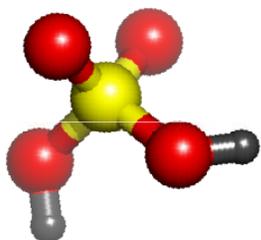


Fundamentals of Chemical Health & Safety

SAND No. 2012-1606C

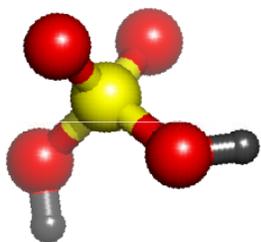
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.





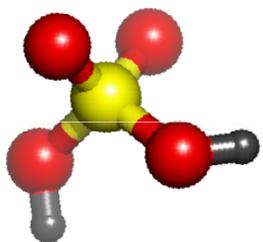
Topics

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



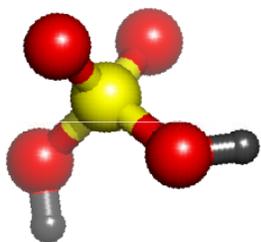
Chemical Safety Defined

- ▶ 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

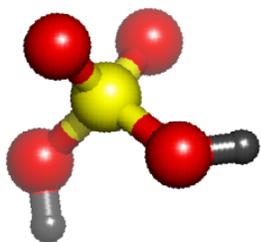
- ▶ Hazard – *the inherent potential to harm*
- ▶ Risk – *the probability that harm will result*



Chemical Hazards

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





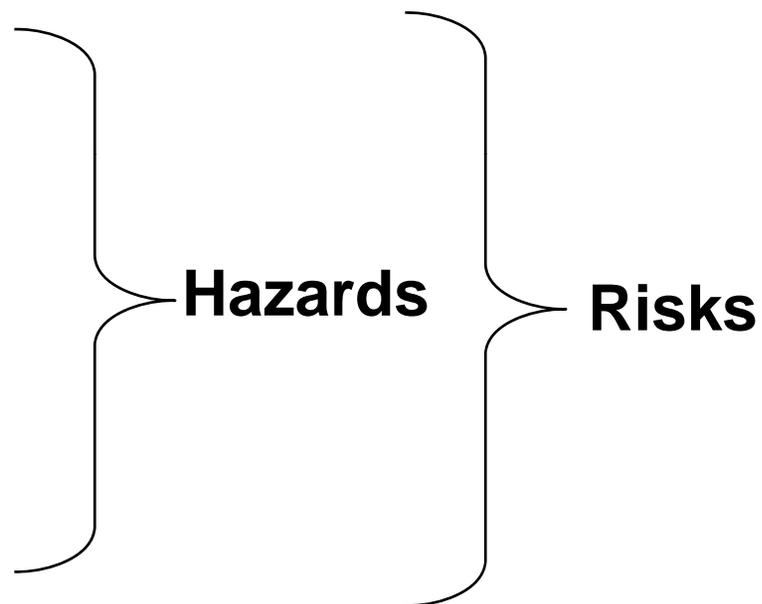
Risk Assessment Process

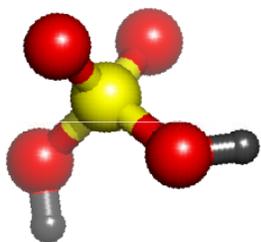
Anticipation

Recognition

Evaluation

Control



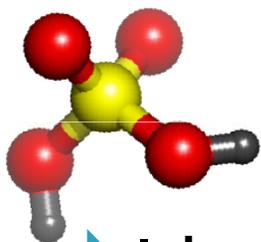


Anticipation

Anticipation = Advance Planning:

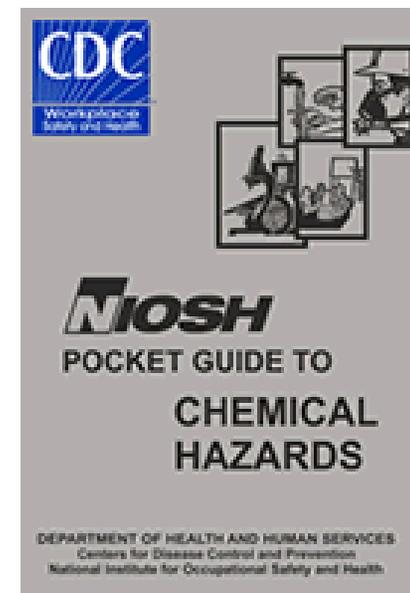
- Team with process engineers, plant facility team leaders, workers, environmental, health & safety professionals, fire protection engineers
- Acquire process information, drawings, equipment requirements and specifications, chemical information, safety data sheets, plant safety procedures, and regulatory requirements



