

Welcome, Introductions, Background and CSP Website

National Research Center (NRC)

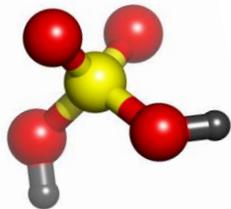
Cairo, Egypt

21 & 22 November 2012



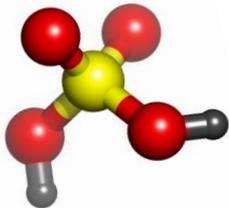
SAND No. 2011-9012P
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy's National Nuclear Security Administration
under contract DE-AC04-94AL85000.





The Chemical Security Engagement Program (CSP)

*US. Department of State
Washington, DC 20520*

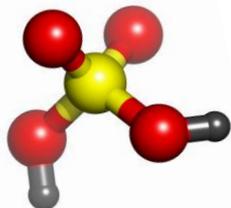


CSP and Program Goals

The Chemical Security Engagement Program (CSP) seeks to improve global chemical security and safety by raising awareness and improving security and safety best practices.

Program Goals:

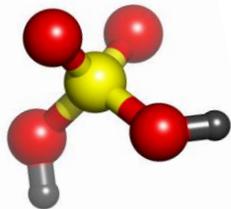
- ▶ Raise awareness about chemical threats and dual-use nature of chemicals.
- ▶ Provide technical assistance to improve chemical security and safety best practices.
- ▶ Foster national and regional dialogue focused on improving chemical security and safety.
- ▶ Promote and strengthen international scientific cooperation among chemical professionals.
- ▶ Establish cadres of safety and security officers.



CSP Strategy

- Work with host countries to assess priorities and gaps in chemical security and safety
- Bring together experts to identify chemical security assistance needs
- Partner with :
 - National chemical organizations (HKI, IKM, etc.)
 - Regional chemical organizations (FACS, FASC, etc.)
 - International chemical organizations (OPCW, IUPAC, UNFAO, etc)
 - Chemical Industry (ACC)
- Engage countries with:
 - Growing chemistry capabilities and industry
 - Regional security concerns
 - Active producers/exporters of industrial chemicals





Initial Workshops Identified Risks and Gaps

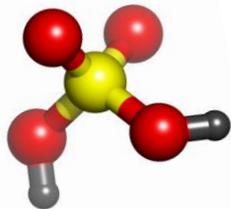
In Industry:

- Theft of unsecured chemicals
- Improper chemical management
- Improper disposal of chemicals
- Lack of enforcement of safety rules/laws

At Universities:

- Lack of safe practices
- Presence of dual-use of chemicals
- Improper chemical management
- Improper storage of chemicals
- Lack of enforcement of safety rules/laws



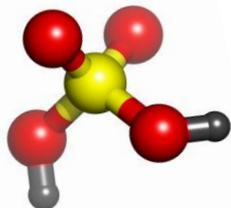


Involving Academia and Industry



To address chemical threat, both sectors must be involved.

- Academia/laboratories have a large variety of chemicals in small amounts
- Industry has a smaller variety of chemicals but in large amounts
- Quite different in needs, outlook, security issues



Chemical Safety and Security Training

Course Goals:

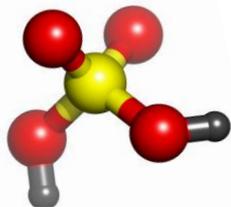
- Increase awareness of the importance of chemical safety and security
- Increase awareness of methods for improving chemical safety and security
- Determine needs for future training/actions

Safety vs. Security:

- Chemical Safety: Protecting people from chemicals
- Chemical Security: Protecting chemicals from people (i.e., terrorists or thieves)

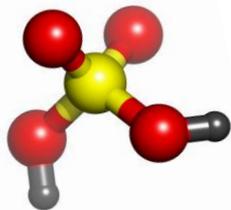


- Half-day seminars
- 1.5-2 day workshops
- 5 day trainings



Training Events Timeline

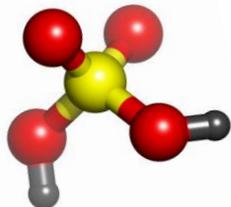




Sandia National Laboratories

The International Chemical Threat
Reduction Team is located in Albuquerque, New Mexico

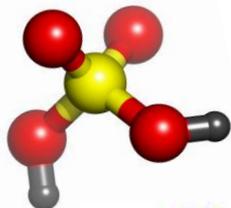




CSP Website

- Offers Networking Opportunities
- Provide Resources
- Discussion boards
 - Share best practices
 - Ask questions/get answers
- Upload/view photos from workshop
- View/download training materials
- See upcoming and past events

<https://chemsecurity.sandia.gov/>



CSP Website – Home Page



[Home](#) [Workshops](#) [Share Your Training](#) [Discussion Board](#) [Resources](#) [Contacts](#)

About Our Program

The Chemical Security Engagement Program (CSP) Partners With Chemical Professionals To:

Raise Awareness: Dual Use Nature of Chemicals

CSP works to reduce the risk of chemical threats by collaborating with partner governments, national and international chemical organizations, and chemical professionals to raise awareness about chemical security and safety, consistent with national and international guidelines, norms, and requirements.



Chemical Security Engagement Team

Foster Collaboration among Chemical Professionals Worldwide

CSP works with chemical organizations and universities to facilitate collaboration between chemical professionals. CSP is particularly interested in funding collaboration that can improve laboratory safety and security.

Provide Training Opportunities and Technical Assistance to Improve Chemical Safety and Security in Laboratories

CSP seeks to work with chemical universities and professional organizations to develop and implement training modules to reinforce chemical security and safety best practices, chemical



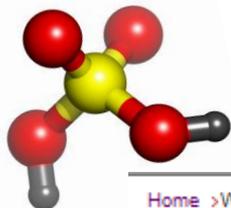
Search

Map of Participant Countries



Click on image for large, interactive map.





CSP Website – Workshops

Home > Workshops



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Workshops

Click on the workshop name to view presentation materials used for that event. To view or upload photos of an event you attended, click on the Photo Gallery link and login with your username and password. To request a username and password, please email us at chemsecurity@sandia.gov.

Please scroll down to the bottom to view document links.

[Egypt- CSS Course- October 2011](#)

[Jordan- CSSI Course- October 2011](#)

[Malaysia- Johu Bahru- October 2011](#)

[Malaysia- Kota Kinabalu- October 2011](#)

[UAE-Dubai Central Laboratories-September 2011](#)

[UAE-University of Sharjah-October 2011](#)

[Morocco](#)

[14th ACC & Advanced Waste Course-September 2011](#)

[Indonesia- HKI July 2011](#)

[Indonesia - Balitvet July 2011](#)

[Indonesia & Malaysia- June 2011](#)

[Qatar- May 2011](#)

[Industry - Philippines and Malaysia | February/March 2011](#)

[Mekong Delta | February 2011](#)



Chemical Security Engagement Program is sponsored by the [U.S. Department of State](#).

Search

Workshops

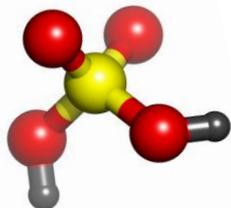
▪ [Photo Gallery](#)

Workshops by year

- [2011](#)
- [2010](#)
- [2009](#)
- [2008](#)

Where We've Been

- [Map of Participant Countries](#)
- [Countries & Institutions](#)



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Login Name

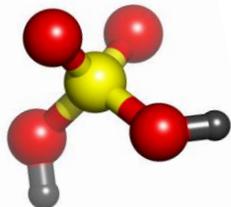
Password

 Log in

Forgot your password?

If you have forgotten your password, [click here to retrieve it.](#)

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CSP Website – Workshops

[Home](#) > [Workshops](#) > [2011 Workshops](#) > [Indonesia & Malaysia- June 2011](#)



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Please tell us about a safety and security training you taught.

Workshops

Click on the workshop name to view presentation materials used for that event. To view or upload photos of an event you attended, click on the Photo Gallery link and login with your username and password. To request a username and password, please email us at chemsecurity@sandia.gov.

Please scroll down to the bottom to view document links.

[Presentations](#)

[Materials](#)

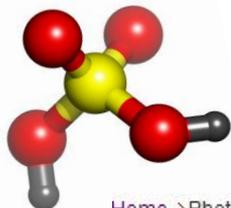
[PowerPoint Presentation Files](#)

[Trainer Bios](#)

[Participant List](#)

[Participant List](#)

[Test](#)



CSP Website – Photos

Home > Photo Gallery

Connie Stewart Log out



Home Workshops Share Your Training Discussion Board Resources **Photos** Contacts

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View Edit Criteria Subfolders Sharing

Photo Gallery



Mekong Delta Photos (18)



Indonesia/Malaysia Trainings (5)



Malaysia Workshop (13)



Photo Gallery (1)

Photo Gallery (0)

Photo Gallery (0)

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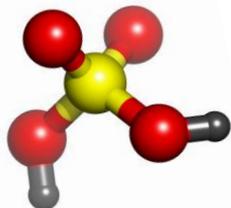
Workshops

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Workshops by year

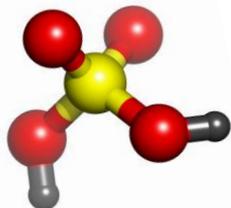
- [2011](#)
- [2010](#)
- [2009](#)
- [2008](#)

Where We've Been



CSP Website – Past event photos





[Add, edit or remove a portlet above the content](#)

Add Training Course

Title - (Required)
Title is required, please correct.

Trainer's First Name

Trainer's Last Name

E-mail Address -

Phone

Training Location/Venue

Training Date
 / /

Participant's Institution

Number of Participants

Type
 Academic
 Industry
 Other

If Other, please specify

Upload Agenda (Word or PDF file)

Will you allow your information to be shared?
 Yes
 No

Additional Comments

[Add, edit or remove a portlet below the content](#)



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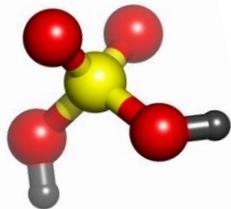
Map of Participant Countries

Click on image for large, interactive map.

- ### Current Events
- October 2011 | Malaysia - Industry Chemical Safety and Security Training
 - October 2011 | Jordan - Industry Chemical Safety and Security Training
 - October 2011 | Egypt - Chemical Safety and Security Training
 - October 2011 | Jordan - Chemical Safety and Security Officer Training
 - October 2011 | Ukraine - Industry Chemical Safety and Security Training
 - December 2011 | Algeria - Chemical Safety and Security Officer Training

- ### Partners
- Chemical Industry and Industrial Organizations
 - [American Chemistry Council](#)
 - [Chemical Industries Council of Malaysia \(CICOM\)](#)
 - [Chemical Industries Association of the Philippines](#)
 - Chemical Professionals and Professional Organizations
 - [International Union of Pure and Applied Chemistry \(IUPAC\)](#)
 - [Federation of Asian Chemical Societies](#)

CSP Website - Share Your Training



CSP Website – Discussion Board

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Home Workshops Share Your Training **Discussion Board** Resources Photos C

Discussion Board

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Add File

Title

Description

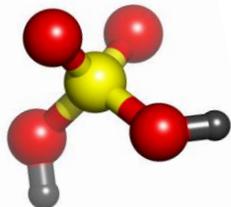
A short summary of the content.

File *

 Browse...

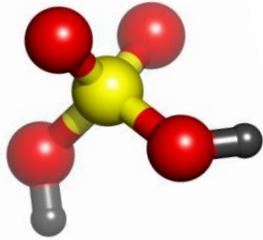
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Summary

- ▶ Defined the Goals and Objectives of the Chemical Security Engagement Program
- ▶ Briefly stated the Strategy of the Program
 - Work with host countries, national and regional organizations,
 - Work with Industry and Universities
- ▶ Chemical Safety & Security Training
 - Increase awareness of chemical safety and security
 - Determine needs for future training/actions
- ▶ Highlight of the CSP Website
 - Networking Opportunities
 - Provide Resources
 - View/download training materials

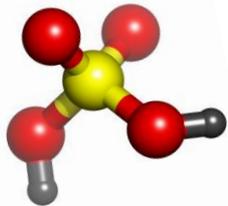


Chemical Safety and Security – An Overview



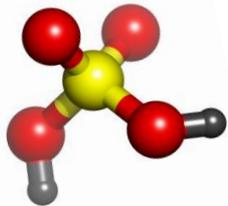
SAND No. 2009-8395P
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Why practice chemical safety?

- ▶ Health and safety of the workers
- ▶ Prevent accidental releases
 - Potential regulatory fines, lawsuits
- ▶ Relationship with the local community
- ▶ Ensure a sustainable environment



Industrial Safety Incidents

Catastrophic process incidents:

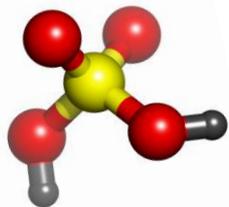
- ▶ 1976 Seveso Italy
- ▶ 1984 Bhopal India
- ▶ 2005 Texas City Texas

More recently:

- ▶ 2009-Fertilizer tank collapses
 - 2 critically injured
 - Responders exposed to ammonia
 - 760cm³ released
 - River contaminated
- ▶ 2007-Fire and Explosion
 - Filling ethyl acetate storage tank
 - Equipment not bonded and grounded



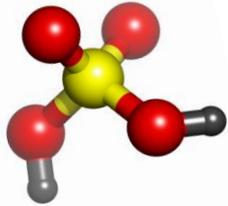
Photo credit. U.S. Chemical Safety Board.
<http://www.csb.gov/>



U. S Chemical Safety Board Video



CSB Video – Reactive Hazards 20 minutes
Reactives_clipped.mpg

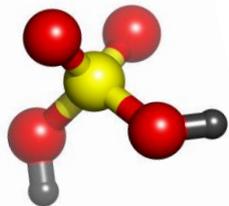


Center for Chemical Process Safety

- ▶ Anyone can subscribe
- ▶ Delivers monthly process safety messages to plant operators and other manufacturing personnel.
- ▶ Presents a real-life accidents, lessons learned, and practical means to prevent accidents at your plant.
- ▶ Published in 29 languages, including Malay
 - <http://www.aiche.org/CCPS/Publications/Beacon/index.aspx>



Adakah anda bersedia untuk bencana alam?



Regulations and Standards

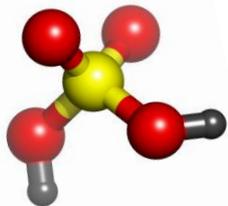
- ▶ Individual country regulations
 - EU REACH
 - U.S. OSHA Process Safety Standard
- ▶ International chemical & labor organizations
 - ICCA Responsible Care
 - International Labor Organization
- ▶ International standards
 - ISO 14001:2004
 - OHSAS 18001
 - United Nations-GHS
 - SAICM



**International
Labour
Organization**



**International
Organization for
Standardization**

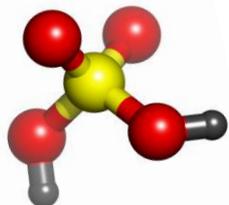


What about chemical security?

- ▶ Chemical theft
 - Precursors for drugs
 - Precursors for chemical weapons
 - Dual-use chemicals
 - Industrial chemicals
 - Flammable/toxic gases
 - Ammonium nitrate
 - Chlorine
 - Pesticides
- ▶ Plant sabotage
 - Deaths, injuries
 - Economic and environmental impact



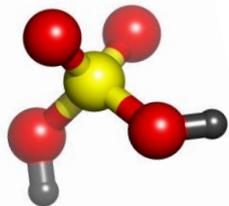
Abandoned Bhopal Plant
Photo credit: AP/Saurabh Das



What are the threats to chemical security?

- ▶ Unlimited access to facilities
 - Chemical storage areas
 - Analytical laboratories
 - Waste storage
 - Construction sites
- ▶ No controls or security checks on chemical procurement
- ▶ Shipping and receiving areas not protected
- ▶ Recruit young chemists
 - Tokyo subway Sarin attack

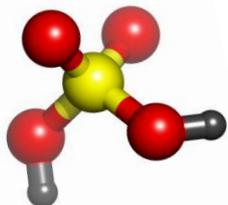




Threats to Cyber Security

- SCADA control software is used by one-third of industrial plants
- Security technology may not work on plant proprietary networks
- Attacks may result in:
 - Loss of process control
 - Loss of production
 - Process safety incidents
- Examples:
 - 2005-Zolob worm shuts down 13 Daimler Chrysler Plants

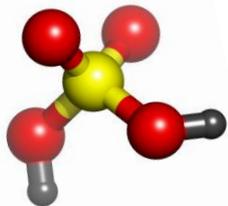




International Resolutions & Organizations Related to Chemical Security

- UN Security Council Resolution 1540
- Australia Group
- Organization for the Prohibition of Chemical Weapons
- American Chemistry Council
 - *Responsible Care Security Code*



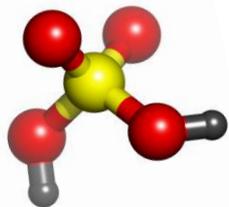


How are chemical safety and chemical security related?

Both Ensure Protection of:

- ▶ Workers
- ▶ Plant facilities
- ▶ Plant processes
- ▶ Community
- ▶ Environment
- ▶ Economy





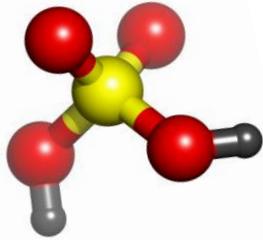
Reflect and Consider

What chemical safety and security practices and controls does your plant require?

...Are they effective?

...Could they be improved?

...How?

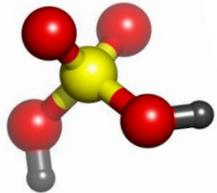


Chemical Safety and Security Principles & Management



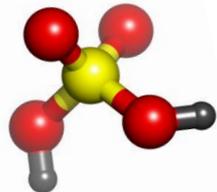
SAND No 2012-1606C
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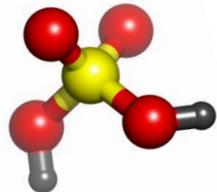
Topics

- 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

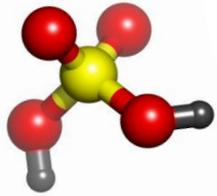
- ▶ Safety: “The condition of being safe from undergoing or causing hurt, injury, or loss”
 - Merriam-Webster <http://www.merriam-webster.com/dictionary/safety>
- ▶ Chemical Safety: “Practical certainty that there will be no exposure of organisms to toxic amounts of any substance or group of substances: 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

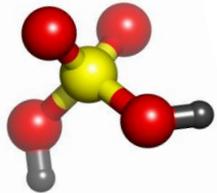
▶ *Chemical hazards*

- Health hazards: toxics, corrosives, carcinogens
- Physical hazards: flammables, explosives, reactivities

▶ *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





Risk Assessment Process

Anticipation

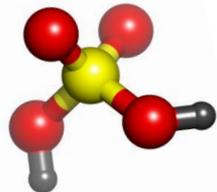
Recognition

Evaluation

Control

Hazards

Risks

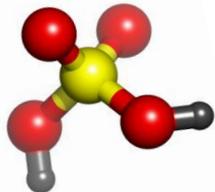


Anticipation

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



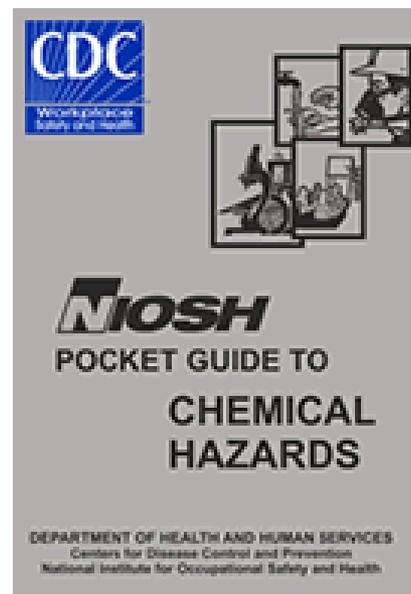


Recognition / Identification

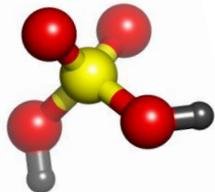
- ▶ Identify each chemical hazard
 - Quantity of each process chemical
 - Identify intermediates, by-products
 - Acquire toxicity information
 - Solid, liquid, or gas?
 - Flashpoint
 - Vapor pressure
 - Air or water reactivity

- ▶ Identify process hazards

- Upper and lower limits of temperature, pressure, flow
- Mechanical hazards
- Electrical hazards

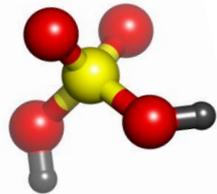


http://www.ilo.org/safework/info/databases/lang_en/WCMS_145760/index.htm



Evaluation

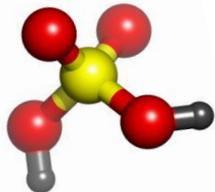
- ▶ What are the tasks in the process? How are chemicals used?
 - Filling, spraying, reacting, mixing?
- ▶ What are the controls for over-pressurization or elevated temperature conditions?
- ▶ Process equipment inspected & maintained?
- ▶ Barriers and guards in place?
- ▶ Workers properly trained?
-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

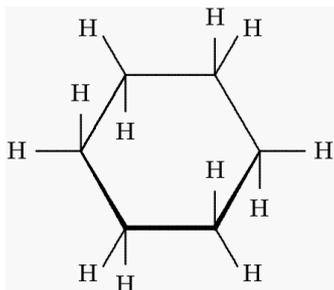


Controls

Change the process

eliminate the hazard

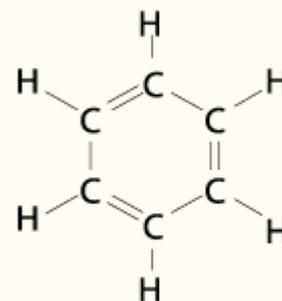
(e.g. Lower process temperature)

