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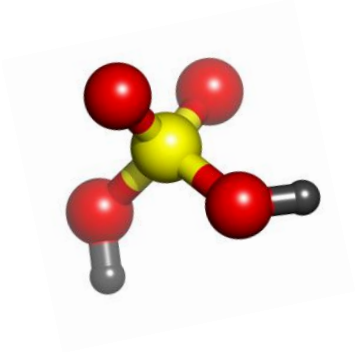
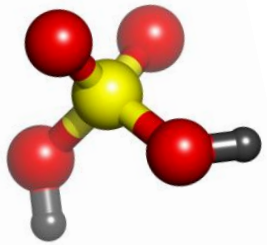


Chemical Safety Principles & Management

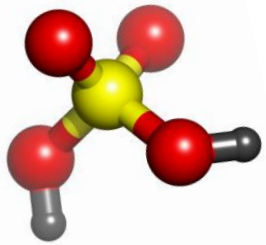
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories



Topics

- Definition of chemical safety
- Hazard vs Risk
  - Assessment Process –
    - anticipation, recognition, evaluation and controls
- Chemical Management
  - Benefits
  - Procurement
  - Storage
  - Inventory Systems
  - Hazard Communications
  - Waste Management

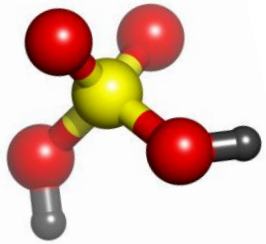


Chemical Safety Defined

- Safety: "The condition of being safe from undergoing or causing hurt, injury, or loss"
  - Merriam-Webster

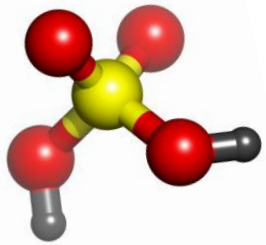
  http://www.merriam-webster.com/dictionary/safety
- Chemical Safety: "Practical certainty that there will be no exposure of organisms to toxic amounts of any substance or group of substances: This implies attaining an acceptably low risk of exposure to potentially toxic substances."
  - IUPAC Glossary of Terms Used in Toxicology

  http://sis.nlm.nih.gov/enviro/iupacglossary/glossaryc.html
- Also:
  - Process Safety
  - Inherent Safety



Hazard versus Risk

- Hazard – *the inherent potential to harm*
- Risk – *the probability that harm will result*

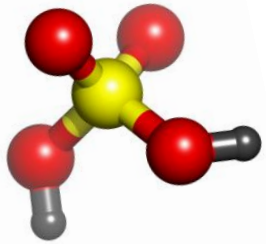


Chemical Hazards

- *Chemical hazards*
  - Health hazards: toxics, corrosives, carcinogens
  - Physical hazards: flammables, explosives, reactives
- *Other industrial hazards*
  - Mechanical–unguarded moving parts, belts, fans
  - Electrical
  - Pressure & temperature extremes
  - Elevated surfaces
  - Noise
  - Non-ionizing radiation–lasers, ultraviolet ligl radiofrequency
  - Ergonomic hazards

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM

Chemical SAFETY AND SECURITY TRAINING



Risk Assessment Process

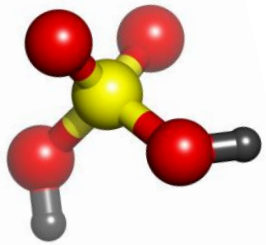
Anticipation

Recognition

Evaluation

Control

→ **Hazards** → **Risks**

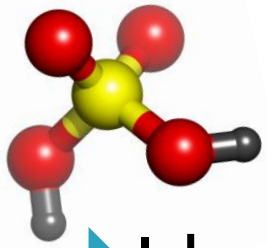


Anticipation

Anticipation = Advance Planning:

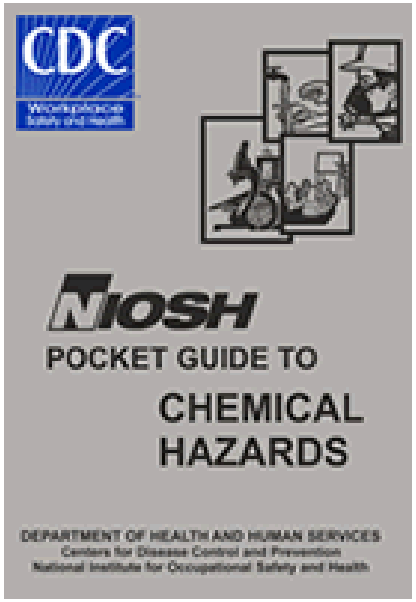
- Team with process engineers, plant facility team leaders, workers, environmental, health & safety professionals, fire protection engineers

