



ADVANCED REACTOR SAFEGUARDS & SECURITY

Security-by-Design for MSR

DOE-ARSS 2024 Spring Program Review

PRESENTED BY

Alan Evans – Sandia National Laboratories

SAND2024-05627PE

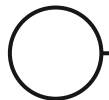
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.



Overview



- Previous Designs and Lessons Learned
- PPS Design Process
- Physical Protection System Components
- Response Force Posture
- Initial Staffing Plan
- Initial Results

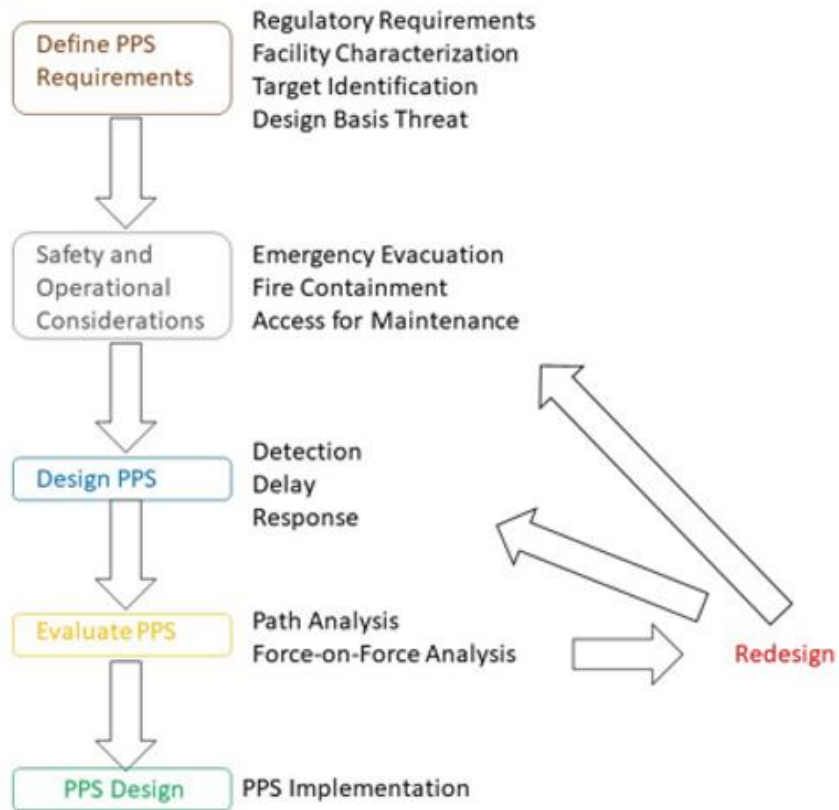


Previous Design Work and Impact on Current Design



Previous Work	Impact
Multiple Buildings for Multiple Reactors	Create multiple adversary pathways and require larger response teams to protect against adversary attack scenarios
Vehicle-Borne Explosive Devices	Required explosive analysis to protect the building and protect responders in external positions which created larger vehicle barrier systems
External Response Towers	Created potential issues during shift change or position rotations as responders could be exposed to adversary fire
Compensatory Measures for System Failure	Required redundant intrusion detection system capabilities and led to benefit of responders in position to see the perimeter as a compensatory measure
Offsite Response	Large amounts of delay were needed and drastically impacted the site layout
Facility Design Before Integrating Security	Required the security system to form to the site layout and target locations and did not create an efficient security system

