SAND2012-4318C

Module 3: Nuclear Energy Security & Safety
(Week 9/Day 1)

Nuclear Security: Technical Design & Objectives

Gulf Nuclear Energy Infrastructure Institute – 2012 Fundamentals Course

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Week #9 Learning Objectives

Module 3/Week 9:

- **Nuclear Security: Technical Design & Objectives**

Week 6 Learning Objectives:

- Understand the international nuclear security regime and GNEII's endorsed method for PPS design & evaluation
- Understand how to define the basic requirements for systems analysis of PPS
- Recognize the basic concepts and the role of detection in PPS
- Recognize the basic concepts and roles of delay and response in PPS
- Demonstrate an understanding of basic PPS evaluation techniques

Module 3: Nuclear Energy Security & Safety (Week 9/Day 1)

Lecture #1: Review of Modules 1 & 2

Dr. Michael Schuller

Today's Primary Learning Objective

Primary Day 1 Learning Objective:

- Understand the international nuclear security regime and GNEII's endorsed method for PPS design & evaluation

Take away from this lecture:

- Review of Modules 1 and 2, and how those topics interact with nuclear security

Module 3: Nuclear Energy Security & Safety (Week 9/Day 1)

Lecture #2: Introduction to the International Nuclear Security Regime

Mr. Riyaz Natha

Today's Primary Learning Objective

Primary Day 1 Learning Objective:

- Understand the international nuclear security regime and GNEII's endorsed method for Physical Protection Systems (PPS) design & evaluation

Take away from this lecture:

- The IAEA is the leader of an international framework for nuclear security issues

Lecture Outline

1. Why is there an international nuclear security regime?

2. What is the international nuclear security regime?

3. How is the international nuclear security regime implemented?

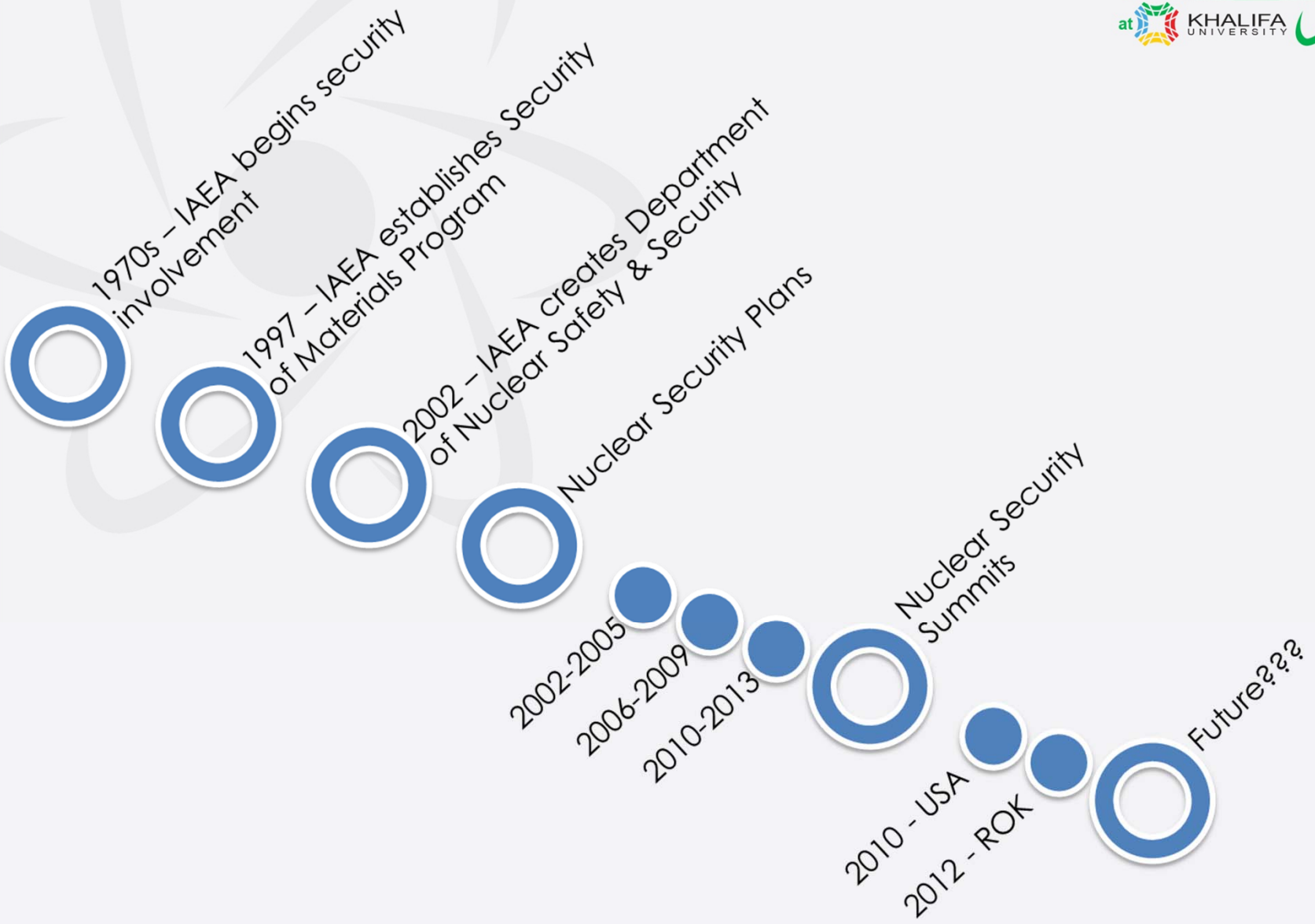
4. How is GNEII related to the international security regime?

