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Light Water Reactor Sustainability Program: September 2019 Physical Security Stakeholder Working Group Meeting

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ABSTRACT

The LWRS Program Physical Security Pathway held the first meeting of the Physical Security Stakeholder working group on September 10-12, 2019 at Sandia National Laboratories. This working group is comprised of nuclear enterprise physical security stakeholders and the meeting included over 10 Utilities representing roughly 60 nuclear power plants, two staff from the Nuclear Regulatory Commission, physical security vendors, the Nuclear Energy Institute, the Electric Power Research Institute, and staff from Sandia National Laboratories and Idaho National Laboratory. The working group was established with the objectives of providing stakeholder feedback to the LWRS Program on their research and development needs and priorities, socializing the progress of Physical Security Pathway initiatives, and identifying opportunities for additional engagement and participation of stakeholders in the pathway research activities. The working group also provided a forum for physical security professionals to share common experiences and recommend prioritized activities based on their common needs.

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ACRONYMS AND DEFINITIONS

Abbreviation	Definition
ADTTM	Access Delay Technical Transfer Manual
ANS	American Nuclear Society
ASME	American Society of Mechanical Engineers
ATOF	Adversary Timelines, Operator Actions, and FLEX
DBT	Design Basis Threat
DMA	Deliberate Motion Algorithm
BWR	Boiling Water Reactor
C2	Command and Control
CAF	Composite Adversary Force
COTS	Commercial of the Shelf
CRADA	Cooperative Research and Development Agreement
CST	Condensate Storage Tank
DET	Dynamic Event Tree
DOE	U.S. Department of Energy
DOE-NE	U.S. Department of Energy's Office of Nuclear Energy
DoD	Department of Defense
EMP	Electrical Magnetic Pulse
EPRI	Electric Power Research Institute
FAA	Federal Aviation Administration
FAR	False Alarm Rate
FoF	Force on Force
IAEA	International Atomic Energy Agency
IDS	Intrusion Detection System
INL	Idaho National Laboratory
INMM	Institute of Nuclear Material Management
ISF	Integrated Security Facility
ISFSI	Independent Spent Fuel Storage Installation
ITC	International Training Course
JCNRM	Joint Committee on Nuclear Risk Management
LPNPP	Lone Pine Nuclear Power Plant
LWR	Light Water Reactor
LWRS	Light Water Reactor Sustainability

Abbreviation	Definition
M&MP	Modeling and Measures of Performance
NAR	Nuisance Alarm Rate
NNSA	National Nuclear Security Administration
NPP	Nuclear Power Plant
NRC	U.S. Nuclear Regulatory Commission
OTH	Other items not covered
P_D	Probability of Detection
P_I	Probability of Interruption
P_N	Probability of Neutralization
PAOA	Protected Area Opening Assessment
PIDAS	Perimeter Intrusion Detection & Assessment System
PRA	Probabilistic Risk Assessment
PSP	Physical Security Pathway
PWR	Pressurized Water Reactor
REG	Regulation Changes
ROWS	Remote Operated Weapons System
SAS	Secondary Alarm Station
SBT	Security Bounding Time
SNL	Sandia National Laboratories
STEC	Sensor Testing and Evaluation Center
UAS	Unmanned Aerial System
UAO	Unattended Opening
USG	U.S. Government
WG	Working Group

1. INTRODUCTION

This report documents the Light Water Reactor Sustainability (LWRS) Program's Physical Security Pathway (PSP) first meeting of the Physical Security Stakeholder working group held on September 10-12, 2019 at Sandia National Laboratories (SNL). This working group is comprised of nuclear enterprise physical security stakeholders and the meeting included over 10 Utilities representing roughly 60 nuclear power plants (NPPs), two staff from the Nuclear Regulatory Commission (NRC), physical security vendors, the Nuclear Energy Institute (NEI), the Electric Power Research Institute (EPRI), and staff from SNL and Idaho National Laboratory (INL). The working group was established with the objectives of providing stakeholder feedback to the LWRS Program on their research and development needs and priorities, socializing the progress of PSP initiatives, and identifying opportunities for additional engagement and participation of stakeholders in the PSP research activities. The working group also provided a forum for physical security professionals to share common experiences and recommend prioritized activities based on their common needs.

1.1. Motivation

Domestic nuclear power generation faces increasing economic pressures, in part, by post-Fukushima regulatory requirements, an increase in subsidized renewable energy sources, and current low-cost natural gas. The requirements for U.S. nuclear power generation sites, post-9/11, to maintain a large on-site physical security force ranks high for related plant operational costs; ~12% of the overall cost (~\$560 million) for decommissioning a nuclear facility [1]. U.S. nuclear power plants are seeking novel physical security methods and technologies to help deliver on the Nuclear Promise [2].

DOE National Laboratories have extensively studied physical security configurations that couple detect, delay, and response attributes to regulatory required physical security postures. This DOE Office of Nuclear Energy (DOE-NE) Light Water Sustainability (LWRS) Program effort seeks to create tools, methods, and technologies that will:

- Apply aspects of risk-informed techniques for physical security decisions and activities to account for a dynamic adversary;
- Apply advanced modeling and simulation tools to better inform physical security posture;
- Assess benefits from proposed enhancements, novel mitigation strategies, and potential changes to regulations; and
- Enhance the technical basis necessary for operating utilities to reevaluate their physical security posture while meeting regulatory requirements.

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2. LWRs PROGRAM PSP STAKEHOLDER WORKING GROUP CHARTER

As part of the first day (see Appendix A for agenda), a review and update to the stakeholder working group charter was conducted. This section provides the current stakeholder working group charter.

