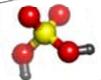


Chemical Safety and Security Officer Training

Algeria
December 2011



SAND No. 2009-936P
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.


Chemical Safety and Security Overview



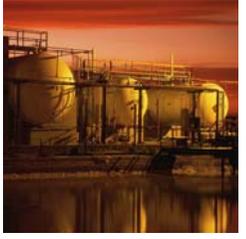
2



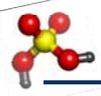

Why worry about chemical safety?

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






3

Possible chemical health problems

<u>Chemicals</u>	<u>Diseases</u>
▶ Vinyl chloride	▶ Liver cancer
▶ Asbestos	▶ Mesothelioma
▶ Carbon tetrachloride	▶ Hepatotoxin (jaundice)
▶ Mercury	▶ Neurotoxin, CNS, narcosis
▶ Lead	▶ Reprotoxin, birth defects
▶ Thalidomide	▶ Reprotoxin, developmental defects
▶ Methanol	▶ Blindness, death
▶ CO, CS ₂	▶ Hematopoietic, hemoglobin, cyanosis



4





Disease depends on many factors...

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






5




University of California Santa Cruz: Fire

- January 11, 2002:
about 5:30 am, 4th floor of
Sinsheimer Lab building, Dept.
of Molecular, Cell and
Developmental Biology.
 - Firefighters responded to alert from heat-detection system in building.
 - Controlled by noon.
 - Up-to-date inventory of hazardous materials allowed firefighters to enter building and contain fire.
 - Building did not have automatic sprinkler system.




<http://ehs.ncsc.edu/ehs/ehs/ehs/sinshfire2.htm>

6




University of California Santa Cruz: Fire, cont'd.

- ▶ Professors and students lost equipment, notes, materials, samples.
- ▶ Other labs in building closed for weeks to months.
 - Water and smoke damage
- ▶ Burned labs took 2 years to reopen.
- ▶ Cause never determined.




7




Environmental hazards

California State Univ. Northridge: Earthquake

- Magnitude 6.7
- January 17, 1994 – 4:31 am
- 57 deaths, 11000 injuries
- Epicenter a few km from California State University Northridge campus





- Several fires in science buildings allowed to burn because firemen worried about chemical hazards
- Professors and students lost equipment, notes, materials, samples

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



8





Dartmouth College: Dimethylmercury poisoning

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



CSP CHEMICAL SECURITY ENFORCEMENT PROGRAM

Chemical SAFETY AND SECURITY TRAINING



Bhopal: Pesticide plant chemical release

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



The Bhopal disaster and its aftermath: a review", Edward Broughton, *Environmental Health: A Global Access* Online Source: 2004-6- http://www.ehjournal.net/content/4/1/6, accessed 12/07

CSP CHEMICAL SECURITY ENFORCEMENT PROGRAM

Chemical SAFETY AND SECURITY TRAINING



Safety Video: Reactive Hazards



CSB U.S. Chemical Safety and Hazard Investigation Board

Safety Video

Reactive Hazards:
Dangers of Uncontrolled
Chemical Reactions

CSP CHEMICAL SECURITY ENFORCEMENT PROGRAM

Chemical SAFETY AND SECURITY TRAINING



Taiwan: Silane fire



- ▶ Motech Industries solar cell plant in Tainan Industrial Park
 - 1 death
 - US \$1.3 million damage
 - Silane / air explosion
 - Operator responded to gas-cabinet alarm
 - Explosion occurred when he opened gas-cabinet
 - Fire burned for 1 hour before being controlled
 - Caused other SiH₄ and NH₃ cylinders to empty
 - November 2005

CSP CHEMICAL SECURITY ENFORCEMENT PROGRAM

Chemical SAFETY AND SECURITY TRAINING



Chemical accidents are now under stricter control and scrutiny

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




CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

13

Chemical
SAFETY AND SECURITY TRAINING



Why worry about chemical safety?

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




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

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

14

Chemical
SAFETY AND SECURITY TRAINING



Why worry about chemical safety?