PPS Design Process

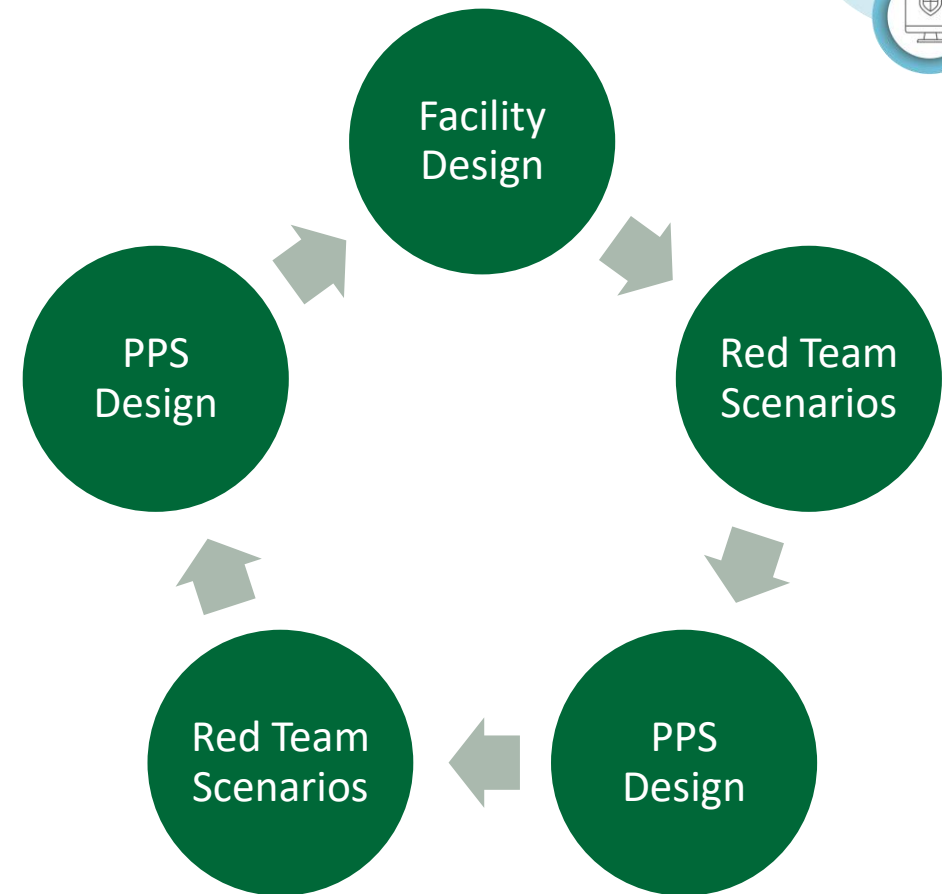


- A group of SMEs was used to
 - Design the reactor, safety and operational systems
 - Conduct a virtual meeting to develop the plant layout to integrate safety, operations, and security
- A large tabletop exercise was conducted to
 - Design the intrusion detection system
 - Design the response strategy
 - Design compensatory measures for system failures
 - Design and integrate intrusion, detection, and access delay in a cost effective manner to reduce overall staffing headcounts and costs

