



Sandia National Laboratories (SNL) and Japan Nuclear Energy Safety Organization (JNES) Meeting

October 2012



Sandia's People, Location and Budget

- On-site workforce: 11,876
- Regular employees: 9,122

Major locations

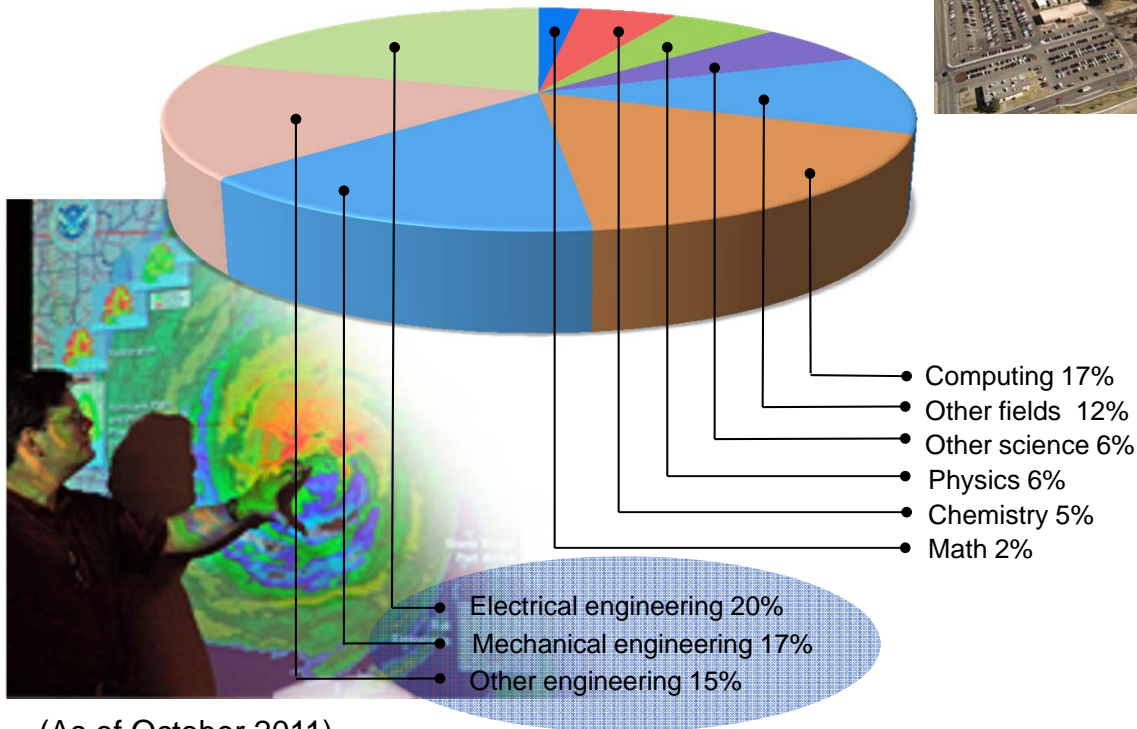
Albuquerque, New Mexico



Livermore, California



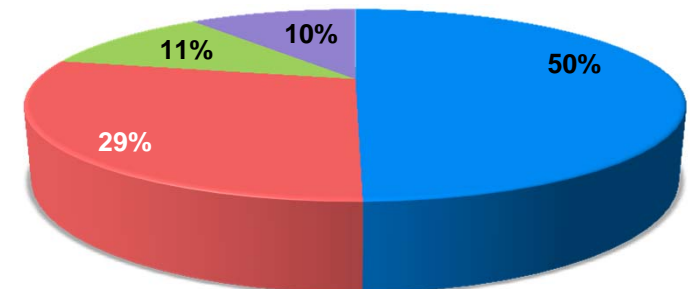
Technical staff (4,557) by discipline



(As of October 2011)

FY11 Operating Revenue

\$2.4 billion





Energy, Climate, and Infrastructure Security

Program Areas

- Infrastructure Security
- Energy Security
- Climate Security
- Enabling Capabilities

Areas of Expertise

- Modeling & Analysis, Cyber, Electricity Distribution, and Energy Assurance
- Renewables, Energy Efficiency, Energy for Transportation, and Nuclear Energy Systems
- Sensing & Monitoring, Carbon Capture, Sequestration, Modeling and Analysis, and Water
- Discovery Science & Engineering, Systems Analysis, and Regulatory & Policy





International, Homeland, and Nuclear Security

Program Areas

- **Critical Asset Protection**
- **Global Security**
- **Homeland Defense and Force Protection**
- **Homeland Security**

