

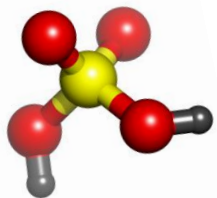
# Sandia National Laboratories International Chemical Threat Reduction

Yemen Workshop  
Amman, Jordan  
June 2012



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



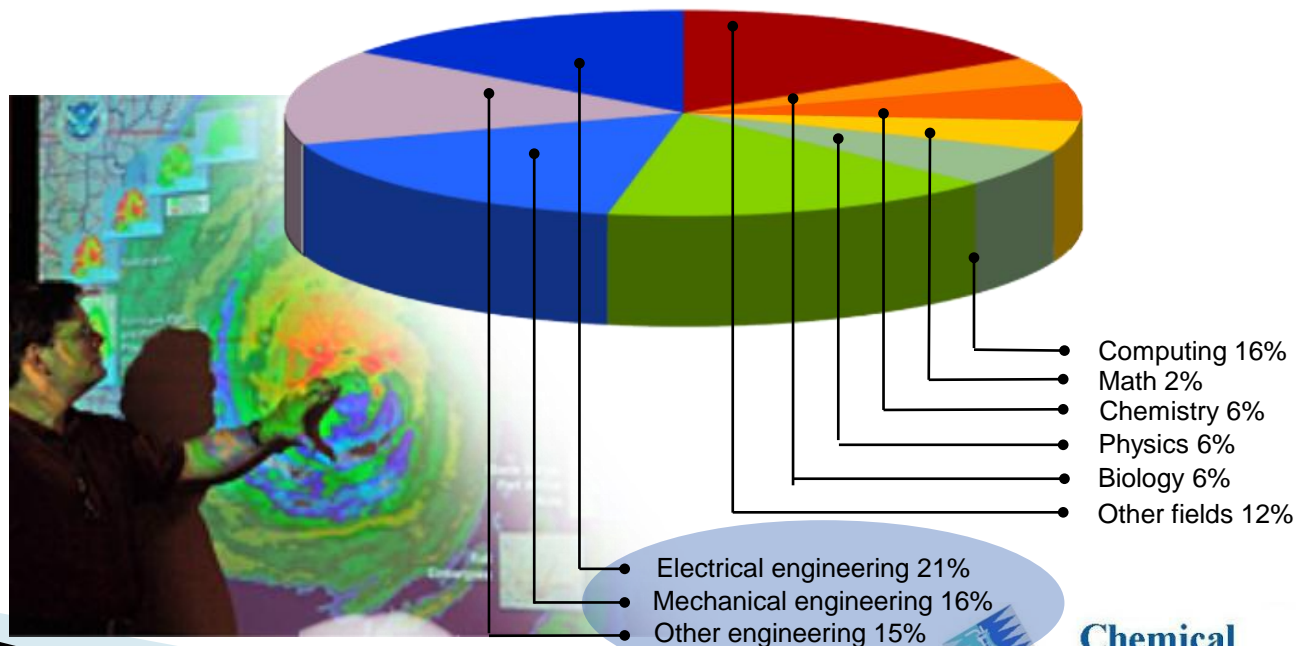


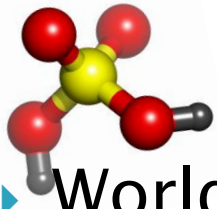
# Sandia Labs Capabilities

## ▶ *WE ARE SCIENTISTS & ENGINEERS*

- Establish relationships in Global science community
- Experience in labs
- Experience with research & development
- Fundamental and applied sciences
- Analytical skills

Technical staff (4,277) by discipline:

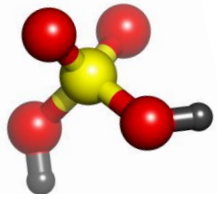




# Sandia Labs Capabilities

- ▶ **World-class technical competence:**
  - One of 16 National Laboratories in U.S.
    - 2 main sites (CA and NM), other facilities/collaborations
  - High-risk/high-benefit research
  - Expertise in engineering and science
    - Energy, security, weapons, nonproliferation, climate, environment, infrastructure, emergency response, fundamental science and engineering, supercomputing.
- ▶ **Risk Analysis:**
  - Vulnerability, safety, security, prioritization, mitigation, strategy.
- ▶ **Threat Reduction:**
  - Nuclear, Biological, Chemical
- ▶ **International:**
  - Experience in every region, (nearly) every country
- ▶ **Honest broker:**
  - No commercial or political objectives





# Sandia Labs Capabilities

SECURING A PEACEFUL AND FREE WORLD THROUGH TECHNOLOGY



**Anthrax-killing foam effective in meth cleanup**  
Sandia's decontamination formula is now also a meth eraser. » [Full Story](#)

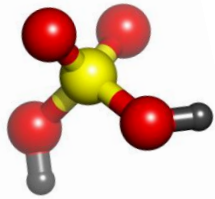


**Sandia's**  
Impact on the  
Nation



**Labs**  
Accomplishments  
Key milestones for  
2012 (PDF)

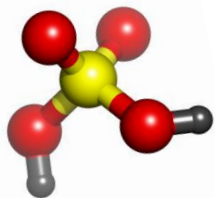
- ▶ Chem/Bio decontamination
- ▶ (Inter)National impacts
- ▶ Accomplishments
  - >1700 patents & commercial copyrights
  - CRADAs (most among National labs)
  - small business tech transfer



# Examples: Nuclear

- ▶ Science & Engineering:
  - “Everything nuclear”
  - Energy, Stockpile Reactors, more...
- ▶ Security:
  - stockpile surveillance (1949–present)
  - satellite systems (1960s–present)
  - training for physical security (1970s–present)
- ▶ Nonproliferation (International Nuclear Threat Reduction):
  - INTR enhance international security by reducing nuclear threats through global engagement. Use technical and analytical tools to address controls on nuclear materials, facilities, and expertise as well as security for weapons of mass destruction proliferation.
  - SNL Cooperative Monitoring Center (CMC, 1994)
    - is now MESIS; in Amman, Jordan.
  - GNEII: to prepare future leaders of Gulf nuclear energy programs



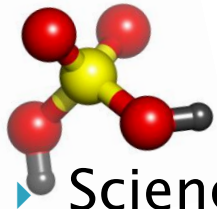


# Examples: Biological



- ▶ Science & Engineering:
  - sensors, medical diagnostics
  - biofuels, biomolecular assemblies, more...
- ▶ Security:
  - Rapid Syndrome Validation Project (RSVP): Department of Health system to quickly detect disease outbreaks (2002)
  - Biodefense and Emerging Infectious Diseases Program
  - Detection – BioWatch program
  - Response & recovery (Sandia foam, etc)
- ▶ Nonproliferation (International Biological Threat Reduction):
  - IBTR enhances US and international security by reducing biological threats worldwide. Protects against accidental or intentional misuse of life sciences to harm people, agriculture, or critical resources.
    - operate in over 40 countries
    - science, public health, veterinary facilities
    - Contributed to WHO *Laboratory Biosafety Manual (2004)*, and developed biosecurity supplement in 2006.
    - Wrote the book – literally – on laboratory security, the *Laboratory Biosecurity Handbook*, established global framework for biosecurity.





# Examples: Chemical

## ▶ Science & Engineering:

- Strained-layer superlattices/semiconductors (1983),
- Sensors, micro-chemlab, micro-machines, more...
- Cleanrooms (1960),
- Energy conversion/storage

## ▶ Security:

- Chemical supply chain surety
- Detection & controls
- Consequence management

## ▶ Nonproliferation (International Chemical Threat Reduction):

- ICTR enhances international security by reducing chemical threats worldwide. Collaborates with partner governments, national and international chemical organizations and professionals to raise awareness about chemical security and safety, consistent with national and international guidelines, norms, and requirements.

- first trainings in 2008
- engaged with >20 countries
- industry and academic institutions
- strategic alliances
- training, technical assistance and facility assessments

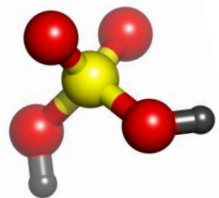


# Chemical Threat Reduction

## Activities Engaging Research & Academia

Laboratory Safety and Security

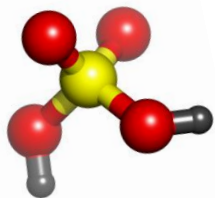




# CSP-ICTR Program: Historical Perspective

- ▶ 2008: CSP program launched
  - Start: academic chemical professionals in South & Southeast Asia
  - Goal: raise awareness of dual-use nature of chemicals
- ▶ Methods:
  - Foster networking & collaboration among chemical professionals
  - Scientist-to-scientist communication
  - Train-the-trainer CSSO
- ▶ Status (2008–2011):
  - Training of chemists from >30 countries
  - CSS training of >2100 scientists
  - CSSO Training of >1200 scientists





# CSP-ICTR: where we work

## Map of Participant Countries



[Afghanistan](#)

[Algeria](#)

[Bahrain](#)

[Burkina Faso](#)

[Cambodia](#)

[Egypt](#)

[Ethiopia](#)

[Indonesia](#)

[Jordan](#)

[Laos](#)

[Lebanon](#)

[Malaysia](#)

[Morocco](#)

[Nigeria](#)

[Pakistan](#)

[Philippines](#)

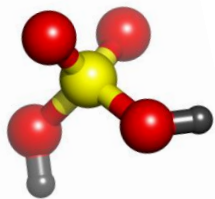
[Thailand](#)

[Tunisia](#)

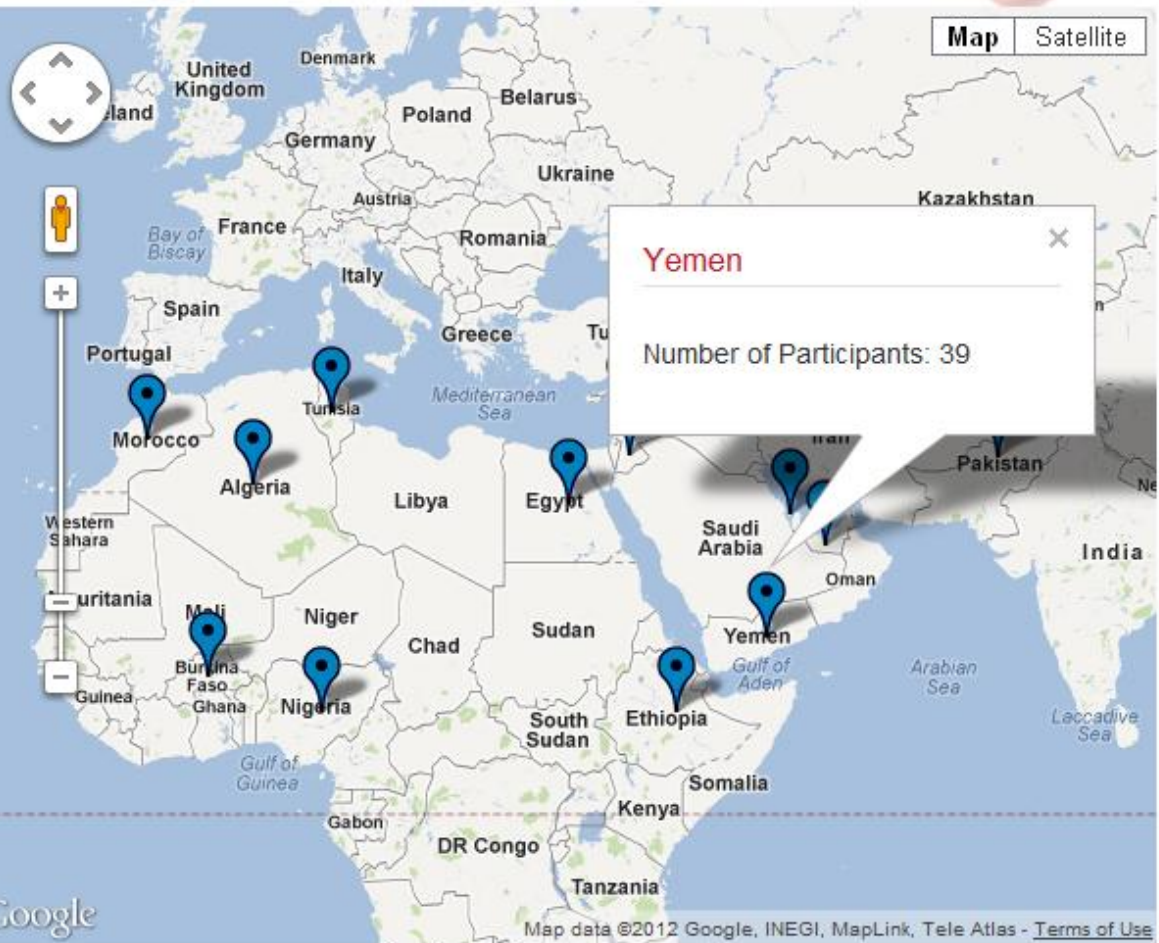
[United Arab Emirates](#)

[Vietnam](#)

[Yemen](#)



# CSP-ICTR: where we work



Search Site

## Workshops

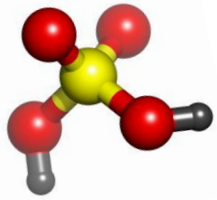
- [Photo Gallery](#)

## Workshops by year

- [2012](#)
- [2011](#)
- [2010](#)
- [2009](#)
- [2008](#)

## Where We've Been

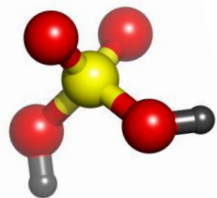
- [Map of Participant Countries](#)
- [Countries & Institutions](#)



# Training Events Timeline

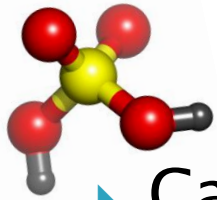
Academic and Industry





# Yemen: Our Chemistry is Good!

- ▶ CSP active with Yemen:
  - October 2011 CSSO:
    - 21 academic scientists & administrators
  - January 2012 CSSO:
    - 29 academic scientists & administrators
  - April 2012 ICYC–CSS:
    - 18 academic scientists supported at ICYC–Jordan
- ▶ Follow–ons of Yemen:
  - Dec 2011:
    - training at Sana'a UST
  - Jan 2012:
    - NCPHL Food & Water Department – chemical management improvements
  - March 2012:
    - Yemen EPA Conference (Dr. Helal Al–rashi) in Sana'a
  - Study proposal:
    - Drs. Abdel Al–Alimi & Saleh Kasem (Dual use)
  - Training Institute proposal:
    - Drs. Abdel Al–Alimi & Shaif Kasem (AYISS)



# CSP–Sandia ICTR

## ▶ Capabilities:

- Chemical supply chain surety
- Vulnerability & risk assessments
- Innovative technologies/solutions
- Physical protection of facilities/assets/targets/borders
- Complex modeling/System dynamics
- Solutions & mitigation analysis/strategies

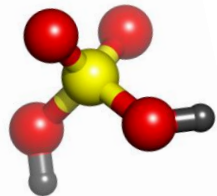
## ▶ Approach:

- Scientist–to–scientist
- Train–the–trainer
- Partner with professional/trade societies
- Risk–based decision making
- Policy and regulation

## ▶ Successes:

- Philippines
- Indonesia
- Malaysia
- **next: Yemen**





# Chemical Security Engagement Program (CSP)

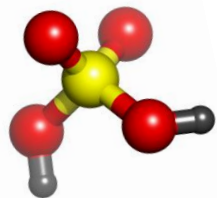


*CSP seeks to improve global chemical security and safety by raising awareness and improving security and safety best practices.*

## Program Goals:

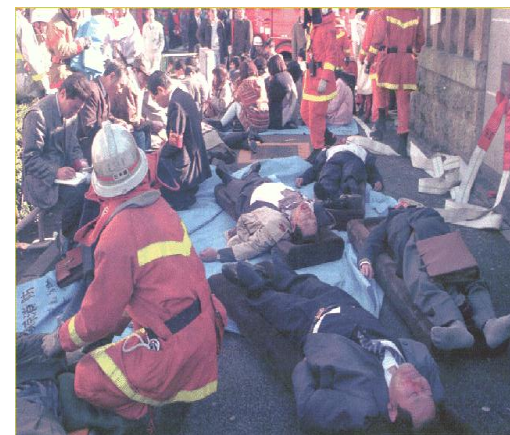
- ▶ Raise awareness about chemical threats and dual-use nature of chemicals.
- ▶ Provide technical assistance to improve chemical security and safety best practices.
- ▶ Foster national and regional dialogue focused on improving chemical security and safety.
- ▶ Promote and strengthen international scientific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

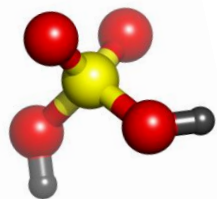




# Motivation: Threat Reduction

- Proliferators and terrorists seek to:
  - use industrial chemicals as low-cost alternatives for a chemical attack
  - recruit scientific experts
  - obtain and use chemical weapons
- Known terrorist use of chemical weapons & toxic industrial chemicals:
  - Japan – Aum Shinrikyo, Sarin gas attacks
  - Iraq - Chlorine gas cylinders combined with explosives
- Risk of lab/industry accidents to the public:
  - Bhopal, India - December, 1984

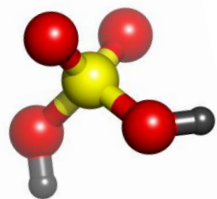




# Program Approach: Connections

- **Connecting science, safety and security:**
  - engage government officials, scientists, engineers and technicians,
  - conduct workshops to train researchers & industry on safe & secure chemical practices,
  - train to become chemical safety and security officers
    - trained scientists return to their institution to promote good chemical safety and security practices and train others
    - good lab security follows from better lab safety practices
- **good lab management provide structure for better security**





# Program Strategy: Partnership



I U P A C



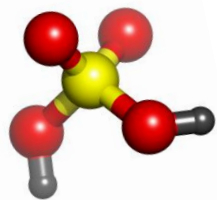
- Engage countries with:
  - growing chemistry capabilities and industry
  - regional security concerns
  - active producers/exporters of industrial chemicals
- Partner with:
  - host governments of countries
  - chemical professionals
  - international, national, and regional chemical professional societies
  - chemical industry and industrial organizations
  - international entities focused on chemical security



SPIK

SAMAHAN SA PILIPINAS NG MGA INDUSTRIYANG KIMIKA





# Program Success: ICP Example



Integrated  
Chemists of the  
Philippines

[Home](#) [About Us](#) |

## All You Need To Know About Chemical Safety – The ICP Curriculum

**Starts:** Monday, February 13th 2012 at 12:00 AM

**Ends:** Tuesday, February 14th 2012 at 8:00 AM

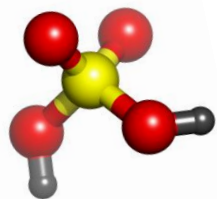
**Venue:** PNP Multi-Purpose Hall, Camp Crame, EDSA, Quezon City

In celebration of CHEMISTRY WEEK 2012, the Integrated Chemists of the Philippines is pleased to invite you an inaugural one and a half day seminar on **All You Need To Know About Chemical Safety**.

The ICP is pleased to launch an integrated curriculum on Chemical Safety. The ICP curriculum has the overall objective of assisting institutions draft their own Chemical Laboratory Safety Manual, which is a basic requirement to educate and inform those working in a chemical laboratory to prevent any untoward incident brought about by the mis-use or mishandling chemicals. As Chemists, we have a major role in ensuring chemical safety to prevent harm to people and damage to the environment.

The objective of this 1½-day seminar is to introduce the ICP curriculum for the preparation of the Chemical Laboratory Safety Manual. The ICP curriculum includes the following topics:

- Introduction to chemical safety
- Roles and responsibilities of key persons
- Classification of chemicals based on hazards
- Overview of Toxicology
- Hazard communication
- Managing chemical stocks
- Chemical storage guidelines
- Control measures
- Emergency preparedness and response (spills, fires, others)
- Personal protection
- Chemical security measures
- Chemical waste storage
- Philippine laws and regulations related to chemicals
- Preparing a Chemical Laboratory Safety Manual



# CSS Awareness Training

## ▶ Audiences:

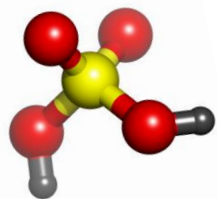
- 1) Leadership for chemical policy, institutions, enterprises.
- 2) Academic scientists, technologists, students.

## ▶ Purpose:

- Raise awareness of CSS issues and how to improve.
- Stimulate high-level comprehensive support to make improvements for CSS concerns.

## ▶ Goals:

- Generate cooperation between lab users, directors, administrators, and ministries.
- Align interests of professionals at all levels to take action on CSS issues.
- Garner support and expertise for appropriate strategies for beneficial policies, mitigations.

