Management of Change

Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

Key acronyms

MOC = *management of change*

RIK = *replacement in kind*

PSSR = *pre-startup safety review*

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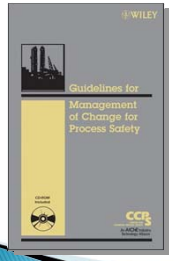
MOC / PSSR resources

CCPS 2008c. Center for Chemical Process Safety, ***Guidelines for Management of Change for Process Safety***, New York: AIChE.



Chapter

1 Introduction
2 Relationship to Risk-Based Safety
3 Designing an MOC System
4 Developing an MOC System
5 Implementing and Operating an MOC System
6 Monitoring and Improving an MOC System
7 The Future of Change Management

CD-ROM (tools; example procedure, forms)

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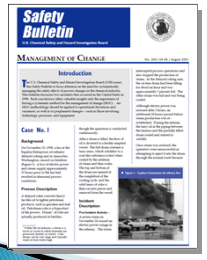
MOC / PSSR resources

CSB 2001. Safety Bulletin No. 2001-04-SB, "**Management of Change**." Washington, DC: U.S. Chemical Safety and Hazard Investigation Board.



(on course CD-ROM)

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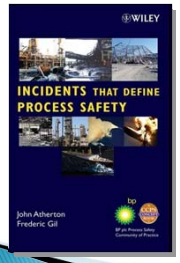
MOC / PSSR resources

CCPS 2008b. Center for Chemical Process Safety, ***Incidents that Define Process Safety***, New York: AIChE.



Chapter 8 Management of Change

- Chernobyl, USSR: How a safety enhancement experiment turned into a world-scale disaster, April 26, 1986
- Dutch State Mines Nypro Plant, Flixborough, UK, June 1, 1974

MOC / PSSR resources

CCPS 2007b. Center for Chemical Process Safety, ***Guidelines for Performing Effective Pre-Startup Safety Reviews***, New York: AIChE.

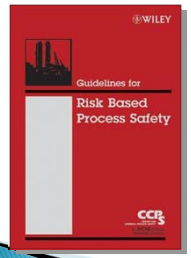
Chapter

1 Introduction
2 What Is a Pre-Startup Safety Review?
3 Regulatory Issues
4 A Risk-Based Approach to PSSR
5 The Pre-Startup Safety Review Work Process
6 Methodologies for Compiling and Using a PSSR Checklist
7 Continuous Improvement

CD-ROM

MOC / PSSR resources

CCPS 2007a. Center for Chemical Process Safety, *Guidelines for Risk Based Process Safety*, New York: AIChE.



Chapter 15 Management of Change
Chapter 16 Operational Readiness

§ .1 Element Overview
§ .2 Key Principles and Essential Features
§ .3 Possible Work Activities
§ .4 Examples of Ways to Improve Effectiveness
§ .5 Element Metrics
§ .6 Management Review

Management of Change

1. Why manage change?
2. What is a "change"?
3. What types of changes need to be managed?
4. What is needed to manage changes?
5. What considerations need to be addressed?
6. What about temporary and emergency changes?
7. What information needs to be updated?
8. What else needs to be done pre-startup?
9. How are changes communicated?

Management of Change

1. **Why manage change?**

> If you want to make enemies, try to change something.
>
> *- Woodrow Wilson*

REVIEW

During "normal operation," all hazards are contained and controlled, so the plant is operating safely.

Key concept

Changes

either

(1) shift the bounds of "Normal Operation"

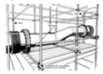
or

(2) put the facility into an "Abnormal Situation"

Flixborough, England 1974

What Happened?

One of the six reactors in series needed repairs. To minimize downtime, it was decided to bypass that one reactor and repair it off line. A temporary bypass line was installed using a pipe with an expansion bellows on each end and supported by scaffolding. Because of the rush to resume production, the new bypass was not tested prior to start up nor were engineering standards or manufacturer's recommendations considered.



Approximately three months later, the expansion bellows in the bypass line failed and released an estimated 30 tons of flammable cyclohexane. The resultant vapor cloud ignited killing 28 people and injuring 89 more. The entire plant was destroyed and hundreds of homes and stores were damaged.

See the Chemical Safety Board web site: http://www.csb.gov/safety_publications/docs/moc082801.pdf for MOC related accidents.

PSID Sponsors see: Free Search—Management of Change

Why this Happened

The temporary modification was not adequately reviewed for potential adverse consequences!

- The temporary bypass was made with two bends in it because the nozzles on the two tanks were at different levels. The impact of internal forces and flow stresses were not considered on the expansion bellows.
- Expansion bellows were left in place on each end of the bypass line. The suitability of this design and manufacturer's recommendations were not considered.
- The weight of the temporary bypass was not securely supported—it was simply placed on scaffolding. The amount of movement and the effect of that movement on the bellows were not considered.

What You Can Do

- Always follow your company's Management of Change (MOC) procedure. *Remember, temporary changes demand the same rigorous review as do permanent changes.* If you do not utilize a MOC procedure, discuss the value it could provide to your facility.
- Make changes only after thorough hazard reviews have been conducted and approved by qualified experts.
- Use good engineering practices and manufacturer's recommendations.

Evaluate Every change, even Temporary ones—for Expected and Unexpected Consequences

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DISCUSSION

Changes

either

(1) shift the bounds of "Normal Operation"

or

(2) put the facility into an "Abnormal Situation"

Which of these occurred at Flixborough?

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Management of Change

1. Why manage change?
2. **What is a "change"?**

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What is a "change"?

Definition:

Change. Any addition, process modification, or substitute item (e.g., person or thing) that is not a replacement in kind.

- CCPS 2008c Glossary

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What is a "replacement-in-kind"?

Definition:

Replacement-in-kind (RIK). An item (equipment, chemicals, procedures, organizational structures, people, etc.) that meets the design specification, if one exists, of the item it is replacing.

- CCPS 2008c Glossary; see Appx. A for change vs RIK examples

What is a "replacement-in-kind"?

Additional information in RIK definition:

This can be an identical replacement or any other alternative specifically provided for in the design specification, as long as the alternative does not in any way adversely affect the function or safety of the item or associated items.

What is a "replacement-in-kind"?

Additional information in RIK definition:

- For nonphysical changes (relating to procedures, personnel, organizational structures, etc.), no specification *per se* may exist.
- In these cases, the reviewer should consider the design and functional requirements of the existing item (even if nothing is written down) when deciding whether the proposed modification is an RIK or a change.

DISCUSSION

Is the following a ***change*** or a ***replacement in kind*** ?

1. Adding a block valve beneath a pressure relief valve so the relief valve can be removed and tested while the system is still in operation.
2. Making minor editorial changes or typographical corrections to an operating procedure.
3. Adding a break room inside the control building.

DISCUSSION

Is the following a ***change*** or a ***replacement in kind*** ?

4 Ordering the same chemical ingredient from a different supplier.

5 Bringing on board a new production supervisor.

6 Installing a gear pump with the same motor, flow capacity and materials of construction as the piston pump it is replacing.

DISCUSSION

Is the following a ***change*** or a ***replacement in kind*** ?

7 Sampling a waste stream on Tuesday and Friday of each week instead of Monday and Thursday.

8 Replacing a section of piping with a higher grade of steel.

9 Going from 8 hour shifts to 12 hour work shifts.

10 Changing a process setpoint within previously established safe operating limits.

Management of Change

1. Why manage change?
2. What is a "change"?
3. **What types of changes need to be managed?**

What is a "change"?

There are many types of changes, such as:

- Equipment changes
- Procedural changes
- Chemical changes
- Process changes
- Control / limit changes
- ITM changes
- Personnel changes
- Infrastructure changes

All must be managed !

DISCUSSION

Give one example of each type of change.

- Equipment change -
- Procedural change -
- Chemical change -
- Process change -

DISCUSSION

Give one example of each type of change.

- Control / limit change -
- ITM change -
- Personnel change -
- Infrastructure change -

Caution

* Changes that are proposed as <u>improvements</u> can have unintended consequences, so must be managed like all other changes! *

Example: **Chernobyl disaster** (see CCPS 2008b).

"Any change, even a change for the better, is always accompanied by drawbacks and discomforts."

- Arnold Bennett

DISCUSSION

Give some reasons <u>why</u> a permanent change might need to be made to a process plant.

It is not necessary to change.
Survival is not mandatory.

- W. E. Deming

Management of Change

1. Why manage change?
2. What is a "change"?
3. What types of changes need to be managed?
4. **What is needed to manage changes?**

MOC ingredients for success[1]

To manage change successfully and safely, you must have:

- A robust management-of-change program in place
- Clear ownership of the program and its constituent parts

[1]CCPS 2008b p. 193

MOC program essential elements[2]

Essential elements of a robust MOC program:

1 Agree on the **technical justification** for each change

2 **Risk-assess** the proposed change

- Use a multi-disciplined team of competent people
- Include specialists and vendors when needed

[2]CCPS 2008b pp. 193-194

MOC program essential elements

Essential elements of a robust MOC program (cont'd):

3 Put in place a rigorous **design approval system**

- To ensure that the proper engineering standards are applied to the design
- To ensure any deviations from design are approved by an engineering authority of sufficient knowledge and experience

4 Write formal **operating procedures** for the change

- Train all staff who are directly affected
- Obtain confirmation that training has been effective

MOC program essential elements

Essential elements of a robust MOC program (cont'd):

5 Carry out a **pre-startup safety review** to:

- Ensure all recommendations from the risk assessment process have been incorporated into the design
- Ensure any deviations from established standards or practices have been approved at the appropriate level
- Confirm that all integrity testing has been successfully completed
- Confirm that operating procedures and training are complete

MOC program essential elements

Essential elements of a robust MOC program (cont'd):

6 **Monitor** the period of change closely

- With people of sufficient knowledge and experience
- Feeding back any lessons learned for the benefit of future projects

Management of Change

1. Why manage change?
2. What is a "change"?
3. What types of changes need to be managed?
4. What is needed to manage changes?
5. **What considerations need to be addressed?**

MOC considerations

All staff must **follow a written MOC procedure** to assure that all of the following considerations are addressed prior to making any change:

- Technical basis for the proposed change
- Impact of change on safety and health
- Modifications to operating procedures
- Necessary time period for the change
- Authorization requirements

- U.S. OSHA Process Safety Management Standard, 29 CFR 1910.119(l)(2)

Written MOC procedure

Aids to develop/implement an MOC procedure:

- Workflow diagrams
  - See Simplified MOC Flowchart on last 2 slides
- Forms
  - Example forms given in CCPS 2008c appendices
- Electronic MOC tracking systems
  - From simple to sophisticated
  - Can tie into plant's work order system
  - Can inform personnel by email
  - Can route MOCs for approvals

Typical MOC procedure outline

Title, Date, Revision No.

1. Purpose
2. Definitions (*change, RIK, emergency change,* etc.)
3. Responsibilities and Accountabilities
4. Initiating a Proposed Change
   - Who can initiate a change
   - Type of change (Chemical, Process, SOP, Equipment, Facilities…)
   - Technical basis for the change
   - Necessary time period for the change

(continued)

5. Evaluating a Proposed Change
   - How the safety/security impact is evaluated and by whom
   - How the safety and health evaluation is to be documented
   - What actions are necessary to safely make the change
6. Authorizing a Proposed Change
   - Who must approve the different types of changes
   - Authorization of emergency changes
   - Authorization requirements for extending a temporary change

(continued)

7. Implementing an Approved Change
   - Making the physical changes
   - Modifying operating procedures
   - Reversing a temporary change; documenting the reversal
   - Training and informing affected employees and contractors
8. Updating the Process Safety Information
9. Performing the Pre-Startup Safety Review
10. Recordkeeping Requirements

Process Safety Beacon

http: //www.aiche.org/ccps/safetybeacon.htm

Messages for Manufacturing Personnel

Sponsored by CCPS Supporters

June 2005

Too Many Start-Stop Switches

PSID Members see: Free Search--Agitator

Here's What Happened

The evening shift was assigned to clean an agitated mixing vessel. The supervisor asked the lead operator to complete the "Lock out." The lead operator tagged and locked out the motor starter in the Motor Control Center, verified the motor would not start by pressing the Start button and put a lock and "Danger—Do Not Operate" tag on the Start-Stop station near the vessel. The supervisor then issued the Confined Space Entry permit and two workers entered the vessel and cleaned it for the rest of the shift.

The oncoming day shift needed to reissue the Confined Space Entry permit. When they tried the Start button on the Start-Stop station, the agitator started! The agitator motor was **NOT** locked out!

http://www.psidnet.com

How Did This Happen ?

Easier than you might imagine. Did the Lock-out undo itself? No, but the wrong motor was locked out. How can that happen when the starter was labeled the same as the agitator? And, why didn't the agitator start when the Start button was tested the first time?

Here's how. Several months before, the agitator motor was changed out to a larger size. The size increase required a larger motor starter and wiring. Because the plant might need the "old" system again some day, it was not removed. Instead, a new Start-Stop station was installed near the vessel, in fact, right next to the old Start-Stop station. The "old" Start-Stop station was on the flange part of a column next to the vessel and the "new" Start-Stop station was in the web of that same column. When the technician locked out and tested the system, he was testing the "old" system which was disconnected. The "new" system was still active!

What You Can Do

- Follow all safety procedures as written. Do not take short cuts or assign your duties to someone else.
- Keep abreast of changes in your unit. Know what has been changed and how that change might affect your job.
- Use your Management of Change procedures to ensure that all out-of-service equipment is labeled so that it cannot be confused with equipment being used.
- Consider disconnecting electrical leads whenever uncertainty exists.
- Check and re-check, especially where safety is concerned. Look around the area. Is anything unusual?
- Remember that your safety depends on others and your own personal actions. Don't bet your life on someone else's word. Verify safety checks yourself.

When you do a safety check, make sure it is on the right equipment !

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DISCUSSION

Discuss the lockout near-miss situation.

- What could have happened?
- How could this been avoided?
- Where does this fit into Management of Change?

Management of Change

1. Why manage change?
2. What is a "change"?
3. What types of changes need to be managed?
4. What is needed to manage changes?
5. What considerations need to be addressed?
6. **What about temporary, emergency changes?**

What is a "temporary change"?

Definition:

Temporary change. A change that is implemented for a short, predetermined, finite period.

