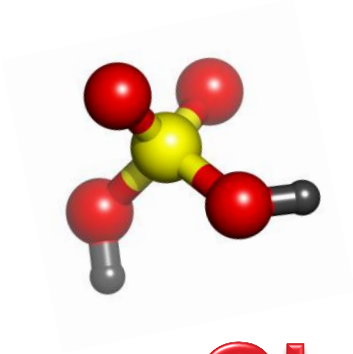


Chemical Risk Management Workshop

Amman, Jordan
7-11 October 2012

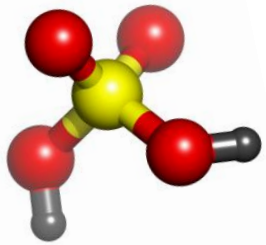
SAND No. 2011-9012P

Sandia National Laboratories

Workshop Overview & Introductions

- **CSP Sponsorship**
- **Purpose of Workshop**
- **Overview of Workshop**
- **Introductions**

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM



Chemical Security Engagement Program (CSP)

U.S. Department of State: CSP Program Objectives

- Raise awareness about the dual-use nature of chemicals
- Foster collaboration among chemical professionals worldwide
- Provide training opportunities, technical assistance, and conduct risk assessments in academic laboratories and industrial settings
- Support local and regional conferences on chemical security policy and regulation

CSP
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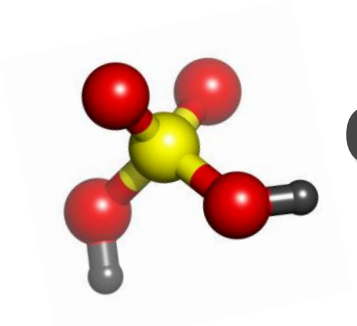
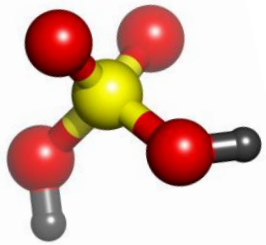


CSP Activities

- Work with host countries to assess their current needs and priorities in chemical risk management
- Partner with :
  - National and regional chemical organizations (HKI, IKM)
  - Universities
  - International chemical organizations (OPCW, IUPAC, UNFAO)
  - Chemical industry associations (CICM, KN-RCI)
- CSP engages ministries/regulatory agencies in countries with:
  - Regional security concerns
  - Active producers/exporters of industrial chemicals

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM

CSP Website – log in



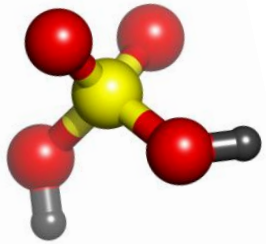
CSP Website

https://chemsecurity.sandia.gov/

- Offers networking opportunities
- Provides resources
- Discussion boards
  - Share best practices
  - Ask questions/get answers
- Upload/view photos from workshops
- View/download training materials
- See upcoming and past events

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM

CSP Website – Workshops



Home >Workshops >2011 Workshops >Indonesia & Malaysia- June 2011

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Home | Workshops | Share Your Training | Discussion Board | Resources | Photos | Con

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

Workshops

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

Please scroll down to the bottom to view document links.

Presentations

Materials

PowerPoint Presentation Files

Trainer Bios

Participant List

Participant List

Test

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CSP Website – Photos

Home >Photo Gallery

Connie Stewart Log out

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Add, edit or remove a portlet above the content

View | Edit | Criteria | Subfolders | Sharing

Photo Gallery

Mekong Delta Photos (18)

Indonesia/Malaysia Trainings (5)

Malaysia Workshop (13)

Photo Gallery (1)

Photo Gallery (0)

Photo Gallery (0)

Chemical Security Engagement Program is sponsored by the U.S. Department of State.

Search Site Search

Workshops

- Photo Gallery

Workshops by year

- 2011
- 2010
- 2009
- 2008

Where We've Been

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM

CSP Website – Past event photos

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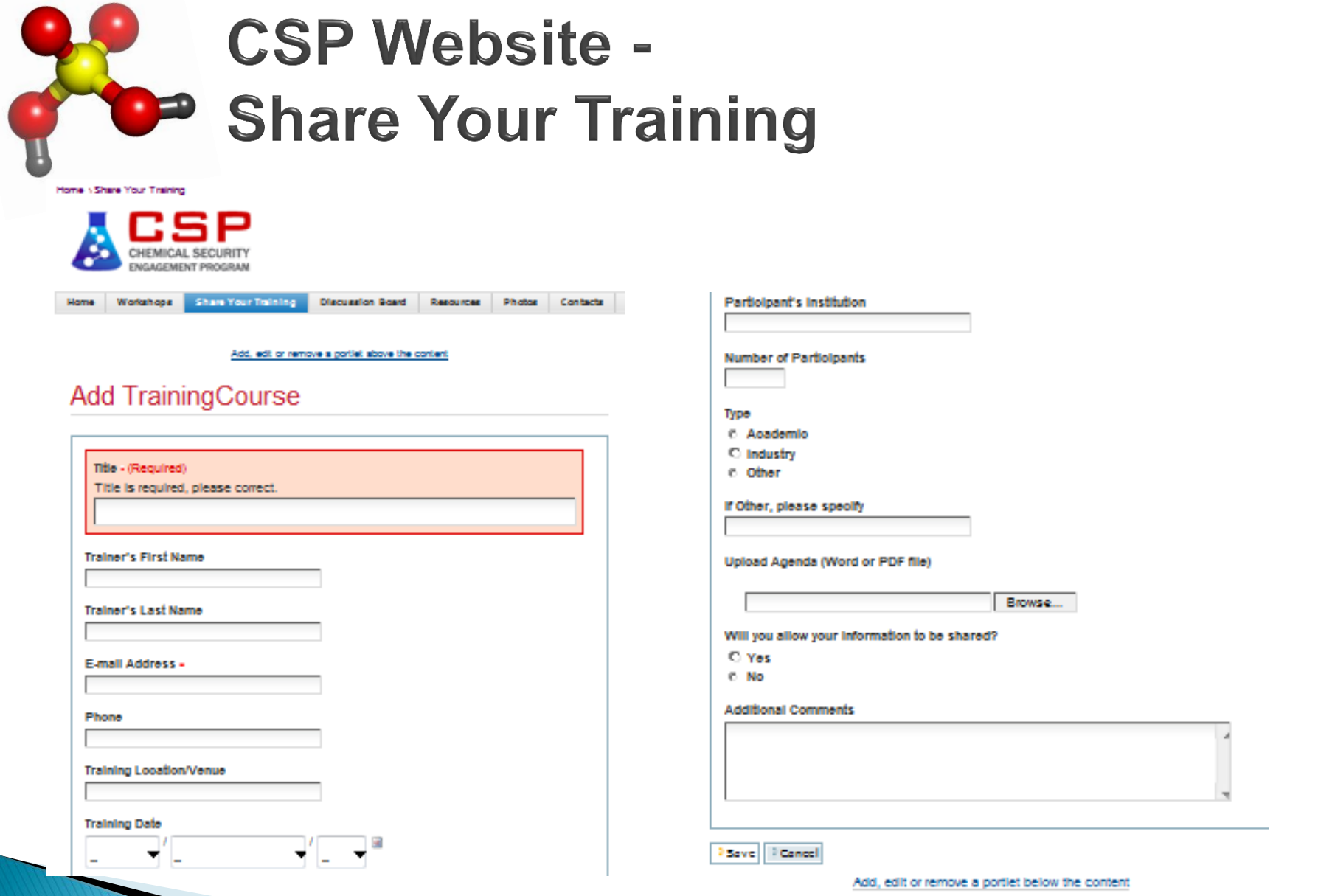
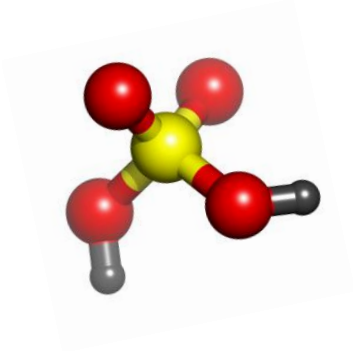
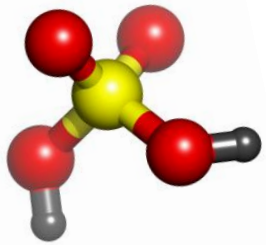
CSP Website - Share Your Training



CSP Website – Discussion Board





CSP Website
Example: Discussion Board

I have post video showing the hood in our laboratory which was not working . After the training, I decided to check for all our hoods. We have about 10 hoods but only three of them are working and the other do not. so I have dismantled one. I was surprised that the motor is located at the top of the hood not abroad which Mr Douglas told us. I have discovered that the most of the breakdown in Hoods is at the motor which my be stop Due to deposition of layers of rust on. I myself have replaced the old motor with new one so It becomes working again and I have also found that it easy to designed hood for your lab. if you do not have more money to buy one.

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CSP Discussion Board
Photo of Fume Hood Motor

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Sandia National Laboratories

Sandia supports the CSP Program

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Sandia National Laboratories
Albuquerque, New Mexico, USA

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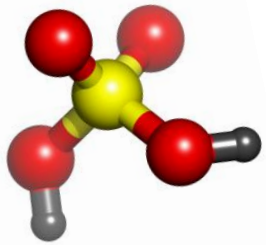

Former Students Risk Management Issues

University Labs:

- Incompatible chemical storage
- Security issues with dual-use chemicals
- Orphan chemicals, waste issues
- Inventory systems

Government/Ministries:

- Global supply chain
- National chemical management
- Promulgation of new chemical regulations

Industry:

- Chemical risk management
- Security concerns affecting business capability
- Lack of adequate response capabilities

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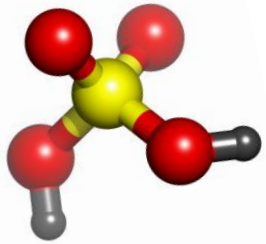

Purpose of this Workshop

- Provide practical chemical risk management tools
- Provide information on identifying, evaluating, and controlling chemical hazards and threats
- Promote a culture of excellence in chemical risk assessment, mitigation, and management
- Determine needs for future training and support

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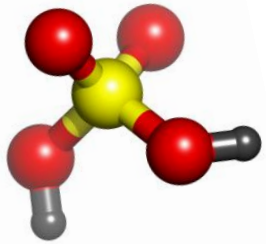

Course Outline

- Day 1: Introduction to Chemical Risk Management
- Day 2: Hazard Identification
- Day 3: Hazard Control
- Day 4: Chemical Security Risk Management
- Day 5: Emergency Management, Waste Management, “Next Steps”

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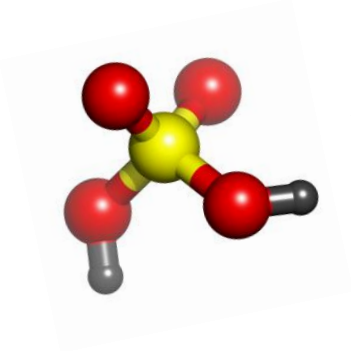

Workshop Speakers Introductions

- Ms. Linda Stiles
- Mr. Eric Branson
- Mr. Steve Iveson

What do you want to learn this week?

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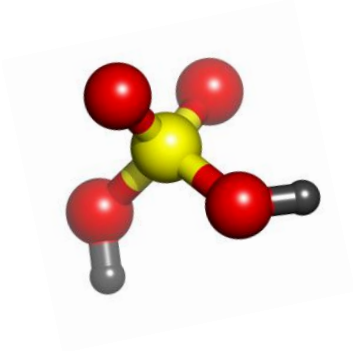
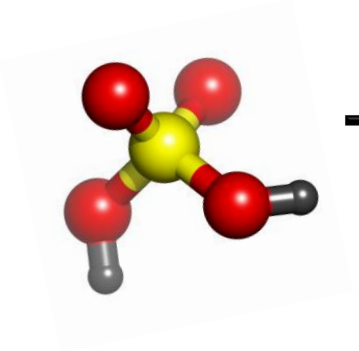


Aspects of Chemical Security
Dual-Use Chemicals

SAND No. 2011-9013P
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories



Topics to be discussed

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

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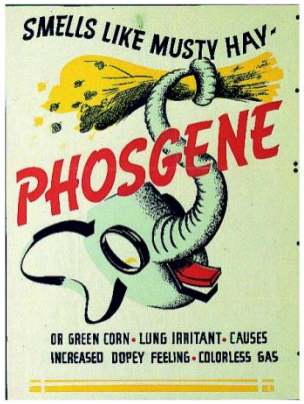
Chemical dual-use awareness

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



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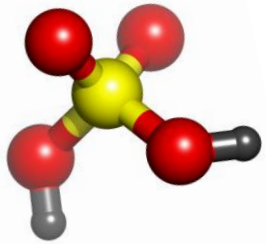

Areas of focus

Four Mains areas of focus:

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

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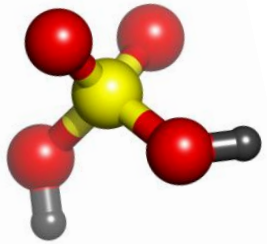
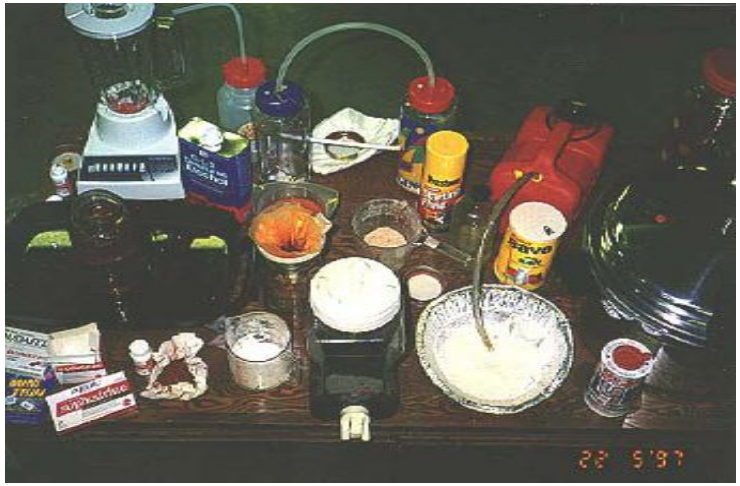


Dual-use chemicals:Pseudoephedrine

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



Illicit Methamphetamine Laboratory

US DEA

Clandestine meth labs in US during 2002

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

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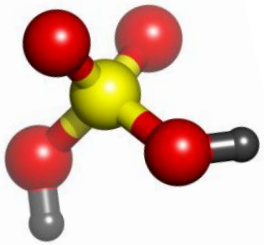

End product of dual-use chemicals: Methamphetamine

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

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

Meth reactor
~ 75kg “Ice”

MDMA reactors
~ 8kg Ecstasy

MDMA = (3,4-methylenedioxymethamphetamine)

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

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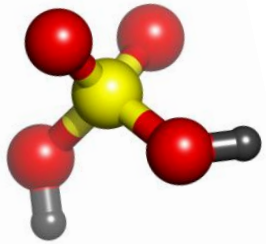
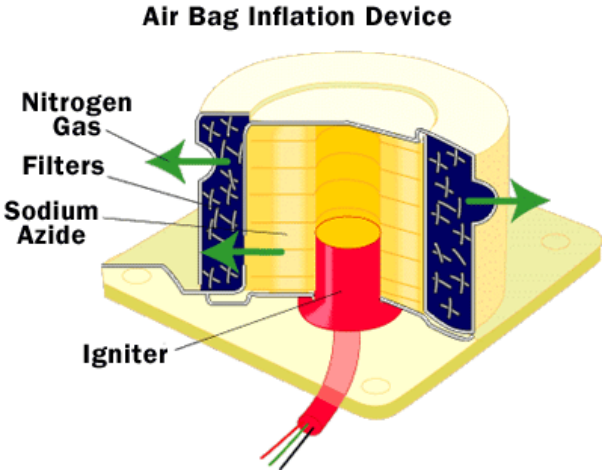


Dual-use chemicals: Sodium azide

- Industrial Uses
  - Propellant in automobile airbags
    - ~ 50g Driver side
    - ~ 200g Passenger side
  - Biocide in hospitals and laboratories
  - Anticorrosion solutions
- Illegal Uses
  - Gas more deadly than Hydrogen Cyanide when reacted with an aqueous oxidizer
  - Toxic by ingestion
  - Detonator for powerful explosives



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

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Dual-use chemicals: Cyanide

Therence Koh/AFP/Getty Images

* "Tylenol Crisis of 1982."