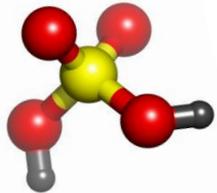


Substitution

less-hazardous substance

(e.g. - cyclohexane for benzene)





Engineering Controls



Enclose the hazard,

Use a barrier,

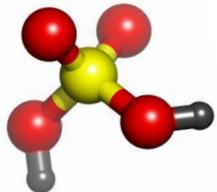
Or

Ventilate

- Dilution ventilation

- Local exhaust ventilation (LEV)



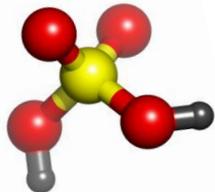


Administrative Controls



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





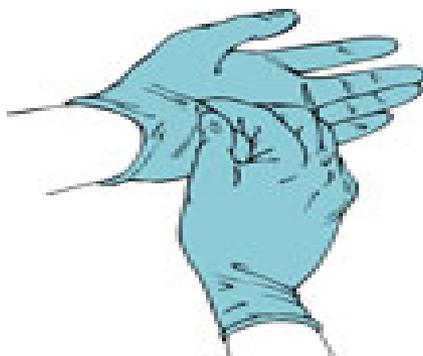
Personal Protective Equipment

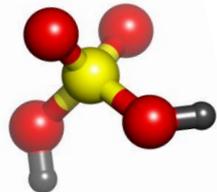
PPE is the *least* desired control

Does not eliminate the hazard

Depends on worker compliance

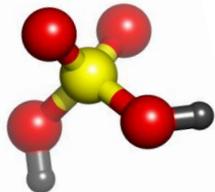
May create heat stress





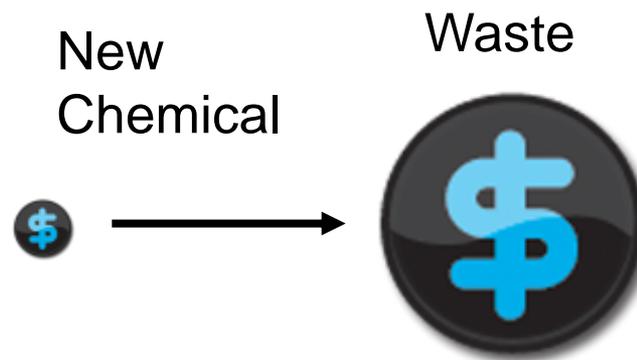
Chemical Management

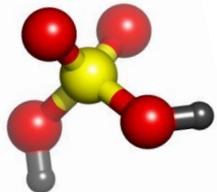
- ▶ Benefits
- ▶ Cradle to Grave Model
- ▶ Procurement
- ▶ Storage
- ▶ Use
- ▶ Disposal



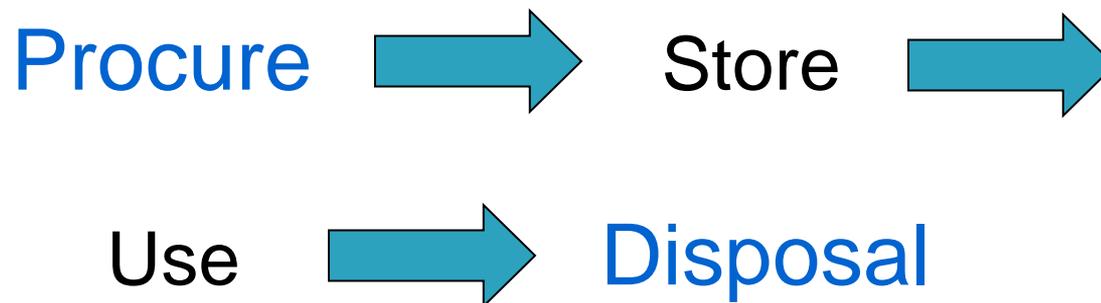
Chemical Management Benefits

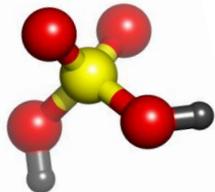
- **Reduces cost of:**
 - Raw materials
 - Hazardous waste disposal
- **Facilitates plant sustainability**
- **Protects the environment**
- **Improves security**
 - Theft
 - Sabotage





Chemical Management Cradle-to-Grave Model

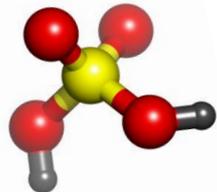




Chemical Procurement

Institute a procurement approval system

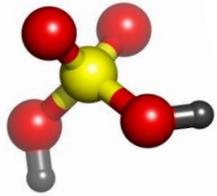
- Written procedure
 - Document who orders chemicals
 - Document what chemicals require approval
 - Who approves
- Link ordering to a product review system
 - Engineering, Environmental Health & Safety, Facility & Fire Protection Staff
- Track “chemicals of concern”



Discussion

- ▶ How are chemicals procured at your university?
 - What are the rules about who can order chemicals?

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

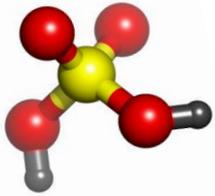


Chemical Storage

- ▶ 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



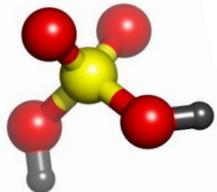


Chemical Storage Cont'd

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)



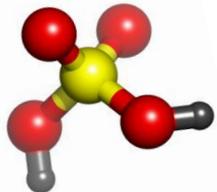


Chemical Storage Cont'd

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



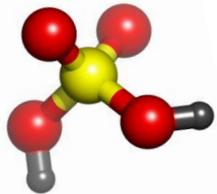


Chemical Storage Cont'd

Design and Construction:

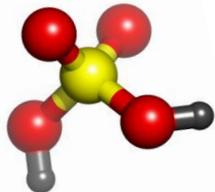
- ▶ Spill containment
 - Maximum probable spill plus fire sprinkler water
 - Primary containment
 - Drains, trenches
 - Secondary containment
 - Recessed loading dock
 - Concrete berms, grates
- ▶ Separate incompatible chemicals
 - Oxidizers, corrosives, flammables





Chemical Storage Cont'd



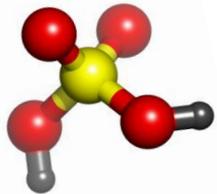


Chemical Storage Cont'd

Gas Cylinders:

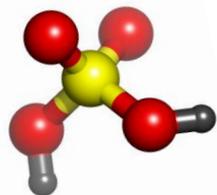
- ▶ Separate incompatible gases
- ▶ Secure all gas cylinders
- ▶ Store in well-ventilated area
- ▶ Provide protection from direct sunlight
- ▶ Screw down cylinder caps when not in use





Chemical Storage Cont'd

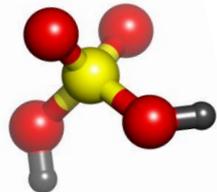




CSB Video: Compressed Gas Cylinder Fire



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

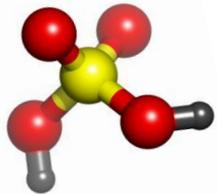


Chemical Storage Cont'd

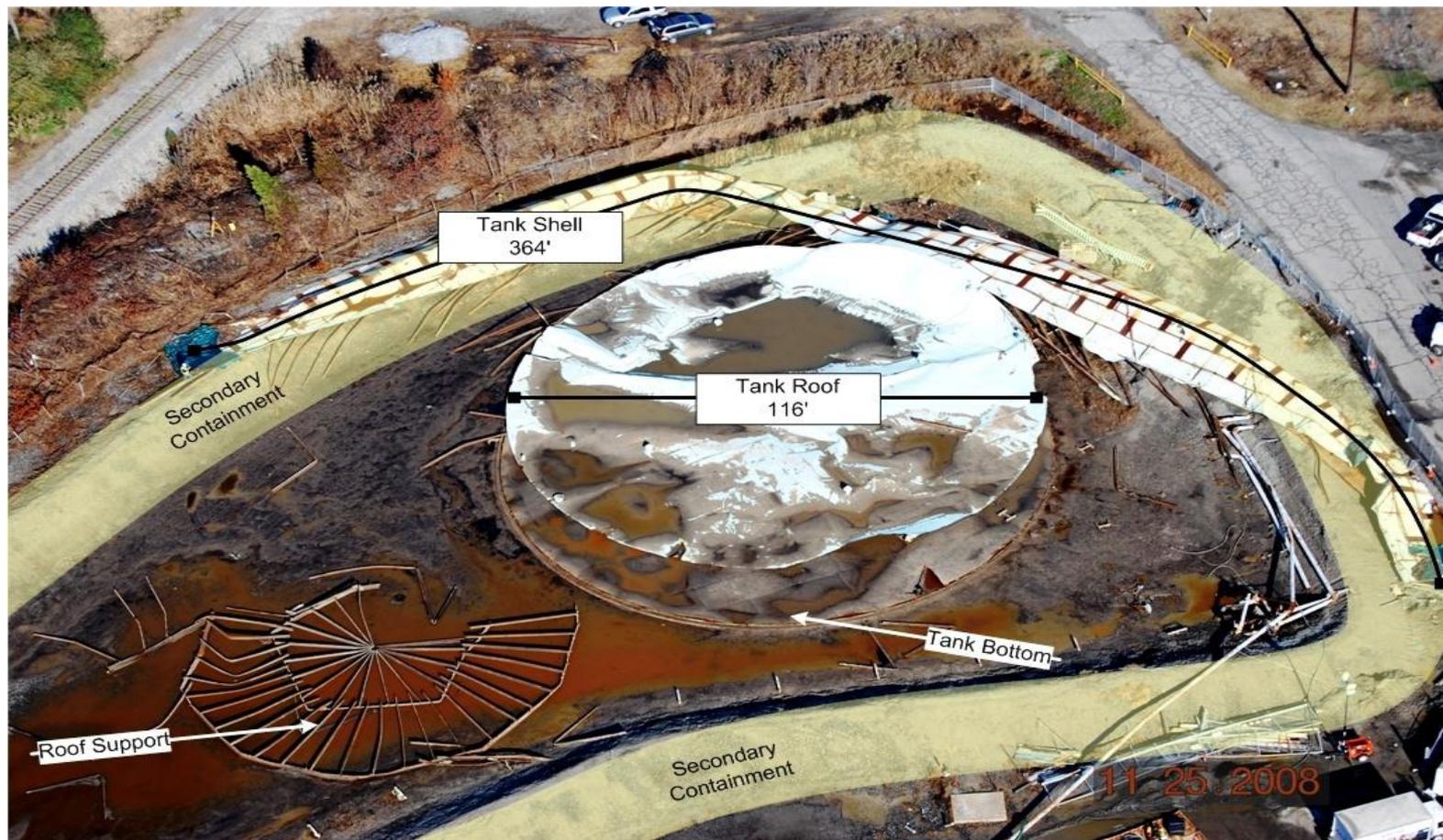
Tank Storage:

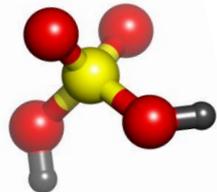
- ▶ Tank material **compatible** with the chemical stored
 - Mild Steel
 - Stainless steel
 - Cross-linked high density polyethylene
- ▶ **Spill containment**
 - Double walled or lined tanks
 - Berms
- ▶ **Security/Impact protection**





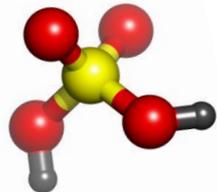
Collapsed Fertilizer Tank





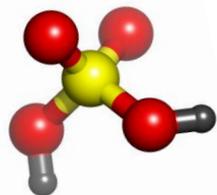
Discussion

What safeguards does your university 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

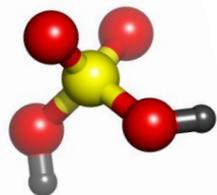
Barcode Systems

- 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 Cont'd

Advantages:

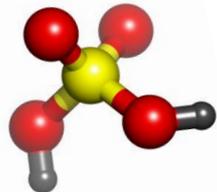
- Query for container location
- Link a chemical container to safety data sheet
- Track chemicals of concern
- Document disposal or waste transfer

Recommendations:

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



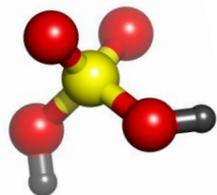
Photo credit: Fabian M. Dayrit and
Jaclyn Elizabeth R. Santos



Chemical Inventory Systems

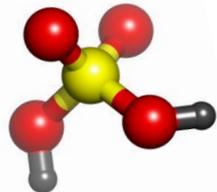
System should be able to query for the following:

- 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

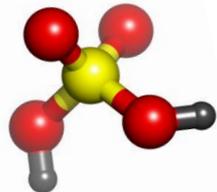
Barcode	Location	Depart.	Quantity	Purchase Date	Expiration Date	Name	State	Waste Disposal
XX00187	110/111 1	02712	40 liters	8/01/2007		BKC 20121	Liquid	
XX00172	110/111 1	02712	80 liters	7/31/2007		DIETHANOLAMINE	Liquid	
XX00173	110/111 1	02712	20 liters	11/18/2010	1/30/2011	ACETONE	Liquid	x
XX00174	110/111 1	02712	28 liters	12/15/2010		ACETONE	Liquid	
XX00175	110/111 1	02712	40 liters	10/17/2010		ISOAMYL 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

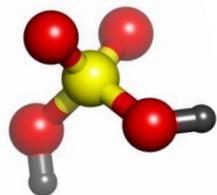
U.S. OSHA

- 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>



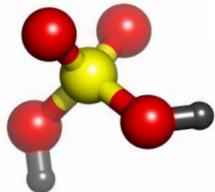
Using Chemicals

Hazard Communication Cont'd

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



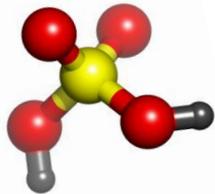


Using Chemicals Hazard Communication Cont'd

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		PRODUCT CODE MSDS NUMBER			
EMERGENCY PHONE NO.					
 EZA Corporation "The EZ-Forms Automation Company" http://www.EZ-Forms.com		HEALTH FLAMMABLE CORROSIVE REACTIVE SPECIFIC			
1. IDENTIFICATION				CAS #	
Chemical Name		Chemical Family		Molecular Weight	
CAS #		CAS Name		Molecular Weight	
Substance Hazard Data		SDS Information			
2. PHYSICAL DATA				CAS #	
Appearance		Melting Point		Boiling Point	
Color		Flash Point		Freezing Point	
Solubility		Relative Volatility		Evaporation Rate (Ea = 1)	
pH		Stability in Water		Stability in Air	
Specific Gravity (Water = 1)		Stability in Water		Stability in Air	
Vapor Density (Air = 1)		Stability in Water		Stability in Air	
Vapor Pressure		Stability in Water		Stability in Air	
3. INGREDIENTS				CAS #	
Material Components		CAS #		CAS Name	
				UN Data	
				Hazard	
4. EXPOSURE CONTROL/PERSONAL PROTECTION				CAS #	
Peak Point		Permissible Exposure Limit (PEL)		OSHA PEL	
Exposure Limit		Permissible Exposure Limit (PEL)		OSHA PEL	
Respiratory Protection		Respiratory Protection		Respiratory Protection	
Eye Protection		Eye Protection		Eye Protection	
Skin Protection		Skin Protection		Skin Protection	
Hand Protection		Hand Protection		Hand Protection	
Foot Protection		Foot Protection		Foot Protection	

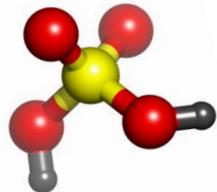


Using Chemicals

Hazard Communication Cont'd

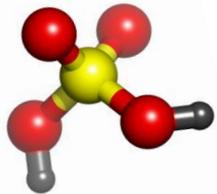
9. Physical/chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

MATERIAL SAFETY DATA SHEET				
PRODUCT NAME:		PRODUCT CODE:		
MSDS NUMBER:		MSDS NUMBER:		
EMERGENCY PHONE NO.:				
 E-Z Corporation The EZ-Forms Automation Company		HAZARD		
http://www.EZ-Forms.com		FLAMMABLE	TOXIC	
		REACTIVE	IRRITANT	
		SPECIFIC		
1. IDENTIFICATION				
Chemical Name:		Chemical Formula:		
Chemical Family:		CAS #:		
CAS #:		Molecular Weight:		
Molecular Weight:		Molecular Weight:		
Molecular Weight:		Molecular Weight:		
2. PHYSICAL DATA				
Appearance:		Melting Point:		
Color:		Boiling Point:		
State:		Flash Point:		
Solubility:		Freezing Point:		
pH:		Relative Volatility:		
Viscosity:		Evaporation Rate (EAP):		
Specific Gravity (20°C):		Stability in Water:		
Vapor Density (Air = 1):		Stability in Air:		
Vapor Pressure:		Stability in Solution:		
3. INGREDIENTS				
Mixture Components:		CAS #:	CAS Name:	EC Data:
				Approx. %:
4. LABEL AND/OR HAZARD DATA				
Trade Name:		Revision (Date / Issue):		
Emergency Info:		Hazard Statement (GHS):		
Special Fire Fighting Procedures:				
Special Precautions:				
Special Precautions:				
Special Precautions:				



Discussion

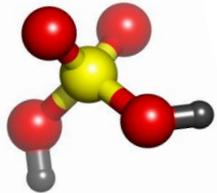
- ▶ What chemical labeling system does your university use?
- ▶ Is the labeling system the same for all containers?
- ▶ How do workers and emergency response staff access safety data sheets in the event of an incident?



Chemical Waste Management

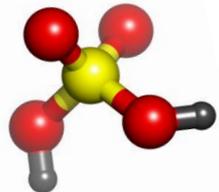
- ▶ Substitute chemicals when process permits
- ▶ Recycle
- ▶ Dispose by incineration, if allowed in your country
- ▶ Injection wells used in U.S.
- ▶ Incineration is NOT the same as open burning



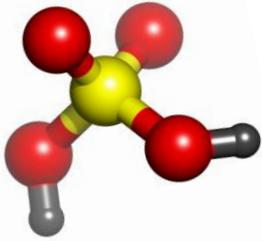


Summary

- 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



Tea Break!



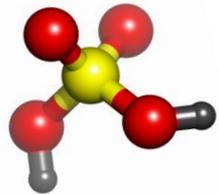
International Safety Management Systems



SAND No 2011-7069C

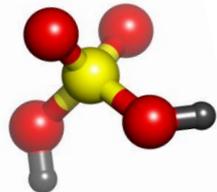
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy's National Nuclear Security Administration
under contract DE-AC04-94AL85000.





International Safety Management Systems

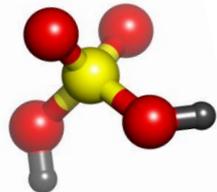
- ▶ Definitions
- ▶ Purpose
- ▶ Safety Concepts
- ▶ Standards
 - BS 8800
 - OHSAS 18001
 - ILO-OSH 2001
- ▶ Approaches
 - SAICM



Definitions

- ▶ Safety: “The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management. “ (U.S. Federal Aviation Administration, 2009)
- ▶ A Safety Management System (SMS) is a systematic way to identify hazards and control risks while maintaining assurance that these risks are effective.
 - Provides for goal setting, planning, and measuring performance
 - SMS is a business imperative: ethical, legal and financial reasons for establishing a SMS (ICAO, 2009)

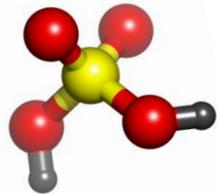
Reference: International Civil Aviation Organization (ICAO), Safety Management Manual, 2009;
U.S. Federal Aviation Administration, System Approach for Safety Oversight, 2009



Purpose

- ▶ Ever-increasing pace of worldwide trade and economies
- ▶ Increase in occupational accidents and diseases
 - Over 1.2 million workers are killed due to work-related accidents and diseases annually
 - ~250 million occupational accidents annually
 - ~160 million work-related diseases annually
- ▶ The economic loss is estimated to be 4% of the world gross national product

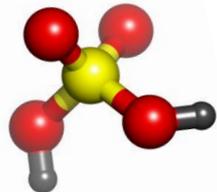
Reference: International Labour Organisation, 2001



Safety Concepts

- ▶ Freedom from hazards
- ▶ Zero accidents or incidents?
- ▶ Instill safety culture towards unsafe acts and conditions
- ▶ Error avoidance
- ▶ Regulatory compliance

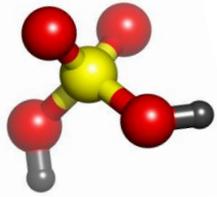
Reference: International Civil Aviation Organization, Safety Management Manual, 2009



Safety Concepts Cont'd

- ▶ Traditional approach – prevent accidents
 - Focus is on outcomes (causes)
 - Focus is on unsafe acts by operational personnel
 - Assign blame/punish for failure to “perform safely”
 - Address identified safety concerns exclusively
- ▶ Traditional approach: WHAT? WHO? WHEN,
but NOT: WHY? HOW?