- CCPS 2008c Glossary

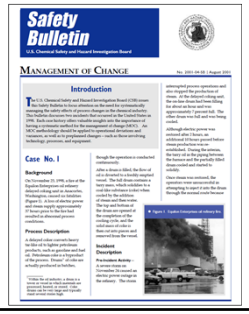
DISCUSSION

Give some reasons why a *temporary* change might need to be made to a process plant.

Temporary changes

"Temporary" changes have led to many severe process safety incidents.

- Flixborough (1974) is an example of a temporary equipment modification
  - **See CSB 2001** (on CD-ROM) **for two incidents involving *deviations from normal operating procedures due to abnormal situations***


Safety Bulletin
U.S. Chemical Safety and Hazard Investigation Board

MANAGEMENT OF CHANGE

Introduction

Case No. 1

Background

Process Description

Incident Description

Temporary changes

A temporary change must go through the same documentation, review and authorization procedure as a permanent change.

IN ADDITION:

- **Change is only authorized for a specific time period**
- **Plant must then be put back to its original state**

What is an "emergency change"?

Definition:

Emergency change. A change needed in a situation where the time required for following the normal MOC procedure could result in an unacceptable safety hazard, a significant environmental or security incident, or an extreme economic loss.

- CCPS 2008c Glossary

DISCUSSION

Give two reasons why an *emergency* change might need to be made to a process plant.

Emergency changes

Typical considerations for emergency changes:

- Have a procedure in place ahead of time to deal with emergency changes, including authorization requirements
- Obtain and document at least verbal approval from line management (often the plant manager or designee)
- Communicate the change to all affected persons
- Follow up through the normal MOC process as soon as possible

Management of Change

1. Why manage change?
2. What is a "change"?
3. What types of changes need to be managed?
4. What is needed to manage changes?
5. What considerations need to be addressed?
6. What about temporary and emergency changes?
7. **What information needs to be updated?**

Information updates

The MOC procedure needs to assure that
all information defining "normal operation"
is updated when changes are made; e.g.:

- Process safety information
  - Drawings
  - Chemical data
  - Equipment files
  - Process chemistry
  - Facilities design data
  - Material / energy balances
  - Safe upper and lower limits

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Information updates

The MOC procedure needs to assure that
all information defining "normal operation"
is updated when changes are made; e.g.:

- Process safety information
- Written procedures
  - Operating
  - Maintenance
  - Emergency
  - Safe work practice

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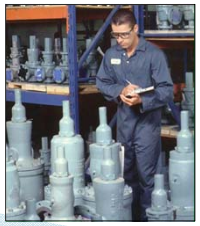
Information updates

The MOC procedure needs to assure that
all information defining "normal operation"
is updated when changes are made; e.g.:

- Process safety information
- Written procedures
- Inspection/testing/maintenance schedules



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Information updates

The MOC procedure needs to assure that
all information defining "normal operation"
is updated when changes are made; e.g.:

- Process safety information
- Written procedures
- Inspection/testing/maintenance schedules
- **Control system documentation**

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DISCUSSION

What are some challenges to getting the process safety documentation updated?

How can they be overcome?

Management of Change

1. Why manage change?
2. What is a "change"?
3. What types of changes need to be managed?
4. What is needed to manage changes?
5. What considerations need to be addressed?
6. What about temporary and emergency changes?
7. What information needs to be updated?
8. **What else needs to be done pre-startup?**

Pre-startup safety reviews

PSSR = *pre-startup safety review*

Pre-startup safety reviews

A PSSR confirms that, before starting up a process:

- ☐ Construction and equipment is in accordance with design specifications
- ☐ Safety, operating, maintenance, and emergency procedures are in place and are adequate
- ☐ Training of each employee involved in operating a process has been completed
- ☐ Modified facilities have completed the MOC process
- ☐ For new facilities, a process hazard analysis has been completed and recommendations are resolved

- U.S. OSHA Process Safety Management Standard, 29 CFR 1910.119(i)(2)

Pre-startup safety reviews

Key elements of successful PSSRs:

- Performed by **team** of knowledgeable persons
- Includes a **field inspection** of modified facilities
- Uses a **checklist** to ensure completeness (see CCPS 2007b)
- Generates list of pre-startup **follow-up items**
- Is **integrated** with the MOC procedure

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Pre-startup safety reviews

Note:

- Larger projects may require multiple PSSRs
- Non-physical changes, such as modifications to operating procedures, may not require PSSRs
- PSSRs are part of the more general idea of "operational readiness" (see CCPS 2007a)

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Management of Change

1. Why manage change?
2. What is a "change"?
3. What types of changes need to be managed?
4. What is needed to manage changes?
5. What considerations need to be addressed?
6. What about temporary and emergency changes?
7. What information needs to be updated?
8. What else needs to be done pre-startup?
9. **How are changes communicated?**

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Communication of changes

Inform of and **train in** the change:

WHO?

- Employees involved in operating a process
- Maintenance and contract employees whose job tasks will be affected by a change in the process

WHEN?

- Before starting up the process or affected part of the process.

- U.S. OSHA Process Safety Management Standard, 29 CFR 1910.119(l)(3)

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Communication of changes

Inform of and **train in** the change:

HOW?

- Through plant training program when needed
  - Use appropriate techniques
  - Verify understanding
- Otherwise inform, such as by
  - Safety meetings
  - Beginning-of-shift communications
  - E-mail
    - Document training/informing

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Communication of changes

Inform of and **train in** the change:

WHAT?

- Physical changes
- Personnel or responsibility/accountability updates
- Operating/maintenance procedures
- Emergency procedures; Response Plan
- Safe work practice procedures
- Control limits or practices

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DISCUSSION

A process manufactures a key chemical intermediate by an exothermic chemical reaction.

The plant chemist has an idea that if a particular new catalyst is used, the yield will be increased by 5%.

- ***This change might lead to what kinds of process safety issues?***
- ***What kind of training or informing might be needed?***

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MOC "To Do" List

- ☐ **Regularly train all staff to recognize change.**
  - MOC awareness training
  - Changes vs RIKs
  - Refresher training

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MOC "To Do" List

- ☐ Regularly train all staff to recognize change.
- ☐ **Follow a written procedure to manage changes.**
  - Assign roles, responsibilities, accountabilities
  - Include temporary and emergency changes
  - Describe the entire process for managing changes

NOTE: Different procedures can be followed for different types of changes (equipment, personnel, control system, operating procedure changes, etc.)

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MOC "To Do" List

- ☐ Regularly train all staff to recognize change.
- ☐ Follow a written procedure to manage changes.
- ☐ **Review all proposed changes for safety impact.**

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MOC "To Do" List

- ☐ Regularly train all staff to recognize change.
- ☐ Follow a written procedure to manage changes.
- ☐ Review all proposed changes for safety impact.
- ☐ **Have all changes approved before making them.**

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MOC "To Do" List

- ☐ Regularly train all staff to recognize change.
- ☐ Follow a written procedure to manage changes.
- ☐ Review all proposed changes for safety impact.
- ☐ Have all changes approved before making them.
- ☐ **Properly reverse all temporary changes.**
  - Go back to exactly how it was before, or do a MOC
  - Don't exceed the authorized time limit
  - Go through the MOC process again to make permanent
  - Inform all affected persons of the reversal
  - Document the reversal

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MOC "To Do" List

- ☐ Regularly train all staff to recognize change.
- ☐ Follow a written procedure to manage changes.
- ☐ Review all proposed changes for safety impact.
- ☐ Have all changes approved before making them.
- ☐ Properly reverse all temporary changes.
- ☐ **Update all process safety information.**

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MOC "To Do" List

- ☐ Regularly train all staff to recognize change.
- ☐ Follow a written procedure to manage changes.
- ☐ Review all proposed changes for safety impact.
- ☐ Have all changes approved before making them.
- ☐ Properly reverse all temporary changes.
- ☐ Update all process safety information.
- ☐ **Communicate changes to all affected persons.**
  - Including reversal of temporary changes
  - Re-training may be required for some changes

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MOC "To Do" List

- ☐ Regularly train all staff to recognize change.
- ☐ Follow a written procedure to manage changes.
- ☐ Review all proposed changes for safety impact.
- ☐ Have all changes approved before making them.
- ☐ Properly reverse all temporary changes.
- ☐ Update all process safety information.
- ☐ Communicate changes to all affected persons.
- ☐ **Field-inspect changes before start-up.**

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MOC "To Do" List

- ☐ Regularly train all staff to recognize change.
- ☐ Follow a written procedure to manage changes.
- ☐ Review all proposed changes for safety impact.
- ☐ Have all changes approved before making them.
- ☐ Properly reverse all temporary changes.
- ☐ Update all process safety information.
- ☐ Update all process safety information.
- ☐ Field-inspect all changes before start-up.

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Final suggestions

- Assign an **MOC Coordinator** who is
  - Knowledgeable
  - Conscientious
  - Persistent
  - Detail-oriented
  - Well-organized

Final suggestions

- Assign an MOC Coordinator
- Keep an **MOC Log**
  - E.g., spreadsheet by MOC number
  - Keeps track of status of all MOCs
  - Helps ensure temporary MOCs do not exceed authorized closure date
  - Helps report key MOC metrics to management

Final suggestions

- Assign an MOC Coordinator
- Keep an MOC Log
- Complete **PSSR follow-up items before start-up**
  - Signage
  - Painting
  - Insulation
  - Clean-up
  - Procedure revisions and approvals
  - Training and Communications
  - Paperwork
  - etc.

Final suggestions

- Assign an MOC Coordinator
- Keep an MOC Log
- Complete **PSSR follow-up items before start-up**
  - Signage
  - Painting
  - Insulation
  - Clean-up
  - Procedure revisions and approvals
  - Training and Communications
  - Paperwork
  - etc.

Possible exception:
Red-lined P&IDs not re-drafted

Final suggestions

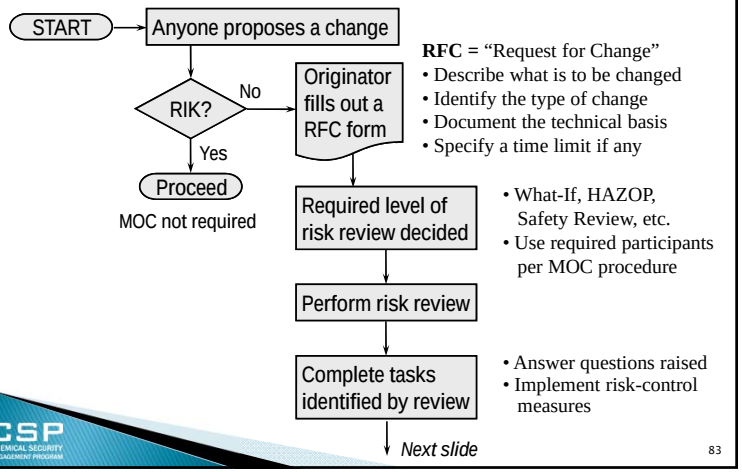
- Assign an MOC Coordinator
- Keep an MOC Log
- Complete PSSR follow-up items before start-up
- Don't short-cut the **safety & health review**!
  - (i.e., the risk assessment)
  - Team-based reviews work best

DISCUSSION

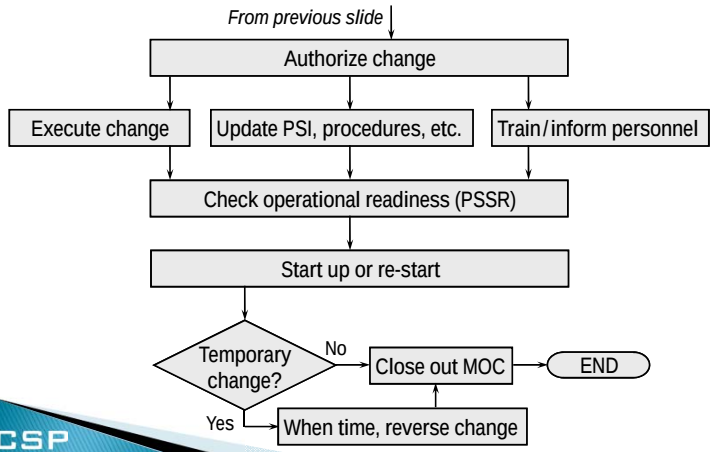
Identify a recent or proposed change at your facility or within your organization, and answer the following questions for that change:

1. What is the technical basis for the change?
2. How might the change impact safety?
3. How might the change impact security?
4. Is it a temporary or permanent change
5. Who should review & authorize the change?
6. Who needs to know about the change?