- Industrial Use
  - Cyanide consumption globally
    - 13% - mineral processing of gold, copper, zinc, silver
    - 87% - plastics, adhesives, and pesticides
- Illegal Use:
  - 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
  - K/NaCN is an Australian Group CW agent

http://en.wikipedia.org/w/index.php?title=Tylenol_Crisis_of_1982&oldid=173056508>.

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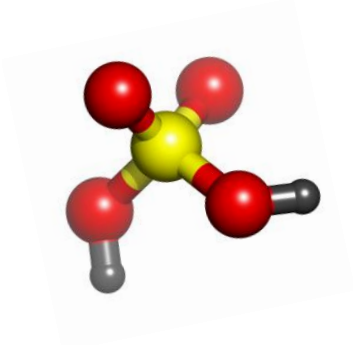

Dual-use chemicals: Chlorine

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

- Industrial Use
  - Manufacture of chlorine compounds
    - 63% - organic chlorine compounds
      - Examples: $C_2H_4Cl_2$ and C_2H_3Cl – (PVC)
    - 18% - inorganic chlorine compounds
      - Examples: HCl, HOCl, $AlCl_3$, $SiCl_4$, PCl_3
    - 19% - bleaches and disinfection products
- Illegal Use:
  - Incidents in which chlorine gas cylinders are blown up with explosives
    - Chlorine likely stolen/diverted from water purification plants or oil industry
    - Civilians and non-combatants injured
  - Chlorine first used in WWI as a chemical weapon

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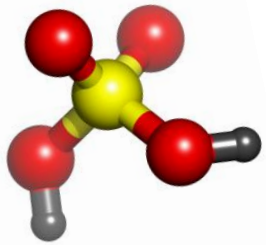
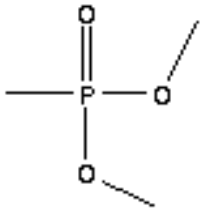
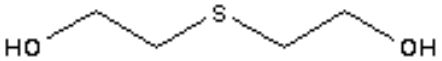


Dual-use chemicals: Precursors

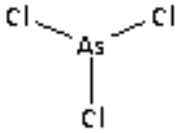
- Dimethyl methyl phosphonate (DMMP)
  - Flame retardant for:
    building materials, furnishings, transportation equipment, electrical industry, upholstery
  - **Nerve agent precursor**



- Thiodiglycol
  - Dye carrier, ink solvent, lubricant, cosmetics, anti-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 (Agent L, Schedule 1 CWC) precursor**



From: Chemical Weapons Convention: Implementation Assistance Programme Manual

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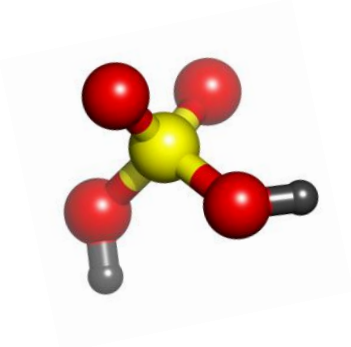

End product of dual-use chemicals: Triacetone Triperoxide

- Triacetone triperoxide (TATP) or Acetone Peroxide
- Nicknamed “Mother of Satan” because of its deadly nature
- Made using acetone, hydrogen peroxide, and a strong acid (i.e. HCl, H_2SO_4)
- Invisible to detectors looking for N-based explosives
- Used as Primary High Explosive
  - Sept 2009 arrest of N. Zazi, NY and Denver
  - July 2005 London suicide bombs
  - 2001 Richard Reid “shoe bomber”
  - 1997 New York subway suicide bomb plot

CAS 17088-37-8

Wikipedia downloaded Oct 2009
http://en.wikipedia.org/wiki/Acetone_peroxide

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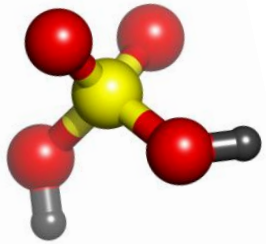

Dual-use Chemicals: Explosives

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

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Diversion of industrial / laboratory chemicals: Oklahoma bombing

Photo: US DOD

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

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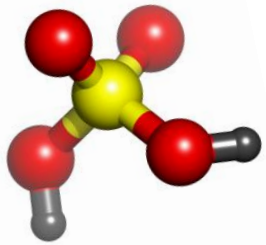

Diversion of industrial / laboratory chemicals: Bali bombing

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

Photo: www.zgeek.com

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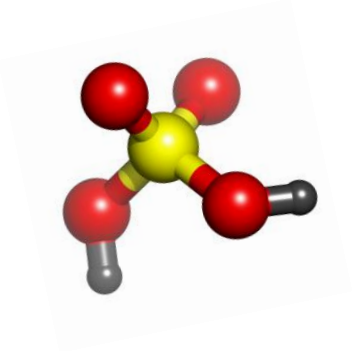

International Chemical Controls

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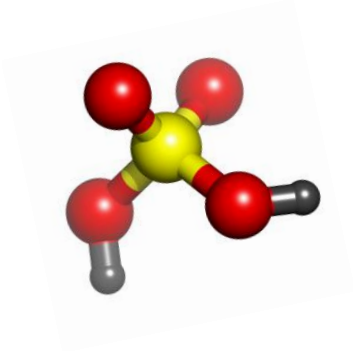

International chemical control groups

Two Main Groups:

Organisation for the Prohibition of Chemical Weapons

- **Implementing body of the Chemical Weapons Convention**

The Australia Group

- **Export controls**

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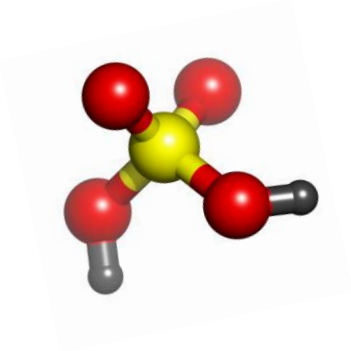
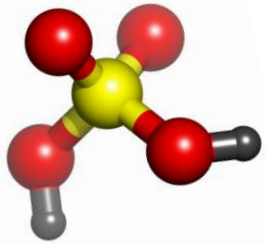


Organization for the Prohibition of Chemical Weapons (OPCW)

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

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM



OPCW: Promotes international cooperation in peaceful uses of chemistry

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

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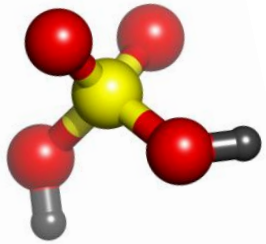

OPCW: Provide assistance and protection to fellow member states

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

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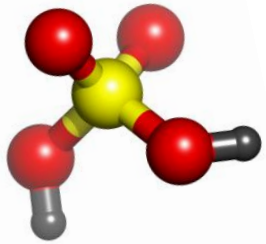

OPCW's – Chemical Weapons Convention

Designated 3 class of controlled substances:

- Schedule 1 – chemicals have few or no uses outside of chemical weapons
- Schedule 2 – chemicals have legitimate small-scale applications
- Schedule 3 – chemicals have large scale uses apart form chemical weapons

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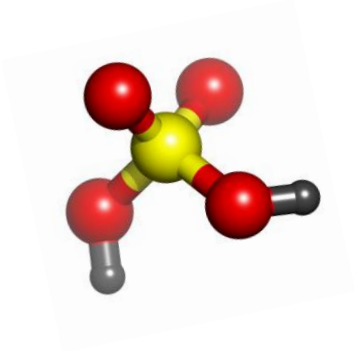

OPCW's – Schedule 1 Chemicals

Chemicals

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

Blistering Agents
5. Sulfur mustards
6. Nitrogen mustards
7. Lewisites

8. Saxitoxin – marine organisms
9. Ricin – plant toxin

Precursors

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

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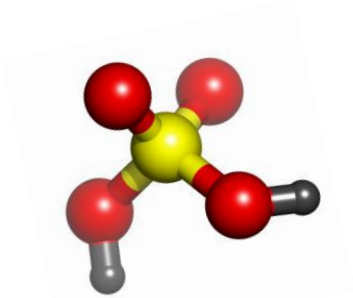

OPCW's – Schedule 2 Chemicals

Toxic chemicals:

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

Precursors:

4. Chemicals, except for those listed in Schedule 1, containing a phosphorus atom to which is bonded one methyl, ethyl or propyl group but not further carbon atoms,
   e.g. Methylphosphonyl dichloride (676-97-1)
   Dimethyl methylphosphonate (756-79-6)
   Exemption: O-Ethyl S-phenyl ethylphosphonothiolothionate (944-22-9)

5. N,N-Dialkyl phosphoramidic dihalides
6. Dialkyl N,N-dialkyl-phosphoramidates
7. Arsenic trichloride (7784-34-1)
8. 2,2-Diphenyl-2-hydroxyacetic acid (76-93-7)
9. Quinuclidin-3-ol (1619-34-7)
10. N,N-Dialkyl aminoethyl-2-chlorides
11. N,N-Dialkyl aminoethane-2-ols
    Exemptions: N,N-Dimethylaminoethanol (108-01-0)
    N,N-Diethylaminoethanol (100-37-8)

12. N,N-Dialkyl aminoethane-2-thiols
13. Thiodiglycol: Bis(2-hydroxyethyl)sulfide (111-48-8)
14. Pinacolyl alcohol: 3,3-Dimethylbutan-2-ol (464-07-3)

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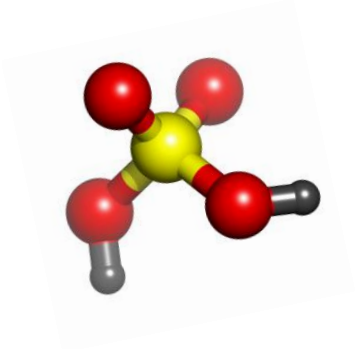

OPCW's – Schedule 3 Chemicals

Toxic chemicals:

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

Precursors:

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

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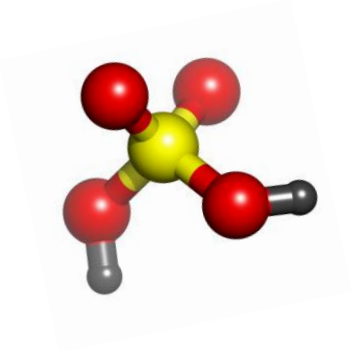

Australia Group

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

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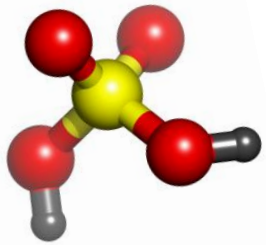

Australia Group: Export Controls

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

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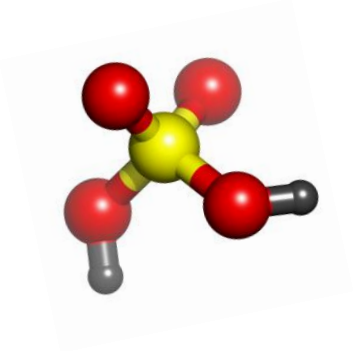

Dual-use summary

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

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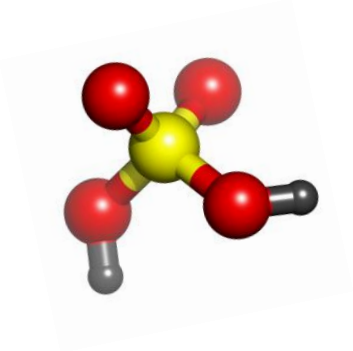
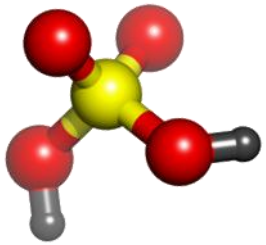


Tea Break!



Overview of Chemical Risk

SAND No. 2012-1606C

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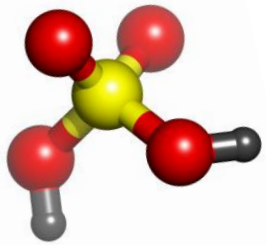
Sandia National Laboratories



Overview of Presentation

- Chemical safety incidents
- Current regulations and standards
- Chemical security incidents
- Security threats
- Cyber security threats
- International security resolutions and organizations

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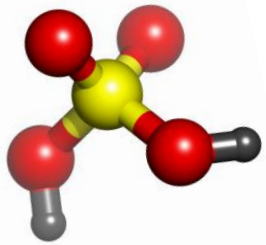

Laboratory Safety Incidents

Recent accidents in U.S. research laboratories

- University of California Los Angeles (UCLA)
  - Scale up of flammable chemical t-butyl lithium
  - Quantities of flammables stored in lab exceeded U.S. regulations
  - Improper personal protective equipment
- Texas Tech University
  - Scale up of nickel hydrazine perchlorate from 300milligrams to 10grams
  - U.S. Chemical Safety Board investigated
    - Physical hazards of chemicals not assessed or controlled
    - Insufficient chemical safety management
    - Lessons from previous incidents not *Learned*

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Texas Tech University Accident

Photo credit: U.S. Chemical Safety Board

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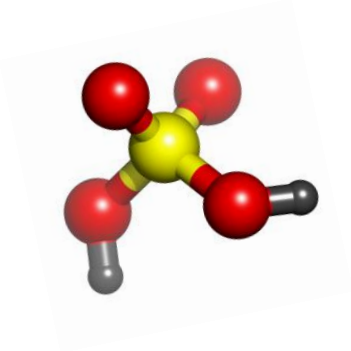

U. S Chemical Safety Board Video

CSB Videos – http://www.csb.gov/videoroom/videos.aspx?cid=1
UCLA/Texas Tech/Dartmouth Incidents

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Industrial Incidents

Catastrophic process incidents:

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

More recently:

- 2009-Fertilizer tank collapses
  - 2 critically injured
  - Responders exposed to ammonia
  - ~760 m^3 of fertilizer released
  - River contaminated
- 2007-Fire and Explosion
  - Filling ethyl acetate storage tank
  - Equipment not bonded and grounded

Photo credit. U.S. Chemical Safety Board.

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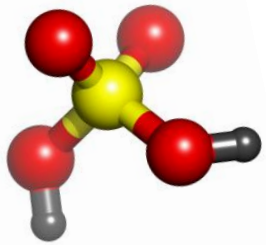

Regulations and Standards

- Individual country regulations
  - European Union REACH
  - U.S. Risk Management Standard
- International chemical & labor organizations
  - ICCA Responsible Care
  - International Labor Organization
- International standards
  - ISO 14001:2004
  - OHSAS 18001
  - United Nations-GHS
  - SAICM

ICCA

ILO International Labour Organization

ISO International Organization for Standardization

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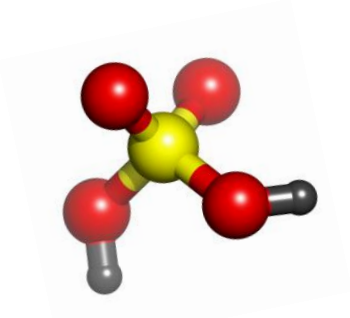

What about chemical security?

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

Abandoned Bhopal Plant
Photo credit: AP/Saurabh Das

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What are the threats to chemical security?

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

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Threats to Cyber Security

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

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International Resolutions & Organizations

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

Responsible Care Security Code

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How are chemical safety and chemical security related?