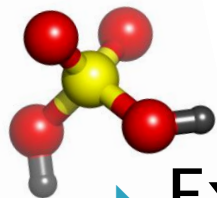


# CSS Awareness Trainings

## ▶ History (2008–2011):

- SNL has conducted ~30 CSS Awareness trainings in ~12 countries,
- About 2100 participants from ~30 countries have attended CSS Awareness trainings,
- There have been many follow-on CSS trainings
  - many not reported
  - CSP-ICTR has supported >10 trainings with >750 participants
- CSP-ICTR has supported five policy & regulation related workshops.
- Materials in English, Arabic, Indonesian and French

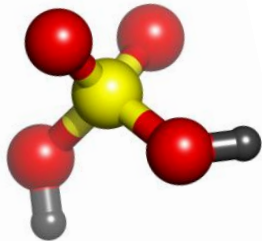




# CSS Awareness Training

## ▶ Example Agenda & topics:

Time	Topic
08:00	Registration
08:30	Welcome, Overview of Workshop, Announcements
08:45	<b>In-Country Perspective on Chemical Safety and Security</b>
09:00	Chemical Safety and Security Overview
09:30	Lab Chemical Safety: <b>Anticipation, Recognition, Evaluation, Control</b>
10:00	Break
10:15	Fundamentals of Chemical Lab Safety: <b>Types of Hazards in Labs</b>
10:45	Lab Safety: <b>Administrative/Operational Practices and Engineering Controls</b>
11:15	<b>Breakout Discussion:</b> Lab Safety and Security
12:00	Lunch
13:00	<b>Chemical Management:</b> Best Practices, Waste & Recycling
13:30	Chemical <b>Dual-Use Awareness</b>
14:30	Break
14:45	<b>Breakout Discussion: Chemical Management and Next Steps</b>
15:15	Report back to group
15:45	<b>Emergency Planning and Chemical Transport</b>
16:15	<b>Chemical Security: Relationships Between Chemical Safety and Security</b>
16:30	Summary, Thanks, Feedback Forms
17:00	Adjourn



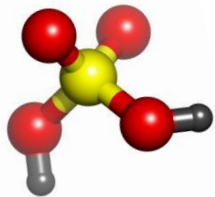
# Chemical Safety & Security Awareness Training

Yemen Workshop  
Amman, Jordan  
June 2012

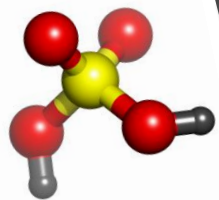


SAND No. **2009-5741C** Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.



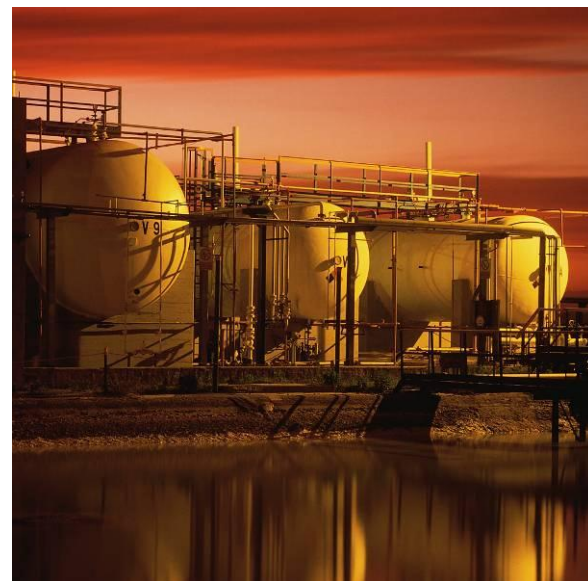


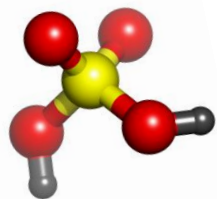
# Chemical Safety and Security Overview



# Why worry about chemical safety?

- **Chemicals used everyday in labs and factories can be hazardous.**





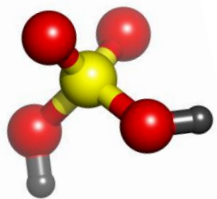
# Chemical health problems

## Chemicals

- ▶ Vinyl chloride
- ▶ Asbestos
- ▶ Carbon tetrachloride
- ▶ Mercury
- ▶ Lead
- ▶ Thalidomide
- ▶ Methanol
- ▶ CO, CS<sub>2</sub>

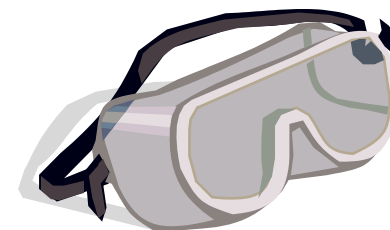
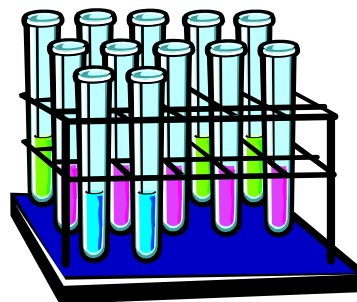
## Diseases

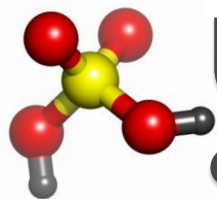
- ▶ Liver cancer
- ▶ Mesothelioma
- ▶ Hepatotoxin (jaundice)
- ▶ Neurotoxin, CNS, narcosis
- ▶ Reprotoxin, birth defects
- ▶ Reprotoxin, developmental defects
- ▶ Blindness, death
- ▶ Hematopoietic, hemoglobin, cyanosis



# Disease depends on many factors...

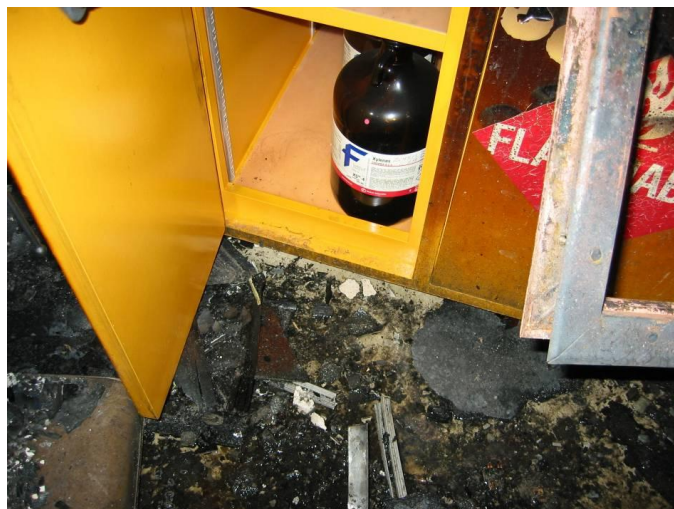
- ▶ Genetics
- ▶ Specific chemical
- ▶ Protection controls used
- ▶ Dose
- ▶ Concentration
- ▶ Duration
- ▶ Life style
- ▶ Environment



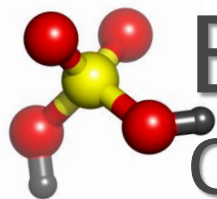


# University of California Santa Cruz: Fire

- **January 2002** - about 5:30 am, 4<sup>th</sup> floor of Lab building, Dept. of Molecular, Cell and Developmental Biology
  - Firefighters responded to heat-detection alarm in building
  - controlled by noon
  - **current inventory** of chemicals:
    - allowed firefighters to enter building and contain fire
  - building did not have automatic sprinkler system
- **Losses:**
  - loss of lab notes, data, equipment, samples
  - two years to restore burned lab
  - other labs damaged (water, smoke)
- **Cause not determined**



<http://ehs.ucsc.edu/emergency/pubs/sinshfire2.htm>



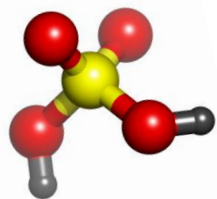
# Environmental hazards

## California State Univ. Northridge: Earthquake

- Magnitude 6.7
  - January 17, 1994 – 4:31 am
  - 57 deaths, 11000 injuries
  - Epicenter a few km from the campus
- **Poor inventory:**
    - Several fires in science buildings allowed to burn because firemen worried about chemical hazards
    - Professors and students lost equipment, notes, materials, samples

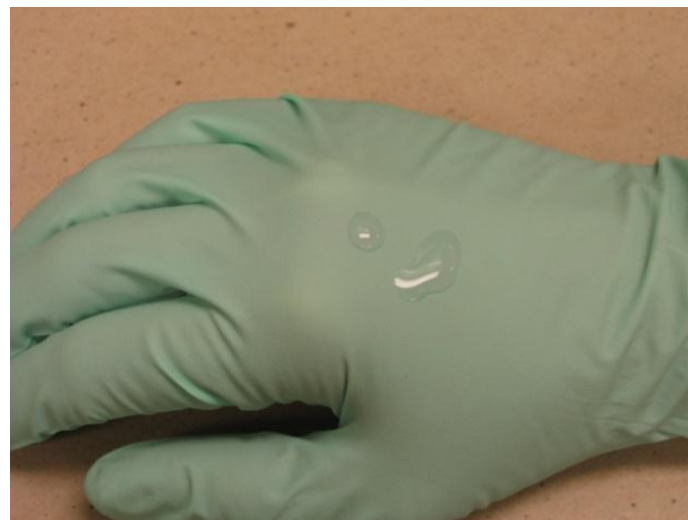


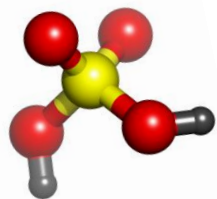
Images courtesy: P.W. Weigand, California State University Northridge Geology Department,  
Image source: Earth Science World Image Bank <http://www.earthscienceworld.org/images>



# Dartmouth College: Dimethylmercury poisoning

- ▶ Karen Wetterhahn, professor and founding director of Dartmouth's Toxic Metals Research Program
  - expert in the mechanisms of metal toxicity
- ▶ In 1996, spilled a few drops of dimethylmercury on her gloved hand
  - Cleaned up spill immediately
  - Latex glove believed protective
- ▶ Six months later, became ill and died of acute mercury poisoning at age 48



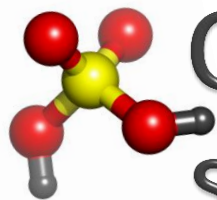


# Bhopal: Pesticide plant chemical release

- **December 1984: One of the worst chemical disasters in history,**
  - Union Carbide plant:
    - making Sevin
    - released ~40 tons of methyl isocyanate
    - release in middle of the night
  - Low local demand for pesticides meant the plant was only partially running
  - Some hardware was broken or turned off, including safety equipment
    - safety measures and equipment far below US standards
  - Plant in heavily populated area

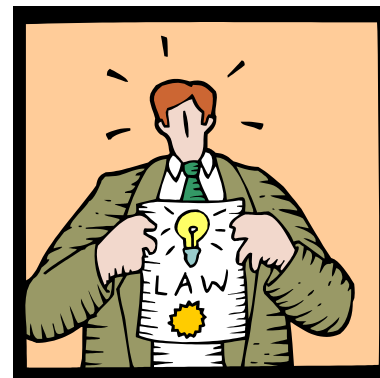


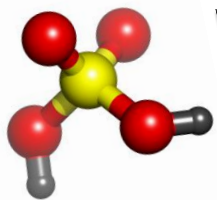
\* “The Bhopal disaster and its aftermath: a review”, Edward Broughton, *Environmental Health: A Global Access Science Source* 2005, 4:6, <http://www.ehjournal.net/content/4/1/6>, accessed 12/07



# Chemical accidents are under stricter control and scrutiny

- ▶ More individual country regulations
- ▶ More international regulations
  - IATA
  - GHS
  - REACH
- ▶ Environmental problems after natural disasters
  - Earthquakes, cyclones, hurricanes, floods
- ▶ Increased public awareness
- ▶ Increased media coverage
- ▶ Less public tolerance





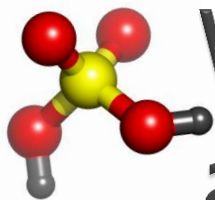
# Why worry about chemical safety?

- ▶ Health of the workers
- ▶ Safety of the workers
- ▶ Safety of the community
- ▶ Safety of the environment



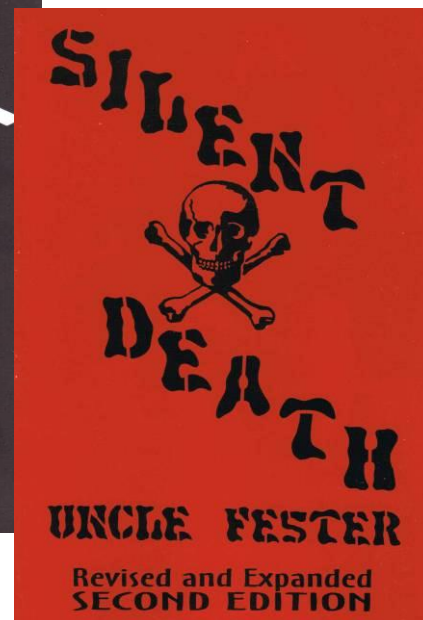
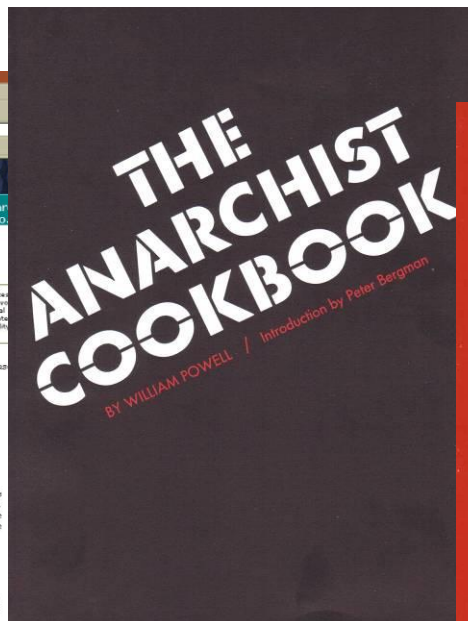
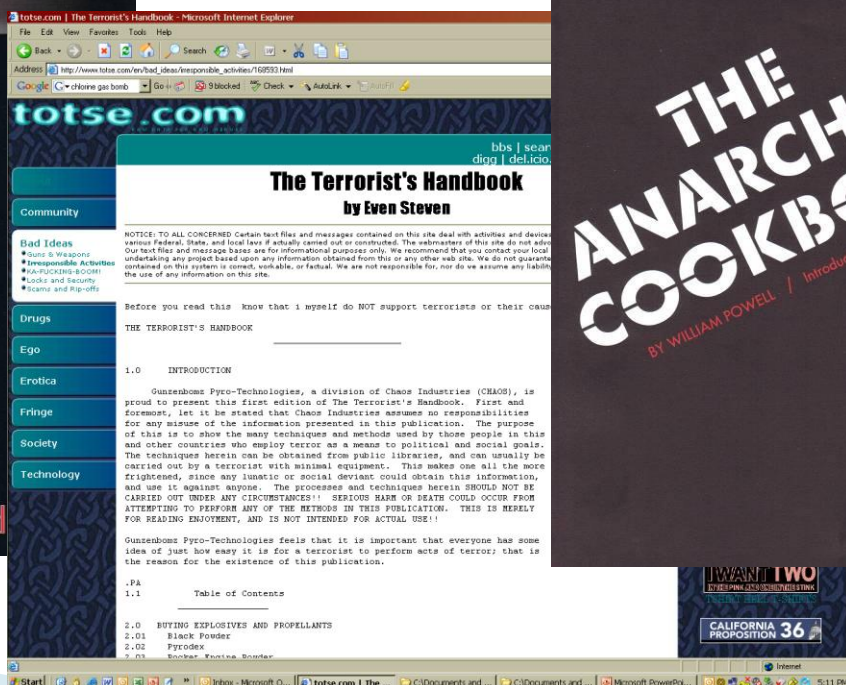
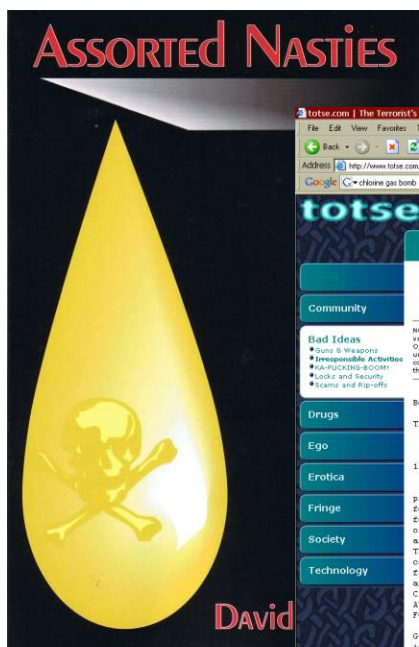
*...It's the right thing to do!*

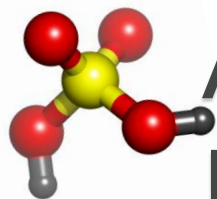




# Why worry about chemical security?

- History of people deliberately using chemicals to harm others.
- Information on how to acquire and deliver them is easy to get:

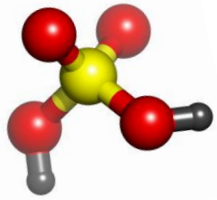




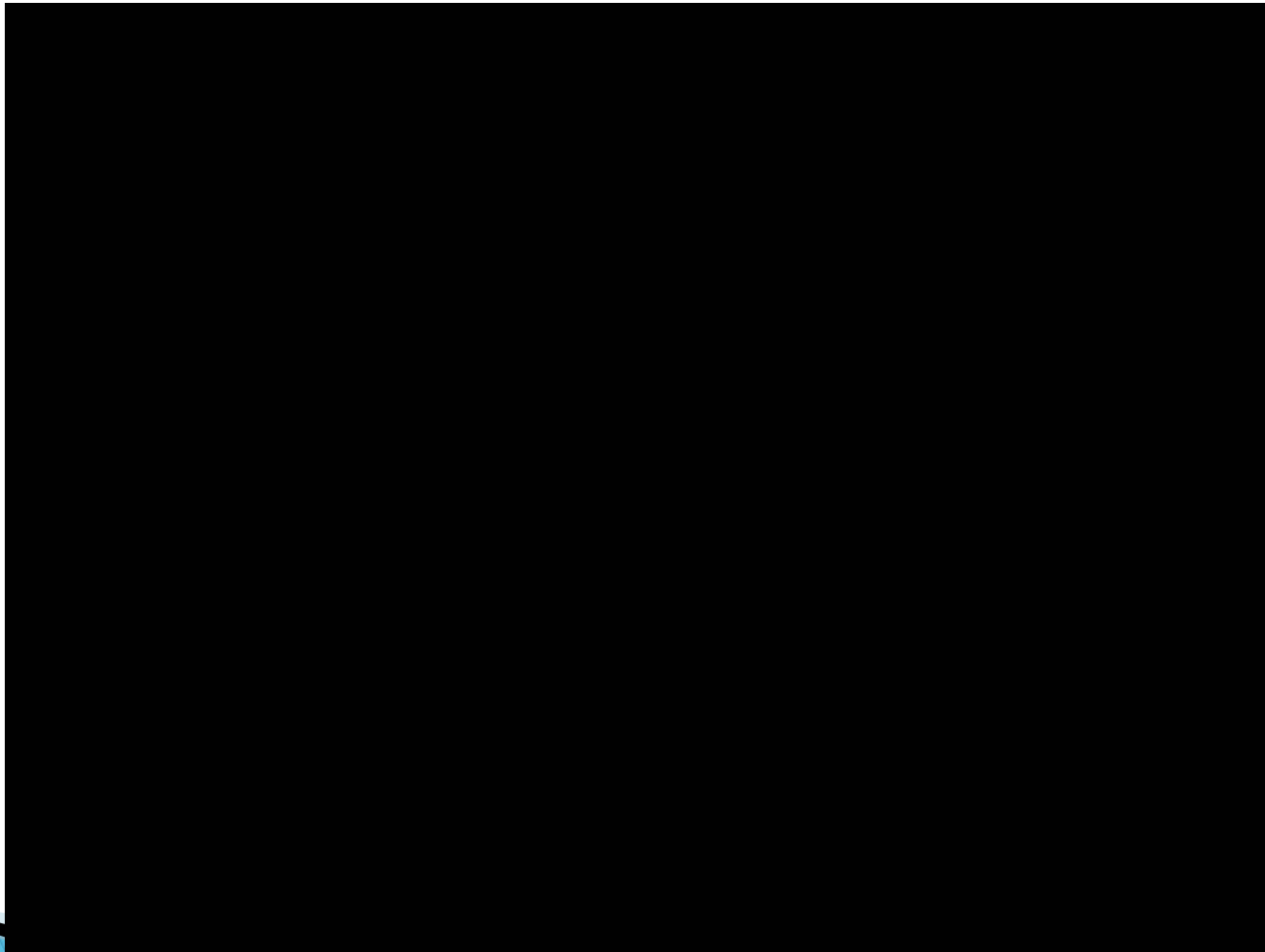
# Aum Shinrikyo: Matsumoto and Tokyo, Japan

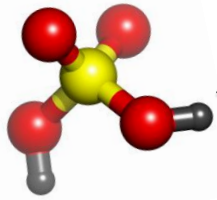
- **Sarin attack on Judges in Matsumoto, June 1994**
  - Sarin sprayed from truck at night
  - 7 deaths, 144 injuries
- **Sarin attack on Tokyo subway, March 1995**
  - 11 bags with 600 g each on 3 main subway lines
  - 12 deaths, 3938 injuries
- **Hydrogen cyanide attacks on Tokyo subway, May 1995**
  - Bags of NaCN and sulfuric acid
  - No deaths, 4 injuries





# Aum Shinrikyo: Tokyo, Japan

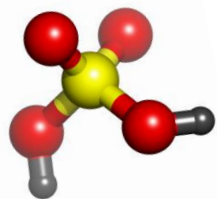




# Aum Shinrikyo: Matsumoto and Tokyo, Japan

- ▶ Recruited young scientists from top Japanese universities.
- ▶ Produced sarin, tabun, soman, VX.
- ▶ Purchased tons of chemicals through cult-owned companies.
- ▶ Motives: proof of religious prophecy, kill opponents, interfere with legal proceedings and police investigations.