Simplified MOC Flowchart



Simplified MOC Flowchart (continued)



Responsible Care
Responsible Care Security Code

SAND No. 2010-4653C
Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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Sandia National Laboratories

Overview

- Protecting employees, communities and assets from accidents or deliberate actions <u>is critical to a competitive global chemical industry and to your reputation</u>
- While different, safety and security practices combine to maximize protection of sites and supply chain
- The industry commitment is reflected through globally recognized and award winning Responsible Care programs

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Responsible Care

- Global (52 countries), voluntary initiative to continuously improve and protect the environment and health, safety, and security (EHSS) of our employees and our communities
- A system to manage and publicly communicate EHSS issues - including performance measures – going *beyond* government requirements
- International Council of Chemical Associations (ICCA):
  - Responsible Care is being practiced at over 80% of the chemical industry world wide

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Securing Facilities = Good Business

Levels of U.S. Security

- Before 9/11/01 U.S. chemical security emphasis on:
  - Sabotage (insiders or outsiders)
  - Accidental releases, process safety and employee safety
  - Theft and diversion (for economic reasons, weapons or illegal drug manufacture)
  - Disgruntled employees (targeting other employees or company)
  - Industrial espionage (competitors stealing/spying)
- After 9/11/01 the emphasis broadened to include terrorism
  - Prevention and mitigation of deliberate attacks on facilities added

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Securing Facilities = Good Business

- ACC Responsible Care ® Security Code was approved within the U.S. Chemical industry within 6 months of 9/11/01 and provided the basis for more recent national and state regulations
- Existing employee safety and process safety principles and practices provided the platform to develop and enhance a comprehensive security code program

http://responsiblecare.americanchemistry.com/Responsible-Care-Program-Elements/Responsible-Care-Security-Code

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Securing Facilities = Good Business

Combined, the ACC Responsible Care ® Management System and addition of the Security Code have:

- Improved security against all threats
- Reduced waste
- Reduced theft and diversion of our products
- Enhanced emergency response capabilities
- Protected vital intellectual capital and cyber systems

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ACC Responsible Care® Security Code

- Driven from the CEO level at the company and focuses on three areas of security:

  — Site — Value Chain — Cyber security

- Designed to protect people, property, products, processes, information and information systems
- Covers activities associated with design, procurement, manufacturing, marketing, distribution, transportation, customer support, use, recycle, and disposal of chemical products

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U.S Regulations

- US Department of Homeland Security and Industry working to implement the Chemical Facility Anti-Terrorism Standards –
  - 40,000 sites assessed security risks
  - 7,000 sites were deemed “high-risk” and required to take action
- Coast Guard’s Maritime Transportation Security Act regulations cover additional facilities
- These two programs are very similar to implementations made under the Responsible Care® Security Code
- Legislation from US Congress was required to implement the two Federal Programs
  - 3 of the 50 US States also have security programs in place

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ACC Responsible Care Security Code: Commonalities with U.S. Regulations

- Assess and prioritize risks
- Restrict access
- Prevent theft/diversion and sabotage
- Know your customer/supply chain
- Cyber/information security
- Report incidents
- Coordinate with local law enforcement and emergency response community
- Personnel surety – hire/train/retain quality people
- Verification of appropriate security actions

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Basic Security Practices – Affordable and Effective

- The basis of security starts with hiring, training and retaining good employees
- Employee awareness training and drills are important elements to prevent incidents, or mitigate those that occur
- Community and employee involvement – reporting suspicious or unusual behavior or even un-ethical activities through regular or anonymous hotlines – prevents accidents, or deliberate events

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Save by Limiting Theft and Diversion

Preventing theft or diversion of chemicals and process information can include a range of chemicals and activities throughout the manufacturing site and supply chain

- Chemical weapons or their precursors
- Explosives or their precursors
- Drug precursors
- Information

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Preventing Theft and Diversion

- Security starts with careful screening to hire trustworthy and qualified personnel
  - Personnel identification (e.g., photo ID checks; employee and visitor badges; biometrics)
  - Hand carried items inspection (e.g., visual inspections; x-ray inspections; metal detectors)
- Most threats occur from either inside jobs, or outsiders working with someone on the inside – stop that and your security risk will be dramatically lower
- Minimally - avoid having less qualified personnel working in highly sensitive areas and restrict access to those areas

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Keep watch on critical assets

Surveillance through guards, monitoring systems, bar code tracking etc. help manage key processes and inventory:

- lessens theft/diversion which reduces cost of stolen goods
- Tracks products to ensure they reach the customer
- Reduces likelihood of sabotage or employee violence

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Save on Transportation - GPS

Fleet tracking cuts costs and product losses:

- Tracked vehicles are driven more safely, stay on time and on route
- If diverted, tracking system allows quicker response to protect personnel and recover products
- Valuable equipment/products can be monitored to ensure no tampering
- Keep tabs on rail shipments

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Save by Tracking Inventory

- Evaluation of up and downstream supply chain to ensure they meet your standards
- Verification of purchasers having "legitimate use" for your products
- Reviewing and auditing your distributors
- Evaluating facility and corporate cyber security – protecting processes and critical information from cyber crimes - www.chemitc.com

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Cost of Inaction

Costs to avoid –

- If diverted/stolen, the average tanker truck inventory costs US $35,000, a rail car US $140,000
- Intellectual capital thefts could run in the millions, or eliminate your competitiveness
- Public outcry over an incident hurts the industry credibility and severely damages the company's profitability
  - Property damage
  - Employee injury/death
  - Added regulation

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TEA BREAK

Industrial Waste Management

SAND No. 2011-0486P
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

Hazardous Waste Management

- Hazardous Waste Definitions and Laws
- Hazardous Waste Management
- Waste Hierarchy
  - Reduce / Substitute
  - Reuse
  - Recycle / Recovery
- Hazardous Waste Treatment
  - Wastewater Treatment
- Case Study

U.S. History of Hazardous Waste Pollution

- In 1962, renowned author and naturalist, Rachel Carson, warned growing contamination “great underground seas” (i.e., groundwater) in “Silent Spring.”
- Love Canal – New York, USA. Buried barrels of chemicals underneath new housing development (1950s). Became main cause for the Superfund legislation. Removed from Superfund in 2004.
- Valley of the Drums – Kentucky, USA, 23 acre site with a large number of leaking drums. Fire at site in 1966. Not completely cleaned up until 1990.
- Times Beach – Missouri, USA community where contaminated oil was used for dust control from 1972-1975.

Relevant U.S. Environmental Legislation and UN Convention

Primary U.S. Legislation

- Clean Air Act- 1970
- Clean Water Act – 1972
- Safe Drinking Water Act – 1972
- Resource Conservation and Recovery Act- 1976
- Comprehensive Environmental Response, Compensation and Liability Act of 1980 (Superfund)
- Hazardous and Solid Waste Amendments - 1984 (Land Ban)
- Pollution Prevention Act -1990

U.N. Convention

- Basel Convention 1992- Control of Transboundary Movements of Hazardous Wastes and their Disposal

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Definition of Waste

Definition of Wastes- Basel

"substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law"

Definition of Hazardous Wastes- EPA

" liquid, solid, contained gas, or sludge wastes that contain properties that are dangerous or potentially harmful to human health or the environment."

Characteristic – Ignitable-Corrosive-Reactive-Toxic

Listed – Industrial source-Type

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Organization for Economic Co-operation and Development (OECD) Definition of Waste

- Materials that are not prime products (i.e. products produced for the market) for which the generator has no further use for own purpose of production, transformation or consumption, and which he discards, or intends or is required to discard.
- Wastes may be generated during the extraction of raw materials during the processing of raw materials to intermediate and final products, during the consumption of final products, and during any other human activity.

The following are excluded:

- Residuals directly recycled or reused at the place of generation (i.e. establishment);
- Waste materials that are directly discharged into ambient water or air.

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Surface and Groundwater Contamination Leads to Health Problems, Water Shortage

- **Mining**
  - Acid mine drainage
  - Heavy metals – Hg, Cr, Pb
- **Industrial / Commercial Pollution**
  - Dyes and pigments
  - Petroleum / gasoline
- **Agricultural runoff**
  - Pesticides
  - Nutrients – nitrates, phosphates
  - Salinization – Sodium, chloride
- **Sewage**
  - Pathogens - Enteric
  - Nutrients – Nitrates, phosphates
  - Contaminated animal feed

Textile Waste

Petroleum

Mining Waste

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Drinking Water, Wastewater Contaminants Directly Affect Public Health

Pathogens
- Bacteria – Enteric, fecal
- Protists – Cysts and spores
- Virus - Enteric

Metals
- Copper
- Lead
- Arsenic

Disinfection byproducts
- Trihalomethanes - $CHCl_3$,CH_2Cl_2, CH_2ClBr
- Haloacetic acid – CH_2ClCO_2H
- NDMA

Pesticides

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Solid Waste can Directly Impact Human Health

Solvents
- Gasoline, diesel, chlorinated

Leachates
- Acid waste, heavy metals

Hazardous waste
- Metals, paints, solvents, pesticides

Leaking fuel tanks
- Gasoline, diesel

Refuse
- Decaying animal and plant matter

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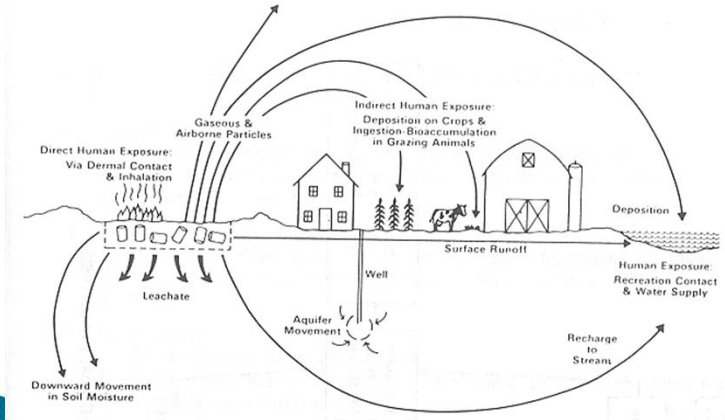
Various Pathways Exist for Contamination From Land Disposal



CHEMICAL SECURITY ENGAGEMENT PROGRAM

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Effective Waste Management Program Involve Planning

1. Define Current Industrial Waste Management Practices.
2. Identify Industrial Waste Management Improvement Options.
3. Compile Findings / Assessment Report.
4. Evaluate Industrial Waste Program Scenarios.
5. Select Preferred Industrial Waste Program.
6. Start the Selected Program.

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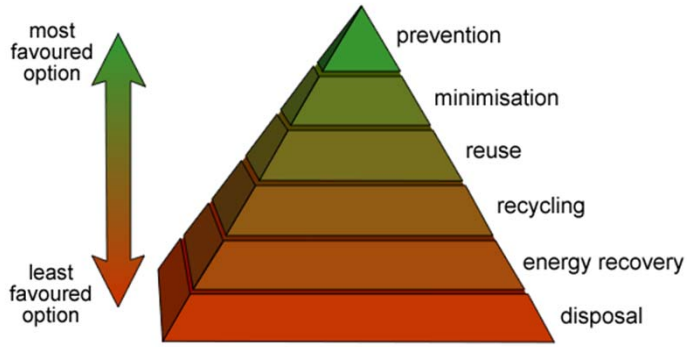
Solid Waste Hierarchy: Reduce, Reuse, Recycle, Treat and Dispose



Source: http://en.wikipedia.org/wiki/Waste_hierarchy

Industrial Hazardous Waste Reduction

- Reduce the amount of reactants necessary
- Incorporate green chemistry
  - 12 principles–reduce energy, catalysis, reduce derivatives, design to decompose….
- Improve recovery of product
- Reuse/recycle off-specification product
- Separate waste streams (cooling water, storm water, process water)
- Combine streams for neutralization

Industrial Hazardous Waste Reduction

- Improve process control
- Improved equipment design
- Use of different raw material
- Good housekeeping
- Preventive maintenance
- Industrial ecology
  - Colocate plants
  - Waste exchange program
  - Waste heat as a resource
  - Beneficial use
  - Waste to energy

Substitution of Hazardous Materials

Substitution of hazardous substances is an innovation process
- Uncertainty of success
- Inertia
- Economic risk assumed to lower ultimate risk

Straightforward systems
Cement
Mineral fibers
Substitution and maintain technical effectiveness

Complex systems
Textile auxiliary agents
Supply chain globally interlinked, more complex products

Metals Recycling – Resource Recovery and Landfill Protection

- Steel
- Aluminum
- Mercury recycling
- Batteries
  - Lead
  - Battery Acid
  - Cadmium
- E-Waste

Off – Specification Materials Returned to Process

Industrial Byproducts can be Recycled

- Construction and Demolition Wastes
- Fly Ash, Bottom Ash, Slags
- Flue Gas Desulfurization Gypsum
- Phosphogypsum
- Red Mud
- Tires

Source: Wikipedia – Harvey Hinklemann

Example: Waste Tires - Technology in Recycling

Simple

- Used to prevent erosion
- Artificial reefs
- Tire derived fuel– cement kiln
- Crushed to crumb rubber for asphalt
- Pyrolyzed to make oil
- Cryogenic grinding– specialty
- High recovery devulcanization

Complex

http://www.youtube.com/watch?v=Vgk1UZ242kM
http://www.youtube.com/watch?v=xmOkvUlpTL0

Example: Spent Catalyst Recovery and Disposal for Petroleum Refineries

- Catalytic cracking- Zeolites regenerated in process
- Hydrotreating – Ni, Mo, W, Co recovery
  - Acid and caustic metals separation and precipitation. (Hydrometallurgical)
  - High temperature fusion (Pyrometallurgical)
- Naptha reforming - Pt or Re on silica or silica alumina support (Recycled for precious metal-chlorinated precipitate)
- Steam reforming - Ni oxide catalyst on alumina support (Nickel recovery Alumina + NaOH)

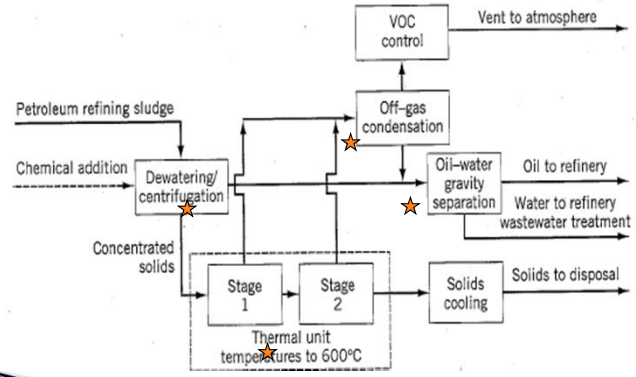
Source: www.matrostech.com

Thermal Technologies for Oily Waste-Recycling Options

Separation - recycle

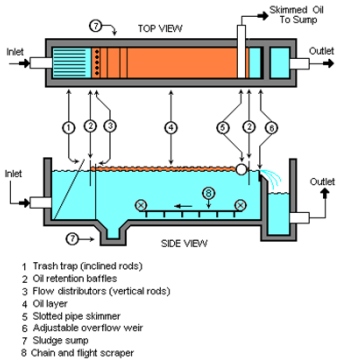
- Solvent Extraction
- Centrifugation - Hydrocyclones
- Air and Steam Stripping
- Distillation
- Recycle

Unit Operations for Product Recovery - Refinery Waste (Thermal Desorb)



Pretreatment of Petroleum Refinery / Oleo Waste

- Heating and decantation with gravity separation
- De-emulsifying
  - Electrostatic coalescers
  - Oil in water
  - Water in oil
- Separation – Centrifugation- Filtration
- Solvent extraction
- Thermal distillation – Product recovery



API Gravity Separator

Source: Milton Beychock Wikipedia

Oily Water Extraction, Separation and Treatment Processes

Solvent Extraction

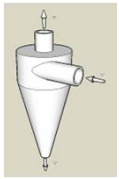
- Preparation (sorting the contaminated material)
  - Extraction
  - Separation of concentrated contaminants from solvent
  - Removal of residual solvent
  - Contaminant recovery, recycling, or further treatment.