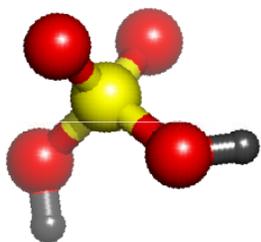


Recognition/Identification

- ▶ 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

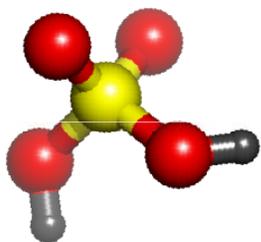


http://www.ilo.org/safework/info/databases/lang--en/WCMS_145760/index.htm



Evaluation

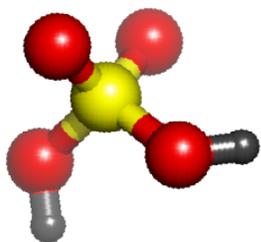
- ▶ What are the tasks in the process? How are chemicals used?
 - Filling, spraying, reacting, mixing?
- ▶ What are the controls for over-pressurization or elevated temperature conditions?
- ▶ Process equipment inspected & maintained?
- ▶ Barriers and guards in place?
- ▶ Workers properly trained?
-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



Controls

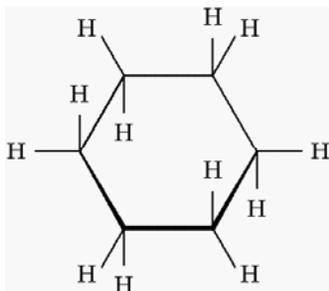
How are the risks controlled?

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



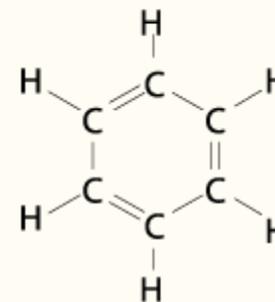
Controls

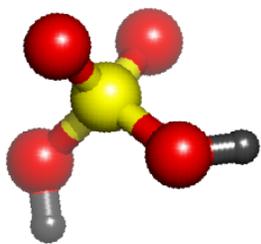
Change the process
eliminate the hazard
(e.g. Lower process temperature)



Substitution

less-hazardous substance
(e.g. – cyclohexane for benzene)





Engineering Controls

Enclose the hazard,

Use a barrier,

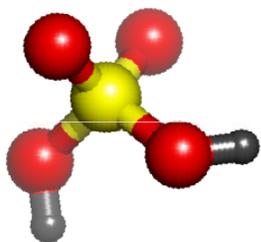
Or,

Ventilate

-Dilution ventilation

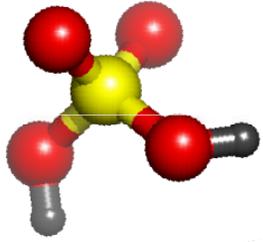
-Local exhaust ventilation (LEV)





Administrative Controls

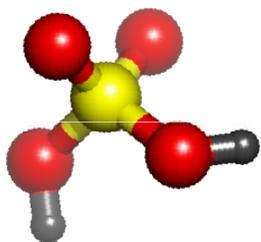
*Organizational safety policies,
Standard operating procedures,
Task-specific procedures*



Personal Protective Equipment – PPE

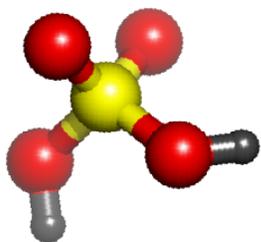
PPE is the *least* desired control
Does not eliminate the hazard
Depends on worker compliance
May create heat stress