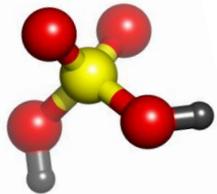
Reference: International Civil Aviation Organization, Safety Management Manual, 2009



Evolution of Safety Concepts

- ▶ Change in approach to incident causation:
 - 1950s to 1970
 - Technical factors
 - 1970s to 1990s
 - Human factors
 - 1990s to present time
 - Organizational factors

Reference: International Civil Aviation Organization, Safety Management Manual, 2009



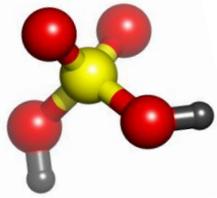
Safety Management Standards

British Standard 8800

British Standard (BS) 8800 (1996)

- A guide to occupational health & safety management systems
- Emphasizes good working practices to prevent accidents and ill health
- Goal is to improve business performance and responsible image
- Assists in continuous improvement beyond regulatory compliance

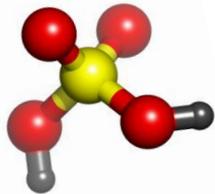




Safety Management Standards British Standard 8800

- ▶ Last edition: July 2004
- ▶ New and improved annexes cover:
 - Hazardous event investigation
 - Risk assessment and control
 - Integration with other quality and environmental management systems into an overall management system

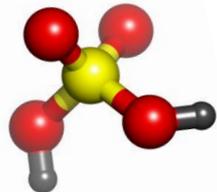




Safety Management Standards

OHSAS 18000

- ▶ OHSAS 18000 system specification comprises both OHSAS 18001 and OHSAS 18002.
- ▶ Created by leading national standards bodies, certification bodies, and specialist consultancies
- ▶ Intent—to remove confusion from the proliferation of certifiable occupational health & safety (OHS) specifications
- ▶ OHSAS publishes *The Essential Health and Safety Manual* for purchase.
- ▶ Emphasis is on policy and procedures



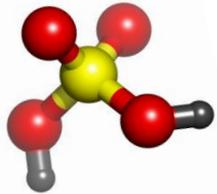
Safety Management Standards

OHSAS 18001

Requirements:

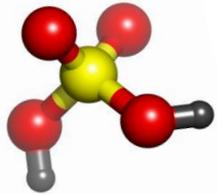
- ▶ Identify occupational health and safety (OHS) hazards
- ▶ Assess the risks associated with OHS hazards
- ▶ Determine the controls necessary to reduce OHS risks to acceptable levels
- ▶ Proactive vs reactive approach to safety and health hazards





OHSAS 18001 Relationships to ISO

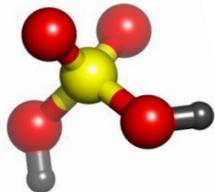
- ▶ OHSAS 18001 developed to be compatible with ISO 9001 and ISO 14001
- ▶ Facilitates the integration of quality, environmental, and OHS management systems
 - Document and data control
 - Auditing
 - Process controls
 - Record controls
 - Training
 - Corrective and preventive actions



OHSAS 18001 Elements

OHS Management Program

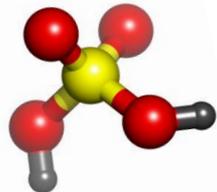
- Designates responsibility and authority
- Defines means through which objectives are to be achieved, and timeline for achieving them
- Must be reviewed at regular, planned intervals
- Must be amended to address relevant changes in activities, products/services or operating conditions
- Top management must provide necessary resources



OHSAS 18001 Elements

- ▶ *Employee Awareness*
 - Importance of conforming to OHS management system
 - Health & safety consequences of their work activities
 - Individual roles & responsibilities
 - Potential consequences of non-conformance to operating procedures
- ▶ Employees should be involved in review of policies/procedures for managing risks and consulted on changes that affect workplace.

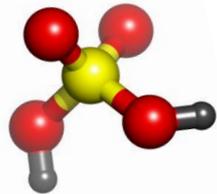
Employee involvement is KEY.



OHSAS 18001 Elements

Document Control

- Document procedures established and maintained
- Can be readily located
- Legible, identifiable and traceable
- Are reviewed periodically and updated if necessary
- Are available at all locations where the OHS management system operates
- Documents may be integrated with other corporate documents where appropriate

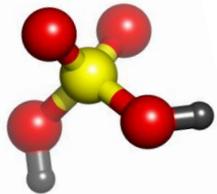


OHSAS 18001 Elements

Records and Reviews

- Compliance records
- Training records
- Accident Information
- Inspection, maintenance and calibration records
- Contractor and supplier information
- Incident reports
- Hazard analyses
- Audit results
- Management review records



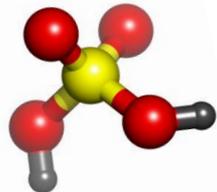


OHSAS 18001 Elements

Emergency Situations

- Identify potential emergency situations and response measures
- There must be review of response measures after any incidents occur
- Emergency response measures must be tested periodically



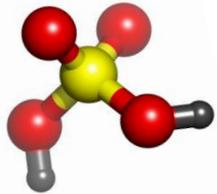


OHSAS 18001 Elements

Audit Program

- Determines whether OHS management plan has been properly implemented and maintained and meets policy and objectives
- Reviews results of previous audits
- Provides audit information to (top) management
- Should be conducted by independent (not necessarily external) personnel

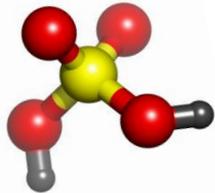




OHSAS 18001 Elements

Management Reviews

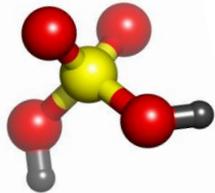
- Should be at specified periodic intervals, documented, and cite any need for changes to policy or objectives
- Should include:
 - Audit results
 - Extent to which objectives are met
 - Confirmation of continued suitability of OHS management system
 - Concerns from any relevant interested parties



OHSAS 18001 Certification

Steps to certification are similar to those for ISO 9001/14001:

- ▶ Commit to developing OHSAS 18001 system.
- ▶ Develop plan for implementation.
 - Understand legal/regulatory requirements.
 - Identify risks/hazards, and controls for them.
- ▶ Implementation and training.
 - Training for management/employees can be done in-house or through consultants.
 - Allow enough time for system to be correctly/effectively implemented.
- ▶ Once system is in place, consider options for certification.



OHSAS 18001 Certification

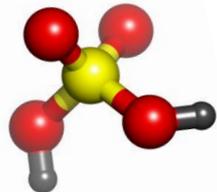
Developing a program can be done with or without consultation:

▶ **Without consultants:**

- Literature can be purchased to help guide through the process of designing and implementing the program.

▶ **With consultants**

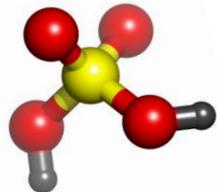
- Some consultants perform initial set-up, through development and implementation and certification.
- Other consultants offer preliminary audits to diagnose implementation problems, and perform audits post-certification to monitor progress.



International Labor Organization (ILO)

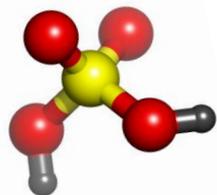
OSH2001 Guidelines on Occupational Safety and Health Management Systems

- ▶ Voluntary guidelines
- ▶ Do not require certification
- ▶ Basic Components
 - Safety Management Policy
 - Organization
 - Planning and Implementation
 - Evaluation
 - Action for Improvement



ILO: OSH 2001

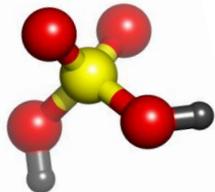
- ▶ Policy statement- state requirements in terms of resources, management commitment, and define OSH targets
- ▶ Organizing – describe organizational structure, responsibilities and accountabilities
- ▶ Planning and Implementation – define regulations and standards that are applicable and how they will be implemented
- ▶ Evaluation – define how OSH performance measured and assessed
- ▶ Continuous improvement processes described



Strategic Approach to International Chemical Management (SAICM)

- ▶ Adopted by the International Conference on Chemicals Management (ICCM), 2006
- ▶ Policy framework to foster safe management of chemicals
- ▶ Multi-sectoral, multi-stakeholder
- ▶ Goal: ensure that by 2020, chemicals are produced and used in ways that minimize the significant adverse impacts on the environment and human health (ICCM, 2006)

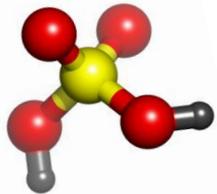
<http://www.saicm.org/index.php?ql=h&content=home>



Strategic Approach to International Chemical Management (SAICM)

Quick Start Programme:

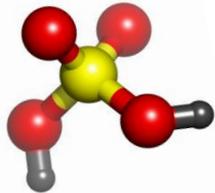
- A voluntary, time-limited trust fund for developing countries, and economies in transition
- Priorities:
 - Development or updating of national chemical profiles
 - Identify capacity needs for sound chemicals management
 - Development and strengthening of national chemicals management institutions, plans, programmes and activities
 - Enable SAICM by integrating the sound management of chemicals in national strategies



Why Implement Safety Management Standards?

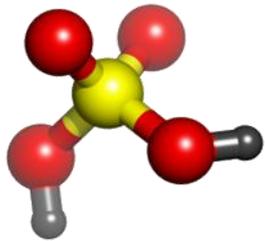
- ▶ Safety of workers
- ▶ Quality of product
- ▶ Increased efficiency
- ▶ Business image





Integrated Management Systems

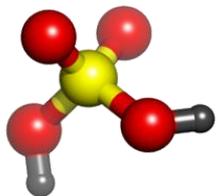
- ▶ Integrated management systems combine quality, environmental and OHS management systems
- ▶ Integration may vary from:
 - Increasing compatibility of system elements, to
 - Embedding an integrated management system (IMS) in a culture of learning and continuous improvements
- ▶ Some national integrated management standards are being developed (ISO (2008). Integrated Use of Management System Standards).
- ▶ For business sustainability an IMS needs to include the entire product chain and all stakeholders
- ▶ Jorgensen, et al. (2006). *Integrated management systems – three different levels of integration*. Journal of Cleaner Production, 14(8), 713-722.



Globally Harmonized System of Classification

SAND No. 2012-5234C

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.



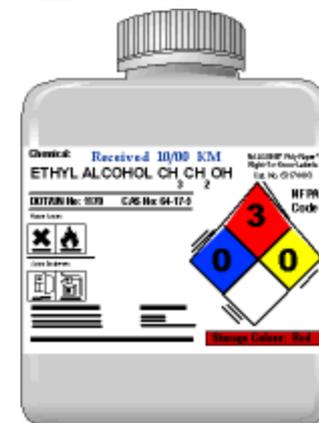
Labeling Basics

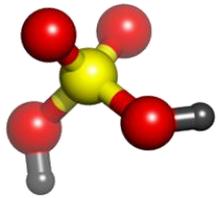
- ▶ Proper Labeling of Laboratory Hazards
 - Chemical
 - Physical
 - Biological
 - Radiological



Just ignore the label...
The worst stuff isn't listed anyway.

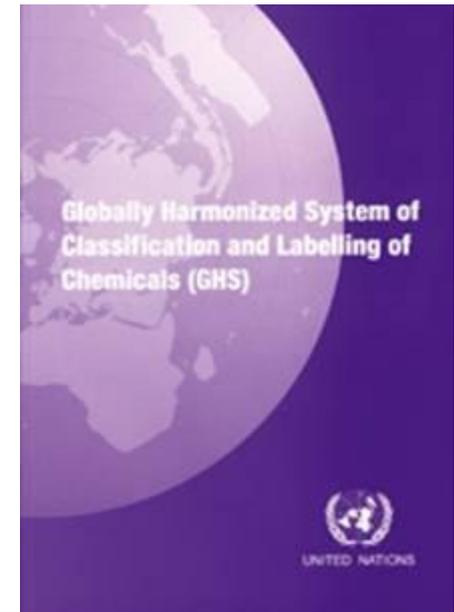
- ▶ Globally Harmonized System (GHS) Hazard Labels



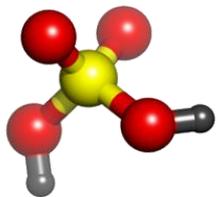


The Globally Harmonized System (GHS) of Classification and Labeling of Chemicals

- ▶ A system for standardizing and harmonizing the classification and labeling of chemicals
- ▶ Not a regulation or a standard.
 - establishes agreed hazard classification and communication provisions with explanatory information on how to apply the system
- ▶ GHS Labels and Safety Data Sheets (SDS)

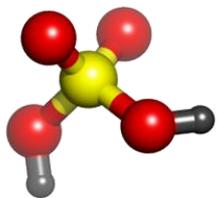


<http://www.osha.gov/dsg/hazcom/ghs.html>

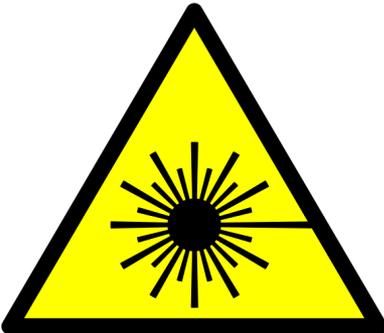


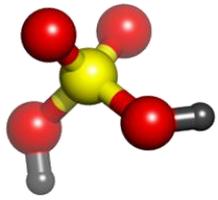
Globally Harmonized System (GHS) Hazard Labels

<p>Corrosive</p>	<p>Irritant</p>	<p>Health Hazard</p>	<p>Acute Toxicity</p>
<p>Flammable</p>	<p>Explosion</p>	<p>Oxidizer</p>	<p>Compressed Gas</p>



Globally Harmonized System (GHS) and Other Hazard Labels

<p>Environmental</p> 	<p>Electricity</p> 	<p>Hot Surface</p> 	<p>Pinch Point</p> 
<p>Biohazard</p> 	<p>Radioactive</p> 	<p>Laser Beam</p> 	<p>Optical Radiation (UV)</p> 



GHS Labels Elements: Example Bottle Label



ToxiFlam (Contains: XYZ)

Danger! Toxic If Swallowed, Flammable Liquid and Vapor



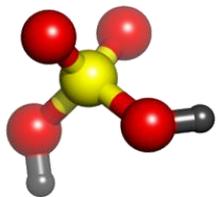
Do not eat, drink or use tobacco when using this product. Wash hands thoroughly after handling. Keep container tightly closed. Keep away from heat/sparks/open flame. - No smoking. Wear protective gloves and eye/face protection. Ground container and receiving equipment. Use explosion-proof electrical equipment. Take precautionary measures against static discharge.
Use only non-sparking tools. Store in cool/well-ventilated place.

IF SWALLOWED: Immediately call a POISON CONTROL CENTER or doctor/physician. Rinse mouth.

In case of fire, use water fog, dry chemical, CO₂, or "alcohol" foam.

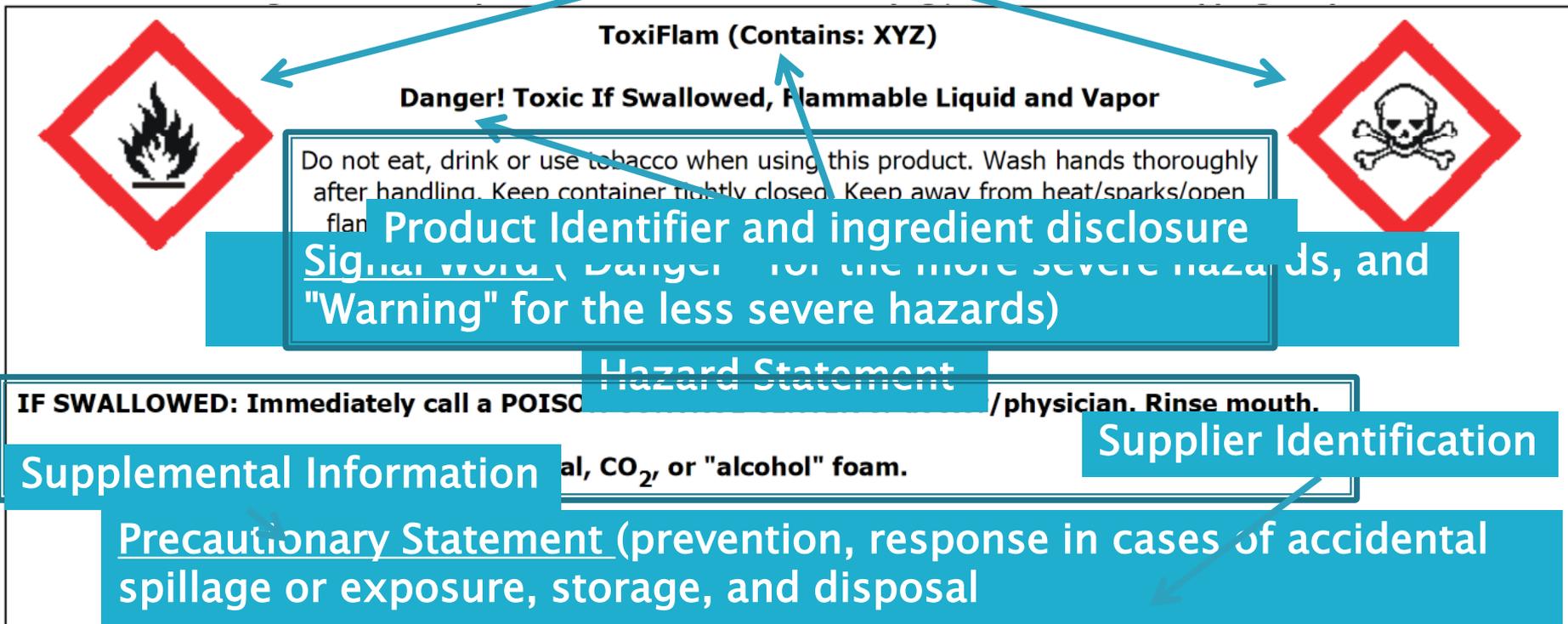
See Material Safety Data Sheet for further details regarding safe use of this product.

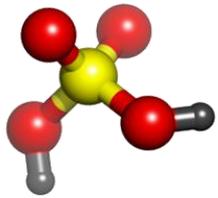
MyCompany, MyStreet, MyTown NJ 00000, Tel: 444 999 9999



GHS Labels Elements: Example Bottle Label

Symbols (Hazard Pictograms)





Example Labels

Label Creation

	Chemical Name _____
	Common Name _____
	Manufacturer _____
	MSDS# _____ Date _____

Chemical Liquor

CLASS: **A** GRADE: **S** TYPE: **II** % w/w active: **7%**

Chemical Agencies Solution. This product conforms to U.S. EN 890-2005

UN No: 1700 CAS No: 18028-22-5 AGH / RID: Class 3, CG PG I HMIG: DATA: Class 3, PG I

Risk Phrases:

- Irritating to eyes and skin.

Subst. Phrases:

- In case of contact with eyes, rinse immediately with plenty of water and seek medical attention.
- May contain proteins causing allergic and/or other reactions.

Hazard pictograms: GHS05 (Corrosive), GHS08 (Explosive), GHS09 (Health Hazard)

Hazard diamond: 8

Company Name, Street, Town, County...
www.chemtrec.com

Chemical: Received 10/00 KM
ETHYL ALCOHOL CH₃CH₂OH

UN No: 1170 CAS No: 64-17-5 MFPA Code

Hazard diamond: 3 (Blue), 0 (Red), 0 (Yellow), 0 (White)

Storage Color: Red

CHEMICAL NAME _____

Mfr. (Emergency Phone) _____

DANGER	DANGER
FLAMMABLE	CORROSIVE
TOXIC	OXIDIZER
ALKALI	WATER REACTIVE
ACID	USE VENTILATION
DANGER EYE PROTECTION REQUIRED	CAUTION USE FACE SHIELD
DANGER USE SELF-CONTAINED AIR RESPIRATORS	CAUTION RESPIRATOR REQUIRED
DANGER HAND PROTECTION REQUIRED	CAUTION USE PROTECTIVE CLOTHING
DANGER EXTREME HAZARD STOP	CAUTION USE CHEMICAL RESISTANT
DANGER NO SMOKING OR OPEN FLAME	CAUTION GROUND BEFORE POURING

Hydrogen Peroxide 35% FOOD GRADE

Danger! STRONG OXIDIZER, Causes eye and skin burns. May cause permanent eye damage. Can react violently with water, acids and other materials.

FIRST AID: Skin-Flush area with water for 15 minutes. And remove contaminated clothing and shoes. contact a physician immediately. **EYES:** Flush eyes for 15 minutes. Contact a physician immediately. **INGESTION:** Do not induce vomiting. Give large quantities of water. contact a physician immediately. **INHALATION:** Remove to fresh air. contact a physician immediately.

PREVENTIVE: Dry chemical, Carbon Dioxide, Chemical foam or water fog.

PROTECTIVE EQUIPMENT: Use chemical gloves and clothing to prevent skin contact, safety goggles or full face mask.

SPILL/DISPOSAL: Caution: This product may react strong with acids or water. Scoop spilled product into marked disposal containers. Flush spill area with water.

STORAGE/USE/HANDLING: Do not add any other product to this container. Avoid contamination from any source.

DOT SHIPPING NAME/UN#: Hydrogen Peroxide 5.1, UN2014, PGII

CAS # 7722-84-1
7732-18-5

LOT No. 662531

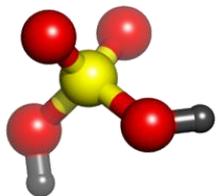
CODE No. 041

NET WT: 500LBS
145LBS CARBOXY

Hazard pictogram: GHS05 (Corrosive)

Hazard diamond: 8

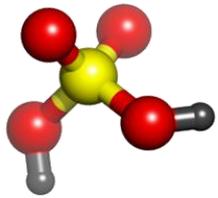
FOR CHEMICAL EMERGENCY SPILL, LEAK, FIRE, EXPOSURE OR ACCIDENT ONLY
Call: CHEMTREC - DAY OR NIGHT - 1-800-424-9300



Other Labeling Considerations

- ▶ Chemical Resistance
- ▶ Environmental Resistance
 - Heat, Fridge, Freezer
- ▶ Age
- ▶ Size
 - Label
 - Container
- ▶ Attachment to Bottle

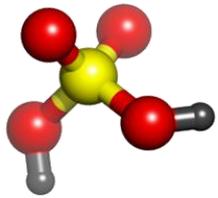




GHS Safety Data Sheets

- ▶ Serve the same function as an MSDS does in ISO, EU and ANSI requirements
- ▶ Most comprehensive source of information
 - Hazards, including environmental hazards
 - Advice and safety precautions
 - Transportation, emergency responders, poison centers
- ▶ Product related and not specific to workplace or task
 - Written and supplied by manufacturer
- ▶ Only for pure substances and some mixtures

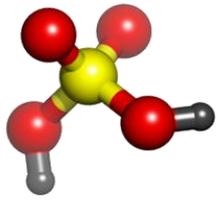
<http://www.osha.gov/dsg/hazcom/ghs.html>



SDS Format

16 Sections

1. Identification
2. Hazard(s) identification
3. Composition/information on ingredients
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and Storage
8. Exposure controls/ personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information



Section 2: Hazards



▶ GHS classification of the substance/mixture and any national or regional information



▶ GHS label elements, including precautionary statements.

