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Physical Protection Attributes for Secure Shipment of Commercial Nuclear and Radioactive Materials

U.S. Transport Council and Sandia National Laboratories

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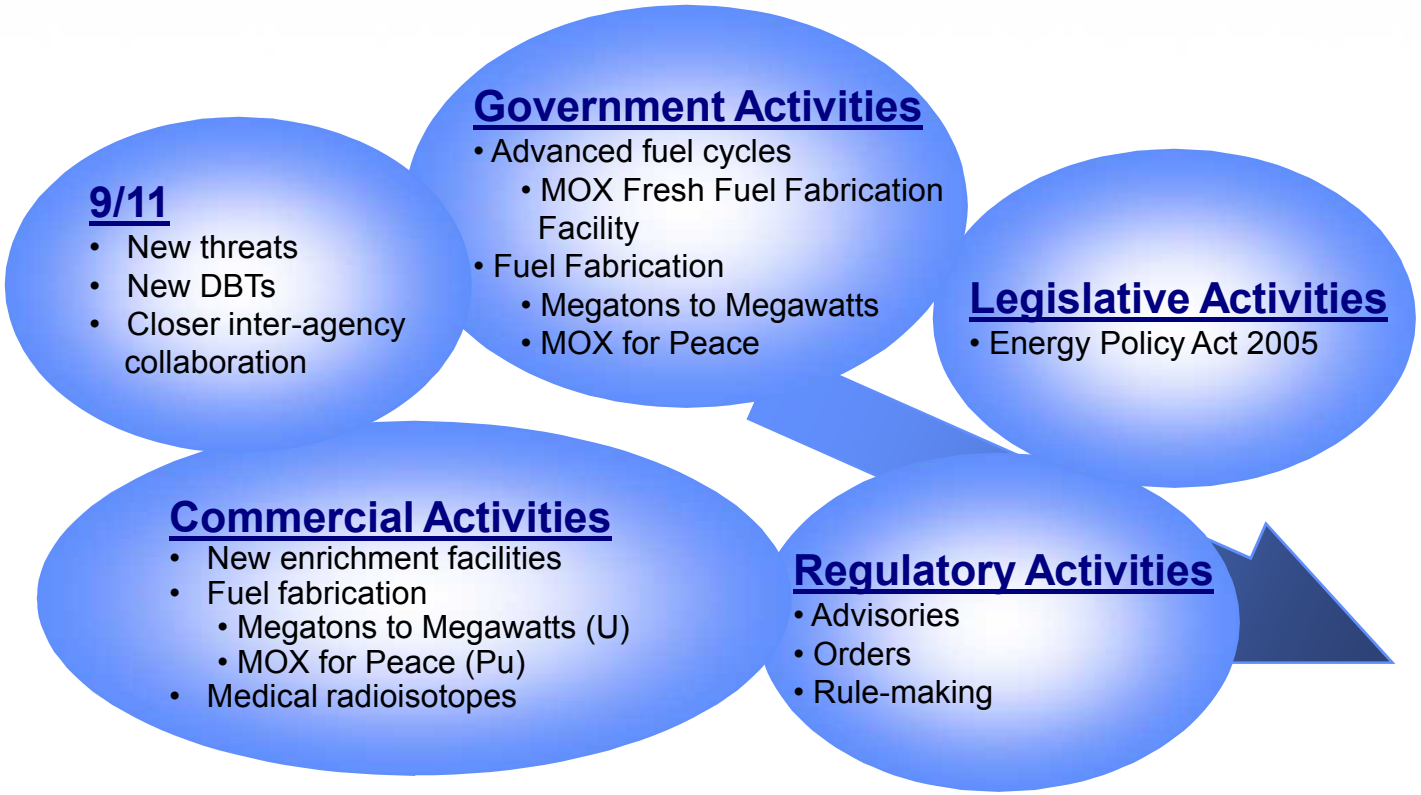
Introduction

Numerous drivers are impacting the need to assess how we provide physical protection for civilian shipments of nuclear and radioactive materials.



