



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

	Step	Strategies	Protection elements
1	Acquire target protracted	5 acquisitions 1,000 g each 1 day each	Access and material control
			Physical Inventory
			Process Monitoring
		10 acquisitions 500 g each 1 day each	Access and material control
			Physical Inventory
			Process Monitoring
		20 acquisitions 250 g each 1 day each	Access and material control
			Physical Inventory
			Process Monitoring
2	Remove from MAA	ECP	Personnel entry/exit
		Clean waste	Confirmatory check
		Rad waste	NDA measurement
3	Remove from PA	ECP	Personnel entry/exit

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)

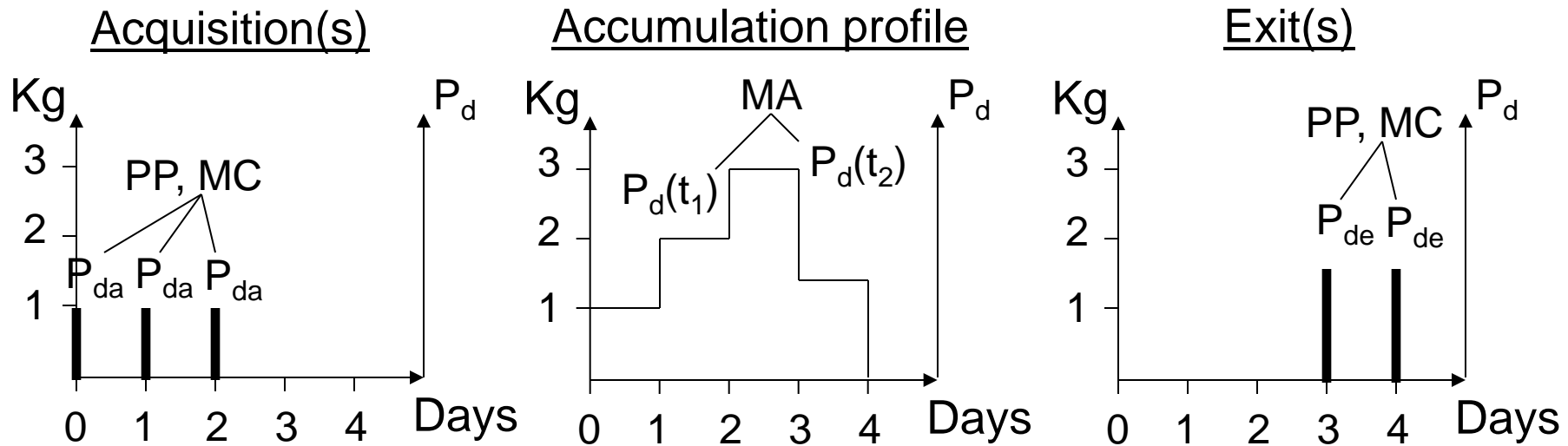
2. Detect reduction in inventory during scenario

- 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



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

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

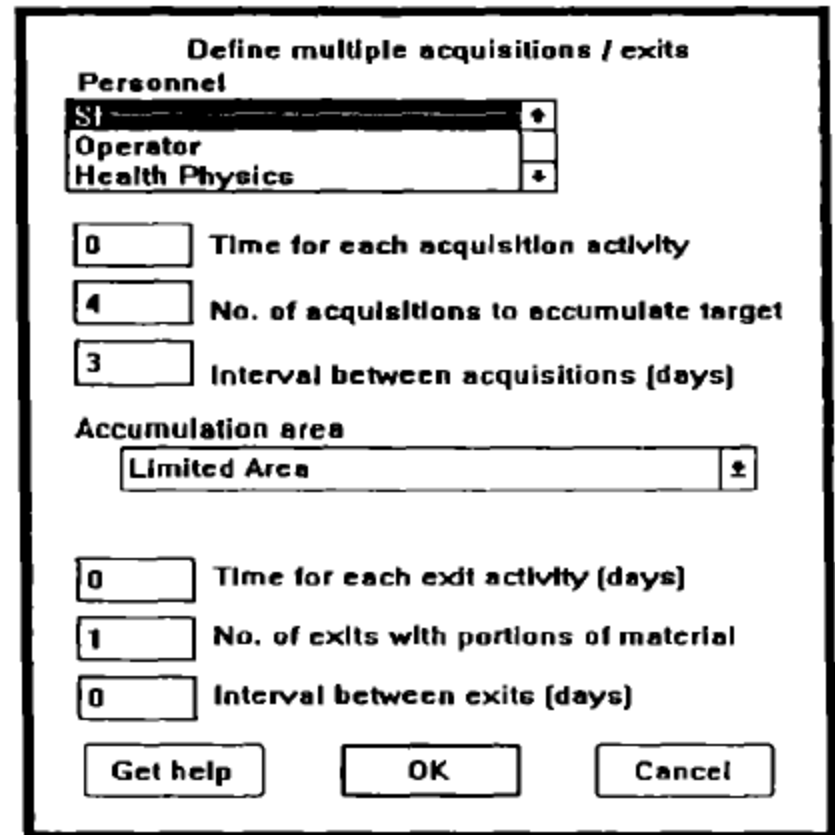
Each abrupt removal from site could be detected with physical protection and material control systems (P_{de}).