2.1. Objectives

A Physical Security Pathway (PSP) stakeholder working group (WG) has been established comprised of nuclear enterprise physical security stakeholders to achieve the following objectives:

- Provide information from stakeholders to the PSP on R&D needs and priorities;
- Provide the status and progress of R&D activities conducted by the PSP to stakeholders;
- Discuss the status of ongoing engagement activities through research and development activities and identify additional engagement and participation opportunities in PSP research activities.

2.2. LWRs Physical Security Pathway Driver

Physical security of nuclear power plants is a vital aspect of maintaining a safe and reliable national nuclear energy capability. Physical security programs at U.S. nuclear sites have evolved to meet changes to their design basis threat (DBT) since the 1980s. The events of September 11, 2001 saw more changes to the DBT and significant increases of physical security at nuclear power plant sites. As U.S. nuclear power plants modernize their infrastructure and control systems, opportunities exist to apply advanced tools, methods, and automation to modernize physical security programs. Potential benefits expected from the LWRs PSP include higher fidelity models that may reduce conservatism in security modeling, leverage automation as force multipliers, optimize security postures, and develop additional means to risk-inform approaches to evaluate security changes.

This LWRs initiative will leverage advances in modeling and simulation, sensor technologies, risk management tools, automation, and other technologic advances to provide the advance technical basis necessary to modernize and optimize physical security capabilities. This initiative includes efforts in the following areas:

- Research and development of risk-informed techniques for physical security to account for a dynamic adversary.
- Research and development of advanced modeling and simulation tools to better inform physical security scenarios.
- Assess benefits from proposed enhancements, novel mitigation strategies, and potential changes to best practices, guides, or regulation.
- Enhance and provide a technical basis for stakeholders to employ new methods, tools, and technologies to achieve optimized physical security.

2.3. Working Group Activities

The working group members will be invited to participate in bi-annual in-person meetings of the stakeholder, participate in periodic updates, and provide input and information to inform the development of ongoing R&D planning and assist in prioritizing activities and engagement opportunities.

2.4. Structure

The PSP stakeholder working group is coordinated through and supports the goals of the Light Water Reactor Sustainability Program to an R&D program based upon private-public partnerships where feasible.

Representation on the Working Group includes fleet security directors or their delegates, LWRS Program PSP members, vendors supporting physical security enhancements, the LWRS Technical Integration Office, representative from the Nuclear Energy Institute's Security WG, and others as identified by the WG.

The Nuclear Regulatory Commission (NRC) is an important stakeholder of the LWRS PSP WG and will be invited to participate on the working group.

Meeting minutes (or summaries) will identify the names, roles, and organizations of members and other participants of the PSP WG.

2.5. Deliverables

The working group will produce meeting minutes including a description of action items; see Table 2.1. Additionally, the WG will provide written recommendations to the LWRS program. Finally, any communication products needed will be created by the WG members.

Table 2.1 Example of Agenda

General Meeting Agenda
Introduction
Agenda Review
LWRS Program Review Update
Industry Topics and Concerns
Action Item Review
Closeout

2.6. LWRS Program PSP Working Group Members

The working group membership and roles are initially defined in Table 2.2. This table will be provided as an appendix within the charter and will be updated on an as-needed basis to ensure proper communication with all stakeholders.

Table 2.2 LWRS Program PSP WG Members

Role	Name	Title	Organization
Working Group Champion	Bruce Hallbert	LWRS National Technical Director	Idaho National Labs
Chair	F. Mitch McCrory	LWRS PSP Manager	Sandia National Labs
Alternate Chair	Douglas Osborn	PSP Technical Lab Lead	Sandia National Labs
Alternate Chair	Shawn St. Germain	PSP Technical Lab Lead	Idaho National Labs
Working Group Members	TBD	--	--

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3. PSP STAKEHOLDER WORKING GROUP MEETING OVERVIEW

During the September 2019 meeting, a series of presentations and discussions were held over the course of three days. This section provides a high-level overview of the discussions and a list of the presentations which can be provided to the meeting attendees.

3.1. Overview

A high-level summary of each briefing and the main presenter(s) is provided.

LWRS Overview – Bruce Hallbert, LWRS National Technical Director, INL

- Discussion on the history and current mission of the DOE-NE Light Water Reactor Sustainability (LWRS) Program. A presentation of each of the LWRS pathways was given as well as the new initiatives such as physical security.

Overview of Physical Security Pathway Program Plan – Mitch McCrory, LWRS Physical Security Initiative, SNL

- Discussion on the motivation and current efforts of the LWRS PSI. The motivation for the LWRS physical security working group and the makeup of the stakeholders was also presented.

LWRS PSI Working Group Charter Review – Mitch McCrory, LWRS Physical Security Initiative, SNL

- A review of the working group charter was conducted. Edits, changes, and questions were to be given to Jodie Lord (SNL).

NEI Security Working Group Update – David Young, Nuclear Security and Incident Preparedness Technical Advisor, NEI

- An overview of the current NEI efforts on physical security was given. A discussion on NEI's priorities and where DOE could provide assistance (e.g., unattended openings) was conducted.

NRC Discussion on Physical Security Regulatory Status and Needs – Michele Sampson, Reactor Security Branch Chief, NRC

- An overview of current NRC efforts and guidance for physical security was given. A discussion on recent regulatory guidance (e.g., security bounding time) was conducted.

Sandia National Laboratories Overview – Sylvia Saltzstein, Nuclear Energy Safety and Security, SNL

- A corporate overview and general discussion of Sandia's capabilities was given. This discussion also included a review of the Sandia mission areas which were assisting with the LWRS PSP.