Areas of Expertise

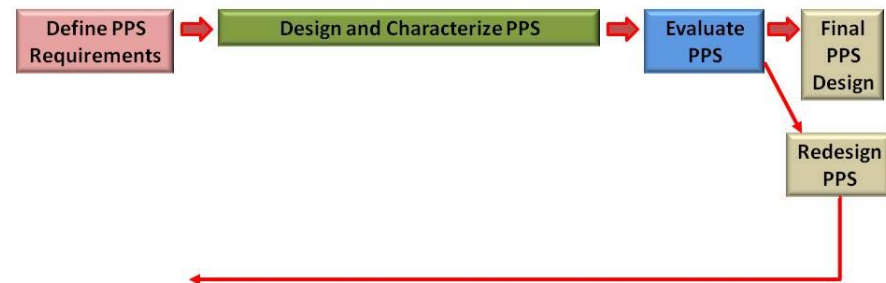
- Countering Bioterrorism
- Nuclear, Radiological, and Chemical Risk Reduction
- Nonproliferation and Arms Control
- Physical Security
- Emergency Response
- Systems Analysis and Engineering
- Border Security
- Aviation and Airworthiness Security





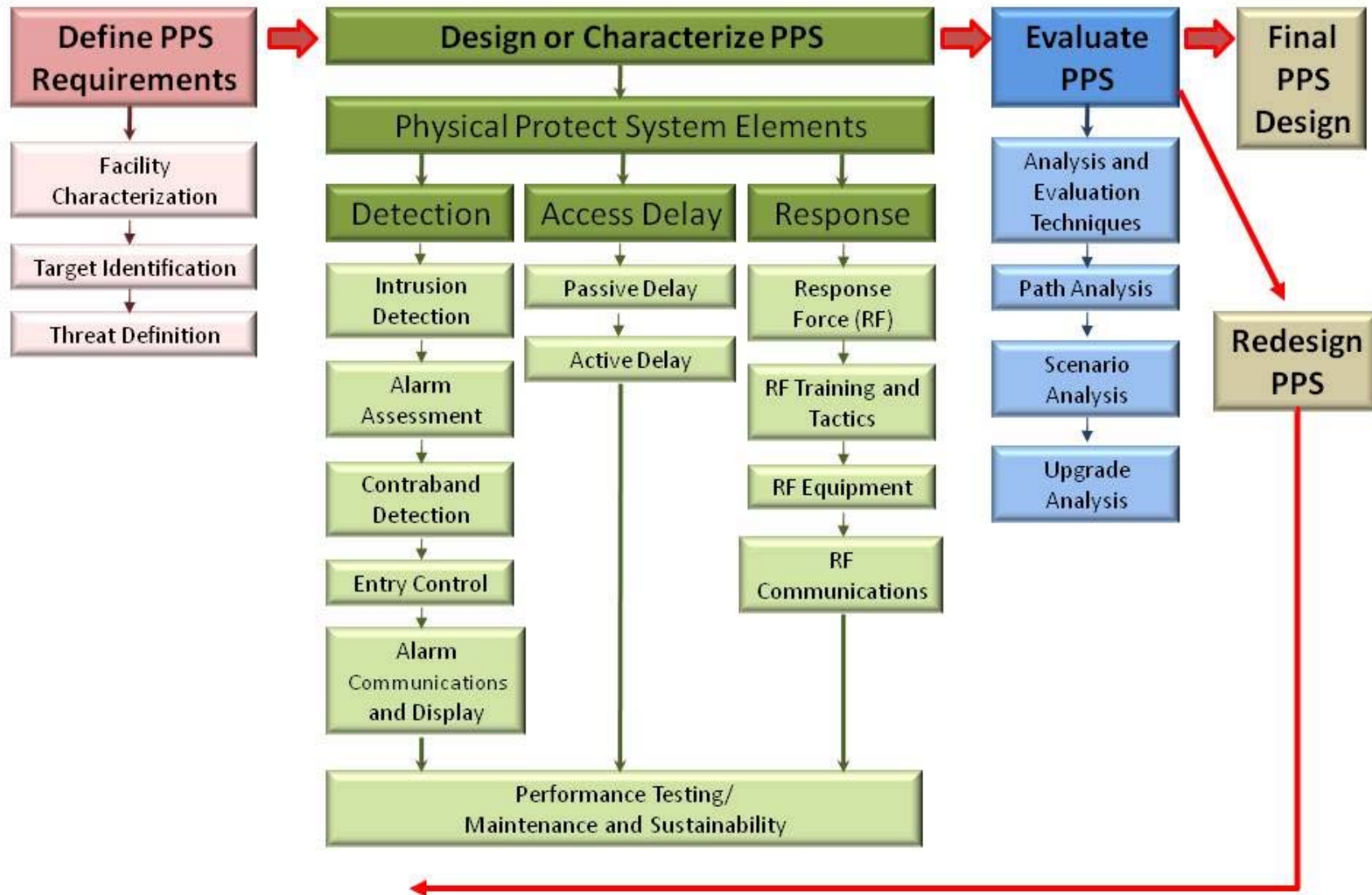
Physical Protection System (PPS) Methodology Basics

- Methodology is performance-based
- Uses system engineering approach
- Design and Evaluation Process (DEPO) requires four steps:
 1. Define PPS requirements
 2. Design or characterize PPS
 3. Evaluate PPS
 4. Finalize or redesign PPS design





