Module 13

Protracted Theft Analysis
Learning Objective

• Recognize situations/opportunities for protracted theft strategies
• Review methodology for analysis of protracted theft
• Apply methodology to URF
Material Accounting (MA) systems provide delayed detection capability against protracted theft

• MA systems may not be effective for *prompt* detection of abrupt theft

• Bulk material inventory differences exceeding acceptable limits or a discrete item not in its authorized location when needed for processing may provide *delayed* detection

• Need to take into account
  ▪ Measurement errors
  ▪ Timing of protracted theft activities and subsequent MA activities
  ▪ Potential insider subversion of or tampering with MA safeguards
  ▪ Potential differences in effectiveness of subsequent MA activities if the first occurrence failed to detect theft
Alternative protracted theft strategies and protection elements must be examined

<table>
<thead>
<tr>
<th>Step</th>
<th>Strategies</th>
<th>Protection elements</th>
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<tbody>
<tr>
<td>1</td>
<td>Acquire target protracted</td>
<td>5 acquisitions 1,000 g each 1 day each</td>
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<td>2</td>
<td>Remove from MAA</td>
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<td>Clean waste</td>
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<td>Rad waste</td>
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<td>3</td>
<td>Remove from PA</td>
<td>ECP</td>
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Three Primary Detection Opportunities for Protracted Theft Scenarios

1. Detect during each acquisition of material
   - Access control (e.g., badge reader)
   - Material control (e.g., two person rule)

2. Detect reduction in inventory during scenario
   - Periodic physical inventory taking, process calls or material transfer checks may reveal absence of material
     - Material transfers could be within MBA, between MBAs or off site

3. Detect during illicit removal from site
   - Material control (e.g., material transfer forms)
   - Access control (e.g., fence and other physical barriers)
   - Physical protection (e.g., radiation portal monitors)
Three Phases Of Protracted Theft Can Be Detected With PP, MC And MA Systems

Acquisition(s)

Each abrupt removal to staging area could be detected with access and material control systems ($P_{da}$).

Accumulation profile

Periodic or random inventories at $t_1$ and $t_2$ could detect missing material or material out of place.

Exit(s)

Each abrupt removal from site could be detected with physical protection and material control systems ($P_{de}$).

PP – physical protection, MC – material control, MA – material accounting
Specify The Parameters Of The Protracted Theft Scenario

1. Insider access, knowledge and authority – determines $P_d$ during acquisition

2. Timing of acquisitions – time required for each acquisition, time interval between acquisitions, number required for goal quantity

3. Accumulation area

4. Timing of exit activities – time for each exit, number of exits, time interval between exits
Specify Material Accounting Activities

• Inventory and production schedules
  ▪ Inventory sampled or required for production (%)
  ▪ Time between inventories or process calls – scheduled or average time between random inventories

• Effectiveness
  ▪ $P_d$ for each insider type - may be small or zero if the insider is responsible for conducting inventories or maintaining records
  ▪ $P_d$ for first inventory
  ▪ $P_d$ for each subsequent inventory – overall probability of detection will increase over time as more material is diverted
Trend Analysis Is Used To Detect Protracted Theft Attempts

- Use cumulative sum (CUSUM) statistical tests
  - Sum likelihoods of observed inventory differences (ID) assuming normal material unaccounted for distribution
    - ID distribution may have negative mean caused by process hold up
    - Variance of ID distribution may change due to equipment modifications or environmental variables
  - Initiate alarm when sum exceeds threshold
    - Or change in slope
    - Or sequence of points near alarm limit
    - Or change in process variance
- For a sequence of two IDs
  - $ID_1 = PB_1 - PE_1 + X_1 - Y_1$
  - $ID_2 = PB_2 - PE_2 + X_2 - Y_2$
  - Do not expect successive IDs to be independent ($PE_1 = PB_2$)
EWMA Or CUSUM Statistical Tests Typically Used For Trend Analysis

- Inventory difference drifts down during protracted theft
- Measurements have error distributions shown
- Probability of detection may change over time
Protracted Theft Scenario Analysis Incorporates PP, MC And MA Factors

• Acquisition and exit events
  ▪ Use abrupt theft techniques

• Material accounting system
  ▪ Compute cumulative probability of detection during protracted theft timeline

• Overall probability of detection for scenario is:

$$P_d = 1 - (1 - P_{da})^n \times (1 - P_d(t))^i \times (1 - P_{de})^m$$

  Avoid detection during n acquisitions
  Avoid detection during i balance periods
  Avoid detection during m exits

• Perform for each adversary, location and scenario

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Summary Of Protracted Theft Analysis Steps

1. Define alternative protracted theft scenarios (number of acquisitions, staging area, exit attempts and timing of each)
2. Identify layers and physical protection elements that would detect acquisitions and exits
3. Identify material accounting elements that would detect missing or staged materials
4. Identify alternative strategies for each insider action
5. Evaluate effectiveness of each element against each insider action
6. Choose best strategy at each layer
## Exercise: Estimate Pd For Alternative Protracted Theft Scenarios

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<tr>
<th>Step</th>
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<th>Protection elements</th>
<th>Pda</th>
<th>Pd(t)</th>
<th>Pe</th>
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<td>Clean waste</td>
<td>Confirmatory check</td>
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<td>NDA measurement</td>
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