Overview of INL Physical Security Research – Vaibhav Yadav, LWRS Principal Investigator, INL

- A presentation of the current INL efforts for the LWRS PSI was given. Stakeholder feedback was provided.

HAZCADS – Doug Osborn, Int’l Nuclear Security Engineering R&D S&E, SNL

- A discussion was held on the need for a novel solution to nuclear security risk assessment through the integration of various risk methods. HAZCADS is an example of this by leveraging advantages of PRA and System Theoretic Process Analysis.

EMERALD – Steve Prescott, Software Analysis/Integration Engineer, INL

- A presentation of the dynamic PRA software was held. An example of using EMERALD’s capabilities was discussed; the risk associated with response force using the restroom.

International Nuclear Security – Jordan Parks, Int’l Nuclear Security Engineering R&D S&E, SNL

- An overview of the new NNSA initiative to collaborate with international nuclear power plants on security (cyber and physical) was given.

ROWS Presentation – Kristopher Klingler, High Consequence Robotic Systems Manager, SNL

- An overview presentation and discussion regarding ROWS technology was given. Discussions of how the domestic nuclear power fleet could leverage this body of work was held. A facility tour was conducted.

INL Nuclear Cyber Research – Shannon Eggers, Cybercore, INL

- An overview of INL’s nuclear energy cyber research was held. A discussion on the possibility of a combined DOE cyber-physical security work group was held; such a meeting from time to time would be appropriate.

Sandia Cyber – Lon Dawson, Energy Security R&D S&E, SNL

- An overview of SNL’s nuclear energy cyber research was held.

Deliberate Motion Algorithms and Water Intakes – J.R. Russell, Technology Development R&D S&E, SNL

- A discussion was held on recent SNL efforts on sensor data fusion to develop deliberate motion algorithms and how this technology could be applied at domestic NPPs. A discussion on SME operational experience and technical solutions was conducted on water intakes.

Access Delay Tech Transfer Volume II – Chad Monthan, Access Delay and Structural Assessment Manager, SNL

- Discussions and a demonstration were held on the use of the Access Delay Tech Transfer Manual Volume II and how to create detailed timelines (e.g., complexity factors). A discussion on application of uncertainty to barriers was also held.

Cyber Security Threat Brief – John Mulder, Critical Infrastructure Systems, SNL

- Discussions on recent cyber events was held

UAS Threat Brief – Daniel Small, Robotics and Counter Robotics R&D S&E, SNL
David Novick, Robotics and Counter Robotics R&D S&E, SNL

- Discussions on recent UAS events and regulatory limitations for counter UAS were held.

UAS VA Brief – Chris Faucett, Severe Accident Modeling and Analysis, SNL

- A presentation of the SNL work supporting NRC's vulnerability analysis from UAS was given.

Human Factors/Reliability Threat Modeling – Jason Morris, Human Factors R&D S&E, SNL

- A presentation of efforts on cognitive modeling for threat was given.

Threat Modeling – Ray Trechter, Interactive System Simulation and Analysis Manager, SNL

- A discussion on SNL's capabilities in adversary and ROWS modeling was given.

EMP Brief – Jason Shelton, Directed Energy Assessments, SNL and Mike Walker, Directed Energy Missions, SNL

- A discussion on threats and vulnerabilities from EMP was held.

3.2. Presentations

The following list of presentations were provided to each of the attendees;

- LWRS Overview – Bruce Halbert
- LWRS Physical Security Initiative Introduction – Mitch McCrory
- NEI Update – David Young
- Sandia Corporate Overview – Sylvia Saltzstein
- Overview of INL Physical Security Research – Vaibhav Yadav
- HAZCADS – Doug Osborn
- EMERALD – Steve Prescott
- International Nuclear Security – Jordan Parks
- INL Nuclear Cyber Research – Shannon Eggers
- Sandia Cyber – Lon Dawson
- Deliberate Motion Algorithms and Water Intake – J.R. Russell
- Human Factors – Jason Morris
- Cyber Security Threat Brief – John Mulder

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4. PSP STAKEHOLDER WORKING GROUP MEETING NOTES

Throughout the meeting, a series of SNL and INL personnel were taking notes to ensure all discussions were captured. This section provides a compilation of the general and detailed notes which were taken.

4.1. General Notes

The following list of general notes which were taken;

- Unattended opening is a priority
 - 2D vs 3D requirements
- Taking credit for ROWS
 - DOE-developed solutions applied to the fleet
- Definition, verification, validation, and NRC approval of performance measure
- Potential pilot for demonstrations
 - ROWS, data fusion, water intakes
- Identifying pilot for going below regulatory requirements using 10CFR 50.90
- 1-year and 2-year milestones to successfully achieve 3+ year mid-term priorities
 - Stakeholder inputs from LWRS working group
- Review of NRC SECY-19-0055
 - Crediting operator actions and law enforcement response
 - Why not credit off-shift response force?
 - Akin to other off-shift personnel manning the TSC
 - MOU with local law enforcement to 'borrow' a bearcat to return
- Review of NEI Security Bounding Time
- Adversary travel speeds
 - Review of DOE data, and methods for achieving site-specific data
- Identify synergy between Physical Security and other LWRS pathways
 - RISA, and Plant Modernization
- Independent spent fuel storage installation (ISFSI) as potential low hanging fruit for pilot
- Drones for patrolling
 - Limitations are with FAA

- Deliberate motion algorithm, data fusion
- Developing knowledge repository at utilities for FoF models, etc.
 - Leverage DOE deep-dive training and workshops on physical security
- Paradigm breaking solutions for relief in everyday task
 - Access control, vehicle inspection
- Sabotage requirement to consider time to irreversible core damage
 - Could better define this out to in-vessel retention or beyond Zirconium metal oxidation
- Consider diminishing adversary capabilities over time
- Review NRC Reg. Guide 5.81
 - Consider including operator actions outside of the control room, FLEX, etc.
- Dynamic analysis will need to be piloted with a known problem
 - A practical bench test

4.2. Detailed Notes

The following are the detailed notes which were taken.