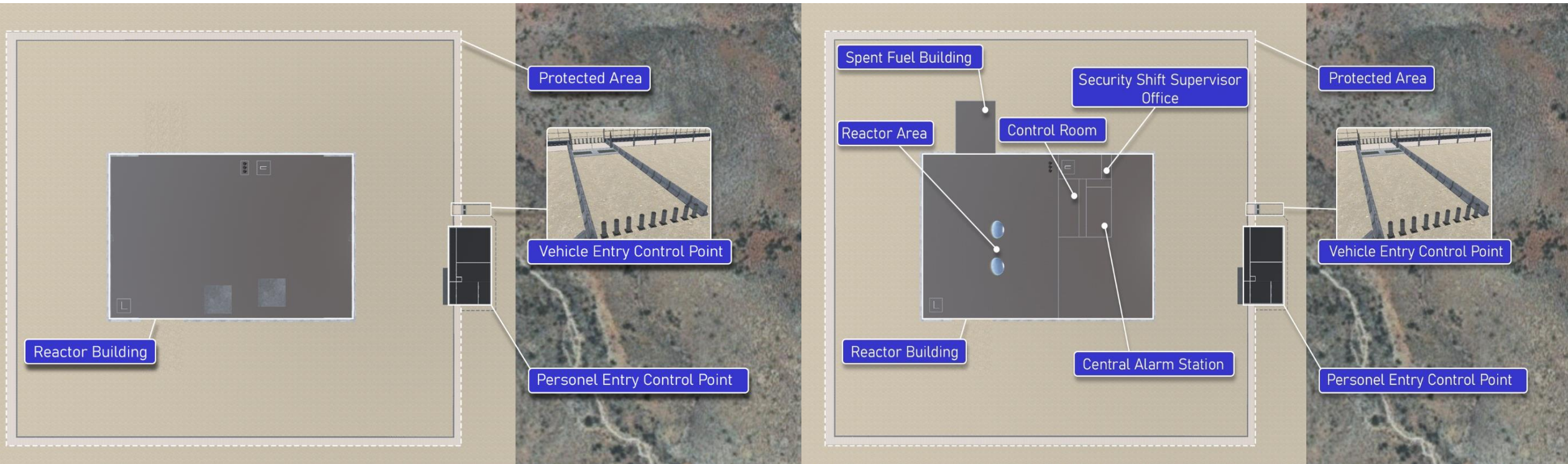


Tabletop Design Methodology Process

- Once an initial facility layout is created a red team is used to identify how they would attack the facility
- Once the adversary attack plan is identified PPS elements (detection, delay, response) are placed into the model and the adversary team develops a new attack scenario
- This process continues until the group of subject matter experts believe that a PPS has been designed to mitigate multiple adversary attacks
- **It is important that cost savings always be in mind and the tradeoff spaces for construction, operation, security, and safety are considered**

