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DEPO-related to Radioactive Sources

Design and Evaluation Process Outline

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Outline

- **DEPO**
  - Detection Features
  - Entry Control and Personnel Identification
  - Delay Features
  - Deliberate Delays
- **Response Features for Users**
- **Deterrence and Mitigation Importance**

Design and Evaluation Process Outline (DEPO)

Basic PPS Function

Detection Process

—————→ Technologies —————→ Guards

Performance measures:

- Probability of sensor alarm (P_S)
- Communication and assessment time (T_C)
- Probability of correct assessment (P_A)
- Nuisance alarm rate (NAR)
- Probability of detection $P_D = F(P_S, T_C, P_A, \text{NAR})$

Delay Process

Performance measures

- Time to penetrate or bypass barriers
- Time to travel across areas

Response Process

Performance measures

- Probability of communication to response force
- Communication time
- Probability of deployment to adversary location
- Deployment time
- Response force effectiveness (Probabilities of interruption and neutralization)

Two Competing Timelines

- **Adversary Timeline**
  - Cross areas
  - Penetrate or bypass barriers
  - Remove or sabotage target
- **PPS Timeline**
  - Detection process
  - Delay process
  - Response process
- **Overlay of two timelines illustrates requirement for PPS effectiveness**

Adversary and PPS Timelines

Principle of Timely Detection

Principle of Timely Detection: To interrupt the adversary before the theft or sabotage task is completed, the PPS response time must be less than the adversary task time remaining after the first sensing.

Critical Detection Point (CDP): The last sensing opportunity along an adversary path for which the PPS response time is less than the adversary task time remaining after the first sensing

- To be an effective PPS, timely detection must be achieved against the DBT along all adversary paths

Effective PPS Design Principles

In addition to designing a PPS to the concept of timely detection, other effective system engineering design principles for PPS are:

- **Balance Protection:** provides adequate protection against all potential adversaries along all paths to the target
- **Defense in Depth:** uses multiple diverse protective measures along each potential adversary path
- **High Reliability:** implementing design features that reduce the likelihood of system failure

Role of Intrusion Detection

- **PPS functions**
- **Detection**
  - Exterior intrusion detection
  - Interior intrusion detection
  - Assessment
  - Alarm communication and display
  - Entry control
- **Delay**
- **Response**

Performance Characteristics of Intrusion Detection Systems

Probability of Detection (P_D)

$$P_D = P_S * P_A$$

- Where P_S is Probability of Sensing and
- P_A is the Probability of Assessment

Protection in Depth

Courtesy of: World Nuclear News
(http://www.world-nuclear-news.org/nn_uae_picks_korea_as_nuclear_partner_2812091.html)

Exterior Sensor Applications

Interior Sensor Applications

Classification of Exterior Systems

	Passive or Active	Covert or Visible	LOS or Terrain Following	Volumetric or Line Detection
Buried Line				
Ported Coax	A	C	TF	VOL
Fiber Optic Cables	P	C	TF	L
Fence Associated				
Fence Disturbance	P	V	TF	L
Sensor Fence	P	V	TF	L
Electric Field	A	V	TF	VOL
Freestanding				
Active Infrared	A	V	LOS	L/VOL
Passive Infrared	P	V	LOS	VOL
Bistatic Microwave	A	V	LOS	VOL
Dual Technology	A	V	LOS	VOL
Video Motion	P	C	LOS	VOL

LOS= Line of Sight

Passive or Active

Covert or Visible

Covert

- Sensors hidden from view
- More difficult for intruder to detect

Visible

- Sensors in plain view of intruder
- Simpler to install and repair

Volumetric or Line Detection

Volumetric

- Detection in a volume of space
- Detection volume is not visible

Line Detection

- Detection along a line or plane
- Detection zone easily identified

Line-of-Sight or Terrain Following

Line of Sight

- No obstacles in the detection space
- Requires flat ground surface

Terrain Following

- Sensors detect over flat or irregular terrain

Exterior Systems

Tautwire

Passive Infrared

Fence Disturbance

Microwave

Active Infrared

Physical and Environmental Conditions Affecting Exterior Systems

Topography

Vegetation

Wildlife

Background Noise

Climate and Weather

Soil and Pavement

Features of a Good Perimeter Sensor System

- Continuous line of detection
- Protection in depth
- Complementary sensors
- Alarm combination and priority schemes
- Clear zone
- Sensor configuration
- Site-specific system
- Tamper indication
- Self-test capability
- Suitable for physical and environmental conditions
- Integration with assessment system
- Integration with barrier delay

Schematic of a Perimeter System

Classification of Interior Systems

	Passive or Active	Covert or Visible	Volumetric or Line Detection
Proximity			
Capacitance	P	V/C	VOL
Interior Motion			
Microwave	A	V	VOL
Passive Infrared	P	V	VOL
Dual Technology	A	V	VOL
Boundary Penetration			
Electromechanical (BMS)	P	V/C	L
Vibration	P	V/C	L
Glass Break	P	V/C	L
Active Infrared	A	V	L
Fiber Optic	P	C	L

Example Interior Layout

Interior System Detection Zones

Designed Detection Zone
(Interior Microwave)

Designed Detection Zone
(Passive Infrared)

Interior Systems

Environmental Conditions that Affect Interior Systems

- **Electromagnetic radiation**
- **Nuclear radiation**
- **Acoustic energy**
- **Thermal radiation**
- **Optical effects**
- **Seismic phenomena**
- **Meteorological conditions**