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



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

15

Chemical
SAFETY AND SECURITY TRAINING



Aum Shinrikyo: Matsumoto and Tokyo, Japan

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



Photo re-posted poster from Wikipedia.com

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

16

Chemical
SAFETY AND SECURITY TRAINING



Aum Shinrikyo: Tokyo, Japan



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

17

Chemical
SAFETY AND SECURITY TRAINING



Aum Shinrikyo: Matsumoto and Tokyo, Japan, cont'd.

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



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

18

Chemical
SAFETY AND SECURITY TRAINING



Chicago, Illinois, USA

- ▶ March 2002, an anarchist (called himself "Dr. Chaos") was found at 2 am in a Univ. Illinois, Chicago, building carrying sodium cyanide
- ▶ Had chemicals in a storage room at the Chicago subway
 - included containers marked mercuric sulfate, sodium cyanide, potassium cyanide, and potassium chlorate
 - 0.25 pound of potassium cyanide and 0.9 pound of sodium cyanide
 - stolen from an abandoned warehouse, owned by a Chicago-based chemical company
 - 15 drums and 300 jars of various other laboratory chemicals were discovered there
- ▶ Sentenced to prison for "possessing a chemical weapon", as well as other charges (interfering with power, air-traffic control systems, computer systems, broadcast systems and setting fires).



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

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

Chemical
SAFETY AND SECURITY TRAINING



Iraq



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

On March 23, 2007, police in Ramadi's Jazeera district seized a truck filled with "five 1000-gallon barrels filled with chlorine and more than two tons of explosives"

From http://www.longwarjournal.org/archives/2007/03/al_qaedas_chlorine_w.php downloaded Jan 2008.

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

20

Chemical
SAFETY AND SECURITY TRAINING



Chemical Security

US Homeland Security Secretary Michael Chertoff told the American Chemistry Council, March 21, 2006:

"Now, the chemical sector certainly stands as one of the principal areas of infrastructure about which we have to be concerned. If you look back at the whole history of the way al Qaeda has conducted its operations, where possible, they have always tried to leverage our own technology against ourselves. They've turned jets, commercial jets, into weapons. They've tried to use our own chemicals and our own products as means of exploding devices against us. And obviously, one of the areas we have to be concerned about are parts of our infrastructure which house chemicals which could, if properly ignited, create a huge amount of havoc in a populated area - whether it be because of a large explosion or whether it's because of toxic inhalation..."




21



Why worry about chemical security?

- Health and safety of people and environment
- Community relationships
- Reduce chance of accidental chemical release
- Avoid loss and damage to labs and equipment
- Prevent criminals and terrorists from getting dangerous chemicals
 - Wide variety of chemicals have been used
 - Wide variety of motivations for actions
- A deliberate attack on a chemical facility could release a large amount of hazardous chemicals
 - Injure or kill people in nearby areas
 - Eliminate jobs and economic assets




22



Safety and Security Issues are similar

<u>Variables</u>	<u>Protect</u>
<ul style="list-style-type: none"> ▶ Many different chemicals with: <ul style="list-style-type: none"> ◦ different properties ◦ different hazard ◦ different applications ▶ Many different ways to misuse chemicals <ul style="list-style-type: none"> - chemical weapons - poisons 	<ul style="list-style-type: none"> ▶ Workers ▶ Facility ▶ Community ▶ Environment





23



Government regulations: Chemical security

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







24



Important Questions:

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

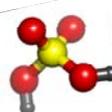
...Is it **effective**?

...Could it be **improved**?

...**How**?




25



Break




26



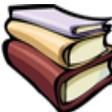

Fundamentals of Chemical Laboratory Safety




27



References



“Safety in Academic Laboratories, Vol.1 & 2,” American Chemical Society, Washington DC, 2003, also available online:
http://portal.acs.org/portal/acs/corg/content?nfpb=true&_pageLabel=PP_SUPERARTICLE&node_id=2230&use_sec=false&sec_url_var=region1&_uuid=ef91c89e-8b83-43e6-bcd0-ff5b9ca0ca33

“Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,” National Academy Press, 1995, also available online:
http://www.nap.edu/catalog.php?record_id=4911




28



Definitions

29

CSP
CHEMICAL SECURITY
ENFORCEMENT PROGRAM

Chemical
SAFETY AND SECURITY TRAINING



Chemical Laboratory Safety

- *The control of exposure to potentially hazardous substances to attain an acceptably low risk of exposure*



30

CSP
CHEMICAL SECURITY
ENFORCEMENT PROGRAM

Chemical
SAFETY AND SECURITY TRAINING



Chemical Laboratory Safety

Hazard - *the potential to harm*



We want to avoid this.