Air or Steam Stripping

- Similar to distillation – recovery and recycle of organics
- Steam stripping can recover low VP and soluble compounds

Centrifugation

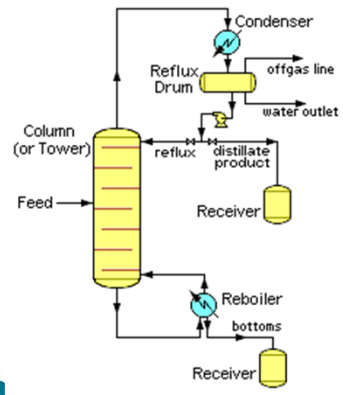
- Hydrocyclone: oil water separator
- Decanter: slop oil, 3 component sludge

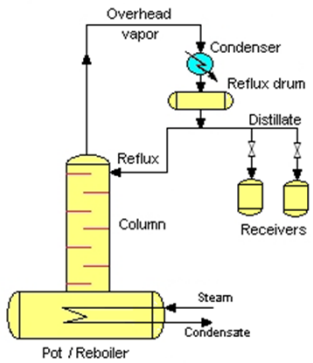


Wet Air Oxidation

- Organic waste oxidation in water
- 150°C-325°C, 300psi-3000 psi

Distillation: Continuous and Batch





Source :H. Padleckas-Wikipedia

Distillation Pros and Cons

- **Advantages**
  - Recovers useable organic solvents from wastes.
  - Product purity of a range of levels can be designed into the distillation process, limited mainly by economic considerations.
- **Disadvantages**
  - Costs of recovery often exceed cost of thermal destruction.
  - Complex operation high capital cost, high energy costs.
  - Columns can be large if a high degree of purity is required (200 feet).
  - Feed must be a free flowing fluid with low solids content.
  - Must be custom designed for a given waste stream not for variable feed.

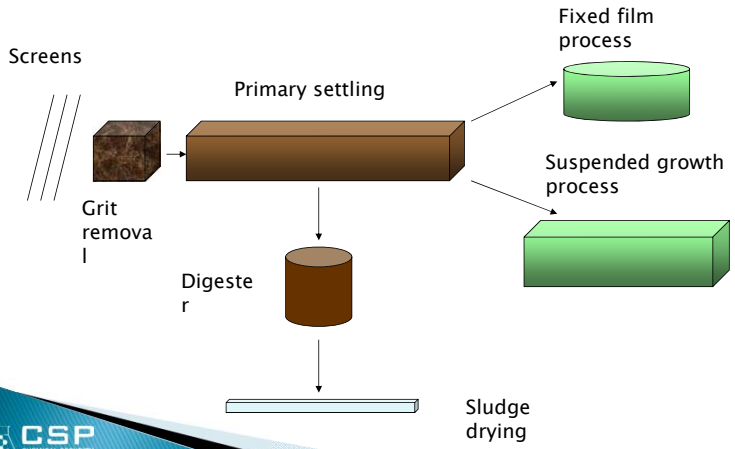
Water Pollution Treatment Processes are Well Established

Water Pollutant	Treatment
Organic chemicals	Air stripping, distillation, oil water separators, adsorption
Biological oxygen demand (BOD)	Aerobic digestion, activated sludge-fixed film and suspended
Chemical oxygen demand (COD)	Aerobic digestion, activated sludge-fixed film and suspended advanced oxidation
Suspended solids (turbidity)	Settling, coagulation, filtration
Color	Coagulation, filtration, adsorption
Metals	Coagulation , filtration, ion exchange, membranes
Microbes	Activated sludge, disinfection
Dissolved solids	Distillation, membranes, electrodialysis, ion exchange

Wastewater Treatment

- Primary
  - Screening
  - Sedimentation /Flotation
  - Hydrocycloning
- Secondary
  - Activated sludge/ lagoons
- Tertiary
  - Oxidation / adsorption
- Dewater sludge
- Digest or incinerate

Wastewater Treatment – Biological Processes



Wastewater-Fixed Film Biological Process

Trickling filter

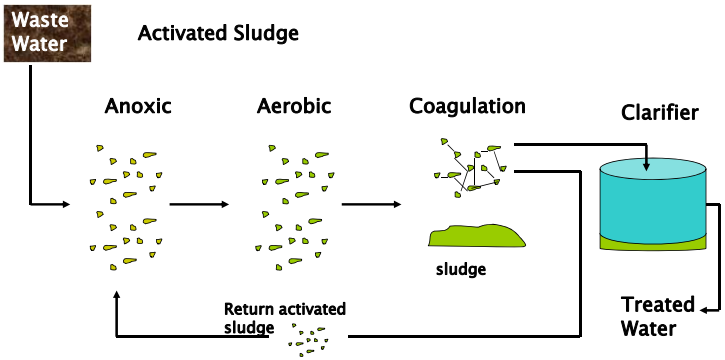
Rotating biological contactor
(40% submerged rotates at 1-1.5 rpm)

Uses biofilm to treat water to remove BOD

Suspended Growth (activated sludge) Process Requires Energy

- Use forced air suspension of biological sludge to reduce BOD
- Largest expense for this process is the electrical energy required

Wastewater Suspended Growth Biological Process



Anoxic – no dissolved oxygen

Wastewater Treatment- Generic

- Coagulation / Flocculation – removes suspended solids whenever natural subsidence rates are too slow to provide effective clarification
  - Water clarification
  - Lime softening
  - Sludge thickening
  - Dewatering
- Solids / Liquid Separation
  - Sedimentation– gravitational settling
  - Air/Gas Flotation
  - Filtration
  - Centrifugation

Wastewater Treatment- Generic (continued)

- Precipitation (Softening) – removes hardness by chemical reaction and settling
  - Lime softening
  - Silica removal
  - Heavy metals removal
- Ion Exchange – removes unwanted ions by transferring them to solid material
  - Anion exchange (weak base, strong base)
  - Cation exchange (weak acid, strong acid)
  - Regeneration with neutralization
  - Ion specific resins (boron removal)

Wastewater Treatment- Generic (continued)

- Neutralization – acid / base addition to adjust pH
  - Neutral pH = 7
  - Neutral pH range = 6 - 9
- Membrane Separation – use membranes to remove suspended and dissolved solids
  - Microfiltration (MF) = removes suspended solids
  - Ultrafiltration (UF) = removes suspended solids
  - Reverse Osmosis (RO) = uses pressure to remove dissolved solids
  - Electrodialysis (ED) = uses electricity to remove dissolved solids

Wastewater Treatment- Generic (continued)

- Adsorption – uses physical adhesion unto porous media to remove unwanted molecules
  - Activated carbon adsorption
  - Resin columns
  - Fluoride removal with alumina
- Evaporation – water vaporization / condensation
  - Flow configurations (rising film, falling film, forced circulation)
  - Energy configurations (multiple effect, vapor recompression)
- Oxidation / Reduction – uses oxidation / reducing agents to remove unwanted constituents
  - Iron & manganese removal
  - Cyanide removal
  - Sulfide removal

US Environmental Protection Agency Resources

LUNCH

Emergency Management & Response

SAND No. 2011-0722C
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Emergency Defined

"An unforeseen combination of circumstances or the resulting state that calls for immediate action"

"An urgent need for assistance or relief"

"May occur without advance warning"

Merriam Webster definition
Photo Credit:http://www.fema.gov/

Emergencies

- Hazardous materials releases
  - Accidental
  - Intentional
- Fires
- Explosions
- Medical

- Natural Occurrences
  - Earthquakes, typhoons, fires, floods, etc.
- Other incidents
  - Bomb threat
  - Terrorism

Emergency Management

- Planning
  - A continuous process
  - Purpose:
    - Avoid the emergency
    - Reduce the impact
- Response/Mitigation
  - Requires highly-trained personnel
- Recovery/Stabilization
  - Community or government support

Emergency Planning

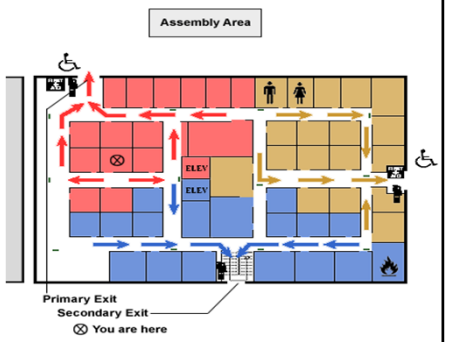
General Plant Emergency Plan

- Involve engineering, safety, & security
- Distribute to and train all employees
- Include in the plan:
  - Roles and responsibilities
  - Procedures for reporting emergencies
  - Emergency phone numbers
  - Procedures for specific emergencies
  - Maps
    - Evacuation routes
    - Assembly areas

Emergency Planning

Have an evacuation map for all buildings and areas and

POST IT



Emergency Planning

Post each area with:

- Emergency phone numbers
- After hours phone numbers
- Person(s) to be contacted
- Alternate person(s)
- Unique hazards & procedures

Location	
Hazards Within:	
Primary Contact:	
Second Contact:	
Building Monitor/Safety:	
Department Head:	
Fire/Police/Ambulance:	911
Envir. Health & Safety (or RSO, if needed)	646-3327

Emergency Planning

Plant Emergency Response Procedures

- Evacuate or shelter in place?
- Respond?
- Who will respond?
  - On-site HAZMAT team?
    - Require training
  - Community fire department?
    - Establish memorandum of understanding
- Medical support
  - In-house?
  - When to call for outside assistance
- Emergency shutdown procedures
- Decontamination procedure

Emergency Planning

General Fire Protection

- Identify your fire and life safety codes
- Inventory your flammable materials
  - Quantity
  - Location
- Secure appropriate flammable liquid storage
- Identify & control ignition sources
- Housekeeping
  - Control combustible materials

Emergency Planning

Post exit signs

Keep exits unlocked or equipped with panic bars.

Emergency Planning

Detection & Mitigation Equipment

Alarms, smoke & heat detectors, sprinklers, emergency lighting and fire extinguishers need to be properly located, maintained, and serviced regularly.

Emergency Planning

Response Equipment

- Initial hazard assessment
- Place in accessible locations
  - Fire extinguishers
  - Spill control kits
  - PPE
  - Respirators
  - DECON showers
- Schedule routine maintenance and inspection of all response equipment

Emergency Planning

American Industrial Hygiene Association Emergency Response Planning Guidelines

- *ERPG-1*

  The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

- *ERPG-2*

  The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

- *ERPG-3*

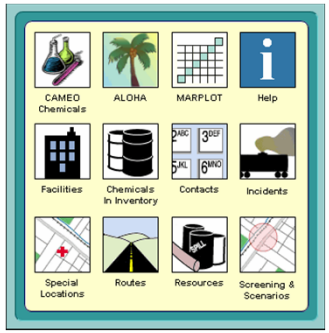
  The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

Emergency Planning

Software Applications

Assist first responders with accessible and accurate response information

- Interactive *Cameo* software modules
- *Cameo Data Management*
  - Location of chemicals
  - Chemical quantities
  - Storage conditions

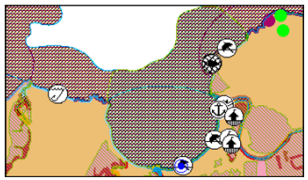


http://www.epa.gov/emergencies/content/cameo/request.htm

Emergency Planning

- Cameo Chemicals
  - Supplies information on the substance released and safe response actions
  - Outputs *chemical response datasheets*
  - http://cameochemicals.noaa.gov
- Mapping applications
  - *MARPLOT*
  - Can overlay a contaminated area over a map
  - Displays threat zones

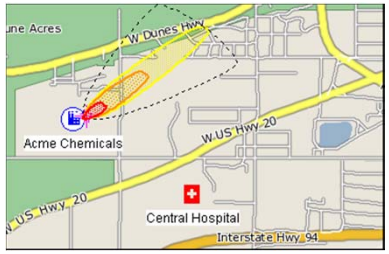
Search *My Chemicals* *Reactivity*



http://www.epa.gov/emergencies/content/cameo/request.htm

Emergency Planning

- Atmospheric dispersion models
- *Aloha* software
- Estimates threat zones associated with chemical releases, including toxic gas clouds, fires, and explosions



http://www.epa.gov/emergencies/content/cameo/request.htm

Emergency Planning

Aloha Software:

- Example of Inputs
  - Enter date, time, location
  - Choose a chemical (Aloha library)
  - Enter atmospheric information
  - Choose a source:
    - direct, puddle, pipeline, or tank
  - Enter source information
    - Release amount, chemical fire
  - Specify the Levels of Concern (LOCs)
  - Choose the type of hazard
    - Toxic vapor cloud or a vapor cloud explosion

Emergency Planning

Unity of Effort:

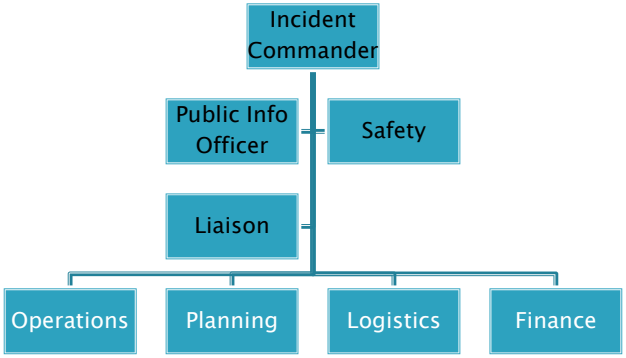
- Success in managing an emergency depends on clear roles and responsibilities and a clear chain of command.
- Use of an Incident Command System (ICS) allows coordination among different jurisdictions and functional responsibilities to interact effectively on the scene.

Emergency Planning

Incident Command System:

- Developed to resolve:
  - Ineffective communication
  - Lack of common command structure
  - Lack of accountability
  - Inability to coordinate resources
- Based on basic business management
  - Plan
  - Direct
  - Organize
  - Communicate
  - Delegate
  - Evaluate

Incident Management System



Emergency Planning

Community Involvement

- Prepare for emergencies involving local communities
  - Communicate!
  - Develop an emergency planning committee
  - Select notification method to community
  - Inform community of hazardous materials at your plant
    - Safety data sheets
    - TOXNET

http://toxnet.nlm.nih.gov/index.html

Emergency Response

Response to Hazardous Materials Incidents

What makes hazardous materials incidents so dangerous?