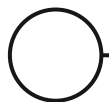


MSR Facility Design

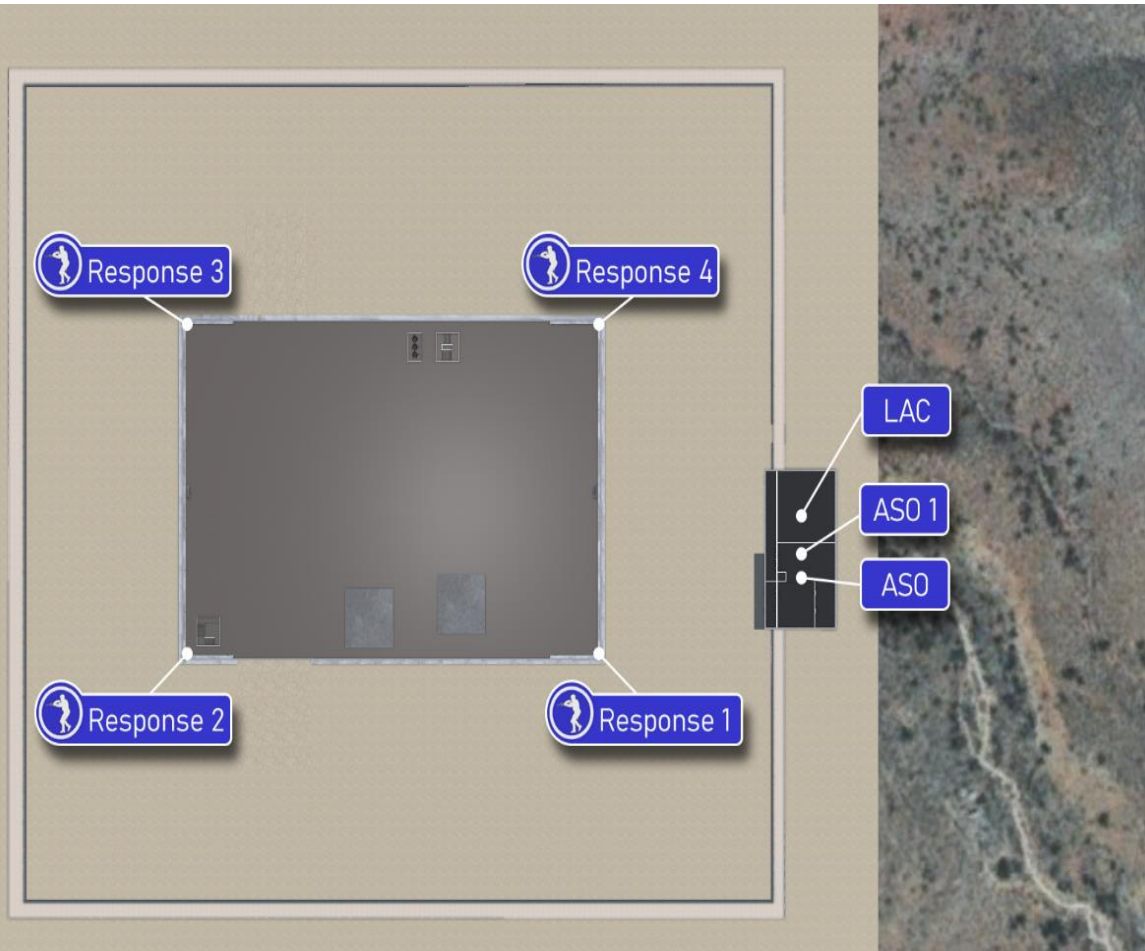


Above-Grade

Below-Grade



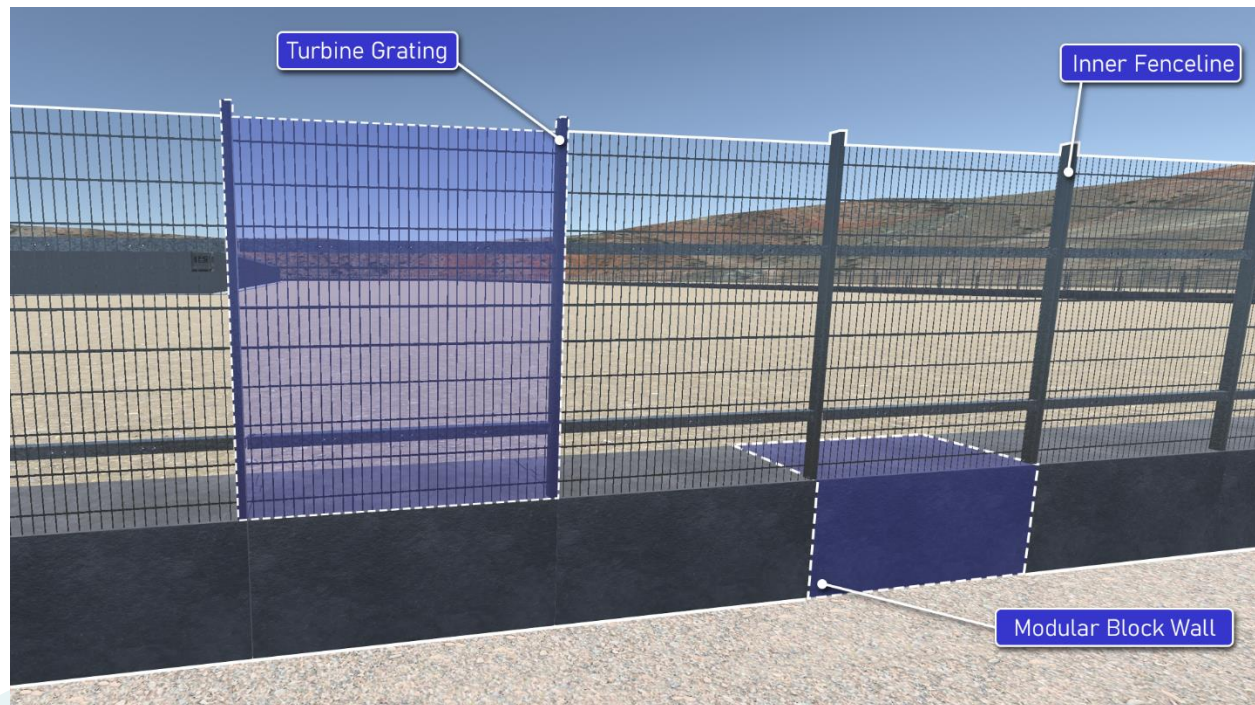
Response Plan



- “Defend the castle” methodology was applied
- Response force is in protected positions that are elevated
- Require the adversaries to cross lots of open space
- Response force can engage adversaries internally and externally
 - Adding a layer of defense-in-depth
- Response force is in positions with protection against vehicle-borne explosives