Features of a Good Interior Intrusion Detection System

- High PD
- Low nuisance alarm rate
- Uses protection-in-depth
- Detects tampering
- Able to self-test
- Is properly installed: no loose mountings, wiring in conduit, proper location for sensors

Example Interior Sensor Layout

System Selection Considerations

- **Application**
- **Operating principle**
- **Detection capabilities**
- **Conditions for unreliable detection**
- **Typical defeat methods**
- **Major causes of nuisance alarms**

Overall System Recap

- **The role of intrusion detection is to provide the first point of detection for the PPS**
- **Sensors are classified as:**
  - Passive or active; covert or visible; line of sight or terrain following; volumetric or line detection; and by application
- **Protection-in-depth is a multi-layered approach to intrusion detection: both exterior & interior**
- **Exterior technology includes:**
  - Buried line sensors, fence-associated sensors, freestanding
- **Interior technology includes:**
  - Boundary penetration, interior motion, and proximity
- **A good intrusion detection system includes: continuity, protection-in-depth, high probability of detection, low nuisance alarm rates, integration with assessment and delay**

Purposes of Entry Control

- **The purpose of a perimeter security system is to provide a boundary around an area to prevent or detect unauthorized penetrations.**
- **The purpose of entry control is to complete that boundary in a way that securely allows authorized persons and materials to move in and out through that boundary. The System must:**
  - Allow entry of
    - Authorized persons
  - Prevent entry of
    - Unauthorized persons
  - Allow exit of
    - Authorized persons

Definitions for Entry Control

- **Access Authorization:** An administrative determination that an individual is eligible for access to enter a secure area or to access a secure cyber space. For instance, he/she is eligible to enter an are where nuclear materials are stored or where classified material is stored
- **Badge:** credential an individual is provided once access authorization is determined
- **Verification:** determination of access authorization at the entry control point
  - Accepts authorized persons
  - Rejects unauthorized persons

*** Verification vs. Recognition:

- **Verify** = the system compares the recorded template for the claimed identity with the live biometric (**one-to-one**)
- **Recognize** = the system searches through its entire database to find a match (**one-to-many**)

Basics of Personnel Entry Control

- **Something you know**
  - Personal Identification Number (PIN)
  - Password
- **Something you have**
  - Key
  - Card
- **Something you are**
  - Biometric feature (i.e., fingerprints)

Types of Personnel Entry Control

Combination of Factors

Combining two or all three factors greatly increases security

Hand-geometry
Biometrics

Badge swipe and PIN

Features of a Good Entry Control System

- **Integration with the boundary**
  - Cannot be bypassed
  - Block individuals until access authorization verified
  - Interfaces with alarm system
- **Integration with the guards/response force**
  - Protects guards
  - Area is under surveillance
- **Personnel integrate with system**
  - Easy to use for entry and exit
  - Accommodates peak throughput (loads)
  - Accommodates special cases

Application of Good Design Criteria

Contraband Defined

Contraband: any object or material that is prohibited in a security area

- Contraband is also any device or material that can be used by an adversary to gain an advantage in an attempt to commit an act detrimental to a facility.

Metal Detection

- **Types of detectors**
  - Continuous wave
  - Pulsed field
  - Magnetometer
- **Factors that affect sensitivity**
  - Orientation
  - Ferromagnetic materials
  - Shape
- **Installation and use**
- **Weapons, shielding, and bomb detection**

Bulk Detection Systems

- **Purpose**

- Detect any contraband contained in packages (weapons and explosives)

- **Methods**

- Guards/response force manually search packages
- X-ray
  - Transmission and backscatter
  - Single energy and dual energy
  - Computed tomography (CT) scan
- Nuclear techniques
  - Thermal neutron activation (TNA)
  - Nuclear quadrupole resonance (NQR)
  - Low dose X-ray (personnel)

Bulk Systems

When directed at a subject material, X-rays may:

- Continue through material (**transmission**)
- Be **absorbed**
- Be redirected back (**backscatter**)

Explosive Detection: Bulk vs. Trace

- **Bulk**

- Detect a macroscopic amount of explosive directly

- **Trace**

- Detect minute amounts of residual explosive material in the form of vapor or particles
- The vapor pressure of an explosive affects detectability
  - Ex: Nitroglycerin vs. trinitrotoluene (TNT) [340 vs 8 parts per billion]

Bench top for
swipe applications

Hand-held

Nuclear Radiation Detection Systems

- **Purpose**

- Detect theft of Special Nuclear Materials (SNM)
- Discriminate SNM, Radiation Dispersal Devices (RDDs), and accidental contamination from natural, industrial, and medical radiation sources

- **Principle of operation**

- Use detected gamma rays and/or neutrons to identify a threat
- Small distance between the source and detector is important

- **Components**

- Radiation detectors
- Analysis software

- **Types:**

- Scintillating Gamma-Ray Detectors (Plastic or Sodium-Iodide)
- Solid-State Gamma Ray Detectors (Cadmium Zinc Telluride or High-Purity Germanium)
- Gas Discharge Counters (Helium-3 (He-3) or Boron trifluoride (BF-3) (neutron) or Geiger-Muller tubes (gamma))

Vehicle Radiation
Portal Monitors

Handheld Radiation Detectors