Why international nuclear security regime?

In their own words…

- "Last Best Chance" Movie
  - http://www.youtube.com/watch?v=z4mmpRdV-3o
- "Nuclear Tipping Point" Documentary
  - http://www.youtube.com/watch?v=pH8UmH712C4&feature=relmfu
- Interview with IAEA Director for Nuclear Security
  - http://www.iaea.org/newscenter/multimedia/videos/nuclearsecurity/200112/mrabit//index.html

International Security Regime Timeline



What is the International Nuclear Security Regime

- 2010-2013 IAEA Nuclear Security Plan (Current):
  - **WHY?**
  - **WHAT?**
  - **HOW?**

- 2010-2013 IAEA Nuclear Security Plan (Current):
  - **WHY?**
    - "The risk that **nuclear** or **other radioactive material** could be used in malicious acts remains **high** and is regarded as a **serious threat** to international **peace** and **security**"

What is the International Nuclear Security Regime

- 2010-2013 IAEA Nuclear Security Plan (Current):
  - **WHAT? –** (1) Contribute to global efforts to secure **nuclear & other radiological material** in use/storage/transport and (2) assist states in implementing full range of **international legal instruments** for nuclear security

Fundamental Nuclear Security Documents	
Convention on the Physical Protection of Nuclear Material	Only legally binding undertaking in the area of physical protection of nuclear material used for peaceful purposes
2005 Amendment to the Convention on the Physical Protection of Nuclear Material	Extends above protection measures to nuclear facilities/materials in peaceful domestic use, storage, or transport; expands cooperation among states regarding locating/recovering/mitigating missing material
International Convention for the Suppression of Acts of Nuclear Terrorism	Seeks to criminalize unlawful/intentional possession or use of nuclear materials or nuclear facility sabotage
Security Council Resolutions 1373 (2001) and 1540 (2004)	1373 – calls all states to become party all international instruments for nuclear security 1540 - calls all states to become party to the CPPNM (and amendment) and IAEA Code of Conduct
Nuclear Security Recommendations on Physical Protection of Nuclear Materials and Nuclear Facilities (INFCIRC/225/Rev.5)	See next slide
Code of Conduct on Safety and Security of Radioactive Sources	Non-binding agreement prevent unauthorized use of and minimize damage from malicious radioactive release

- Cornerstone for physical protection:
  - *Nuclear Security Recommendations on Physical Protection of Nuclear Materials and Nuclear Facilities* (INFCIRC/225/Rev.5)
    - Per INFCIRC/225/Rev/5: the **objective** of the **nuclear security regime** is "to protect persons, property, society, and environment from malicious acts involving nuclear material and other radioactive material"
    - ...[and] the **goal** of **physical protection** is to:
      - Protect against theft or other unauthorized removal of nuclear material
      - Locate and recover missing nuclear material,
      - Protect material and facilities against sabotage,
      - Mitigate and minimize the radiological consequences of sabotage