Design and Evaluation Process (DEPO)



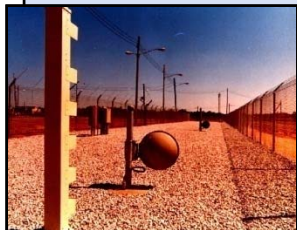


Basic PPS Functions

Physical Protection System Functions

Detection

- **Intrusion Sensing**
 - Exterior Sensors
 - Interior Sensors
- **Contraband Detection**
- **Entry Control**
- **Alarm Assessment**
- **Alarm Communication and Display**



Delay

- **Passive Barriers**
- **Active Barriers**



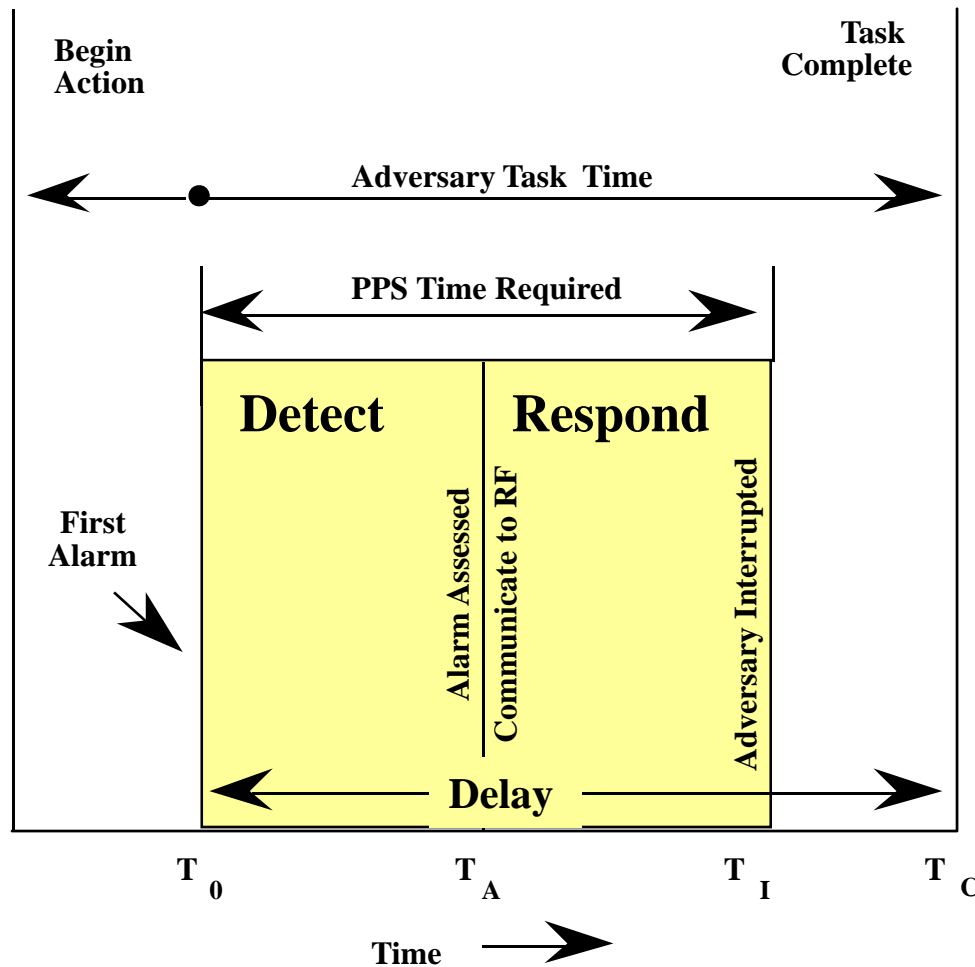
Response

- **Guards, Response Force**
- **Interruption**
 - Communication to RF
 - Deployment of RF
- **Neutralization**





Adversary Task Time vs. PPS Time Requirements



T_0 = First alarm occurs

T_A = The time at which the alarm is assessed to be valid

T_I = The time at which the response force interrupts adversary actions

T_C = Adversary task completion time



Access Delay Definition

- **Access Delay** — The elements designed to slow down an adversary, **after they have been detected**, by use of fixed barriers, dispensable barriers, or responders





Three Elements of Access Delay



Fixed or Passive Barriers

- In place, fail secure
- Commercially available
- Weak against explosives
- Operational impacts



Dispensable Barriers

- Compact, rapidly deployed
- Maximize delay at target
- Somewhat threat independent
- Safety concerns



Response Force

- Flexible
- Sensitive to numbers
- Subject to compromise
- Continuous operational costs

Effective Access Delay Systems



Response Force Definitions

- **Guard Forces** — Persons entrusted with responsibility for patrolling, monitoring, assessing, escorting individuals during transport, controlling access, and/or providing initial response
- **Response Forces** — Persons, on-site or off-site, who are armed and appropriately equipped and trained to counter an attempted *unauthorized removal* of critical assets or an act of *sabotage*