Credit for Active Protection Measures

Develop methodology to determine adversary timelines;

- Adapt and enhance material in NUREG/CR-7145
- Include criteria for adversary travel speeds
- A manual for method and standards using computer modeling
- Methodology should recognize that an adversary timeline may end in neutralization of the adversary
- Establish standards for probabilities of interruption & neutralization (P_I & P_N in NUREG/CR-7145)

Final product should have both a technical basis section and an implementation section with instructions and worksheets appropriate for use by a site target set analyst in the application of Security Bounding Time (SBT)

Credit for law enforcement tactical support to enable operator actions/SBT

Methods to identify target sets where credit for an SBT may be practical

- Times to fuel damage will permit performance of a post-SBT operator action to prevent damage
- Assumptions, case boundaries and simplified approaches for use by site target set analysts
- Identify post-SBT operator actions to include within target sets
- Actions to prevent or mitigate the loss of a target element

Unattended Openings and Protected Areas

Make existing research and testing documentation available to licensee personnel

- Document review may provide a technical basis for a limiting 3-dimensional pathway size
- If needed, conduct additional testing on various pathway sizes and configurations
- Coordinate tests with NRC and licensees to ensure development of useful data

Performance-Base Testing Requirements

Develop a technical basis for using performance/reliability data to inform security equipment testing requirements (e.g., IDS, contraband detection, etc.).

- Include a template/procedure that a licensee could follow for how to use their data to generate new performance-based testing requirements

AI-Driven ROWS

Longer-term action – something like the Samsung SGR-A1.

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5. PRIORITIZATION OF BREAKOUT SESSIONS

During the meeting, two breakout sessions were held to brainstorm near-term and mid-term priorities. This section provides the results and ranking of these sessions. As in Section 6, the following are the acronym definitions for the ‘Topic Group’ column of the tables:

- M&MP = Modeling and Measures of Performance
- ROWS = Remote Operated Weapons Systems
- PAOA = Protected Area Opening Assessment
- ATOF = Adversary Timelines, Operator Actions, and FLEX
- PIDAS = Perimeter Intrusion Detection and Assessment Systems and Detection & Assessment Technology
- REG = Regulation Changes
- OTH = Other items not covered by the above groupings

5.1. Near-Term Priorities

Table 5.1 LWRS Program PSP WG Meeting Near-Term Priorities

Item Name	TOTAL 1st	TOTAL 2nd	TOTAL 3rd	TOTAL Other	Weighted Value	Topic Group
Measure of system effectiveness	6	1	1	0	21	M&MP
Adversary timelines	4	1	0	0	14	ATOF
Deliberate Motion Algorithms (DMA)	2	3	2	1	14	PIDAS
Mobile PIDS; portable detection (fire watch, compensatory measures, etc.)	0	3	3	1	9	PIDAS
3D UAOs; large as technically justifiable/Technical basis/testing of unattended openings	1	2	1	0	8	PAOA
ROWS survivability - what does it realistically take to disable; vulnerability study	0	2	2	0	6	ROWS
Intake/waterway detection and assessment (swimmers, rafts, etc.)	0	2	1	0	5	PIDAS
Review and validation of current target set; inclusion of operator actions and FLEX equipment	0	1	2	0	4	ATOF

Item Name	TOTAL 1st	TOTAL 2nd	TOTAL 3rd	TOTAL Other	Weighted Value	Topic Group
Technical basis for delays and barriers (UAVs, pipes, doors, walls, etc.)	1	0	0	0	3	OTH
Vulnerability assessment best practices	1	0	0	0	3	OTH
Approved methodology site-specific performance measurements	1	0	0	0	3	M&MP
Test data developed and documented (3D openings, wall breaching times, survivability of ROWS)	0	1	0	0	2	OTH
UAS detect/mitigate	0	0	1	0	1	OTH
Risk-informed approach to manning posts (temporary post abandonment to begin rotation, bathroom, etc.)	0	0	1	0	1	OTH
Fire & aim simulations	0		1	0	1	OTH
Access automation	0		1	0	1	OTH
Realism - white paper addressing consequences of successful attack & security really needed	0		1	0	1	REG
Total	16	16	17	2		

5.2. Mid-Term Priorities

Table 5.2 provides the ranked list of mid-term (3-5 years) priorities and the ranking metrics.