What is the International Nuclear Security Regime

- 2010-2013 IAEA Nuclear Security Plan (Current):
  - **WHAT? –** An effective nuclear security infrastructure requires a **multi-disciplinary** approach with :
    - Clearly defined legal & regulatory systems
    - Human resource development
    - Established procedures and functions
    - Technical support at regional/national/facility levels

Nuclear Security Summits	
Washington, D.C., USA (2010)	(1) First international gathering focused on preventing nuclear terrorism; (2) Brought security of special nuclear materials to global forefront; (3) Reiterated need for increased international cooperation
Seoul, Republic of Korea (2012)	(1) Progress report on 2010 Summit; (2) Included emphasis on integration of security and safety; (3) Call for sustained, concrete efforts at global collaboration
The Netherlands (2014)	?????

Nuclear Security International Guidelines

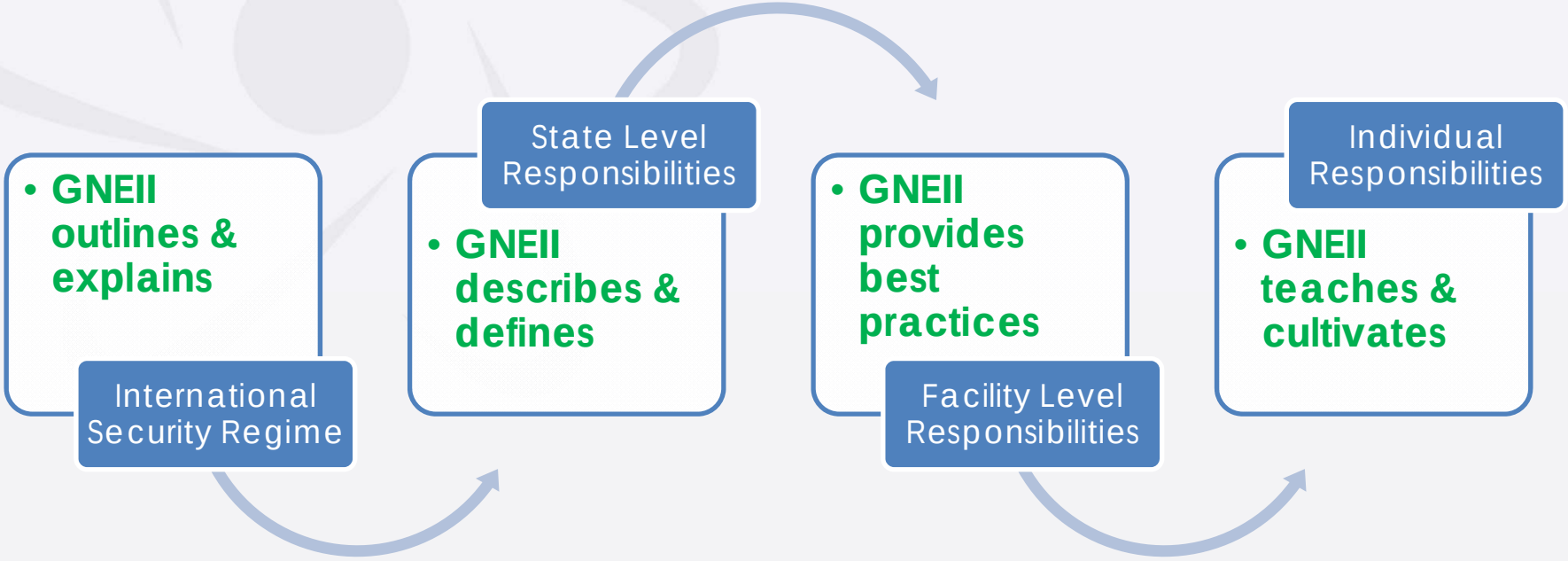
- Nuclear Security Guidelines:
  - Comprehensive guides on all aspects of nuclear security and physical protections
  - Include: recommendations, technical guidance, implementing guidelines
- Nuclear Security Series
  - Technical and Functional Specifications for Border Monitoring Equipment
  - Nuclear Forensics Support
  - Monitoring for Radioactive Material in International Mail Transported by Public Postal Operators
  - Engineering Safety Aspects of the Protection of Nuclear Power Plants Against Sabotage
  - Identification of Radioactive Sources and Devices
  - Combating Illicit Trafficking in Nuclear and Other Radioactive Material
  - Nuclear Security Culture
  - Preventive and Protective Measures Against Insider Threats
  - Security in the Transport of Radioactive Material
  - Development, Use and Maintenance of the Design Basis Threat
  - Security of Radioactive Sources
  - Educational Programme in Nuclear Security
  - Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities
  - Nuclear Security Recommendations on Radioactive Material and Associated Facilities
  - Nuclear Security Recommendations on Nuclear and Other Radioactive Material our of Regulatory Control