Types of Response

- Two types of response used to counter attempted *unauthorized removal (theft)* of critical assets or act of *sabotage*
 - **Interruption** – Successful arrival of response forces at an appropriate location to stop the adversary
 - Communication
 - Timely deployment of RF
 - Tactical requirements / training (survivability)
 - **Neutralization** – When response force kills, captures, or causes adversary to flee before adversary is able to complete the task
 - Appropriate use of force
 - Proper use of weapons and equipment

Right time
Right place



Example Fighting Positions



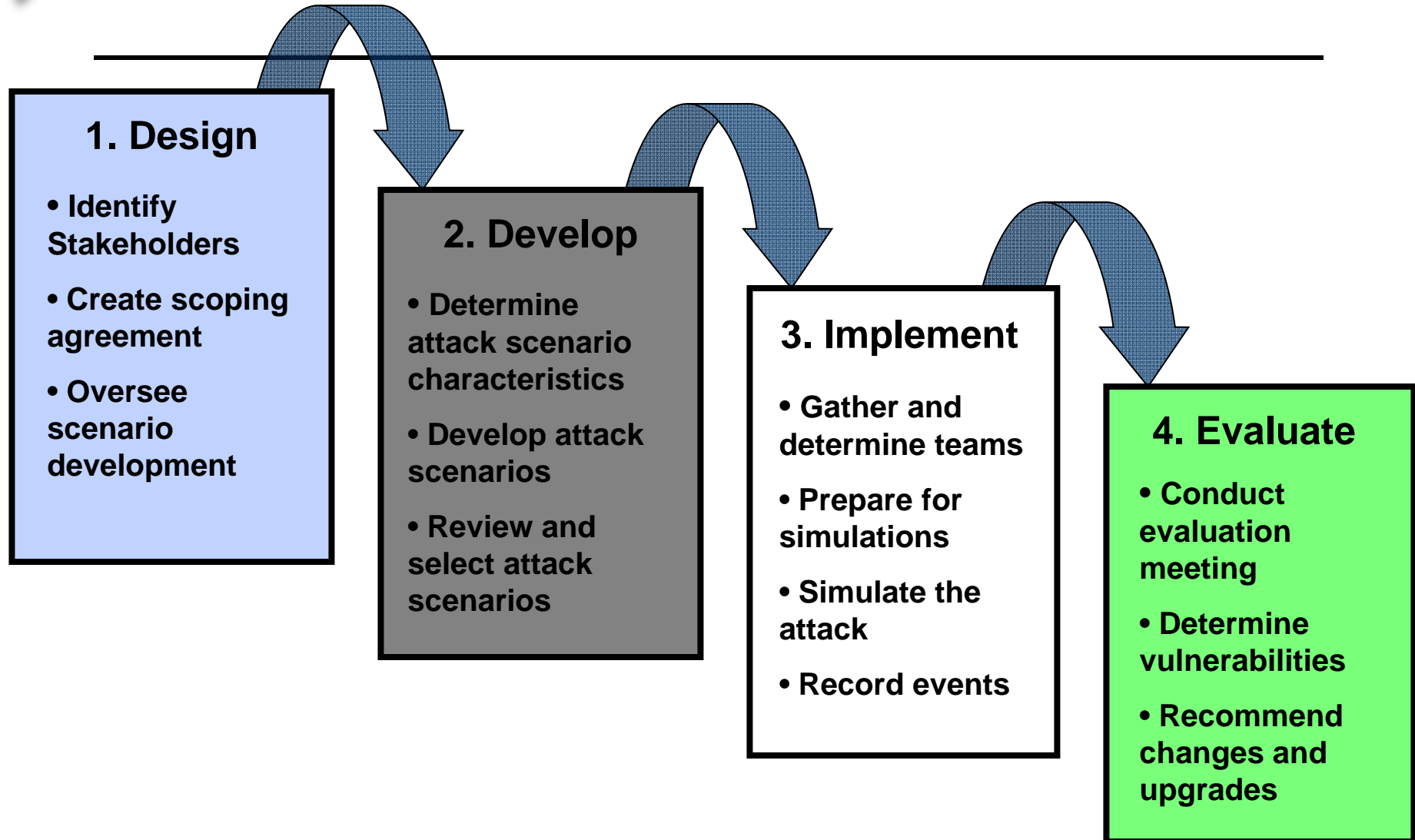


Evaluation Methodologies

- **Two complementary methodologies typically used in evaluation of P_E**
 - **Path modeling and analysis**
 - **Determines whether detection and delay are sufficient along all potential adversary paths to provide an adequate level of PI, based on planned response times**
 - **Scenario development and analysis**
 - **Determines whether P_E is adequate across range of detailed attack scenarios that might be credibly planned and conducted by adversaries within DBT**



