Learning Objectives

After completing this module, you should be able to:

• Identify an Adversary Sequence Diagram (ASD) and describe what it represents
• Describe why an ASD is useful in the analysis of a PPS
• Identify the three steps to use when developing an ASD
• Develop an ASD for an example facility
INFCIRC/225/Revision 5

- Chapter 4 – Requirements for measures against unauthorized removal of nuclear material in use and storage
- Chapter 5 – Requirements for measures against sabotage of nuclear facility and nuclear materials in use and storage

Adversary Sequence Diagram Model

Adversary Sequence Diagram

**Adversary Sequence Diagram:** A graphical model used to help evaluate the effectiveness of the PPS at a facility

- ASD represents
  - Paths that adversaries can follow to accomplish sabotage or theft
  - PPS elements along paths
- ASD is used to determine the most vulnerable path for specific PPS and threat
Concept of Adversary Sequence Diagram

- Composed of layers
- Target locations that define an ASD are at the bottom

Three Steps to Create an Adversary Sequence Diagram

1. Model the facility by separating it into adjacent physical areas
2. Define protection layers in terms of path elements between areas
3. Assign minimum probability of detection ($P_D$) and delay time ($T$) for each path element and physical area
Step 1: Model the Facility

- Separate it into adjacent physical areas
Step 2: Define Protection Layers

- Identify protection layers at the facility
- Each protection layer separates two physical areas

![Diagram showing protection layers and path elements]

Step 2: Define Protection Layers (cont’d)

- Identify Path Elements in Protection Layers
  - A Path Element is any distinct part of the protection layer between two physical areas
  - An adversary must pass over, under, around or through a Path Element to move between adjacent physical areas

![Diagram showing path elements within a protection layer]
Step 3: Assign Detection and Delay Values

- Assign minimum Probability of Detection (P_D) and delay time (T) for each path element and physical area

**Path elements**
- Determine minimum P_D
  - Intrusion detection
  - Entry control
  - Human surveillance
  - Contraband and Category 1 detection
- Determine minimum delay time
  - Barriers
  - Security officers
  - Locks
  - Theft or sabotage tasks

**Physical areas**
- Determine minimum P_D
  - Intrusion detection
  - Human surveillance
- Determine minimum delay time
  - Security officers
  - Transit time

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**Sample Facility**

[Diagram of a facility with labeled areas such as Off Site, Site Campus, Fence, Gate, Vehicle Portal, Personnel Portal, Reactor Complex, Reactor Building, Reactor Area, Secure Room, Target, Isolation Zone, and DOORSURFACE.]
Step 1: Model the Sample Facility

- Separate it into adjacent physical areas

![Adversary Sequence Diagram Model]

Step 2: Define Protection Layers - Path Elements in Layer around Site Campus Area

- Off Site
- Site Campus
- Reactor Complex
- Reactor Building
- Reactor Area
- Secure Room

![Adversary Sequence Diagram Model]
Protection Layer around Site Campus Area

Path Elements:
- Off Site
- Site Campus
- Reactor Complex
- Reactor Building Area
- Reactor Area
- Secure Room

Physical Area:
- Fence
- Gate
- Secure Room
- Reactor Building
- Reactor Area
- Isolation Zone

Step 2: Define Protection Layers - Path Elements in Layer Around Reactor Complex

Off Site
- Site Campus
- Reactor Complex
- Reactor Building
- Reactor Area
- Secure Room
- Target
- Isolation Zone
Protection Layer around the Reactor Complex

- Offsite
  - Facility Gate
  - Facility Fence
- Site Campus
  - Personnel Portal
  - Vehicle Portal
  - Isolation Zone
- Reactor Complex
- Reactor Building Area
- Reactor Area
- Secure Room

Path Elements

Protection Layer

Physical Areas

Third Protection Layer at the Sample Facility

- Off Site
- Site Campus
- Fence
- Gate
- Vehicle Portal
- Personnel Portal
- Reactor Complex
  - Reactor Building
    - Reactor Area
      - Secure Room
      - Target
    - Isolation Zone
- Surface
- Door
- Portal
Step 2: Define Protection Layers - Path Elements in Layer around Reactor Building

Path Elements from Reactor Complex to Reactor Building

- Include characteristically different path elements in each protection layer
- Multiple path elements with the same characteristics can be represented by a single element
Completed Site-Specific ASD for Sample Facility

Example of a Jump
Jumps Create Redundancies When Protection Layers Are Identified around Adjacent Areas

- The same path element will appear in protection areas around two or more adjacent physical areas

Path elements in protection layer boundary around Reactor Area

Site-Specific ASD for Sample Facility with a Jump

Representation of Jump
Multiple ASDs May Be Required

- A different ASD may be required for each unique situation
  - Target
  - Target location (glove box versus floor vault)
  - Facility condition (day, night, normal operation, shutdown, refueling, etc.)
  - Adversary objective (theft or sabotage)
  - Threat characteristics
- The complexity of multiple targets may be reduced by examining “worst-case” or “bounding” situations