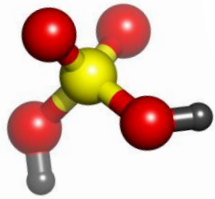




# Diversion of chemicals: Bali bombing

- ▶ Chemicals purchased to make bombs
- ▶ One ton of potassium chlorate purchased in three transactions from a fertilizer and industrial chemicals store.
  - Purchaser claimed to be a chemical salesman.
  - Obtained a false receipt saying he purchased sodium benzoate.
  - Store lacked proper permit, didn't know the chemical would be used to make a bomb.
- ▶ Details of Aluminum powder purchases not known.





# Terrorist groups recruit science/engineering students

Tuesday, August 10, 2010 Jakarta Globe

## Fighting Back: Roundup of 5 in Bandung exposes plan to target capital Aceh Anti-Terror Sweep Rolls on

Armando Slahaan

The arrest of five terror suspects in West Java at the weekend brought to 102 the number arrested in relation to the Aceh militant network and police are seeking more fugitives, including a French national.

Of those arrested, 66 are still in custody, while the others have been released. National Police spokesman Insp. Gen. Edward Arifanting said on Monday, adding that all would eventually be tried in Jakarta.

The suspected terrorists are linked to militant groups in the Middle East and the southern Philippines. Police allege they were training for formal-style assaults on key government and Western interest targets.

On Saturday, the Denzas 88 counterterrorist squad arrested five people believed to be from the Aceh group in four raids in West Java. The raids also unearthed a makeshift laboratory where police claimed the suspects were developing high-powered explosives.

In Cibin, Bandung, Denzas 88 arrested Fakrulloh, Sanjung, a.k.a. Bayu, and Hamzah, a.k.a. Helmi. In this raid they also seized a car they alleged was being prepared for a bomb attack and uncovered the bomb lab.

Police say the car was listed as belonging to a French national, who is at large.

"We're still looking for the person who bought this car and gave it to the group," Edward said. "He's a French national," he said to a Moroccan woman. Police were working with inspectors for more information on his background and known associates.

On the same day in Subang, West Java, Denzas 88 arrested a suspect identified as a top aide



A policeman showing a photo of one of the five terror suspects arrested in Bandung at the weekend. Police believe Kurnia Widodo is a bomb maker. JG Photo/Atmad Hiaral

received 34 members of 38 other militant groups and millions of chemical compounds.

In a raid in Bandung, including the squad arrested Kurnia Widodo, a recent university graduate who majored in chemical engineering. "We believe Kurnia Widodo was the technician at the bomb lab," Edward said.

The first arrest on Saturday was that of a cleric named Kili.

During this raid, Denzas 88 confiscated chemical compounds used to make explosives, books on jihad and sketches of targeted buildings.

Edward said the targets included the police Mobile Brigade headquarters in Depok, West Java, as well as the National Police headquarters, international hotels and embassies in Jakarta.

He said Saturday's raids were

made in anticipation of an attack on President Susilo Bambang Yudhoyono during his visit to the area over the weekend, but said there was no evidence the suspects were planning an attack.

Yudhoyono claimed on Saturday that a terrorist cell in Cusway, West Java, was planning to attack him. "I received a security report last night that several elements around intentions were lurking

in the Cusway area to do something against me," he said.

Edward said the president was one of the targets of the Aceh group.

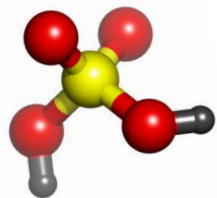
A flurry of arrests followed,

stretching from Aceh to Java Island.

Stacey Jones, from the International Crisis Group, said police were not fighting just one group, but a network of allied cells.

"What we see in Aceh was an

August 10, 2010  
...the squad arrested a recent university graduate in chemical engineering. "We believe [he] was the technician at the bomb lab," ...

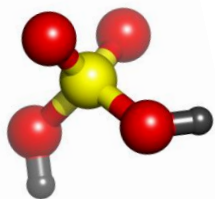


# Chicago, Illinois, USA

- ▶ March 2002, an anarchist was found at 2 am in a Univ. Illinois – Chicago, building carrying sodium cyanide
- ▶ He stored chemicals in a room at the Chicago subway, including:
  - 100g (0.25 lb) of potassium cyanide and 400 g (0.9 lb) of sodium cyanide
  - also mercuric sulfate, sodium cyanide, and potassium chlorate
  - stolen from an abandoned warehouse owned by a chemical company
    - 15 drums and 300 jars of other laboratory chemicals discovered there.
- ▶ Sentenced to prison for:
  - “possessing a chemical weapon”,
  - other civil disruption charges (Interfering with power, air-traffic control systems, computer systems, broadcast systems, setting fires).



<http://cns.miis.edu/db/wmdt/incidents/1190.htm>, accessed 12/07



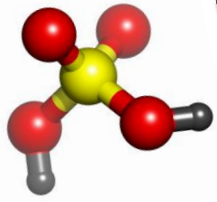
# Iraq



- Many incidents in which chlorine gas cylinders are blown up with explosives
  - chlorine probably stolen/diverted from water purification plants or oil industry
  - many civilians and non-combatants injured
- Chlorine first used as a chemical weapon in WWI.

On March 23, 2007, police in Ramadi's Jazeera district seized a truck filled with "five one-ton containers filled with chlorine and more than two tons of explosives"

From [http://www.longwarjournal.org/archives/2007/03/al\\_qaedas\\_chlorine\\_w.php](http://www.longwarjournal.org/archives/2007/03/al_qaedas_chlorine_w.php) - downloaded Jan 2008.



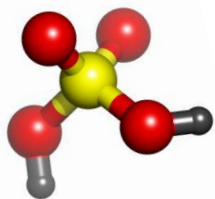
# Why worry about chemical security?

Safety AND Security

- ▶ Health and safety of people and environment
- ▶ Community relationships
- ▶ Reduce chance of release
- ▶ Avoid loss and damage to labs and equipment

Unique to Security

- ▶ Prevent criminals and terrorists from getting dangerous chemicals & information
  - Wide variety of chemicals have been used
  - Wide variety of motivations for actions
- ▶ A deliberate attack on a chemical facility could release a large amount of hazardous material
  - Injure or kill people in nearby areas
  - Eliminate jobs and economic assets



# Safety and Security Issues are similar

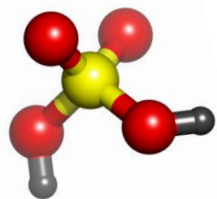
## Variables

- ▶ Many different chemicals with:
  - different properties
  - different hazard
  - different applications
- ▶ Many different ways to misuse chemicals
  - chemical weapons
  - poisons, toxins
  - reaction/explosion

## Protect

- ▶ Workers
- ▶ Facility
- ▶ Community
- ▶ Environment

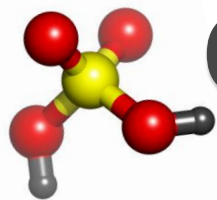




# Government regulations: Chemical security

- Differ from country to country
- Legislation needed to fulfill requirements under the Chemical Weapons Convention
  - Each country passes appropriate laws
  - Each country must declare and track certain chemicals
- UN Resolution 1540
- Other export control legislation





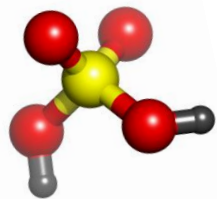
# Chemical Security Questions:

How does your country **regulate** and **control** chemical safety and security?

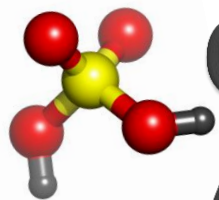
...Is it effective?

...Could it be improved?

...How?



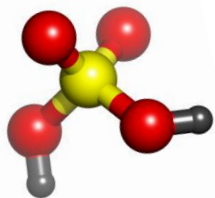
# Aspects of Chemical Security: Dual-use Chemicals



# Chemical Dual-use Awareness

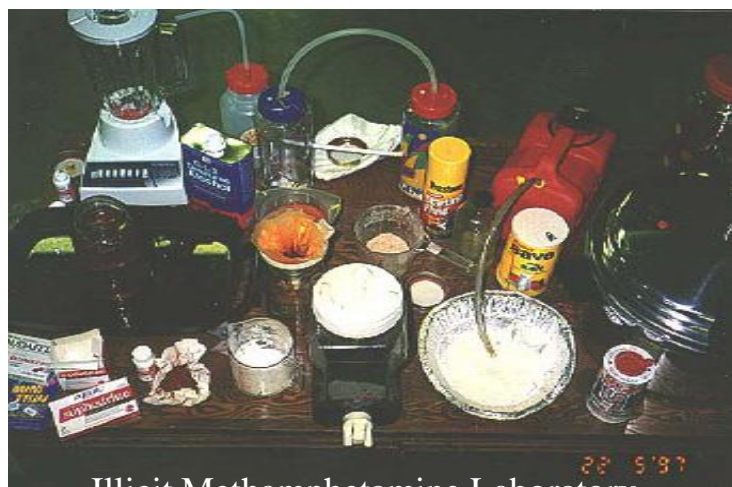
Dual use chemicals: Chemicals used in industry or everyday life that can also be used in bad ways.





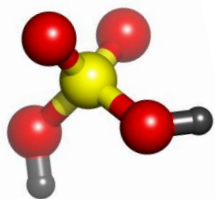
# Dual-use chemical example: Pseudoephedrine

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



Illicit Methamphetamine Laboratory

- Clandestine meth labs in US, 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



# Dual-use chemical example: Cyanide

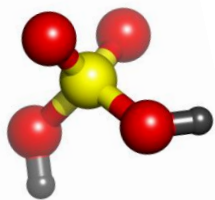


Therence Koh/AFP/Getty Images



- ▶ Widely used in mining and metal plating industries, but is also a well known poison.
- ▶ Product tampering\*
  - Tylenol capsules
    - laced with KCN
    - 7 deaths, fall 1982, Chicago, Illinois, USA
    - Led to tamper-proof product packaging
- ▶ Popular with criminals and terrorists because it is relatively easy to obtain
- ▶ HCN is CW agent AC

\* "Tylenol Crisis of 1982." *Wikipedia, The Free Encyclopedia*. 22 Nov 2007, 06:04 UTC. Wikimedia Foundation, Inc. 28 Nov 2007 <[http://en.wikipedia.org/w/index.php?title=Tylenol\\_Crisis\\_of\\_1982&oldid=173056508](http://en.wikipedia.org/w/index.php?title=Tylenol_Crisis_of_1982&oldid=173056508)>.



# Dual-use chemical example: Pesticides

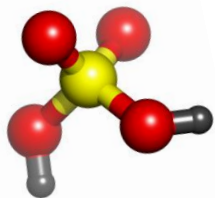
- **Widely used in homes and agriculture, but also used to poison people.**

FIGURE. Package of Chinese rodenticide implicated in the poisoning of a female infant aged 15 months — New York City, 2002



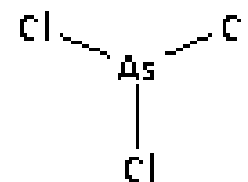
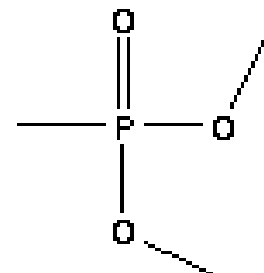
Photo/New York City Poison Control Center

- ▶ **Dushuqiang (Strong Rat Poison)**
  - Outlawed in China in the mid-1980s, but was still available
  - Nanjing, Sept. 2002
    - 38 people killed by poison in snack-shop food, >300 sick
    - Jealousy by rival shop owner
  - Hunan, Sept. 2003
    - 241 people poisoned by cakes served in school cafeteria
    - Motive and perpetrator unknown
  - Tongchuan City, Shaanxi, April 2004
    - 74 poisoned by scallion pancakes
    - Motive and perpetrator unknown
  - 5 other incidents reported between 1991 and 2004

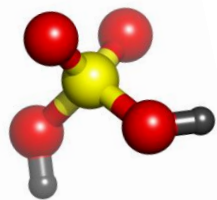


# Many lab/industrial chemicals have dual uses

- ▶ **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-arthritic 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 precursor



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

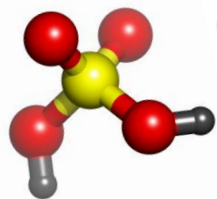


# Theft / manufacture of explosives: Fertilizer Bomb



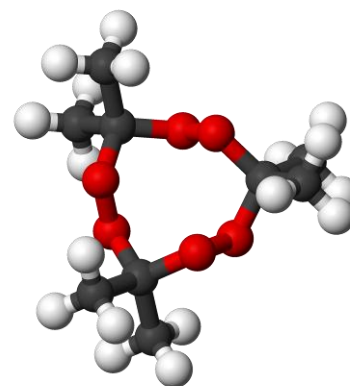
Photo: US DOD

- ▶ Ammonium nitrate fertilizer and fuel oil (diesel, kerosene)
- ▶ Used to bomb Alfred P. Murrah building in Oklahoma City, OK, USA
  - with nitromethane and commercial explosives
  - 168 dead, including children
  - April 1995
- ▶ Favored by IRA, FARC, ETA, etc.



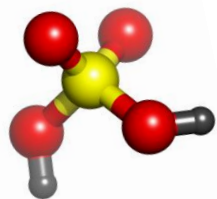
# Theft / manufacture of explosives: TATP

- ▶ Triacetone triperoxide (TATP)
- ▶ Invisible to detectors looking for N-based explosives
- ▶ Made using acetone, hydrogen peroxide, strong acid (HCl, sulfuric)
- ▶ Favored by terrorists “Mother of Satan”
  - 1997–New York subway suicide bomb plot
  - 2001–Richard Reid “shoe bomber”
  - 2005–London suicide bombs
  - 2009 – Arrest of N. Zazi, NY and Denver



CAS: 17088-37-8

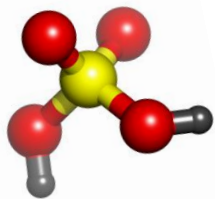
Wikipedia downloaded Oct 2009  
[http://en.wikipedia.org/wiki/Acetone\\_peroxide](http://en.wikipedia.org/wiki/Acetone_peroxide)



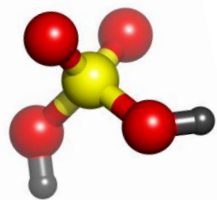
# Diversion of chemicals: Sodium azide



- ▶ Widely available from older automobile airbags
  - 1980s to 1990s
- ▶ Poisonous
- ▶ Reacts explosively with metals
  - Biological laboratory drains have exploded from discarded waste solutions containing  $\text{NaN}_3$  as a preservative.
- ▶ Has been found in possession of terrorists



# International Chemical Controls



# International Chemical Control Groups



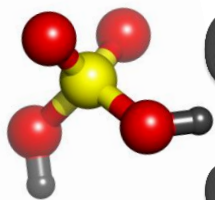
ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

**Chemical weapons convention**

**The Australia Group**

**Export controls**

**UN Security Council Resolution 1540**

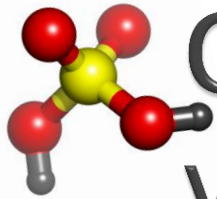


# CWC: Prevent spread of chemical weapons



- ▶ States declare and agree to inspections of many other chemical facilities, depending on chemical type and amount produced
- ▶ As of April 2012, over 4,680 inspections have taken place at 195 chemical weapon-related and over 1,100 industrial sites on the territory of 81 States Parties
- ▶ Worldwide, >4,900 industrial facilities are liable to inspection



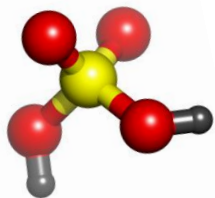


# CWC: Chemicals subject to verification measures



- ▶ **Schedule 1:**
  - Known CW agents
  - Highly toxic, closely related chemicals, or CWA precursors
  - Has little or no peaceful application
- ▶ **Schedule 2:**
  - Toxic enough to be used as a CWA
  - Precursor to or important for making a Schedule 1 chemical
  - Not made in large commercial quantities for peaceful purposes
- ▶ **Schedule 3:**
  - Has been used as a CWA
  - Precursor to, or important for making a Schedule 1 or 2 chemical
  - Is made in large commercial quantities for peaceful purposes
- ▶ **Unscheduled Discrete Organic Chemicals (UDOC)**
- ▶ Lists of scheduled chemicals are on workshop CD.





# CWC:

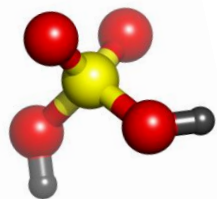


## Reporting Requirements

- ▶ Use/transfer of these chemicals is allowed for research, medical, or pharmaceutical purposes.
- ▶ Reporting requirements depend on facility type, chemical types and amounts.
  - “**Other Facility**” type, as defined in CWC, most relevant
  - *Amounts of chemicals* required for your National Authority to approve the work and report your **institution** annually to the OPCW:
    - Schedule 1: 100 g aggregate
    - Schedule 2: 1 kg for 2A\*, 100 kg for other 2A, 1 Tonne of 2B
    - Schedule 3: 30 Tonnes
    - UDOC: 30 or 200 Tonnes (lower number if contains P, S, or F)

**Caution!!**

**Your country might require reporting of lower amounts!**

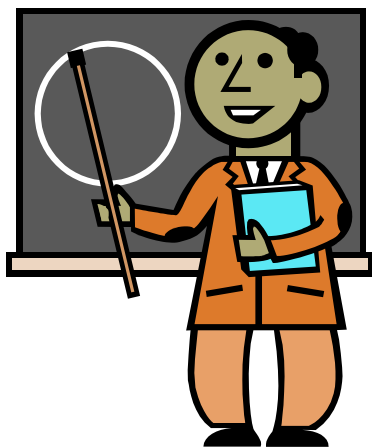


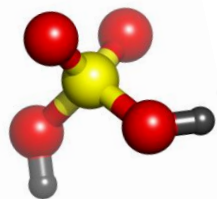
# OPCW:

## Protecting each other



- ▶ 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

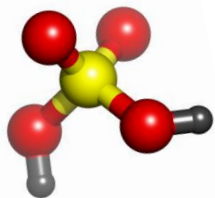




# Australia Group

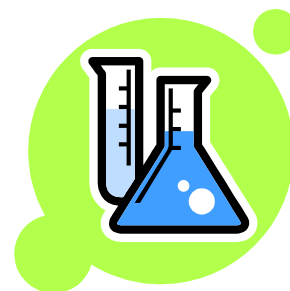
- ▶ An informal arrangement to minimize the risk of assisting chemical and biological weapon (CBW) proliferation.
  - Harmonizing participating countries' national export licensing measures
  - Started in 1985 when Iraq CW program was found to have diverted chemicals and equipment from legitimate trade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

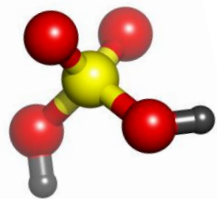
## The Australia Group



# Australia Group: Export Controls

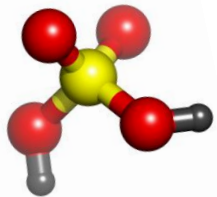
- ▶ Controls exports of:
  - 63+ Chemical weapon agent precursor chemicals
  - Dual-use chemical manufacturing facilities and equipment and related technology
  - Dual-use biological equipment and related technology
  - Biological agents
  - Plant pathogens
  - Animal pathogens
- ▶ Includes no-undercut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



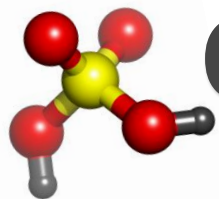


# UN Security Council Resolution 1540

- ▶ Unanimously passed on 28 April 2004
- ▶ UN Member States:
  - must refrain from supporting **non-State** actors in developing, acquiring, manufacturing, possessing, transporting, transferring or using nuclear, chemical or biological weapons and their delivery systems.
  - must establish domestic controls to prevent the proliferation of nuclear, chemical and biological weapons, and their means of delivery, including by establishing appropriate controls over related materials.
- ▶ Enhanced international cooperation is encouraged, promoting universal adherence to existing international non-proliferation treaties.



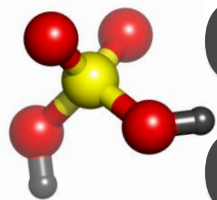
# Components of Chemical Security



# Chemical Security Questions

- Is your facility secure?
- How easy would it be for someone to steal chemicals?
- Are the chemistry workrooms, stockrooms, classrooms and labs always locked and secure?
- Is someone always there when these rooms are open?
- Do you check your orders when chemicals arrive to be sure some chemicals are not missing?