Table 5.2 LWRS Program PSP Meeting Mid-Term Priorities

Item Name	TOTAL 1st	TOTAL 2nd	TOTAL 3rd	TOTAL Other	Weighted Value	Topic Group
Target Set optimization; risk-informed approach; deep dive	1	4	1	0	12	M&MP
Measure of effectiveness (protective strategy)	2	2	0	0	10	M&MP
Change to minimum number regulatory requirement; reduction of prescriptive regulation; minimum number of responders	3	0	0	0	9	REG
Drone/UAS patrol/security use	3	0	0	0	9	PIDAS
Approved performance measures; FoF process aligned with DOE & DoD; standardize DOE/NRC metrics (hard performance measure)	2	1	0	0	8	M&MP
Non-lethal denials and quick deployables	0	1	6	1	8	OTH

Item Name	TOTAL 1st	TOTAL 2nd	TOTAL 3rd	TOTAL Other	Weighted Value	Topic Group
Integration of DMA to accepted use	1	2	0	0	7	PIDAS
Crediting use of Operator actions	1	2	0	0	7	ATOF
Crediting use of FLEX equipment	0	3	1	0	7	ATOF
Approved methodology for probability of attack; likelihood of attack	1	0	2	0	5	M&MP
ROWS use and deployment	0	1	2	0	4	ROWS
Non-traditional delay/denial technologies	0	0	3	0	3	OTH
Risk modeling – realism	1	0	0	0	3	M&MP
Rule changes that eliminate specifying number of armed responders	1	0	0	0	3	REG
Survivability of ROWS system	1	0	0	0	3	ROWS
AI in CAS/SAS	1	0	0	0	3	OTH
ISFSI & protective force for optimization	0	1	0	0	2	OTH
Use of operators or shift personnel as officers/responders	0	1	0	0	2	OTH
Autonomous operations	0	1	0	0	2	OTH
Accepted threshold for irreversible core damage/radiological sabotage	0	0	1	0	1	M&MP
Cost-effective tech for early warning detection (i.e. video to eliminate outside controlled area patrols and increase adversary timeline)	0	0	1	0	1	PIDAS
10CFR-73.55 “At All Times” (might tie with measure of effectiveness efforts)	0	0	1	0	1	REG
No PIDS	0	0	1	0	1	OTH
No SAS or have it offsite	0	0	0	1	0	OTH
Locate chemicals outside PA to eliminate vehicle escort	0	0	0	1	0	OTH
Self-healing/protecting Target Sets	0	0	0	1	0	OTH
AI controlled ROWS or drones	0	0	0	1	0	ROWS
Automated vehicle search	0	0	0	1	0	OTH
Automatic disabling of vehicle	0	0	0	1	0	OTH
Total	18	19	19	7		

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6. STAKEHOLDER EMAIL INPUT

This section provides stakeholder input which occurred after the meeting. As in Section 5, the following are the acronym definitions for the ‘Topic Group’ column of the tables:

- M&MP = Modeling and Measures of Performance
- ROWS = Remote Operated Weapons Systems
- PAOA = Protected Area Opening Assessment
- ATOF = Adversary Timelines, Operator Actions, and FLEX
- PIDAS = Perimeter Intrusion Detection and Assessment Systems and Detection & Assessment Technology
- REG = Regulation Changes
- OTH = Other items not covered by the above groupings

6.1. Compiled Ideas from Stakeholder Emails

Table 6.1 provides a compilation of the ideas from follow-up emails. The ‘ID’ number in Table 6.1 corresponds with the ‘ID’ number listed in Table 6.2.

Table 6.1 LWRS Program PSP Meeting Compiled Ideas from Stakeholder Emails

ID	Idea	Topic Group
1	Utilize the USG ROWS data and experience to quantify the business case to overcome the NRC objections	ROWS
2	LWRS to consider the SENTRY II ROWS and US Government ROWS technology.	ROWS
3	Vendor collaboration on the ROWS Safety Basis pilot	ROWS
4	A whitepaper for DOE-NE and the LWRS Working Group and stakeholders explaining the history and evolution of ROWS based on the experiences and data from Sandia, USG, and Precision Remotes to the present systems available	ROWS
5	DMA collaboration with vendor systems which are similar to the DMA discussed and are currently being deployed by DOD. The Sandia DMA added to one of these systems might be of great benefit to non-nuclear physical security systems.	PIDAS

6	Vendor interest in licensing DMA, and additional testing in other real environments.	PIDAS
ID	Idea	Topic Group
7	Propose CRADAs around simulation and training.	OTH
8	Propose visits to vendors for additional follow-on discussions.	OTH
9	Vendor support in determining "Measure of System Effectiveness."	M&MP
10	Conducting an adversary/responder timeline methodology course with a practical application portion.	ATOF
11	Create a Volume II of ADTTM for the industry.	OTH
12	Utilities see benefit in the use of the DMA fusing Radar and Video Motion Detection along our perimeter vehicle barrier system. Various utilities have offered to pilot and/or deploy DMA technologies along with other near-term DOE technologies. Upgrades to security computer systems using COTS systems and leveraging DOE past integration solutions for such systems.	PIDAS
13	Explore viability of a pilot installation of ROWS.	ROWS
14	Detailed discussions on creating and applying adversary timelines and barrier delays; identifying artificialities within FoF applications.	ATOF
15	Unattended openings – data on a pathway restriction in Volume II of ADTTM; a point of contention between NRC and the utilities is. The data within Volume II of the ADTTM can supports proper implementation of delay timelines.	PAOA
16	Linking DMA with a utility's IDS/PIDAS systems to reduce FARs and NARs and applications for early detection.	PIDAS
17	Develop a traversable standard for potential adversary exploitation of a 3D pathway as a route to a target. The NRC is open to establishing a new standard for a 3D opening; pathways less than an established standard would be considered as non-traversable and would require minimal protective measures. This may be achievable using existing test data and human factors engineering (through modeling) or by actual performance testing with live test subjects.	PAOA