Both Ensure Protection of:

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

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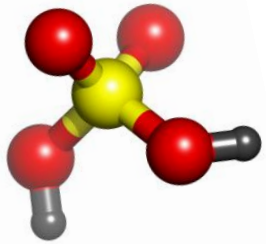

Summary of Presentation

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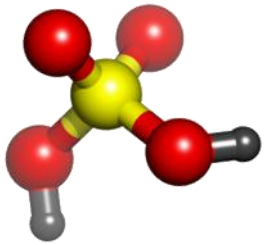

Chemical Safety and Security Risk Assessment

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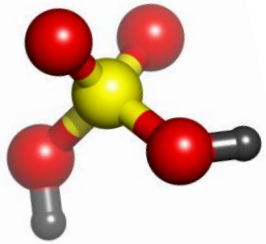

Module Overview: Chemical Safety and Security Risk Assessment

- Module Learning Outcomes
- Risk Basics
- Chemical Safety Risk Assessment
- Chemical Security Risk Assessment
- Summary, Conclusions, and Evaluations

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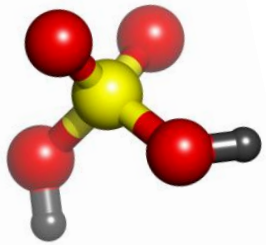

Module Outcomes: After this module, you should…

- Understand the definition of risk and the difference between hazard and risk
- Understand how other factors can influence risk perception
- Be able to assess and characterize the safety risks associated with chemical facilities
- Be able to assess and characterize the security risks associated with chemical facilities

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Risk Basics Overview

- Hazard vs. Risk
- Definition of Risk
- Activity: Risk Perception
- Safety and Security
- Risk Characterization
- Risk Reduction

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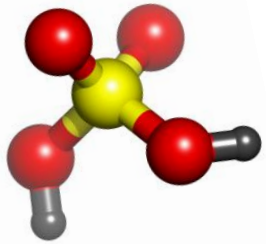

Risk Basics: Hazard vs. Risk

- There is a difference between ***hazard*** and ***risk***
  - Hazard
    - Something that has the potential to do harm
- Is there a hazard in this picture? If so, what type?
- Is it a risk? If so, how much of a risk?
  - Depends on the situation

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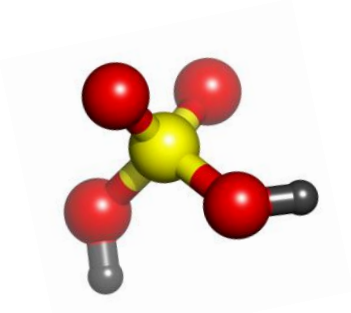

Risk Basics: Hazard vs. Risk

- What is wrong?
  - Overloaded circuit

Hazard

- What are the possible scenarios?
  - Blown fuse
  - Worker injury
  - Fire
- What is the likelihood?
  - Factors that lead to an event
    - Work habits, no electrical training
- What are the consequences?
  - Other factors and things that follow an event
    - Electrocution, fire, loss of experiment/process

Risk

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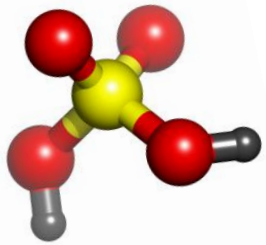
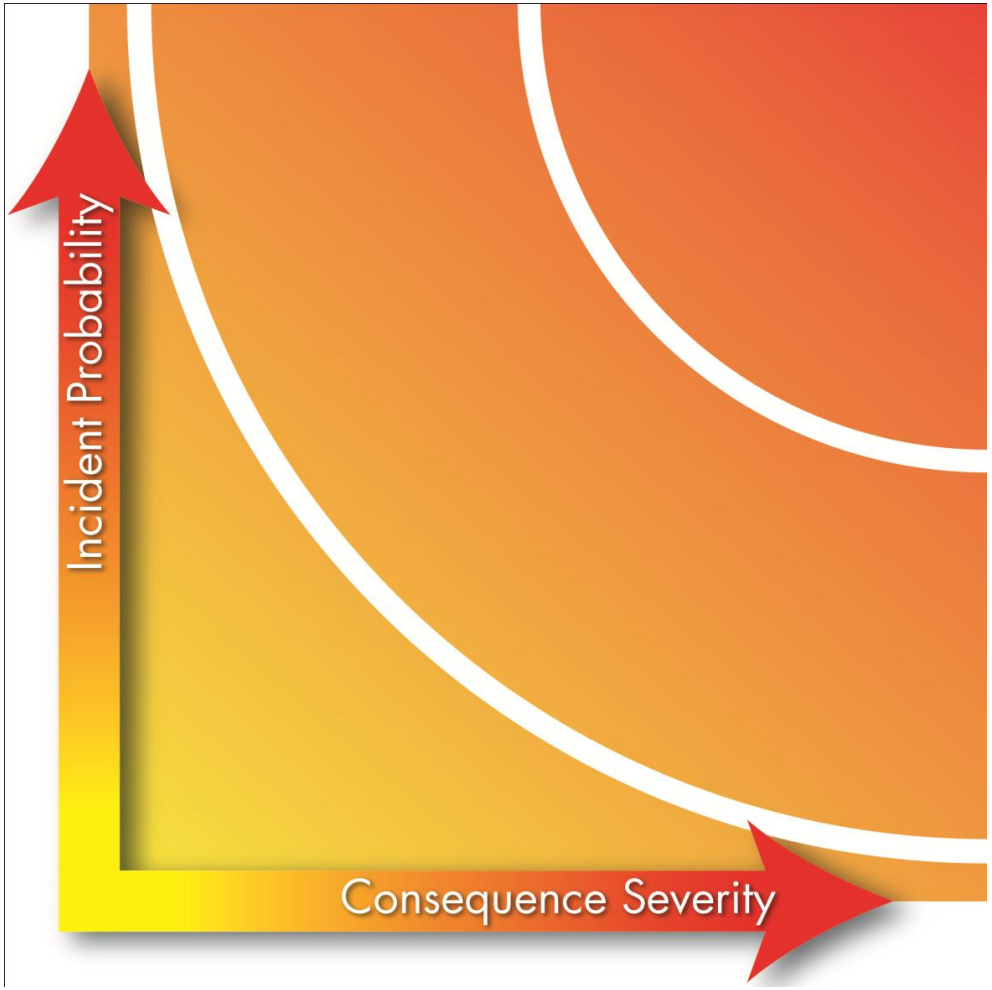


Risk Basics: Definition

Risk is a function of

- Probability that an incident will occur (**likelihood**)
- Severity if the event occurs (**consequence**)



Risk = *f* (Likelihood, Consequence)

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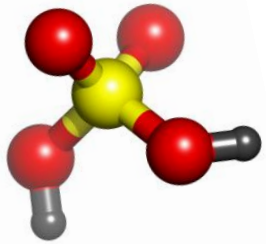

Activity: Risk Perception

- On the next page--

- Rank each action or technology according to your perception of its RISK
  - A rank of 1 means riskiest
  - A rank of 15 means least risky

Take about 10 minutes to do this

* Adapted from Slovic et al. “Facts and Fears: Understanding Perceived Risk.” In R. C. Schwing and W. A. Albbers, Jr. (eds.) Societal Risk Assessment: How Safe is Safe Enough? New York: Plenum, 1980, 181-216.

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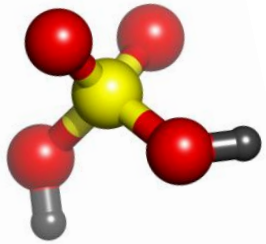

Rank these Activities (#1- #15) by Risk Level

Police work
Commercial Air
X-rays
Mountain climbing
Prescription antibiotics
Alcoholic beverages
Nonnuclear electric power
Railroads
Smoking
Pesticides
Motor vehicles
Spray cans
Bicycles
Swimming
Nuclear power

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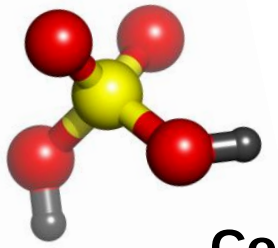

Activity: Risk Perception

College Students[1]	Experts[2]
1. Nuclear power	1. Motor vehicles
2. Smoking	2. Smoking
3. Pesticides	3. Alcoholic beverages
4. Motor vehicles	4. X-rays
5. Alcoholic beverages	5. Pesticides
6. Police work	6. Nonnuclear electric power
7. Spray cans	7. Swimming
8. Traveling by commercial flight	8. Bicycles
9. X-rays	9. Travelling by commercial flight
10. Nonnuclear electric power	10. Police work
11. Prescription antibiotics	11. Railroads
12. Mountain climbing	12. Nuclear power
13. Railroads	13. Prescription antibiotics
14. Bicycles	14. Spray cans
15. Swimming	15. Mountain climbing

1 Thirty US college students participated in this study
2 A group of fifteen risk assessment professionals in the US

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Risk Basics: Definition

College Students

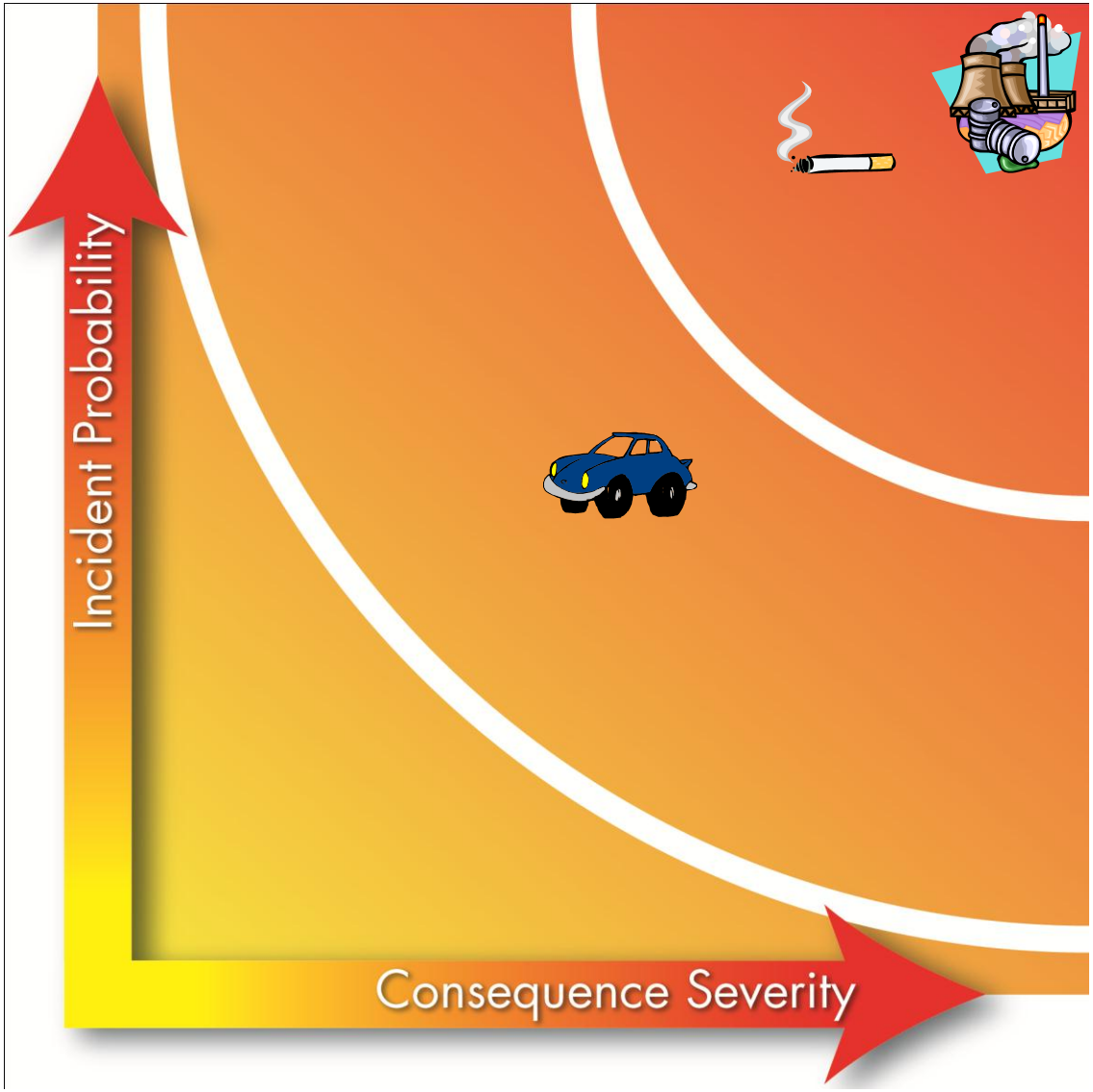
1. Nuclear Power
2. Smoking

4. Motor Vehicles

Experts

1. Motor Vehicles
2. Smoking

12. Nuclear Power



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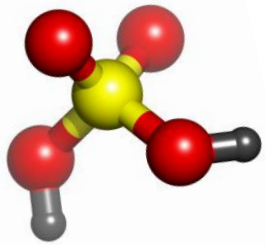

Activity: Risk Perception

- What do you think may have influenced your risk assessment besides your best guesses regarding ***likelihood*** and ***consequence***?

- Emotional Risk Perception Factors (examples)
  - Involuntary vs. Voluntary
  - Immoral vs. Moral
  - Unfamiliar vs. Familiar

What ***should*** be the basis for your professional Risk Assessment of Chemical Safety and Security?

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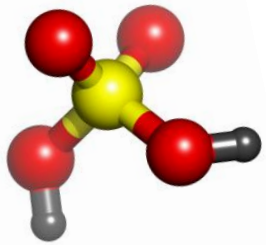

Risk Basics: Safety and Security

- Risk concept
  - Applies to both Chemical ***Safety*** and Chemical ***Security***

- Safety Incident
  - Spill
  - Accidental exposure
  - Uncontrolled reaction

- Security Incident
  - Theft or diversion of dual-use chemicals
  - Intentional release
  - Sabotage

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Chemical Safety Risk Characterization

1. **Low**
   - Procedures are routine; staff is trained and experienced; materials used are mostly benign and/or present in microscale amounts only
   - An incident would not likely be an emergency

2. **Moderate**
   - Procedures are not routine; staff may be partially trained or have limited experience; materials are reactive, flammable, toxic, and/or present in moderate quantity
   - An incident could constitute or develop into an emergency

3. **High**
   - Procedures are novel or extremely delicate; staff may be untrained or inexperienced; materials are highly reactive, toxic, explosive and/or present in large quantities
   - Process is under high temperature and/or pressure
   - An incident would be a life and facility-threatening emergency

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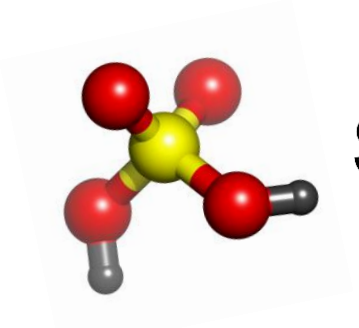
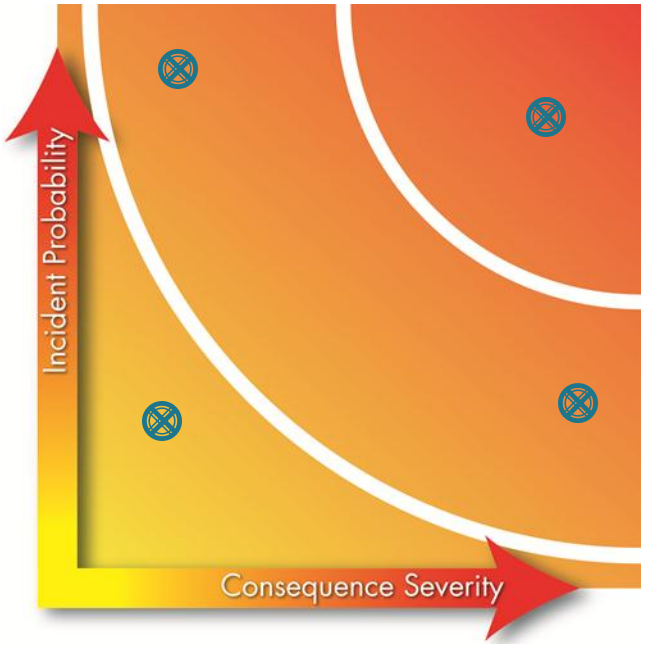


Security Risk Characterization

1. **Low**
   - Assets are possibly targets for theft or diversion
   - Consequences of loss or release are minimal

2. **Moderate**
   - Assets are attractive for theft or diversion due to monetary value or dual-use
   - Consequences could threaten the public; misuse could be harmful or even lethal to a small number of people, and would certainly damage the institution, its programs, and reputation

3. **High**
   - Assets are very valuable or hard to acquire dual-use materials
   - Consequences of misuse could result in harm or death to many people



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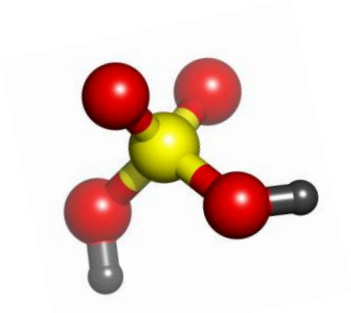

Safety and Security Risk Characterization

- What are the benefits of characterizing risks?
- Can risks ever be reduced to zero?
- What does it take to reduce CSS risk?
  - Are resources for risk reduction limitless?