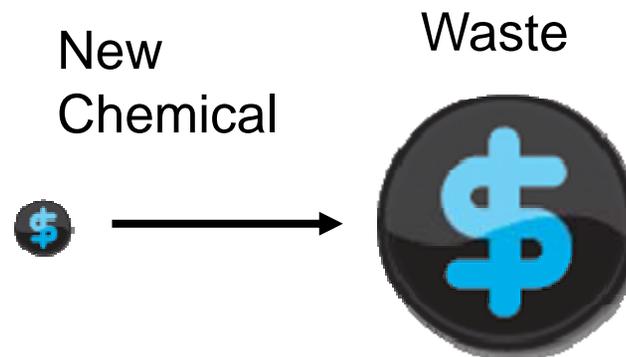
Chemical Management

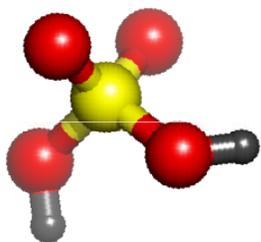
- ▶ Benefits
- ▶ Cradle to Grave Model
- ▶ Procurement
- ▶ Storage
- ▶ Use
- ▶ Disposal



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

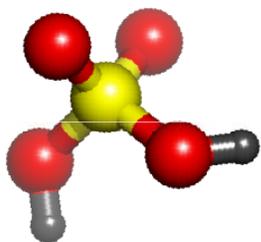


Use



Disposal

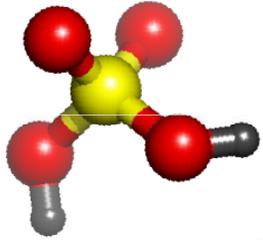




Chemical Procurement

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”

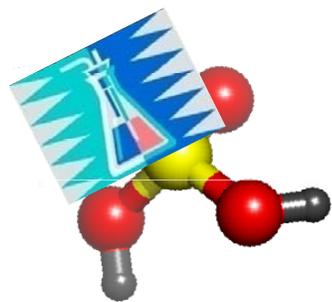


Chemicals Storage

- ▶ 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



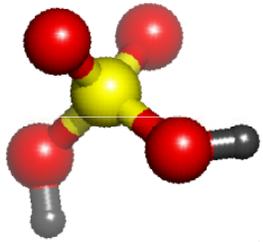


Chemical Storage

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)



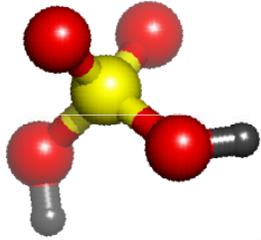


Chemical Storage

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



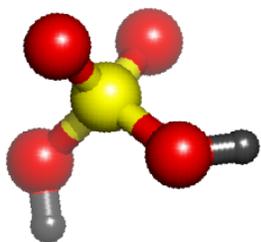


Chemical Storage

Design and Construction:

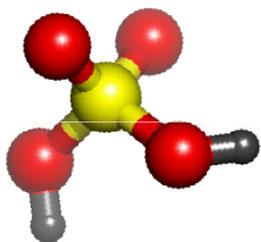
- ▶ Spill containment
 - Maximum probable spill plus fire sprinkler water
 - Primary containment
 - Drains, trenches
 - Secondary containment
 - Recessed loading dock
 - Concrete berms, grates
- ▶ Separate incompatible chemicals
 - Oxidizers, corrosives, flammables





Chemical Storage



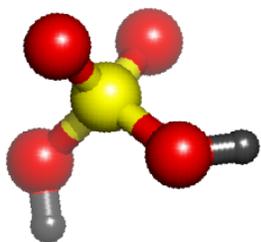


Chemical Storage

Gas Cylinders:

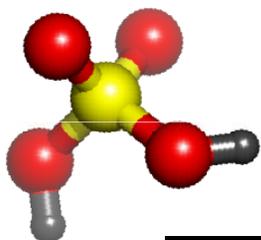
- ▶ Separate incompatible gases
- ▶ Secure all gas cylinders
- ▶ Store in well-ventilated area
- ▶ Provide protection from direct sunlight
- ▶ Screw down cylinder caps when not in use



