust Area	Report Name	Report Number
Risk-Informed Physical Security	*Domestic Nuclear Power Plant Physical Security Reevaluation – High-Level Project Plan*	SAND2018-12483
	Initial Physical Security Assessment of Domestic Nuclear Power	SAND2019-9063
	Joint INL/SNL Physical Security Evaluation	SAND2019-11878
	Current Challenges, Constraints, and Recommendations for Reducing Costs of Physical Security at U.S. Commercial Nuclear Power Plants	INL/EXT-19-54452
	Physical Security Initiative Site Visit of the Monticello Generating Plant – April 16-18, 2019 – Trip Report	INL/EXT-19-54297
	Modeling for Existing Nuclear Power Plant Security Regime	SAND2019-12015
	Lone Pine Nuclear Power Plant Description	SAND2019-12227
	Integration of FLEX Equipment and Operator Actions in Plant Force-On-Force Models with Dynamic Risk Assessment	INL/EXT-20-59510
	Economic Analysis of Physical Security at Nuclear Power Plants	INL/EXT-20-59737
	Methodology and Application of Physical Security Effectiveness Based on Dynamic Force-on-Force Modeling	INL/EXT-20-59891
	September 2019 Physical Security Stakeholder Working Group Meeting	SAND2020-0764
	Light Water Reactor Sustainability Program: November 2019 Physical Security Stakeholder Working Group Meeting	SAND2020-4616
	Evaluate Tools and Technologies that Would Benefit the Advancement of Risk-Informed Models	SAND2020-9055
	Risk Informed Access Delay Timeline Development	SAND2020-9176
	Development of Performance-Based Metrics for Overall Physical Security System Effectiveness	SAND2020-9430
	Risk Informed Timeline Tool	SAND2021-9430

Research Thrust Area	Report Name	Report Number
Risk-Informed Physical Security	*A Review of Risk-Informed Approaches for Physical Security*	SAND2021-10500
	Performance Testing of Person-Passable Unattended Openings	SAND2021-12792
	Guidance Document for Using Dynamic Force-on-Force Tools	INL/EXT-21-64214
	Integration of Physical Security Simulation Software Applications in a Dynamic Risk Framework	INL/EXT-21-64333
	Security System Desk Reference – Interim Access Delay	SAND2021-15454
	Performance Testing of Person-Passable Unattended Openings – Revision 2	SAND2022-5525
	Enhancing Sites' Physical Security through a Structured Performance-Based Assessment Framework	Sandia R&A: 1677363
	Evaluation of Physical Security Risk for Potential Implementation of FLEX using Dynamic Simulation Methods	INL/EXT-22-70315
	Plant-Specific Model and Data Analysis using Dynamic Security Modeling and Simulation	INL/RPT-23-73490
	Risk-Informed Security Optimization Recommendations	INL/RPT-23-74548
	Enhancing Sites' Physical Security through a Vulnerability Assessment Process	Sandia R&A: 1722301