What is the International Nuclear Security Regime

- 2010-2013 IAEA Nuclear Security Plan (Current):
  - **HOW? –** Four Elements of the IAEA Nuclear Security Program

Needs Assessment, Information Collation & Analysis	(1) develop/maintain information platform; (2) update threat analysis for global nuclear security needs; (3) assist in prioritizing nuclear security improvement; (4) facilitate international cooperation/collaboration
Contributing to the Enhancement of a Global Nuclear Security Framework	(1) Provide set of nuclear security recommendations/guidance (INFCIRC 225/Rev5); (2) facilitate adherence/implementation of international legal instruments; (3) provide useful, up to date nuclear security guidance to implement a global framework
Providing Nuclear Security Services	(1) Provide peer reviews/assessments and provide upgrade recommendations; (2) assist states in human and infrastructure capacity building in nuclear security
Risk Reduction and Security Improvement	(1) Support states' requests in reducing the risk of nuclear material in use/storage/transport; (2) support states' requests in meeting international obligations

Nuclear Security and GNEII



Summary

- Nuclear and radioactive material pose a unique and significant threat to individual, national, regional and international peace and security

- The international security regime is a framework of international legal instruments implemented at a national and facility level to ensure that nuclear materials remain secure in use/storage/transport
  - Binging & non-binding agreements
  - Nuclear Security Summits
  - IAEA Nuclear Security Plan
  - Individual responsibilities

- GNEII seeks to outline, describe, demonstrate, and teach important best practices in nuclear security at the international, state, facility, and individual level

Module 3: Nuclear Energy Security & Safety (Week 9/Day 1)

Lecture #2: Introduction to Nuclear Security & the Design Evaluation Process Outline (DEPO)

Mr. Riyaz Natha

Today's Primary Learning Objective

Primary Day 1 Learning Objective:

- Understand the international nuclear security regime and GNEII's endorsed method for PPS design & evaluation

Take away from this lecture:

- Understand the systems solution approach of DEPO

Lecture Outline

1. Understand the need to identify how nuclear security may be part of an “Integrated 3S” mindset
2. List the objectives of a Physical Protection System (PPS)
3. Recognize different approaches for the design and evaluation of PPS
4. Identify the approach used globally endorsed by the IAEA to design and evaluate PPS
5. List the three basic steps in the Design and Evaluation Process Outline (DEPO)
6. Identify the primary steps in defining PPS requirements

Objectives of PPS

- Protect against unauthorized removal of nuclear materials during use, storage, and transport (theft)

- Protect against sabotage of nuclear facilities and sabotage of nuclear material during use, storage, and transport

Note: In this course "sabotage" means radiological sabotage.

Alternative PPS Design and Evaluation Approaches

- Expert
- Features
- Component Criteria
- System Performance

Expert Approach

- ***Expert:*** Performs PPS design and evaluation activities relying on personal knowledge and experience

- Example:
  - Experts design and evaluate physical protection system based on prior personal experience

Expert Approach

- ***Advantages:***
  - Less time (for design/evaluation)
  - Lower cost
  - Can be insightful
- ***Disadvantages:***
  - No metric
  - Subjective
  - Inconsistent (among experts)
  - Can have a limited focus

Features Approach

- ***Features Approach:*** PPS design and evaluation based on specification and implementation of a required set of features

- ***Example:***
  - Two intrusion sensors with video assessment
  - Security locks on gates, doors, and containers
  - Central Alarm Station
  - 24/7 response force

Features Approach

- ***Advantages:***
  - Clear requirements
  - Easy to regulate/inspect
  - Consistent among facilities
- ***Disadvantages:***
  - No performance metric
  - May be inadequate
  - May be excessive
  - May provide false sense of security

Component Criteria Approach

- ***Component Criteria Approach:*** Standards approach to PPS design and evaluation that uses performance criteria for some security features

- ***Example:***
  - Perimeter security zone will detect intruder running (speed), crawling (speed), or jumping (height) with a 95% probability of detection and a 90% confidence level.