Scenario Analysis Process





Definition of Probability of Neutralization

Probability of Neutralization (P_N): the probability that the response force can prevent a threat from completing a malevolent act such as theft of nuclear material or sabotage of a nuclear facility

- **Mathematically, P_N is:**
- **$P_N = N_{\text{wins}}/N_{\text{engagements}}$, assuming:**
 - **$N_{\text{engagements}}$ is a statistically significant number of engagements**
 - **All engagements have the same initial conditions**
 - **Two possible outcomes per engagement: win or loss**



Some Factors Affecting Probability of Neutralization

| Factors | Examples |
|----------------------|--|
| Numbers | |
| Weapons suite | None, baton, HG, SG, SMG, SAR, FAR, LMG, HMG, SNP |
| Area kill | Mortar, LAW, grenades, mines, IEDs |
| Ammo limits | Rounds/magazine, number of magazines |
| Training | None, basic, SWAT, military |
| Tactics | None, simple, advanced, military |
| Body armor | None, Level I, Level II, Level III, Level IV |
| Posture | Stand, kneel, prone |
| Exposure | 0%–100% |
| Movement | Stopped, very slow, slow, medium, fast, very fast, riding |
| Vehicles | Soft, armored, weaponized |
| Range | |

Note: HG = hand gun; SG = shot gun; SMG = submachine gun; SAR = semi-automatic rifle; FAR = fully automatic rifle; LMG = light machine gun; HMG = heavy machine gun; SNP = sniper rifle; LAW = light anti-tank weapon; IED = improvised explosive device; SWAT = special weapon and tactic (team).



Neutralization Analysis Methods

- Expert judgment
- Simple numerical methods for P_N (path analysis)
 - Data Tables
 - Tabletop path analysis
 - Markov chains
 - Monte Carlo Simulation
- Simulations (scenario analysis determines P_N as part of P_E)
 - Table-top exercises
 - Complex computer simulations
 - Computerized war games example
 - Simulated physical engagements
 - Force-on-Force (FOF)
- Actual engagements