- Acquire process information, drawings, equipment requirements and specifications, chemical information, safety data sheets, plant safety procedures, and regulatory requirements



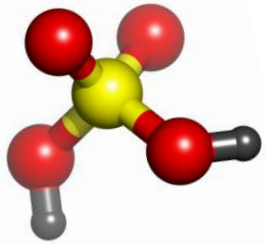
Recognition/Identification

- Identify each chemical hazard
  - Quantity of each process chemical
  - Identify intermediates, by-products
  - Acquire toxicity information
  - Solid, liquid, or gas?
  - Flashpoint
  - Vapor pressure
  - Air or water reactivity
- Identify process hazards
  - Upper and lower limits of temperature, pressure, flow
  - Mechanical hazards
  - Electrical hazards



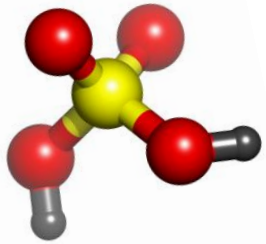
International Labour Organization

http://www.ilo.org/safework/info/databases/lang--en/WCMS_145760/index.htm



Evaluation

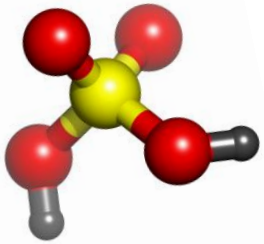
- What are the tasks in the process? How are chemicals used?
  - --Filling, spraying, reacting, mixing?
- What are the controls for over-pressurization or elevated temperature conditions?
- Process equipment inspected & maintained?
- Barriers and guards in place?
- Workers properly trained?
- What are the consequences of process deviations?
- Emergency shut-down equipment or ventilation?



Controls

How are the risks controlled?

- Eliminate the hazard
- Substitute process materials
- Engineering controls
- Administrative controls/operational practices
- Personal Protective Equipment (PPE)

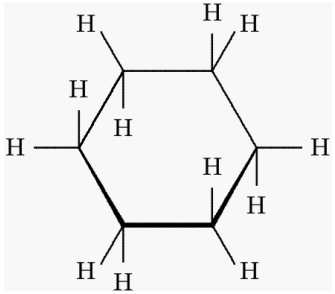


Controls

Change the process

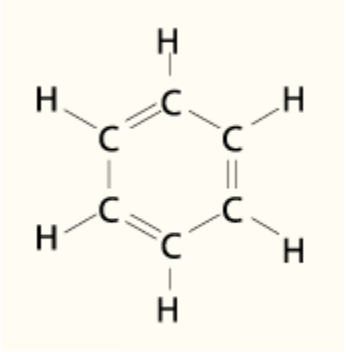
eliminate the hazard

(e.g. Lower process temperature)



Substitution

less-hazardous substance



(e.g. – cyclohexane for benzene)

Engineering Controls

Enclose the hazard,

Use a barrier,

Or,

Ventilate

-Dilution ventilation

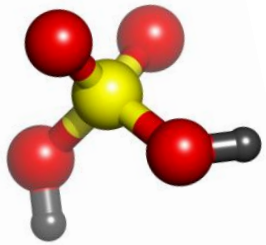
-Local exhaust ventilation (LEV)

Administrative Controls

Organizational safety policies,
Standard operating procedures,
Task-specific procedures

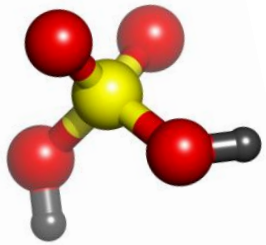
Personal Protective Equipment – PPE

PPE is the *least* desired control
Does not eliminate the hazard
Depends on worker compliance
May create heat stress