Risk - *the probability that harm will result*

31

CSP
CHEMICAL SECURITY
ENFORCEMENT PROGRAM

Chemical
SAFETY AND SECURITY TRAINING



Chemical Laboratory Hazards

- **Chemical hazards**
 - dusts, fumes, mists, vapors, gases
- **Physical hazards**
 - fire, electrical, radiation, pressure vibration, temperatures, noise
- **Ergonomic hazards**
 - repetitive motion (pipetting), lifting, work areas (computers, instruments)
- **Biological hazards**
 - pathogens, blood or body fluids



32

CSP
CHEMICAL SECURITY
ENFORCEMENT PROGRAM

Chemical
SAFETY AND SECURITY TRAINING



Chemical Laboratory Safety

based on the principle of

Industrial Hygiene

- *The **anticipation, recognition, evaluation and control** of health hazards in the work environment to protect workers health and well-being and to safeguard the community and the environment*



33




Chemical Laboratory Safety

↓

Industrial Hygiene Principles

Anticipation	}	Chemical hazards
Recognition		Physical hazards
Evaluation		Ergonomic hazards
Control		Biological hazards



34




Anticipation

Safety First !

To consider safety in the beginning is:

	Easier,	
	Cheaper,	
	Safer,	

... and it saves you time !



35




Anticipation

Advance Experiment Planning:



Outline proposed experiment

Acquire safety information (MSDS, REACH)

Consult with CSSO?



36





Anticipation

Risk Analysis

- ▶ Which chemicals?
- ▶ How much?
- ▶ Special equipment needed?
- ▶ Who does the work?
- ▶ Staff properly trained?
- ▶ Can the experiment go wrong?
- ▶ Do you have an emergency plan?




37




Recognition



Types of lab hazards:

- chemical toxicity
- fire / explosion
- physical hazards
- biohazards
- radiation
- special substances







38




Recognition & Evaluation

What are the anticipated risks?

- Are the equipment & facilities adequate?
- Are staff properly and sufficiently trained?
- Risks if experiment goes wrong?
- Is there a plan for this?




39




Control

How are the risks controlled?

- **Engineering controls:**
 - enclosure / isolation
 - ventilation / hoods
- **Emergency Plan**
- **Personal Protective Equipment (PPE)**




40





Recognition of Chemistry Laboratory Hazards

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

41

Chemical
SAFETY AND SECURITY TRAINING



Chemical Toxicity



Acute (short term, poisons, asthmagens)
cyanide
strychnine

Chronic (long term, carcinogens, reproductive)
vinyl chloride (liver cancer)
asbestos (mesothelioma, lung cancer)
thalidomide (developmental birth defects)

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

42

Chemical
SAFETY AND SECURITY TRAINING



Routes of Exposure

Breathing Zone

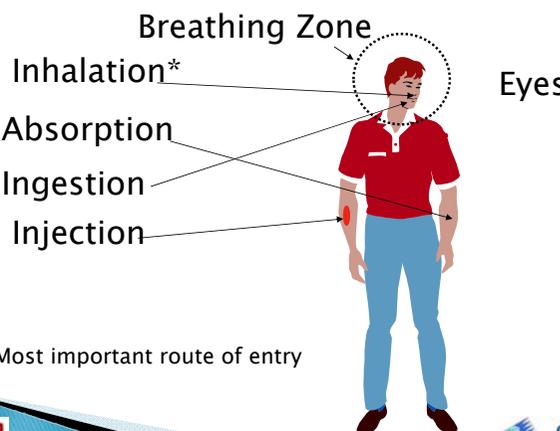
Inhalation*

Absorption

Ingestion

Injection

Eyes



*Most important route of entry

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

43

Chemical
SAFETY AND SECURITY TRAINING



Fire and Explosion Hazards






CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

44

Chemical
SAFETY AND SECURITY TRAINING

Physical and Ergonomic Hazards

- ▶ Moving unguarded parts, pinches
- ▶ vacuum pump belts
- ▶ Broken glassware and sharps, cuts
- ▶ Pressure apparatus
- ▶ Vacuum containers
- ▶ Dewar flasks
- ▶ High voltage equipment
- ▶ Computer workstations
- ▶ Slips, trips & falls