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

ASSESS Screenshot



Define multiple acquisitions / exits

Personnel

SI	+
Operator	
Health Physicist	-

Time for each acquisition activity

No. of acquisitions to accumulate target

Interval between acquisitions (days)

Accumulation area

Time for each exit activity (days)

No. of exits with portions of material

Interval between exits (days)

Get help OK Cancel

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

Define Material Accounting Activities

Name

Time interval in Activity is
 Scheduled
 Random

Target location

Personnel	Pd 1st	Pd 2nd	
SI	0.20	0.20	<input type="button" value="↑"/>
Operator	0.20	0.20	<input type="button" value=""/>
Health Physics	0.20	0.20	<input type="button" value=""/>
Maintenance	0.20	0.20	<input type="button" value=""/>
Production Super	0.20	0.20	<input type="button" value="↓"/>

Pd per 1 2

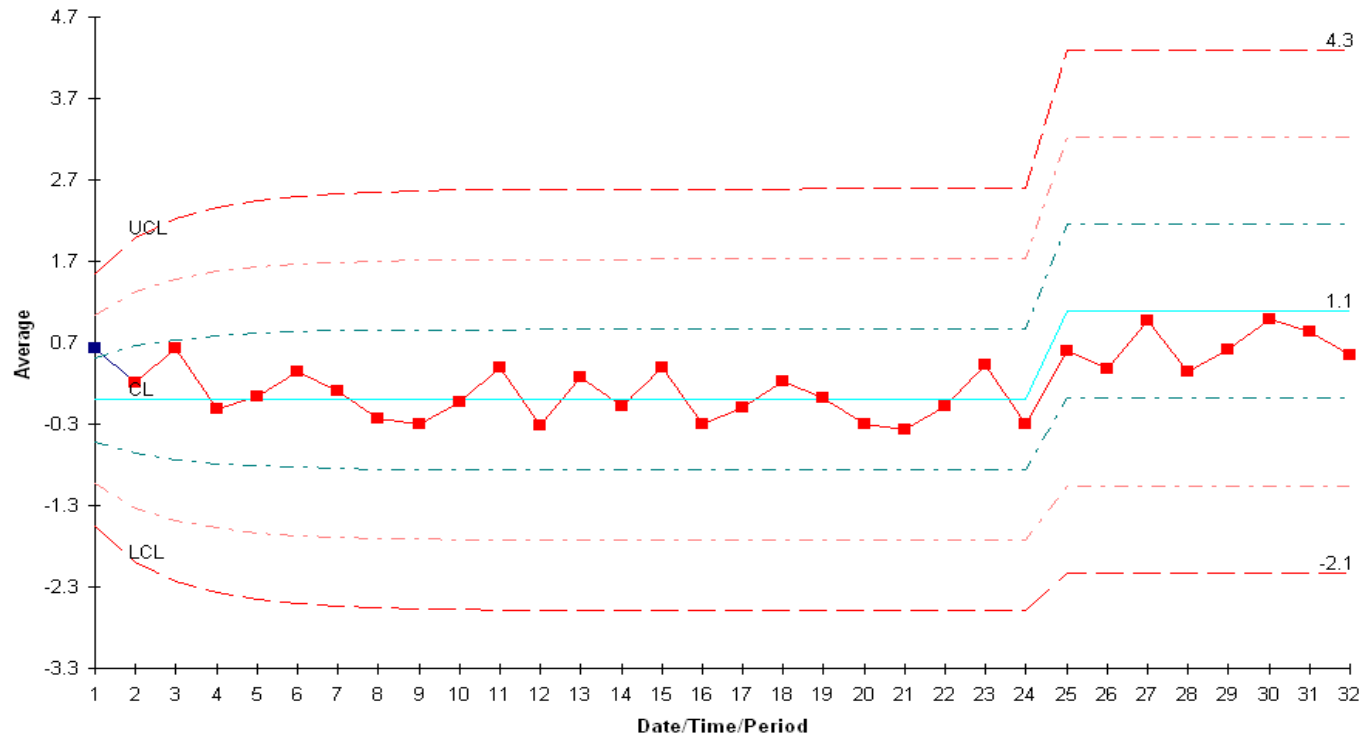
ASSESS Screenshot

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 ($PE_1 = PB_2$)

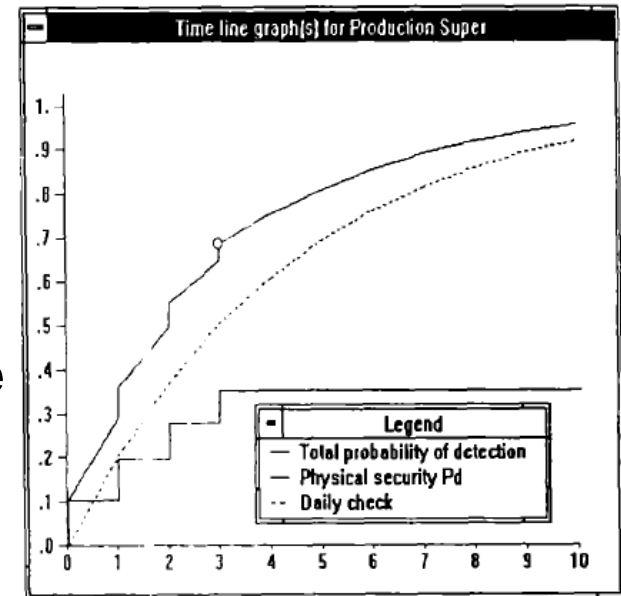
EWMA Or CUSUM Statistical Tests Typically Used For Trend Analysis

- 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

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

	Step	Strategies	Protection elements	Pda	Pd(t)	Pe
1	Acquire target protracted	5 acquisitions 1,000 g each 1 day each	Access/matl. control			
			Physical Inventory			
			Process Monitoring			
		10 acquisitions 500 g each 1 day each	Access/matl. control			
			Physical Inventory			
			Weekly trending			
		20 acquisitions 250 g each 1 day each	Access/matl. control			
			Physical Inventory			
			Process Monitoring			
2	Remove from MAA	ECP	Personnel entry/exit			
		Clean waste	Confirmatory check			
		Rad waste	NDA measurement			
3	Remove from PA	ECP	Personnel entry/exit			