Component Criteria Approach

- ***Advantages:***
  - Clear requirements
  - Consistent among facilities
  - Performance metric for protection elements
- ***Disadvantages:***
  - Requires testing
  - More difficult to inspect
  - No system performance metric

System Performance Approach

- ***Advantages:***
  - System performance metric
  - Better resource allocation
  - Increased confidence in PPS
- ***Disadvantages:***
  - Requires more performance testing
  - More difficult regulation and inspection
  - Requires system effectiveness policy

PPS Design and Evaluation Approaches

Approach	Requirement	Metric
Expert	Satisfy expert	Opinion
Features	Include required features	Presence of features
Component Criteria	Include required features that meet specific standard	Presence of feature and performance standard
System Performance	Prevent theft or sabotage of nuclear material	System Effectiveness

INFCIRC/225/Rev. 5 - "The State should define requirements for the PPS"

System Performance Approach

- ***System Performance Approach:*** A systems engineering approach to the design and evaluation of PPS based on specifying and achieving an overall system effectiveness against the Design Basis Threat (DBT) for theft and sabotage.

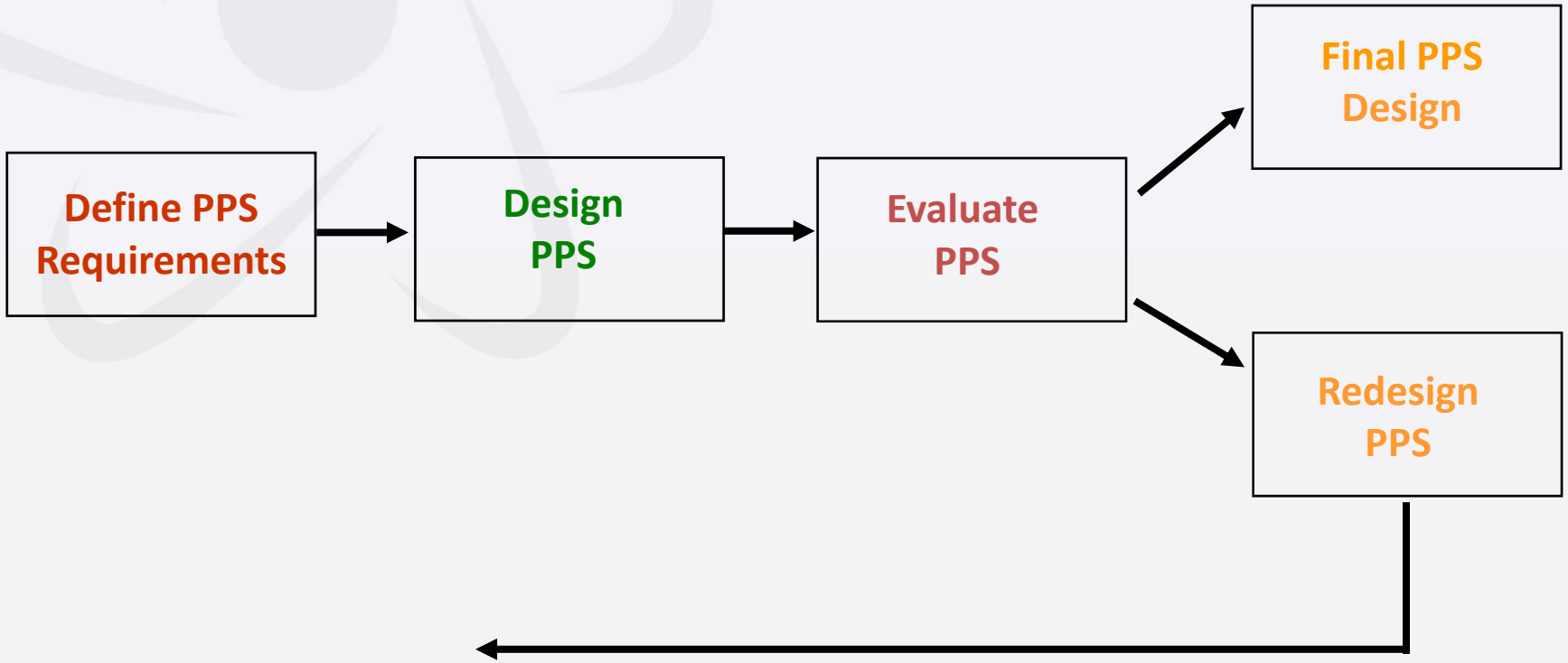
- ***Example:***
  - PPS will prevent the DBT from success with a system effectiveness against theft or sabotage.