- Material characteristics may be unknown
- Chemical, physical hazards, biological (?) hazards
  - Toxic
  - Corrosive
  - Flammable
  - Reactive

- Conditions may be confusing
- Limited time to respond to the incident

Who Will Respond?

- Employees?
- Local police and fire department?
- Local ambulance, hospital?
- Military?
- Local HAZMAT team?
- Plant HAZMAT team?

OR, ALL OF THE ABOVE

Emergency Response Decision Making

DECIDE Process

- Detect hazmat presence
- Estimate likely harm
  - Material properties
  - Containment
  - Weather
  - Modeling data
- Decide on objectives
- Identify action options
- Do best option
- Evaluate progress

Benner, L. (1978) *DECIDE for Hazardous Materials Emergencies, Presented Papers.*

Emergency Response Decision Making

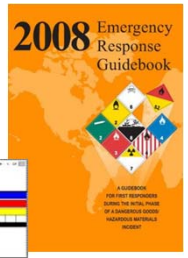
Detect Hazmat Presence

- Worker reports incident/spill/injury
- Odors, smoke, flames, reactions
- Response team detection
  - Instrumentation must be calibrated!
  - Direct reading instruments
    - LEL, oxygen monitors
    - Photoionization detectors
    - Gas detectors-methane, NH_3, CO, Cl_2, H_2S
  - Personal sampling and analysis

Industrial Scientific. http://www.indsci.com/products/#multi
RAE Instruments. http://www.raesystems.com/products
Sensidyne Air pumps. http://www.sensidyne.com

Emergency Response
Estimate Likely Harm

- Material properties
  - Safety data sheets
  - Emergency Response Guidebook
  - ERPGs
- Site conditions
  - Size of spill / release
  - Weather
  - Models
    - Cameo software



Emergency Response
Estimate Likely Harm

Evaluate chemical(s) released:

- By quantity
  - Greater than 500 grams ? (40 CFR 302 & 355)
- Toxicity
  - $LC_{50} \leq$ 200 ppm or 20mg/liter
- Dispensability
  - Boiling point $\leq$ 100º C, $\leq$ 10 microns particle size
- Flammability/Reactivity
  - Flashpoint < 60º C
- Dispersion Modeling
  - Example: AIHA ERPG 1 at 30 meters

(ERPG–1: 2 ppm; ERPG–2: 50 ppm; ERPG–3: 170 ppm)

Emergency Response
Decide on Objectives

Priorities

1. Persons
   - Responders
   - Workers
   - Community
2. Property
   - At the site
   - Protecting community
3. Environment
   - Air, ground and surface water, soil, wildlife

Emergency Response

Initiate the Incident Command System:

- Incident Commander
  - Establishes the strategy and tactics
  - Has ultimate responsibility for incident outcome
  - The position is established for every incident
  - May establish a command post
- Command Staff positions
  - Safety officer
  - Liaison officer
  - Information officer

Identify Action Options

Size of spill determines response

Emergency Response Identify Action Options

Large Catastrophic Incidents

- Perform a risk analysis of response options
  - Should be a continuous process during an event
- Response options are dependent on plant capabilities and approach
  - Mode of response-defensive or offensive?
  - Training levels of responders (HAZMAT trained?)
  - Technical resources
  - External support available?
    - Local fire department or HAZMAT
    - Military

Defensive or Offensive Approach?

Identify Action Options Defensive Options Large Event

- Persons
  - Evacuate if possible
  - Shut off air intakes
  - Shelter-in-place/safe rooms
- Property/Equipment
  - Emergency shut offs
  - Emergency ventilation
  - Purging hazardous gas systems
- Environment
  - Diking water sources

http://earthbagbuilding.wordpress.com/
http://www.sb.fsu.edu/~xray/emergency.html
http://www.lpgventures.com/compliance/page2.html

Identify Action Options Offensive Options Large Event

- Written Standard Operating Procedures
  - For each hazardous material or process on-site
- Select action from alternative strategies
- Select PPE/equipment for responders
  - http://osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9767
  - Ensure compatibility of PPE with hazards
- Safe approach is to select the highest PPE level
- Then, reduce the level when sufficient information on the hazard

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Offensive Options Small Spills

- Spills of < 4 liters
- Must have appropriate PPE, spill equipment and training
- Do not clean up small spills of :
  - Acutely toxic (Low LD_{50}) chemicals
  - Carcinogens
  - Flammable liquids or metals
  - Chemicals of unknown toxicity or hazards

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Offensive Options Small Spills

- Perform a risk assessment of potential spills
- Have a written procedure
  - Who responds to spill?
  - Identify all chemicals and their hazards
  - Identify and purchase appropriate PPE and emergency equipment
  - Describe procedures for:
    - Emergency shutoffs, circuit breakers, valves
    - Injuries and exposures
    - When and how to evacuate

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Offensive Options Small Spills

Minimal equipment:

- Plastic pail/bucket(s) with lids (large enough to contain spill and cleanup material)
- Plastic dust pan
- Broom or brush
- Plastic bags
- Sealing tape
- pH paper
- Sign(s):
  Danger Chemical Spill
  Keep Out

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Offensive Options Small Spills

Maintain complete Spill Kits

- Absorbent material
  - Absorbent pillows or powders
  - Activated carbon for organic solvents
- Neutralizing agents
  - Acid Neutralizers –e.g., sodium bicarbonate ($NaHCO_3$) powder
  - Base Neutralizers-e.g., citric acid powder
  - Solvent Spills-activated carbon

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Emergency Response Restoring Processes

Backup power

Does power switch-over automatically?

How long will it run?

How much fuel do you have?

What areas will it support?

How often is it tested and maintained?

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Post-Incident Follow-up

- Debriefing
- Post-incident investigation
  - Prepare a report of the incident
  - Revise response plans/lessons learned
  - Share lessons learned
  - Keep all records
  - Correct response deficiencies
  - Mitigate identified hazards

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Video – A North Carolina town is evacuated due to fire at waste site

Apex Hazardous Waste Site Fire -
Video file = EmergencyinApe_pdl.wmv 17 min

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Emergency Planning Exercise

- This scenario was taken from an incident investigated by the U.S. Chemical Safety Board that took place on August 14, 2002.
- Approximately 20,000 kilograms of chlorine gas were released from a railroad tank car unloading operation.
- 66 persons in a nearby community sought medical evaluation following the release.

Photo of Actual Chlorine Release

Summary of Incident

Around 9:20 am on March 3, 2011, a 2.5 centimeter chlorine transfer hose used in a railroad tank car unloading operation at the XXX Company facility ruptured, releasing 20,000 kilograms of chlorine. Unloading activities involve transferring liquefied pressurized chlorine gas from the tank car to individual gas cylinders.

Prior to the event, the two employees who were transferring the chlorine put the system on standby, and took their morning break in the break room next to the unloading area.

NOTE THAT WHEN THE SYSTEM IS IN STANDBY MODE, THE HOSE REMAINS CONNNECTED TO THE TANK CAR.

Upon hearing a large pop, the employees ran outside and observed that chlorine gas was being released from the tank car. They manually activated the emergency shut-down (ESD) system. The ESD system was designed to close the valves on the tank car and prevent release of chlorine. Three of the five valves failed to close and chlorine continued to be released from the tank car.

*continued on next slide

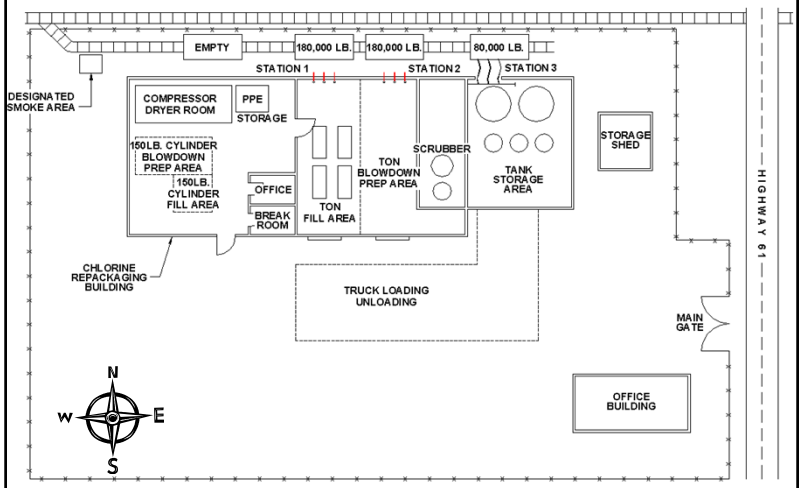
Summary of Incident, continued

A chlorine detection sensor in the facility activated an evacuation alarm. The XXX Company employees, who were also the emergency response team, attempted to respond to the release, but were unable to access the emergency protective equipment (PPE). The equipment consisted of self-contained breathing apparatus (SCBA), a chemical *resistant* suit, gloves, and boots.

The employees evacuated to the designated assembly point. One of the employees called 911 from the assembly point at approximately 7 minutes after the release.

Upon receiving the 911 call, the Local HAZMAT team arrived at XXX Company, but did not have the appropriate PPE to respond to the release and could not shut down the chlorine leak. The HAZMAT team then evacuated the neighboring community. However, sixty-six people still required medical evaluation for respiratory distress. The release continued for 3 hours before the valve on the tank could be closed by the company's HAZMAT team who were finally able to access their emergency equipment (PPE). Two of the Company HAZMAT team received skin burns because they were not wearing fully-encapsulated PPE.

Facility Map



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Tanker Hose Rupture

Photo credit: US Chemical Safety Board

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Emergency Planning Exercise

1. What emergency plans might XXX Company have had in place?

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Emergency Planning Exercise

2. What procedures/practices might XXX Company have for potential equipment malfunctions?

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Emergency Planning Exercise

3. How could the XXX Company emergency response team be better prepared?

Emergency Planning Exercise

4. How could the Local HAZMAT team be better prepared?

Emergency Planning Exercise

5. What improvements might be made in regards to communication between XXX Company and the community HAZMAT team?

Emergency Planning Exercise

6. What improvements might be made in regards to communication with the local community?

Emergency Planning Exercise

7. What did XXX Company and the community HAZMAT team do *right* in planning and responding to this emergency?

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Tea Break

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Sandia National Laboratories

Security Vulnerability Assessments

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SAND No. 2010-4653C
Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

Presentation Objectives

- Discuss the purpose and objectives of security vulnerability assessments (SVA)
- Detail the methodology for conducting a SVA
- Provide discussion and exercises to help practice the SVA methodology

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Key acronyms

ASD – Adversary Sequence Diagram
CCTV – Closed Circuit Television
CSC – Central Security Control
DBT – Design Basis Threat
DEPO – Design and Evaluation Process Outline
DOL – Department of Labor
EPA – Environmental Protection Agency
FAR – Failure Alarm Rate
HVAC – Heating, Ventilation, and Air Conditioning
IR - Infrared
NAR – Nuisance Alarm Rate
OSHA – Occupational Safety and Health Administration
PE – Path Element
PIDAS – Perimeter Intrusion Detection and Assessment System
PPS – Physical Protection System
RF – Radio Frequency
SVA – Security Vulnerability Assessment

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Key Definitions

Collusion Threat – adversaries comprised of insiders and outsiders

Insider Threat – adversary with authorized access

Outsider Threat – adversary with no authorized access

Security Vulnerability Assessment – systematic evaluation process in which qualitative and/or quantitative techniques are applied to detect vulnerabilities and to arrive at an effectiveness level for a security system to protect specific targets from specific adversaries and their acts. (Garcia, 2008)

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Presentation Overview

1. SVA objectives and overview
2. Describe methodology and practice exercises for SVA
   a) Physical Protection System (PPS) objectives
      - Facility characterization
      - Threat definition
      - Target Identification
   b) Design a PPS
      - Detection
      - Delay
      - Response
   c) Analyze PPS design
      - Evaluate effectiveness of safeguards
      - Determine adequacy of safeguards
   d) Identify and implement improvements
3. Compare with process safety

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Primary SVA Objectives

- Detect vulnerabilities (weaknesses) in a facility's ability to protect critical assets against adversaries
  - Theft
  - Sabotage
- Design security systems to achieve a desired level of effectiveness
  - Physical protection systems
  - Cyber security protection systems

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SVA Overview

Understand what is being protected and from what threat it is being protected against

- Facility characterization such as size and intended use
  - Large/medium/small industrial facility
  - Academic chemistry laboratory
- Relevant threats
  - Outsider
  - Insider
  - Collusion
- Target chemical identification and characterization
  - Quantities
  - Physical state

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SVA Overview

- Design a Physical Protection System (PPS) to prevent theft and sabotage
- Four D's
  - Deter – implementation of a PPS which adversaries perceive as too difficult to defeat; difficult to quantify
  - Detect – discovery of unauthorized action against facility and target
  - Delay – use of obstacles to increase the time it takes for an adversary to succeed at given task
  - Defeat – cause to flee; in other cases capture or kill
- Must consider facility and target being protected

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SVA Overview

- Analyze a PPS design
  - Identify system deficiencies
  - Select system improvements
  - Support cost/benefit decisions
- Redesign PPS if additional protection is required
- Remember to consider scope of the SVA

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SVA Methodology

- Design and Evaluation Process Outline (DEPO)
- SVA methodology developed at Sandia to analyze security at critical facilities
- Systematic process
  - Determine Physical Protection Systems (PPS) objectives
  - Design PPS
  - Analyze PPS
  - Finalize PPS design
  - Review and redesign PPS

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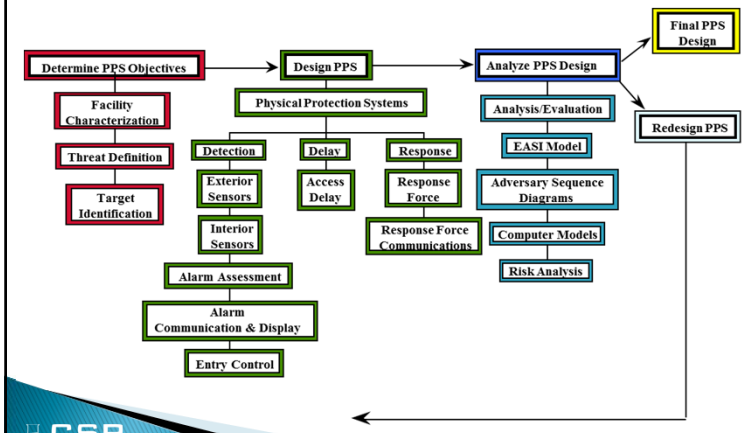
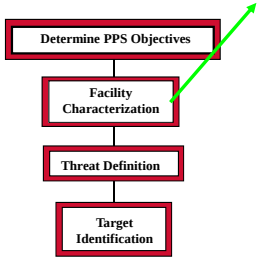
Overview of SVA-DEPO Methodology