Care in handling glassware and electricity



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

45

Chemical
SAFETY AND SECURITY TRAINING

Biohazards

- Blood borne pathogens
 - AIDS, HIV, hepatitis, clinical chemistry labs
- Recombinant DNA
 - Genetic engineering, cloning
- Work with animals
 - Zoonoses, diseases from animals

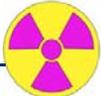


CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

46

Chemical
SAFETY AND SECURITY TRAINING

Radiation Hazards




Ionizing Radiation:
alpha α , beta β , gamma γ ,
X-rays, neutrons

Radioactive isotopes:
tritium, H-3, carbon, C-14,
sulfur, S-35, phosphorus, P-32/33, iodine, I-135



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

47

Chemical
SAFETY AND SECURITY TRAINING

Radiation Hazards



Non-Ionizing Radiation:
Ultraviolet (UV spectrometers)
Magnetic (NMR, MRI)
Microwave
(Heart pacemaker hazard)
Lasers
(eye protection required)




CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

48

Chemical
SAFETY AND SECURITY TRAINING

Special Chemical Substances

Controlled Substances:
regulated drugs, psychotropic
(hallucinogenic) substances, heroin



Highly Toxic Chemicals:
nerve gas, phosgene, riot control
agents, chemical warfare agents



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

49

Chemical
SAFETY AND SECURITY TRAINING

Evaluation & Control

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



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

50

Chemical
SAFETY AND SECURITY TRAINING

Administrative Practices



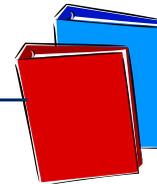
organizational *safety policies*
that apply to everyone

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

51

Chemical
SAFETY AND SECURITY TRAINING

Lab Safety Policies



- ❖ Have a Safety Manual
 - Never work alone, especially after hours.
 - Specify when eye protection & PPE is required.
 - Specify operations that require hood use.
 - Specify required training.
 - No mouth pipetting.
 - No long hair or dangling attire.

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

52

Chemical
SAFETY AND SECURITY TRAINING

Lab Safety Policies

- ▶ No eating, drinking, smoking in laboratories
- ▶ Label all chemical containers
- ▶ Label refrigerators, No Food
- ▶ Label explosion safe refrigerators
- ▶ Require periodic fire drills



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

53

Chemical
SAFETY AND SECURITY TRAINING

Operational Practices

Safe Laboratory Procedures:

- ▶ Packages opened only in labs, not receiving
- ▶ Receiving staff trained to look for signs of breakage and/or leaking shipments
- ▶ Receiving area has spill kits
- ▶ Mailroom/receiving alert for suspicious shipments



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

54

Chemical
SAFETY AND SECURITY TRAINING

Safe Laboratory Procedures



Use hoods properly:

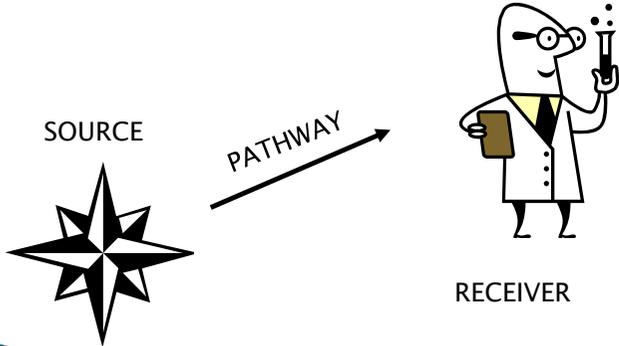
- Work 6" (15 cm) in from sash
- In center of hood
- Work with hood sash at ~18" (45 cm) high
- Close sash when not in use
- Don't use for storage