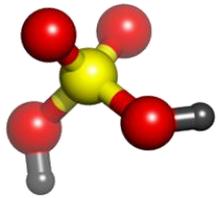


◦ Pictograms, black and white reproduction of the symbols, or the name of the symbol, e.g., flame, skull and crossbones.



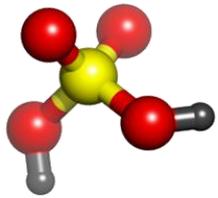
▶ Other hazards which do not result in classification (e.g., dust explosion hazard) or those not covered by the GHS.





Section 4: First-aid Measures

- ▶ Description of necessary measures, subdivided according to the different routes of exposure, i.e., inhalation, skin and eye contact, and ingestion.
- ▶ Most important symptoms/effects, acute and delayed.
- ▶ Indication of immediate medical attention and special treatment needed, if necessary.



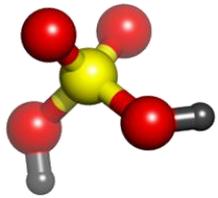
Section 6 and 7

Section 6: Handling and Storage

- ▶ Precautions for safe handling.
- ▶ Conditions for safe storage, including any incompatibilities.

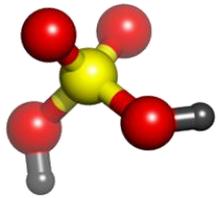
Section 7: Exposure controls/ personal protection

- ▶ Control parameters, e.g., occupational exposure limit values or biological limit values.
- ▶ Appropriate engineering controls.
- ▶ Individual protection measures, such as personal protective equipment (PPE).



Section 10: Stability and reactivity

- ▶ Reactivity
- ▶ Chemical stability
- ▶ Possibility of hazardous reactions
- ▶ Conditions to avoid (e.g., static discharge, shock or vibration)
- ▶ Incompatible materials
- ▶ Hazardous decomposition products



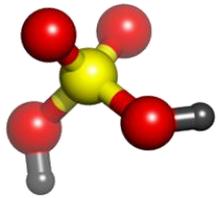
Section 13 and 15

Section 13: Disposal Considerations

- ▶ Description of waste residues and information on their safe handling and methods of disposal, including the disposal of any contaminated packaging.
 - May be region, country specific

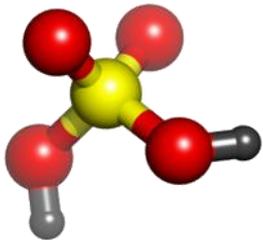
Section 15: Regulatory Information

- ▶ Safety, health and environmental regulations specific for the product in question.
 - May be region, country specific



GHS Safety Data Sheets (SDS)

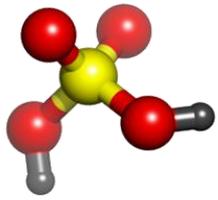
- ▶ **Benefits of the SDS**
 - The SDS contains comprehensive information for chemical management in one place
- ▶ **Drawbacks**
 - Not always current
 - Lack of toxicity information for most chemicals
 - Industry focus, not specific to laboratory scale
 - Sometimes inconsistent
- ▶ **Keep a SDS for each chemical in your inventory**
- ▶ **Ensure all SDSs are accessible to workers and auditors**



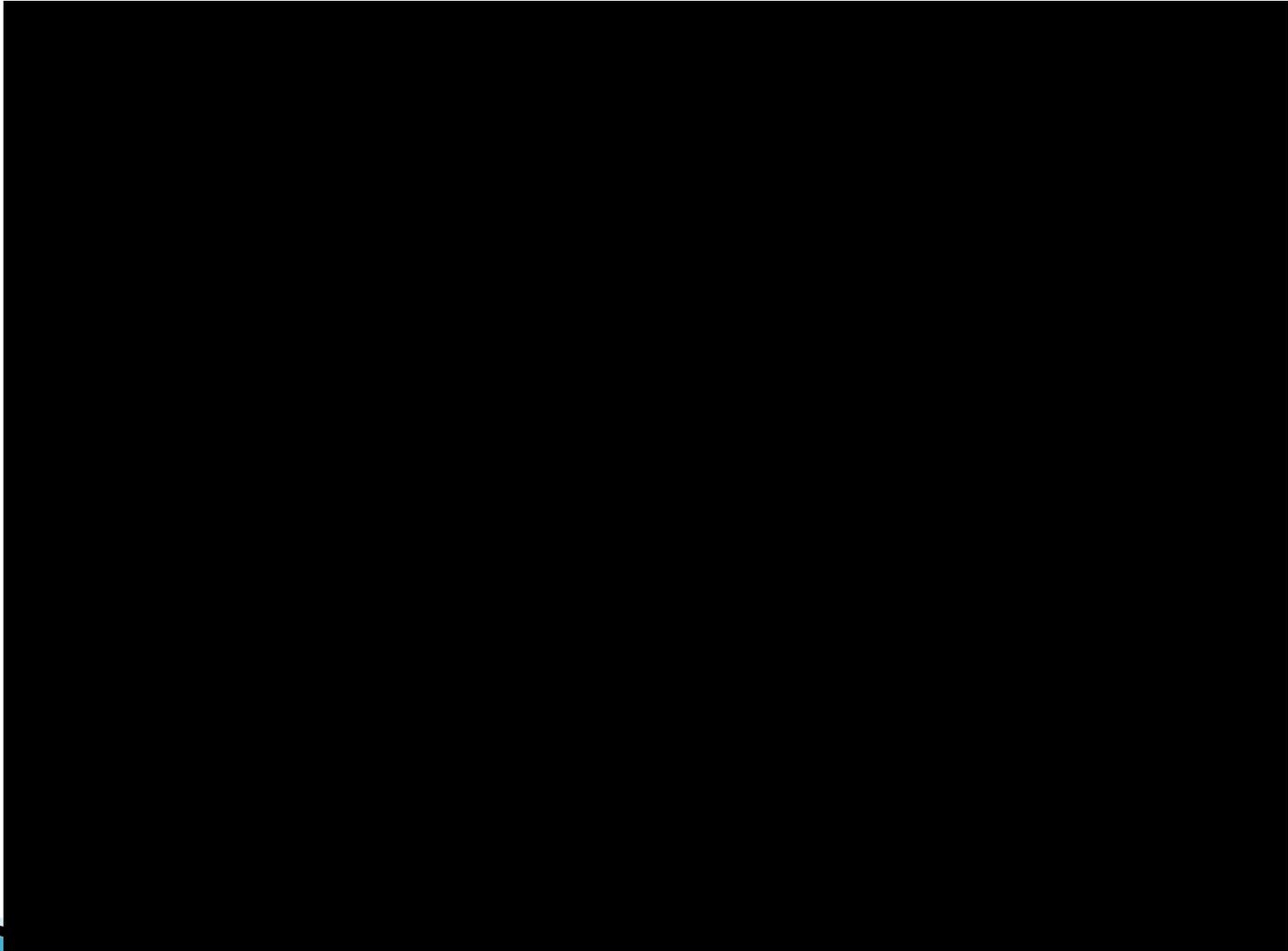
(Material) Safety Data Sheet (SDS) Overview

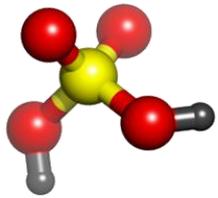


Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.



(M)SDS Basics

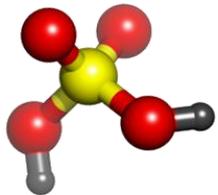




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<http://www.osha.gov/dsg/hazcom/ghs.html>

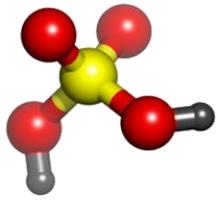


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15. Regulatory information
16. Other information

Look at Sulfuric Acid SDS provided in Booklet, as we describe some of the important sections



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▶ GHS classification of the substance/mixture and any national or regional information



▶ GHS label elements, including precautionary statements.

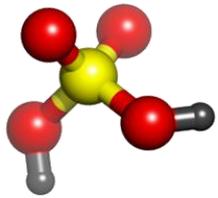


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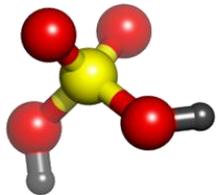
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- ▶ Description of necessary measures, subdivided according to the different routes of exposure, i.e., inhalation, skin and eye contact, and ingestion.
- ▶ Most important symptoms/effects, acute and delayed.
- ▶ Indication of immediate medical attention and special treatment needed, if necessary.



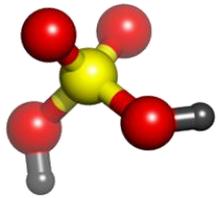
Section 6 and 7

Section 6: Handling and Storage

- ▶ Precautions for safe handling.
- ▶ Conditions for safe storage, including any incompatibilities.

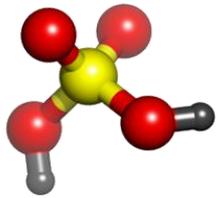
Section 7: Exposure controls/ personal protection

- ▶ Control parameters, e.g., occupational exposure limit values or biological limit values.
- ▶ Appropriate engineering controls.
- ▶ Individual protection measures, such as personal protective equipment (PPE).



Section 10: Stability and reactivity

- ▶ Reactivity
- ▶ Chemical stability
- ▶ Possibility of hazardous reactions
- ▶ Conditions to avoid (e.g., static discharge, shock or vibration)
- ▶ Incompatible materials
- ▶ Hazardous decomposition products



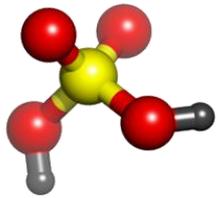
Section 13 and 15

Section 13: Disposal Considerations

- ▶ Description of waste residues and information on their safe handling and methods of disposal, including the disposal of any contaminated packaging.
 - May be region, country specific

Section 15: Regulatory Information

- ▶ Safety, health and environmental regulations specific for the product in question.
 - May be region, country specific

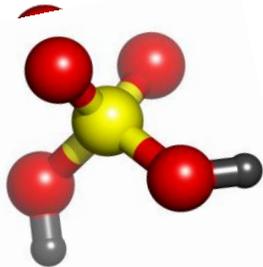


GHS Safety Data Sheets (SDS)

- ▶ Drawbacks
 - Not always current
 - Lack of toxicity information for most chemicals
 - Industry focus, not specific to laboratory scale
 - Sometimes inconsistent

SDS contains comprehensive information for chemical management in one place

Keep SDS for each chemical in your inventory



Aspects of Chemical Security Dual-Use Chemicals



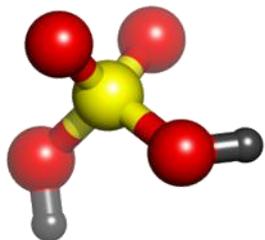
SAND No. 2011-9013P

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.

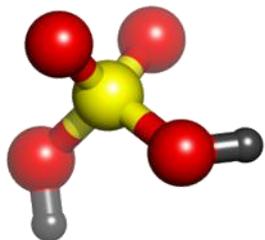
Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.





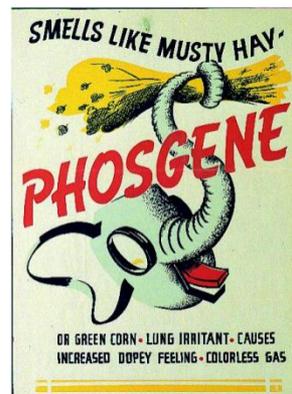
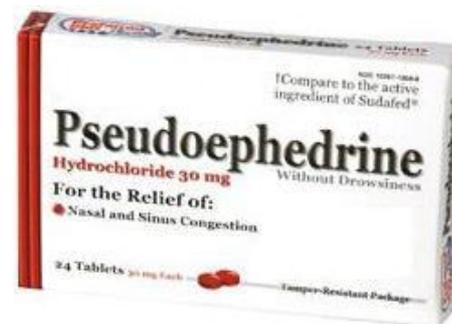
Topics to be discussed

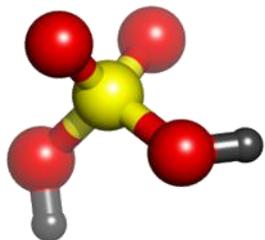
- ▶ What are dual use chemicals?
- ▶ Areas of focus for this talk
- ▶ Examples of each area:
 - Explosive / Chemical Weapons / Precursors (drug and weapons)
- ▶ International chemical controls



Chemical dual-use awareness

Dual use chemicals: Chemicals that can be used for both legal and illegal purposes.

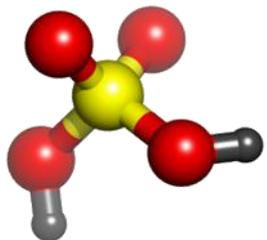




Areas of focus

Four Mains areas of focus:

1. Drug precursors
2. Chemical weapons
3. Explosives
4. Chemical weapon precursors



Dual-use chemicals: Pseudoephedrine

- ▶ Pseudoephedrine is a common ingredient in cold medicines
- ▶ Precursor to crystal methamphetamine
- ▶ Recipes for conversion available on web



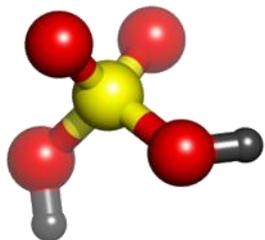
Illicit Methamphetamine Laboratory

US DEA



Clandestine meth labs in US during 2002

- Caused 194 fires, 117 explosions, and 22 deaths
- Cost \$23.8 million for cleanup
- Dumped chemicals led to
 - deaths of livestock
 - contaminated streams
 - large areas of dead trees and vegetation



End product of dual-use chemicals: Methamphetamine



Late 2005: Indonesian authorities raided a very large Meth Lab in Cikande, Indonesia 60km West of Jakarta.

- 75 kg of crystalline style Meth per batch
- 250,000 tablets of MDMA (Ecstasy) every 8hrs



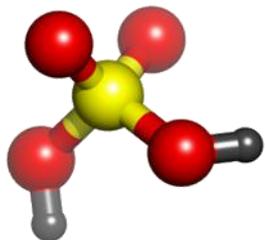
Meth reactor
~ 75kg "Ice"



MDMA reactors
~ 8kg Ecstasy

MDMA = (3,4-methylenedioxymethamphetamine)

<http://www.justice.gov/dea/programs/forensicsci/microgram/mg1106/mg1106.html>



Dual-use chemicals: Sodium azide

▶ Industrial Uses

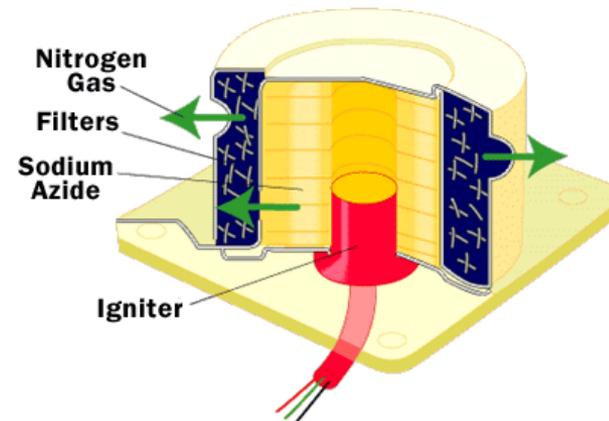
- Propellant in automobile airbags
 - ~ 50g Driver side
 - ~ 200g Passenger side
- Biocide in hospitals and laboratories
- Anticorrosion solutions

▶ Illegal Uses

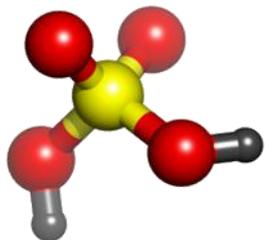
- Gas more deadly than Hydrogen Cyanide when reacted with an aqueous oxidizer
- Toxic by ingestion
- Detonator for powerful explosives



Air Bag Inflation Device



<http://auto.howstuffworks.com/car-driving-safety/safety-regulatory-devices/airbag1.htm>



Dual-use chemicals: Chlorine

▶ Industrial Use

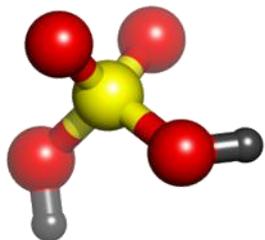
- Manufacture of chlorine compounds
 - 63% - organic chlorine compounds
 - Examples: $C_2H_4Cl_2$ and C_2H_3Cl – (PVC)
 - 18% - inorganic chlorine compounds
 - Examples: HCl, HOCl, $AlCl_3$, $SiCl_4$, PCl_3
 - 19% - bleaches and disinfection products

▶ Illegal Use:

- Incidents in which chlorine gas cylinders are blown up with explosives
 - Chlorine likely stolen/diverted from water purification plants or oil industry
 - Civilians and non-combatants injured
- Chlorine first used in WWI as a chemical weapon



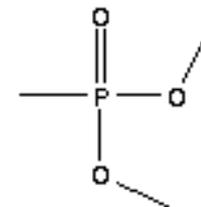
www.longwarjournal.org/archives/2007/03/al_qaedas_chlorine_w.php



Dual-use chemicals: Precursors

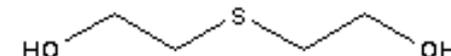
▶ Dimethyl methyl phosphonate (DMMP)

- Flame retardant for:
building materials, furnishings, transportation equipment,
electrical industry, upholstery
- **Nerve agent precursor**



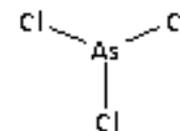
▶ Thiodiglycol

- Dye carrier, ink solvent, lubricant, cosmetics, anti-arthritis drugs, plastics, stabilizers, antioxidants, photographic, copying, antistatic agent, epoxides, coatings, metal plating
- **Mustard gas precursor**

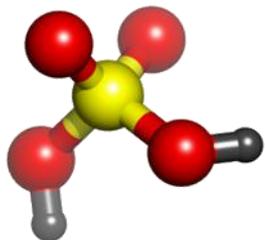


▶ Arsenic Trichloride

- Catalyst in CFC manufacture, semiconductor precursor, intermediate for pharmaceuticals, insecticides
- **Lewisite (Agent L, Schedule 1 CWC) precursor**

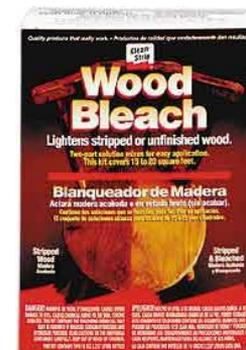


From: Chemical Weapons Convention: Implementation Assistance Programme Manual (on CD)

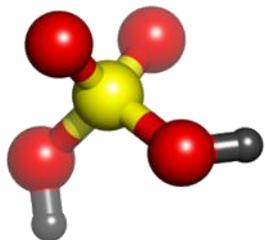


End product of dual-use chemicals: TATP

- ▶ Triacetone triperoxide (TATP) or Acetone Peroxide
- ▶ Nicknamed “Mother of Satan” because of its deadly nature
- ▶ Made using acetone, hydrogen peroxide, and a strong acid (i.e. HCl, H₂SO₄)
- ▶ Invisible to detectors looking for N-based explosives
- ▶ Used as Primary High Explosive
 - Sept 2009 arrest of N. Zazi, NY and Denver
 - July 2005 London suicide bombs
 - 2001 Richard Reid “shoe bomber”
 - 1997 New York subway suicide bomb plot

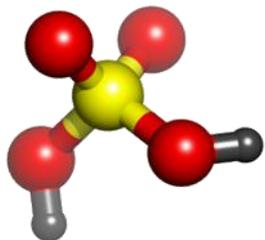


CAS 17088-37-



Dual-use Chemicals: Explosives

- ▶ Theft of conventional explosives
 - Chemical suppliers
 - Users such as mines or construction sites
- ▶ Diversion of industrial or laboratory chemicals
 - Chemical suppliers
 - Chemical factories
 - Academic teaching or research laboratories
 - Disposal sites

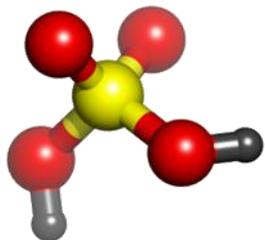


Diversion of industrial / laboratory chemicals: Oklahoma bombing



Photo: US DOD

- ▶ Bomb was made of:
 - 108 – 22.5kg bags of Ammonium nitrate fertilizer
 - 3 – 210L drums of liquid nitromethane
 - Several crates of Tovex
 - Water-gel mixture composed of ammonium nitrate and methyl-ammonium nitrate
 - 17 bags of ANFO – 94% ammonium nitrate / 4% fuel oil
 - 60L of diesel fuel
 - Cannon fuse
- ▶ How were the chemicals obtained?