18	Establish a method or model for determining adversary timeline across varied conditions (e.g., open ground, under engagement, encountering barriers, etc.) that accounts for fatigue of the adversary over time.	ATOF
ID	Idea	Topic Group
19	Complete on-going ROWS safety basis. Additionally, conduct modeling or testing to determine survivability of a ROWS as currently designed and with ballistic protection.	ROWS
20	Develop a model or tool to measure system effectiveness of a licensee's physical security program.	M&MP
21	Continue development and testing of DMA using multiple sensor technologies for use by licensees currently used in their sensor systems.	PIDAS
22	<p><u>Credit for Active Protection Measures</u> Develop methodology to determine adversary timelines; Adapt and enhance material in NUREG/CR-7145 Include criteria for adversary travel speeds Create a manual for the method and develop standards for computer modeling</p> <p>Methodology should recognize that an adversary timeline may end in neutralization of the adversary; Establish standards for probabilities of interruption & neutralization (P_I & P_N) used in NUREG/CR-7145</p> <p>Final product should have both a technical basis section and an implementation section with instructions and worksheets, as appropriate, for use by a site target set analyst in determining security bounding time (SBT)</p>	ATOF

23	<p><u>Credit for law enforcement tactical support to enable operator actions/SBT</u> Methods to identify target sets where credit for an SBT may be practical; Realistic timelines to fuel damage will permit performance of a post-SBT operator action to preclude damage Assumptions, case boundaries, and simplified approaches for use by site target set analysts</p> <p>Identify post-SBT operator actions to include within target set analysis; Actions to prevent, preclude, or mitigate the loss of a target set element</p>	ATOF
ID	Idea	Topic Group
24	<p><u>Unattended Protected Area Openings</u> Make existing research and testing documentation available to licensee personnel; Document review may provide a technical basis for a limiting 3D pathway size</p> <p>If needed, conduct additional testing on various pathway sizes and configurations; Coordinate tests with NRC and licensees to ensure development of useful data</p>	PAOA
25	<p><u>Performance-Base Testing Requirements</u> Develop a technical basis for using performance/reliability data to inform security equipment testing requirements (e.g., IDS, contraband detection, etc.). Include a template/procedure that a licensee could follow on how to use their site-specific data to generate new performance-based testing requirements.</p>	PIDAS
26	<p><u>AI-Driven ROWS</u> Longer-term action; something like the Samsung SGR-A1.</p>	ROWS

6.2. Stakeholder Discussions on Specific Ideas

Table 6.2 provides a compilation of the discussions for specific ideas from follow-up emails. The 'ID' number in Table 6.2 corresponds with the 'ID' number listed in Table 6.1.

Table 6.2 LWRS Program PSP Meeting Stakeholder Specific Ideas

ID	Continued stakeholder discussions: ID number ties back to Table 6.1	Topic Group
17	<p>Why: The NRC is open to establishing a new standard for a 3D opening; pathways less than an established standard would be considered as non-traversable and would require minimal protective measures. Those at or above the established standard would require additional evaluation by a licensee to determine if the pathway is traversable or non-traversable based on environmental conditions inside the 3D opening (e.g., bends, rise, and fall within the pathway, etc.). After review of the Access Delay Tech Transfer Manual (ADTTM) Volume II, the industry and NRC could be close to reaching agreement on a revised standard for underground pathways. However, the ADTTM manual did not address some specific 3D openings; consequently, additional modeling or testing would help inform this initiative. Any change in the current standard for 3D pathways will result in actual cost savings to licensees. Moreover, implementing this change applies a “risk-informed” approach to addressing 3D pathways; in turn, this supports the industry and NRC’s initiative to move from a prescriptive based standard to a risk-informed standard for physical protection requirements.</p> <p>Current Status: Licensees currently implement protective measures for 3D pathways based on the standard for 2D openings. The current Sandia ADTTM Volumes I & II contain information that likely support licensee and NRC efforts to move from a prescriptive physical security standard for securing 3D pathways to a risk-informed physical security standard. For example, Table B-1 in Volume II references a specific diameter hole through a concrete wall of determined thickness that is considered non-traversable; however, that table appears to be applied to a 2D opening and not a 3D pathway.</p>	PAOA
18	<p>Why: The industry and NRC currently utilize an adversary speed that is derived from the industry Composite Adversary Force (CAF). In turn, this results in licensees placing more responders than what may be necessary if a realistic timeline to targets were developed. Implementation of realistic adversary timelines will likely result in licensees being able to reduce security posts while maintaining an equal or greater level of protection for target set equipment.</p> <p>Current Status: Existing standard for adversary movement is based on a requirement for the industry CAF and does not consider an adversary encountering responders, moving with mission equipment, or the impact of fatigue on an adversary over time required to execute the mission.</p>	ATOF