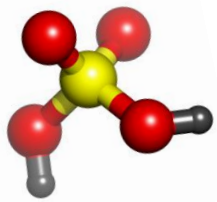


# Components of Chemical Security

- Physical security of site
- Personnel management
- Information security
- Management of chemical security activities
- Allocation of chemical security responsibilities
- Development of emergency plans
- Chemical security training



**Goal: Ensure that you don't accidentally help a criminal or a terrorist get dangerous chemicals**



# Chemical Security: Physical Site

**LOCK UP!!**

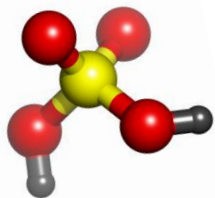


**Controlled drugs**

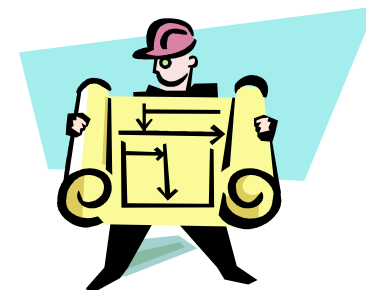
**Chemical Surety Agents**

**Highly toxic chemicals**



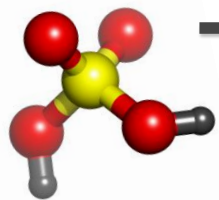


# Facility Characterization



Characterize the facility in terms of:

- Site boundary
- Buildings (construction and HVAC systems)
- Room locations
- Access points
- Processes within the facility
- Existing Protection Systems
- Operating conditions (working hours, off-hours, potential emergencies)
- Safety considerations
- Types and numbers of employees
- Legal and regulatory issues

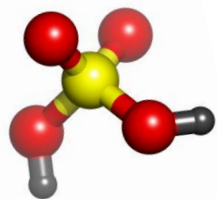


# Threat Definition

## Threat classes:

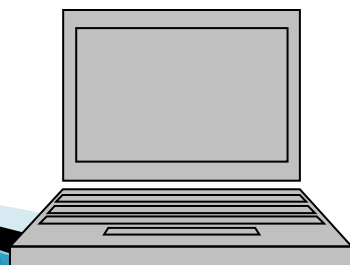
- Outsiders—no authorized access
- Insiders—authorized access
- Collusion—between Outsiders and Insiders

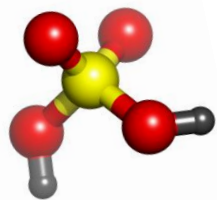




# Target Identification

- Determine the possible targets for the following actions:
  - Sabotage
    - identify vital areas to protect
  - Theft of chemicals
  - Theft of information
    - identify location of materials to protect

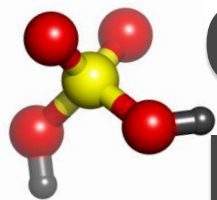




# Chemical Security: Personnel Management

- Guard against both *Insider and Outsider* threat
- Who checks people entering the building?
- Who has keys? How do they get authorized?
  - Building
  - Stockroom
  - Individual Labs
- When someone leaves, do you make sure they turn in keys?
  - Don't want people making duplicate keys

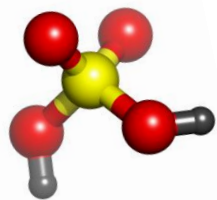




# Chemical Security: Information Security

- How do you track chemical inventory?
  - Is the information secured so unauthorized people can't read it or alter it?
- Would you know if:
  - some toxic chemicals disappeared overnight?
  - some toxic chemicals didn't arrive?
  - someone was ordered chemicals in the name of your institution but diverted them?

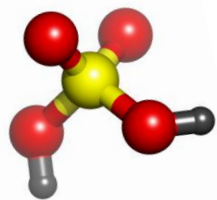




# Chemical Security: Assign Responsibilities

- Identify people responsible for various chemical security activities:
  - physical security, building modifications
  - chemical tracking and reporting
  - personnel and access management
  - information management
  - emergency planning
- Ensure they have the time and resources to do the job.
- Integrate with chemical safety responsibilities.



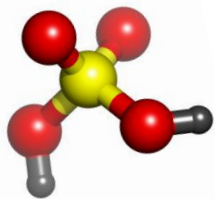


# Chemical Security: Professional Behavior

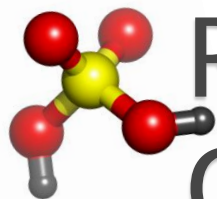
- **Chemical professionals**
- use their scientific knowledge in a responsible manner.



- **Chemical Educators**
- need to train their students to use their scientific knowledge in a responsible manner.



# Relationships between Chemical Security and Chemical Safety

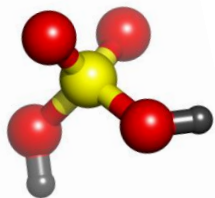


# Relationships Between Chemical Safety and Security

- Chemical safety:
  - Protection against *accidents*
- Chemical security:
  - Protection against *deliberate* harm

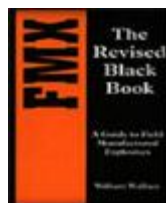
Many practices are the same for chemical safety and security, but there are a few areas of conflict.





# Chemicals are Ubiquitous

- ▶ Universities and Industry need to protect chemicals – without economic consequences



## A Field Guide To Manufactured Explosives



Moscow: Ricin recipe found on Chechen fighter

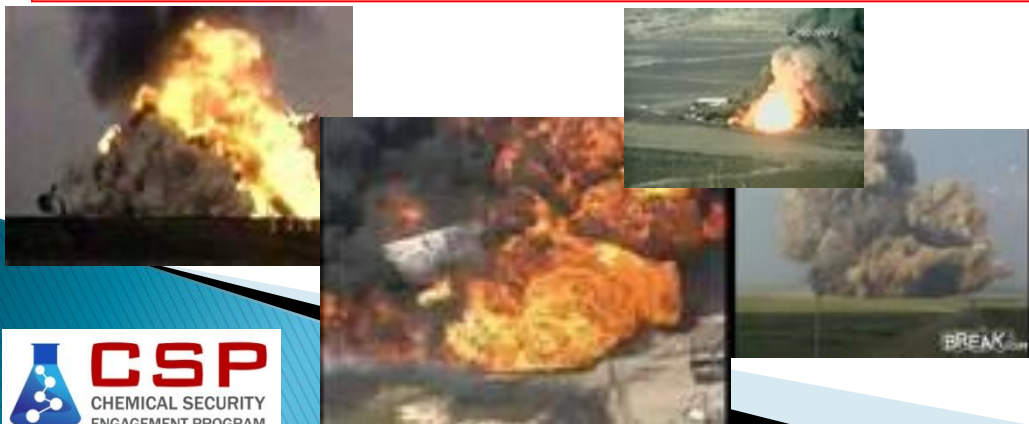
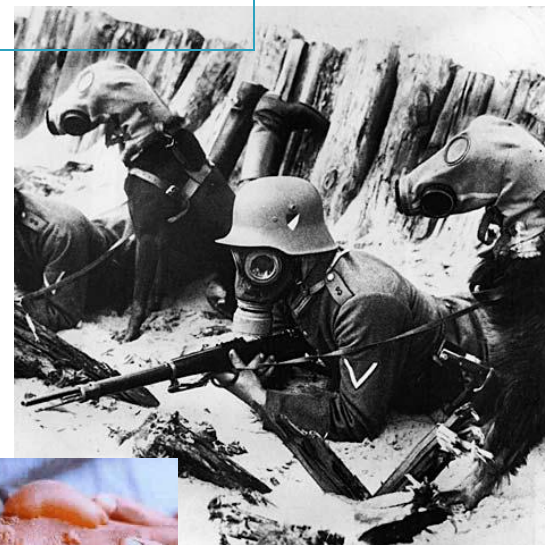
CNN, January 13, 2003

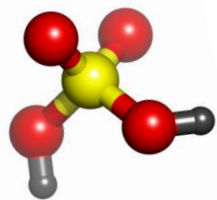


**Al Jazeera.net: Al-Qaeda 'planned poison plot'**

Doha 06 Dec 10

Al-Qaeda members planned to kill Saudi Arabian government and security officials, as well as media workers, by sending poisoned gifts to their offices,

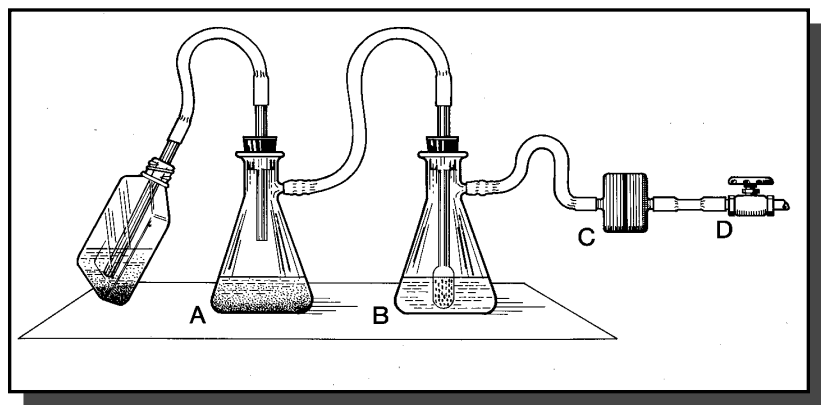




# Chemical Safety & Security

## Basic Principles

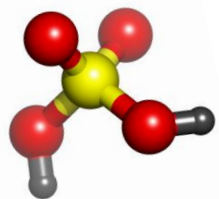
Are all agents dangerous?



or



Is it their *improper* use that makes them dangerous?

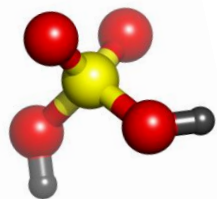


# Principles of Security

For effective and appropriate security, general security principles should be followed:

- Detect
- Delay
- Respond

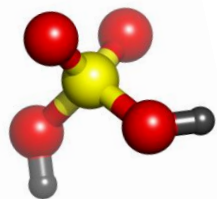




# Good Practices for Both Chemical Safety and Security

- **Minimize use of hazardous chemicals.**
  - Replace with less-hazardous chemicals, if possible.
  - Reduce scale of experiments.
- **Minimize supply of hazardous chemicals.**
- **Restrict access to hazardous chemicals.**
  - Know what you have.
  - Know how to store, handle and dispose of what you have.
  - Know who has access to materials, knowledge and expertise.
- **Plan what to do in an emergency.**





# Principles of Green Chemistry: Chemical Safety and Security

## ▶ Prevention

Better to prevent waste than to treat or clean up waste after it is created.

## ▶ Safer Solvents and Auxiliaries

Use of auxiliary substances (e.g., solvents, separation agents, etc.) should be eliminated when possible, and made safe when used.

## ▶ Inherently Safer Chemistry for Accident Prevention

Choose substances for a chemical process to minimize the potential for chemical accidents, (releases, explosions, fires, etc).

## ▶ Reduce Derivatives

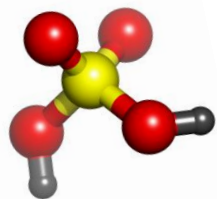
Derivatization (use of blocking groups, protection/ deprotection, temporary modification of physical/chemical processes) should be minimized/avoided; such steps require additional reagents and can generate waste.

## ▶ Design for Degradation

Chemical products should be designed to break down into innocuous material at the end of their function, and do not persist in the environment.

## ▶ Real-time analysis for Pollution Prevention

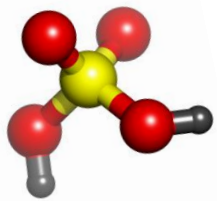
Develop analytical methods for real-time, in-process monitoring and control to prevent formation of hazardous substances.



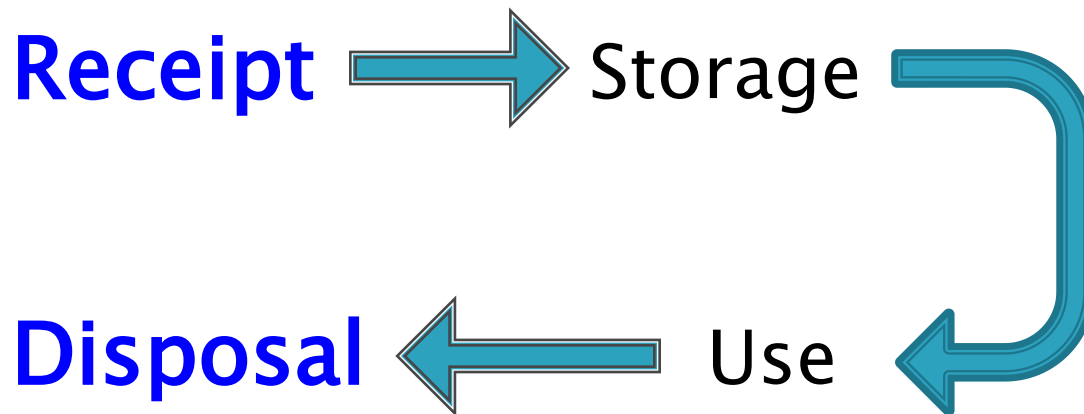
# Chemical Management

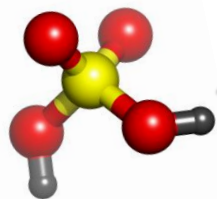
- ▶ **Key to Chemical Safety and Security**
- ▶ Institute a Chemical Management Program
  - Form a Safety team
    - Develop a safety manual
    - Have periodic safety training
    - Have safety inspections
    - Investigate serious incidents
    - Follow-up!
  - Form Chemical Management Team
    - Manage access
    - Manage chemical wastes
    - Recycle chemicals when possible
    - Develop *and USE* a Chemical Inventory System





# Cradle-to-grave care of chemicals





# Conflicts between Chemical Safety and Security

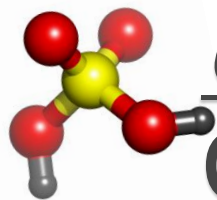
Science generally means **sharing information widely**,  
but this may not always be advisable.

## • Safety

- label everything so people recognize hazardous chemicals,
- let community and especially emergency responders know what chemical dangers exist,
- share knowledge about chemical hazards so people know to be alert.

## • Security

- labels help identify targets for theft or attack,
- sharing locations of chemicals can publicize targets for theft or attack,
- sharing knowledge of chemical hazards could inspire harmful behavior (copy-cat criminals).

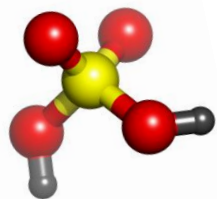


# Conflicts between Chemical Safety and Security

Locking exit doors is  
secure, but not safe.

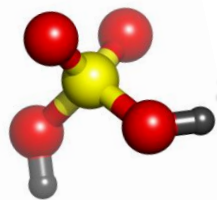
- For **safety**, people need to be able to leave the facility quickly and by many routes.
- For **security**, you want to control exits as well as entrances so chemicals (or equipment) are not taken.





# Setting Priorities

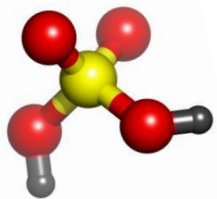
- **Labs need to be safe, secure and productive.**
  - policies and practices need to be flexible enough to allow for the uncertainties of research.
  - policies and practices need to align with local laws, regulations, practices and culture. Can't just copy from somewhere else.
- **Use risk-based security and safety measures.**
  - can't afford to defend against every imaginable hazard.
  - identify threats, characterize facilities, identify alternatives, analyze costs vs. performance.
- **Be alert for suspicious activities or inquiries.**



# All Chemical Facilities Need to be Secured

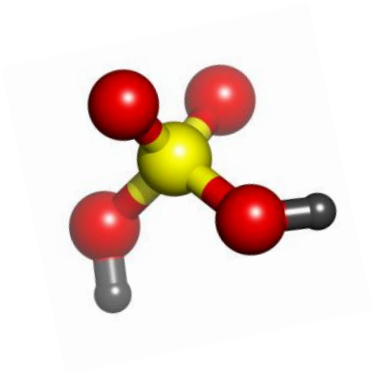


- **Small-scale research laboratories**
  - Many different chemicals used in small amounts.
- **Large-scale manufacturing plants**
  - Limited types of chemicals used in large amounts.
- **Security measures need to match facility and threat**
  - Can't afford to defend against all imaginable threat.

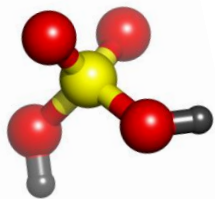


# Questions? Open Discussion

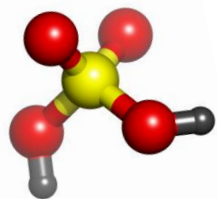




# Break

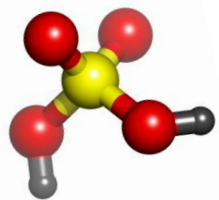


# Principles of High Security Systems

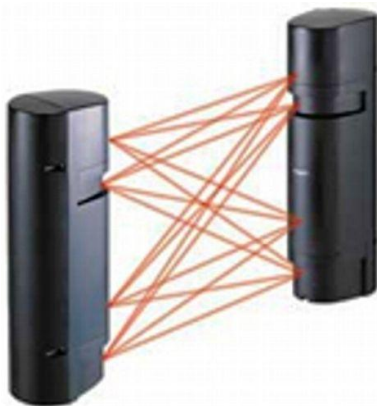


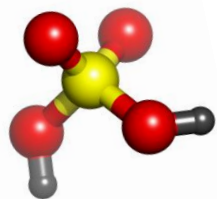
# Objectives

- ▶ Review Definition and Objective of Security
- ▶ Describe four Principles of Security
- ▶ Tell the importance of Performance-Based Security
- ▶ Provide a Model for a Systematic Approach to Security



# What is security?

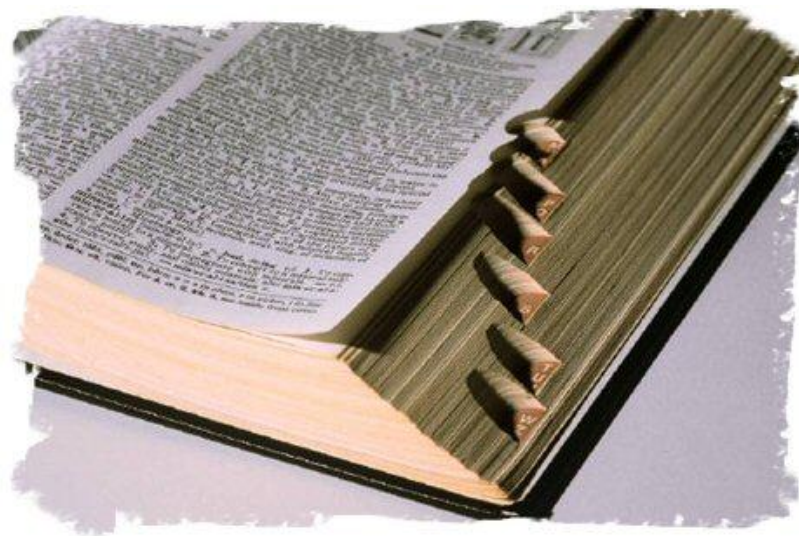


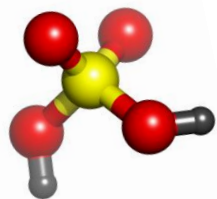


# Security Definition

Security is:

a combination of *technical* and *administrative* controls to deter, detect, delay, and respond to an *intentional, malevolent* event.