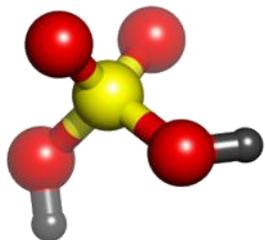


Diversion of industrial / laboratory chemicals: Bali bombing

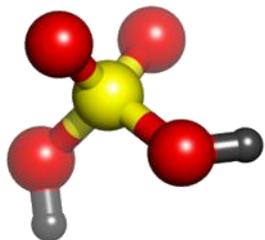
- ▶ Van bomb was made of:
 - Potassium chlorate
 - Aluminum powder
 - Sulfur mixed with TNT (trinitrotoluene)
 - 150 meters of PETN (pentaerythritol tetranitrate) filled detonating cord
 - 94 RDX (cyclotrimethylenetrinitramine) electric detonators
- ▶ How where the chemicals obtained?



Photo: www.zgeek.com



International Chemical Controls



International chemical control groups

Two Main Groups:

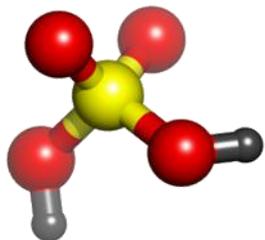


Organisation for the Prohibition of Chemical Weapons

- Implementing body of the Chemical Weapons Convention

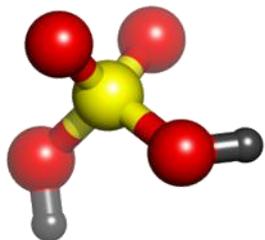
The Australia Group

- Export controls



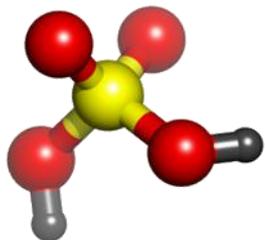
Organization for the Prohibition of Chemical Weapons (OPCW)

- ▶ International group headquartered in The Hague, Netherlands
 - <https://www.opcw.org/index.html>
- ▶ Chemical weapons convention (CWC)
 - International treaty which bans the development, production, stockpiling, transfer and use of chemical weapons
- ▶ Promotes international cooperation in peaceful uses of chemistry
- ▶ Provide assistance and protection to fellow member states



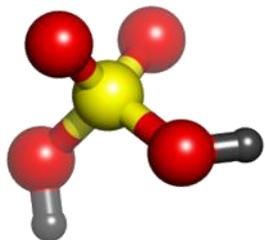
OPCW: Promotes international cooperation in peaceful uses of chemistry

- ▶ Associates program
- ▶ Analytical skills development course
- ▶ Conference support program
- ▶ Research projects program
- ▶ Internship Support Program
- ▶ Laboratory Assistance Program
- ▶ Equipment Exchange Program



OPCW: Provide assistance and protection to fellow member states

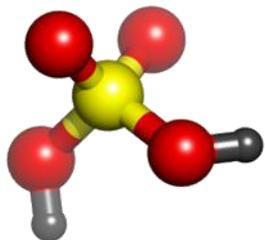
- ▶ Each member state can request assistance from other member states in the event of a threat or attack, including chemical terrorism
- ▶ This can take the form of expertise, training, materials, and/or equipment



OPCW's – Chemical Weapons Convention

Designated 3 class of controlled substances:

- ▶ [Schedule 1](#) – chemicals have few or no uses outside of chemical weapons
- ▶ [Schedule 2](#) – chemicals have legitimate small-scale applications
- ▶ [Schedule 3](#) – chemicals have large scale uses apart from chemical weapons



OPCW's – Schedule 1 Chemicals

Chemicals

Nerve Agents

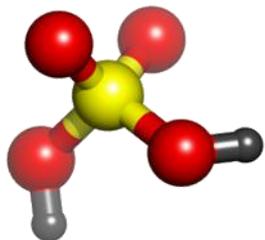
1. Sarin
2. Soman
3. Tabun
4. VX - persistent

Blistering Agents

5. Sulfur mustards
6. Nitrogen mustards
7. Lewisites
8. Saxitoxin – marine organisms
9. Ricin – plant toxin

Precursors

1. **DF** - Methylphosphonyl difluoride
 - React with IPA and IPAmine to make Sarin
2. **QL** - Isopropyl aminoethylmethyl phosphonite
 - React with Sulfur to make VX
3. **Chlorosarin** - isopropyl methylphosphonochloridate
 - Used to make Sarin
4. **Chlorosoman** – pinacolyl methylphosphonochloridate
 - Used to make Soman



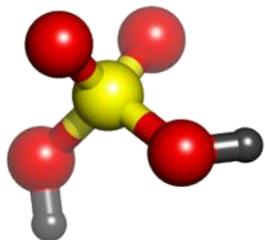
OPCW's – Schedule 2 Chemicals

Toxic chemicals:

1. Amiton (78-53-5)
- V-series nerve agent
2. PFIB (382-21-8)
- perfluoroisobutene
3. BZ (6581-06-2)
- 3-quinuclidinyl
benzilate

Precursors:

4. Chemicals, except for those listed in Schedule 1, containing a phosphorus atom to which is bonded one methyl, ethyl or propyl group but not further carbon atoms,
e.g. Methylphosphonyl dichloride (676-97-1)
Dimethyl methylphosphonate (756-79-6)
Exemption: O-Ethyl S-phenyl ethylphosphonothiolothionate (944-22-9)
5. N,N-Dialkyl phosphoramidic dihalides
6. Dialkyl N,N-dialkyl-phosphoramidates
7. Arsenic trichloride (7784-34-1)
8. 2,2-Diphenyl-2-hydroxyacetic acid (76-93-7)
9. Quinuclidin-3-ol (1619-34-7)
10. N,N-Dialkyl aminoethyl-2-chlorides
11. N,N-Dialkyl aminoethane-2-ols
Exemptions: N,N-Dimethylaminoethanol (108-01-0)
N,N-Diethylaminoethanol (100-37-8)
12. N,N-Dialkyl aminoethane-2-thiols
13. Thiodiglycol: Bis(2-hydroxyethyl)sulfide (111-48-8)
14. Pinacolyl alcohol: 3,3-Dimethylbutan-2-ol (464-07-3)



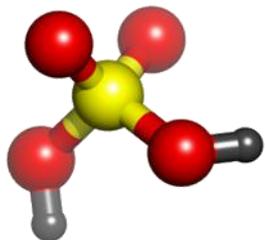
OPCW's – Schedule 3 Chemicals

Toxic chemicals:

1. Phosgene: Carbonyl dichloride (75-44-5)
2. Cyanogen chloride (506-77-4)
3. Hydrogen cyanide (74-90-8)
4. Chloropicrin: Trichloronitromethane (76-06-2)

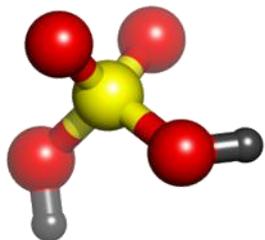
Precursors:

1. Phosphorus oxychloride (10025-87-3)
2. Phosphorus trichloride (7719-12-2)
3. Phosphorus pentachloride (10026-13-8)
4. Trimethyl phosphite (121-45-9)
5. Triethyl phosphite (122-52-1)
6. Dimethyl phosphite (868-85-9)
7. Diethyl phosphite (762-04-9)
8. Sulfur monochloride (10025-67-9)
9. Sulfur dichloride (10545-99-0)
10. Thionyl chloride (7719-09-7)
11. Ethyldiethanolamine (139-87-7)
12. Methyl diethanolamine (105-59-9)
13. Triethanolamine (102-71-6)



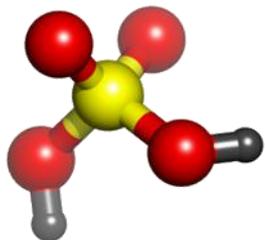
Australia Group

- ▶ An informal arrangement to minimize the risk of assisting chemical and biological weapon (C&BW) proliferation.
 - Harmonizing participating countries' national export licensing measures
 - Started in 1985 when Iraq CW program was found to have diverted chemicals and equipment from legitimate trade
- ▶ 40 nations plus European Commission participate



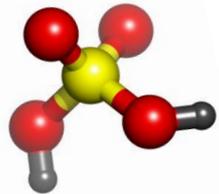
Australia Group: Export Controls

- ▶ Controls exports of:
 - 63+ Chemical weapon agent precursor chemicals
 - Dual-use chemical manufacturing facilities and equipment and related technology
 - Dual-use biological equipment and related technology
 - Biological agents
 - Plant and animal pathogens
- ▶ Includes no-undercut policy
 - Countries will not approve an export that another member country denied

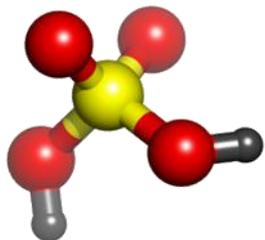


Dual-use summary

- ▶ Defined dual use chemicals
- ▶ Discussed examples in each area of focus:
 - Explosive / Chemical Weapons / Precursors (drugs and weapons)
- ▶ Discussed International chemical control groups
 - OPCW – schedule 1, 2, & 3
 - Australia group



Lunch



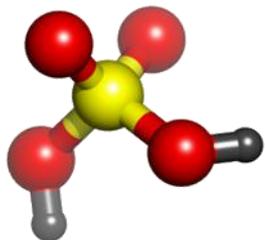
Chemical Toxicity, Health Hazards, Exposure Standards



2012-1601C

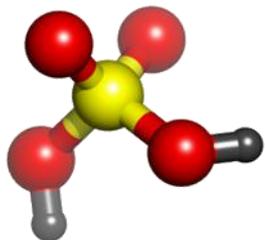
Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.





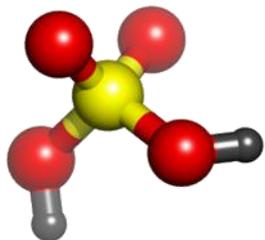
Learning Objectives

- ▶ Understand the routes of exposure to chemicals in humans
- ▶ Understand the concept of Pharmacokinetics
- ▶ Understand the relationship between Dose/Response and health effects
- ▶ Become familiar with the routes of exposure commonly encountered in industrial settings.
- ▶ Understand the methods and equipment used to measure worker exposure to hazardous chemicals
- ▶ Become familiar with the concepts of Occupational Exposure Limits



Overview

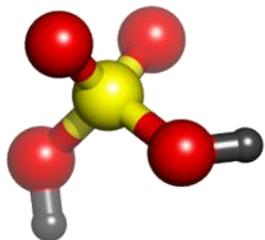
- ▶ Definitions
- ▶ Exposure
- ▶ Dose response
- ▶ Industrial exposures
- ▶ Health effects
- ▶ Exposure limits
- ▶ Evaluating exposure
- ▶ Control banding



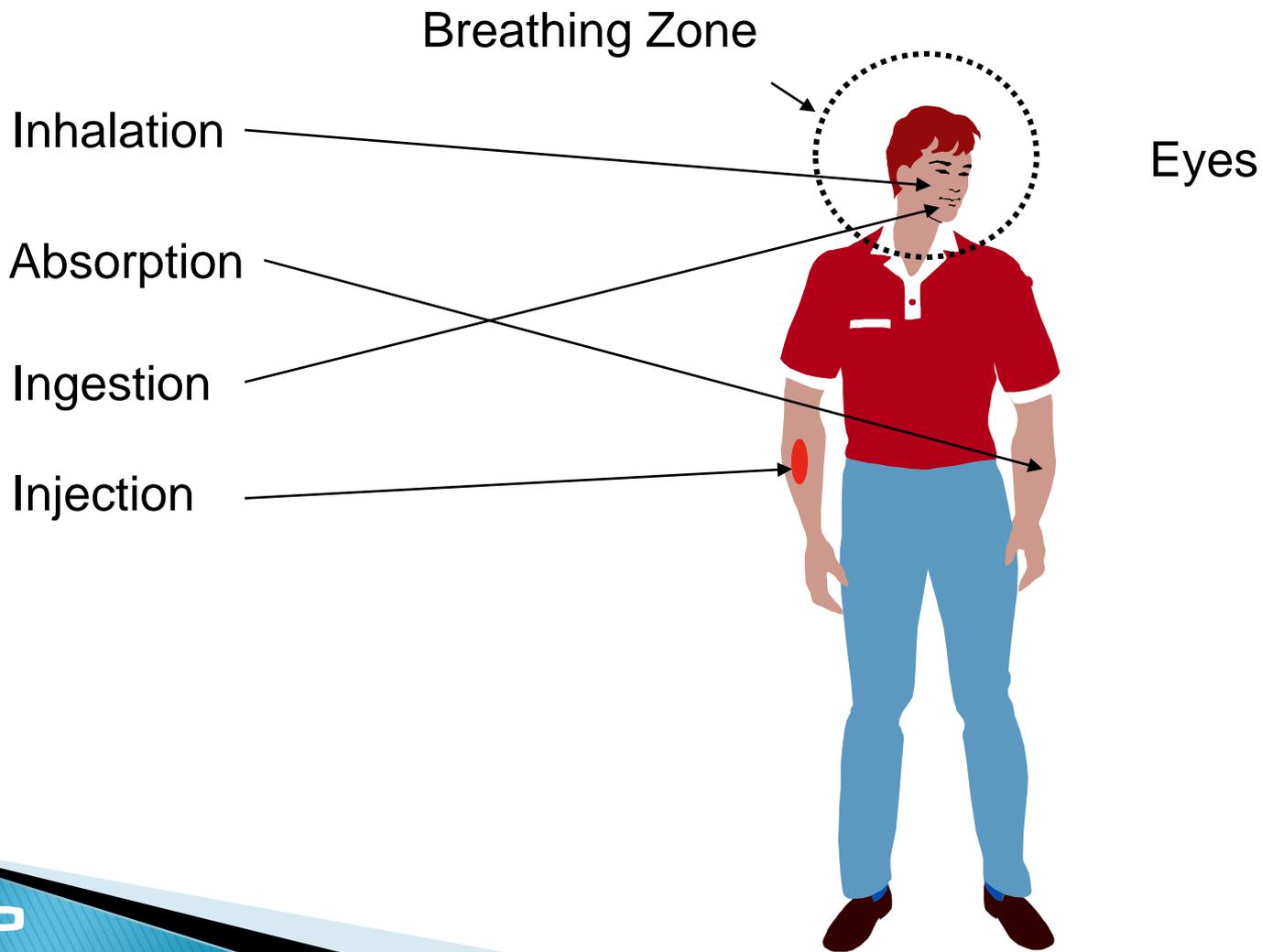
Definitions

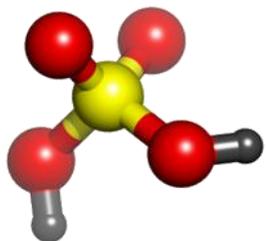
- ▶ Toxicology: the study of the adverse effects of chemicals (xenobiotics) on living organisms.
- ▶ Toxicity: ability of a chemical to produce an unwanted effect.
- ▶ Hazard: presence of an agent that has inherently hazardous properties and the potential to cause harm.
- ▶ Exposure: Contact with the chemical substance.
- ▶ Dose: the amount of the chemical that has the potential to produce injury or death.

Klassen, C. (2001). Casarett and Doulls Toxicology
Plog, B. (2002). Fundamentals of Industrial Hygiene



Exposure





Exposure: Inhalation

- Most important route of exposure for workers
 - Gases, solvent vapors, acid mists, dusts, particles, and metal fumes
- Exposure is dependent on:
 - Duration and frequency of task
 - Breathing rate
 - Concentration of the chemical
 - Particle size
 - Inhalable size = 0.1 mm to 10 mm
 - Solubility of gases & vapors
 - Formaldehyde versus chloroform

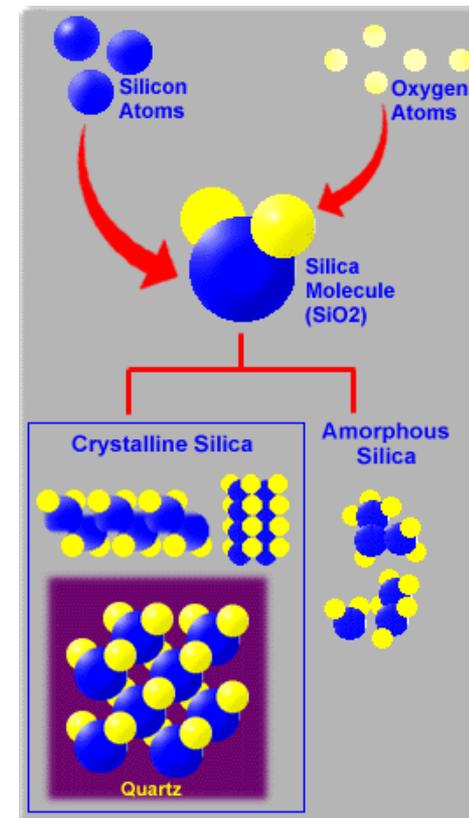
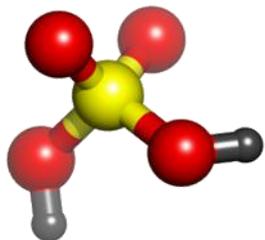
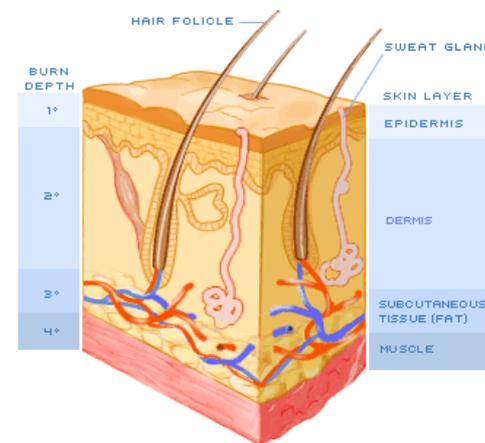


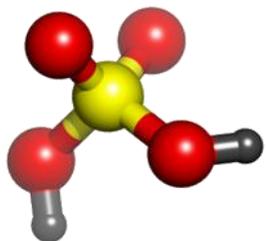
Photo Credit: US OSHA



Exposure: Skin Absorption

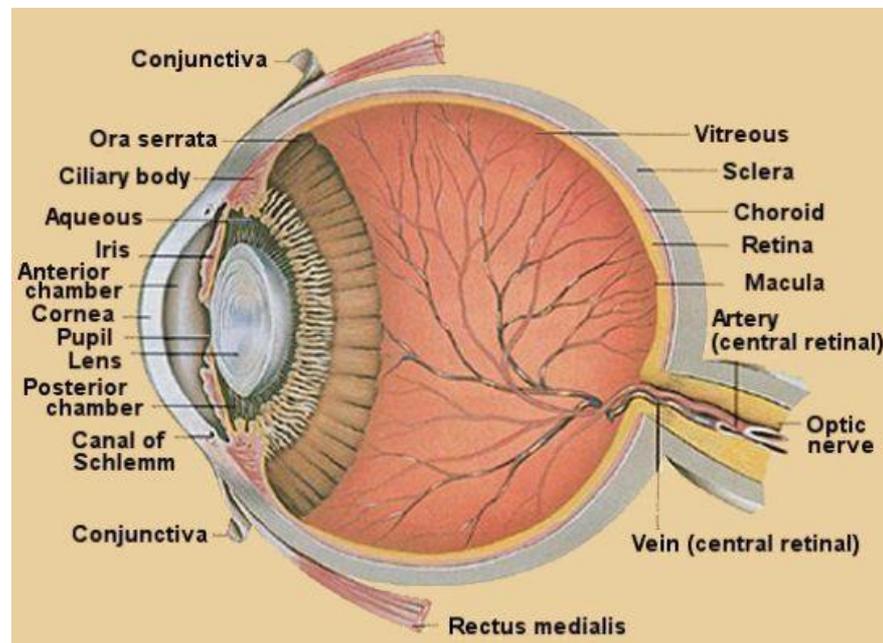
- Depends on skin location and thickness
 - Palms of the hands are thickest
 - Skin on abdomen is thin
- Depends on skin condition
 - Dry and broken skin more susceptible
 - Sweat increases absorption
- Duration of contact
- Properties of the chemical
 - Concentration
 - Solubility (in fat or water)
 - Molecular size (nanoparticles)

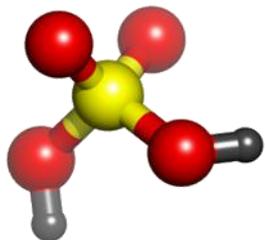




Exposure: Eyes

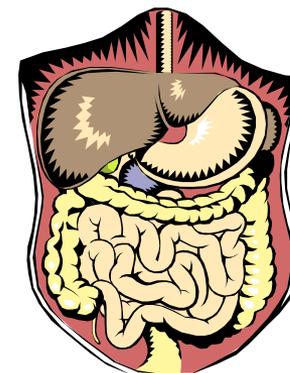
- ▶ Corneal irritation or trauma
 - Gases, particles
- ▶ Corneal burns
 - Acids, ammonia
 - Mustard agents
- ▶ Optic nerve damage
 - Thallium, methanol (ingested)

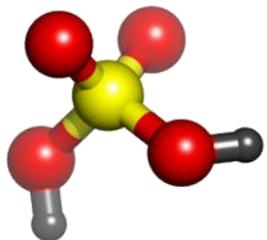




Exposure: Ingestion

- Rare exposure route, but possible
 - Swallow chemicals after inhaling
 - Eating, drinking, smoking in work areas
- Factors affecting absorption
 - Ionized versus nonionized form of compound
 - Weak base absorbed in intestines
 - Weak acid absorbed in stomach