Step 3: Assign Detection and Delay Values

- Assign minimum Probability of Detection \( (P_D) \) and delay time \( (T) \) for each path element and physical area
  - Path element
    - Determine minimum \( P_D \)
      - Intrusion detection
      - Entry control
      - Human surveillance
      - Contraband and Category 1 detection
    - Determine minimum delay time
      - Barriers
      - Security officers
      - Locks
      - Theft or sabotage tasks
  - Physical area
    - Determine minimum \( P_D \)
      - Intrusion detection
      - Human surveillance
    - Determine minimum delay time
      - Security officers
      - Transit time

Data for the detection and delay values can be found in the hypothetical facility data book.
Minimum Performance Values

- Minimum performance data are used for each path element and physical area to provide a conservative estimate of system performance.
- Review data for each path element and select the minimum performance value that is within the DBT capabilities.
- $P_D$ and delay time values do not have to be for the same DBT tool set.

Path Element Example

- Building Door Characteristics
  - 10-cm wood door with metal sheeting
  - Balanced magnetic switch position sensor
  - Vibration sensor
- DBT capabilities
  - Traveling on foot
  - Hand tools / Power tools
  - Explosives
Path Element Data

- Door penetration time: 30 sec

<table>
<thead>
<tr>
<th>Component Type</th>
<th>Component Description</th>
<th>No Equipment</th>
<th>Hand Tools (sec)</th>
<th>Power Tools (sec)</th>
<th>Explosives (sec)</th>
<th>Land Vehicle (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doors</td>
<td>10 cm wood door with metal sheeting</td>
<td>Infinite</td>
<td>300</td>
<td>180</td>
<td>30</td>
<td>5 for large vehicle door</td>
</tr>
</tbody>
</table>

- Probability of detection: 0.4

<table>
<thead>
<tr>
<th>Component Type</th>
<th>Component Description</th>
<th>No Equipment P(D)</th>
<th>Hand Tools P(D)</th>
<th>Power Tools P(D)</th>
<th>High Explosives P(D)</th>
<th>Land Vehicle P(D)</th>
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</thead>
<tbody>
<tr>
<td>Position Sensors</td>
<td>Position Switch</td>
<td>0.5</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>N/A</td>
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<tr>
<td></td>
<td>Balanced Magnetic Switch</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>N/A</td>
</tr>
<tr>
<td>Barrier Sensors</td>
<td>Vibration</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Glass Breakage</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Path Element – $P_D$ and Delay Time Example

The Twenty-Sixth International Training Course
Page 15
### Physical Area Example

- **Research Complex**
  - 30 meters minimum distance from isolation zone to building
  - Random patrol by guards

```
B  Reactor Complex
  East and West Doors
    EAST DOOR
  Wall and Roof
C  Reactor Building
```

- **DBT Capabilities**
  - Traveling on foot
  - Hand tools / power tools
  - Explosives

### Physical Area Data

- **Transit time:** 6 seconds (Data book, Table 18, Running Rates; running with tools)
- **Probability of detection:** 0.02 (Security Officer on random patrol)

<table>
<thead>
<tr>
<th>Component Type</th>
<th>Component Description</th>
<th>No Equipment P(D)</th>
<th>Small Arms P(D)</th>
<th>Light Antitank Weapons (LAW) P(D)</th>
<th>Independent of threat attribute P(D)</th>
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</thead>
<tbody>
<tr>
<td>SO on Patrol</td>
<td>Random</td>
<td></td>
<td></td>
<td></td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Scheduled</td>
<td></td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
</tbody>
</table>
Adversary Sequence Diagram Model

ASD – Physical Area P₀ and Delay Example

<table>
<thead>
<tr>
<th>O</th>
<th>Offsite</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Facility Gate</td>
</tr>
<tr>
<td>A</td>
<td>P₀ = T₀</td>
</tr>
<tr>
<td></td>
<td>Personnel Portal</td>
</tr>
<tr>
<td>B</td>
<td>P₀ ≤ 0.6</td>
</tr>
<tr>
<td></td>
<td>East and West Doors</td>
</tr>
<tr>
<td>C</td>
<td>P₀ = T₀</td>
</tr>
<tr>
<td></td>
<td>Door in Reactor Area</td>
</tr>
<tr>
<td>D</td>
<td>P₀ = T₀</td>
</tr>
<tr>
<td></td>
<td>Secure Room Door</td>
</tr>
<tr>
<td>E</td>
<td>P₀ = T₀</td>
</tr>
</tbody>
</table>

Requirements Can Be Linked to ASD Features

• May be useful to identify security areas associated with physical areas
Summary

• An ASD represents
  ▪ Paths that adversaries can follow to accomplish sabotage or theft
  ▪ PPS elements along paths
• ASD is used to determine the most vulnerable path for a specific PPS and threat
• Three steps used to create an ASD
  1. Model the facility by separating it into adjacent physical areas
  2. Define protection layers in terms of path elements between areas
  3. Assign probability of detection (P_d) and delay time (T) for each path element and physical area