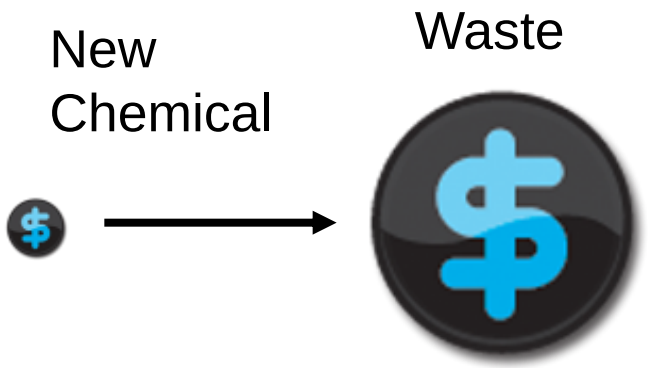
Chemical Management

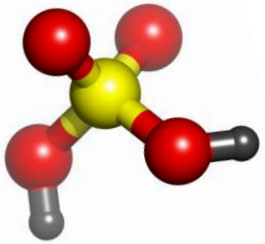
- Benefits
- Cradle to Grave Model
- Procurement
- Storage
- Use
- Disposal



Chemical Management Benefits

- **Reduces cost of:**
  - **Raw materials**
  - **Hazardous waste disposal**
- **Facilitates plant sustainability**
- **Protects the environment**
- **Improves security**
  - **Theft**
  - **Sabotage**

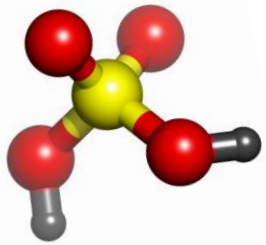




Chemical Management Cradle-to-Grave Model

Procure → Store →

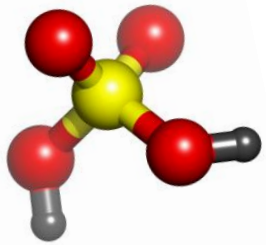
Use → Disposal



Chemical Procurement

Institute a *procurement approval system*

- Written procedure
  - Document who orders chemicals
  - Document what chemicals require approval
  - Who approves
- Link ordering to a product review system
  - Engineering, Environmental Health & Safety, Facility & Fire Protection Staff
- Track “chemicals of concern”



Discussion

- How are chemicals procured at your facility?
  - What are there rules about who can order chemicals?

- How do you track the purchase of –
  - highly toxic,
  - flammable, or
  - reactive chemicals?

Chemicals Storage

- Where are chemicals stored?
- Consider unusual storage sites
  - Loading docks
  - Outside locations
  - Waste storage facility
  - Chemicals contained in equipment
- Resource

  Guidelines for Safe Warehousing of Chemicals, Center for Chemical Process Safety,
  ISBN: 978-0-8169-0659-8

Chemical Storage

Design and Construction:

- Building and fire codes are specific for each country
- U.S. uses International Code Council http://www.iccsafe.org/
- Combines many building, fire, and energy codes
- Incorporates by reference
  - National Fire Protection Association (NFPA) Codes
  - NFPA Electric Code (70)

Chemical Storage

Best Practices:

- Safe path during normal and emergency conditions
- Determine travel distance to exits
- Separate personnel areas from chemical storage
- Adequate aisle spacing
- Exit signage
- Emergency lighting

Chemical Storage

Design and Construction:

- Spill containment
  - Maximum probable spill plus fire sprinkler water
  - Primary containment
    - Drains, trenches
  - Secondary containment
    - Recessed loading dock
    - Concrete berms, grates
- Separate incompatible chemicals
  - Oxidizers, corrosives, flammables

Chemical Storage

Chemical Storage

Gas Cylinders:

- Separate incompatible gases
- Secure all gas cylinders
- Store in well-ventilated area
- Provide protection from direct sunlight
- Screw down cylinder caps when not in use