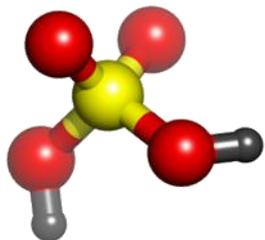




Pharmakokinetics

- Absorption
 - Chemical enters the body by exposure route
- Distribution or storage
 - Distributed to organs, or
 - Stored in bone, proteins, fat
- Metabolism
 - Liver, kidney enzymes
 - May metabolize to a more toxic chemical
- Excretion
 - Sweat, urine, feces

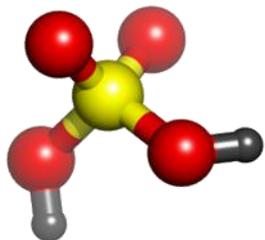




Dose Response

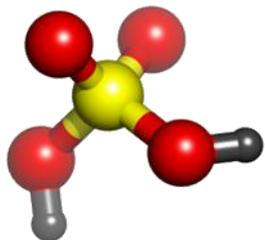
“All substances are poisons;
There is none which is not a poison.
The right dose differentiates a
poison from a remedy...”
-Paracelsus (1493-1541)





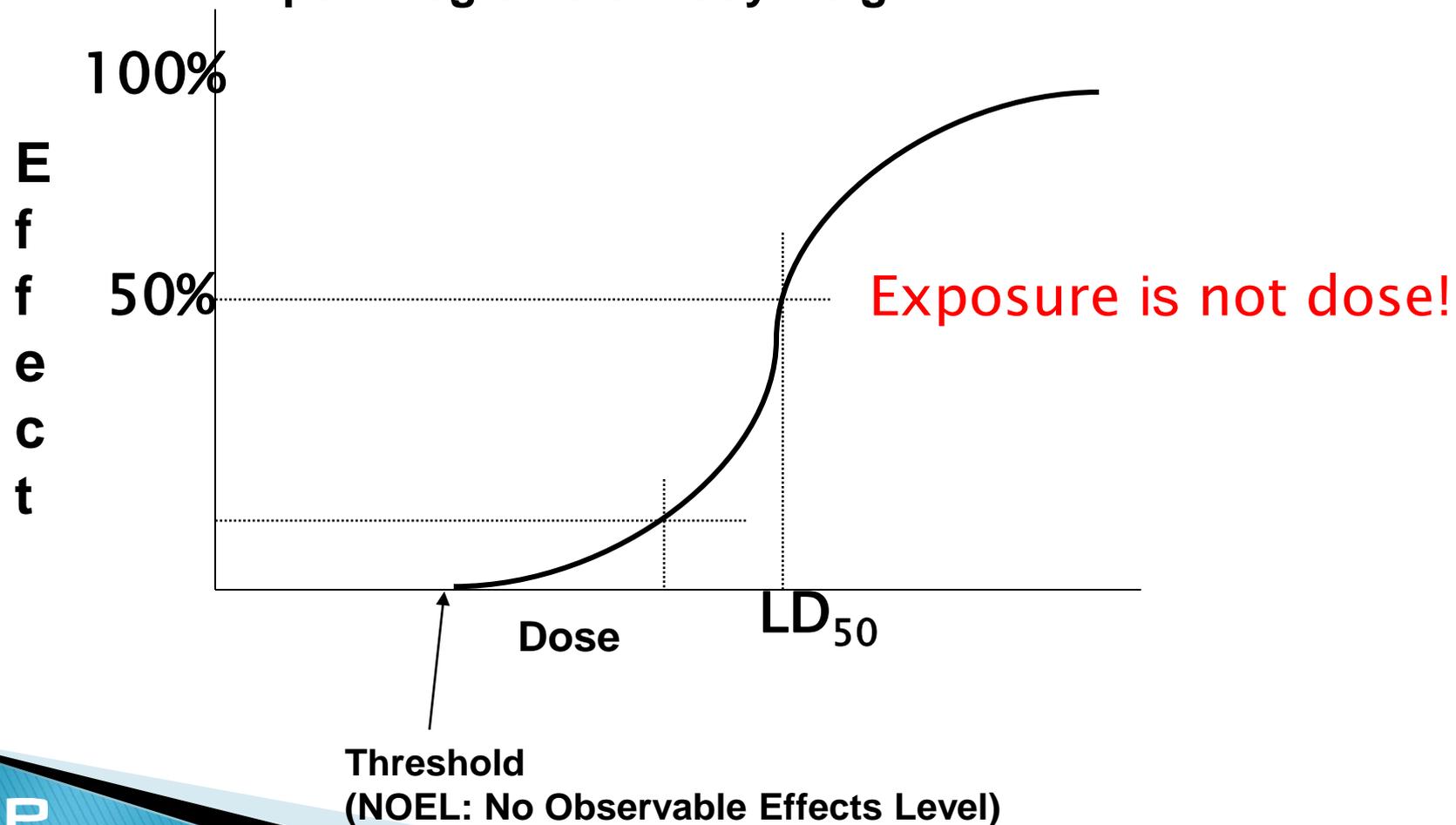
Dose Response Terminology

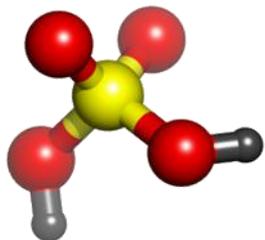
- ▶ TD_{10} – Toxic dose low - lowest dose for effect
- ▶ LD_{50} – Lethal dose 50% - dose that causes death in 50% of the test population
- ▶ TC_{10} – Toxic concentration low - used to express toxic concentration *via* inhalation
- ▶ LC_{50} – Lethal concentration 50% - concentration that causes death in 50% of the test population *via* inhalation



Dose Response

Dose is measured in milligrams of toxicant per kilograms of body weight

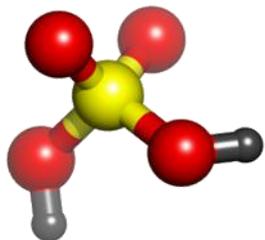




Health Effects

- ▶ Acute Health Effects-severe injury or death
 - High concentration of chemical over short time period
 - Chemicals with acute effects:
 - Toxic gases: hydrogen sulfide, phosgene
 - Asphyxiants gases: nitrogen, methane
 - Corrosive gases and liquids: chlorine, acids

- ▶ Chronic Health Effects-chronic disease
 - Low concentration over long time period
 - Chemicals with chronic effects:
 - Carcinogens: benzene, asbestos, arsenic
 - Reproductive agents: glycol ether acetates, lead, carbon disulfide
 - Sensitizers-glutaraldehyde, toluene diisocyanate



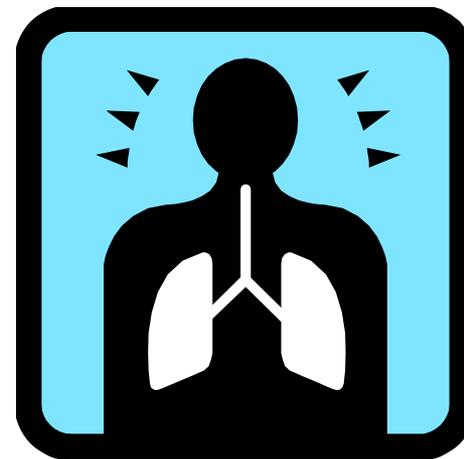
Health Effects

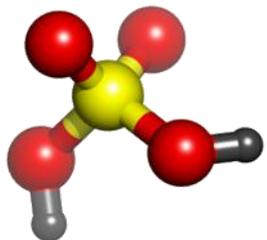
▶ Local

- Effect occurs at site of contact
- Skin rash, burns, coughing
- Chemicals with local effects:
 - Cutting oils, solvents, acids
 - Cotton dust, aluminum oxide

▶ Systemic

- Chemical distributed by circulation
- Effect occurs in body organs
- Chemicals with systemic effects:
 - Methylene chloride to heart muscle
 - Lead to bone and brain

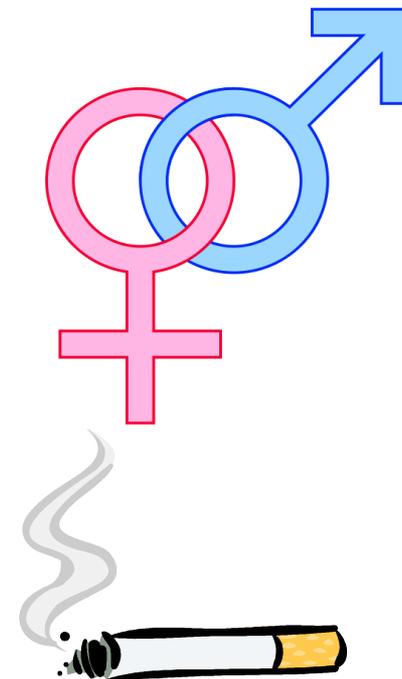


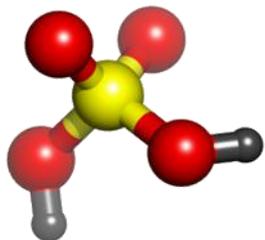


Health Effects

Chemicals affect people differently:

- ▶ Age
- ▶ Gender
- ▶ Genetic makeup
- ▶ Disease or stress
- ▶ Nutrition
- ▶ Lifestyle
- ▶ Interactions between chemical toxicants





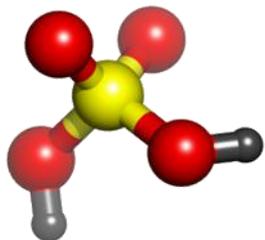
Health Effects Chemical Interactions

▶ Additive Effect

- Combined effect of 2 chemicals equals sum of each agent alone...($2 + 3 = 5$)
- Example: **Parathion, methyl-parathion pesticides**

▶ Synergistic Effect

- Combined effect of 2 chemicals is greater than sum of each agent alone...($2 + 3 = 20$)
- Example: **Carbon tetrachloride & ethanol**



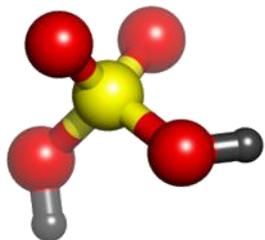
Health Effects Chemical Interactions

▶ Potentiation

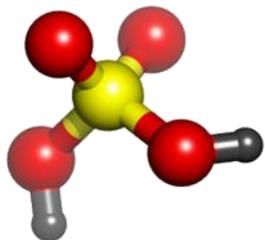
- One substance does not have toxic effect on certain organ or system, but when added to another chemical, it makes the latter more toxic...(0 + 2 = 10)
- Example: **Isopropanol & carbon tetrachloride**

▶ Antagonism

- 2 chemicals, when given together, interfere with each other's actions or one interferes with the action of the other chemical...(4 + 6 = 8)
- Example: **BAL (chelating agent) and lead**



Industrial Exposures



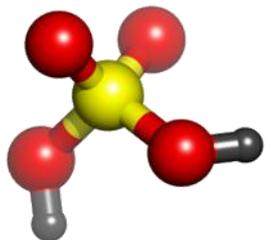
Industrial Exposures: Metals

Exposure primarily by inhalation:

- **Particulates**
 - Processes: grinding, cutting, sanding, mixing
 - Examples: copper, nickel, zinc
- **Fumes**
 - Processes: welding, smelting
 - Examples: lead, manganese, hexavalent chromium, zinc
- **Mists (soluble metal compounds)**
 - Processes: spraying anticorrosives, metal plating
 - Examples: hexavalent chromium, nickel chloride

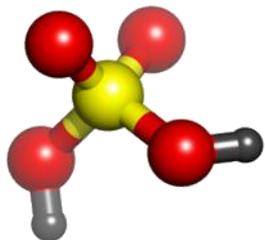


<http://www.millerwelds.com/>



Health Effects: Metals

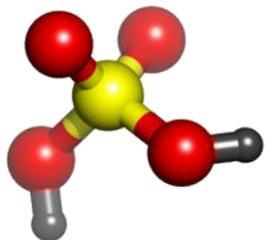
- ▶ Sensitizers (skin and lungs)
 - Nickel, beryllium, chromium
- ▶ Metal fume fever
 - Oxides of zinc, magnesium, and copper
- ▶ Organ toxicity
 - Arsenic—neurotoxicity, liver injury
 - Cadmium—kidney, lung fibrosis
 - Lead—nervous system, blood, kidney, reproductive
- ▶ Carcinogens
 - Arsenic, soluble nickel, hexavalent chromium



Industrial Exposures: Solvents

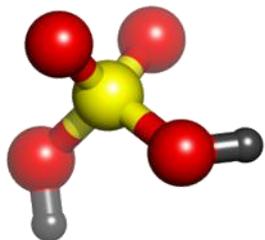
Exposure by inhalation and skin absorption:

- **Process: transfer, mixing, spraying, high vapor pressure solvents**
 - Examples: ethers, ketones, chloroform, benzene
- **Process: Heating solvents**
 - Examples: styrene, dimethyl formamide
- **Process: skin immersion in process baths, parts cleaning**
 - Examples: acetone, trichloroethylene, dimethyl sulfoxide (DMSO)

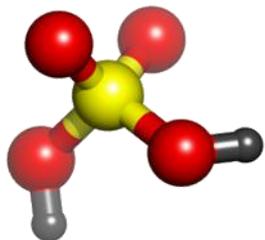


Health Effects: Solvents

- ▶ Skin irritants, dermatitis
 - Acetone, alcohols
- ▶ Organ toxicity
 - N-hexane—neurotoxicity
 - Chloroform, vinyl chloride—liver toxicity
 - Methylene chloride—heart toxicity
- ▶ Carcinogens
 - Benzene, formaldehyde
- ▶ Reproductive toxicants
 - Glycol ether acetates



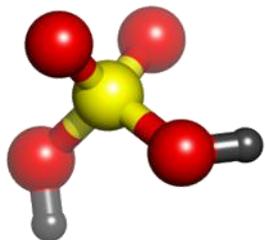
Occupational Exposure Limits: Evaluating Exposure



Occupational Exposure Limits (OELs)

- Government regulation or professional standard organizations set OELs
- OELs apply to workers only, NOT the general public
- Primarily limits for inhalation exposure
- Expressed in milligrams/cubic meter (mg/m^3) or parts per million (ppm)
- Exposure must be measurable for comparison with the OEL
- Some publish exposure standards for noise, lasers, non-ionizing radiation, heat & cold stress, as well as chemicals



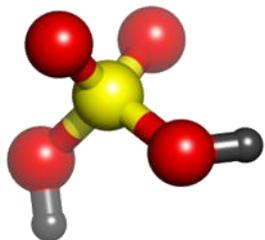


International Occupational Exposure Limits

- ▶ Indicative OEL Values (IOELVs)
 - Specified by the Council of the European Union
 - Based on advice from Scientific Committee on Occupational Exposure Limits (SCOEL)
 - 2009 -Third list of IOELVs published
 - Member states have until 12/2011 to implement legislation

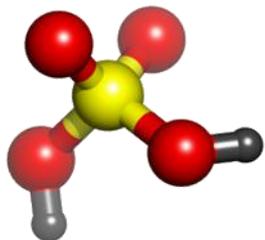
- ▶ European Union Reach
 - Worker derived no-effect levels (DNELs)
 - Must be calculated for quantities >10 tons/year
 - Safety margins higher than the IOELVs

- ▶ German Exposure Limits
 - DFG MAK – Maximum Workplace Concentrations



U.S. Exposure Limits

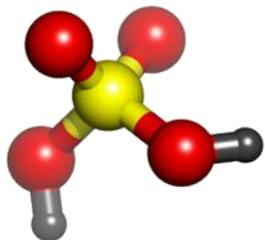
- ▶ PEL – Permissible Exposure Limits
 - Occupational Safety and Health Administration (OSHA)
 - USA legal limits
- ▶ REL – Recommended Exposure Limits
 - National Institute of Occupational Safety & Health (NIOSH)
 - Recommended, not legal limits
- ▶ ACGIH TLV® – Threshold Limit Values®
 - American Conference of Governmental Industrial Hygienists
 - Recommended, not legal limits
- ▶ AIHA WEEL – Workplace Environmental Exposure Limits American Industrial Hygiene Association (AIHA)
 - Recommended, not legal limits



Exposure Limits

Permissible Exposure Limit (PEL)

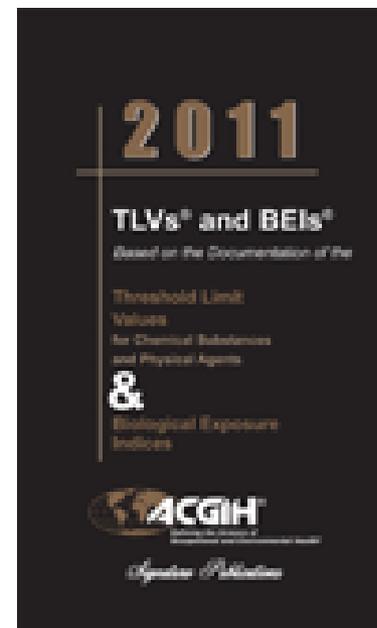
- ▶ Exposure limits are published by the U.S Occupational Safety and Health Administration (OSHA)
- ▶ Intended to control health effects from exposures to “air contaminants”
- ▶ Applies only to workplaces covered by OSHA
- ▶ Action Levels published for highly toxic chemicals
 - $\frac{1}{2}$ the PEL
 - Benzene, asbestos, vinyl chloride, formaldehyde

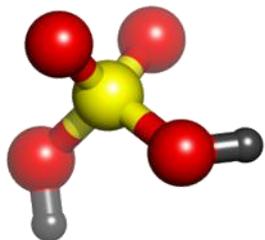


Exposure Limits

ACGIH TLVs®:

- ▶ ACGIH is a private, non-governmental corporation
- ▶ ACGIH TLVs are published as guidelines
- ▶ Not legal standards
- ▶ ACGIH TLVs are usually lower than PELs
- ▶ Reviewed and revised annually

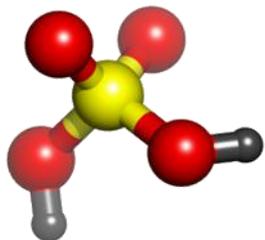




Exposure Limits

ACGIH TLVS®:

- 8 Hour time-weighted average (TWA)
- 15 minute short-term exposure limit (STEL)
- Ceiling value (C)
- TLV Examples:
 - Carbon dioxide = 5000 ppm TWA
 - Osmium tetroxide = 0.0002 ppm TWA
 - Hydrogen chloride = 2 ppm ceiling
 - Ammonia = 35 ppm STEL



Time Weighted Average (TWA)

Average exposure for an individual over a working period of time, determined by taking one or more samples during the working period:

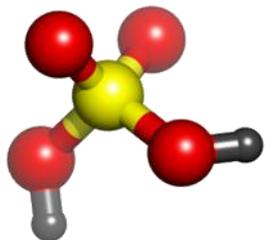
$$\text{TLV - TWA}^* = \frac{C_1T_1 + C_2T_2 + \dots + C_NT_N}{T_1 + T_2 + \dots + T_N}$$

Where:

C = airborne concentration

T = time

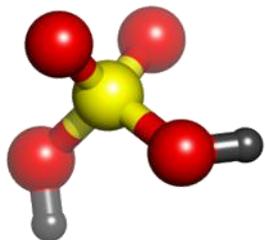
*** A TLV expressed as a TWA**



8-Hr Time Weighted Average

Average exposure for an individual over an 8-hr working period of time, determined by taking one or more samples during the 8-hr working period:

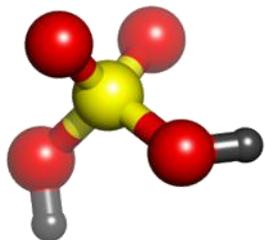
$$\text{TLV} - \text{TWA}_8 = \frac{C_1T_1 + C_2T_2 + \dots + C_NT_N}{8 \text{ hrs}}$$



Example:

A degreaser operator is monitored for exposure to Stoddard solvent. The monitoring data is:

<i>TIME PERIOD (NUMBER)</i>	<i>CONCENTRATION (PPM)</i>	<i>TIME (HOUR)</i>
1	80	2
2	110	4
3	55	2



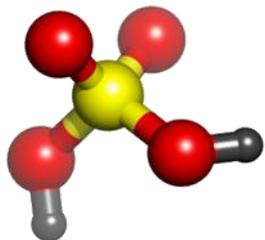
Solution

$$\text{TLV - TWA}_8 = \frac{C_1 T_1 + C_2 T_2 + \dots + C_N T_N}{8 \text{ hrs}}$$

$$\text{TLV - TWA}_8 = \frac{(80 \times 2) + (110 \times 4) + (55 \times 2)}{8 \text{ hrs}}$$

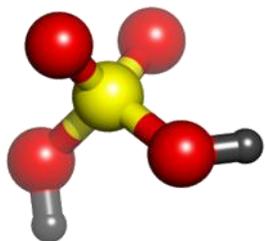
EIGHT HOUR TLV-TWA = 89 ppm

Over exposed?
(TLV-TWA = 100 ppm)



Other ACGIH TLV Notations ...