Transportation

- **New materials**
- **New regulations**
- **New security framework**

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Introduction

Current capability to ship commercial "highly attractive" materials (i.e., Cat I materials) resides with the DOE Office of Secure Transport system

Industry Considerations:

- The Safeguards Trailer (SGT) costs ~$2.8M
- Convoy shipment cost ~$1M/trip
- Usable payload is reduced due to high trailer weight
- Interior dimensions reduced due to thick trailer walls

A commercial secure trailer could be developed that:

- Is more economical to procure and operate
- Can be customized to adapt to a variety of payloads that will require different levels of physical protection
- Is designed and operated to NRC regulations

Conclusion:

- Industry should consider the development of a secure trailer for transport of commercial attractive materials.

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Regulatory Environment

There are four classes of materials that need to be assessed for physical protection requirements. A graded approach is used that recognizes that the required level of protection is a function of material attractiveness

Nuclear Regulatory Commission (NRC) physical protection (PP) regulations during transit are defined in 10CFR73 for three of these classes:

1. Cat I quantities of Special Nuclear Materials (SNM)

- Must protect against the regulatory DBT for theft and/or sabotage
- Must have an approved PP system that includes escorts as well as a response force
- Focus is on mass of SNM shipped without consideration for attractiveness
- Commercial shipments in this category include fresh MOX fuel

2. Irradiated reactor fuel (> 100 g and > 100 rem/hr @ 3 ft)

- The regulatory DBT is not used for SNF
- The focus is on sabotage
- Escorts are required
- Response is coordinated through Local Law Enforcement Agencies (LLEA)

Regulatory Environment

3. Cat II/III quantities of Special Nuclear Materials (SNM)

- The DBT is not used to design the PP system for Cat II/III shipments
- General performance objectives are ensured through an approved Security Plan:
  - Establish and maintain a PP system that will:
    - Minimize the potential of unauthorized removal of SNM consistent with the potential consequences
    - Facilitate the location and recovery of missing SNM
  - For Cat II quantities:
    - Make all shipments in dedicated transports or under custody acknowledged by signature

4. Radioactive materials: Physical protection requirements for radioactive materials are also being addressed through rule-making

- RAMQC (not part of 10CFR73)
  - Transportation of Radioactive Material in Quantities of Concern - RAMQC (January 2008)
  - Adds 16 radiological isotopes to new physical protection rule-making
  - Rule-making is harmonized with IAEA Code of Conduct
  - SNF is NOT included in this rule making