Characterizing CSS risks is a necessary step toward responsible and effective allocation of finite resources to reduce risk to acceptable levels

Risk reduction measures should always be applied in a graded manner

Large effort made to reduce high risks

Smaller effort made to reduce low risks

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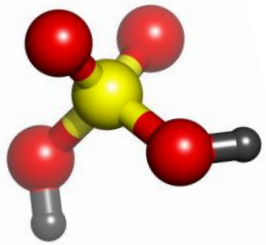

Risk Basics: Reduction

- Types of CSS Controls
  - Administrative
  - Operational
  - Engineering
  - PPE
- Decrease likelihood
- Decrease consequence

Risk = *f*(Likelihood, Consequence)

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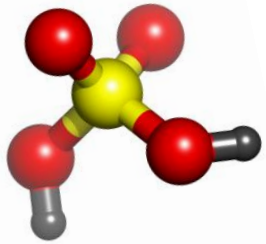

Module Overview: Chemical Safety and Security Risk Assessment

☑Module Learning Objectives

☑Risk Basics

- **Chemical Safety Risk Assessment**
- Chemical Security Risk Assessment
- Summary, Conclusions, and Evaluations

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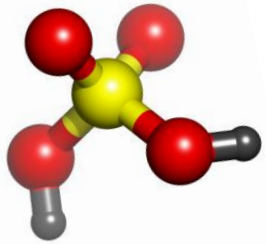
Chemical Safety Risk Assessment: Overview of the Process



1. Examine Jobs and

2. Identify Hazards

3. Characterize Safety Risks

4. Are Risks Acceptable?

Yes

No

5. Implement Additional Control

Proceed with work and
6. Follow up with periodic repeat of steps 1-5

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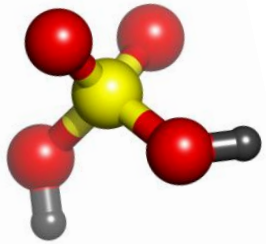

Chemical Safety Risk Assessment

1. Examine jobs and processes

- Analyze for each step in the process
  - Who, what, where, when, and how?
    - Could exposure occur?
    - Could an accident occur?

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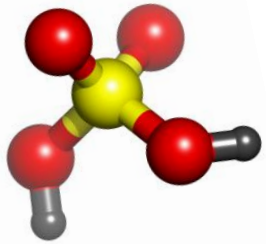

Chemical Safety Risk Assessment

1. Examine jobs and processes

Example: Precipitation of gold from cyanide solution

- 2 junior researchers in the laboratory with only minimal training and not accustomed to using PPE
- About twice a week, zinc powder is added to 100 mL of an aqueous, 0.10 M sodium cyanide solution containing dissolved gold
- The gold precipitates and is collected by filtration
- Work is performed on a crowded open benchtop alongside work on another project that involves preparing numerous HCl solutions

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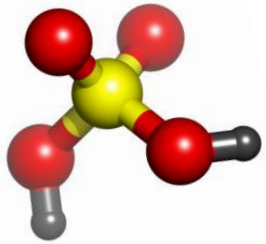

Chemical Safety Risk Assessment

2. Identify hazards

- On the basis of materials and equipment present

Example: 100 mL of a 0.10 M sodium cyanide solution

- Acute toxin
  - Harmful exposure can occur through ingestion, absorption through broken skin, or inhalation upon conversion to HCN gas by reaction with an acid

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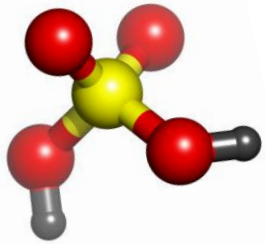

Chemical Safety Risk Assessment

3. Characterize safety risks

Example: regular work with sodium cyanide solutions

- What are the factors affecting the likelihood of exposure?
  - Do you think the likelihood of exposure is low, moderate, or high?

- What are the factors affecting the consequences of exposure?
  - Do you think the consequences of exposure are low, moderate, or high?

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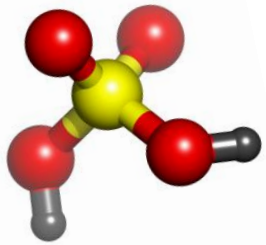
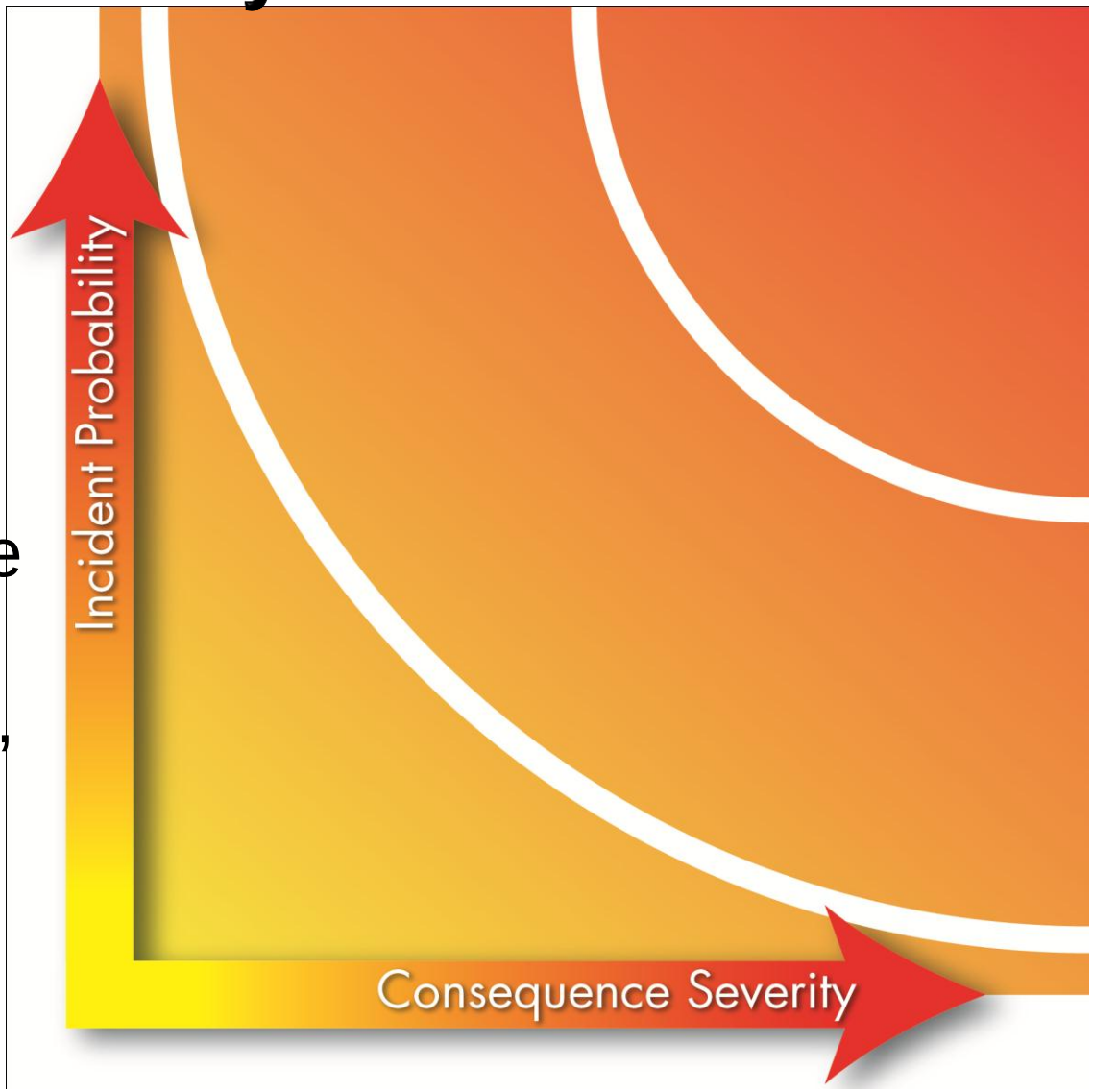


Chemical Safety Risk Assessment

3. Characterize safety risks

On the basis of *likelihood* and *consequence*, are the risks of exposure to NaCN low, moderate, or high?

Why?



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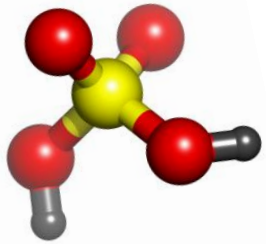

Chemical Safety Risk Assessment

4. Are risks acceptable?

- Would you feel safe if you were doing this work?
  - Why/why not?
- Are current controls and practices reducing risk of exposure to acceptable levels?
  - Why or why not?
- Are there national standards for occupational exposure to cyanide?
- Are there other limits imposed by the institution?
  - If you don't know, how can you find out?
  - What do you do if there are not established limits?

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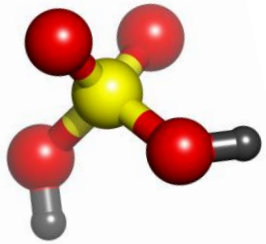

Chemical Safety Risk Assessment

5. Implement additional control measures where needed to reduce safety risks to acceptable levels

- What controls are needed to reduce the risk of exposure?
  - Substitution
  - Engineering
  - Administrative
  - PPE

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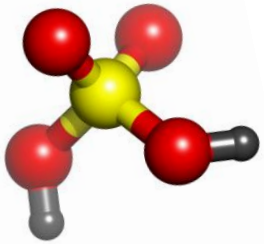
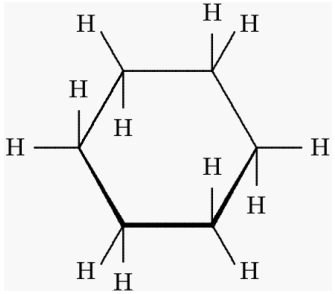


Controls

Change the process

eliminate the hazard

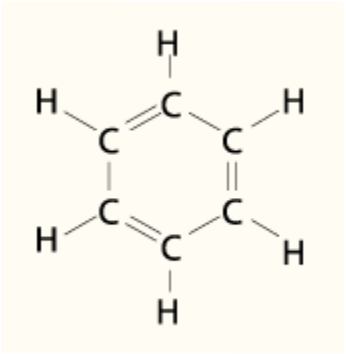
(e.g. Lower process temperature)



Substitution

less-hazardous substance

(e.g. - cyclohexane for benzene)



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Engineering Controls

Enclose the hazard,

- **Use a barrier or**
- **Ventilate**
  - **Dilution ventilation**
  - **Local exhaust ventilation** (LEV)

Administrative Controls

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

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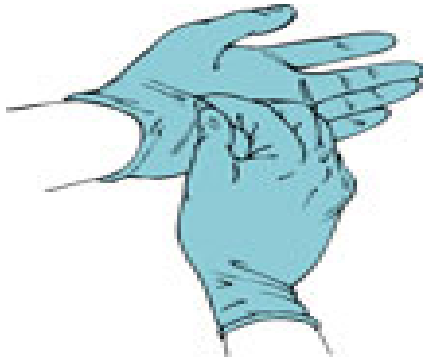
Personal Protective Equipment – PPE

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



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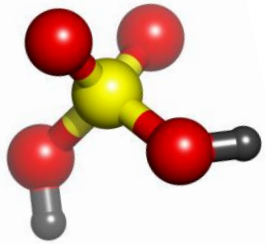

Chemical Safety Risk Assessment

6. Follow up with periodic repeat of steps 1-5

- Have practices or people changed?
- Could further improvements be made?
- How often should follow-up assessments be performed?

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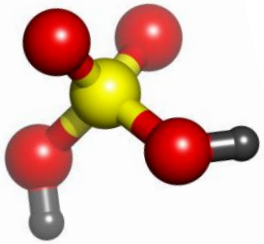
Chemical Safety Risk Assessment: Overview of the Process



1. Examine Jobs and

2. Identify Hazards

3. Characterize Safety Risks

4. Are Risks Acceptable?

Yes

No

5. Implement Additional Control

Proceed with work and
6. Follow up with periodic repeat of steps 1-5

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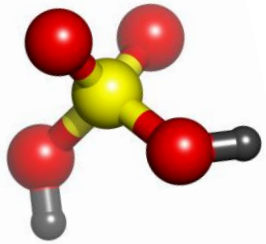

Activity: Chemical Safety Risk Assessment

- Get into three groups
- Identify one job or process that occurs in your laboratory or facility
- Perform a safety risk assessment
- Be prepared to discuss your results with the whole group

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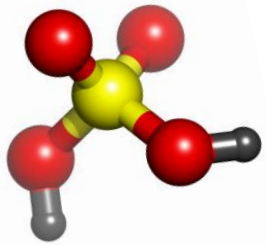


Module Overview: Chemical Safety and Security Risk Assessment

☑Module Learning Objectives

☑Risk Basics

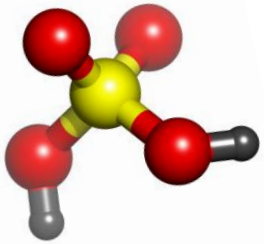
☑Chemical Safety Risk Assessment

- **Chemical Security Risk Assessment**
  - **Dual-Use Chemicals**

- Summary, Conclusions, and Evaluations

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM

Chemical Security Risk Assessment: Overview of the Process



1. Evaluate Threat Potential
2. Identify Assets
3. Characterize Security
4. Are Risks Acceptable?
   - Yes
   - No → 5. Implement Additional Security → 1. Evaluate Threat Potential
6. Proceed with work and follow up with periodic repeat of steps 1-5

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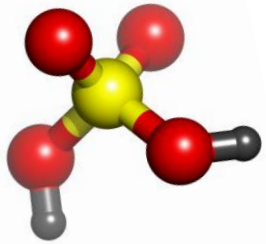

Chemical Security Risk Assessment

1. Evaluate threat potential

- Adversaries
  - Motive
  - Means
  - Opportunity
    - Outsiders — no authorized access
    - Insiders — authorized access
    - Collusion — between Outsiders and Insiders
- Actions
  - Sabotage
  - Theft
- Assets

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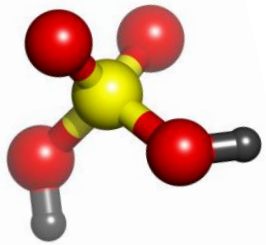

Chemical Security Risk Assessment

2. Identify security hazards - Assets

- Information
- Equipment
- Expertise
- Dual-use materials
  - Need a working inventory
  - Need an understanding of dual-use materials
    - Likelihood and Consequences of malicious use
      - Ease or difficulty
      - Quantity
      - Location
      - How they are used

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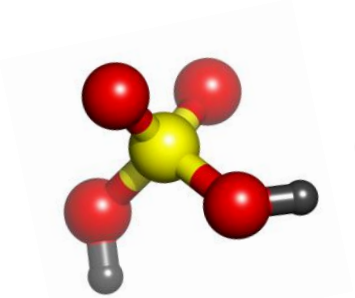

Chemical Security Risk Assessment

3. Characterize security risks

- Create and analyze scenarios
  - Adversary
  - Action
  - Asset

  - What are the factors affecting the likelihood of a security incident?
    - Do you think the likelihood is low, moderate, or high?

  - What are the factors affecting the consequences of a security incident?
    - Do you think the consequences are low, moderate, or high?