Chemical Storage

CSB Video: Compressed Gas Cylinder Fire

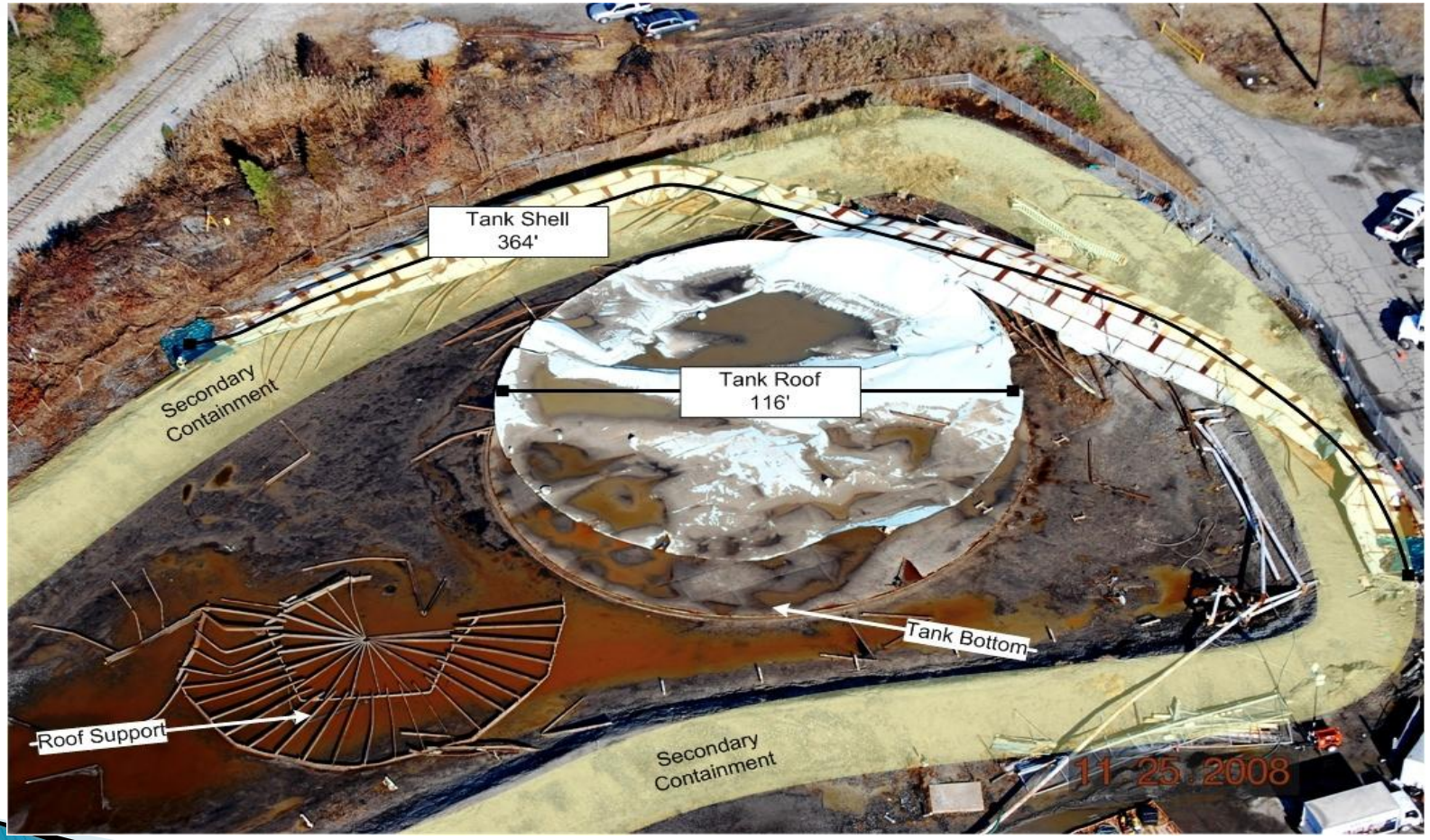
Danger of Propylene Cylinders in hot weather –
Video file = Praxair Clip (small).mpg 8.5 min

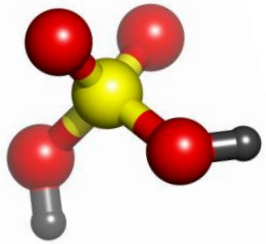
Chemical Storage

Tank Storage:

- Tank material compatible with the chemical stored
  - Mild Steel
  - Stainless steel
  - Cross-linked high density polyethylene
- Spill containment
  - Double walled or lined tanks
  - Berms
- Security/Impact protection

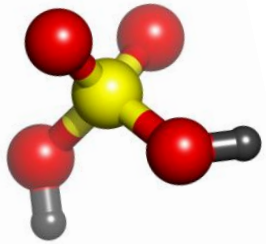
Collapsed Fertilizer Tank





Discussion

What safeguards does your facility have in place to prevent, mitigate, or respond to a release in a chemical storage area?