Detailing the SVA-DEPO Methodology

1. Determining PPS objectives
2. Designing PPS
3. Analyzing PPS design
4. Finalizing or redesigning PPS design

Detailing the SVA-DEPO Methodology



- Gather as much information as possible about facility
- Requires a mix of tours, document review, interviews, research, and luck
- Identify issues, constraints, and enablers
- Understand the environment
- Leads to understanding of critical assets, their locations, and operational constraints that must be incorporated into final design

Facility Characterization

Characterize the facility in terms of:

- Physical conditions
- Facility operations
- Facility policies and procedures
- Regulatory requirements
- Legal/Liability issues
- Safety considerations
- Agency/enterprise goals and objectives

Facility Characterization – Physical Conditions

Characterize the facility in terms of:

- Site boundary
- Buildings (construction, HVAC systems, communication/network lines)
- Room locations, critical equipment/offices
- Access points
- Existing security technology, procedures, training
  - Detection, delay, response functions

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Facility Characterization – Facility Operations

- Product of facility
- Operating conditions (working hours, off-hours, potential emergencies, shift changes)
- Facility processes and supporting functions
  - Shipping and receiving, payroll, benefits, HR, engineering, marketing
- Types and numbers of employees
- Overlap of physical and cyber systems

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Facility Characterization – Policies and Procedures

- Written and unwritten; it is not uncommon to find that procedures in use are not as documented
- Documentation of work areas (lockers, desk, computer, etc) where there is no expectation of privacy, use of CCTV, drug/alcohol policy, weapons on-site, etc.
- Training on policies and procedures including a schedule of required training, provision of training, and records
- Should include employee responsibilities for security--wear your badge, question/report strangers or suspicious activity, etc

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Facility Characterization – Regulatory Requirements

- In the United States, there are a number of interested regulators:
  - EPA, OSHA, DOL, local and state Fire Code, area politicians
- Depends on size of company, what they produce, and how items are produced
  - Chemical plant compared to a university

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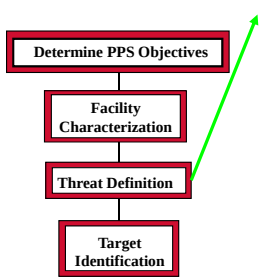
Facility Characterization – Legal Issues

- Invasion of privacy
- Wrongful/negligent hiring
- Excessive use of force
- Due diligence
- Access for the disabled
- Labor law
- False imprisonment
- Failure to protect

Facility Characterization – Safety Considerations

- Safety is <u>not</u> security
  - Security is protection of assets against malevolent human threats
  - Safety deals with abnormal operations such as accidents, bad weather, fires, etc.
- These are overlapping though occasionally conflicting needs; protect assets without injury or death
- Adversary may use a safety event as a diversion

Detailing the SVA-DEPO Methodology



- List information required
- Collect information
- Organize information
- Use all information sources to determine the classes of adversaries

Three Types of Adversaries

- Outsiders – those with no authorized access
  - Terrorists
  - Criminals
  - Extremists/Activists
- Insiders – those with authorized access; may be passive or active
  - Disgruntled employees
  - Blackmailed or coerced employees
  - Criminals
- Collusion – combination of insiders and outsiders

Adversary Information Required to Define Threat

- Motivations
- Goals based on targets
- Tactics
- Numbers and capabilities

Motivations of Adversary

- Ideological
  - Political or philosophical opposition
- Economic
  - Desire for financial gain
- Personal
  - Desire for revenge
  - Mental instability
  - Under threat, coercion

Potential Goals of Adversary

- Theft
- Sabotage
- Other
  - Drug/alcohol abuse or activity
  - Workplace violence

Threat Definition

- Wide range of adversary tactics
  - Stealth
  - Force
  - Deceit
- Capabilities
  - Knowledge
  - Motivation
  - Skills
  - Weapons and tools

Organize Threat Information

- Compile and summarize collected threat information
- Rank adversaries in order of threat potential
  - Likelihood of occurrence
  - Consequence of event
- Result is design basis threat (DBT)

Outsider Adversary

		Type of Adversary		
		Terrorist	Criminal	Extremist
Potential Action Likelihood *(H, M, L)	Theft			
	Sabotage			
	Other _____			
Motivations *(H, M, L)	Ideological			
	Economic			
	Personal			
Capabilities	Number			
	Weapons			
	Equipment and tools			
	Transportation			
	Technical experience			
	Insider assistance			

* H = High
M = Medium
L = Low

Insider Adversary

Insider	Access to Asset (Often, Occasionally, Never)	Access to PPS (Often, Occasionally, Never)	Access to Vital Equipment (Often, Occasionally, Never)	Theft Opportunity *(H, M, L)	Sabotage Opportunity *(H, M, L)	Collusion Opportunity *(H, M, L)

* H = High
M = Medium
L = Low

Defined Threat Example

- Outsider
  - Non-violent attack
  - Two well-trained personnel
  - Hand-held tools
  - No weapons
  - Theft or sabotage goal
  - Insider assistance (passive or active)
  - Land vehicles for transportation
- Insider
  - Employee in any position
  - Operate alone or in collusion with outsiders
  - Same attributes as above

Features of Good Threat Policy

- Established by appropriate entity with relevant information
- Periodic review and revision
- Local assessment supplements national policy
- Addresses insider and outsider potential
- Identifies numbers, motivation, goals, equipment, weapons, and transportation

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Risk Equation

$$Risk\ (R) = P_A \times [1 - (P_i \times P_N)] \times C$$

- P_A = Probability of Attack (1 is worst case scenario)
- P_i = Probability of Interruption (from path analysis)
- P_N = Probability of Neutralization (from data tables)
- C = Consequence Value

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Probability of Attack (P_A)

- In some cases, there is actual data to predict P_A
  - Shoplifting, crime statistics
- In other cases there is no predictable data
  - Terrorists attacks
- Where there is no data, can assume there will be an attack on critical assets, develop a process to determine P_A for other assets

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Probability of Interruption (P_i)

- Probability that a PPS detects adversary and response force prevents completion of intended task

$$P_i = \prod_{1}^{N-1} (1 - P_{D,n}) \times (P_{D,N})$$

- $P_{D,N}$ = Probability of detection on the Nth task

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Probability of Detection (P_D)

- Probability that PPS will lead to assessed detection
- Function of numerous variables

$$P_D = F(P_S, T_C, NAR, PA)$$

- P_S = Probability of sensor alarm
- T_C = Time for communication and assessment
- NAR = Frequency of nuisance alarms
- P_A = Probability of assessment

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Probability of Neutralization (P_N)

- Probability that response force will successfully neutralize adversary
- Sources must be statistically significant
  - Data tables
  - Tabletop exercises
  - Simulated/Actual engagements

$$P_N = \frac{N_{wins}}{N_{engagements}}$$

- N_{wins} = Number of wins
- $N_{engagements}$ = Number of engagements

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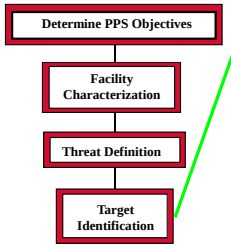
Detailing the SVA-DEPO Methodology



- Prevention of sabotage
  - Identify vital areas to protect
- Prevention of material theft or information loss
  - Identify location of material to protect

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Steps in Target Identification

1. Specify Undesirable Consequences
2. Select Technique for Target Identification
3. Identify Targets

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Undesirable Consequences

- Theft of critical assets
- Sabotage which would endanger public health and safety
- Industrial sabotage which would result in loss of production or information

Techniques for Target Identification

- Manual listing used for:
  - Theft of localized items
  - Theft of material-in-process
  - Sabotage of critical components or material
- Logical identification used for:
  - Theft of material in process
  - Sabotage of critical components or material

Targets

- Theft
  - Localized items (e.g., tools, computers)
  - Materials-in-process (e.g., chemicals, drugs)
- Release of hazardous material
  - Results in substantial release of hazardous agents - chemical, biological, radiological
- Industrial sabotage
  - Items which could result in loss of production - like stepper motors, conveyor belt, robots

Vital Area Identification

Establish:

- What you are trying to prevent
- Sources that cause the event you are trying to prevent
- Facility operating states
- What are the ways those sources occur (people, equipment, procedures)

Summary—Steps in Vital Area Identification

Event	What is the event?
Causes	What are the sources of the event?
Facility Operating States	What are the distinct operating states of the facility?
Mechanisms	How does the source contribute to event?
Functional System Failures	What actions are necessary for the source to occur?
Locations	Where are the components of the source actions?
Analysis	Use fault tree analysis and generic sabotage fault trees

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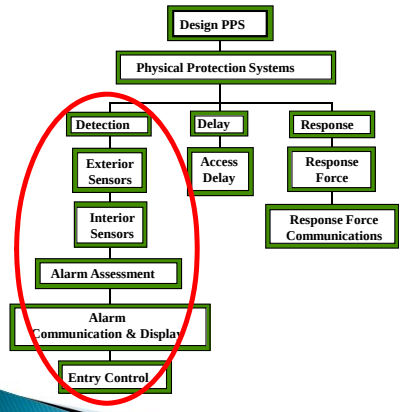
Detailing the SVA-DEPO Methodology



- Detection
- Intrusion sensing
- Alarm assessment
- Alarm communication

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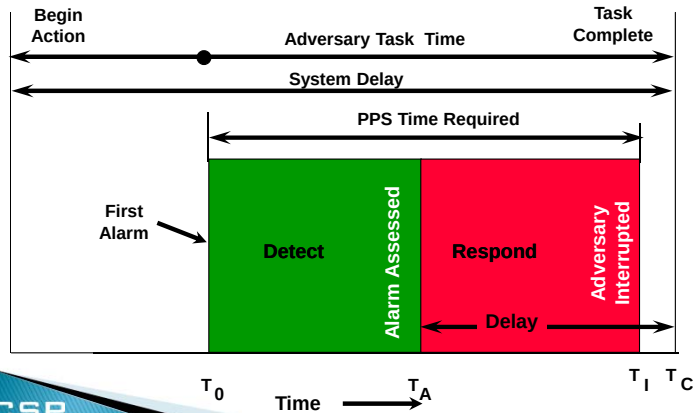
PPS Diagram and Adversary Task Time



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Detection

Sensor Activated → Alarm Signal Initiated → Alarm Reported → Alarm Assessed

- Performance measures:
  - Probability of detection
  - Time for communication and assessment
  - Frequency of nuisance alarms
  - Alarm without assessment is not detection

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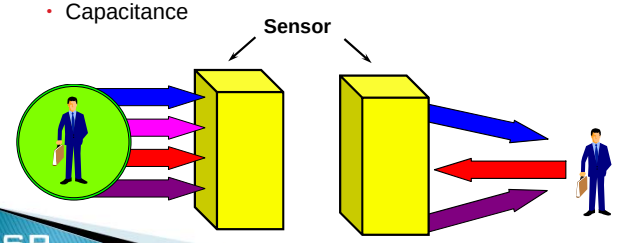
Sensor Classification

- Passive or Active
- Covert or Visible
- Volumetric or Line-Detection
- Line-of-Sight or Terrain-Following (for external sensors)
- Mode of Application for external sensors
  - Buried line
  - Fence-associated
  - Freestanding
- Mode of Application for internal sensors
  - Boundary penetration
  - Interior motion
  - Proximity

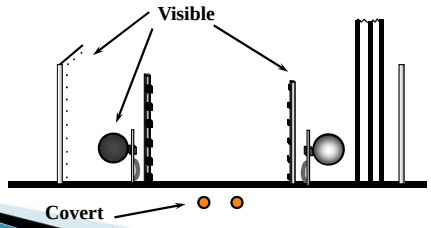
Sensor Classification

- Passive
  - Receiver
    - Vibration
    - Heat
    - Sound
    - Capacitance
- Active
  - Transmitter and receiver
    - Microwave
    - Infrared
    - RF



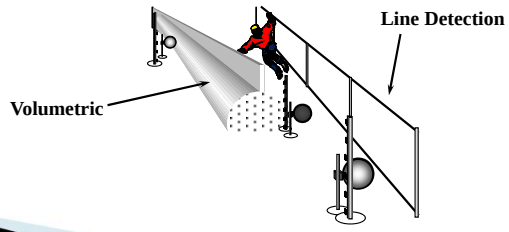
Sensor Classification

- Covert
  - Sensors hidden from view
  - More difficult for intruder to detect
- Visible
  - Sensors in plain view of intruder
  - Simpler to install and repair



Sensor Classification

- Volumetric
  - Detection in a volume of space
  - Detection volume usually not visible
- Line Detection
  - Detection along a line
  - Detection zone easily identified



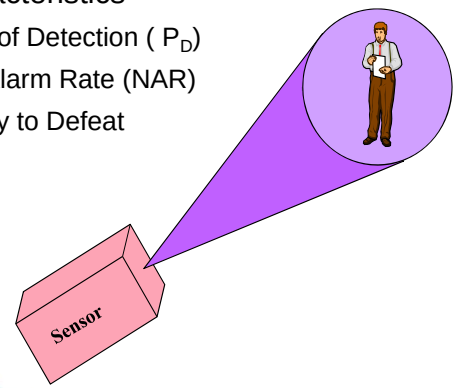
Sensor Classification

- Freestanding
  - Sensor mounted on its own support
- Fence-Associated
  - Sensor either mounted on a fence or forms a sensor fence
- Buried Line
  - Sensor in the form of a line buried in the ground

Sensor Performance

Sensor characteristics

- Probability of Detection (P_D)
- Nuisance Alarm Rate (NAR)
- Vulnerability to Defeat