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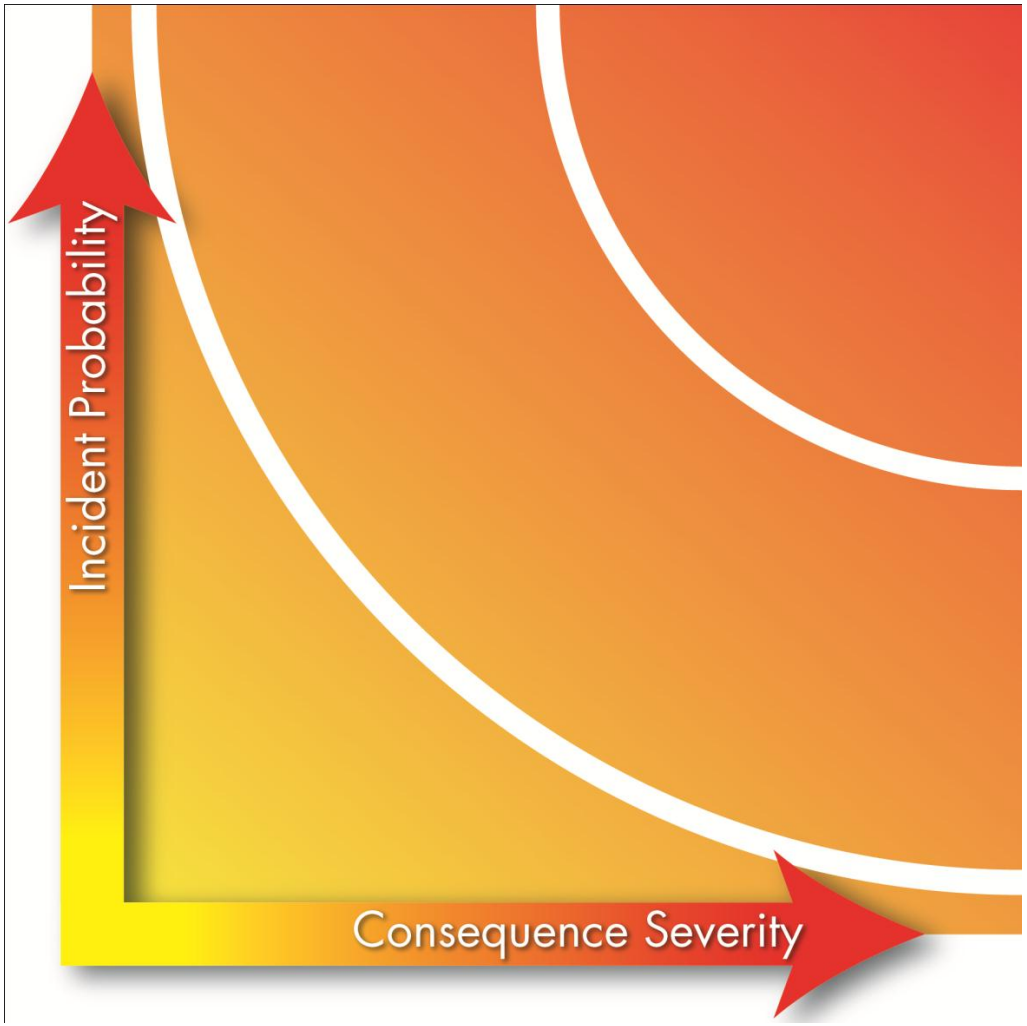
Chemical Security Risk Assessment

3. Characterize security risks

On the basis of *likelihood* and *consequence*, are the security risks low, moderate, or high?

Why?



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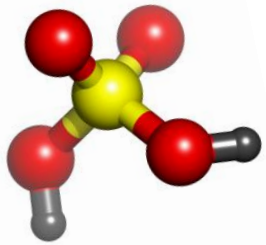

Chemical Security Risk Assessment

3. Characterize security risks

- Is it possible to analyze, protect against, or even think of every possible scenario?
  - No

- So what should be done?

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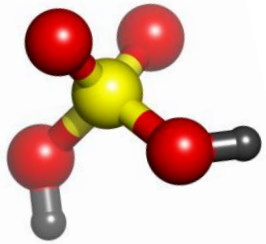

Chemical Security Risk Assessment

4. Are risks acceptable?

- If you are accountable for the security of the assets, how do you establish an acceptable level of security risk?
  - Are there national security standards?
  - Are there other limits imposed by the institution?
    - If you don't know, how can you find out?
    - What do you do if there are not established limits?

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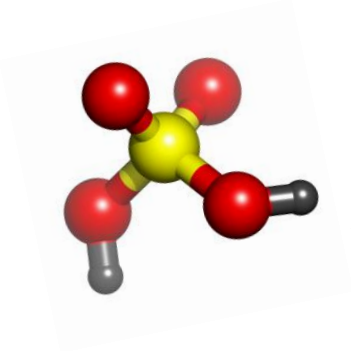

Chemical Security Risk Assessment

5. Implement additional control measures where needed to reduce security risks to acceptable levels

- What controls are needed to reduce the security risks?
  - Administrative
  - Operational
  - Engineering

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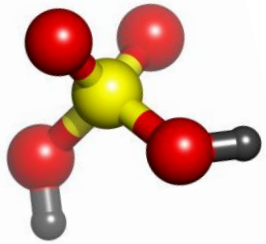

Chemical Security Risk Assessment

6. Follow up with periodic repeat of steps 1-5

- Have scenarios changed?
- Could further improvements be made?
- How often should follow-up assessments be performed?

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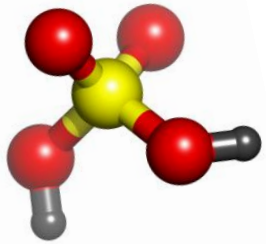
Chemical Security Risk Assessment: Overview of the Process



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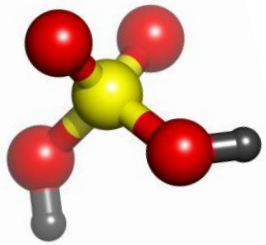

Chemical Security Risk Assessment

- Main points
  - Likelihood of a security threat scenario may be higher than you think
    - Out of chemical, biological, nuclear, and radiological materials, ***chemicals*** are used maliciously ***the most often***
  - Consequences can range from low to high

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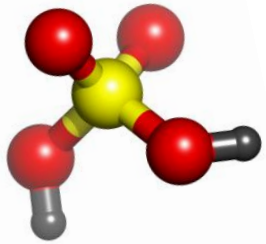
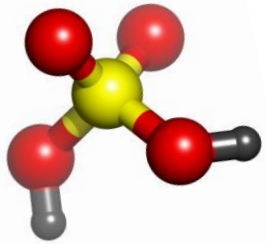


Module Summary: Chemical Safety and Security Risk Assessment

- ☑Module Learning Objectives
- ☑Risk Basics
- ☑Chemical Safety Risk Assessment
- ☑Chemical Security Risk Assessment
- **Summary, Conclusions, and Evaluations**

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM



Conclusions

- Risk is a function of Likelihood and Consequence
  - Applies to both safety and security

- Chemical labs and plants need to be ***safe***, ***secure***, and ***productive***
  - Assessing and characterizing CSS risks allows controls to be applied in a graded manner
    - Larger efforts toward reducing high risks
    - Smaller efforts toward reducing low risks

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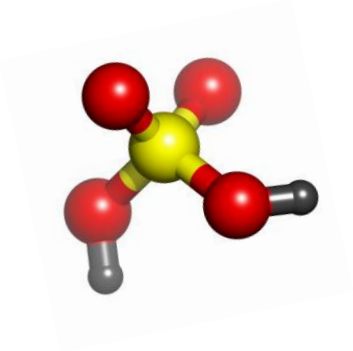

LUNCH

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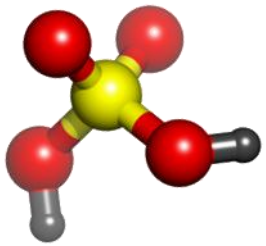

Deepwater Horizon Oil Spill a Case Study in Risk Assessment & Risk Management

SAND No. 2011-4999 P
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.

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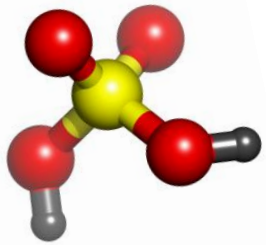
Sandia National Laboratories



Deepwater Horizon Oil Spill

- Background
- Accident Investigation
- Critical Factors
- Key Findings from the Accident Investigation
- Management of Risks from the Investigation's Recommendations
- Mitigation of Risks
- Discussions

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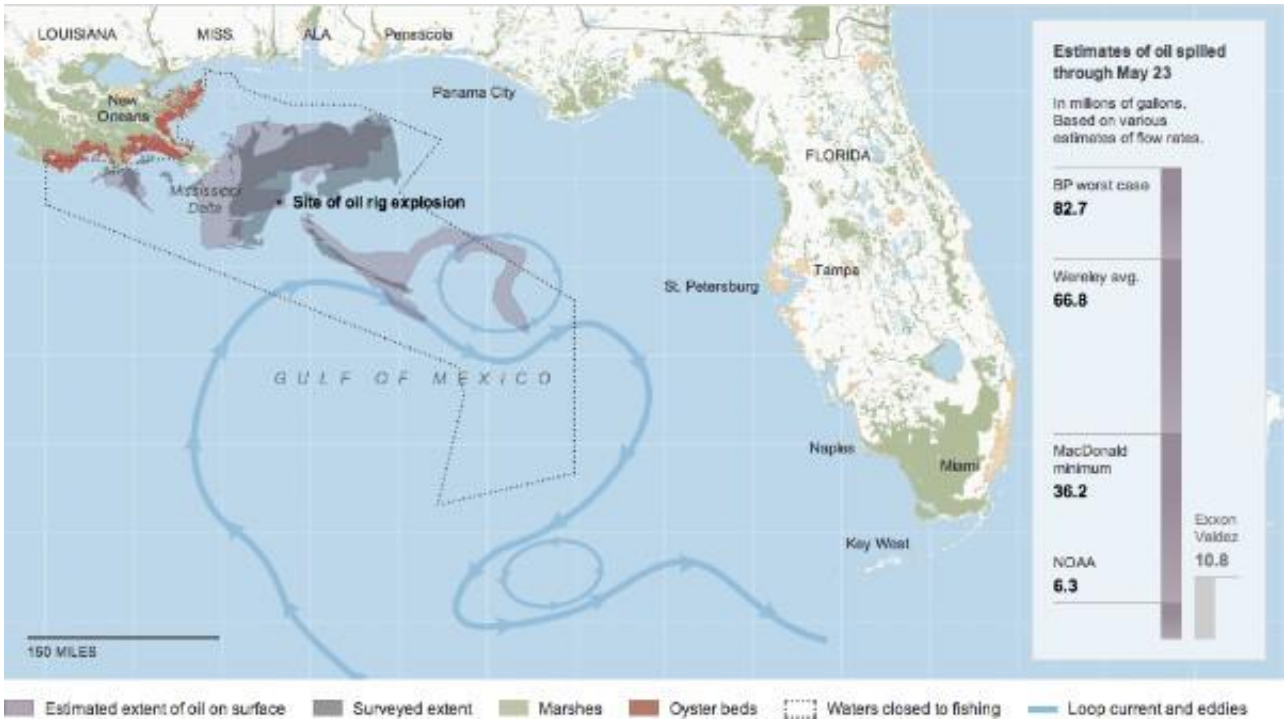
Background

April 20, 2010 – the Deepwater Horizon, an offshore drilling rig owned by Transocean and under lease to BP, was performing drilling operations in the Gulf of Mexico 77 km (48 miles) off the Louisiana coast.



From the New York Times' Interactive Oil Spill Map, 24 May 2010. Deepwater Horizon Oil Spill.

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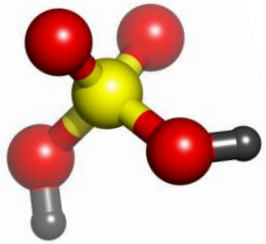

Background

During the operation a complex series of events permitted hydrocarbons from the well to enter into the wellbore and up into the Deepwater Horizon rig. The presence of hydrocarbons in the rig resulted in a series of explosions and fires in which;

- 11 people lost their lives,
- 17 others were injured,
- the rig burned and sank after 36 hours,
- Hydrocarbons continued to flow from the reservoir for 87 days until it was sealed on July 15, 2010,
- The estimated amount of oil spilled over the 87 days was 4.9 million barrels (780,000 m^3).

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM

Background

Coast Guard Image of the Deepwater Horizon Oil Rig fire taken Wed 21 Apr 2010 08:20:15 AM EDT

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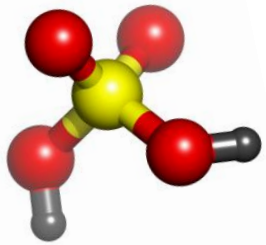


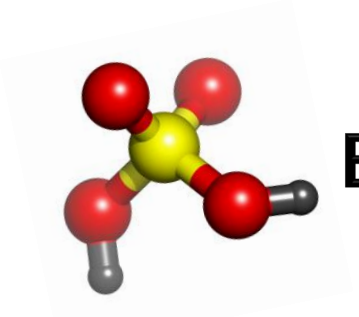
Background

- *Deepwater Horizon Oil Rig* – a semi-submersible, dynamically positioned, ultra-deep water mobile off-shore drilling platform. It was built by Hyundai Heavy Industries in 2001 for R&B Falcon (which was acquired by Transocean Ltd.). The cost was US $340 million dollars. In 2010 it was insured for US $560 million.[1]

- *BP Plc British Petroleum* – BP is a global company. It is one of the world's leading international companies specializing in oil and gas exploration, and supply. Sales and other operating revenues were $297,107 million in 2010; 79,700 employees and active in 29 countries.[2]

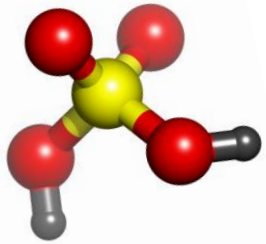
- *Transocean Ltd.* – the world's largest offshore drilling contractor with 18,000 employees. They leased the Deepwater Horizon Oil Rig to BP and operated it.

1) Wikipedia – http://en.wikipedia.org/wiki/Deepwater_Horizon
2) www.bp.com



Background

- *Halliburton* – one of the world's largest providers of services and products to the oil industry. They have more than 60,000 employees worldwide and operate in 80 countries. They supplied the cement.
- *Cameron International Corp.* – provides flow equipment products, system and services worldwide to oil, gas and process industries. They have 18,000 employees worldwide and operate in more than 300 locations around the world. They designed and built the blow out preventer (BOP).
- *US Coast Guard* – performs annual inspections on US flagged rigs and annual examinations on foreign flagged rigs. For US flagged rigs they focus on safe manning and operation, inspect lifesaving, fire-fighting, hull integrity, vessel stability, occupational health & safety, electrical systems, etc. The flag state of the rig has the primary responsibility of ensuring compliance with international standards. The US can set certain requirements and conditions for foreign flagged rigs.



Accident Investigation

- Following the accident BP put together an investigation team.
- The team consisted of the following specialists:
  - safety, operations, subsea, drilling, well control, cement, modelers specializing in well flow dynamics, blow out preventer system specialists as well as process hazard analysts.
- The team used information from Transocean, Cameron, Halliburton and other companies to compile this report.

There was no one single cause for this accident; rather, a complex and interlinked series of mechanical failures, human judgments, engineering design, operational implementation and team interfaces that came together.[1]

1) BP Report - "Deepwater Horizon Accident Investigation Report", Sep. 8, 2010, p. 11, issued by BP, this document and accompanying appendices can be downloaded from the BP Website, http://www.bp.com/sectiongenericarticle.do?categoryId=9036598&contentId=7067574.

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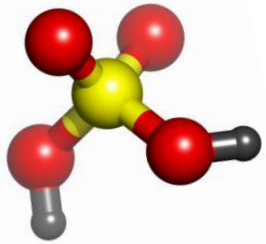

Critical Factors

The following critical factors were responsible for the accident and the aftermath to occur –

- Oil well integrity was not established or failed,
- Hydrocarbons entered the well undetected and well control was lost,
- The hydrocarbons ignited on the Deepwater Horizon Rig,
- The blow out preventer (BOP) malfunctioned and did not seal the well.