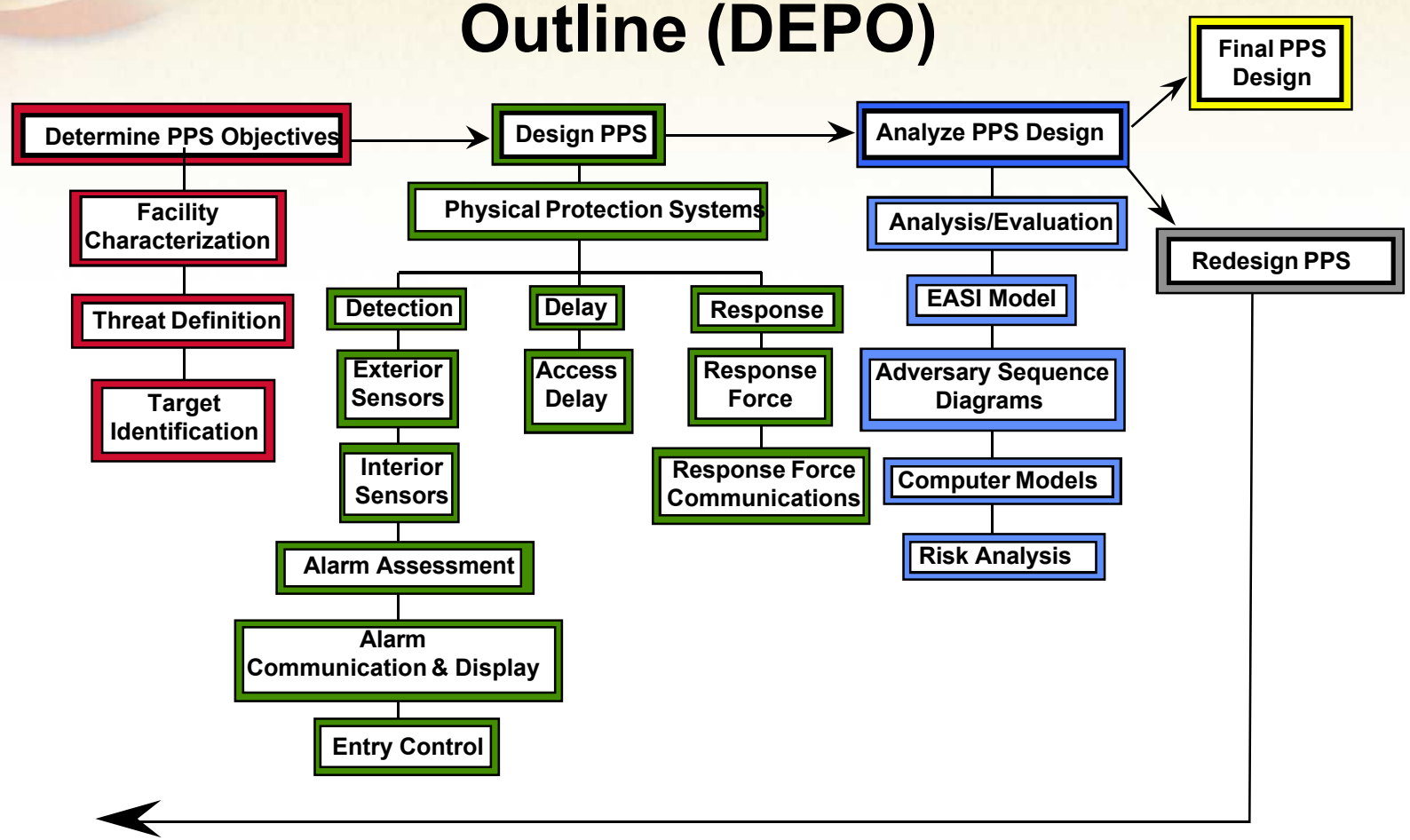
Regulatory Environment

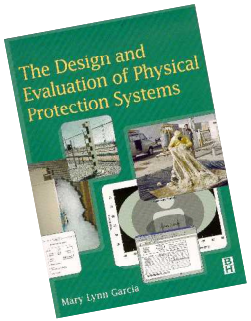
- **Observations**
  - **Nuclear and radioactive material shipments must be protected according to existing regulations with recognition that the regulations are evolving.**
  - **Regulatory requirements for physical protection are graded and will vary substantially given the types and quantities of materials being shipped.**
  - **The commercial industry will need to develop PP systems that can be customized in order to provide the right level of protection for the materials being shipped.**
    - **Nuclear v. radioactive**
    - **Bulk v. self-protecting**
    - **Small v. large quantities**

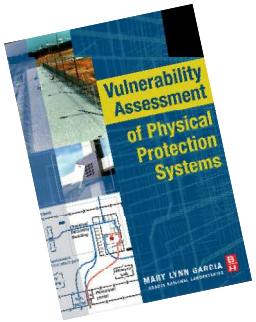
Physical Protection Approach

- The main attributes to a physical protection system are:
  - Detect
  - Delay
  - Respond
- These attributes must be designed as a system that provides a balanced level of protection for the material being shipped.
- For commercial shipments, it is critical that a balanced PP system be designed that is flexible for different payloads and efficient based on operations and costs
  - Balancing a system is two-dimensional
    - Detect/Delay/Respond attributes must be balanced with payload security requirements
    - Operational requirements must be balanced with often conflicting PP requirements

Security Design and Evaluation Process Outline (DEPO)







