Emerging Trends For Physical Protection

The 3rd U.C. Forum on the Future of Nuclear Power

Berkeley, California
June 11-12, 2009

Mark K. Snell
Sandia National Laboratories
This Presentation

• Takes into consideration the potential for a nuclear renaissance and the corresponding increase in the number of nuclear facilities that are potential targets for theft and sabotage of nuclear material
• The need to reduce the risk of such theft and sabotage by improved physical protection
• Some existing international instruments that concern PP of nuclear materials/facilities
• Achievement of increased security at reduced cost by incorporating security in design of facilities
• The need to attain synergism among security, safety and safeguards
Facets of Nuclear Physical Protection

State: Responsible for Physical Protection Regime

**What to Protect**
- Theft Targets
  - Category I amounts of HEU/PU/MOX
  - Other Category amounts
- Radiological Sabotage Targets (fixed/transport)
  - Nuclear Power Plants
  - Spent Fuel
  - Other (e.g., low-level rad waste)

**Who to Protect**
- Design Basis Threat (DBT)

**Risk Management Decision: How Well to Protect**
- Requirements
  - Compliance
  - Performance
- Requirements
  - Compliance
Example Detail Found in a DBT

<table>
<thead>
<tr>
<th>Likelyhood of Potential Action</th>
<th>Protestor</th>
<th>Criminal</th>
<th>Terrorist</th>
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<tbody>
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<td>Theft</td>
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<td>Sabotage</td>
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<td>Other ___</td>
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<td>Motivations</td>
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<td>Capabilities</td>
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<td>Number of attackers</td>
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<td>Type of weapons</td>
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<td>Explosives (Type and Quantity)</td>
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<td>Transportation</td>
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<td>Power and hand tools</td>
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<td>Technical skills</td>
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<td>Level of funding</td>
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</table>

- While not a Statement of Today’s/ Projected Threat the DBT affects facilities designed based on it
System Functions to Provide PP

- Detection
  - Intrusion Sensing
  - Entry Control
  - Contraband Detection
  - Alarm Assessment
  - Alarm Communication and Display

- Delay
  - Passive Barriers
  - Active Barriers

- Response
  - Guards
  - Response Force

Technology, Guards & Response Forces
International Requirements and Recommendations for Physical Protection

- UNSCR 1540
- Amended Convention on the Physical Protection of Nuclear Material (CPPNM)
- INFCIRC/225 (Rev 4): The Physical Protection (PP) of Nuclear Material and Nuclear Facilities
  - Elements of a State’s System of PP
    - State Responsible for PP and Maintaining DBT
  - PP Requirements
    - Currently under revision to meet current threat environment and amended CPPNM
INFCIRC/225 (Rev 4): PP Requirements (Sections 6, 7, 8)

• Specific requirements:
  – Category I NM used or stored in inner area(s) within protected area (PA)
  – Intrusion detection at PA boundary

• Performance-associated objectives
  – Arrival of *adequately armed* response forces in time
  – Central alarm stations hardened against the DBT

• Performance-associated requirements
  – Regular exercise of coordination between guards and response forces
Increasing PP Cost Trends

- Countries moving from Compliance-based to Performance-based Security using DBT’s
- DBT’s have expanded in a post-9/11/2001 world
  - Toolsets demonstrated: vehicle bombs, aircraft impacts
  - Demonstrated willingness to inflict mass causalities
  - Announced intentions to acquire nuclear material
- PP systems have been enhanced as a result
  - Increased numbers of response forces, and their levels of training, weaponry
  - Enhanced security systems
  - Decreased response time
Reactors Designs in R&D Could Be Used in Facilities Needing PP 80+ years from Now

- Observation: DBT’s tend to get more capable over time
- Issue: how does one design PP for facilities that may be operating in 2100?
  - Do not want to overbuild today
  - Adding security later is extremely costly
- Currently, design to meet today's DBT as set forth by competent authority
- Security by design will be important component of future facilities
  - Will help reduce life cycle physical protection costs
Design Option Studies for NPPs and Fuel Cycles