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

55

Chemical
SAFETY AND SECURITY TRAINING

Engineering Controls



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

56

Chemical
SAFETY AND SECURITY TRAINING



Engineering Controls

1. Change the process
eliminate the hazard




2. Substitution
non-hazardous substance for hazardous
(e.g. - toluene for benzene)

CSP
CHEMICAL SECURITY
EMPLOYMENT PROGRAM

57

Chemical
SAFETY AND SECURITY TRAINING



Engineering Controls

3. Isolate or enclose the process or worker



Use a barrier



4. Ventilation

Dilution (general ventilation) - Not good
Local exhaust ventilation (LEV) - Preferred

CSP
CHEMICAL SECURITY
EMPLOYMENT PROGRAM

58

Chemical
SAFETY AND SECURITY TRAINING



Engineering Controls



Properly functioning
& used correctly!
Laboratory hoods
and ventilation are
the basis of
engineering
controls.

CSP
CHEMICAL SECURITY
EMPLOYMENT PROGRAM

59

Chemical
SAFETY AND SECURITY TRAINING



Laboratory Hoods

Must be used and maintained
properly.




CSP
CHEMICAL SECURITY
EMPLOYMENT PROGRAM

60

Chemical
SAFETY AND SECURITY TRAINING

 Engineering Controls

Local exhaust ventilation includes:
snorkels



 61 

 Engineering Controls

Local exhaust ventilation includes:
vented enclosures




 62 

 Engineering Controls

Local exhaust includes:
special containment devices
(e.g. – glove boxes)



 63 

 Engineering Controls

Local exhaust includes:
special containment devices
(e.g. – isolation chambers)



 64 



Engineering Controls

Hood exhaust should not be blocked or deflected downward, but should exhaust straight up




65




Personal Protective Equipment

PPE includes:



eye protection,
gloves,
laboratory coats, etc.,
respirators,
appropriate foot protection




66




Emergency Planning & Response

- Have routine, unannounced evacuation drills.
- Designate a person for each area to ensure that inner rooms are evacuated.
- Locate outside staging areas at sufficient distance from the building.
- Test and maintain alarms.
- Post a person to meet/direct emergency vehicles.





67




Emergency Planning & Response

Post each room with:

- Emergency phone numbers
- After hour phone numbers
- Person(s) to be contacted
- Alternate person(s)
- Unique procedures to be followed



68





Aspects of Chemical Security

Dual-use Chemicals

69





Chemical dual-use awareness

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



70



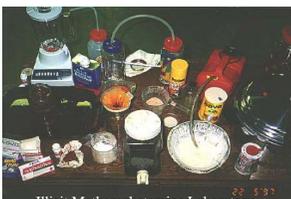


Dual-use chemical example: Pseudoephedrine

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



- Clandestine meth labs in US, 2002
 - Caused 194 fires, 117 explosions, and 22 deaths
 - Cost \$23.8 million for cleanup
 - Dumped chemicals led to
 - deaths of livestock
 - contaminated streams
 - large areas of dead trees and vegetation



71





Dual-use chemical example: Cyanide

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



Therence Koh/AFP/Getty Images



72






Dual-use chemical example: Pesticides

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

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



Photo: New York City Poison Control Center

Ann. Emerg. Med., Vol. 45, pg. 609, June 2005

CSP CHEMICAL SECURITY ENFORCEMENT PROGRAM

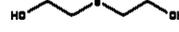
Chemical SAFETY AND SECURITY TRAINING

73



Many lab/industrial chemicals have dual uses

- Dimethyl methyl phosphonate (DMMP)
 - Flame retardant for:
 - building materials, furnishings, transportation equipment, electrical industry, upholstery
 - Nerve agent precursor
- Thiodiglycol
 - Dye carrier, ink solvent, lubricant, cosmetics, anti-arthritis drugs, plastics, stabilizers, antioxidants, photographic, copying, antistatic agent, epoxides, coatings, metal plating
 - Mustard gas precursor
- Arsenic Trichloride
 - Catalyst in CFC manufacture, semiconductor precursor, intermediate for pharmaceuticals, insecticides
 - Lewisite precursor