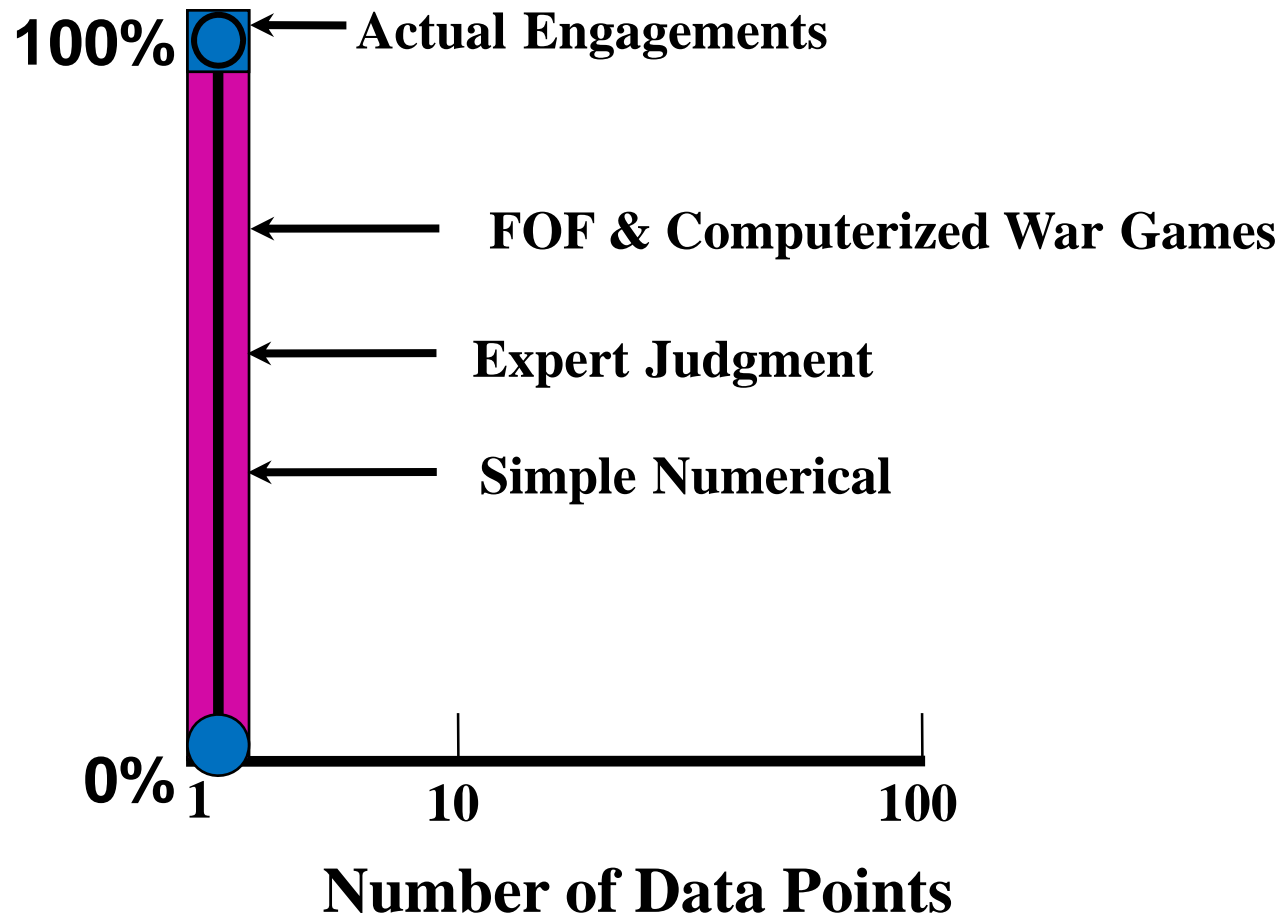


Potential Merits of Three Types of Simulations

| Force-on-Force | Computer-Based | Table-tops |
|--|--|---|
| Good at replicating individual behaviors <ul style="list-style-type: none">▪ Individual and team tactics | Good at replicating events <ul style="list-style-type: none">▪ Munitions effects | Good at replicating decision-making <ul style="list-style-type: none">▪ Security/adversary commanders▪ Completeness of plans |
| More required tasks actually executed <ul style="list-style-type: none">▪ Murphy's law | Comprehensive view and record of events <ul style="list-style-type: none">▪ Engagements▪ Movement | Transparency to observers <ul style="list-style-type: none">▪ Event handling▪ Tactical decisions |
| More fidelity in representing actual site: <ul style="list-style-type: none">▪ Terrain fidelity▪ Actual responders | Flexibility of application: <ul style="list-style-type: none">▪ Any attack location/situation▪ Can run multiple iterations to develop statistical data▪ Less impact on operations | When lead by an expert exercise moderator tabletops can: <ul style="list-style-type: none">▪ Identify issues to be addressed by other simulations▪ Bring in stakeholders as supporters that the simulation was done correctly |