• Reduce sets of targets or harden them
  – Reduce number of Category I theft targets
  – Use “inherently secure” plants, processes, and materials against radiological sabotage
• Associated issue: Maturity of understanding about sabotage sequences for non-traditional designs

• Improve passive security
  – Sizing of reactors to fit buried or bermed configurations
  – Use of remote handling and processes
  – Lay out facilities to maximize delays
Ensure Synergies Among Safety, Security, and Safeguards

• Designs that ensure synergies can have lower life-cycle costs
  – E.g., “inherently safe“ and “inherently secure”
• Historically, such potential synergies have not been adequately addressed
• Achievement of such synergies may require changes in regulatory approval for the design or for an operating license
Summary

• The increasing number of nuclear facilities are potential targets for theft or sabotage of nuclear material.
• There is need to reduce the risk of such theft and sabotage by improved physical protection.
• Some existing international instruments provide guidance for better protection of nuclear materials/facilities.
• Increased security at reduced life cycle cost can be obtained by incorporating security in the design of facilities.
• It is important to attain synergism among security, safety and safeguards to improve all three at reduced cost.
Backup slides if there are questions
Feature-Based Versus Performance-Based Physical Protection

**Feature Based Protection**

Definition:
- PPS design and evaluation based on specification and implementation of a set of required features

Example:
- Two intrusion sensors with video assessment
- Security locks on gates, doors, and containers

**Performance-Based Protection**

Definition:
- PPS design and evaluation based on specifying and achieving an overall system effectiveness against the Design Basis Threat (DBT) or current evaluation of the threat for theft and sabotage.

Example:
- PPS will, with a probability of $P^*$ or greater, 1) detect intrusion and 2) delay unauthorized entry until the response arrives.
4.4. Evaluation of the Implementation of PP Measures

- 4.4.1. To ensure that physical protection measures are maintained in a condition capable of meeting the State's regulations and of effectively responding to the design basis threat, the State's competent authority should ensure that evaluations are conducted by operators at nuclear facilities and for transport. Such evaluations, which should be reviewed by the State's competent authority, should include administrative and technical measures, such as testing of detection, assessment and communications systems and reviews of the implementation of physical protection procedures. Such evaluations should also include exercises to test the training and readiness of guards and/or response forces. When deficiencies are identified, the State should ensure that corrective actions are taken by the operator.
General Performance-Based Design and Evaluation Process

1. Define PPS Requirements
   - What are we protecting? *(Characterize Facility Identify Targets)*
   - Who are we protecting it from? *(Define Threats/DBT)*
   - How well do we need to protect it? *(Performance metric goals)*
2. Characterize PPS
   - Detection, assessment, communications
   - Delay
   - Response
     - Time to respond
     - Neutralization capabilities
3. Evaluate PPS
   - Timely response?
   - Overall effectiveness meets regulatory goals?
4. Final PPS Design
5. Redesign PPS
Define Design Basis Threat (DBT)

• A Design Basis Threat (DBT) specifies:
  • The attributes and characteristics of potential insider and/or external adversaries, who might attempt unauthorized removal of nuclear material or sabotage, against which a physical protection system is designed and evaluated
  • The DBT is a policy document, not a statement of today’s threat
• Value of a DBT
  • Provides technical basis for defining performance requirements used in the design and evaluation of PP systems
  • Supports efficient and effective allocation of resources
  • Helps provide assurance that level of protection is adequate
Performance Metric Goals

• Performance Metrics describe how well the PP System works:
  – System Effectiveness ($P_E$)
    *The probability that the physical protection system will defeat the adversary*
    • $P_E = P_I \times P_N$
  – Probability of Interruption ($P_I$)
    *Probability that the Response arrives in time to stop the adversary*
  – Probability of Neutralization ($P_N$)
    *The probability, given interruption of the adversary by the response force, that the response force kills or captures the adversary, or causes the adversary to flee*

• Examples of Performance Goals
  – $P_I$ must meet or exceed 90% against outsiders in the DBT
  – $P_E$ must meet or exceed 85% against outsiders in the DBT
Target Identification

**Target Identification**: Where can the adversary steal material or cause radiological sabotage?