ID	Continued stakeholder discussions: ID number ties back to Table 6.1	Topic Group
19	<p>Why: ROWS are a force multiplier and provide licensees with the potential to significantly modify existing protective strategies using fewer posted security personnel while providing a greater level of security for target set equipment. However, most licensees are hesitant to fully invest in ROWS because of two concerns;</p> <ol style="list-style-type: none"> 1. The perception that ROWS are unsafe or are less safe than a security officer behind a weapon. The on-going safety basis will address this concern once it is completed. 2. Survivability of the ROWS under adversary action is perhaps a more significant concern regarding licensee investment into ROWS. Traditionally, during NRC conducted FoF inspections at stations that have installed ROWS, the NRC has contended that a ROWS can be easily disabled or destroyed by an adversary. <p>Consequently, licensees have been hesitant to make a major investment such as ROWS and credit them as part of their protective strategy given that under rules of engagement applied during NRC FoF inspections.</p> <p>Current Status: ROWS have matured and currently provide a commercial off-the-shelf force multiplier that would significantly enhance effectiveness of most, if not all, current commercial nuclear power reactor site protective strategies. ROWS are deployed by the US Government, however, commercial reactor sites have been hesitant to install and implement ROWS as part of their credited protective strategy based on safety concerns as well as return on investment.</p>	ROWS
20	<p>Why: No common or standardized approach for determining System Effectiveness for a site's protective strategy, leading to overly conservative, expensive, and discretely different solutions. Establishing and implementing a mutually agreed upon standard is needed in order to achieve the maximum level of system efficiency in a licensee's physical security program.</p> <p>Current Status: Licensees are currently using many different methods to assess the system effectiveness of their protective strategies. These include two combat simulation or pathway analysis computer modeling tools, peer assessments, limited and full scope FoF exercises. However, none of the current methods integrates with safety system modeling tools used to determine effects of damaged/destroyed equipment and actions taken by operators to mitigate lost equipment.</p>	M&MP
21	<p>Why: New technology which takes identification and assessment of known threats to the next level.</p> <p>Current Status: Technology is not deployed operationally at this time.</p>	PIDAS
22	Please review the NEI letter recently sent to the ANS/ASME Joint Committee on Nuclear Risk Management (JCNRM).	ATOF

7. MEETING SUMMARY

The LWRS Program Physical Security Pathway (PSP) wrapped up the fiscal year with the first meeting of the Physical Security Stakeholder working group. It was held September 10-12, 2019 at Sandia National Laboratories (SNL). This working group is comprised of nuclear enterprise physical security stakeholders. The meeting included over 10 Utilities representing roughly 60 nuclear power plants, two staff from the Nuclear Regulatory Commission (NRC), physical security vendors, the Nuclear Energy Institute (NEI), the Electric Power Research Institute (EPRI), and staff from SNL and Idaho National Laboratory (INL). The working group was established with the objectives of providing stakeholder feedback to the LWRS PSP on their research and development (R&D) needs and priorities, socializing the progress of PSP initiatives, and identifying opportunities for additional engagement and participation of stakeholders in the PSP research activities. The working group also provided a forum for physical security professionals to share common experiences and recommend prioritized activities based on their needs.

The three-day meeting started by giving working group members an overview and purpose of the LWRS Program by the LWRS National Technical Director, Bruce P. Hallbert, and followed by an overview of the PSP objectives by the pathway lead, F. Mitch McCrory. The program overview was followed by security related presentations from NRC, NEI, and EPRI. Afterwards, SNL and INL presented various physical security related capabilities and research of potential interest to the working group members in areas such as advanced risk methods research relative to physical security, deliberate motion algorithms, remote operated weapon systems, advanced force-on-force modeling and simulation, and cyber security research related to physical security. The meeting also had two breakout sessions where the stakeholders focused on prioritizing and brainstorming around near-term (<3 years) and mid-term (3-5 years) research areas that have the most potential to benefit the industry. Proposed areas of interest include:

- Assess benefits from proposed enhancements, novel mitigation strategies, and potential changes to best practices, guides, or regulation.
 - A near-term priority is creating metrics to determine measures of system effectiveness for a security posture.
- Evaluation and potential deployment of DOE-developed security technologies.
 - Near-term priorities are deliberate motion algorithms, mobile perimeter intrusion and detection system.
- R&D of risk-informed techniques for physical security to account for a dynamic adversary.
 - A mid-term priority is target set optimization
- R&D of advanced modeling and simulation tools to better inform physical security scenarios.
- Enhance and provide a technical basis for stakeholders to employ new methods, tools, and technologies to achieve optimized physical security.

This first-time meeting between utilities, vendors, NRC, and DOE physical security experts generated a lot of excitement around near-term potential that the LWRS Program can have on physical security for the nuclear industry stakeholders. The working group agreed that they would like to have two stakeholder meetings a year initially and a follow up meeting in November 2019 to further explore ideas generated. The November meeting will provide input to the PSP as we head in to FY20 and prioritize tasks. The working group also provided a venue for connections to be made on LWRS pilot programs and collaborations.

8. REFERENCES

- [1] Pacific Gas & Electric Company, “PG&E Company 2018 Nuclear Decommissioning Costs Triennial Proceeding Prepared Testimony – Volume 1,” December 13, 2018.
<https://analysis.nuclearenergyinsider.com/pge-seeks-decommissioning-head-start-cost-estimates-rise>
- [2] Nuclear Energy Institute, “Delivering the Nuclear Promise,” 2016-2019.
<https://www.nei.org/resources/delivering-the-nuclear-promise>

APPENDIX A. PSP STAKEHOLDER WORKING GROUP AGENDA

September 10-12, 2019 – Sandia National Laboratories, Albuquerque, New Mexico

Attendees: DOE-NE
US Nuclear Utility Security Directors
Nuclear Energy Institute (NEI)
Electric Power Research Institute (EPRI)
Physical Security Vendors
U.S. Nuclear Regulatory Commission (NRC)

Hosts: Mitch McCrory, LWRS Physical Security Initiative, SNL

Tuesday, September 10, 2019

Location: 822/105

7:15 am **Meet at Innovation Parkway Office Center (IPOC)**
1611 Innovation Parkway, Albuquerque, NM 87123

7:15 am – 7:45 am **Badging at IPOC**

7:45 am **Bus Transport to 822/105**

8:00 am – 8:15 am **Safety & Security Brief**
Coffee and Introductions

8:15 am – 8:30 am **Welcome**
Rodney Wilson, Director Global Security and Cooperation, SNL