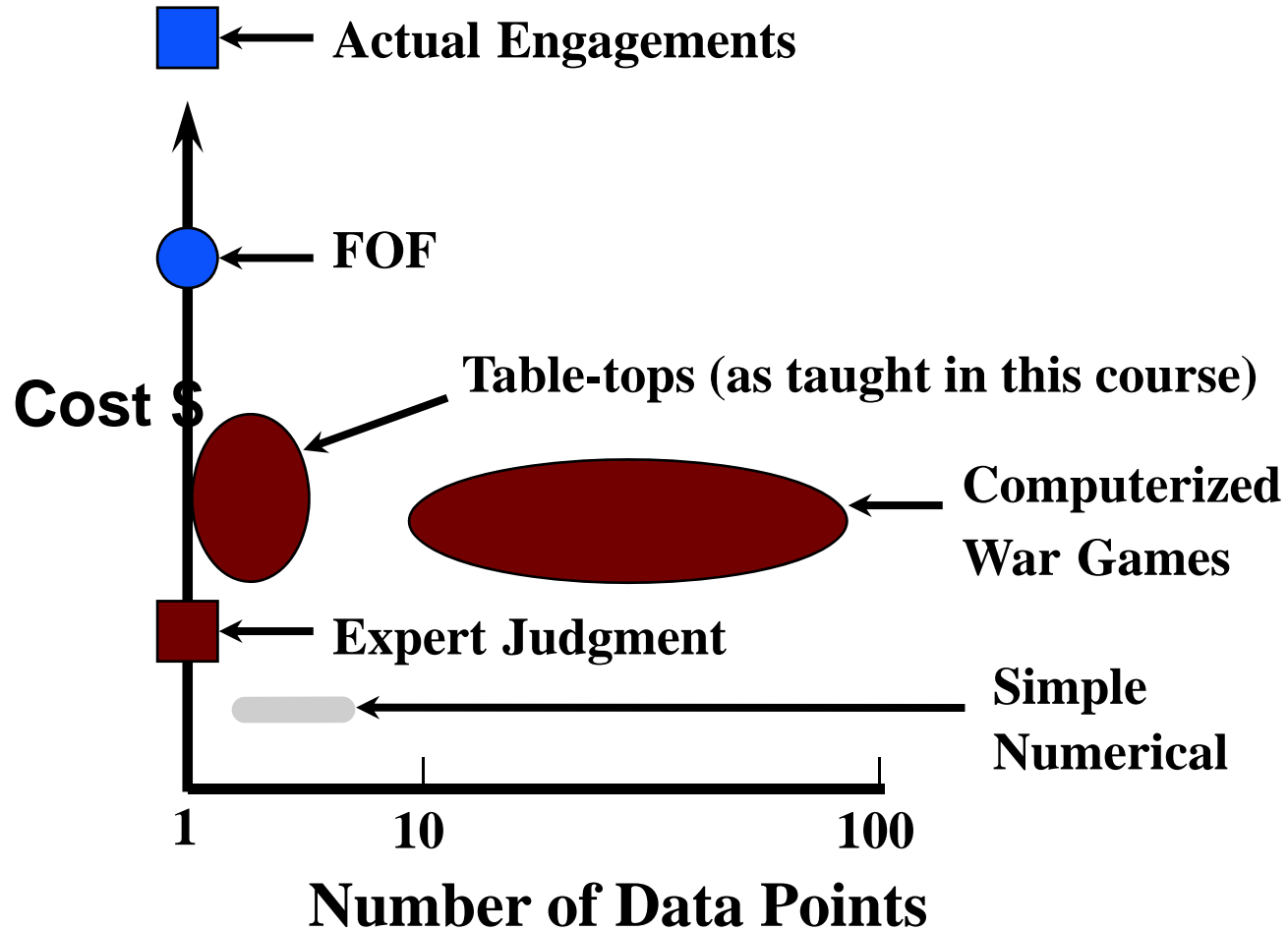


P_N Accuracy





P_N Cost





Probability of Neutralization Process

- 1. Choose a Methodology**
- 2. Select Scenario to Analyze**
- 3. Gather Data**
 - a) Threat**
 - b) Response Force**
 - c) PPS**
- 4. Analyze Engagements**



Data Requirements

- **Threat Characteristics Data**
- **Threat Scenario**
- **Response Force Data**
 - **Characteristics**
 - **Strategy**
 - **Order of battle (per target)**



Threat Characteristics Data

-
- **Target**
 - **Type of Threat**
 - **Strategy**
 - **Number**
 - **Weapons**
 - **Transport**
 - **Training**
 - **Equipment**
 - **Tactics**
 - Ambush
 - Diversion
 - Vehicle bomb
 - **Body Armor**
 - **Communications**
 - **Path delay in**
 - **Target task time**
 - **Path delay out**



Threat Scenario

-
- **A specific threat scenario is necessary to estimate P_N . A scenario includes the goals, methods, and plan the threat will use**
 - **Goals at a nuclear facility could be theft of nuclear material or sabotage**
 - **Methods include:**
 - **Force**
 - **Stealth**
 - **Deceit**
 - **Communication Jamming**
 - **Ambush**
 - **Diversion**
 - **Plan describes:**
 - **Adversary Actions**
 - **Adversary Path**



Response Force Data

- **Strategy**
 - **Response Force types**
 - **Numbers**
 - **Weapons**
 - **Locations**
 - **Transport**
 - **Tactics**
 - **Training**
 - **Equipment**
- **Body armor**
 - **Communications**
 - **PPS Response time**
 - Alarm communication
 - Assessment
 - Deploy order
 - Preparation
 - Travel
 - Deploy



Preliminary Study on Technical Elements for Development of Scenarios for Nuclear Facilities

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Project Summary

- Collaborative initiative between DOE, JNES and SNL relating to the mitigation of sabotage threats against nuclear power plants (NPP).
- This project considers:
 - A range of threats and uses available data/information
 - Conducts computer modeling and performance testing of protective doors
 - Analyzes force-on-force engagements and the impact of shielding and other factors on adversary timelines
 - Develops a draft guide for Scenario Analysis for NPPs



Project Impact

- From this project JNES will have the capability to estimate the impact of various factors on the adversary timeline and have an approach to develop and evaluate adversary scenarios.
- The draft guide will provide JNES with the framework for defining, developing and evaluating adversary sabotage scenarios at NPPs and would also be valuable to other IAEA Member States in the implementation of INFCIRC 225/Rev 5.
- This project consists of three major tasks:
 - Evaluation of Delay by Protective Doors
 - Effect of Response Force engagements and Shielding on Delay
 - Development of a Draft Guide for Scenario Analysis for NPPS



Evaluation of Delay by Protective Doors and Shielding

- This task will perform computer modeling and testing of protective doors from three Japanese door manufacturers.
- The information from the modeling and testing will be used to help develop estimates to possible adversary timelines and scenarios.
- JNES will gain knowledge in computer modeling and testing and how results can be applied in scenario analysis.



Effect of Response Forces and Shielding on Delay

- This task will provide a simple model for the delay provided by onsite response forces given various combinations of protective shields/fighting positions, body armor, and walls (to include none).
- Guidance will also be developed on how to use this model as part of scenario development and evaluation within the sabotage guide.
- Methods will also be developed on how to validate the simple model using site specific testing data, table-top exercises, computer simulations, and the guidance in the sabotage guide. These methods will be demonstrated by applying them to hypothetical facilities.



Development of a Draft Guide for Scenario Analysis for NPPs

- This task will involve the development and preparation of a guide for scenario analysis of adversary attack scenarios for Nuclear Power Plants (NPPs) and also help to meet the intent of IAEA INFCIRC/225/Revision 5.
- The guide will include a basic framework for an approach, scenario development, evaluation and testing. It will include a hypothetical/sample facility to help discuss scenarios. It will include results from other tasks within this project as well as other available information.
- The plan is to have two versions of the manual. One more focused on Japan and related testing and modeling and another for international use which may support IAEA/DOE needs.