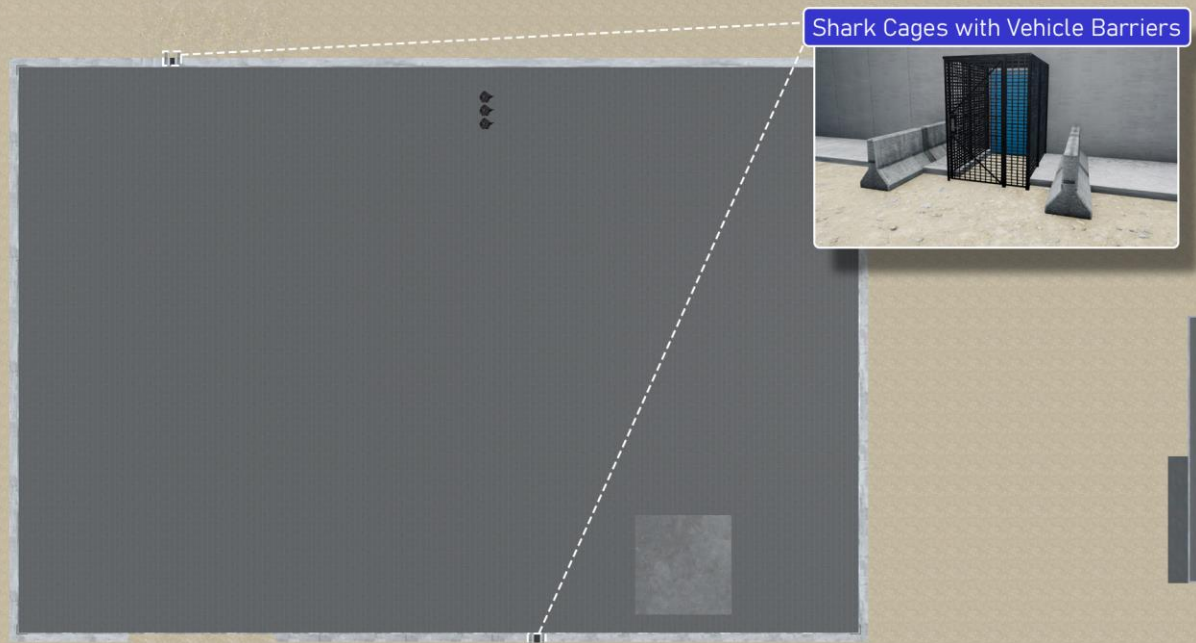


Unique PPS Components

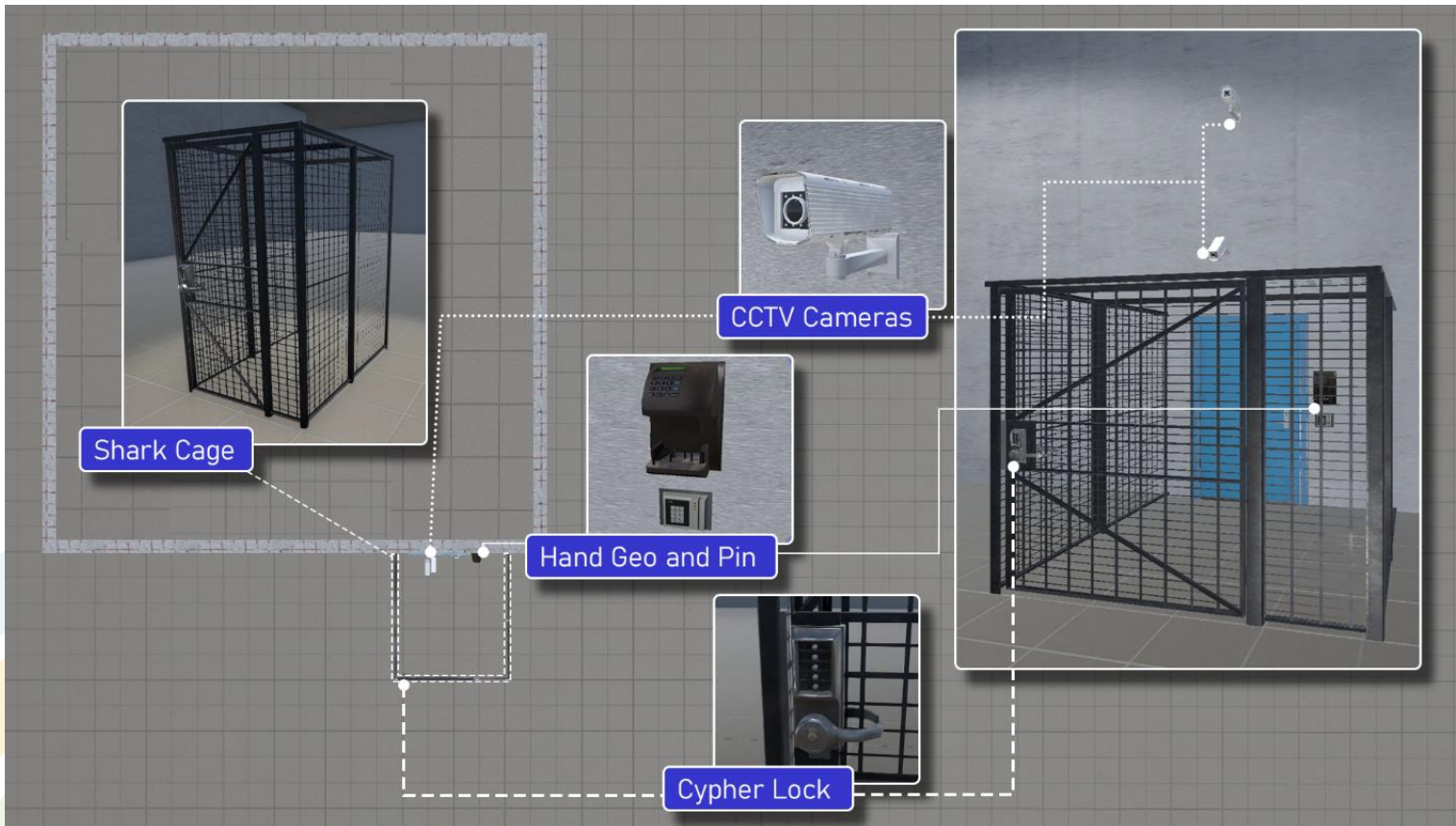


- The vehicle barrier system is robust against hand tools and power tools
- Requires large amounts of explosives to breach
- Integrated into the vehicle barrier system
- Exposes adversaries to response positions

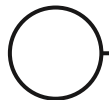
- Building entry points were designed with “shark cages”
- Exposes the adversaries longer when attempting to enter the building
- Vehicle barriers prevent insider threats from destroying the “shark cages”