Design and Evaluation Approach

- GNEII will teach the IAEA-endorsed (and globally accepted) ***performance based*** PPS effectiveness, design, and evaluation approach

- In practice, State systems of physical protection generally include a mixture of performance-based and prescriptive approaches

Design and Evaluation Process Outline (DEPO)



Define PPS Requirements

- PPS Objective: Prevent theft and/or radiological sabotage
- PPS Requirements Definition
  - Facility characterization and Target identification
  - Threat definition
  - Risk management and regulatory requirements

Protect What? From Whom? How Well?

Facility Characterization

- Collect all relevant information from all available sources
  - Location (e.g., proximity to roads, major cities)
  - Environment (e.g., weather, terrain)
  - Infrastructure (e.g., construction, buildings, rooms)
  - Operations/Procedures (e.g., employees, work-day)
  - Safety
- Consider impact of facility characterization, on the DBT and the PPS
- For teaching purposes, GNEII will use a hypothetical facility (specifically in the Final Exercise)

Target Identification

- Identify:
  - Types of malicious acts:
    - Theft of nuclear material (material form?)
    - On-site radiological sabotage (exposure?)
  - The potential consequences:
    - Loss of life, human health effects, environmental contamination
  - The target characteristics:
    - Location
    - Quantity
    - IAEA Categorization (INFCIRC/225/Rev.5)

Target Identification

- Identify malicious acts and the consequences:
  - Theft of nuclear material
  - Nuclear weapons proliferation
  - Nuclear explosion
  - Loss of life
- On-site radiological sabotage
  - Radiation exposure to employees
  - Radiation exposure off-site to the public
  - Radioactive material contamination of the environment
  - Increased cancer rate and deaths

Identify target characteristics:

- Theft of nuclear materials
  - Location of nuclear materials
  - Quantity of nuclear materials
  - IAEA categorization, INFCIRC/225/Rev. 4
- On site radiological sabotage
  - Reactor vital areas
  - Spent nuclear fuel
  - Certain radioactive sources

Threat Definition

- Design Basis Threat (DBT) for each nation:
  - Credible assumed adversary force
  - Developed using systematic methodology
  - Based on State's evaluation of the threat
  - Accepted by all security-related agencies
  - Provided by competent authority to facility operator
  - Used as requirement for system performance