8:30 am – 9:00 am **LWRS Overview**
Alison Hahn, LWRS Federal Programs Manager, DOE-NE
Bruce Hallbert, LWRS National Technical Director, INL

9:00 am – 9:30 am **Overview of Physical Security Pathway (PSP) Program Plan**
Mitch McCrory, LWRS Physical Security Pathway, SNL

9:30 am – 10:00 am **LWRS PSI Working Group Charter Review**
Mitch McCrory, LWRS Physical Security Pathway, SNL

10:00 am – 10:15 am **Break**

10:15 am – 10:45 am **NEI Security Working Group Update**
David Young, Nuclear Security and Incident Preparedness Technical Advisor

10:45 am – 11:15 am **NRC Discussion on Physical Security Regulatory Status and Needs**
Michele Sampson, Reactor Security Branch Chief, NRC

Lab Capability Examples 1

11:15 am – 11:45 am **Sandia National Laboratories Overview**
Sylvia Saltzstein, Nuclear Energy Safety and Security, SNL

11:45 am – 12:30 pm **No Host Lunch**

12:30 pm – 2:30 pm *Overview of INL PSI Research – Vaibhav Yadav, LWRS Principal Investigator*
HAZCADS – Doug Osborn, Int'l Nuclear Security Engineering, SNL
EMERALD – Steve Prescott, Software Analysis/Integration Engineer, INL
International Nuclear Security – Jordan Parks, Int'l Nuclear Security Engineering, SNL

2:30 pm – 2:45 pm **Break**

2:45 pm – 3:00 pm **Bus Transport to 895/1015**

3:00 pm – 5:00 pm **ROWS Presentation and Bldg. 895 Facility Tour**
Kristopher Klingler, High Consequence Robotic Systems Manager, SNL

5:00 pm **Adjourn: Bus Transport to IPOC**

Wednesday, September 11, 2019

Location: 905/103E

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7:45 am **Meet at Innovation Parkway Office Center (IPOC)**
1611 Innovation Parkway, Albuquerque, NM 87123

8:00 am – 9:45 am **Safety & Security Brief**
Tours: ISF and STEC Facilities
Gregory Baum, Int'l Nuclear Sec. Engineering Program/Project Lead, SNL

9:45 am **Bus Transport to 905/103E**

Lab Capabilities Panel

10:00 am – 11:45 am *INL Nuclear Cyber Research – Shannon Eggers, Cybercore, INL*
Sandia Cyber – Lon Dawson, Energy Security R&D S&E, SNL

Deliberate Motion Algorithms and Water Intake – JR Russell, Technology Development, SNL

- 12:00 pm – 12:30 pm **No Host Lunch**
- 12:30 pm – 1:30 pm **Breakout Session 1: Priorities**
- 1:30 pm – 2:00 pm **Report Out**
Open Discussion
- 2:00 pm – 2:15 pm **Break**
- 2:15 pm – 3:00 pm **Breakout Session 2: Brainstorm Out of the Box Thinking**
- 3:00 pm – 3:15 pm **Report Out**
Open Discussion
- 3:15 pm – 4:00 pm **Feedback on Charter and Working Group Logistics**
Open Discussion
- 4:00 pm – 4:30 pm **Closing Remarks**
Alison Hahn, LWRS Federal Programs Manager, DOE-NE
Bruce Hallbert, LWRS National Technical Director, INL
Mitch McCrory, LWRS Physical Security Pathway, SNL
- 4:30 pm **Adjourn: Bus Transport to IPOC**

Thursday, September 12, 2019 – Special Session and Threat Brief¹

Location: 810/C117 and 962/3033

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- 7:30 am **Meet at Innovation Parkway Office Center (IPOC)**
1611 Innovation Parkway, Albuquerque, NM 87123
- 7:45 am **Bus Transport to 810/C117**
- 8:00 am – 8:15 am **Safety & Security Brief**
Overview of Objectives
Doug Osborn, Int'l Nuclear Security Engineering R&D S&E, SNL
- 8:00 am – 9:30 am **Access Delay Tech Transfer Volume II**

¹ The September 12th briefing requires a DOE or NRC-L clearance; limited attendance and is based on 'need to know'

Chad Monthan, Access Delay and Struct. Assessment Manager, SNL

- 9:30am – 10:00 am **Cyber Security Threat Brief**
John Mulder, Critical Infrastructure Systems, SNL
- 10:00 am – 10:45 am **UAS Threat Brief**
Daniel Small, Robotics and Contr-Robotics R&D S&E, SNL
David Novick, Robotics and Contr-Robotics R&D S&E, SNL
- 10:45 am – 11:15 am **UAS VA Brief**
Chris Faucett, Severe Accident Modeling and Analysis, SNL
- 11:15 pm – 12:00 pm **Human Factors/Reliability Threat Modeling**
Jason Morris, Human Factors R&D S&E, SNL
- 12:00 pm **Lunch**
- 12:15 pm – 1:00 pm **Threat Modeling**
Ray Trechter, Interactive Sys. Simulation and Analysis Manager, SNL
- 1:00 pm – 2:30 pm **C109 Technology Tour**
John Kiegel, Deputy Research, Programs, Ops. Technical BD Specialist, SNL
- 2:30 pm **Bus Transport to Bldg. 962**
- Location: 962/3033**
- 2:45 pm – 3:15 pm **EMP Brief**
Jason Shelton, Directed Energy Assessments, SNL
Mike Walker, Directed Energy Missions, SNL
- 3:15 pm – 3:45 pm **Closeout Discussion**
- 3:45 pm **Dismiss: Bus Transport to IPOC**

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