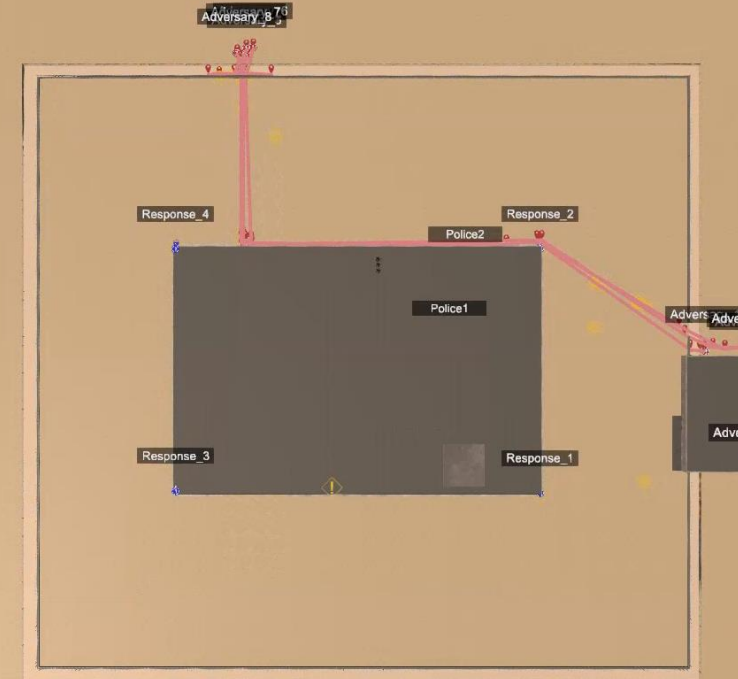
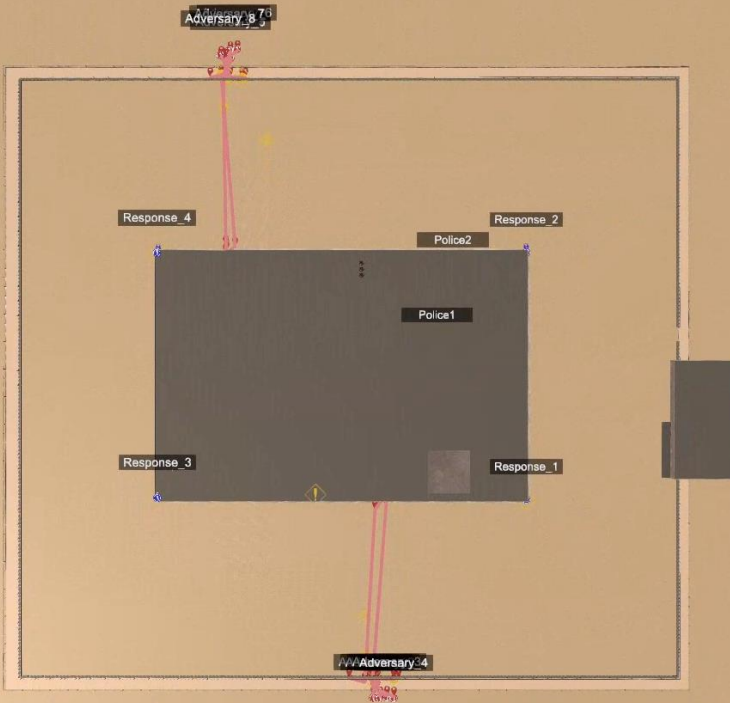
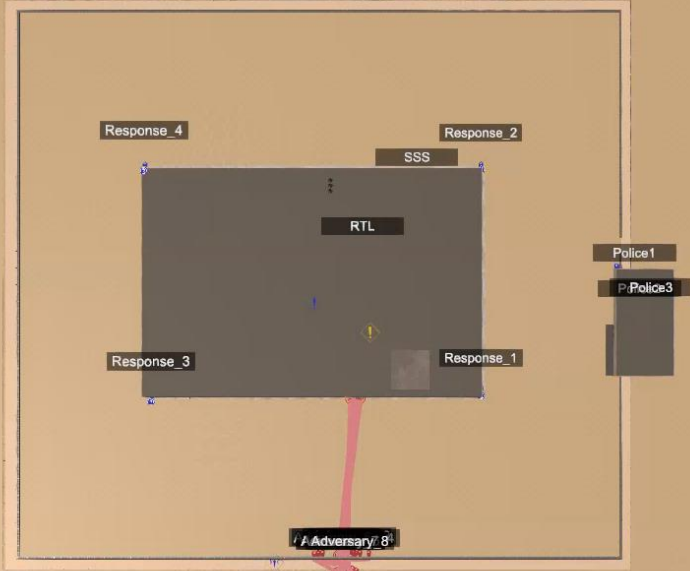
Unique PPS Components



