



Chemical Safety Principles & Management

Indonesia
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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 light, radiofrequency
 - Ergonomic hazards





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Risk Assessment Process



Anticipation }
Recognition } Hazards } Risks
Evaluation }
Control }

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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



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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

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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

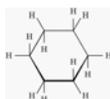
How are the risks controlled?

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

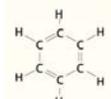


Controls

**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





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Chemical Management

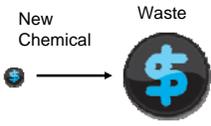
- ▶ Benefits
- ▶ Cradle to Grave Model
- ▶ Procurement
- ▶ Storage
- ▶ Use
- ▶ Disposal



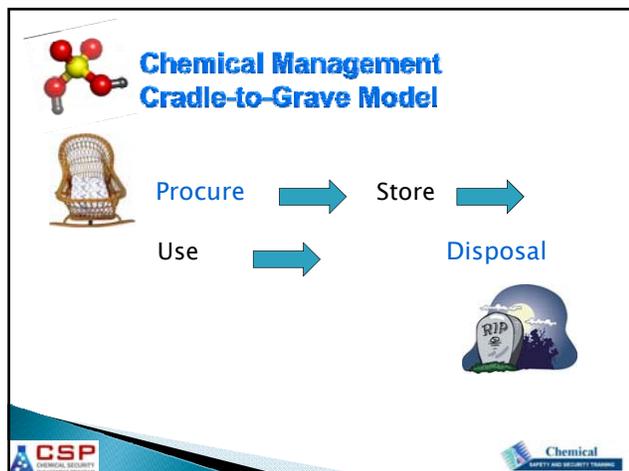
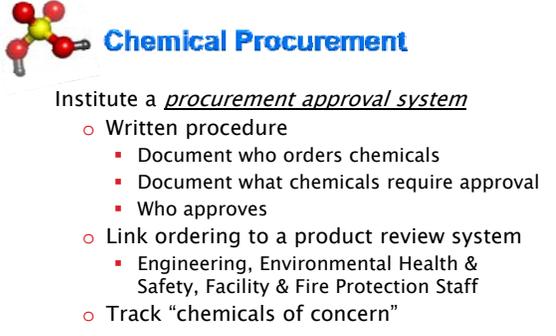


Chemical Management Benefits

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





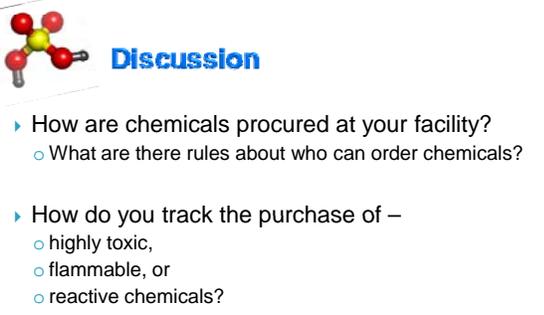
Chemical Procurement

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”

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Discussion

- ▶ How are chemicals procured at your facility?
 - What are the rules about who can order chemicals?
- ▶ How do you track the purchase of –
 - highly toxic,
 - flammable, or
 - reactive chemicals?

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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



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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)




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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



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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



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Chemical Storage




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 **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

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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	110/111 1	02712	40 liters	8/01/2007		BKC 2012L	Liquid	
XX00172	110/111 1	02712	80 liters	7/31/2007		DIETHANOLAMINE	Liquid	
XX00173	110/111 1	02712	20 liters	11/18/2010	1/30/2011	ACETONE	Liquid	x
XX00174	110/111 1	02712	28 liters	12/15/2010		ACETONE	Liquid	
XX00175	110/111 1	02712	40 liters	10/17/2010		ISODAMYL ACETATE	Liquid	
XX00176	110/111 1	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





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

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