1) BP Report - “Deepwater Horizon Accident Investigation Report”, Sep. 8, 2010, p. 31, issued by BP, this document and accompanying appendices can be downloaded from the BP Website, http://www.bp.com/sectiongenericarticle.do?categoryId=9036598&contentId=7067574.

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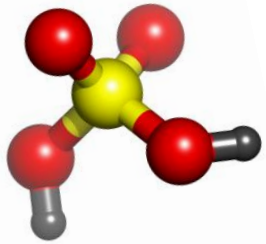

Key Findings from the Accident Investigation

- The following key findings were taken from an internal report prepared by BP titled - “Deepwater Horizon Accident Investigation Report”, Sep. 8, 2010 issued by BP (192 pages),[1]
- They also prepared a video titled “Deepwater Horizon Investigation”. [1]

1) BP Report - “Deepwater Horizon Accident Investigation Report”, Sep. 8, 2010 issued by BP, this document and accompanying appendices can be downloaded from the BP Website, http://www.bp.com/sectiongenericarticle.do?categoryId=9036598&contentId=7067574.

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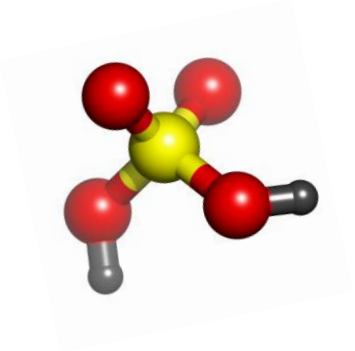
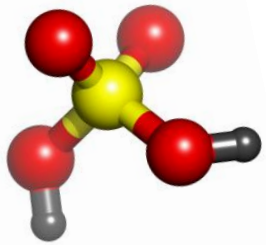


8 Key Findings[1]

- Key Finding #1 – The annulus cement barrier did not isolate the reservoir hydrocarbons.
- Key Finding #2 – Two barriers that should have prevented hydrocarbons from entering the well bore failed (the shoe track and the float collar).
- Key Finding #3 – Personnel accepted a negative pressure test, but in fact well integrity had not actually been established.
- Key Finding #4 – Even though hydrocarbons had made their way into the wellbore the crew did not recognize it. They responded after the hydrocarbons had passed the BOP and into the riser.

1) BP Report - "Deepwater Horizon Accident Investigation Report", Sep. 8, 2010 issued by BP, this document and accompanying appendices can be downloaded from the BP Website, http://www.bp.com/sectiongenericarticle.do?categoryId=9036598&contentId=7067574.

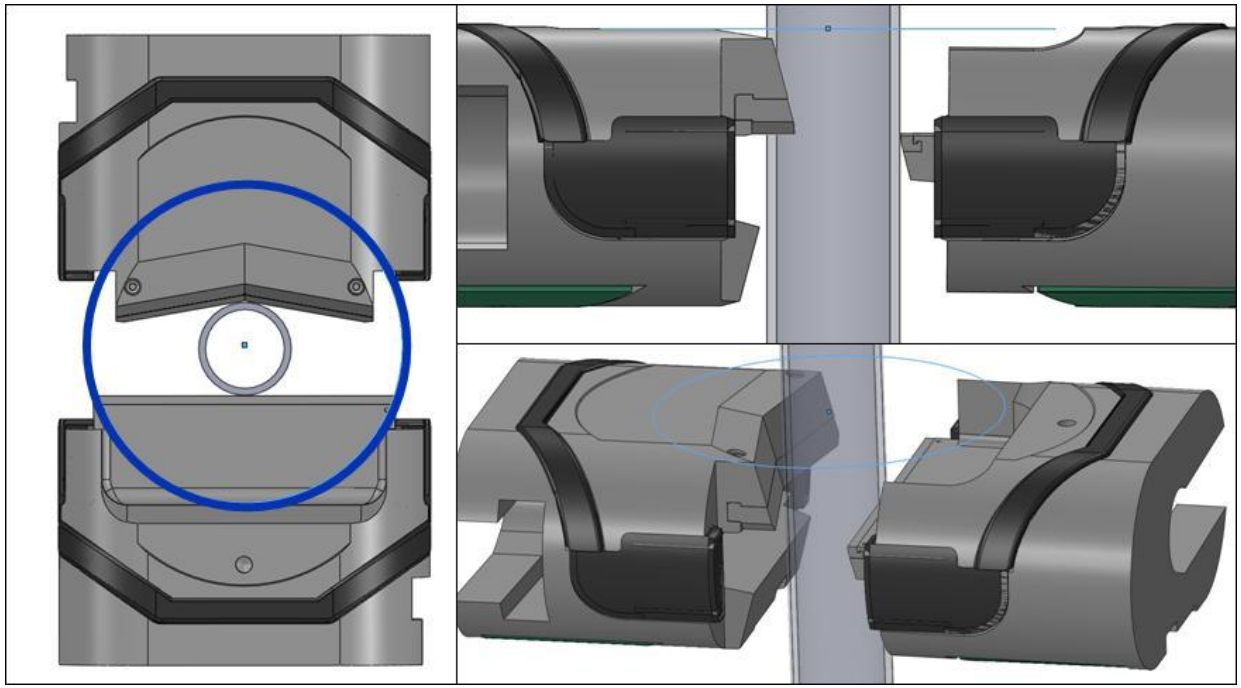


8 Key Findings - continued

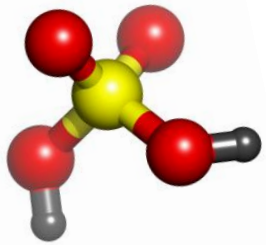
- Key Finding #5 – Actions to gain control of the well failed when they did not close the BOP[1] and the diverter. The high pressure fluids should have been diverted overboard rather than into the mud gas separator (MGS).
- Key Finding #6 – By allowing the large quantity of mud and hydrocarbons to go into the MGS the MGS was overwhelmed and the hydrocarbons were vented into the rig. These flammable gases found their way to any number of ignition sources.
- Key Finding #7 – The oil rig as a whole was not electrically classified, only certain sections.
- Key Finding #8 – The BOP emergency mode operation failed to seal the well. There are three methods for operating the BOP during an emergency – all three failed.

1) Cameron Intl. Corp., who supplied the BOP, claimed that the BOP was not designed to operate at the extreme ocean depths where the Deepwater Horizon rig drilling at the Macondo well.

Blind Shear Ram



Source - DET NORSKE VERITAS Final Report for UNITED STATES DEPARTMENTOF THE INTERIOR BUREAU OF OCEAN ENERGY MANAGEMENT, REGULATION, AND ENFORCEMENT WASHINGTON, DC 0240 FORENSIC EXAMINATION OF DEEPWATER HORIZON BLOWOUT PREVENTER CONTRACT AWARD NO. M10PX00335 VOLUME I FINAL REPORT Report No. EP030842 20 March 2011



Key Findings from the Accident Investigation

- BP's investigation team did not identify any single action or lack of any action that was the cause of the accident.
- They found that the accident was caused by a complex and interlinked series of –
  - Mechanical failures,
  - Human judgments,
  - Engineering design,
  - Operational implementation,
  - Team interfaces.

These factors all allowed the initiation and escalation of the accident.

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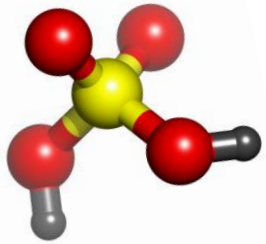

BP Investigation Team's Recommendations

From the Investigation Team's 8-Key Findings they outlined a series of recommendations that cover two areas –

1. Drilling and Well Operations Practice (DWOP) and Operating Management System (OMS) implementation

2. Contractor and service provider oversight and assurance

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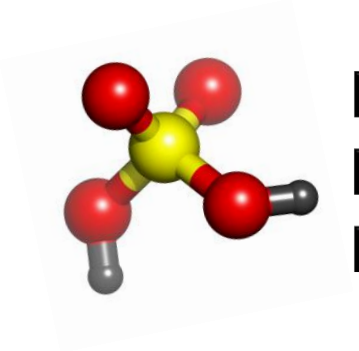

BP Investigation Team's Recommendations - DWOP & OMS Implementation Recommendations…

- Update, review and clarify Procedures and Engineering Technical Practices
- Strengthen Capability and Competency
  - Reassessing key personnel's roles in the areas of cementing,
  - Ensure adequate coverage of key personnel,
  - Develop programs to build key technical proficiencies,
  - Develop certification processes that include testing and demonstration of skills,
  - Develop advanced deepwater well control training programs,
  - Embed lessons learned from the Deepwater Horizon accident,
  - Request that the International Association of Drilling Contractors, review and consider developing formal certification programs.

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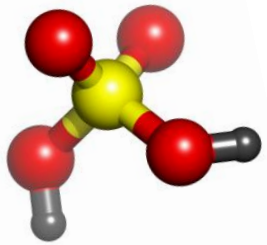
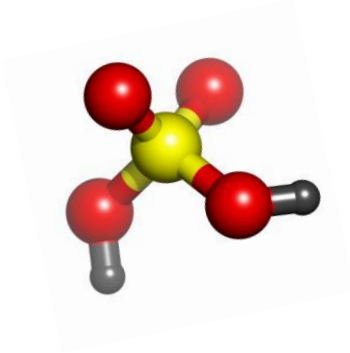


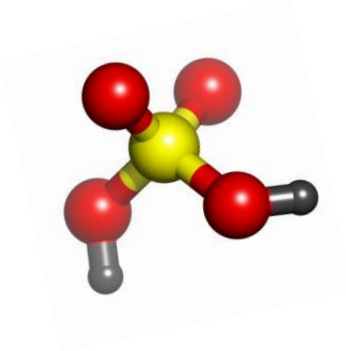
BP Investigation Team's Recommendations - DWOP & OMS Implementation Recommendations…

- Audit and Verification
  - Improve the rig audit process across BP-owned and BP-contracted rigs.
- Process Safety Performance Management
  - Establish leading and lagging indicators for the Drilling and Completion process for; well integrity, well control and critical safety equipment on rigs,
  - Require drilling contractors to have auditable integrity monitoring system to asses and improve well control equipment against a set of established standards (leading and lagging indicators).



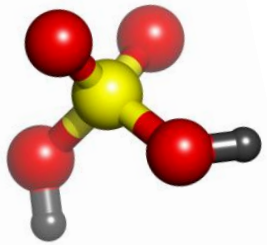
BP Investigation Team's Recommendations - Contractor and Service Provider Oversight and Assurance…

- Cementing Services Assurance
  - Conduct an immediate review of the services provided by all cement suppliers and confirm adequate oversight and controls.
    - Cement service supplier should be compliant with BP and Industry Standards,
    - Ensure the competency of the supervisory personnel and engineers,
    - Effectively identify, communicate and be prepared to mitigate risks associated with the provider's services.
- Well control Practices
  - Assess and confirm that essential well control and well monitoring practices are clearly defined and rigorously applied on all BP-owned and BP-contracted offshore rigs.



BP Investigation Team's Recommendations - Contractor and Service Provider Oversight and Assurance…

- Rig Process Safety
  - Require hazard and operability (HAZOP) reviews of the surface gas and drilling fluid systems for all BP-owned and BP-contracted rigs,
  - Include in the HAZOP reviews a study of all surface system hydrocarbon vents and review suitability of location and design.
- Blow Out Preventer Design and Assurance
  - Establish minimum levels of redundancy and reliability for BP's BOP systems,
  - Strengthen BP's minimum requirements for contractors BOP testing, include emergency systems,
    - Demonstrate that their maintenance management systems meet or exceed BP's minimum requirements,



BP Investigation Team's Recommendations - Contractor and Service Provider Oversight and Assurance…

Blow Out Preventer Design and Assurance continued…..

- Define BP's minimum requirements for drilling contractors' management of change (MOC) for subsea BOPs,
- Develop a clear plan for remotely operated vehicle (MOV) intervention as part of the emergency BOP operations,
- Require drilling contractors to implement a process to verify that shearing performance capabilities of blind shear rams (BSRs) are compatible with inherent variations of drill pipe inventory.

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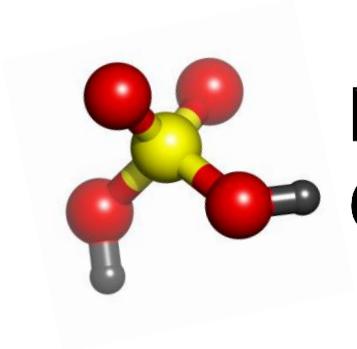

Important Findings in BP's Report Concerning Risk Assessment

- In section 2.6 – Planning for Temporary Abandonment, page 66.
  - "The BP Macondo well team decided not to run a cement evaluation log prior to temporary abandonment, reportedly reflecting consensus among the various parties on the call. The investigation team has not seen evidence of a documented review and risk assessment with respect to well condition and duration of suspension, regarding the annulus cement barriers."
  - "By not conducting a formal risk assessment of the annulus cement barriers per the *ETP* recommendation, it is the investigation team's view that the BP Macondo well team did not fully conform to the intent of *ETP GP 10-60*. [1] Such a risk assessment might have enabled the BP Macondo well team to identify further mitigation options to address risks such as the possibility of channeling; this may have included running a cement evaluation log."

1) *BP's Engineering Technical Practice, GP 10-60*. Zonal Isolation Requirements.

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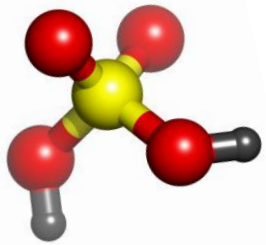

Some Important Findings in the US Coast Guard's Investigation[1]

- The vessel's dual-command organizational structure impacted the crew's situational awareness, risk assessment and decision making.
- Training scenarios did not prepare the merchant marine officers and industrial drilling crew to function as a team under foreseeable hazards such as a well blowout.
- Failure of the onboard management team to demand that the BOP be maintained in accordance with the manufacture's recommendations.

1) United States Coast Guard – Report of Investigation into the Circumstances Surrounding the Explosion, Fire, Sinking and Loss of Eleven Crew Members Aboard the MOBILE OFFSHORE DRILLING UNIT *DEEPWATER HORIZON* In the GULF OF MEXICO, April 20 – 22, 2010.

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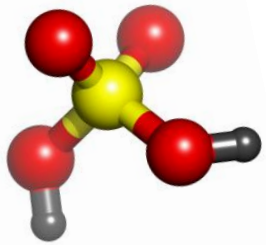

Mitigation of Risks

Recall from BP's report that the accident was caused by a complex and interlinked series of –

- Mechanical failures,
- Human judgments,
- Engineering design,
- Operational implementation,
- Team interfaces.

How can these risks be lowered?

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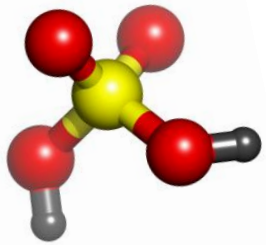

Mitigation of Risks

Risk	Mitigation
Mechanical failures	Inspections, strict adherence to servicing schedules, redundancies, follow standard operating procedures
Human judgments	Training, skills evaluations, certifications, build technical proficiencies, develop specialized training programs
Engineering design	Multiple reviews, internal oversight, outside review by experts
Operational implementation	Review operations and procedures and include all stakeholders, perform hazard scenario analyses
Team interfaces	Communication, team training across groups, provide redundancies in key personnel positions

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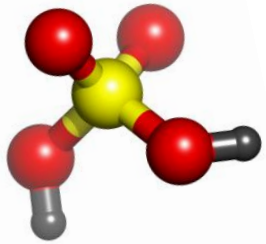
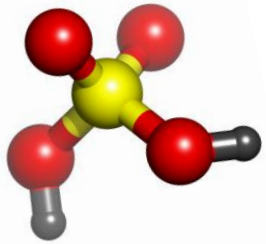


Mitigation of Risks

Mechanical failures

- Routine inspection and a strict adherence to servicing schedules could have insured that the BOP would have functioned properly,
- Redundancies in the BOP (which are now required) could also have increased the chances that the well blowout and subsequent results could have been avoided.