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

CSP CHEMICAL SECURITY ENFORCEMENT PROGRAM

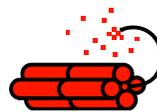
Chemical SAFETY AND SECURITY TRAINING

74



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




CSP CHEMICAL SECURITY ENFORCEMENT PROGRAM

Chemical SAFETY AND SECURITY TRAINING

75



Theft / manufacture of explosives: Fertilizer Bomb

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



Photo: US DOD

CSP CHEMICAL SECURITY ENFORCEMENT PROGRAM

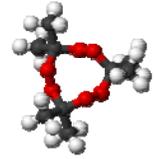
Chemical SAFETY AND SECURITY TRAINING

76



Theft / manufacture of explosives: TATP

- ▶ Triacetone triperoxide (TATP)
- ▶ Invisible to detectors looking for N-based explosives
- ▶ Made using acetone, hydrogen peroxide, strong acid (HCl, sulfuric)
- ▶ Favored by terrorists "Mother of Satan"
 - 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

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

77

Chemical
SAFETY AND SECURITY TRAINING



Diversion of industrial / laboratory chemicals: Sodium azide



- ▶ Widely available from older automobile airbags
 - 1980s to 1990s
- ▶ Poisonous
- ▶ Reacts explosively with metals
 - Biological laboratory drains have exploded from discarded waste solutions containing NaN_3 as a preservative.
- ▶ Has been found in possession of terrorists

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

78

Chemical
SAFETY AND SECURITY TRAINING



Diversion of industrial / laboratory chemicals: Bali bombing

- ▶ Amrozi purchased chemicals used to make bombs
- ▶ One ton of potassium chlorate* purchased in three transactions from the Toko Tidar Kimia fertilizer and industrial chemicals store in Jalan Tidar, Surabaya, owned by Sylvester Tendean.
 - Claimed he was a chemical salesman.
 - Obtained a false receipt saying he purchased sodium benzoate.
 - Tendean lacked proper permit to sell this chemical, didn't know the chemical would be used to make a bomb.
- ▶ Details of Aluminum powder purchases not known

* Some press reports state potassium chloride, but this is clearly an error
<http://www.smh.com.au/articles/2003/06/09/1055010930128.html>
<http://www.thejakartapost.com/news/2002/12/18/amrozi-owns-possessing-chemicals.html>

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

79

Chemical
SAFETY AND SECURITY TRAINING



International Chemical Controls

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

80

Chemical
SAFETY AND SECURITY TRAINING



International Chemical Control Groups



ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS

Chemical weapons convention

The Australia Group

Export controls

UN Security Council Resolution 1540



81




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
- ▶ Protecting each other




82




Chemical Weapons Convention (CWC)



- ▶ International treaty which bans the development, production, stockpiling, transfer and use of chemical weapons
 - Entered into force in April 1997 with 87 State Parties participating
 - Today: 183 nations have joined, 5 others have signed, only 7 have not taken any action.
 - Each nation enacts appropriate laws
 - Each nation agrees to assist other Member States





83




CWC: Destroy existing stockpiles and facilities



- ▶ Twelve States parties have declared CW production facilities.
 - Bosnia and Herzegovina
 - China
 - France
 - India
 - Islamic Republic of Iran
 - Japan
 - Libyan Arab Jamahiriya
 - Russian Federation
 - Serbia
 - United Kingdom of Great Britain and Northern Ireland
 - United States of America
 - another State Party
- ▶ As of August 2007, 42 of 65 declared CW production facilities have been certified as destroyed, 19 converted to peaceful purposes.
- ▶ As of August 2007, 23,912 metric tonnes of CW agent has been destroyed out of 71,330 metric tonnes declared.
- ▶ On 11 July 2007, the OPCW confirmed the destruction of the entire chemical weapons stockpile in Albania.
- ▶ Includes old and abandoned CW munitions

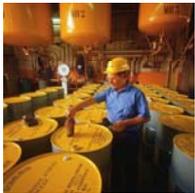


84



CWC: Prevent spread or production of new chemical weapons

- States declare and agree to inspections of many other chemical facilities, depending on chemical type and amount produced
- Over 3,000 inspections have taken place at 200 chemical weapon-related and over 850 industrial sites on the territory of 79 States Parties since April 1997
- Worldwide, >5,000 industrial facilities are liable to inspection

85

CWC: Chemicals on schedules subject to verification measures

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



86

CWC: Reporting requirements

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

Caution:
Your country might require reporting of lower amounts!