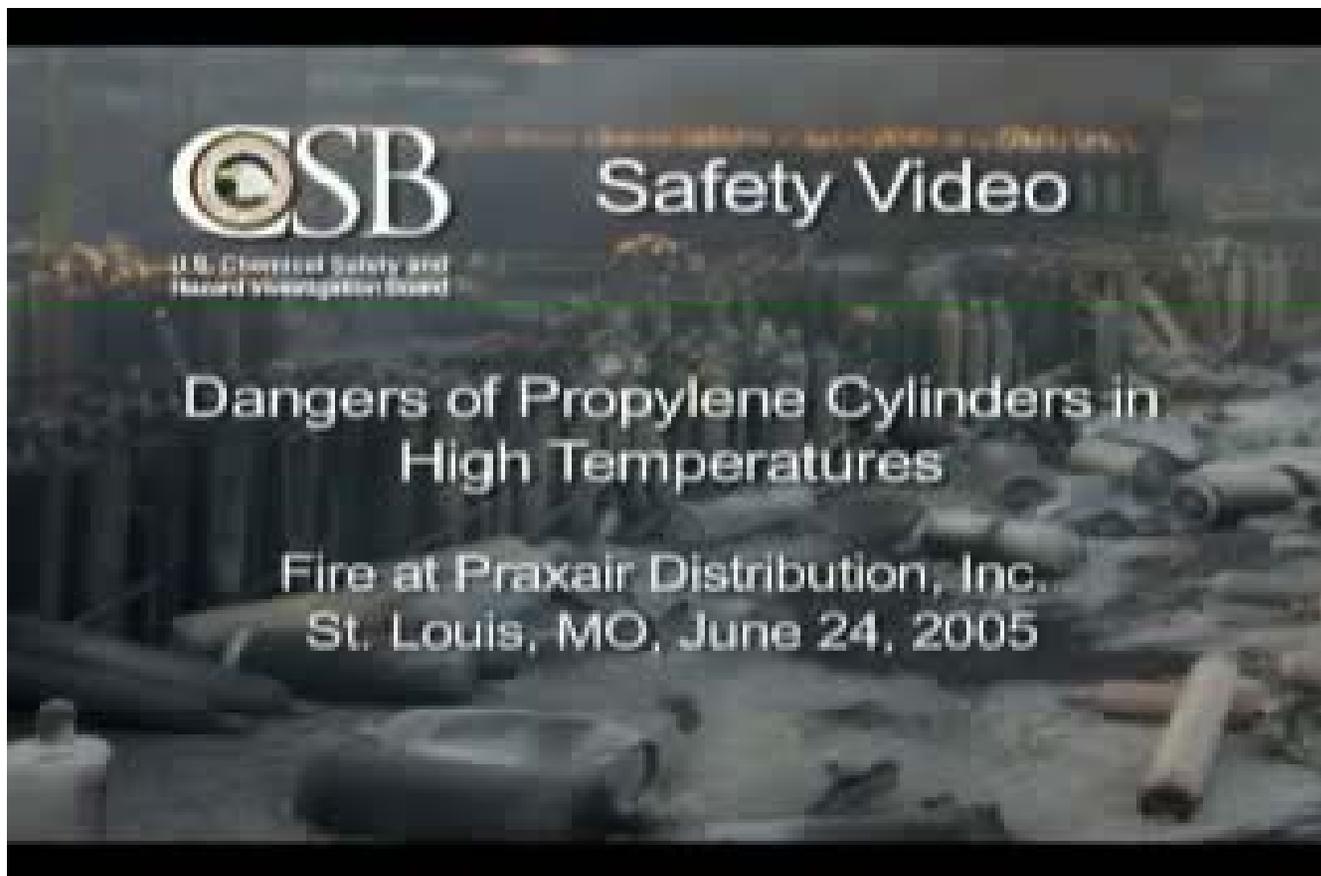


Chemical Storage

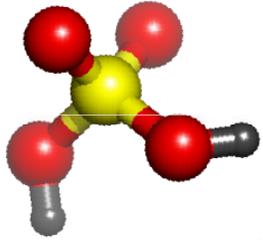




CSB Video: Compressed Gas Cylinder Fire



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

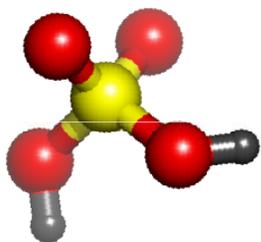


Chemical Storage

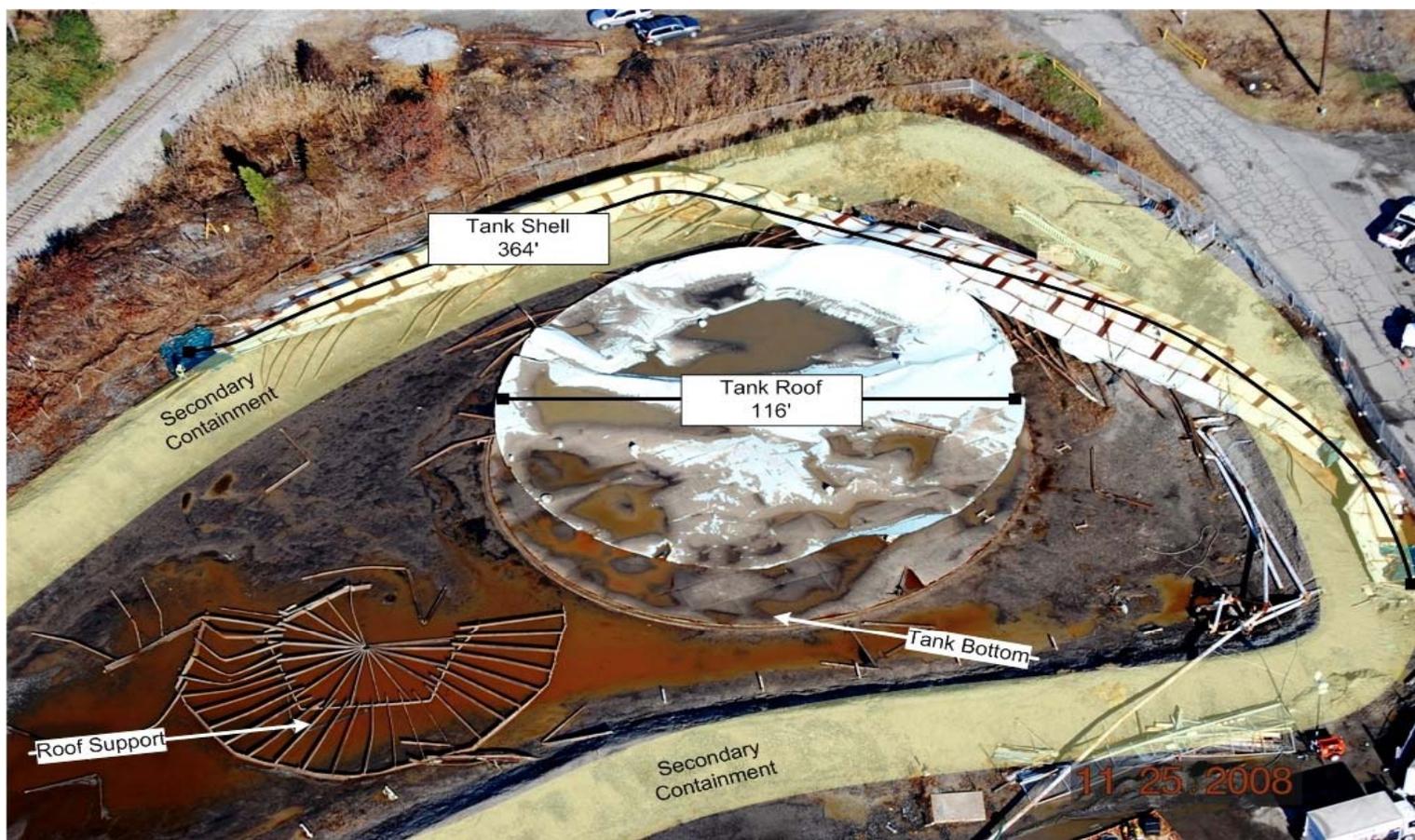
Tank Storage:

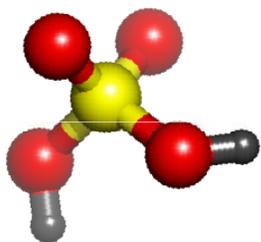
- ▶ Tank material **compatible** with the chemical stored
 - Mild Steel
 - Stainless steel
 - Cross-linked high density polyethylene
- ▶ Spill containment
 - Double walled or lined tanks
 - Berms
- ▶ Security/Impact protection





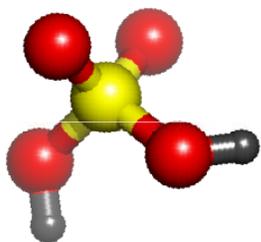
Collapsed Fertilizer Tank





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

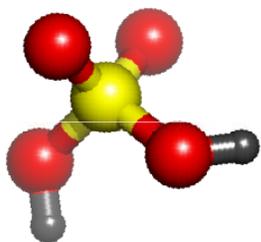
Barcode Systems

- 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
Jaelyn Elizabeth R. Santos