Mitigation of Risks

Human judgments

- Rigorous training both for individuals and teams,
- Skills evaluations can help determine when more training and education is required,
- Certifications help insure that individuals have the skills and knowledge to perform their duties,
- Building technical proficiencies and specialized training programs helps advance the workforce to a higher level.

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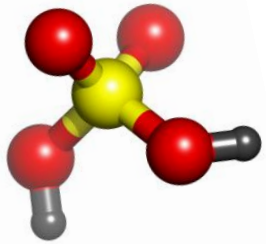

Mitigation of Risks

- Engineering design
  - Multiple reviews and internal oversight help avoid making critical mistakes,
  - Review by outside experts provides the opportunity for a “fresh set of eyes” to evaluate the design.

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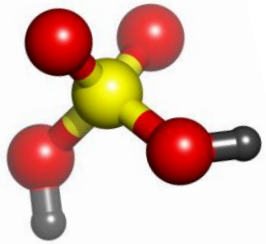

Mitigation of Risks

Operational implementation

- Reviewing operations and procedures to include all stakeholders avoids the possibility of miscommunication. This is important when multiple people/teams are working on different aspects of a process to achieve a goal or objective.
- By performing hazard scenario analyses the team(s) will know what to do in the in the event of an emergency or “off normal event” and will be able to implement emergency operation procedures.

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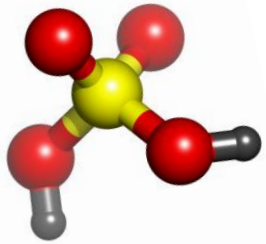

Mitigation of Risks

Team interfaces

- Improve communication,
- Team training across groups can insure that operations (both routine and emergency) go according to plan,
- Provide redundancies in key personnel positions to insure coverage.

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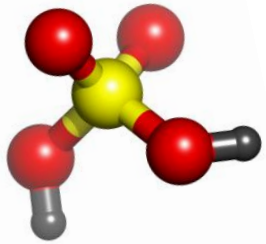

Discussion

Discuss how organizational structures might increase the risk of accidents.

What are some methods to reduce the risk of mechanical failures?

Comment on team training and emergency preparedness with respect to mitigating and controlling accidents.

What can government regulatory agencies do to help reduce the risk of inherently hazardous operations?

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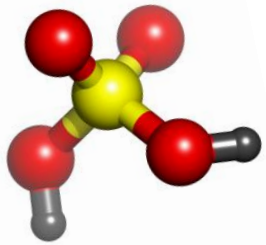

References

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- United States Coast Guard, “Report of Investigation into the Circumstances Surrounding the Explosion, Fire, Sinking and Loss of Eleven Crew Members Aboard the MOBILE OFFSHORE DRILLING UNIT *DEEPWATER HORIZON* In the GULF OF MEXICO”, April 20 – 22, 2010 (288 pages).
- Sutherland Asbill & Brennan LLP, “RESPONSE TO COAST GUARD DRAFT REPORT BY TRANSOCEAN OFFSHORE DEEPWATER DRILLING INC. AND TRANSOCEAN HOLDINGS LLC”, June 8, 2011 (112 pages).
- Rawle O. King, Congressional Research Service Report, “Deepwater Horizon Oil Spill Disaster: Risk Recovery, and Insurance Implications”, July 12, 2010 (24 pages).
- Final Report for US Dept. of the Interior Bureau of Ocean Energy and Management, Regulation, and Enforcement, by Det Norske Veritas, Washington, DC 0240; Forensic Examination of Deepwater Horizon Blowout Preventer, Contract Award No. M10PX00335 VOLUME I FINAL REPORT, Report No. EP030842 20 March 2011 (200 pages).

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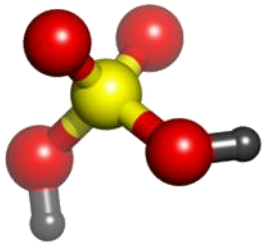

International Safety Management Systems Standards & Approaches

SAND No. 2011-7069C

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.

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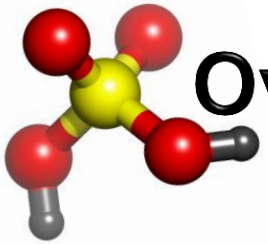
Sandia National Laboratories



Overview of Presentation

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

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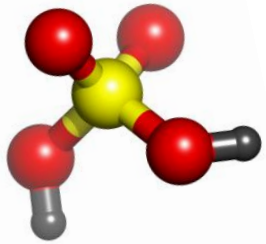

Definitions

- Safety: “The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and *safety risk management*. “ (U.S. Federal Aviation Administration, 2009)

- A Safety Management System (SMS) is a *systematic way* to identify hazards and control risks while maintaining assurance that these risks are effective.
  - Provides for goal setting, planning, and measuring performance
  - SMS is a business imperative: ethical, legal and financial reasons for establishing a SMS (ICAO, 2009)

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

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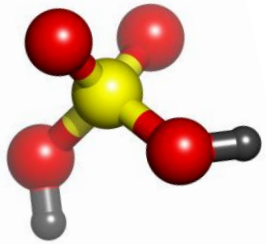

Purpose

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

Reference: International Labour Organisation, 2001

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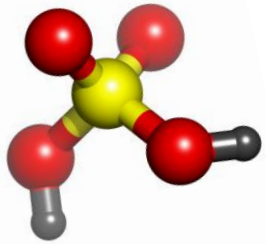

Safety Concepts

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

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

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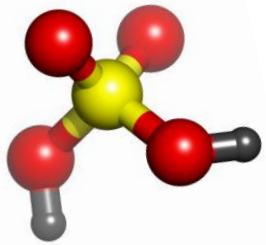

Safety Concepts

- Traditional approach – prevent accidents
  - Focus is on outcomes (causes)
  - Focus is on unsafe acts by operational personnel
  - Assign blame/punish for failure to “perform safely”
  - Address identified safety concerns exclusively

- Traditional approach: WHAT? WHO? WHEN, but NOT: WHY? HOW?

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

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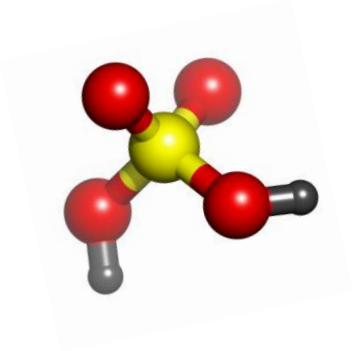

Evolution of Safety Concepts

Change in approach to incident causation:

- 1950s to 1970
  - Technical factors
- 1970s to 1990s
  - Human factors
- 1990s to present time
  - Organizational factors

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

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Safety Management Standards
BS (British Standard) 8800

BS (British Standard) 8800 (1996)

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

Safety Management Standards BS (British Standard) 8800

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

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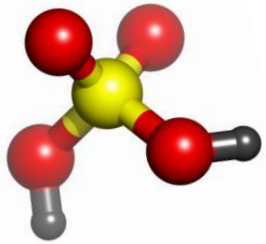

Safety Management Standards OHSAS 18000

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

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Safety Management Standards OHSAS 18001

Requirements:

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

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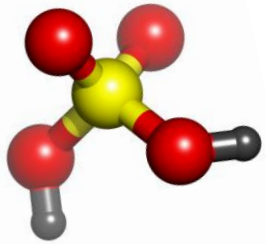

OHSAS 18001 Relationships to ISO

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

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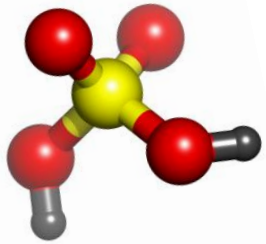

OHSAS 18001 Elements

OHS Management Program

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

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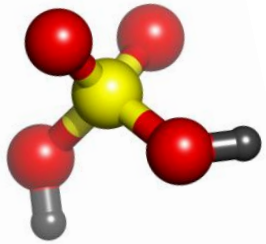

OHSAS 18001 Elements

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

Employee involvement is KEY.

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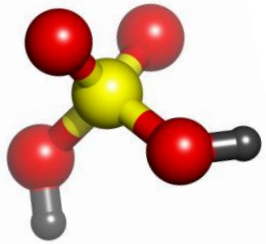

OHSAS 18001 Elements

Document Control

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

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OHSAS 18001 Elements

Records and Reviews

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

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OHSAS 18001 Elements

Emergency Situations

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

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OHSAS 18001 Elements

Audit Program

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

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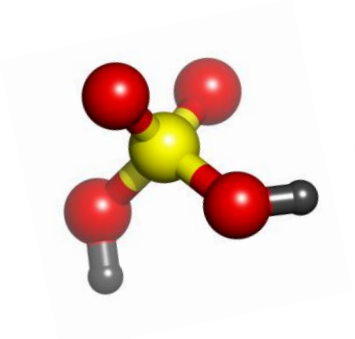

OHSAS 18001 Elements

Management Reviews

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

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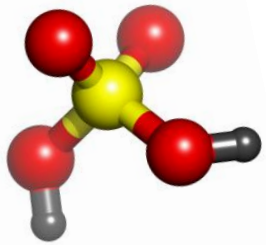

OHSAS 18001 Certification

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

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

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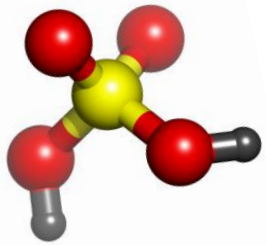

OHSAS 18001 Certification

Developing a program can be done with or without consultation:

- Without consultants:
  - Literature can be purchased to help guide through the process of designing and implementing the program.

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

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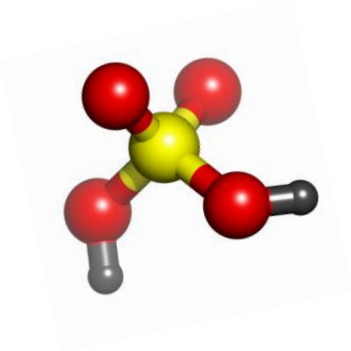

International Labour Organisation (ILO)

OSH2001 Guidelines on Occupational Safety and Health Management Systems

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

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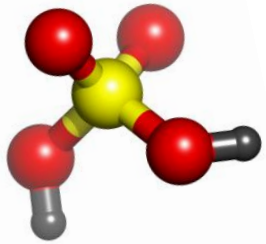

ILO: OSH 2001

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

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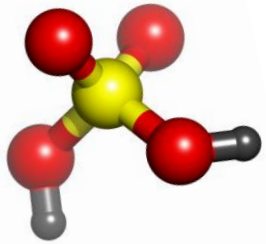

Strategic Approach to International Chemical Management (SAICM)

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

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

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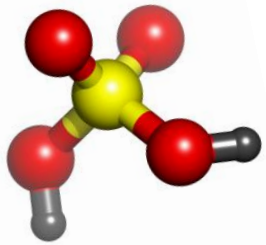

Strategic Approach to International Chemical Management (SAICM)

Quick Start Programme:

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

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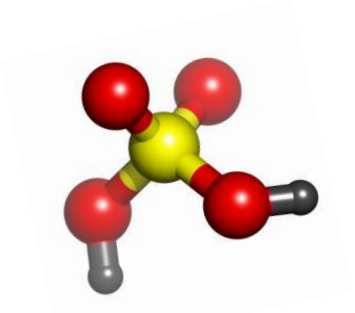
Why Implement Safety Management Standards?

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



Integrated Management Systems

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

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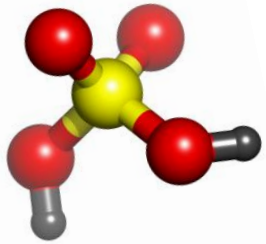

Summary of Presentation

- Defined safety & safety management system
- Purpose of safety management systems
- Discussed safety concepts
- Described three safety management standards
  - BS 8800
  - OHSAS 18001
  - ILO-OSH 2001
- Described SAICM approach
- Described integrated management systems

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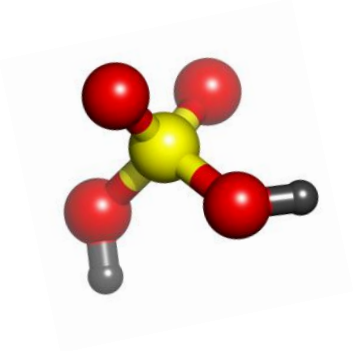
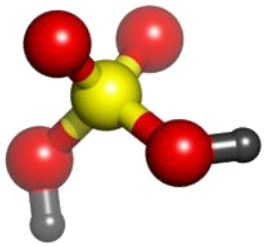


Tea Break!



Developing a National Chemical Management Program

SAND No. 2012-7129 P

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

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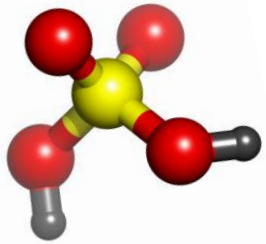
Sandia National Laboratories



Outline of Presentation

- Chemical management program (CMP) components
- US and EU approach to a national CMP
- SAICM and activities in Yemen
- Discussion/questions

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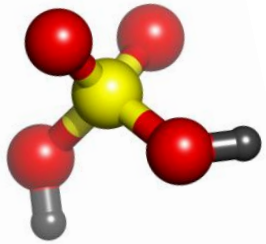

National Chemical Management Program (CMP) Approaches

Many different approaches have been applied to chemical management by countries

- Some involve a broad scope and relatively sophisticated approaches, while others are more targeted and focused on specific problems
- The key for each country is to develop and implement an approach that is tailored to its needs and capabilities

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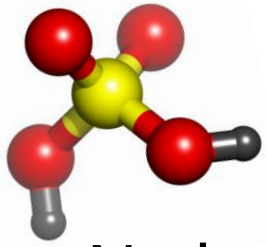

National CMP Approaches

- National CMPs generally focus on one or more of:
  - Commercial manufacture, import, and use
  - Generally includes industrial and consumer chemicals
  - Hazardous waste generation and management
  - Contaminated environments

- And apply key concepts in differing degrees to achieve sound management, including, e.g.,
  - Burden of proof (who is responsible?)
  - Risk reduction strategies
  - Prevention-based strategies
  - Emission inventories and data bases

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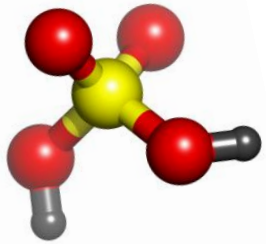

National CMP Approaches

An important and obvious consideration to a country in designing its CMP concerns the resources, including:

- funding
- people
- skills, etc.

which are available to the government, industry, etc.