- Response force positions allow them to engage internally to the building as well as externally
- “Shark cages” were placed at all vital area access points to the below-grade
- Exposes adversaries for longer
- Requires large amounts of explosives to breach
- Can add active delay features to increase adversary task time and expose the adversaries for longer periods of time



Adversary Attack Scenarios



- Adversary attack scenarios were
- Three adversary attack scenarios were analyzed
- Adversaries ranged from groups of 4-8
- Adversaries acted in split teams and in one large group

Tabletop Results – Scenario One



Number of Adversaries	Engagement Number	Number of Adversaries in Engagement	Number of Responders	Blue Wins	Red Wins	Internal or External Engagement
8	1	8	2	64	936	External
	2	6	2	924	76	Internal
7	1	7	2	575	425	External
	2	2	2	999	1	Internal
6	1	6	2	554	446	External
	2	3	2	706	294	Internal
5	1	5	2	768	214	External
	2	3	2	996	4	Internal
4	1	4	2	946	54	External

Tabletop Results – Scenario Two



Number of Adversaries	Engagement Number	Number of Adversaries in Engagement	Number of Responders	Blue Wins	Red Wins	Internal or External Engagement
8	1	4	2	936	64	External
	2	4	2	947	53	External
7	1	3	2	985	15	External
	2	4	2	947	53	External
6	1	3	2	985	15	External
	2	3	2	990	10	External
5	1	2	2	993	7	External
	2	3	2	990	10	External
4	1	2	2	993	7	External
	2	2	2	998	2	External



Tabletop Results – Scenario Three

Number of Adversaries	Engagement Number	Number if Adversaries in Engagement	Number of Responders	Blue Wins	Red Wins	Internal or External Engagement
8	1	1	1	923	77	External
	2	4	2	874	126	External
	3	3	2	997	3	External
7	1	1	1	923	77	External
	2	3	2	983	17	External
	3	3	2	997	3	External
6	1	3	2	983	17	External
	2	3	1	844	156	External
5	1	2	2	996	4	External
	2	3	1	844	156	External
4	1	2	2	996	4	External
	2	2	1	1000	0	External

Staffing Headcount



Efficient PPS Design Staffing Headcount

Current NRC Approach Staffing Headcount

Position	1 Shift	24/7 FTE
Response Team Lead	1	4
Security Shift Supervisor	1	4
Field Supervisor	1	4
Last Access Control	1	4
Armed Security Officer	2	8
Responders	4	16
Total	10	40

Position	1 Shift	24/7 FTE
Response Team Lead	1	4
Security Shift Supervisor	2	8
Field Supervisor	1	4
Last Access Control	1	4
Armed Security Officer	4	16
Responders	10	40
OCA Rover	1	4
Total	20	80

Excludes technical security, performance testing, and maintenance personnel

Results and Discussion



- **General reduction from 80 to 40 staff using this design methodology and exemptions to 10 CFR 73.55**
- Using a “protecting the castle” method created inherent protections to the facility
 - Engagement with adversaries external and internal to the building
 - Large standoff distances up to the building skins
 - Multiple gun ports for each responder
- Robust protected area barrier increases adversary exposure
- Shark cages at building entrances and vital area entries exposes adversaries to response force for longer
- One square building improves response force effectiveness and could lead to overall smaller security staffing requirements

