Chemical
SAFETY AND SECURITY TRAINING

# Emergency Management

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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.

Sandia National Laboratories

## 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: http://www.merriam-webster.com/dictionary/emergency
Photo Credit: Federal Emergency Management Agency: 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**

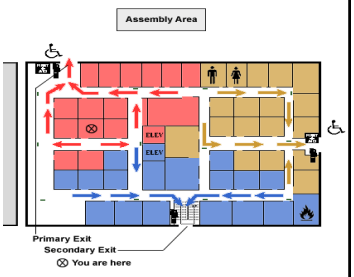
- Involve engineering, safety, & security
- Distribute to and train all employees
- Include in the plan:
  - Roles and responsibilities
  - Procedures for reporting emergencies
  - Emergency phone numbers
  - Procedures for specific emergencies
  - Maps
    - Evacuation routes
    - Assembly areas



## 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

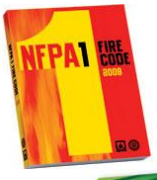
**Plant Emergency Response Procedures**

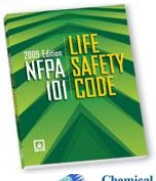
- Evacuate or shelter in place?
- Respond?
- Who will respond?
  - On-site HAZMAT team?
    - Require training
  - Community fire department?
    - Establish memorandum of understanding
- Medical support
  - In-house?
  - When to call for outside assistance
- Emergency shutdown procedures
- Decontamination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

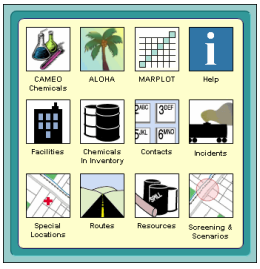
- ***ERPG-3***

  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**

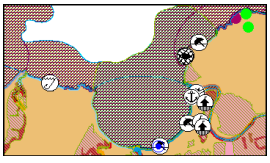
- Assist first responders with accessible and accurate response information
  - Interactive *Cameo* software modules
  - *Cameo Data Management*
    - Location of chemicals
    - Chemical quantities
    - Storage conditions




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

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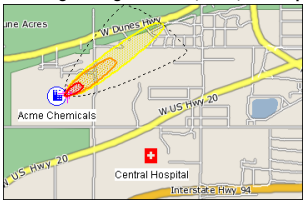
## Emergency Planning

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

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## 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.**

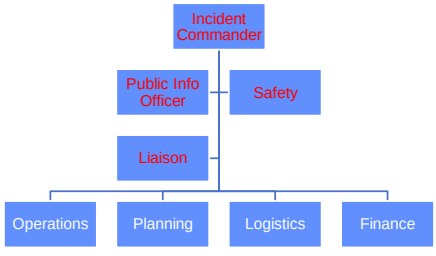
## Emergency Planning

**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


Photo credit:
http://www.savelives.com

## 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

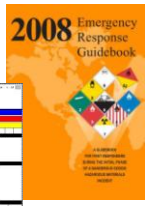
**Detect Hazmat Presence**

- 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 $\leq 100^{o}$ C, $\leq$ 10 microns particle size
- Flammability/Reactivity
  - Flashpoint < $60^{o}$ 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 may 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

## 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

## 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

## 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*

## 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


## 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?

## 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

## Video

## 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***

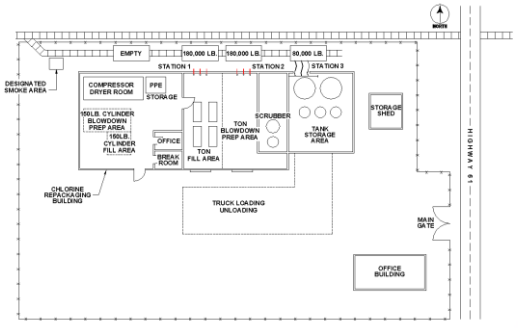
## Summary of Incident, continued

**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




## Tanker Hose Rupture

*Photo credit: US Chemical Safety Board*

## Emergency Planning Exercise

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

## Emergency Planning Exercise

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

## 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?**