Environmental Effects

Exterior Nuisance Sources

Topography

Vegetation

Wildlife

Background Noise

Climate and Weather

Soil and Pavement

Environmental Effects

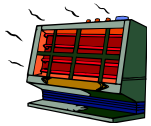
Interior Nuisance Sources

Movement of Objects or People

Fluorescent Lights

Wildlife or Insects

Background Noise


Heaters or Fans

Vibration

Sensor Performance: NAR/FAR

- Nuisance alarm rate (NAR)
  - Expected rate of alarms from an intrusion detection sensor which **can** be attributed to known causes, unrelated to intrusion attempts
- False alarm rate (FAR)
  - Expected rate of alarms from an intrusion detection sensor which **cannot** be attributed to known causes, subset of nuisance alarms

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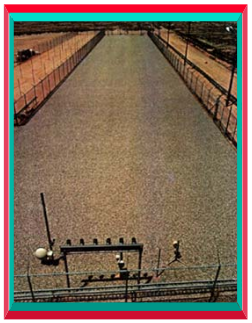
Sensor Technologies

- Microwave
- Ultrasonic
- Active Infrared
- Passive Infrared
- Capacitance
- Balanced Magnetic Switches
- Sonic
- Vibration
- Fiber Optics
- Video Motion Detectors
- Proximity



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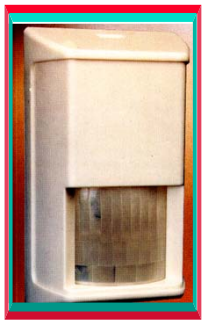
Combination of Technologies

- Dual
  - "AND" alarms
  - Increase sensitivity setting
- Alarm Processing
  - Reduce NAR
  - Also reduces P_D



MUST DETECT INTRUSION TWICE

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Interior Sensor Systems

Preferred Features

- Uses protection-in-depth
- Detects intruder in time for adequate response
- Detects tampering
- Performs self-test
- Is properly installed

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Sensor Selection Considerations

- Application
- Operating Principle
- Detection Capabilities
- Conditions for Unreliable Detection
- Typical Defeat Methods
- Major Causes of Nuisance Alarms

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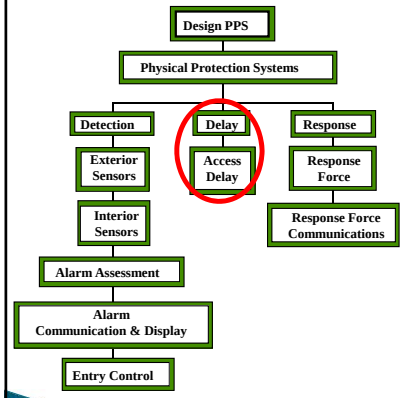
Detailing the SVA-DEPO Methodology



- Delay
- Barriers
- Dispensable barriers

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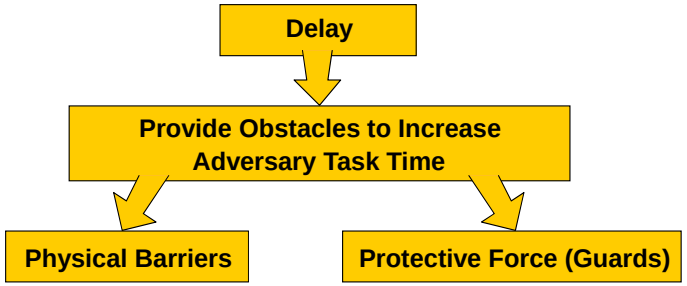
Delay

Performance measure is the time to defeat obstacle



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Access Delay

Will be discussed in terms of

- Role of access delay
- Access delay concepts
- Passive barriers
- Active barriers
- Delay testing

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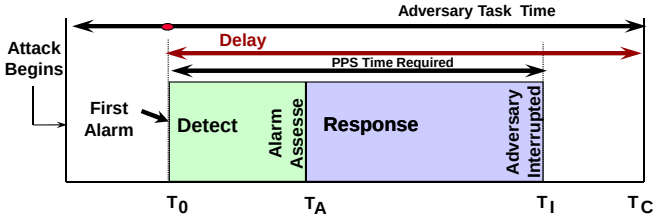
Role of Access Delay



- Detection and response time must be less than adversary task time after the first alarm
- To increase system success probability
  - Detect intrusion earlier
  - Reduce assessment time
  - Reduce response time
  - Increase adversary task time by adding Delay

Access Delay Concepts

- Provide delay after detection
  - **(No credit for delay before detection)**
- Long delay times are difficult, but need enough delay for response force to win
- Balance delay, analyze all paths and all attacks
- Multiple different sequential barriers, with greatest delay at the target
- Force adversary to perform sequential operations
- Minimize adversary work area
- Create difficult working environment for adversary
- Intimate Containment

Access Delay Concepts

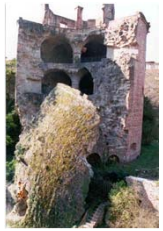
- Concealed delay features
- Synergistic delay features
- Combination of active and passive features
- Limit adversaries' use of vehicles
- Design a penalty into the parts
- Consider insider issues in the design, use 2-person control

Access Delay Concepts

- Optimize response force effectiveness
- Consider recapture issues in the design
- Robust design for changing threats
- Design for maximum credible threat
- Analyze and test against realistic adversary threat capability

Limits of Access Delay

- Any barrier can be breached given enough time
- System must detect attack and summon response force
- Need enough delay for response force to win
- Concentrate delay at target using layers of delay
- Achieving long delays is difficult and costly



Passive Delay

- Conventional construction provides minimal delay against formidable threat
- Include walls, doors, windows and utility ports, and roofs and floors
- Delay time depends on tools and type of attack
- Barriers can detain an adversary at predictable locations
- Multiple and different barriers are effective
- Barriers close to assets are usually most cost effective
- Vehicle barriers are important to limit adversary tools
- Access delay features should be present 100% of the time or take compensatory measures

Passive Delay Examples

- Tie-downs & Cages
- Multiple Layer Barriers
- Shrouded Locks
- Intimate Containment
- Sharps and Entanglements
- Ballistic Protection
- Vaults
- Space Fillers
- Custom Tools
- Thick walls
- Vehicle Barriers
- Hardened doors
- Buried structures

Attributes of Active Barriers

- Exert minimum impact on operations
- Provide maximum delay at target
- Afford volume protection
- Must provide adequate safety to personnel
- Offer multiple activation options
- Have long storage life
- Can be very expensive
- Require command and control
- Insider issues
- May become the initial target

Active Delay Examples

- Fog
- Pyrotechnic Smoke
- Irritant
- Aqueous Foam
- Rigid Foam
- Immobilization
- Electronic Locks with 2-person control
- Command and Control system
- Tracking
- Lethal Options

Delay Test Concepts

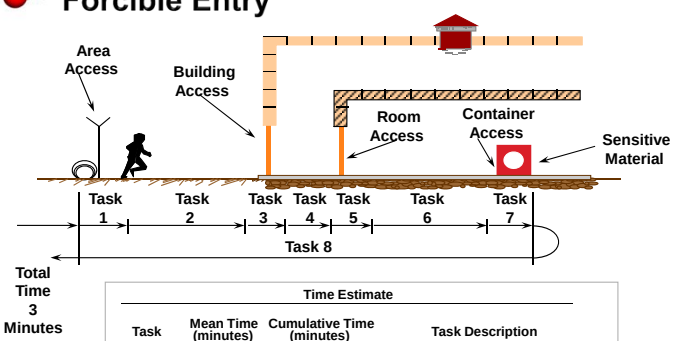
- The measure of delay system effectiveness is time
- Achieving long delay times is difficult and expensive. It usually requires a combination of a number of robust passive barriers and active barriers
- Any delay system has a range of delay times depending on the attack scenario, path, and complexity, and the adversary objective, capabilities, tools, and practice

Determining Delay Times for Specific Barriers

1. Develop and use an access delay database to determine an estimate of the barrier delay
2. Buy commercial security products developed and already tested to a specific threat
3. Perform access delay performance tests based on a DBT, a defined adversary toolkit and as close as possible to the actual conditions an adversary will face in attempting to breach the barrier

Each of these methods has advantages and disadvantages

Estimating Delay Time—Example of Forcible Entry



Time Estimate

Task	Mean Time (minutes)	Cumulative Time (minutes)	Task Description
1	0.1		Climb over fence
2	0.3	0.4	Run 76 m
3	0.8	1.2	Force door
4	0.4	1.6	Walk 45 m
5	0.2	1.8	Cut lock
6	0.1	1.9	Walk to container
7	0.2	2.1	Open container and gather material
8	0.9	3.0	Escape
	3.0		Total (approx. 3 minutes)

Fence Penetration Tests

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Vehicle Barrier Tests

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Vehicle Barrier Tests

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Window Delay Tests

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Personnel Door Tests

Attack	Tools	Time
Smash glass	hand	0:10
Cut mesh, smash glass	power	0:30
Cut louvers	hand	1:30
Cut hole	hand	3:30
Cut hole	thermal	4:00
Cut section	power	3:00
Cut section	thermal	2:00
Pry door jamb	hand	0:15
Pull exit bar	hand	1:00
Cut hinges	thermal	1:00
Remove cylinder lock, manipulate latch	hand	0:15

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Roof Delay Tests

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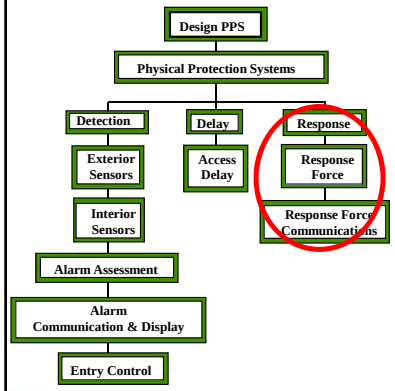
Detailing the SVA-DEPO Methodology



- Response
- Interruption
  - Identify vital areas to protect
  - Deployment of response force
- Neutralization

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Response

Communicate to Response Force → **Deploy Response Force** → **Neutralize Adversary Attempt**

Performance measures

- Probability of communication to response force
- Time to communicate
- Probability of deployment to adversary location
- Time to deploy
- Response force effectiveness

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Response Functions

- Deterrence
- Interruption
  - Alarm Communications
  - Correct Assessment
  - Communication to guards
  - Deployment to correct location
- Neutralization/Capture
  - Location
  - Use of force

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Deterrence

- Dependent on facility; different sites will have different security needs
- Guards may or may not be necessary
- Random guard patrols may be used
- Deployment of response must be timely
- Possibility to use multiple guards

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Interruption

- Deployment of the response force
  - Measured in time
  - EASI or ASSESS
- Tactical training if necessary
  - Cover and concealment
  - Team movement
  - Ambush response
  - Use and limitations of weapons

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Interruption

- Reliable, fast, communication of alarms to Central Security Control (CSC)
- Correct assessment of problem
- Reliable communication of CSC to security responders
  - At least two timely means of communication
- Security responders must deploy to correct locations
  - Planning, training, exercises
- Coordination with other responders
- Clear chain of command

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Interaction with Outside Agencies

- Written agreement
- Key issues for consideration
  - Role of support agencies
  - Off-site operations
  - Communication with other agencies
- Joint training exercises

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Communication Systems

- Most common is radio frequency communication system
- Typical radios operate on any one of two to six frequencies or channels
- Maximum range for communication between two radios is 2 to 5 km
- Most systems are conventional, narrow-band frequency modulation, clear-voice systems

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Deficiencies of Radio Frequency Systems

- Short range of hand-held systems
- Gaps in communication coverage
- Eavesdropping by adversary is possible
- Deceptive messages can be transmitted by adversary
- Jamming of frequency channel by adversary from remote location is possible

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Neutralization

Requirements for accomplishment

- Equipment
- Knowledge of tactics
- Physical fitness
- Proficiency
- Application of tactics

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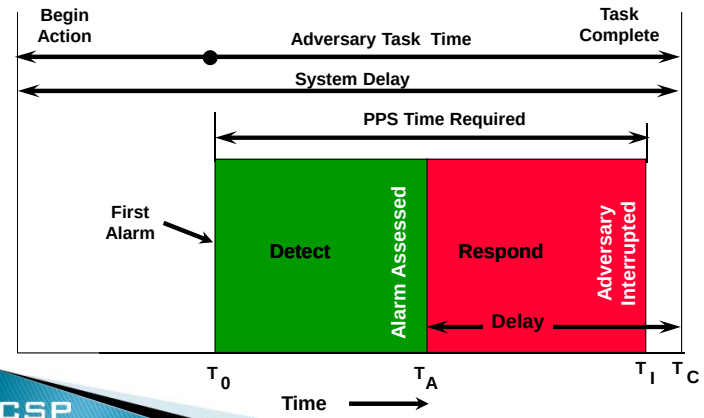
Response Force Equipment

- Weapons
- Vehicles
- Communication equipment
  - Radio
  - Telephone
  - Duress alarm
- Night vision device
- Personal protection equipment
  - Gas mask
  - Self-contained breathing apparatus
  - Helmet
  - Body armor
  - Armored vehicle
  - Binoculars
  - Vest (tactical)
  - Intermediate force weapon

Adversary Task Time vs. PPS Time Requirements



Characteristics of an Effective PPS

- Protection-in-depth
- Minimum consequence of component failure
- Balanced protection

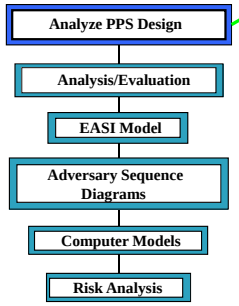
Minimum Consequence of Component Failure

- Contingency plans must be provided so the PPS continues to operate after a component fails
- Redundant equipment can take over function of disabled equipment in some cases
- Some failures require aid from sources external to the facility

Balanced PPS

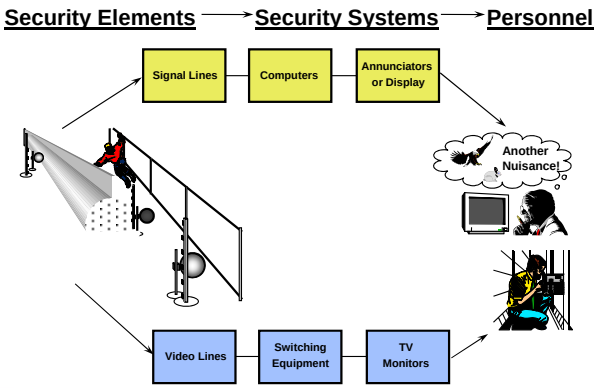
- Provides adequate protection against all threats along all possible paths
- Maintains a balance with other considerations
  - Cost
  - Safety
  - Structural integrity