Draft Project Schedule (Jul12)

| ID | Task Name | Start | Finish | 2012 | | | 2013 | | | | 2014 | | | | 2015 | | | | 2016 | | | | |
|----|--|-----------|------------|------|----|----|------|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|--|
| | | | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | |
| 1 | JNES schedule - Preliminary studies | 4/2/2012 | 4/1/2013 | █ | | | | | | | | | | | | | | | | | | | |
| 2 | JNES schedule - Testing and Studies | 4/1/2013 | 3/31/2015 | | | | █ | | | | | | | | | | | | | | | | |
| 3 | JNES schedule - General Testing, Results, Briefings, Future Activities | 4/1/2015 | 3/31/2016 | | | | | | | | | | | | | █ | | | | | | | |
| 4 | Protective Door Task – Initial meetings, visit to door manufacturers, data review | 4/2/2012 | 9/28/2012 | █ | | | | | | | | | | | | | | | | | | | |
| 5 | Protective Door Task – Phase 1, preliminary modeling/testing of 3-9 coupons, reports | 10/1/2012 | 9/30/2013 | | | | █ | | | | | | | | | | | | | | | | |
| 6 | Protective Door Task – Phase 2, preliminary modeling/testing of 20 coupons, pre-test for doors, reports | 10/1/2013 | 9/30/2014 | | | | | | | | █ | | | | | | | | | | | | |
| 7 | Protective Door Task – Phase 3, preliminary modeling/testing of 10 coupons and 3 doors, reports | 10/1/2014 | 9/29/2015 | | | | | | | | | | | | | █ | | | | | | | |
| 8 | Protective Door Task – Phase 4, additional modeling/testing, reports and presentations | 10/1/2015 | 9/30/2016 | | | | | | | | | | | | | | | | | █ | | | |
| 9 | RF/Shield Task – Subtask 1, initial review and discussions | 8/1/2012 | 12/31/2012 | █ | | | | | | | | | | | | | | | | | | | |
| 10 | RF/Shield Task – Subtask 2, problem formulation, engagement time model | 10/1/2012 | 3/28/2014 | | | | █ | | | | | | | | | | | | | | | | |
| 11 | RF/Shield Task – Subtasks 3&4, review data on shields, fighting positions, body armor, walls, create database; test to fill gaps if required | 11/1/2012 | 9/30/2014 | | | | █ | | | | | | | | | | | | | | | | |
| 12 | RF/Shield Task – Subtask 5, develop specific scenarios for guide, how to apply shields and other measures | 10/1/2013 | 12/31/2014 | | | | | | | | █ | | | | | | | | | | | | |
| 13 | RF/Shield Task – Subtasks 6&7, update model using test and other data, future activities planning | 4/1/2014 | 9/30/2015 | | | | | | | | | | | | | █ | | | | | | | |
| 14 | Sabotage Guide Task – organize guide, threat definition | 7/9/2012 | 9/27/2013 | █ | | | | | | | | | | | | | | | | | | | |
| 15 | Sabotage Guide Task – Collect and review data, analysis, scenario development, draft report | 10/1/2012 | 3/31/2015 | | | | █ | | | | | | | | | | | | | | | | |
| 16 | Sabotage Guide task – Final Report Preparation, future activities | 4/1/2015 | 9/30/2016 | | | | | | | | | | | | | | | | | █ | | | |

Draft Project Schedule (Oct12)

| ID | Task Name | Start | Finish | 2012 | | | 2013 | | | | 2014 | | | | 2015 | | | | 2016 | | | |
|----|--|-----------|------------|------|----|----|------|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|
| | | | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
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| 4 | Protective Door Task – Initial meetings, visits, data review, prelim analysis | 4/2/2012 | 4/1/2013 | █ | | | | | | | | | | | | | | | | | | |
| 5 | Protective Door Task – Phase 1, preliminary modeling/testing of 3-9 coupons, reports | 4/1/2013 | 3/31/2014 | | | | █ | | | | | | | | | | | | | | | |
| 6 | Protective Door Task – Phase 2, preliminary modeling/testing of 20 coupons, pre-test for doors, reports | 10/1/2013 | 9/30/2014 | | | | | | | | █ | | | | | | | | | | | |
| 7 | Protective Door Task – Phase 3, preliminary modeling/testing of 10 coupons and 3 doors, reports | 10/1/2014 | 9/29/2015 | | | | | | | | | | | | █ | | | | | | | |
| 8 | Protective Door Task – Phase 4, additional modeling/testing, reports and presentations | 10/1/2015 | 9/30/2016 | | | | | | | | | | | | | | | | █ | | | |
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| 11 | RF/Shield Task – Subtasks 3&4, review data on shields, fighting positions, body armor, walls, create database; test to fill gaps if required | 10/1/2013 | 8/28/2015 | | | | | | | | █ | | | | | | | | | | | |
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