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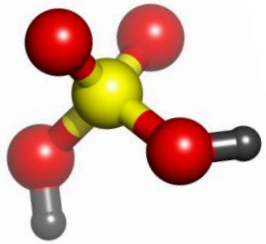

CMP Instruments for Commercial Chemicals

A variety of CMP instruments have been developed and used by countries for oversight of commercial production, import, export, and use of chemicals, including:

- Chemical Inventories
  - a list of the chemicals which are produced or imported

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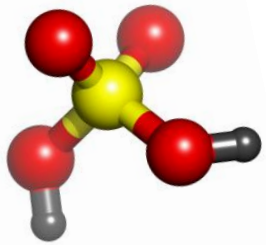

CMP Instruments for Commercial Chemicals

- National Tracking of production and importation and exportation
  - often limited to chemicals of concern
- Broader chemical information reporting
  - can be used as needed to obtain information
- Product registers
  - reporting of basic information on product composition

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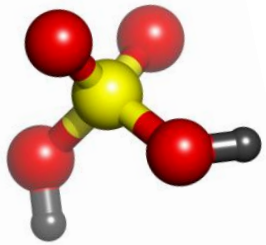

CMP Instruments for Commercial Chemicals

Chemical assessment and control authorities – two broad approaches used:

- General authorities which apply to all chemicals made or used in a country
- Approaches which distinguish “new” versus “existing” chemicals

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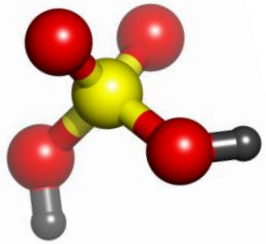

CMP Instruments for Commercial Chemicals

Approaches which distinguish “new” versus “existing” chemicals:

- Requires creation of an inventory of “existing” chemicals
  - These chemicals are then subject to certain authorities for assessment and control
- “New” chemicals subject to notification and assessment prior to their entry into commerce
- Different authorities generally applied to “new” versus “existing” chemicals

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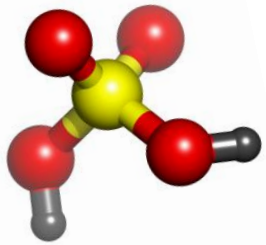

CMP Instruments for Commercial Chemicals

- **Classification and labeling** of dangerous goods and chemicals
  - Generally applies the internationally agreed “Globally Harmonized System (GHS) for Classification and Labeling”
- **Pollutant Release and Transfer Registers** (PRTRs)
  - Used to track environmental releases of certain pollutants over time; can include a public access component
- **Product Stewardship**
  - Applies the concept of industry responsibility for minimizing chemical risks during production and use by a company and by its customers

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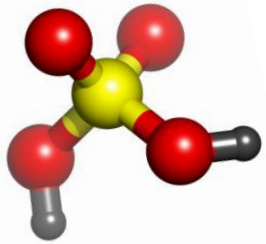

Overview of U.S./Canadian/EU Approaches to CMP

The key implementing statutes are as follows:

- U.S. Toxic Substances Control Act (TSCA)
- Canadian Environmental Protection Act (CEPA)
- EU Registration, Authorization, and Restriction of Chemicals (REACH)

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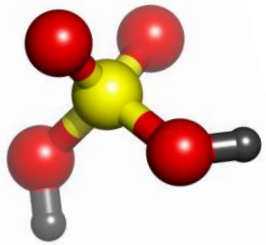

Toxic Substances Control Act (TSCA)

- Enacted in 1976 and has not been amended
- Currently under review by U.S. Congress for amendment
- Established U.S. national program to test, assess, and regulate chemicals while not creating economic barriers or impediments to innovation

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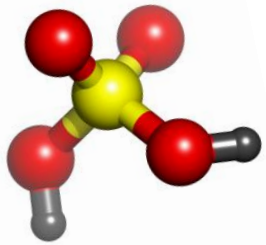

Key Provisions of TSCA

- TSCA Inventory (§8(b))
  - Identified all “existing” chemicals in U.S. commerce
  - Initial Inventory ~61,000 chemicals. Currently in excess of 83,000 chemicals.

- Testing (§4)
  - New test data can be obtained from industry via
    - regulations
    - negotiated instruments, or
    - voluntarily

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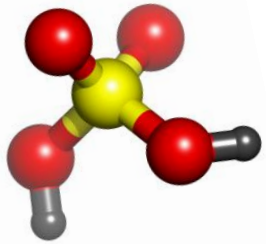

Key Provisions of TSCA

New Chemicals (§5)

- Defined as commercial chemicals not on Inventory
- Premanufacture notice (PMN) must be submitted to EPA 90 days prior to production/import
  - Includes basic production and exposure information and available test data
  - EPA receives ~1,000/yr
- EPA reviews PMN to determine need for control action, testing, "Significant New User Rule"
  - SNUR (§5a2) authority used to extend controls to other companies, limit uses, etc.
- "New" chemicals are added to Inventory after EPA review (Inventory currently ~ 85,000 chemicals)

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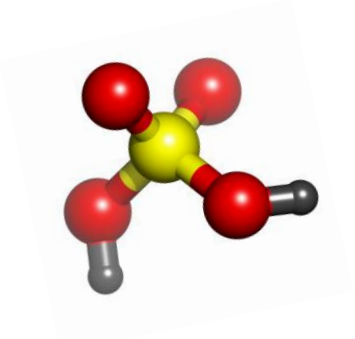

Key Provisions of TSCA

Existing Chemical Regulation (§6)

- Control action requires legal finding of “unreasonable risk”
  - Consider risks and costs/benefits, including availability of substitutes
  - Infrequently used (5 final regulations)
- SNUR (§5a2) authority available as well
- Voluntary programs also play a role (e.g., 2010/2015 PFOA Stewardship Program)

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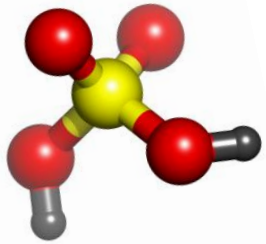

Key Provisions of TSCA

- Information gathering authority (§8)
  - Exposure information
  - Health and safety studies
- Relationship to other Federal laws (§9)
  - Procedures under which EPA can refer regulation to and coordinate TSCA actions with other agencies
- Confidential Business Information (§14)
  - Sets out requirements/procedures for claiming/handling CBI. Very important for industry participation.

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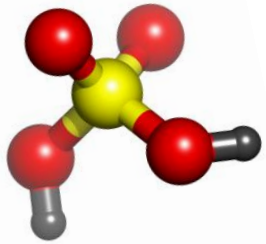

Canadian Environmental Protection Act (CEPA)

- Enacted in 1988 and subsequently amended
- National chemicals management regime “respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development”

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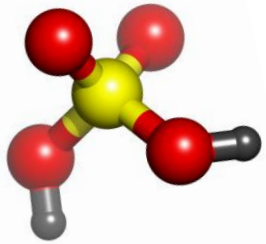

Key Provisions of CEPA

- Established 2 Inventories
  - Domestic Substances List (DSL)
    - 23,000 chemicals in commerce in Canada
  - Non-DSL (NDSL)
    - chemicals not in commerce in Canada but otherwise listed on 1985 TSCA Inventory
- Key regulatory finding: CEPA “Toxic” (§64)
  - provides that a chemical can be found “toxic” if, based on a science-based risk assessment,
  - the chemical “constitutes or may constitute a danger” to humans or the environment

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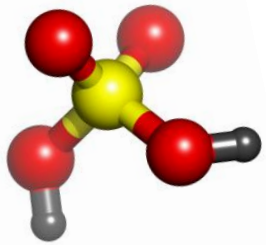

Key Provisions of CEPA

New chemicals

- CEPA distinguishes new vs. existing chemicals
- Notification requirements differ depending on the type of new chemical, volume, etc.
  - Approximately 500 notices received per year
- Review focused on determining if chemical meets CEPA "toxic"
  - If so, additional testing can be required and/or controls imposed, including **S**ignificant **N**ew **Ac**tivity (SNAc) notice requirements

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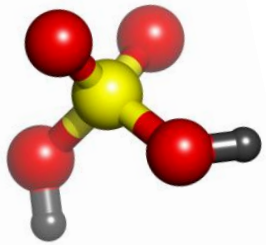

Key Provisions of CEPA

Existing Chemicals Categorization, Assessment, and Management

- CEPA applies staged process involving risk assessment determination followed by risk management action
  - Screen the DSL and “categorize” chemicals presenting certain concerns,
  - Conduct “screening” risk assessment on “categorized” chemicals to determine if they are CEPA “toxic”
  - “Toxic” chemicals must proceed to risk management stage

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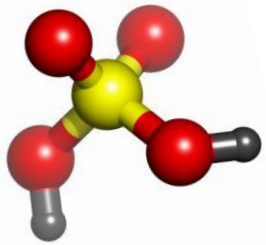

Key Provisions of CEPA

- Risk management of chemicals Determined to be CEPA “Toxic”
  - CEPA authorizes variety of risk management tools for “toxic” chemicals, including:
    - bans/restrictions; pollution prevention plans; guidelines/codes of practice for use; economic instruments; SNAc notification; etc.
- Decisions include consideration of social/economic/ technological factors and must be proposed/taken within established timelines

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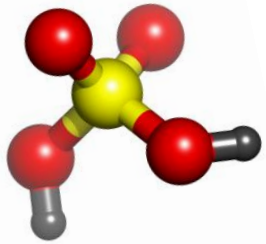

Other CEPA Provisions

CBI

- Allows information to be claimed CBI with appropriate justification (§313)
- Authorities can share/receive CBI with other governments that can protect the CBI (§316)

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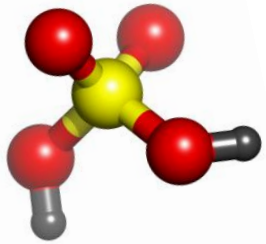

REACH
(Registration, Evaluation, Authorization and Restriction of Chemicals)

- Entered into force June 2007
- EU-wide chemicals management regime
- Key objectives/provisions:
  - Protection of human health and environment
  - Free circulation of chemicals on “internal market” while enhancing competitiveness and innovation
  - Single system for both new and existing chemicals
  - Shift of responsibilities from government to industry
  - Underpinned by the precautionary principle
  - European Chemicals Agency (ECHA) established to centrally manage system

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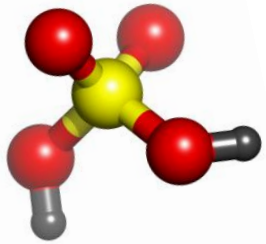

Key REACH Provisions

Registration

- Required of companies throughout supply chain of all chemicals manufactured/imported ≥ 1t/yr, includes:
  - Technical dossier with tiered hazard data and exposure information
  - Chemical Safety Report (CSR; >10t/yr)
  - Use by downstream users (DUs) must be consistent with supplier's registration and CSR, or DUs must separately register their uses

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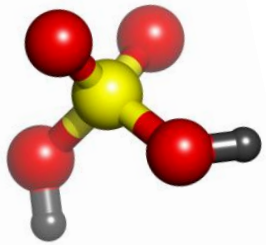

Key REACH Provisions

- Evaluation and Restriction
  - Evaluation of substances by Member States (MS) can be followed by EU-wide restriction action where risk “not adequately controlled”
  - Includes consideration of socioeconomic impacts/availability of alternatives
- Authorization
  - Procedure limited to chemicals of “very high concern” (includes CMRs, PBTs, vPvBs,* etc.)
  - Candidates published for comment
  - Chemicals whose risks are not adequately controlled can be added to authorization annex

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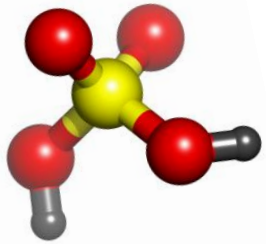

Key REACH Provisions

- Burden on industry to submit authorization application demonstrating that
  - Risks are adequately controlled* or
  - Socioeconomic benefits outweigh risks and that no suitable alternatives are available
- EC considers information and takes authorization decision which
  - Applies by company and by use
  - Specifies any conditions under which the authorization is granted and its time period for review

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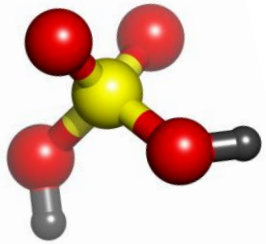

Other REACH Provisions

- CBI
  - Eligible information is defined (§118) and any broader requests need to be justified
  - Includes a provision (§120) allowing negotiated sharing of CBI with other governments
- Fees (§74) on industry for registration, authorization applications, appeals, etc.

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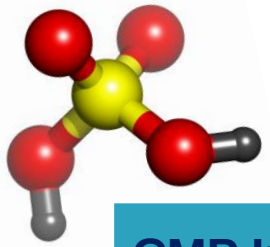
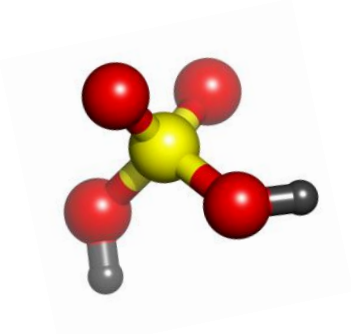


Comparison Table for CMP Instruments

CMP Instrument	US	CD	EU
Inventory	√	√	√
Tracking of Production	√	√	√
Broader Reporting Authority	√	√	√
Product Register			
CM Applies to All Chemicals			√
CM Distinguishes New/Existing Chems	√	√	
Classification/Labeling	~√	√	√
PRTR	√	√	√
Product Stewardship	√	√	√

CSEP CHEMICAL SECURITY ENGAGEMENT PROGRAM



Strategic Approach to International Chemical Management (SAICM)

- **SAICM is an internationally agreed policy framework intended to promote chemical safety around the world.**

- **The overall objective is to achieve the goal adopted by the World Summit on Sustainable Development**

  "to achieve, by 2020, that chemicals are used and produced in ways that lead to the minimization of significant adverse impacts on human health and the environment"

- **SAICM was adopted in 2006 and is comprised of**
  - the **Dubai Declaration on International Chemicals Management**, expressing high-level political commitment to SAICM,
  - an **Overarching Policy Strategy** which sets out its scope, objectives, underlying principles and approaches, financial considerations, and arrangements for implementation and ongoing review, and
  - a **Global Plan of Action** that serves as a working tool and guidance document to support implementation of SAICM

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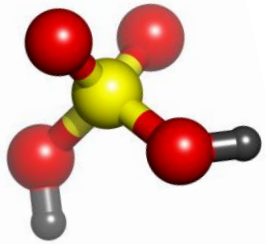

SAICM

Key attributes of SAICM include its:

- comprehensive scope
- openness to participation by both governments and civil society, including industry and health and environmental groups
- capabilities for resource mobilization, and
- broad cooperative engagement by key intergovernmental organizations (UNEP, WHO, UNITAR, UNIDO, FAO, OECD, etc.)

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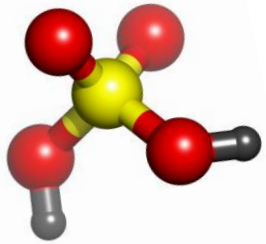

SAICM

- **The Overarching Policy Strategy (OPS) includes five key areas:**
  - risk reduction
  - knowledge and information
  - governance
  - capacity building and technical cooperation, and
  - illegal international traffic in chemicals
- **It is intended that SAICM's 2020 objective will be achieved through efforts in these five areas as well as activities in the Global Plan for Action**

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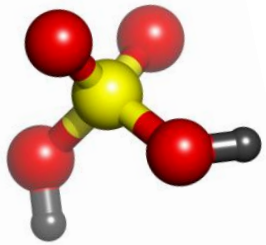

SAICM's Implementation Arrangements

- The OPS also discusses financial considerations and the mobilization of resources at the international level
- Thus far SAICM resources have been used to support activities by:
  - the Quick Start Programme (QSP), and
  - the SAICM Secretariat
- The QSP aims to support enabling activities in developing countries and consists of a trust fund, as well as bilateral, multilateral and other forms of cooperation
- Support can also be provided by the SAICM Secretariat

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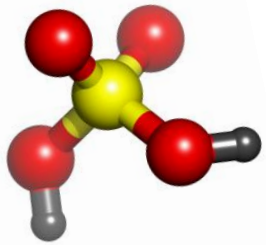

SAICM's Implementation Arrangements

The QSP aims to mobilize resources for national priority enabling activities, including:

- Development or updating of national chemical profiles and the identification of capacity needs;
- Development and strengthening of national chemicals management institutions and enabling associated activities; and
- Undertaking activities directed at
  - integrating SAICM and sound management of chemicals into national strategies, and
  - thereby informing development assistance cooperation priorities

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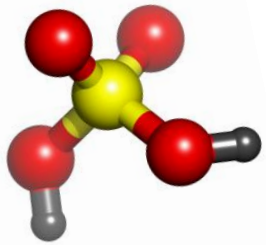

Implementation of SAICM in Yemen

First steps completed:

- Completion of National Profile on Chemical Management
- QSP funding for an integrated national program and implementation of SAICM in Yemen.
- Next steps?

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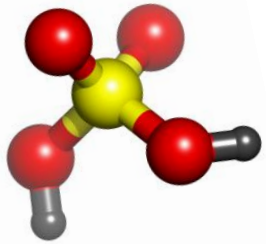

Summary of Presentation

- Discussed the components of a Chemical management program (CMP)
- Compared US and EU approach to a national CMP
- Discussed SAICM and activities in Yemen

CSP
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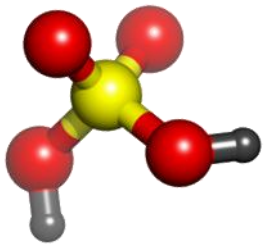
ENGAGEMENT PROGRAM



Breakout Sessions: Chemical Risk Management in Yemen

Break into Three Groups

CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM

Sandia National Laboratories