Overview of SVA-DEPO Methodology



- Identify system deficiencies
- Help to select system improvements
- Allow cost vs. system effectiveness comparisons to be made

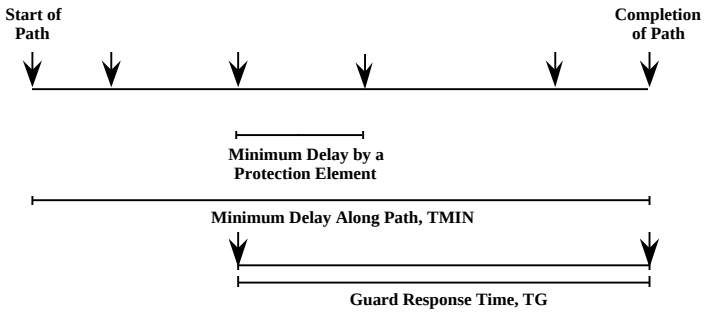
Analysis



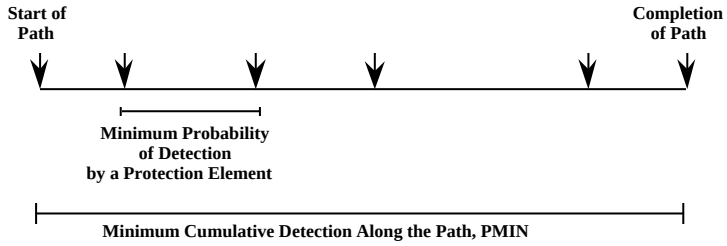
Measures of Effectiveness

- Delay time
- Cumulative probability of detection
- Timely detection

Minimum Time as a Measure of Effectiveness



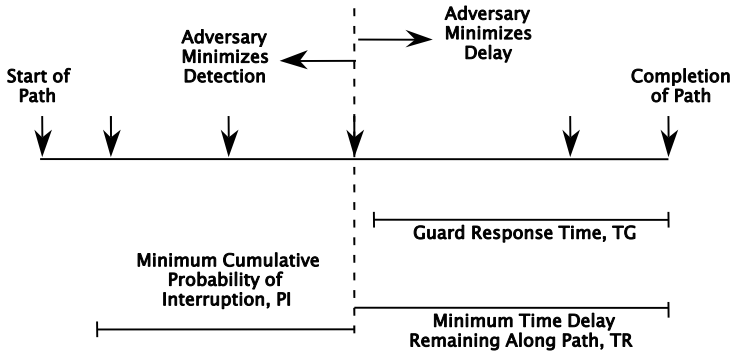
Cumulative Probability of Detection as a Measure of Effectiveness



Timely Detection

- The minimum cumulative probability of detecting the adversary *while there is enough time remaining for the response force to interrupt the adversary*
- Delay elements on path determine the point by which adversary must be detected. That point is where the *minimum delay remaining on the path just exceeds response time*.

Timely Detection as a Measure of Effectiveness



EASI Model

- Advantages of EASI
  - Provides analysis of interactions
  - Is simple to use
  - Gives a quantitative result
  - Allows sensitivity analysis
- Limitations of EASI
  - Analyzes a single path
  - Does not guarantee protection
  - Is simple in its analysis
  - Does not model neutralization

EASI Input Summary

The following input information is required by the EASI model

- Detection probability for each sensor
- Communication probability of alarm to guards
- Guard response time and response time standard deviation
- Delay times of each element and delay standard deviation

EASI Output Summary

- Gives probability of interruption along a single path for a defined adversary
- Does not prove adequacy
- Does not model neutralization

EASI Example

Probability of Guard Communication	**0.90**
Guard Response Time	**5.00**
Standard Deviation of Response Time	**1.50**

Task	Delay Time	Standard Deviation	Probability of Detection
1. Cut Fence	1.00	0.30	0.0
2. Run to Building	0.20	0.06	0.0
3. Open Door	2.00	0.60	0.9
4. Run to Vital Area	0.50	0.15	0.0
5. Open Door	3.00	0.30	0.9
6. Sabotage Target	1.00	0.30	0.0

Probability of Interruption: 0.64

Adversary Sequence Diagrams (ASDs)

- Graphical model used to help evaluate the effectiveness of the PPS at a facility
- Represent
  - Paths that adversaries can follow to accomplish sabotage or theft
  - PPS elements along paths
- Used to determine most vulnerable path for specific PPS and threat

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Steps to Create an ASD

- Model the facility by separating it into adjacent physical areas
- Define protection layers and path elements between areas

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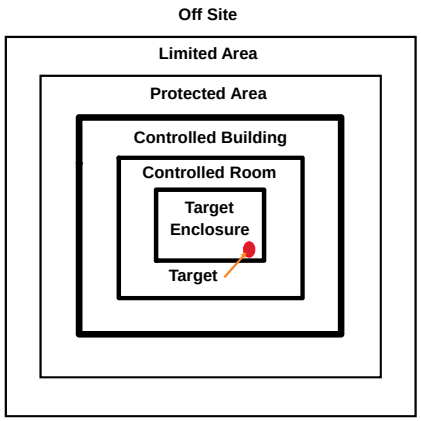
Facility



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Physical Areas of Facility

- Off Site
- Limited Area
- Protected Area
- Controlled Building
- Controlled Room
- Target Enclosure
- Target

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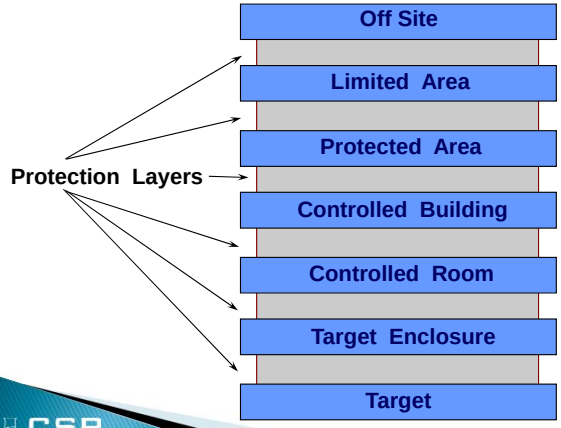
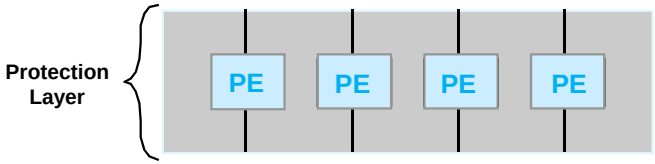
PPS Layers of Facility



Path Element (PE)

- Each protection layer consists of one or more path elements
- Path elements are the basic building blocks of a PPS



Path Elements and Target Locations

Path Elements:

DUC	Duct
EMC	Emergency Evacuation Corral
EMX	Emergency Exit
EMP	Emergency Portal
FEN	Fenceline
GAT	Gateway
HEL	Helicopter Flight Path
ISO	Isolation Zone
PST	Material Passthrough
MAT	Material Portal
OVP	Overpass
DOR	Personnel Doorway
PER	Personnel Portal
SHD	Shipping/Receiving Doorway
SHP	Shipping/Receiving Portal

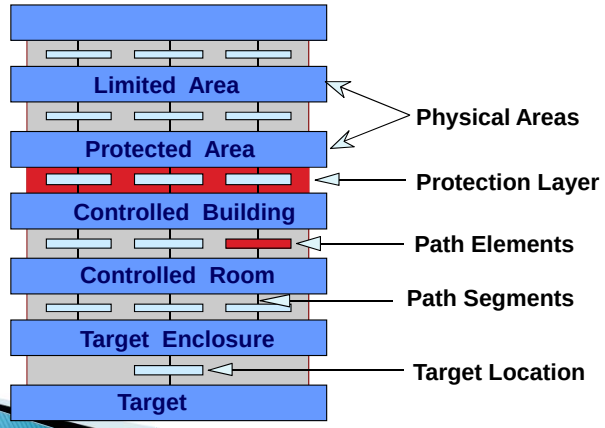
Path Elements (continued):

SUR	Surface
TUN	Tunnel
VHD	Vehicle Doorway
VEH	Vehicle Portal
WND	Window

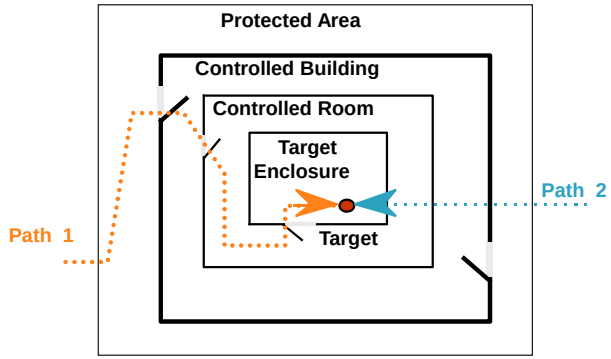
Target Locations:

BPL	Bulk Process Line
CGE	Cage
FLV	Floor Vault
GNL	Generic Location
GBX	Glovebox
IPL	Item Process Line
OPN	Open Location
TNK	Storage Tank

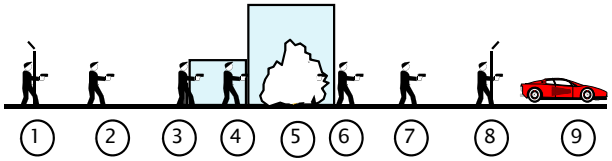
Concept of Adversary Sequence Diagram



Adversary Path



Path Analysis



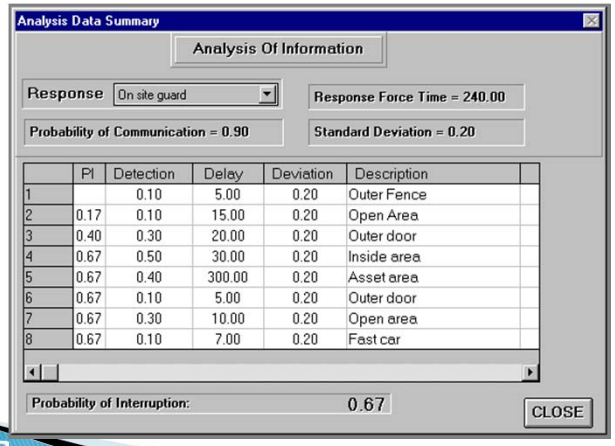
#. Action (Probability of Detection, Delay Time)

1. Climb fence (0.1, 5)
2. Run to building (0.1, 15)
3. Open door (0.3, 20)
4. Move to asset (0.5, 30)
5. Remove asset (0.4, 300)
6. Exit building (0.1, 5)
7. Run to fence (0.3, 15)
8. Climb fence (0.3, 5)
9. Leave area (0.1, 7)

Protection Elements Along Path

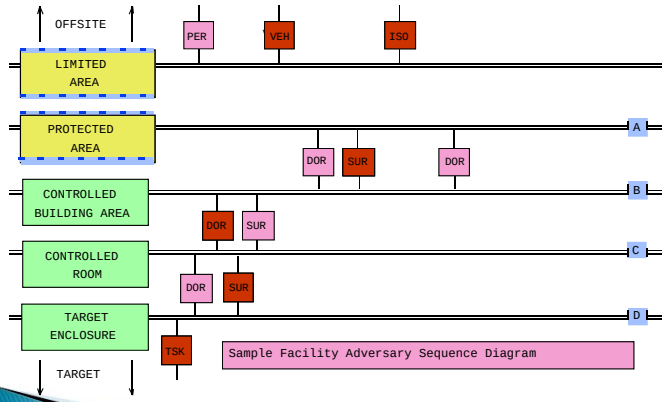
Adversary Action	Delay Element	Detection Element
• Penetrate Fence	• Fence Fabric	• Fence Sensor
• Penetrate Outer Door	• Door Hardness	• Sensors on Door
• Penetrate Wall	• Wall Hardness	• Personnel Hear Noise
• Penetrate Inner Door	• Door Hardness	• Sensors on Door
• Destroy Pump	• Time Required to Sabotage Target	• Loss of Pump

Analysis Results



	PI	Detection	Delay	Deviation	Description
1		0.10	5.00	0.20	Outer Fence
2	0.17	0.10	15.00	0.20	Open Area
3	0.40	0.30	20.00	0.20	Outer door
4	0.67	0.50	30.00	0.20	Inside area
5	0.67	0.40	300.00	0.20	Asset area
6	0.67	0.10	5.00	0.20	Outer door
7	0.67	0.30	10.00	0.20	Open area
8	0.67	0.10	7.00	0.20	Fast car

Adversary Sequence Diagram

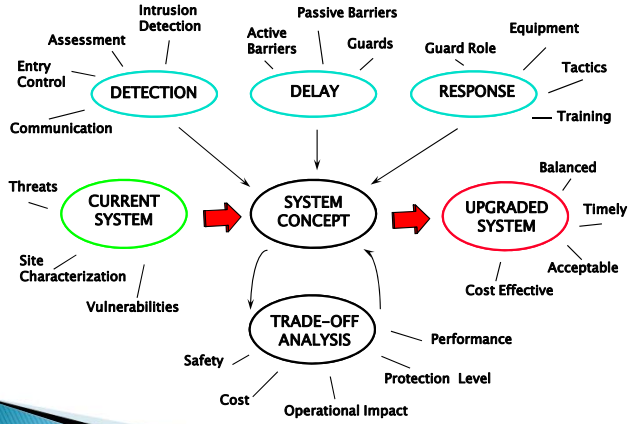


Redesign or Upgrade of PPS

As a result of the analysis:

- Identify vulnerabilities in the PPS
- Redesign system to correct noted vulnerabilities
- Reevaluate to verify vulnerability is corrected

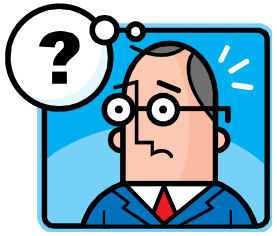
System Integration



Presentation Summary

- Discuss the purpose and objectives of security vulnerability assessments (SVA)
- Detail the methodology for conducting a SVA
- Provide discussion and exercises to help practice the SVA methodology

Questions?



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