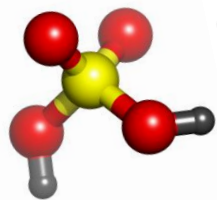




# Security Objective

- ▶ Security intends to prevent *intentional acts* which could result in unacceptable consequences
  - Death/Severe Injury
  - Chemical contamination
    - People
    - Environment
  - Political Instability
  - Economic Loss
  - Industrial capacity loss
  - Negative public psychology, fear, lack confidence
  - Adverse media coverage, Reputation

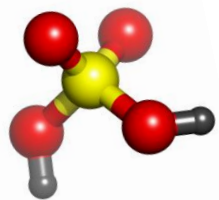




# What chemical facilities need security?

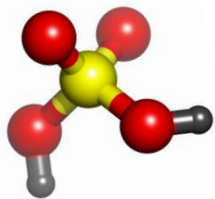


- ▶ Potential consequence severity determines which facilities need to be secured
  - Small-scale research laboratories
    - Many different chemicals used in small amounts
  - Large-scale manufacturing plants
    - Limited types of chemicals used in large amounts



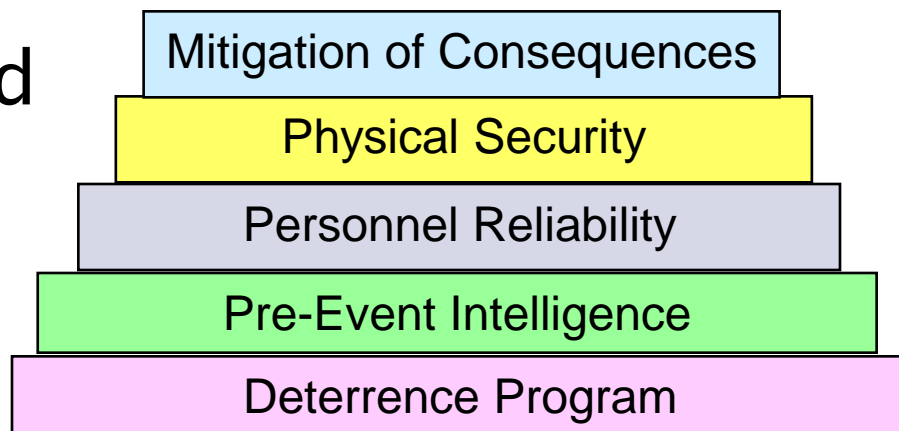
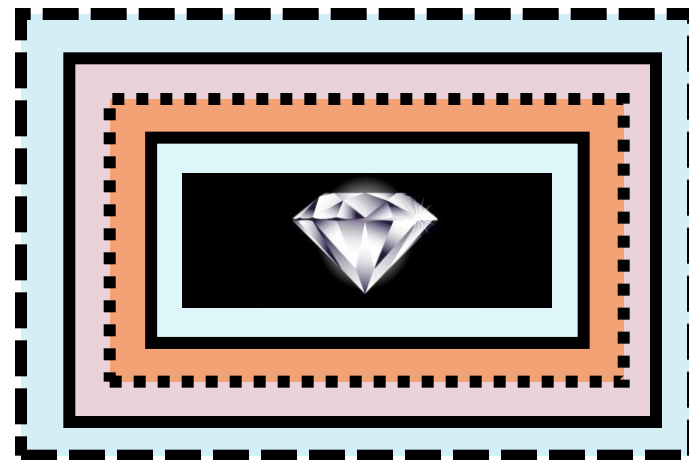
# Principles of Physical Security

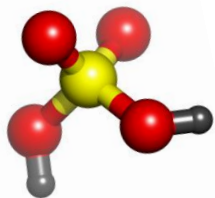
- ▶ General Principles to help ensure effective, appropriate security
  1. Defense in Depth
  2. Balanced Security
  3. Integrated Security
  4. Managed Risk
    - Graded Security



# Principle 1: Defense in Depth

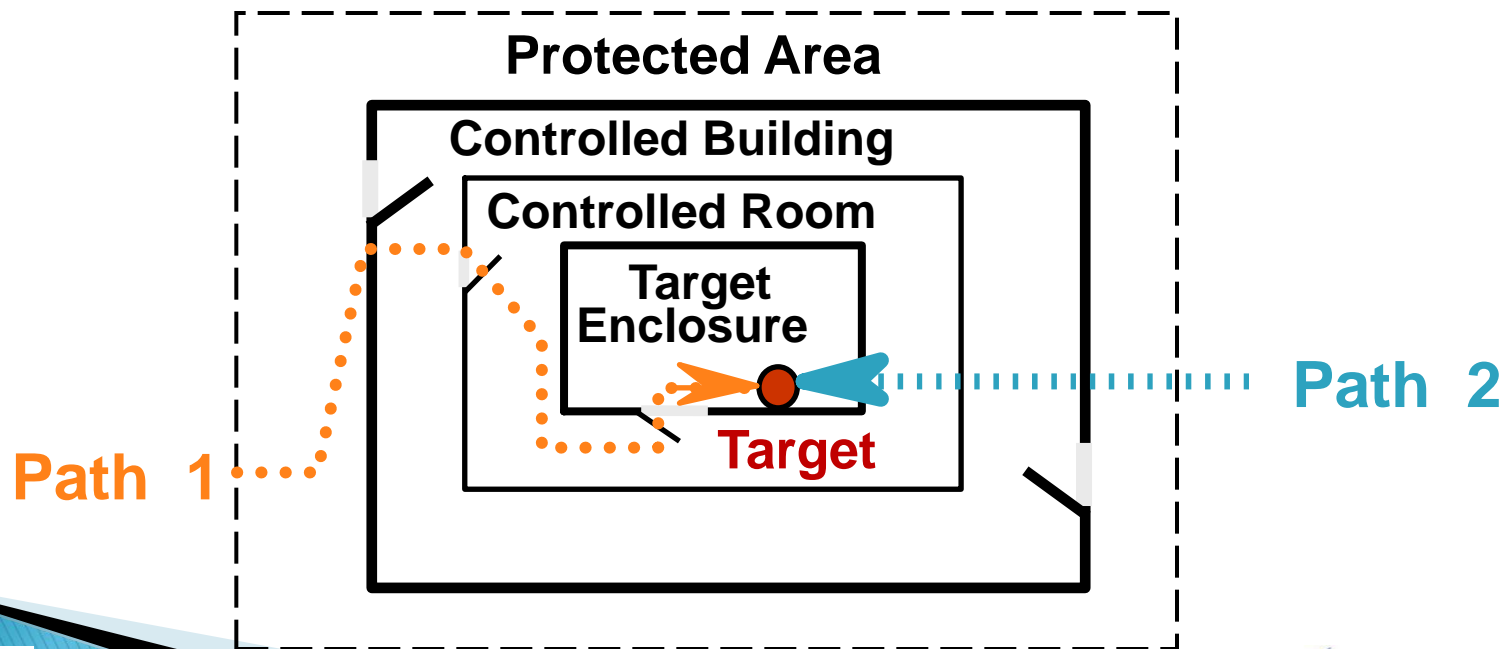
- ▶ Layers, redundancy:
  - Physical
  - Administrative and Programmatic

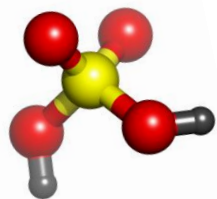




# Principle 2: Balanced Protection

- ▶ Physical Layers
- ▶ Adversary Scenarios
  - adversary paths (physical)

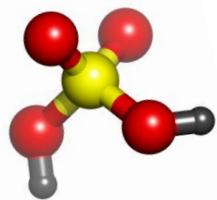




# Balanced Protection

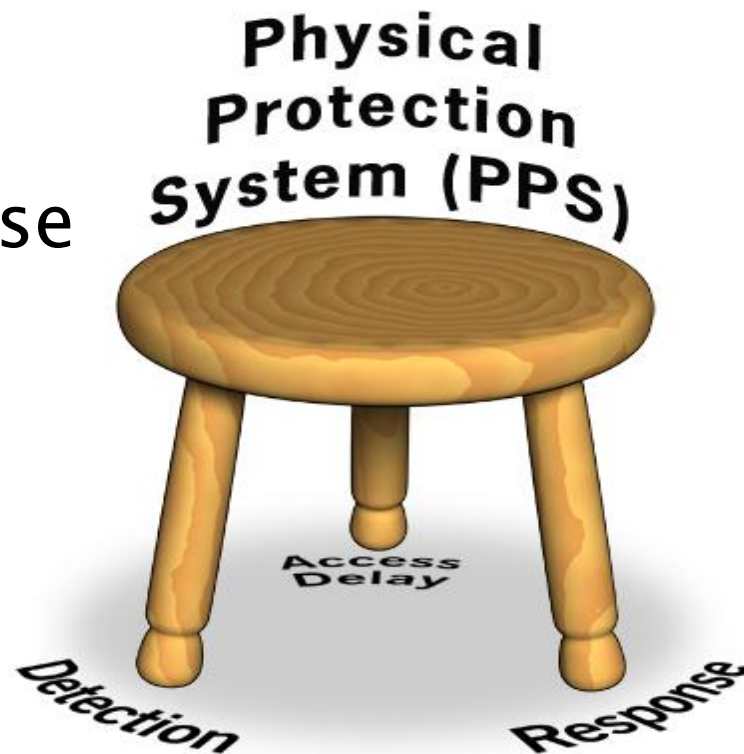
- ▶ Each Path consists of many protection elements
  - barriers, sensors, cameras, access control, etc.
- ▶ Protection elements possess delay and detection components
  - a hypothetical scenario could be:
    - a fence could delay adversaries *20* seconds, and provides 50% likelihood that adversary is detected
    - a wall could delay adversary 120 seconds and provides a 10% likelihood of detection
    - a guard could delay adversary 20 seconds and provides a 30% likelihood of detection
- ▶ Balanced protection objective:
  - cumulative detection and delay encountered along any/all paths will be the similar
  - NO WEAK PATH

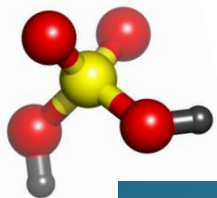




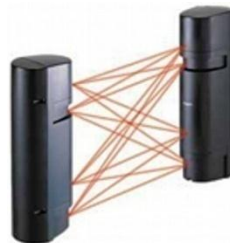
# Principle 3: System Integration

- ▶ System approach:
  - Detection alerts Response
  - Access Delay slows adversary to allow Response
  - Response prevents consequence

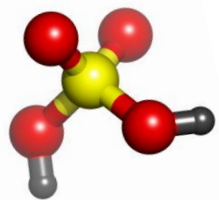




# Integrated Security



- ▶ Contribution of each component to the security system can be reduced to:
  - Detection of adversary or malevolent event
  - Delay of adversary
  - Response to adversary
- ▶ Integrated security evaluates composite contribution of all components to the three elements
  - that overall detection is sufficient and *precedes delay*
  - that adversary delay time *exceeds* expected response time
  - that response capability is greater than expected adversary



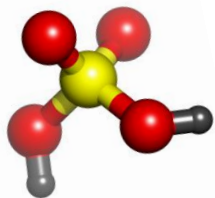
# Principle 4: Managed Risk

- ▶ How much Security is enough??

Cost of  
Security

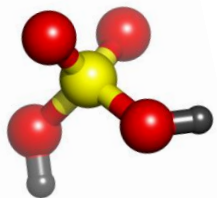


Benefit of  
Security

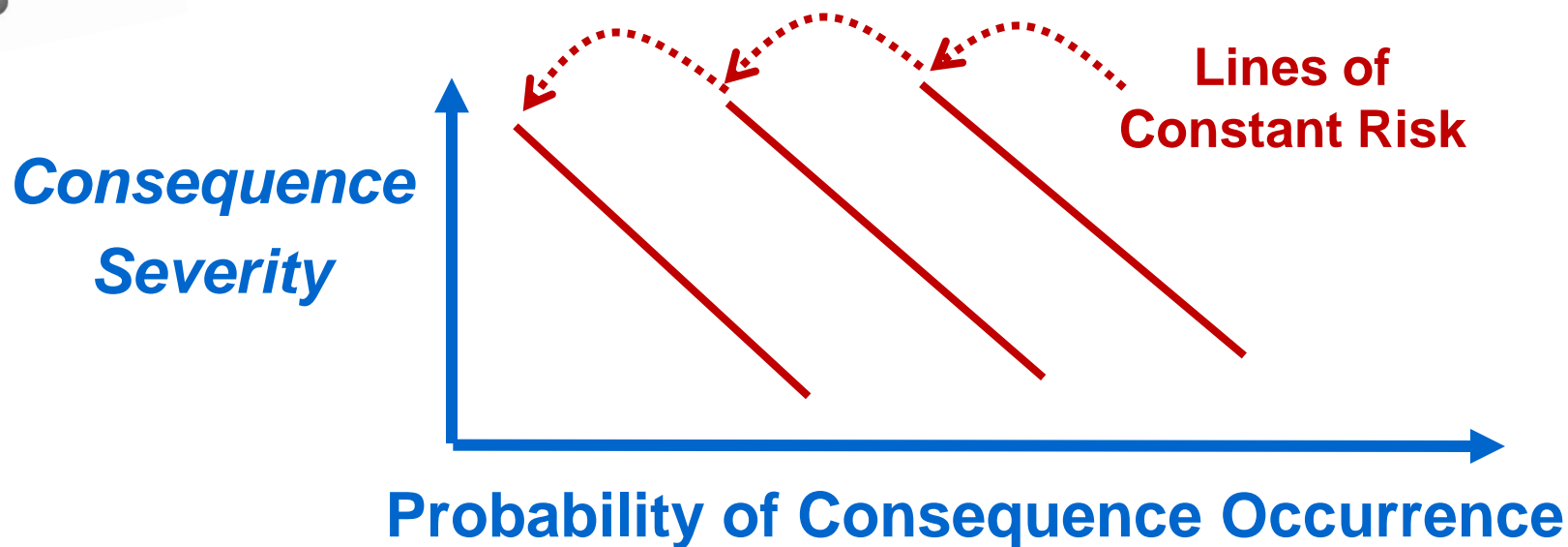


# Managed Risk

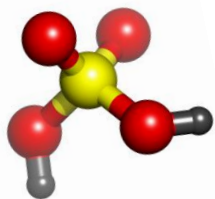
- ▶ Benefit of Security is **Reduced Risk**
- ▶ What is Risk?
  - Risk = Consequence **Severity**  
×  
Probability of Consequence **Occurrence**
- ▶ What is **Security Risk**?
  - Probability of Consequence **Occurrence** =  
Probability of **attempted** event  
×  
Probability of **successful** attempt
  - Probability of successful attempt is:  
One – Probability of security system effectiveness



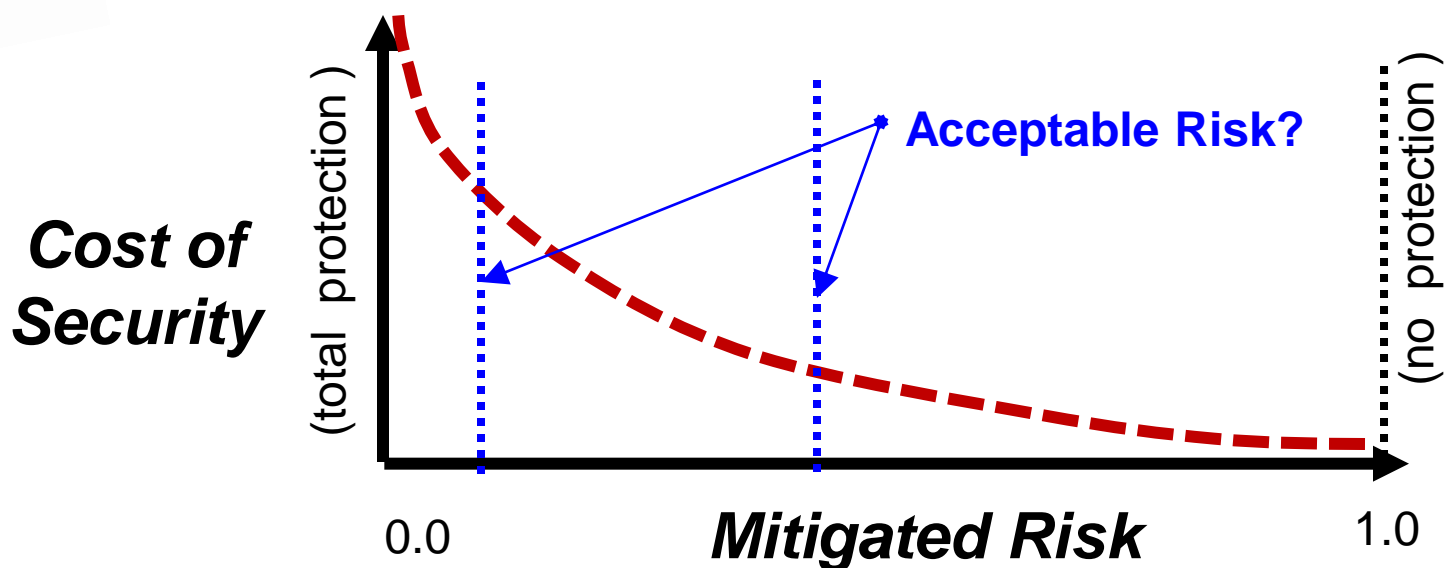
# Managed Risk



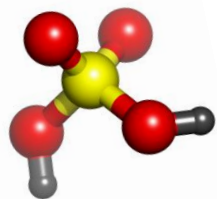
- ▶ To reduce risk, increase security
- ▶ To manage risks (keep risks constantly low), apply more security for higher severity consequence
  - This is called the **Graded Approach** to security



# Managed Risk



- ▶ The benefit (risk reduction) increases with increased security investment (cost)
- ▶ There is a point where the increased benefit does not justify the increased cost
- ▶ What is the level of Acceptable Risk?



# Managed Risk

- How much Security is enough??

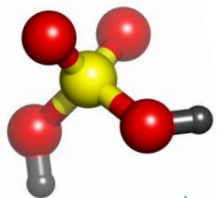
**Security Decision is  
based on Managed Risk**

Cost of  
Security



Level of  
Acceptable  
Risk

Provides sufficient **confidence** that  
materials are **appropriately** protected



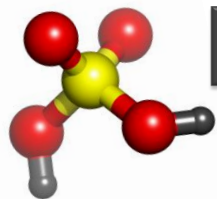
# Performance-Based Security

- ▶ Requirements driven
- ▶ Engineering principles used for security
  - what are **requirements** for system?
  - what are **constraints** of system?



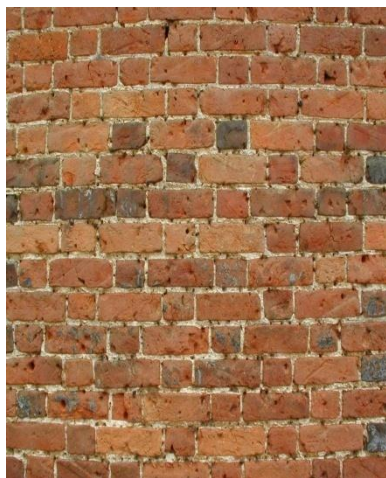
Tacoma Narrows Bridge Collapse:

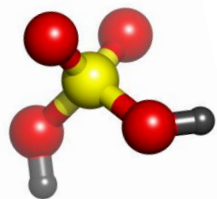
credit: <http://www.enm.bris.ac.uk/research/nonlinear/tacoma/tac06.gif>



# Requirements-driven Security

- ▶ Design Constraints
  - Understand Operational Conditions
- ▶ Design Requirements
  - Consequences to be prevented
    - Identify Targets to be protected
  - Define Threats against which targets will be protected

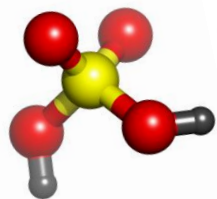




# Operational Conditions

- ▶ Characterize the facility considering:
  - Mission
  - Operations
  - Budget
  - Safety
  - Legal Issues
  - Regulatory Issues

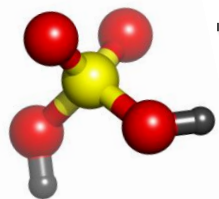




# Target Identification

- What are the *un*acceptable consequences to be prevented?
  - Death/severe Injury
  - Chemical contamination
    - people
    - environment
  - Political Instability
  - Economic Loss
  - Industrial capacity loss
  - Negative public psychological effect
  - Adverse media coverage

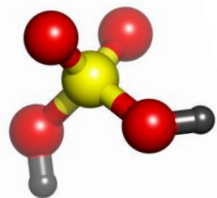




# Target Identification

- What are possible **sources** of **un**acceptable consequences?
  - **Dispersal**
    - Identify areas to protect
  - **Theft**
    - Identify material to protect



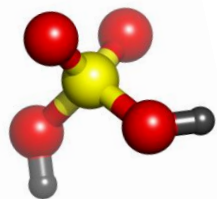


# Define the Threats

- The Art of War, Sun Tse
  - If you know neither yourself nor your enemies, you will lose most of the time,
  - if you know yourself, but not your enemies, you will win 50%,
  - if you know yourself and your enemies, you will win most of the time

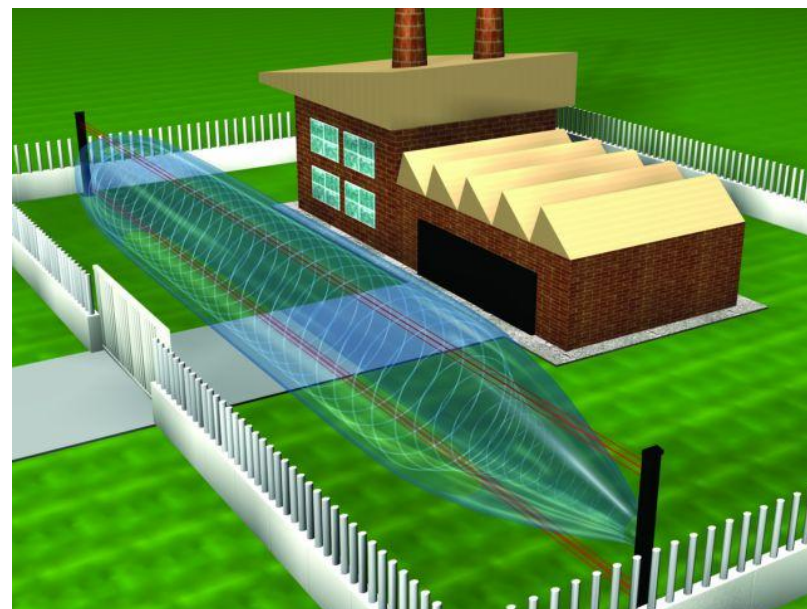


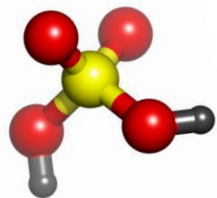
Knowing your threats permits  
proper preparation



# Define the Threats

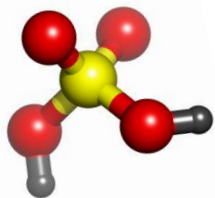
- In physical security:
  - knowing adversary allows:
    - customized security,
    - maximized effectiveness
  - if adversary is not known, develop hypothetical adversary to customize security,
  - hypothetical adversary description should be influenced by actual threat data.