- “Skin” potential exposure by the dermal route, including mucous membranes and the eyes
 - **Examples: some solvents, phenol, pesticides**
- “SEN” potential to produce sensitization
 - **Example: toluene diisocyanate**

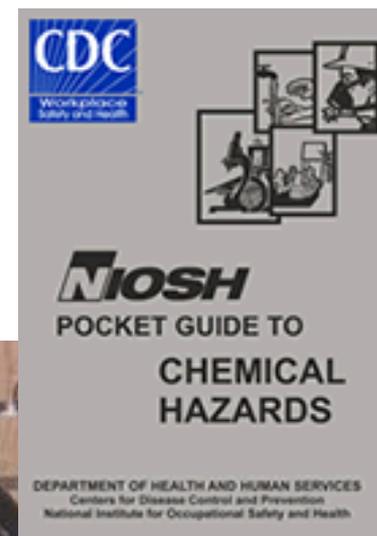


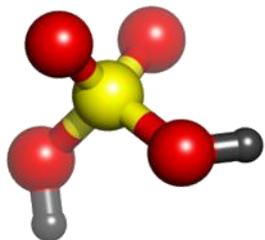
Evaluating Exposure

- ▶ Qualitative assessment
 - **Observe task**
 - Airborne contaminants ?
 - Skin immersion ?
 - **Evaluate toxicity**
 - Safety data sheets
 - NIOSH Pocket Guide

<http://www.cdc.gov/niosh/npg/>

- ▶ Quantitative
 - **Model exposure**
 - **Perform air sampling**





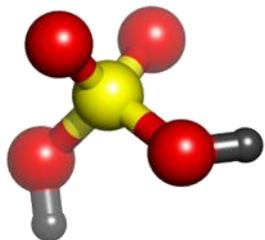
Evaluating Exposure

▶ Quantitative

- Model the contaminant concentration in the room
- Example: What concentration, in mg/m^3 would be produced by the release of 1 gram (g) of benzene in a 125 cubic meter room (m^3)?

Mass of contaminant/volume of room

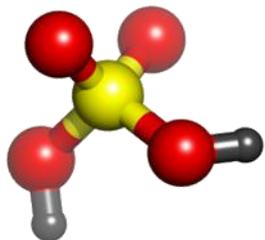
$$1 \text{ g}/125 \text{ m}^3 = 1000 \text{ milligrams}/125 \text{ m}^3 = 8 \text{ mg}/\text{m}^3$$



Calculation for PPM Concentration

$$\frac{(8 \text{ mg/m}^3) \quad (24.45)}{(78.11 \text{ MW})} = 2.5 \text{ ppm}$$

**ACGIH STEL for benzene is 2.5 ppm
(15 minute short term exposure)**

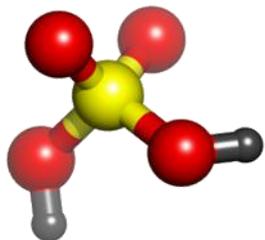


Evaluating Exposure

Air monitoring:

- ▶ Results must be analyzed
- ▶ Results are compared against a standard OEL
- ▶ Methods:
 - Air sampling pump and media or badges
 - Filters-for metals, particulates
 - Charcoal tubes-for solvents
 - Silica gel tubes-for acids



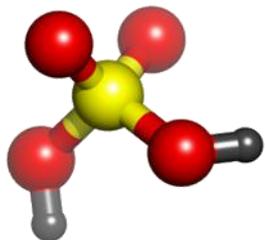


Evaluating Exposure

Other air monitoring methods:

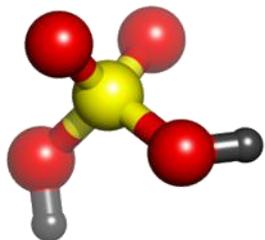
- ▶ Direct reading instruments
 - Photoionization detectors-solvents
 - Particle counters-dusts
 - Portable gas detection
 - Operate with hand pump
 - Color coded detector tubes
 - Detect 500 gases and vapors





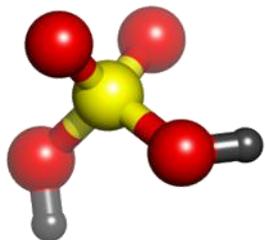
Evaluating Exposure: Control Banding

- ▶ Initiatives:
 - World Health Organization (WHO)
 - International Labor Organization (ILO)
- ▶ Over 17 million organic and inorganic substances
- ▶ 170,000 chemicals may require registration under EU REACH regulations
- ▶ Shift in traditional industrial hygiene approach towards exposure



Evaluating Exposure: Control Banding

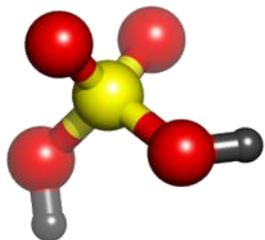
- ▶ Qualities of Control Banding
- ▶ A complementary approach to traditional industrial hygiene
- ▶ Focuses resources on exposure controls rather than exposure assessment
- ▶ Provides technical expertise to chemical users through simplified guidance



Evaluating Exposure: Control Banding

- ▶ Web Page: National Institute of Occupational Safety and Health (NIOSH)
 - www.cdc.gov/niosh/topics/ctrlbanding/
- ▶ Publications:
- ▶ AIHA (2007)
 - *Guidance for Conducting Control Banding Analysis*
- ▶ ACGIH (2008)
 - *Control Banding: Issues and Opportunities*
- ▶ NIOSH (2009)
 - *Qualitative Risk Characterization and Management of Occupational Hazards*

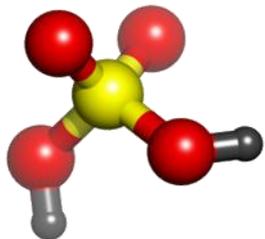
<http://www.cdc.gov/niosh/docs/2009-152/>



Conclusion

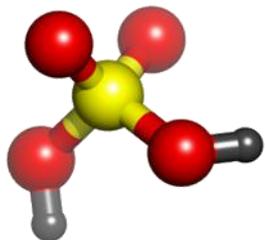
- ▶ Chemical exposure occurs via inhalation, ingestion, absorption and injection
- ▶ Pharmacokinetics is how chemicals react within the bodies metabolic systems
- ▶ Dose/Response curves reveal varying health effects based on the chemical
- ▶ Routes of exposure in industrial settings are largely inhalation and absorption.
- ▶ Industrial Hygiene monitoring equipment
- ▶ PELs, OELs, TLV-TWA, STEL

Emergency Management



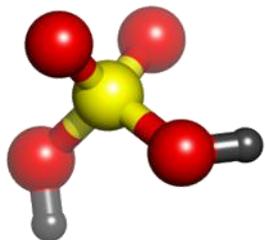
SAND No. 2011-0722C

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.



Overview

- ▶ *Emergency* Defined
- ▶ Types of Emergencies
- ▶ Emergency Management
 - Emergency Planning
 - Incident Command System
 - Emergency Response
- ▶ Emergency Management Exercise

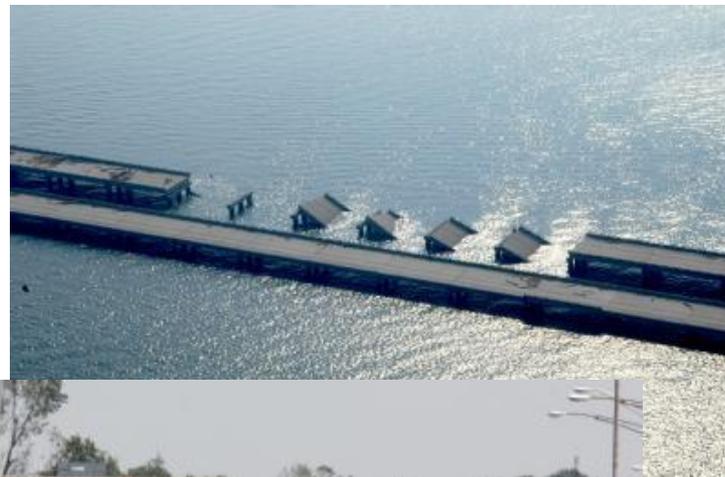


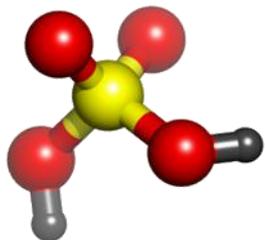
Emergency Defined

“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”





Emergencies

- ▶ Hazardous materials releases

- Accidental
- Intentional

- ▶ Fires

- ▶ Explosions

- ▶ Medical

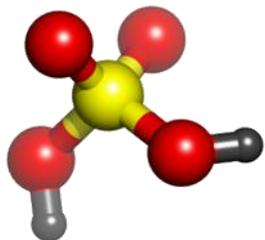


- ▶ Natural Occurrences

- Earthquakes, typhoons, fires, floods, etc.

- ▶ Other incidents

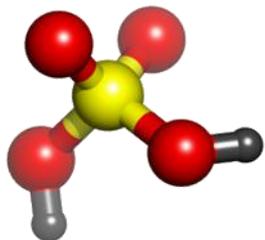
- Bomb threat
- Terrorism



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



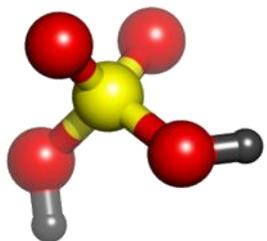


Emergency Planning

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

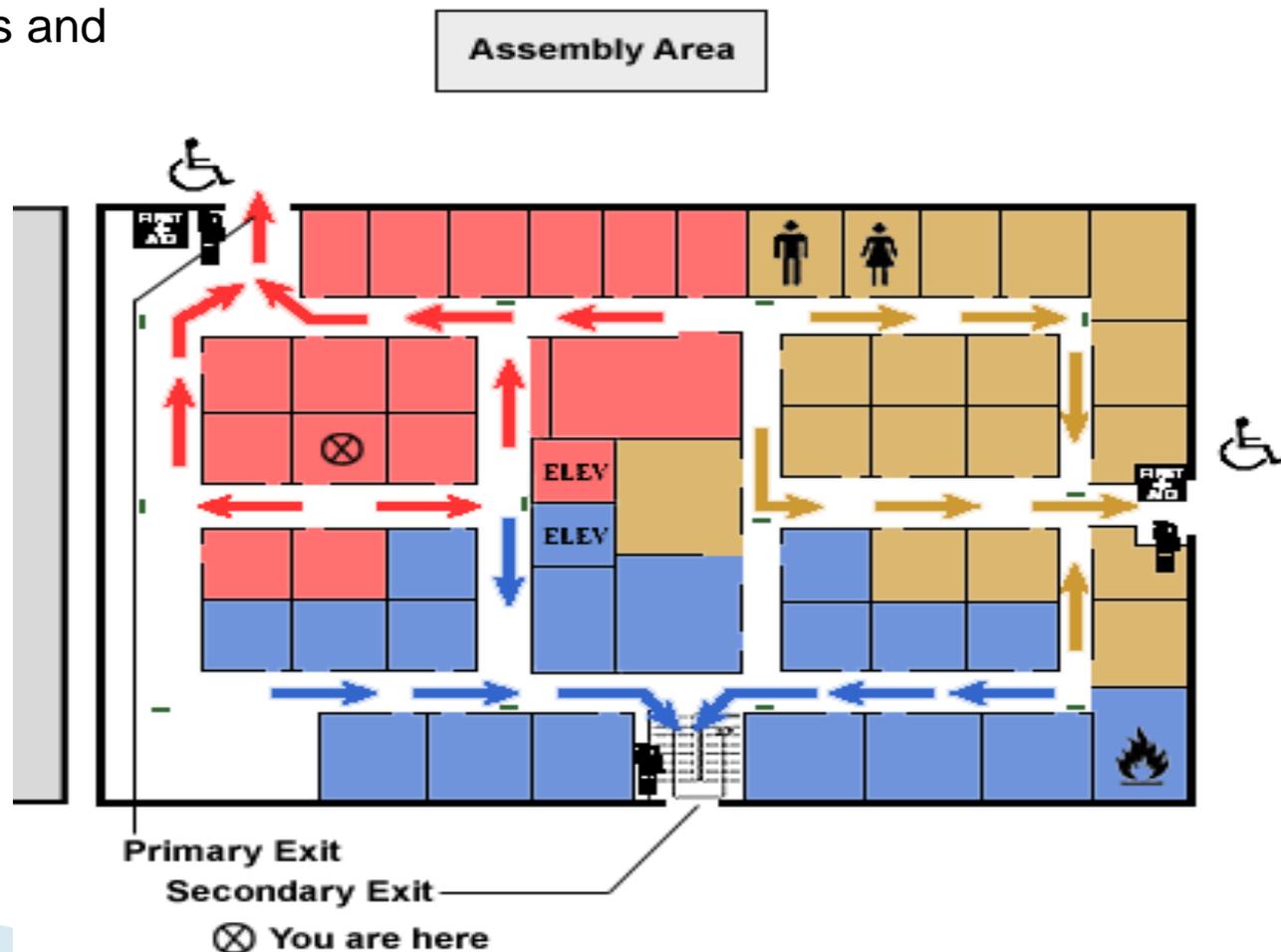


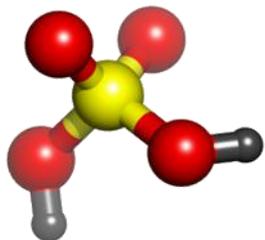


Emergency Planning

Have an evacuation map for all buildings and areas and

POST IT



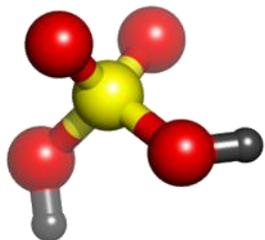


Emergency Planning

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

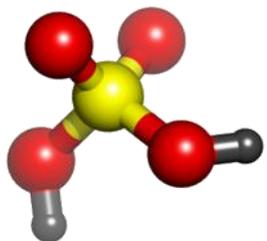


Emergency Planning



Plant Emergency Response Procedures

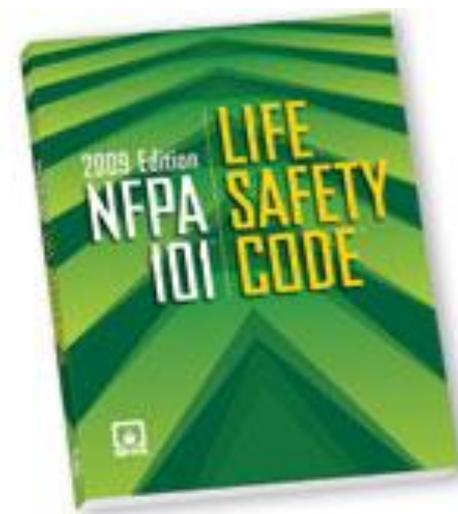
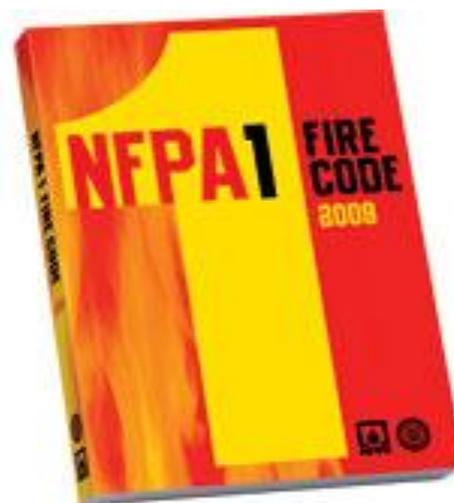
- Evacuate or shelter in place?
- Respond?
- Who will respond?
 - On-site HAZMAT team?
 - Require training
 - Community fire department?
 - Establish memorandum of understanding
- Medical support
 - In-house?
 - When to call for outside assistance
- Emergency shutdown procedures
- Decontamination procedure

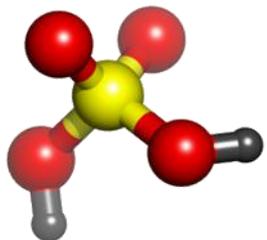


Emergency Planning

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



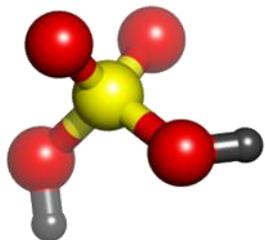


Emergency Planning

Post exit signs

Keep exits unlocked or equipped with panic bars.



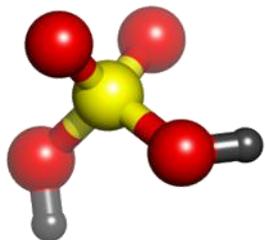


Emergency Planning

Detection & Mitigation Equipment

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



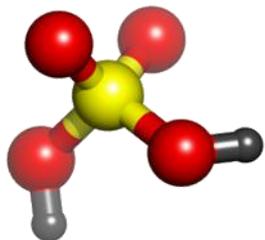


Emergency Planning

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*

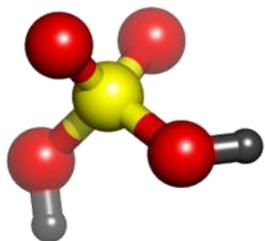
The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

▶ *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.

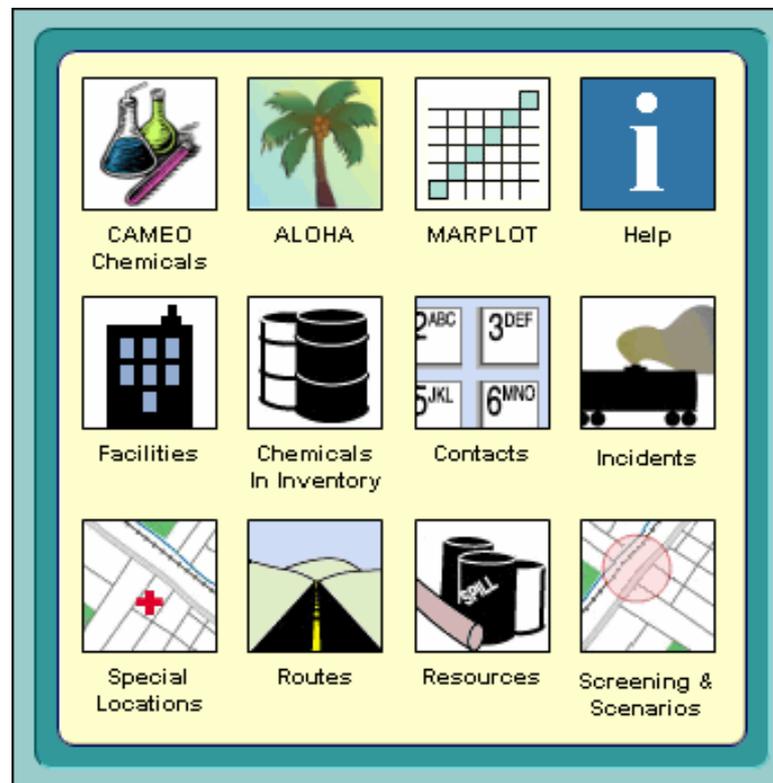


Emergency Planning

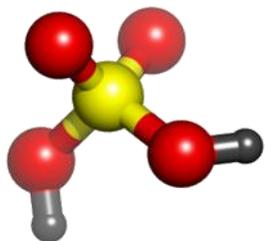
Software Applications

Assist first responders with accessible and accurate response information

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

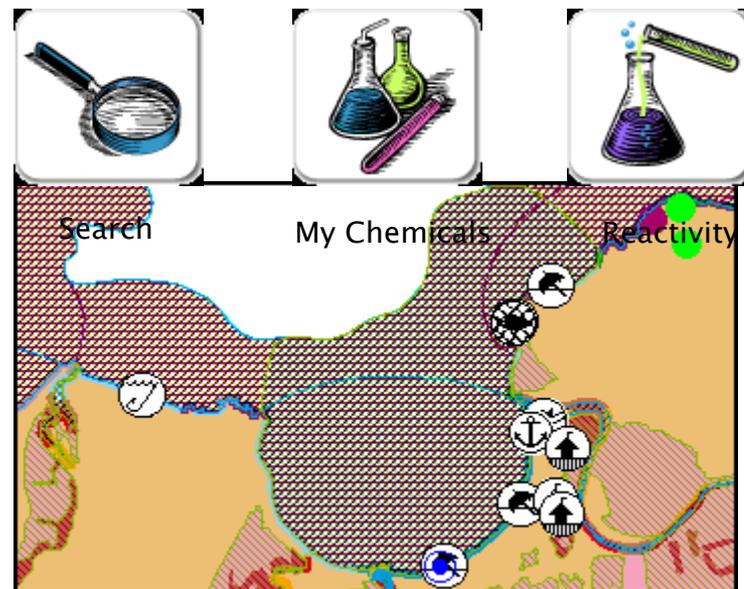


<http://www.epa.gov/emergencies/content/cameo/request.htm>

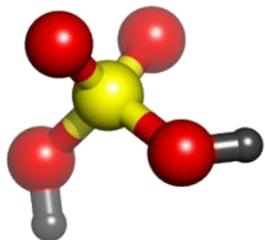


Emergency Planning

- ▶ 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

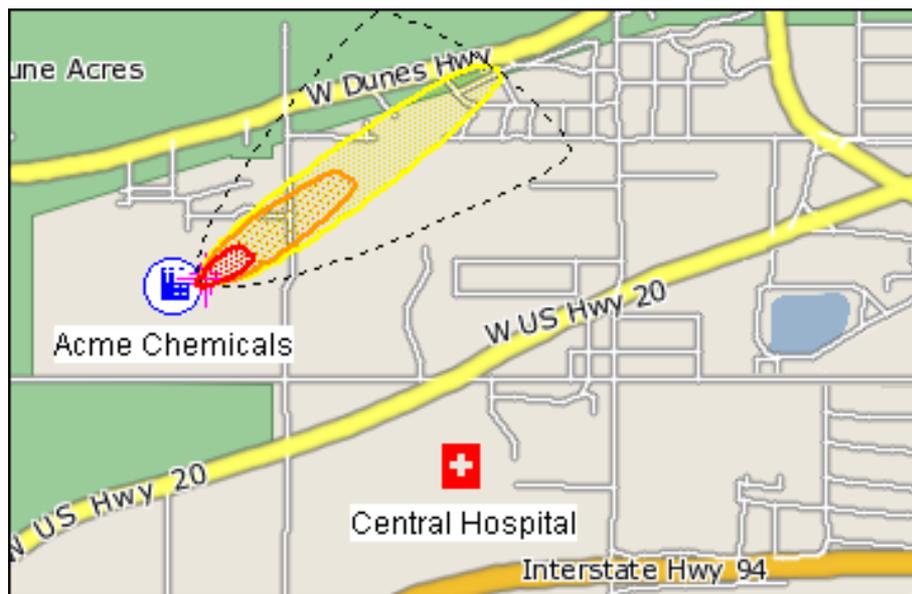


<http://www.epa.gov/emergencies/content/cameo/request.htm>

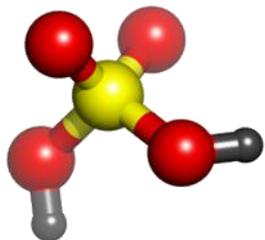


Emergency Planning

- ▶ 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>

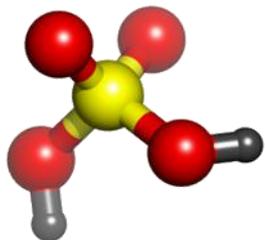


Emergency Planning

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

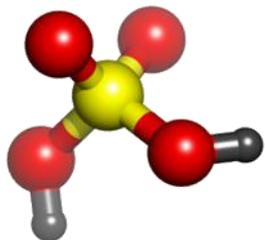




Emergency Planning

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.