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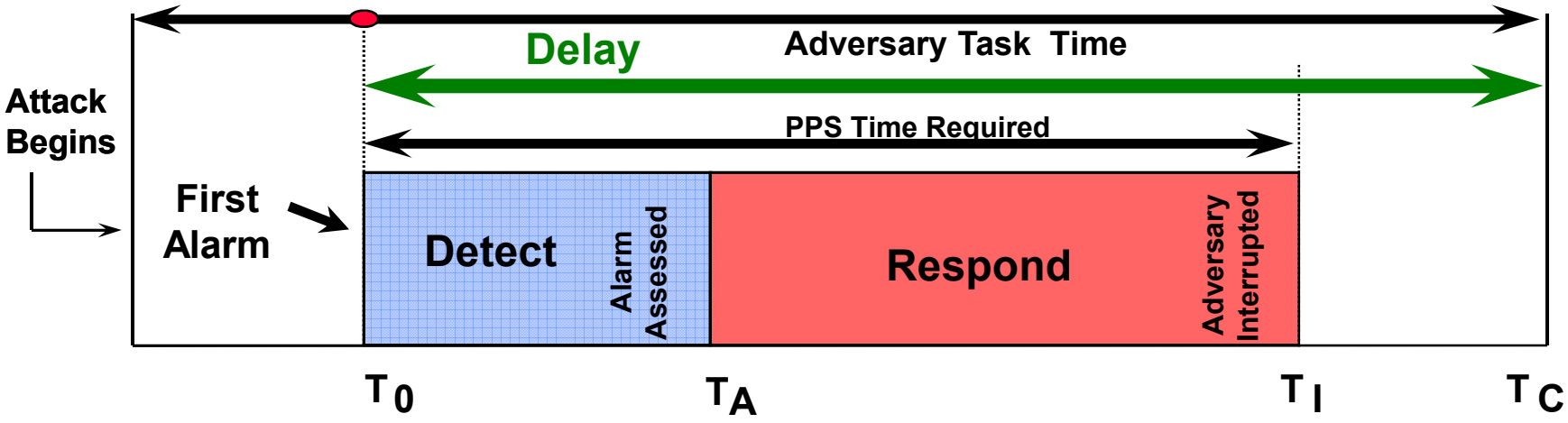
Physical Protection Approach

In order to properly assess physical protection effectiveness across the range of graded protection, an assessment of detection and delay capabilities needs to be conducted.

The DEPO method provides a way to assess vulnerabilities based on potential threats. It was developed for Cat I types of applications, but is adaptable to less attractive material shipments.



- System detection and response time must be less than adversary task time
- To increase system success probability:
  - Detect intrusion earlier
  - Reduce assessment time
  - Increase adversary task time
  - Reduce response time

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Physical Protection Approach

For commercial systems, the range of appropriate responses points to a flexible delay component that must balanced with operational efficiencies

- **Potential attributes of physical barriers that provide access delay to material:**
  - **Multiple Layers**
  - **Fully enclosed transporter…Ballistically-Hardened…Designed to remain intact in worst case accident scenario…Designed with access delay conceptual guidelines.**
  - **Transporter interior volume access delay…Cages/Safes.**
  - **Transporter material target delay…Tiedowns…Bolted to truck bed.**
  - **Material container…Cask…Shipping Container.**
  - **Does the Material Transporter provide layers of delay and sufficient delay to allow for arrival of secondary responders if needed?**
  - **Does the Material Transporter provide sufficient delay to protect against both theft and sabotage scenarios if needed?**

Physical Protection Approach

Why is Access Delay more critical in Transportation Security than in Fixed-Site Security?

- Detection occurs much closer to the target during transportation scenarios
- The number of armed escorts with the transport convoy may be limited
- Secondary responders (LLEA) may be further away and response times will vary as the transit may pass through both urban and rural areas.
- Fixed Facilities have hardened fighting positions, armored response vehicles, potentially stronger Rules of Engagement, significant weapons and recapture/recovery tools, and many other response features not necessarily found in transportation security
- Fixed Facilities do not have the public within their perimeter and have vehicle barriers to prevent entry of adversary vehicles
- Fixed Facilities have multiple layers of barriers that provide significant access delay and thus allows for optimal & multiple response tactics

Physical Protection Approach

Examples of package tie-downs to increase target access delay

Shrouded Locks

Packages can be secured with a host of different locks and tie-downs that meet the physical protection needs for specific payloads

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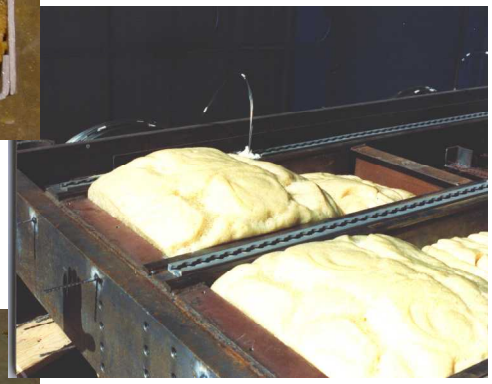
Physical Protection Approach

Examples of trailer access delay features

Multiple layer barriers



Intumescent foam

Cable netting

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Conclusions

- There is a need for a transporter that addresses the security aspects of shipping Cat I/II/III commercial nuclear and radioactive materials.
- The transporter should be adaptable to handle a broad range of materials through a flexible PP framework that can be customized to ensure the proper level of security for the material being shipped.