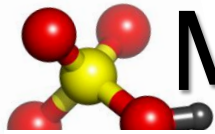
# Design Basis Threat

- ▶ A Design Basis Threat (DBT) is a formalized approach to develop a threat-based design criteria
- ▶ Design Basis Threat consists of the characteristics of potential adversaries, used as criteria to develop a customized security design.
- ▶ DBT is defined at a national level for a State.
- ▶ At the facility level, also consider:
  - local threats
    - local criminals, terrorists, protestors
  - insider threats
    - employees and others with access



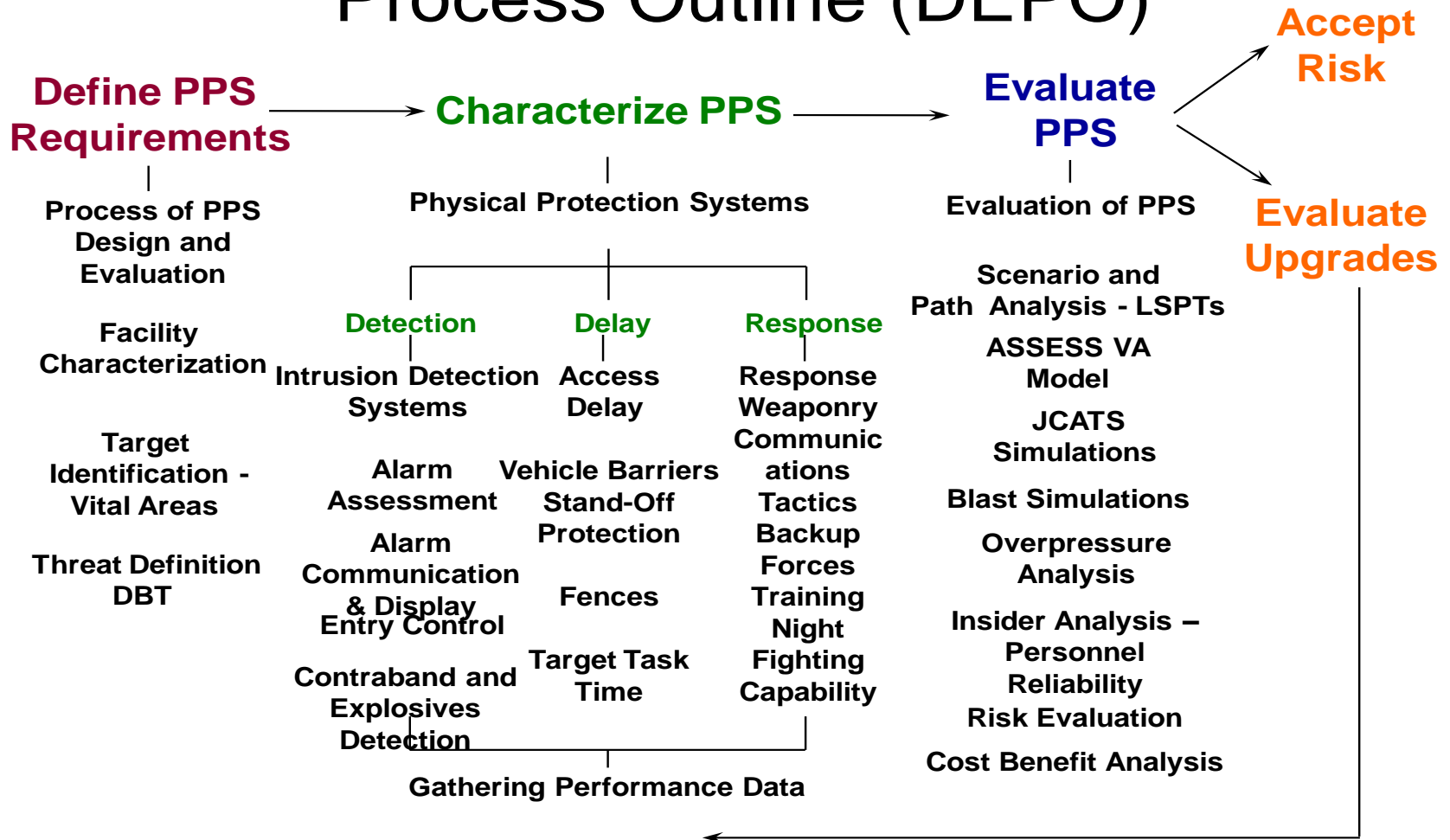
# Safety Program is compliment to Security Culture

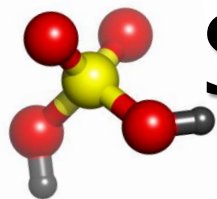
- ▶ Security
- ▶ Reduce Risk by:
  - Detect adversary
  - Delay
    - layered protection
    - barriers
  - Respond
    - security force
- ▶ Know:
  - targets
  - threat
  - security system
- ▶ Safety
- ▶ Reduce Risk by:
  - Awareness & Recognition
  - Controls
    - container-in-container
    - engineered controls
  - Emergency
    - emergency response
- ▶ Know:
  - hazards
  - chemical properties
  - safety systems



# Model for Systematic Approach

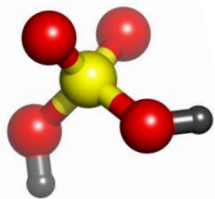
## Design and Evaluation Process Outline (DEPO)



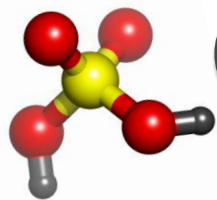


# Summary

- Principles for security can lead to more effective protection
  - defense in depth
  - balanced security
  - integrated security
  - managed risk
- Performance-based approach for confidence in adequate security measures
  - Threat criteria
  - Detect, Delay, Response
- A model for systematic security design and analysis evaluates design and performance based approach



# Fundamentals of Chemical Laboratory Safety



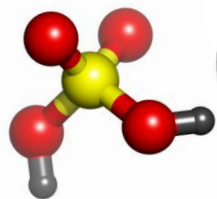
# Chemical Laboratory Safety

Hazard – the *potential* to harm



We want to avoid this.

Risk – the *probability* that harm will result



# Chemical Laboratory Safety



## Industrial Hygiene Principles

**A**nticipation

**R**ecognition

**E**valuation

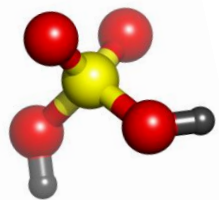
**C**ontrol

Chemical hazards

Physical hazards

Ergonomic hazards

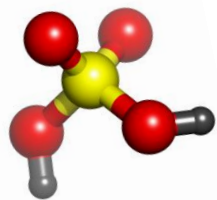
Biological hazards



# CSS Implementation

- Administrative practices  
organizational policies
- Operational practices  
work practices
- Engineering controls  
ventilation, barriers

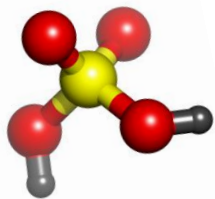




# Emergency Planning & Response

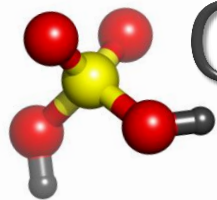
## Post each room with:

- ▶ emergency phone numbers
- ▶ after hour phone numbers
- ▶ person(s) to be contacted
- ▶ alternate person(s)
- ▶ unique procedures to be followed

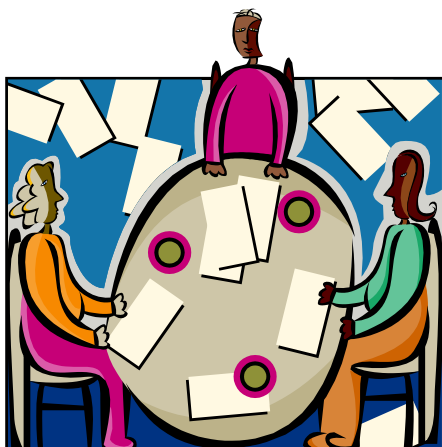


# Chemical Safety and Security Program

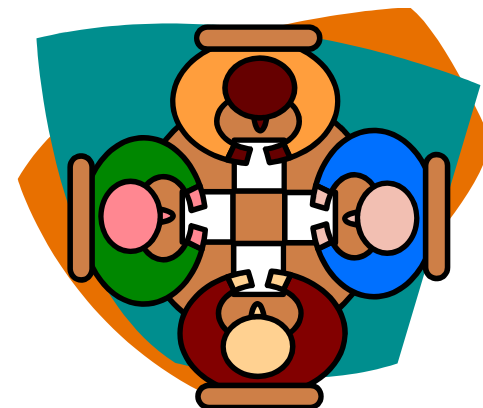
## Organization and Responsibilities



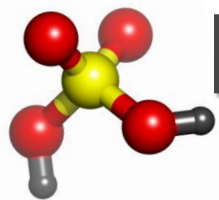
# Chemical Safety and Security Applies to Everyone



Administration  
Human Resources  
Purchasing  
Facilities  
Construction  
Police/Security



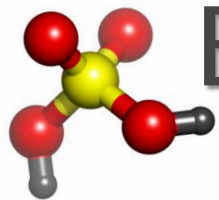
Department Administration  
Research Administration  
Employees  
Students  
Contractors  
*All* visitors



# Faculty / Principal Investigator

has the responsibility

to *teach, model* and *encourage*  
good Chemical Safety and  
Security practices

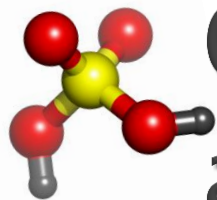


# Employees and Students

have a responsibility

to *actively* support and participate  
in the CSS Program.

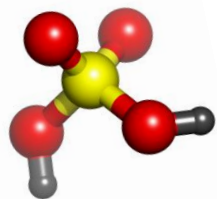




# Chemical Safety and Security Committee

has the responsibility...

to oversee and monitor the CSS  
Program for management so that  
a safe and healthy workplace  
is maintained



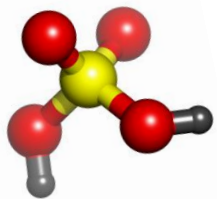
# Management CSS Responsibilities

## Commitment:

- ▶ Establish a formal CSS Program
- ▶ Announce formation of a CSS Program
- ▶ Create a written policy statement
- ▶ Designate a Chemical Safety and Security Officer
- ▶ Endorse a written CSS Plan (Manual)
- ▶ Participate and intervene as needed

## Support:

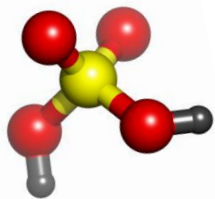
- ▶ Financial support (budget)
- ▶ Staffing
- ▶ Response/resolution of problems by
  - Establishing a CSS Committee
- ▶ Stipulates CSS is part of everyone's job
  - CSS applies to everyone
  - Specifies CSS orientation for new employees
- ▶ Supports CSS staff



# Director/President CSS Responsibilities

- ▶ Establish an effective CSS Program
- ▶ Provide for a budget
- ▶ Endorse written Policies, Plans and Manuals
- ▶ Appoint CSS Officers
- ▶ Ensure CSSO has responsibility, authority and accountability to perform assigned duties
- ▶ Establish a CSS Committee
- ▶ Maintain support and endorsement
- ▶ Timely response to Safety Committee recommendations
- ▶ Follow and set example, e.g., wears PPE

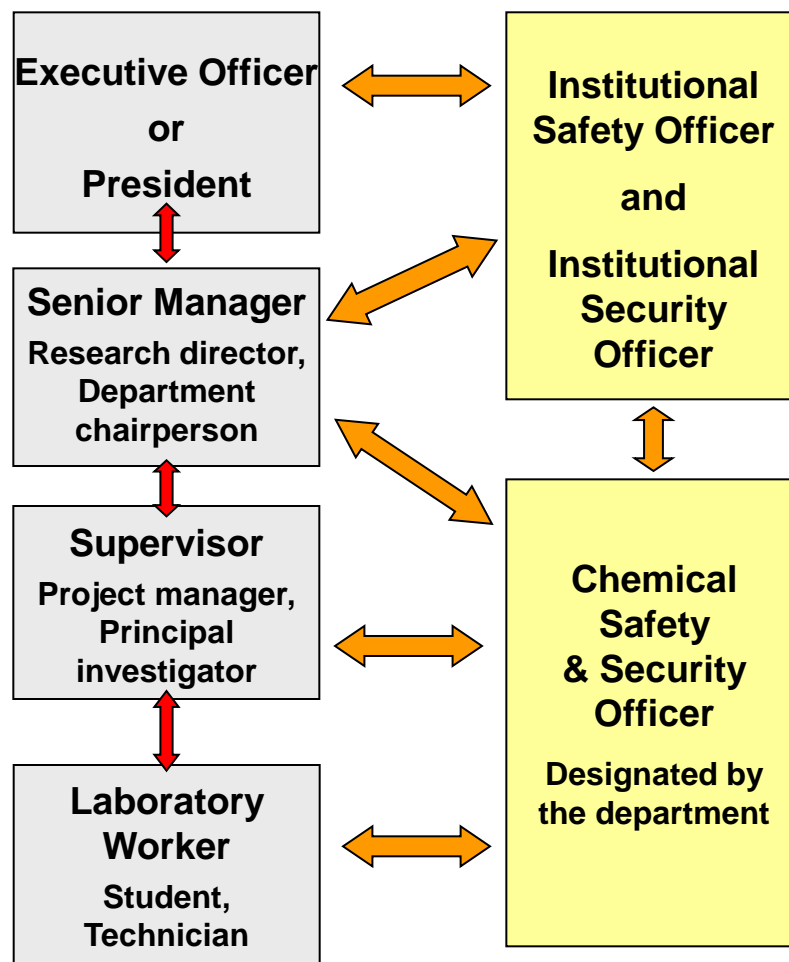


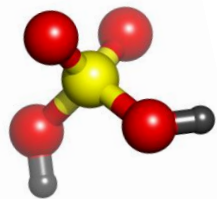


# Chemical Safety and Security Program Ideal Roles

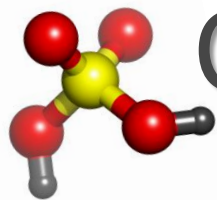
- ▶ Culture of Chemical Safety and Security should exist at all levels of the organization.
- ▶ Top management sets policy, provides resources.
- ▶ Workers, students, researchers must understand and implement.
- ▶ Many organizational interactions are important for chemical safety and security

◦ After Fig 1-1 in Prudent Practices in the Laboratory, NRC 1995



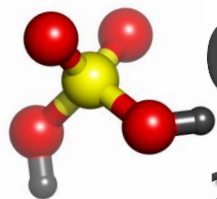


# Chemical Safety and Security Officer Duties



# CSSO Duties Include:

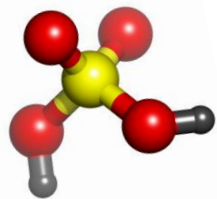
- Surveys
- Job Hazard Analysis
- Inspections
- Training
- Medical Monitoring
- Investigations



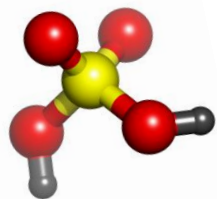
# Chemical Safety and Security Officer

The CSSO has the responsibility to provide expertise and information so that a safe and healthy workplace is present...

The Function of the CSSO is to act as a co-worker, *NOT* as a policeman.

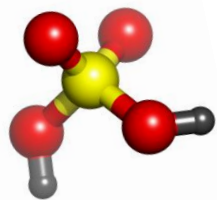


# Chemical Safety and Security Plan



# Parts of a Chemical Safety and Security Plan

- ▶ Policy statement from Senior Management
- ▶ Safety & Security Organization
  - Management
  - Responsibilities
    - Management
    - Administration
    - CSSO staff
    - Facilities Management
    - Principal Investigators
    - Staff
    - Contractors
- ▶ General Policies
  - Housekeeping
  - Eating, smoking areas
  - Signs and labels
  - Emergency procedures
  - Chemical storage
  - Facilities Management
  - Personal Protective Equipment
  - Respirator program

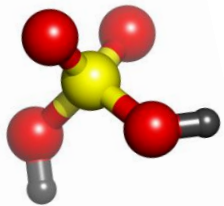


# Parts of a Chemical Safety and Security Plan



- ▶ Engineering Controls
  - Ventilation
  - Laboratory hoods
- ▶ Waste Management
- ▶ Training
- ▶ Record keeping
- ▶ Fire Protection & Protection
- ▶ Location of emergency equipment
- ▶ Evacuation plans
- ▶ Personal and environmental monitoring
- ▶ Inspections
- ▶ Medical surveillance
- ▶ Administration
  - Purchasing chemicals
  - Purchasing safety equipment

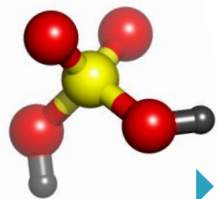




# Academic & Institutional Program

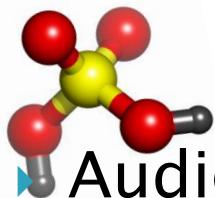
U.S. Department of State  
Chemical Security Engagement  
Program





# Academic Training Types

- ▶ Chemical Safety and Security Awareness Training
  - ½ to 1–½ day course
  - for leadership, decision-makers, administrators
  - awareness for support of CSS improvements, programs, training & development
- ▶ Advanced CSS Training
  - 1–2 day courses (4–5 days combined)
  - Chemical inventory & management
  - Procurement, storage, excess chemicals, orphan chemicals, handling, disposal.
  - Lab safety/security assessment, prioritization, remediation, planning & improvement
  - Lab remodel & design



# CSSO Trainings

## Audience:

- Academic scientists, technologists, students, lab managers, administrators, safety officials, security officials.

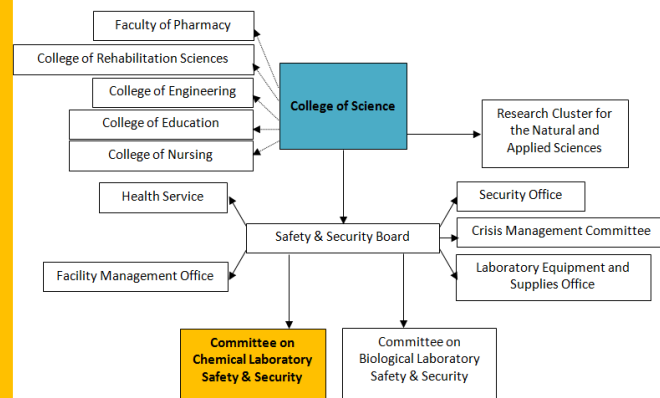
## Purpose:

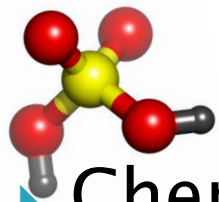
- Raise awareness of CSS issues
- Effect CSS improvements
  - CSS organization & implementation,
  - facility design & operation,
  - stimulate networking & resources
  - CSS culture & quality research.
  - chemical management, procedures, assessments,

## Goals:

- Train-the-trainer ← **sustainability (DO THIS AT HOME) !!**
- Align interests of lab users to take action on CSS issues.
- Garner expertise for appropriate mitigation strategies.

UST COLLEGE OF SCIENCE CHEMICAL SAFETY AND SECURITY PLAN



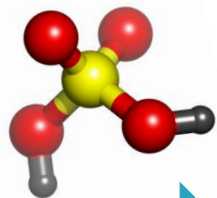


# CSSO Trainings

## ▶ Chemical Safety and Security Officer Training

- 3–5 day course
- comprehensive curriculum
- lab visits, demonstrations and mock inspection
- interactive lessons
- train-the-trainer
  - published resources
  - topical information, presentations
  - teach-back
- practical exercises (examples):
  - lab assessments & planning
  - chemical segregation
  - Standard Operating Procedures (SOPs)
- tangible products to use in lab/training
- materials in English, Arabic, Indonesian and French

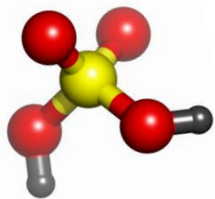




# CSSO Training Goals

- ▶ Provide practical chemical risk management tools for use by **chemical lab professionals**
  - **administration**
  - **faculty**
  - **technicians**
  - **students**
  - **all users**
- ▶ Provide information on identifying, evaluating, and controlling chemical hazards and security threats
- ▶ Promote **a culture of excellence** in chemical risk assessment, mitigation, and management
- ▶ Incorporate CSS materials in university **curricula**
- ▶ **Sustainability**
  - Train-the-trainer: Ownership, customizable
  - Alumni support & mentoring





# Standard CSSO Training

## Day 1

Welcome, Purpose, Goal, and Overview  
Introductions of Staff and Participants  
Chemical Safety and Security Overview  
Fundamentals of Chemical Health and Safety  
Aspects of Chemical Security, Dual Use, International Controls, Chemical Safety Versus Security  
CSSP Organization and Responsibilities & CSSO Duties  
Chemical Safety and Security Plan  
SOP-MSDS Exercise  
Lab Assessment Exercise, Open Discussion  
Group Welcome Dinner

## Day 2

Lab Assessment Exercise Part 1: Lab Layout & Safety Controls  
Principles & Concepts of Lab Design  
Principles & Concepts of Lab Ventilation  
Laboratory Chemical Hoods  
Chemical Management Best Practices  
Other Hazards in the Chemical Laboratory  
Lab Assessment Exercise Part 2: Lab Hazards  
Questions, Open Discussion

## Day 3

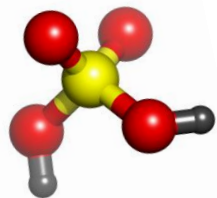
Lab Visit - Inspection Demonstration  
Lab Visit - Spill Cleanup Demonstration  
Lab Visit Observations & Discussion  
Chemical Toxicology & Physiology  
Safe/Secure Transport of Chemicals  
REACH and GHS for Labeling of Chemicals  
Lab Assessment Exercise Part 3: Lab Assessments  
Questions, Open Discussion

## Day 4

Fire Prevention and Protection in the Laboratory  
Laboratory Emergency Planning, Response, and Management  
Chemical Spill Response and Cleanup  
PPE and Safety Equipment Performance Specifications  
Lab Assessment Exercise Part 4: Lab Improvements (Prioritization, CSS Team and Scheduling)  
Questions, Open Discussion

## Day 5

Lab Visit - Practice Inspection & Spill Cleanup  
Case Studies  
Hazardous Waste Management & Disposal  
Lab Assessment Exercise Part 5: Assessment Presentations  
Questions, Open Discussions, Next Steps, Feedback  
Group Celebration Dinner & Certificate Presentations