Chemical Inventory Systems

- Home made – Access or Excel programs
- Commercial – Chemical inventory linked to Safety Data Sheets (SDS)
- Freeware – Web-based, Hypertext Preprocessor (PHP) software
- Radiofrequency Identification (RFID) tracking

Chemical Inventory Systems
Barcode Systems

- System of tracking is container-based or static inventory
- Each container, tank, or cylinder is provided with a barcode sticker
- Barcode labels may be printed using a direct thermal printer

Photo credit: Fabian M. Dayrit and Jaclyn Elizabeth R. Santos

Chemistry Department
Ateneo de Manila University
Loyola Heights, Quezon City

Chemical Inventory Systems
Barcode Systems

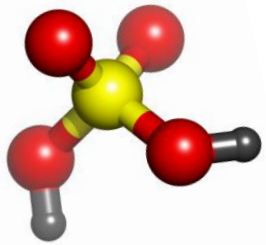
Advantages:

- Query for container location
- Link a chemical container to safety data sheet
- Track chemicals of concern
- Document disposal or waste transfer

Recommendations:

- Perform a periodic site inspection
  - -Assures accuracy of the inventory
  - -Provides visual inspection of container condition

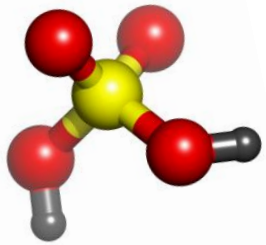
Photo credit: Fabian M. Dayrit and Jaclyn Elizabeth R. Santos



Chemical Inventory Systems

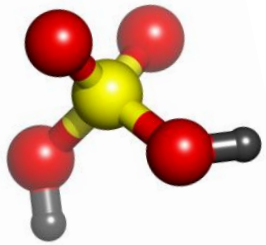
System should be able to query for the following:

- Barcode number
- Trade or IUPAC name
- Chemicals in a mixture
- CAS number
- Location (process unit)
- Quantity
- Shelf life/expiration date
  - Lab chemicals



Example:
Barcode System for Static Inventory

Barcode	Location	Depart.	Quantity	Purchase Date	Expiration Date	Name	State	Waste Disposal
XX00187	110/1111	02712	40 liters	8/01/2007		BKC 20121	Liquid	
XX00172	110/1111	02712	80 liters	7/31/2007		DIETHANOLAMINE	Liquid	
XX00173	110/1111	02712	20 liters	11/18/2010	1/30/2011	ACETONE	Liquid	x
XX00174	110/1111	02712	28 liters	12/15/2010		ACETONE	Liquid	
XX00175	110/1111	02712	40 liters	10/17/2010		ISOAMYL ACETATE	Liquid	
XX00176	110/1111	02712	20 liters	11/18/2010		SOLVENT 25	Liquid	



Commercial Inventory Systems

- Commercial systems typically include:
  - Barcode Scanner
  - Database
  - Link to safety data sheets
- May also include:
  - Link to chemical suppliers
  - Report function
    - Reportable chemicals
      - Community Right-to-Know, air emissions, etc.
    - Internal reports

Using Chemicals
Hazard Communication

Globally Harmonized System (GHS)

- Hazard pictograms
- Signal words
- Hazard statements

Danger
Flammable Liquid

U.S. OSHA

- Label all chemical containers
  - Product or chemical name
  - Supplier name/contact information
  - Hazard

A Guide to The Globally Harmonized System of Classification and Labeling of Chemicals:
http://www.osha.gov/dsg/hazcom/ghs.html

Using Chemicals
Hazard Communication

Pipe Labeling

- 2007 ANSI/ASME A13.1 *Scheme for the Identification of Piping Systems*
- Does not apply to buried pipelines or electrical conduit
- Label must state contents, hazard, direction of flow
- May use color coding

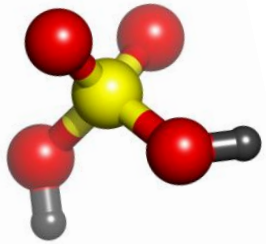
Using Chemicals
Hazard Communication

Safety Data Sheet:

1. Identification
2. Hazard(s) identification
3. Composition information
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure control/personal protection

Using Chemicals
Hazard Communication

9. Physical/chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

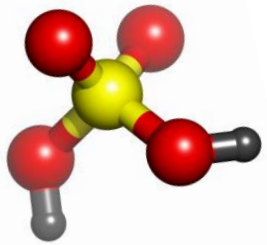


Discussion

- What chemical labeling system does your facility use?
- Is the labeling system the same for all containers?
- How do workers and emergency response staff access safety data sheets in the event of an incident?

Chemical Waste Management

- Substitute chemicals when process permits
- Recycle
- Dispose by incineration, if allowed in your country
- Injection wells used in U.S.
- Incineration is NOT the same as open burning



Summary

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  - Assessment Process –
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- Chemical Management
  - Benefits
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  - Storage
  - Inventory Systems
  - Hazard Communications
  - Waste Management