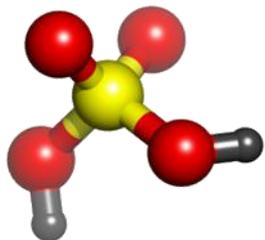


Emergency Planning

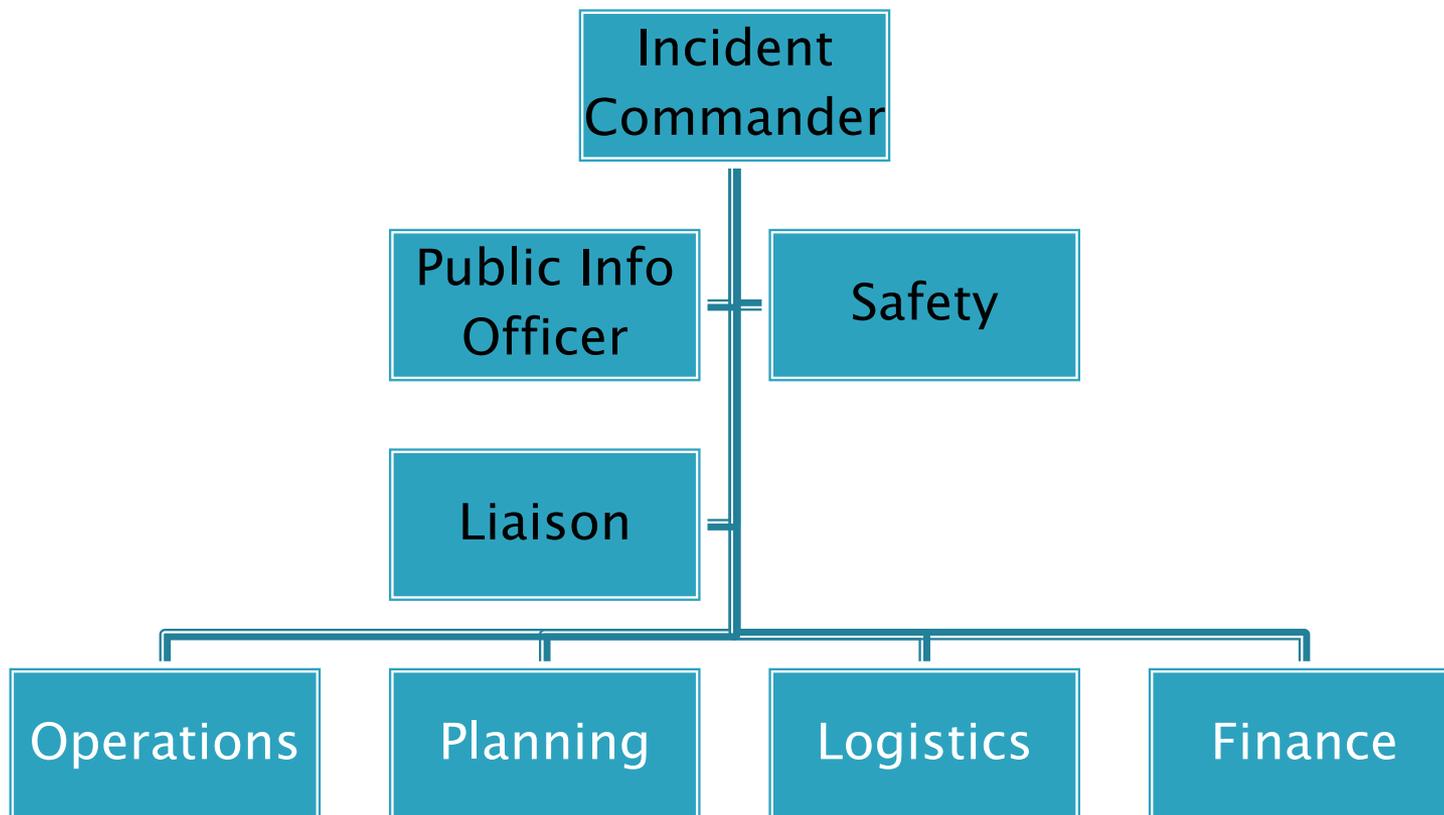
Incident Command System:

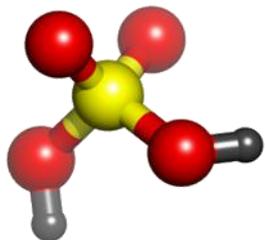
- ▶ Developed to resolve:
 - Ineffective communication
 - Lack of common command structure
 - Lack of accountability
 - Inability to coordinate resources
- ▶ Based on basic business management
 - Plan
 - Direct
 - Organize
 - Communicate
 - Delegate
 - Evaluate





Incident Management System





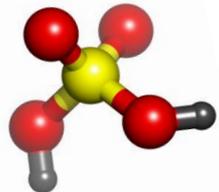
Emergency Planning

Community Involvement

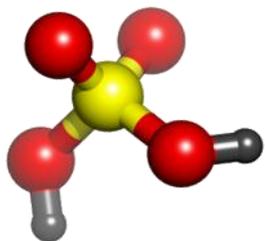
- Prepare for emergencies involving local communities
 - Communicate!
 - Develop an emergency planning committee
 - Select notification method to community
 - Inform community of hazardous materials at your plant
 - Safety data sheets
 - TOXNET

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





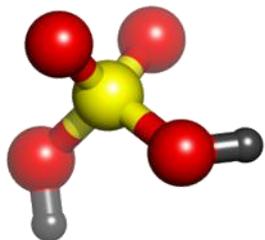
Tea Break!



Emergency 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.

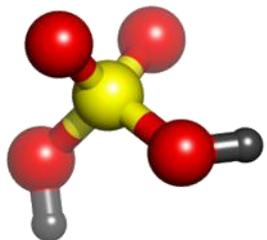


Response to Hazardous Materials Incidents

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



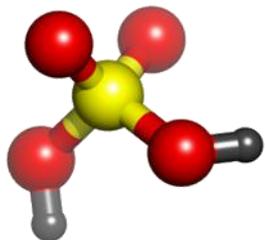


Who Will Respond?

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

OR, ALL OF THE ABOVE





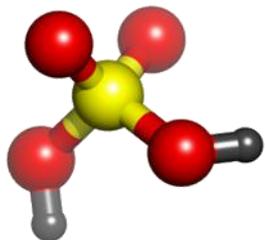
Emergency Response Decision Making

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, NH₃, CO, Cl₂, H₂S
 - Personal sampling and analysis



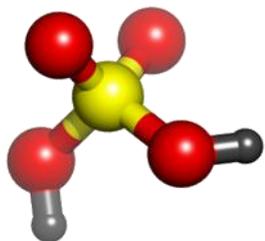
Industrial Scientific.

<http://www.indsci.com/products/#multi>

RAE Instruments.

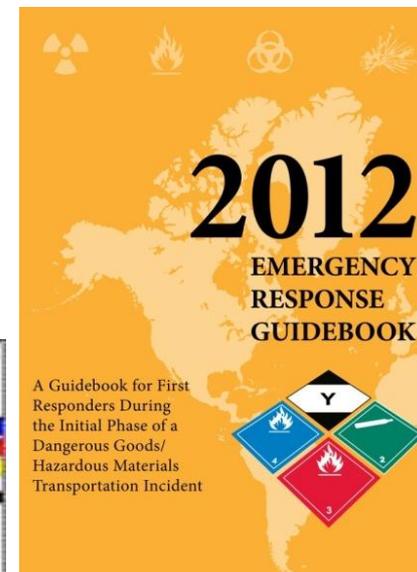
<http://www.raesystems.com/products>

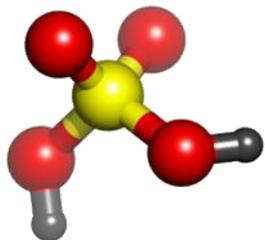
Sensidyne Air pumps. <http://www.sensidyne.com>



Emergency Response Estimate Likely Harm

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

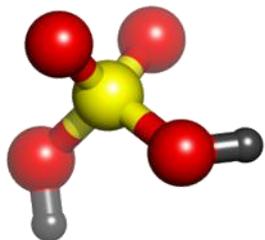




Emergency Response Estimate Likely Harm

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 $\leq 100^{\circ}$ C, ≤ 10 microns particle size
- ▶ **Flammability/Reactivity**
 - Flashpoint $< 60^{\circ}$ 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

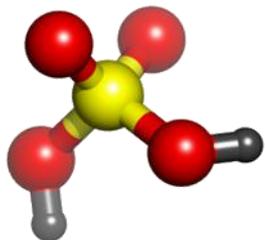
2. Property

- At the site
- Protecting community

3. Environment

- Air, ground and surface water, soil, wildlife

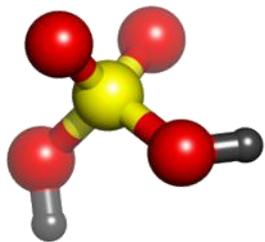




Emergency Response

Initiate the Incident Command System:

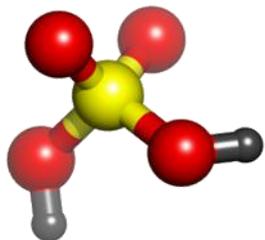
- ▶ Incident Commander
 - Establishes the strategy and tactics
 - Has ultimate responsibility for incident outcome
 - The position is established for every incident
 - May establish a command post
- ▶ Command Staff positions
 - Safety officer
 - Liaison officer
 - Information officer



Identify Action Options-

Size of spill may determine response



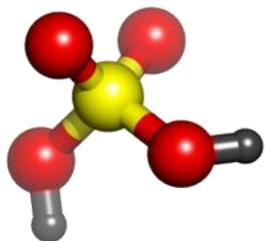


Emergency Response

Identify Action Options

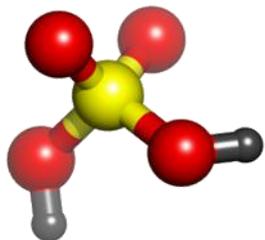
Large Catastrophic Incidents

- ▶ 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?





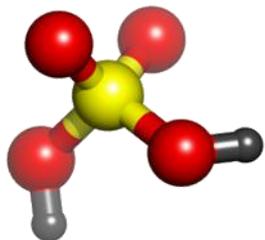
Identify Action Options

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



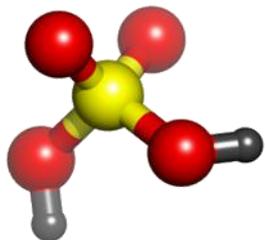
<http://earthbagbuilding.wordpress.com/>
<http://www.sb.fsu.edu/~xray/emergency.html>
<http://www.lpgventures.com/compliance/page2.html>



Identify Action Options

Offensive Options Large Event

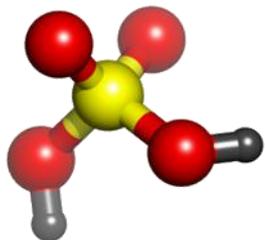
- ▶ Written Standard Operating Procedures
 - For each hazardous material or process on-site
- ▶ Select action from alternative strategies
- ▶ Select PPE/equipment for responders
 - http://osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9767
 - Ensure compatibility of PPE with hazards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



Offensive Options–Small Spills

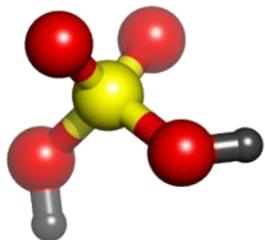
- Spills of < 4 liters
- Must have appropriate PPE, spill equipment and training
- Do not clean up small spills of :
 - Acutely toxic (Low LD₅₀) chemicals
 - Carcinogens
 - Flammable liquids or metals
 - Chemicals of unknown toxicity or hazards





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



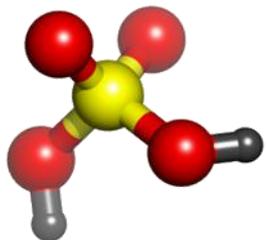
Offensive Options Small Spills

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”



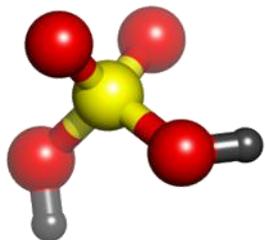


Offensive Options Small Spills

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?

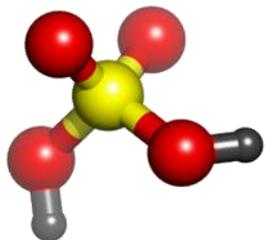
How long will it run?

How much fuel do you have?

What areas will it support?

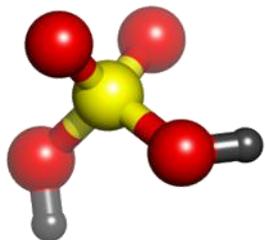
How often is it tested and maintained?





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

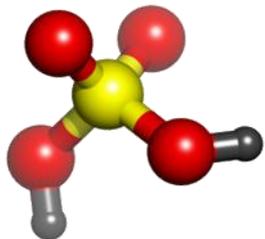


Video – A North Carolina town is evacuated due to fire at waste site



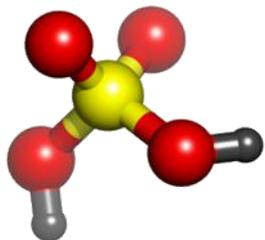
Apex Hazardous Waste Site Fire –
Video file = EmergencyinApe_pdl.wmv 17 min

Emergency Management Exercise



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 Management 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.

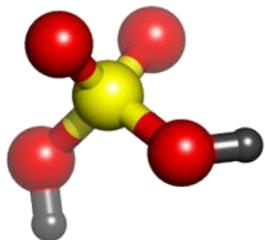
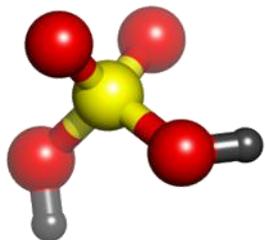


Photo of Chlorine Release





Summary of Incident

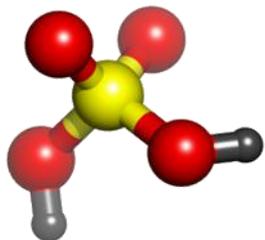
Around 9:20 am on March 3, 2011, a 2.5 centimeter chlorine transfer hose used in a railroad tank car unloading operation at the XXX Company facility ruptured, releasing 20,000 kilograms of chlorine. Unloading activities involve transferring liquefied pressurized chlorine gas from the tank car to individual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



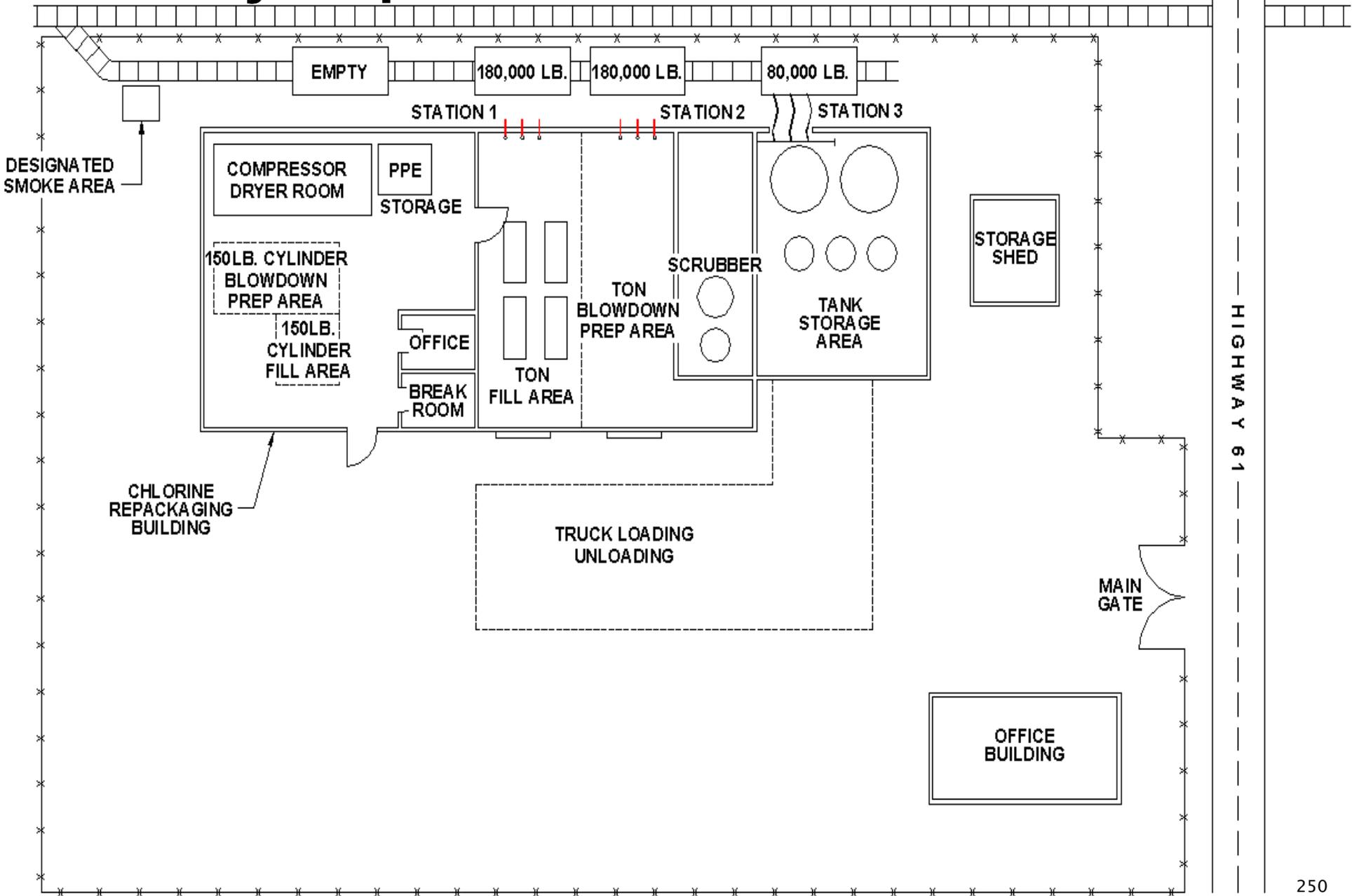
Summary of Incident, continued

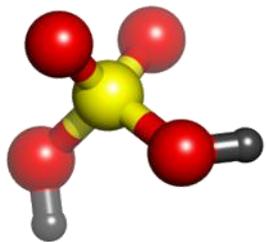
A chlorine detection sensor in the facility activated an evacuation alarm. The XXX Company employees, who were also the emergency response team, attempted to respond to the release, but were unable to access the emergency protective equipment (PPE). The equipment consisted of self-contained breathing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

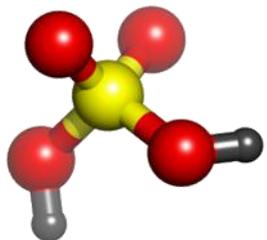




Tanker Hose Rupture

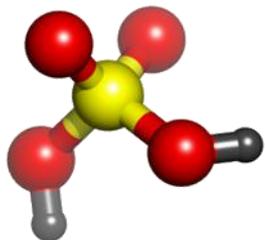


Photo credit: US Chemical Safety Board



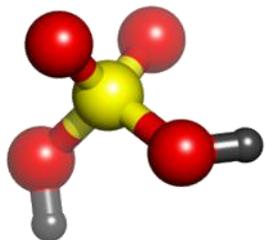
Emergency Management Exercise

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



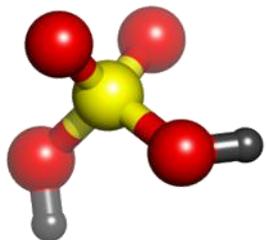
Emergency Management Exercise

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



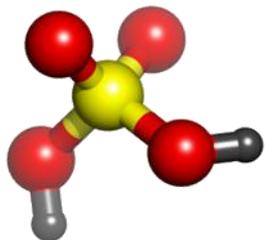
Emergency Management Exercise

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



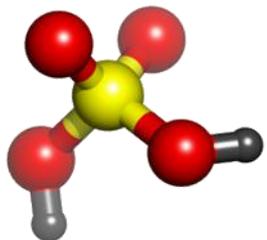
Emergency Management Exercise

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



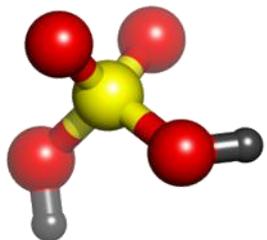
Emergency Management Exercise

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



Emergency Management Exercise

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



Emergency Management Exercise

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