# Condensed CSSO Training

## Day 1

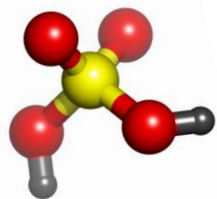
Welcome, Purpose, Goal, and Overview  
Introductions of Staff and Participants  
Chemical Safety and Security Overview  
Fundamental Chemical Health and Safety  
Chemical Security, Dual-Use,  
International Controls, Safety Vs Security  
CSP Workshop Orientation  
CSSP Organization and Responsibilities  
& CSSO Duties  
Chemical Safety and Security Plan  
SOP-MSDS Exercise  
Lab Exercise : Layout and Safety  
Controls; Open Discussion  
Adjourn

## Day 2

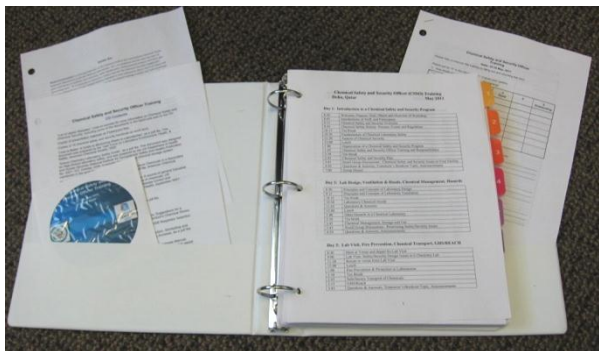
Chemical Management Best Practices  
Other Hazards in the Chemical Laboratory  
Principles & Concepts of Lab Design & Ventilation  
Lab Exercise Part 2: Lab Hazards & Assessments  
Safe/Secure Transport of Chemicals - REACH and GHS  
Laboratory Emergency Planning, Response, and Management  
Lab Exercise Part 3: Prioritization, CSS Team and Scheduling  
Questions, Open Discussion  
Adjourn

## Day 3

Lab Visit - Inspection Demonstration  
Lab Visit - Case Studies  
Mock Inspections  
Lab Visit Observations & Discussion  
PPE and Safety Equipment Performance Specifications  
Fire Prevention and Protection in the Laboratory  
Lab Exercise Part 4: Prioritization, CSS Team and Scheduling  
Lab Exercise Part 5: Lab Assessment Presentations  
Questions, Open Discussions, Next Steps, Feed back  
Adjourn  
Group Dinner & Certificates Presentations



# Workshop Materials



## ▶ Binder:

- Presentations (in Arabic, French, Indonesian)
- Compact Discs (CDs)
- Resource section
  - Useful Websites
  - Information for labs and teaching resources

## ▶ CDs:

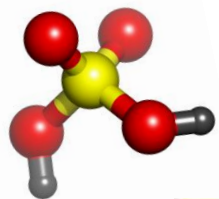
- Presentations (in language)
- Resource section (same as Binder)
- Additional resources
  - PDF of Chemical Security Reference and Toolkit



## ▶ Chemical Security Reference Book and Toolkit:

- Book for institutional/academic CSS planning
- Guidelines for chemical storage groups
- Toolkit:
  - Instructor's guide
  - Case studies/lessons
  - Lab hazard signs





# CSSO Trainings



Professional Networking



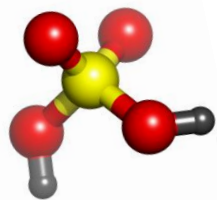
Lab Demonstrations



Group Exercises



Tangible Resources



# Success Story: 14th ACC Workshop on Chemical Safety

## Learning to be safe: Measures taken in promoting chemical safety and security in the Philippines

**Patrick John Y. Lim, Ph.D.\***

Department of Chemistry, University of San Carlos, Cebu City 6000 Philippines

[pjlim@usc.edu.ph](mailto:pjlim@usc.edu.ph)

**Mylene M. Uy, Ph.D.**

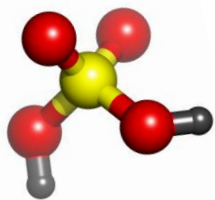
Department of Chemistry, MSU-Iligan Institute of Technology, Iligan City 9200 Philippines

[mylene.uy@g.msuiit.edu.ph](mailto:mylene.uy@g.msuiit.edu.ph)

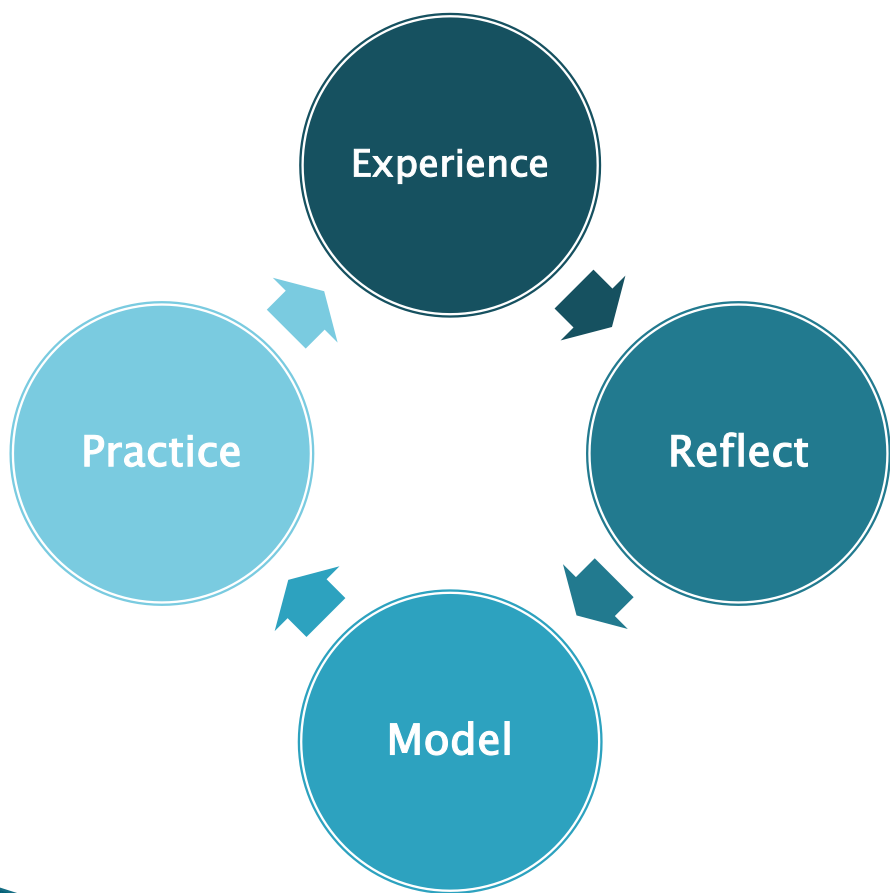
**Fabian M. Dayrit, Ph.D.**

Department of Chemistry, Ateneo de Manila University, Quezon City 1108 Philippines

[fdayrit@ateneo.edu](mailto:fdayrit@ateneo.edu)



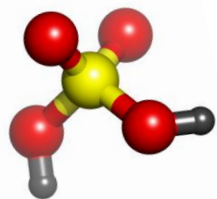
# Module Development: Training Approach



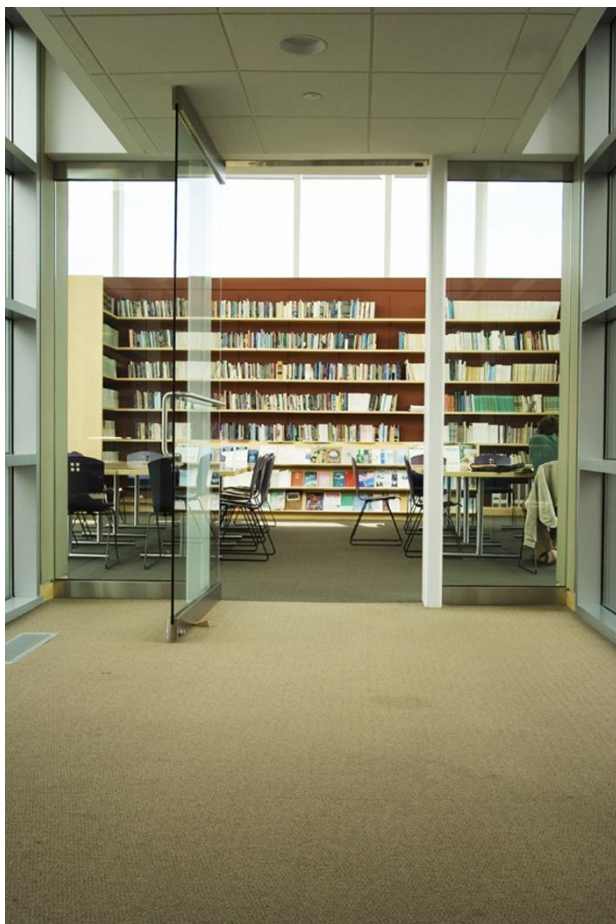
- ▶ Place increased emphasis on:
  - **Experiential learning**
    - not just a transfer of facts
    - Kolb's Cycle<sup>1</sup>
  - **Active participation**
    - not passive attendance
  - **Facilitate learning**
    - not teaching or lecturing
  - **The learner is focus**
    - not the instructor

**Encourages participants to  
become invested  
in the learning process**

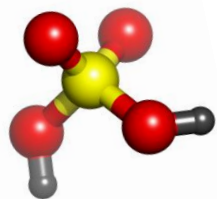
<sup>1</sup> Kolb, David (1984) *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.



# CSP Module Library: Concept



- ▶ To Provide training materials that are:
  - complete, self-contained modules
    - each module to be 2–4 hours
  - readily used by others (train-the-trainer)
  - customizable, adaptable
  - utilize effective training techniques



# CSP Module Library: Components

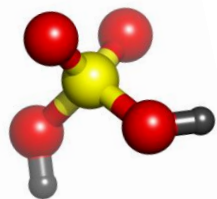
## Instructor Guide + Student Workbook

### ▶ Instructor Guide

- Module Overview
  - Module description
  - Relation to CSP objectives
  - Module learning outcomes
  - Target audience description
  - Module Outline
- Training Walkthrough
  - Slides
  - Detailed notes
  - Directions and materials for activities
  - Handouts if applicable

### ▶ Student Workbook

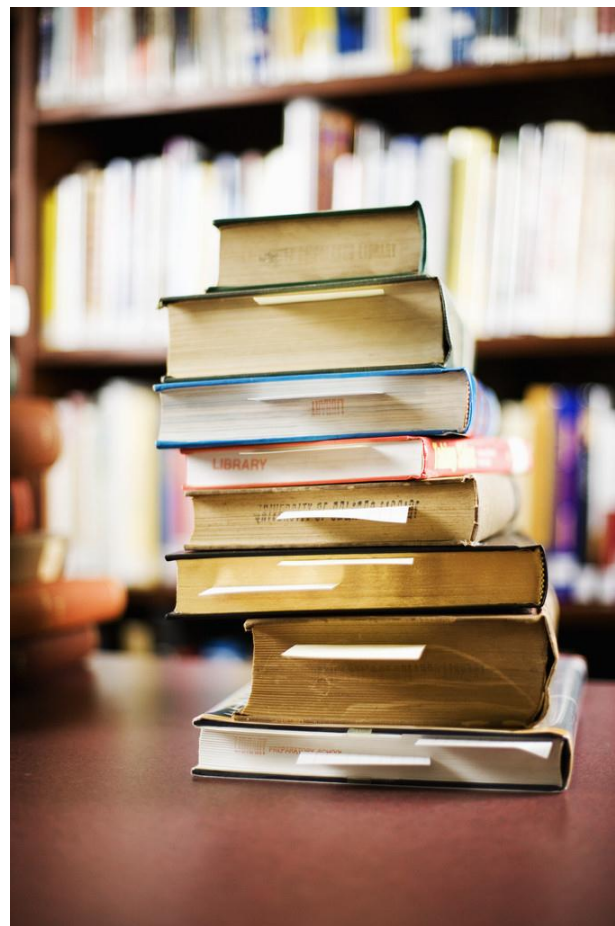
- Slides and areas for notes
  - Binding at top to accommodate different languages
- Instructions and materials for activities
  - Space for answers to activity and discussion questions
- References and resources
- Evaluation forms
  - Instructor evaluation
  - Module evaluation
  - Self evaluation of learning

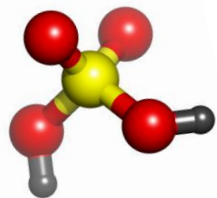


# CSP Module Library: Workshop Configuration

- ▶ Workshops are configured by stacking individual modules
  - Allows customization for:
    - Workshop length  
*Example: A 3-day CSSO versus a 1-day Awareness workshop*
    - Target audience  
*Example: National leadership versus University staff/students*

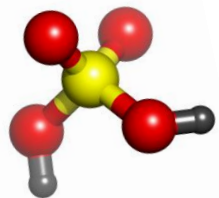
**Match Training Content to  
Training Needs**





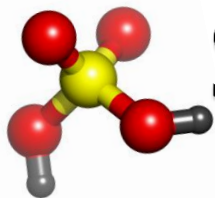
# CSP Module Library: Catalog

- ▶ Core Modules
  - Serve as prerequisites
  - Appropriate at the beginning of most training courses
  - Are applicable regardless of the participant
  - Examples:
    - Orientation to Chemical Safety and Security
    - Fundamentals of Chemical Safety and Security
    - Chemical Management
- ▶ Laboratory Track
  - Build upon the core modules
  - Target Audience: lab managers, workers, students, CSS personnel
  - Examples:
    - Personal Protective Equipment
    - Fire Prevention and Protection
- ▶ Leadership Track
  - Build upon the core modules
  - Target Audience: senior leadership, administrators, department management, and dedicated CSS personnel
  - Examples:
    - Establishing a CSS Program
    - Laboratory Design



# CSP Module Library: Catalog

- ▶ Orientation to Chemical Safety and Security
- ▶ Fundamentals of Chemical Safety and Security
- ▶ Establishing a CSS Program
- ▶ Chemical Management
- ▶ Risk and Assessment
- ▶ PPE
- ▶ Fire Prevention and Protection
- ▶ Laboratory Design
- ▶ Training Others in CSS
- ▶ Half-day Workshop for Young Chemists



# SOP Exercise: Electrophoresis

## ▶ Use MSDS information:

### ◦ MSDS sections:

#### • Section 2. HAZARDS IDENTIFICATION.

– OSHA Hazards, Hazard statement(s), Precautionary statement(s), HMIS Classification, NFPA Rating, Potential Health Effects

#### • Section 4. FIRST AID MEASURES

– General advice, if inhaled, in case of skin contact, in case of eye contact, if swallowed

#### • Section 5. FIRE-FIGHTING MEASURES

– Suitable extinguishing media,

#### • Section 7. HANDLING AND STORAGE

– Precautions for safe handling, Conditions for safe storage

#### • Section 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

– OELs, PPE

#### • Section 10. STABILITY AND REACTIVITY

– Chemical stability, Conditions to avoid, Materials to avoid, Hazardous decomposition products

#### • Section 12. ECOLOGICAL INFORMATION

– Toxicity

**SIGMA-ALDRICH** sigma-aldrich.com

**Material Safety Data Sheet**  
Version 4.0  
Revision Date 03/14/2010  
Print Date 01/07/2011

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**1. PRODUCT AND COMPANY IDENTIFICATION**

Product name : Glacial acetic acid  
Product Number : A9967  
Brand : Sigma-Aldrich  
Company : Sigma-Aldrich  
3050 Spruce Street  
SAINT LOUIS MO 63103  
USA  
Telephone : +18003255832  
Fax : +18003255052  
Emergency Phone # : (314) 776-8555

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**2. HAZARDS IDENTIFICATION**

Emergency Overview

OSHA Hazards  
Combustible Liquid, Target Organ Effect, Harmful by skin absorption., Skin sensitizer, Corrosive

Target Organs  
Teeth., Kidney

Other hazards which do not result in classification  
Lachrymator.

GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H226	Flammable liquid and vapour.
H303	May be harmful if swallowed.
H312	Harmful in contact with skin.
H314	Causes severe skin burns and eye damage.
H317	May cause an allergic skin reaction.
H331	Toxic if inhaled.
H402	Harmful to aquatic life.

Precautionary statement(s)

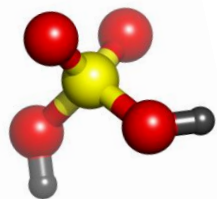
P261	Avoid breathing dust/fume/gas/mist/vapours/spray.
P260	Wear protective gloves/protective clothing/eye protection/face protection.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.

HMIS Classification

Health hazard:	3
Chronic Health Hazard:	*
Flammability:	2
Physical hazards:	1

NFPA Rating

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# CSP Module Library Example: 3-day CSSO + Lab Review

## Day 1

1. Orientation to Chemical Security
  - a. Objectives, introductions, basic definitions, resources, etc.
2. Fundamentals of Chemical Security
  - a. Lab Hazards, GHS labels, security issues
  - b. Hierarchy of CSS controls

## Day 2

3. Establishing a CSS Program
  - a. CSS plan and organization
  - b. CSSO duties
  - c. emergency response planning
  - d. training requirements
  - e. assessments reporting, and follow-up
4. Chemical Management
  - a. procurement & inventory
  - b. handling (SOPs, spill response, cleanup)
  - c. storage (segregation, access controls)
  - d. chemical transport
  - e. disposal

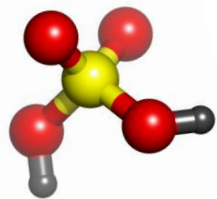
## Day 3

5. Laboratory Design
  - a. safety and security considerations
  - b. utilities & services
  - c. ventilation & engineered controls
6. Fire Prevention and Protection
7. Personal Protective Equipment
8. How to use CSP resources to train others