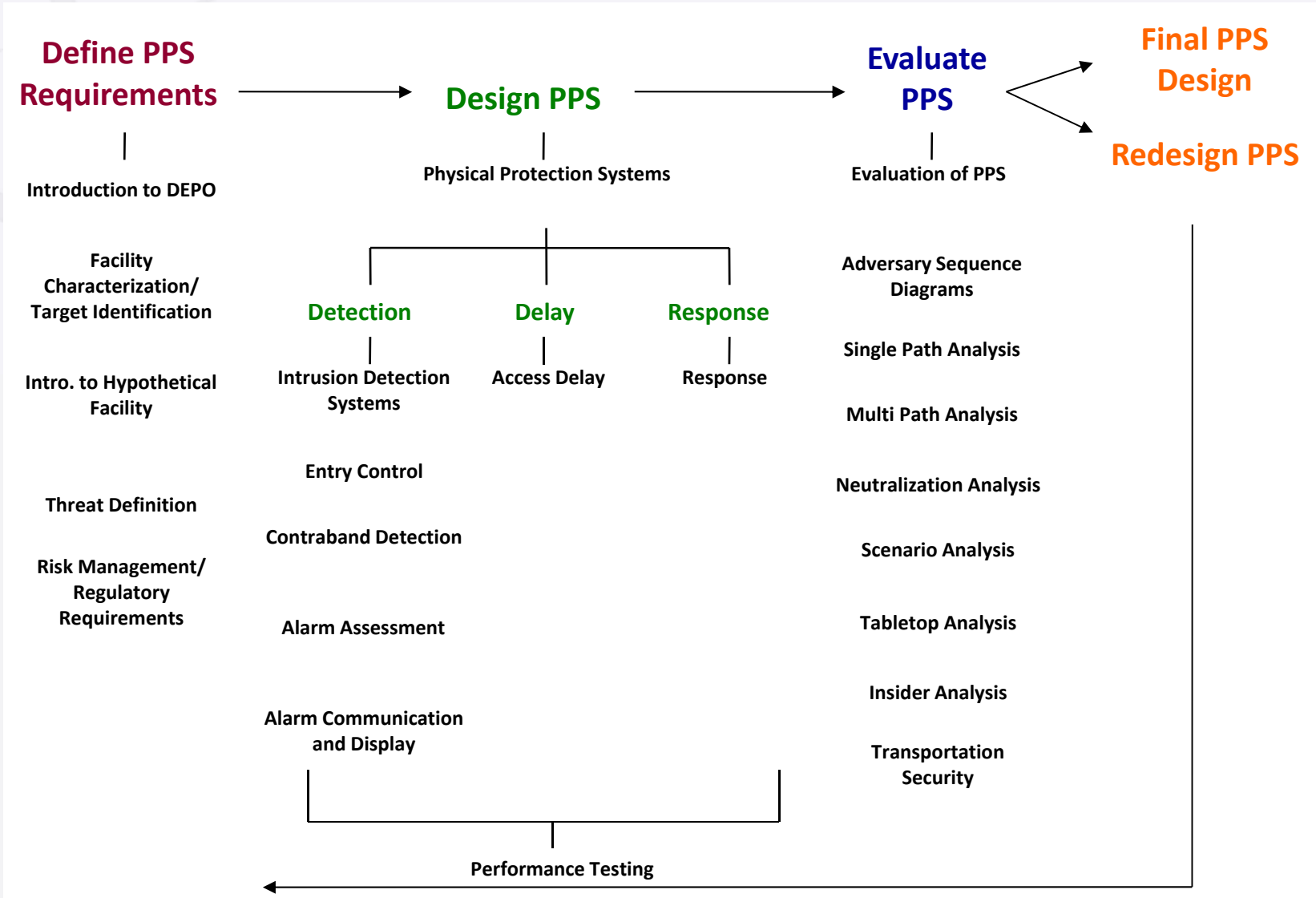
Risk Management

- Risk management is the responsibility of the state's government
- The state makes a tradeoff between reducing the risks and reducing the costs
- Risks are potential losses due to theft or sabotage
- Risk is a function of:
  - Likelihood of malicious acts
  - Effectiveness of physical protection system
  - Consequences of malicious acts
- Risk is difficult to quantify
  - Attack probability is unknown
  - Risk factors have some interdependence
  - Consequences depend on PPS and mitigation

Regulatory Requirements

- Physical protection of nuclear facilities and materials is the right and responsibility of every sovereign state
- State government establishes laws for the state's system of physical protection regime
- Competent authority establishes regulations and is responsible for oversight of physical protection
- Facility operators implement physical protection and are responsible for satisfying state requirements

Design and Evaluation Process Outline (DEPO)



Summary

- Understand that elements of nuclear security impacts and is impacted by nuclear safety and safeguards
- The objectives of a PPS are:
  1. Protect against unauthorized removal of nuclear material (theft).
  2. Protect against sabotage of nuclear facilities and material (sabotage).
- PPS design and evaluation approaches include expert, features, component criteria, and system performance
- GNEII emphasizes the performance-based PPS effectiveness approach
- Three basic steps of DEPO are define PPS requirements, design PPS, and evaluate PPS
- Basic steps to define PPS requirements are to characterize facility, identify targets, define threat, and define the risk

References

- Garcia, Mary Lynn. The Design and Evaluation of Physical Protection Systems. 2nd ed. Boston: Butterworth-Heinemann, 2008. Print.

- Garcia, Mary Lynn. Vulnerability Assessment of Physical Protection Systems. Boston: Butterworth-Heinemann, 2006. Print.

- INFCIRC/225/Rev.5 – The Physical Protection of Nuclear Material and Nuclear Facilities - http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc225.pdf