Chemistry Department
Ateneo de Manila University
Loyola Heights, Quezon City



Chemical Inventory Systems Barcode Systems

Advantages:

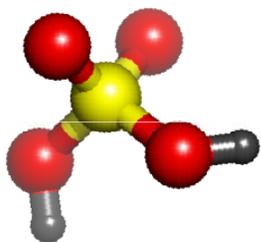
- Query for container location
- Link a chemical container to safety data sheet
- Track chemicals of concern
- Document disposal or waste transfer

Recommendations:

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



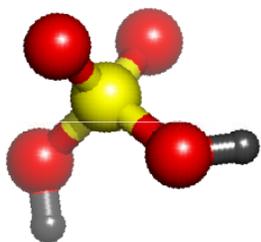
Photo credit: Fabian M. Dayrit and
Jaclyn Elizabeth R. Santos



Chemical Inventory Systems

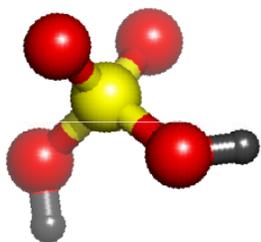
System should be able to query for the following:

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



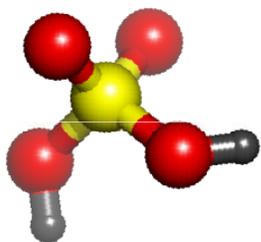
Example: Barcode System for Static Inventory

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		DIETHANO LAMINE	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

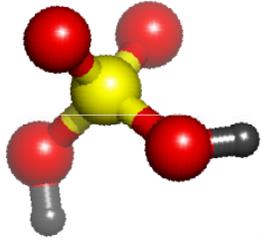
U.S. OSHA

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



Danger
Flammable Liquid

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

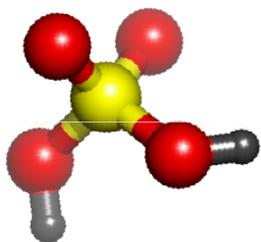


Using Chemicals Hazard Communication

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

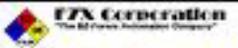


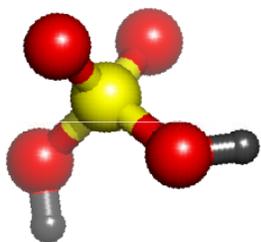


Using Chemicals Hazard Communication

Safety Data Sheet:

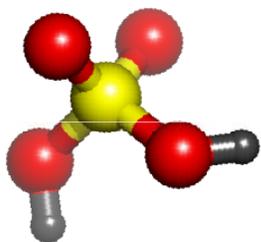
1. Identification
2. Hazard(s) identification
3. Composition information
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure control/personal protection

MATERIAL SAFETY DATA SHEET				Page: 1 of 1
PRODUCT NAME: MSDS NUMBER: EMERGENCY PHONE NO.:		PRODUCT CODE: MSDS NUMBER:		
 http://www.EZ-Forms.com		HEALTH FLAMMABLE CORROSIVE REACTIVITY SPECIFIC		
1. IDENTIFICATION <input type="checkbox"/> See Additional <input type="checkbox"/> See Page 2				
Chemical Name: Chemical Family: CAS #: Substance / Hazard Name: SDS Information:		Molecular Formula: Molecular Weight:		
2. PHYSICAL DATA <input type="checkbox"/> See Additional <input type="checkbox"/> See Page 2				
Appearance: Color: State: Odor Characteristics: pH: Viscosity: Specific Gravity (Water = 1): Vapor Density (Air = 1): Vapor Pressure:		Melting Point: Boiling Point: Flash Point: Freezing Point: Percent Volatile: Evaporation Rate (Air = 1): Solubility in Water: Stability in Air: Stability in Water:		
3. INGREDIENTS <input type="checkbox"/> See Additional <input type="checkbox"/> See Page 2				
Material Components:		CAS #	CAS Name	
4. EXPOSURE CONTROL/PERSONAL PROTECTION DATA <input type="checkbox"/> See Additional <input type="checkbox"/> See Page 2				
Exposure Route: Exposure Media: Respiratory Protection: Skin Protection: Eye Protection:		Permissible Exposure Limit (PEL) (mg/m ³): TLV (mg/m ³):		



Summary

- ▶ 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