## Days 4 & 5

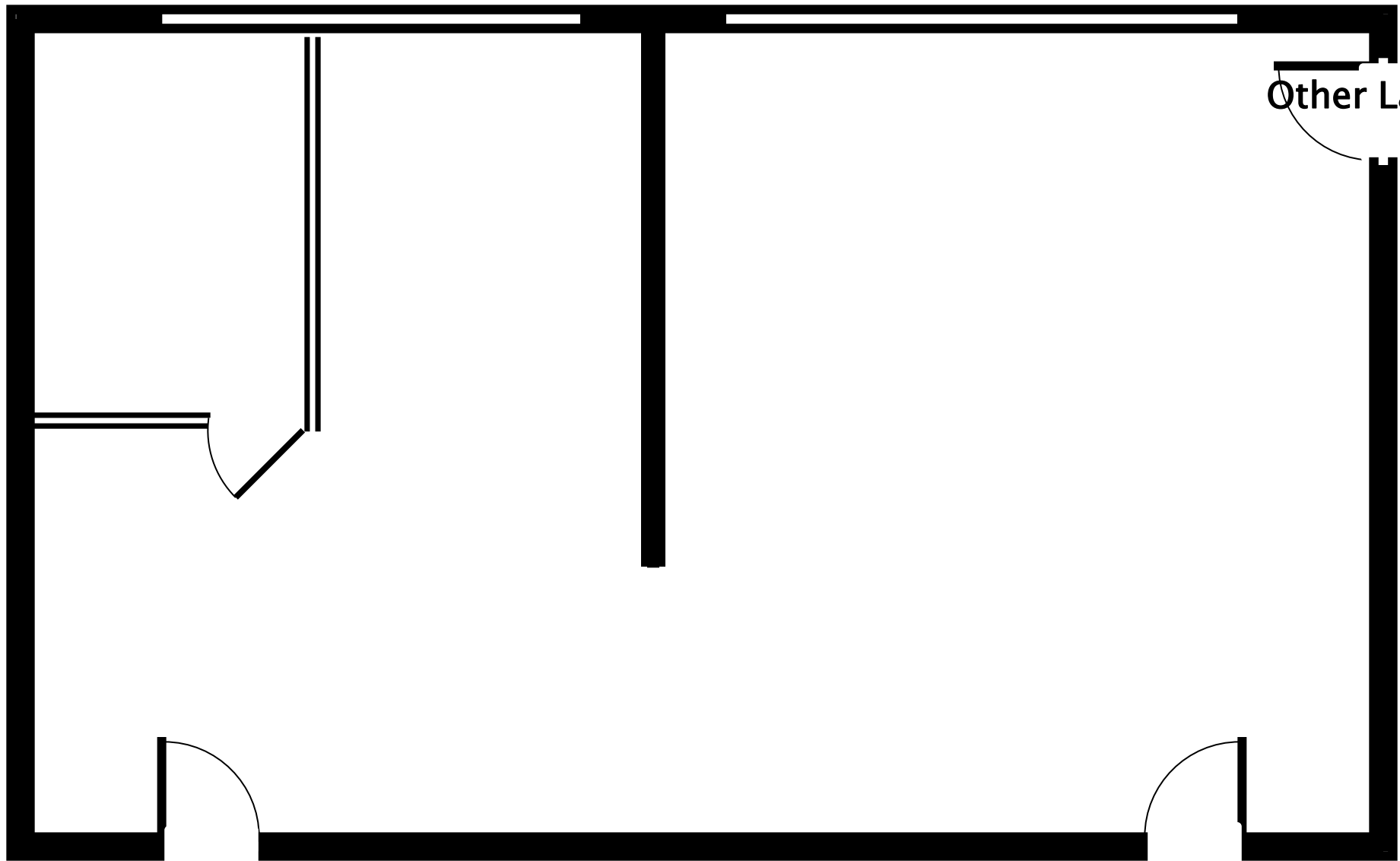
- ▶ Lab visits & recommendations





# Lab Assessment Exercise

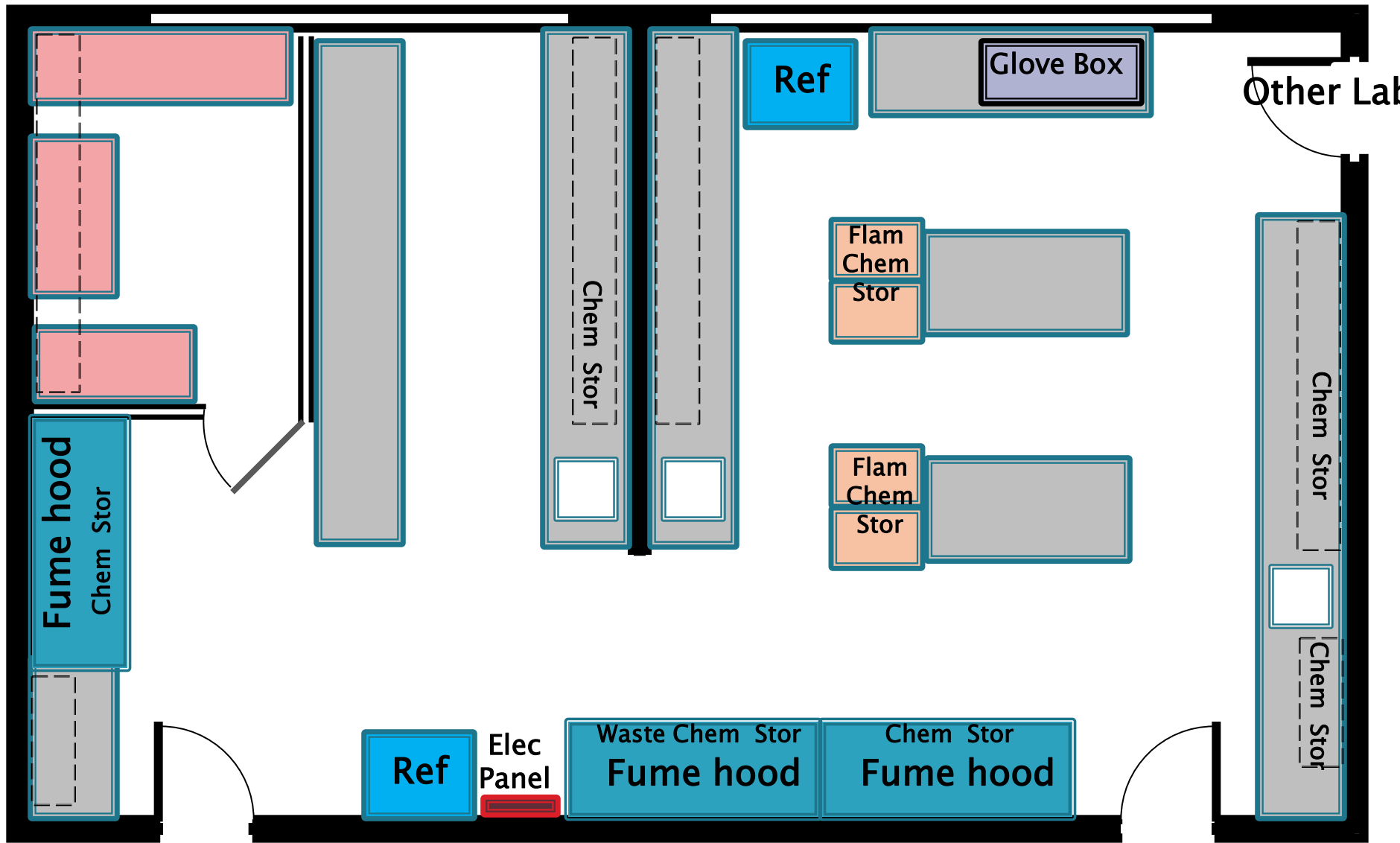
## Introduction



Other Lab

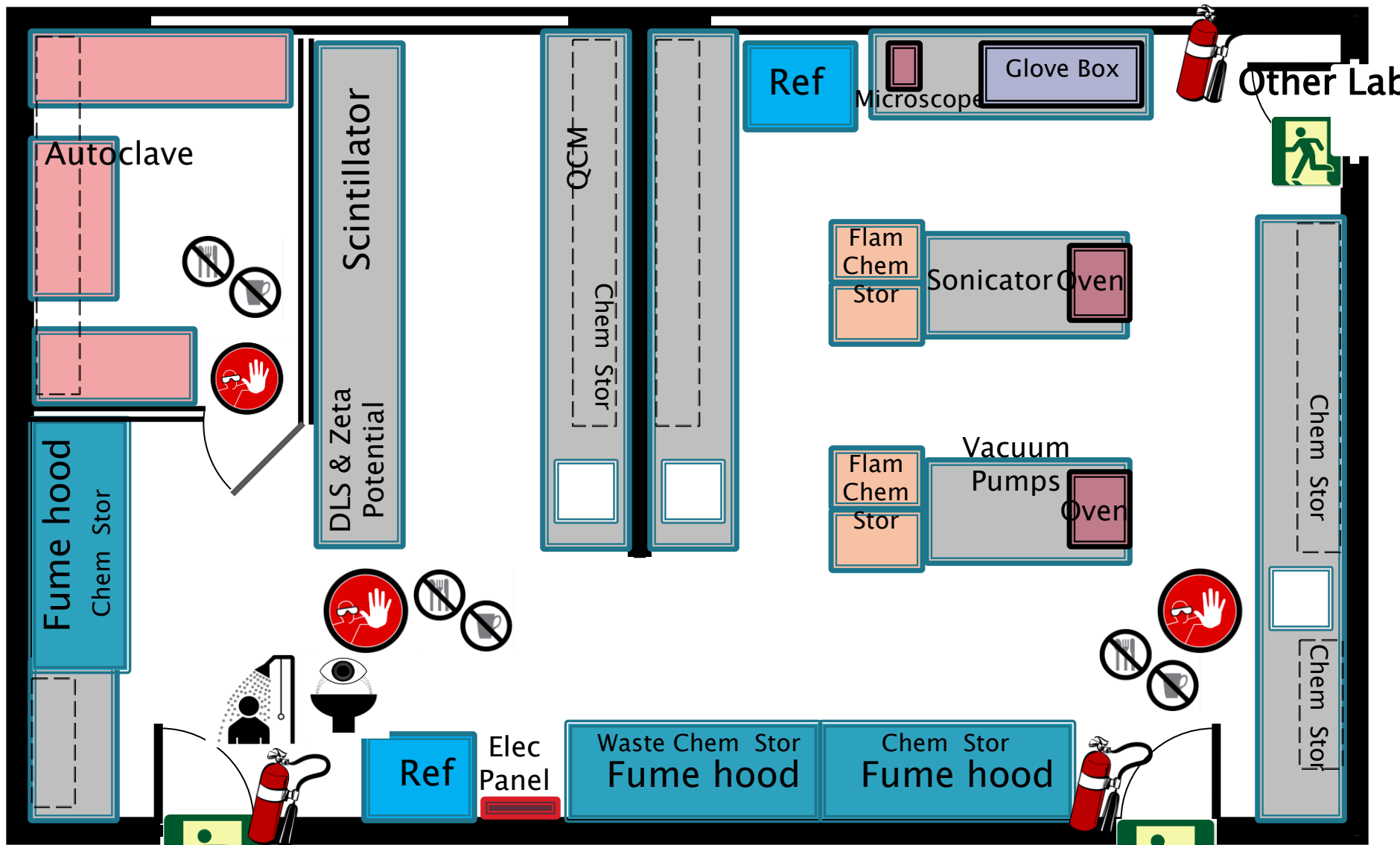
Corridor

# Chemical Lab Floor Plan



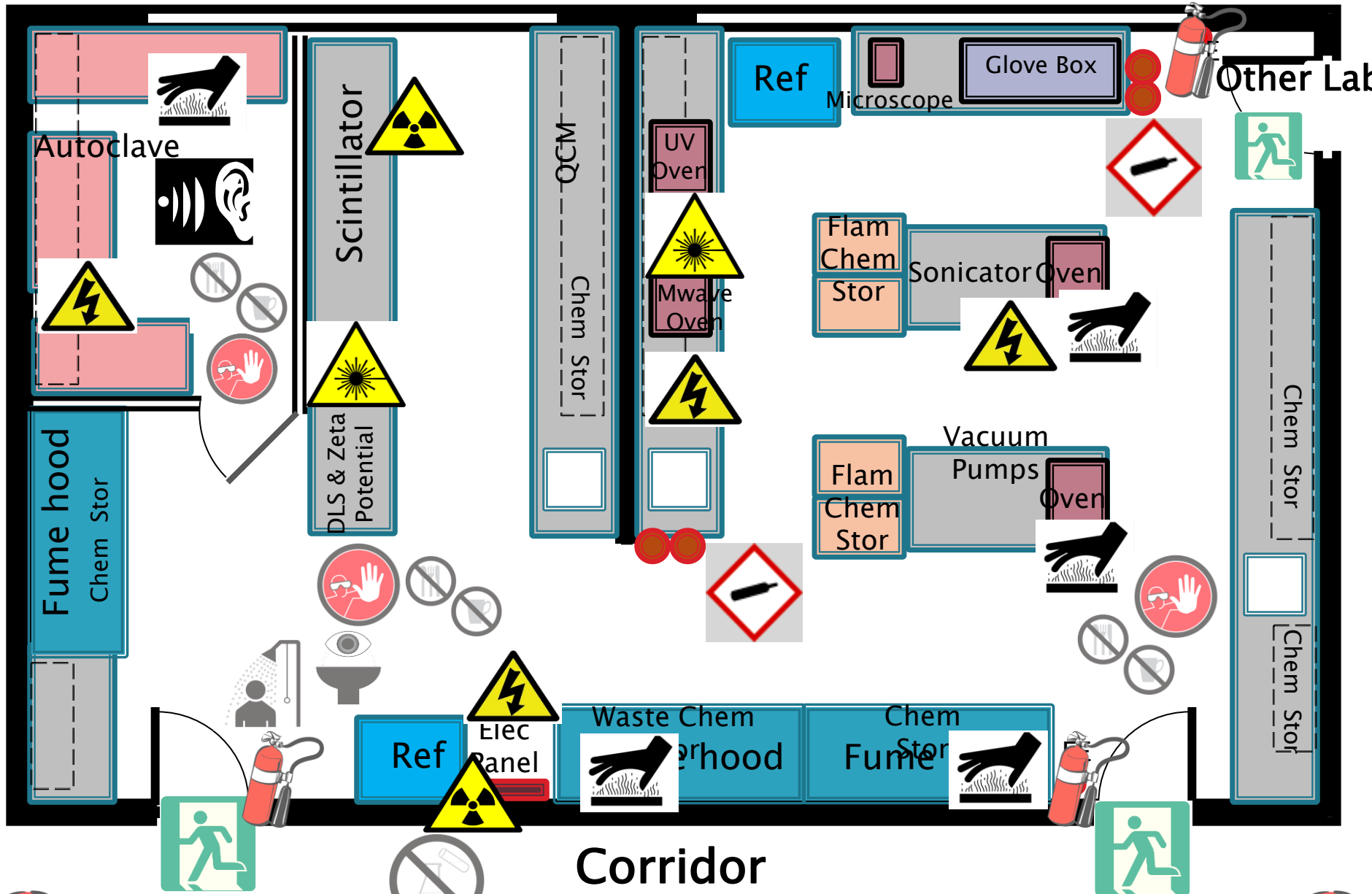
Corridor

# Chemical Lab Floor Plan

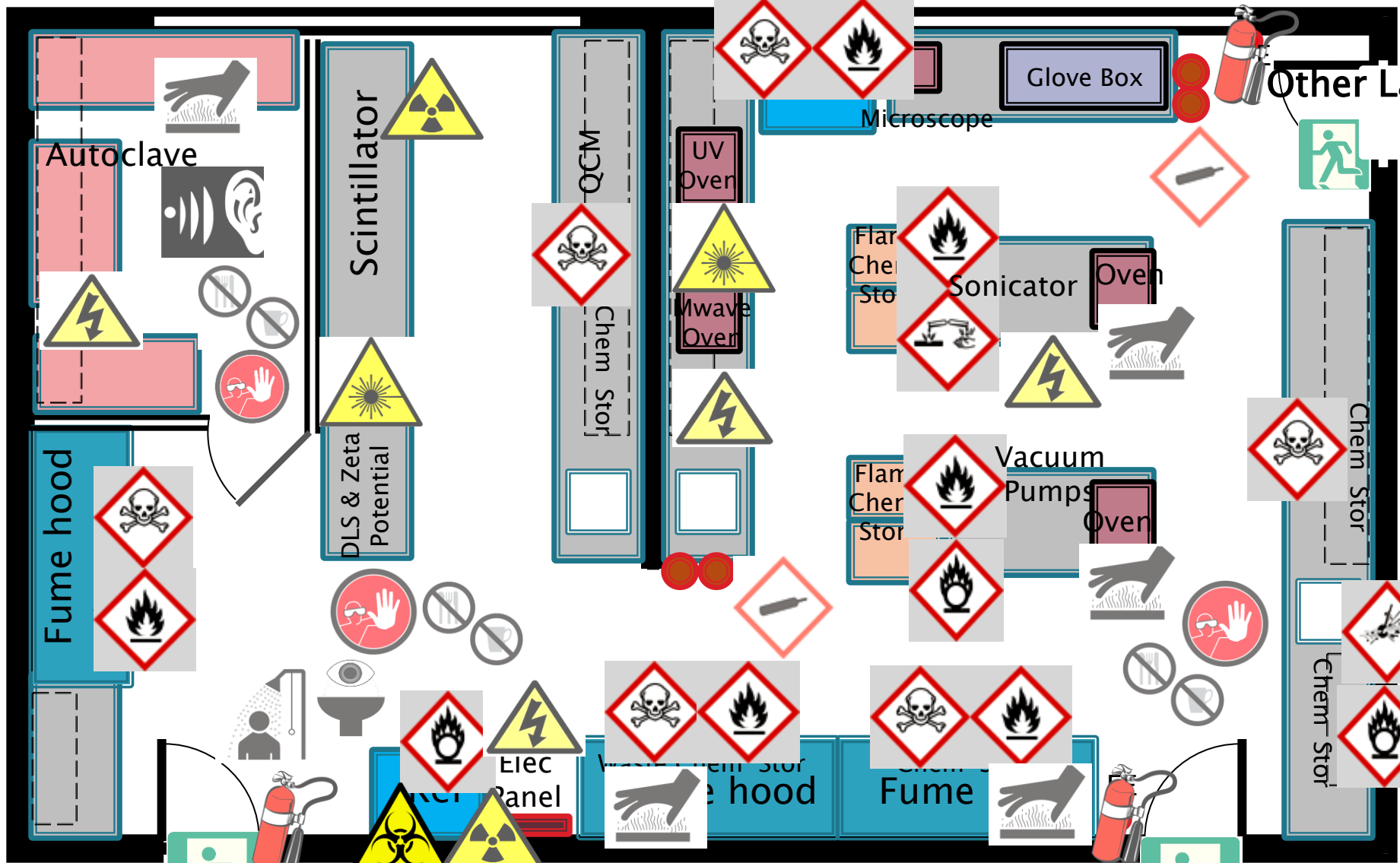


# Chemical Lab Floor Plan





Chemical Lab Floor Plan

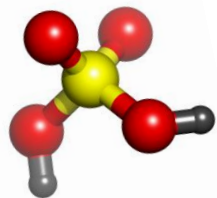


Corridor

# Chemical Lab Floor Plan







# CSS Action Plan

## ▶ Prioritization:

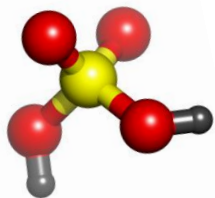
- Easiest → Medium → Difficult
  - inventory
    - check actual
    - remove spent chems
    - separate groups
    - secondary containment
  - training
  - collect MSDS info
- fire storage cabinets
  - develop SOPs
- new fume hood
  - proper waste disposal

## ▶ CSS leadership team:

- You, fellow labmate? fellow professor? EHS specialist? department director? others?

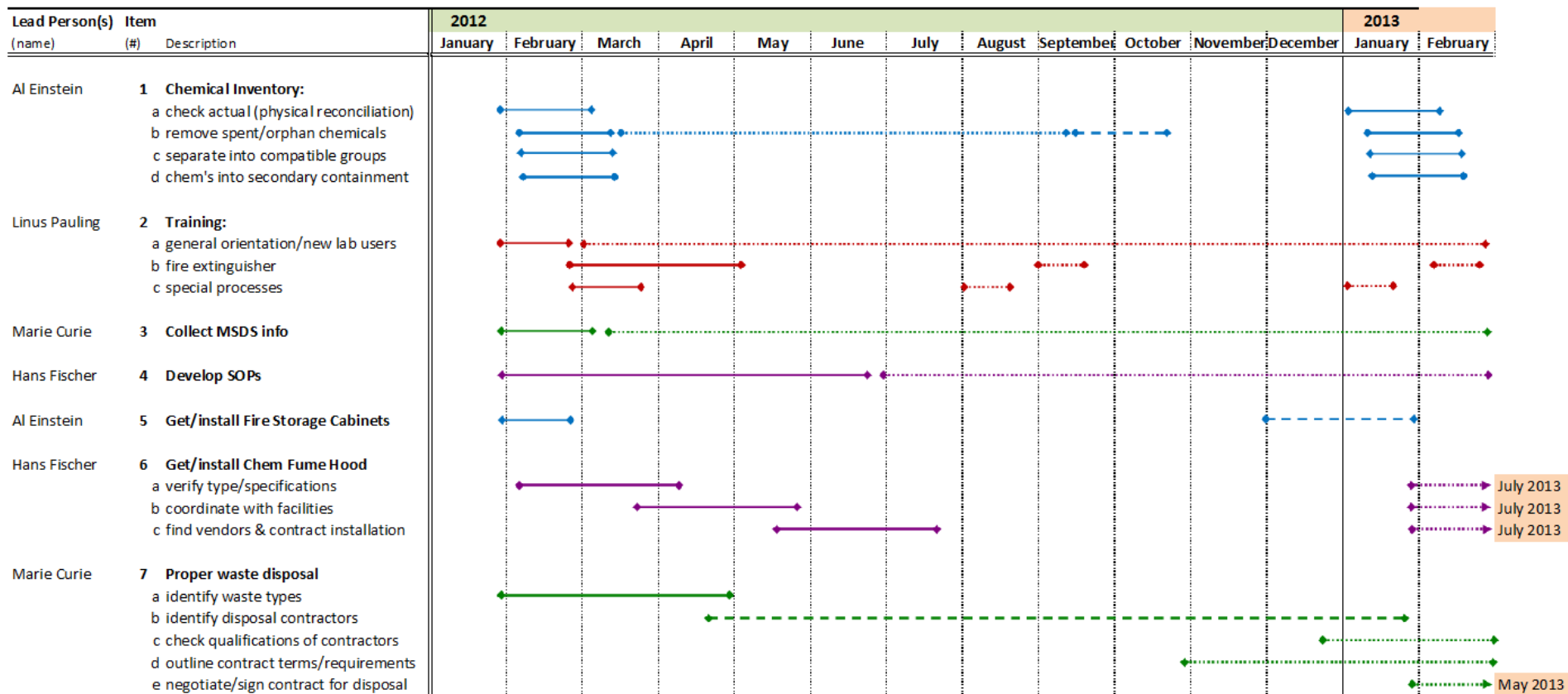
## ▶ Timeline & commitment:

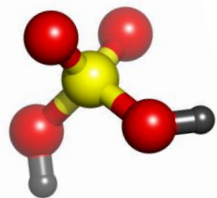
- initiate actions, complete actions, ongoing actions, persons responsible



# CSS Action Plan

- ▶ Timeline & commitment:
  - initiate & complete actions, ongoing actions, persons responsible





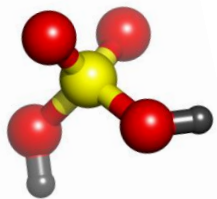
# Yemen: Our Chemistry is Good!

## ▶ CSP active with Yemen:

- October 2011 CSSO:
  - 21 academic scientists & administrators
- January 2012 CSSO:
  - 29 academic scientists & administrators
- April 2012 ICYC–CSS:
  - 18 academic scientists supported at ICYC–Jordan

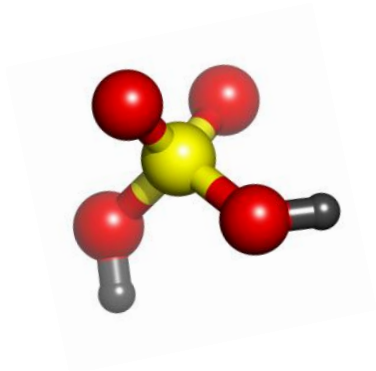
## ▶ Follow–ons of Yemen:

- Dec 2011:
  - training at Sana'a UST
- Jan 2012:
  - NCPHL Food & Water Department – chemical management improvements
- March 2012:
  - Yemen EPA Conference (Dr. Helal Al-rashi) in Sana'a
- Study proposal:
  - Drs. Abdel Al-Alimi & Saleh Kasem (Dual use)
- Training Institute proposal:
  - Drs. Abdel Al-Alimi & Shaif Kasem (AYISS)



# Questions? Open Discussion





# Lunch