87

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



88



OPCW: Protecting each other

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





89




Australia Group

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


90




Australia Group: Export Controls

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




91




UN Security Council Resolution 1540

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


92




Components of Chemical Security

93





Chemical Security Questions

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

94






Components of Chemical Security

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

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

95





Chemical Security: Physical Site

LOCK UP!!

Controlled drugs

Chemical Surety Agents

Highly toxic chemicals

96










Facility Characterization



Characterize the facility in terms of:

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



97




Facility Characterization

Facility characterization provides important data that:

- Identifies locations and assets to be protected
- Establish what existing Protection System components are already present at the facility
- Documents facility layout for use in analysis



98




Threat Definition



Threat classes:

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



99




Target Identification

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






100





Chemical Security: Personnel Management

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




101




Chemical Security: Information Security

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




102




Chemical Security: Assign Responsibilities

- Identify people responsible for various chemical security activities:
 - Physical security, building modifications
 - Chemical tracking and reporting
 - Personnel and access management
 - Information management
 - Emergency planning
- Ensure they have the time and resources to do the job.
- Integrate with chemical safety responsibilities.




103




Chemical Security: Professional Behavior

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





104





Relationships between Chemical Security and Chemical Safety

105





Relationships Between Chemical Safety and Security

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

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




106





Good Practices for Both Chemical Safety and Security

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



107





Conflicts Between Chemical Safety and Security: Information Sharing

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

- **Safety**
 - Label everything so people can recognize hazardous chemicals.
 - Let community and especially emergency responders know what chemical dangers are there.
 - Share knowledge about chemical hazards so people know to be alert.

- **Security**
 - Labels help identify targets for theft or attack.
 - Sharing locations of chemicals can publicize targets for theft or attack.
 - Sharing knowledge of chemical hazards could inspire harmful behavior (copy-cat criminals).

108






Conflicts Between Chemical Safety and Security: Facility Exits

Locking exit doors is **secure**, but not **safe**.

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



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

109

Chemical
SAFETY AND SECURITY TRAINING



Setting Priorities

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

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

110

Chemical
SAFETY AND SECURITY TRAINING



All Chemical Facilities Need to be Secured




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

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

111

Chemical
SAFETY AND SECURITY TRAINING



Lunch

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM



Chemical Safety and Security Program Organization and Responsibilities



113




Chemical Safety and Security Program Purpose

- ▶ Help establish a safe and secure workplace.
- ▶ Help safeguard the environment.
- ▶ Prevent/reduce release of hazardous chemicals and operations.
- ▶ Prevent/reduce exposure to staff.
- ▶ Reduce stress.
- ▶ Enhance community relations.
- ▶ Comply with regulations.
- ▶ Crisis management




114




Crisis Management: Prevention & Response

- Facility crisis
 - Fire
 - Explosion
 - Chemical release
- Natural disaster
 - Earthquakes
 - Hurricane/typhoon
 - Tsunami
- Disgruntled personnel
 - Employees
 - Ex-workers
 - Students
- Demonstrations, protests
- Evacuation/reoccupancy
- Terrorism



115




Crisis Management: Criminal & Terrorism Concerns

- External security
 - Fences
 - Cameras
 - Guards
- Internal security
 - Personnel background checks
 - Employees, contractors, students
- ▶ Theft
 - Chemicals, materials
 - Equipment
- ▶ Bombing
- ▶ Toxic release



116





Chemical Safety and Security Applies to Everyone




Administration
Human Resources
Purchasing
Facilities
Construction
Police/Security
Department Administration
Research Administration
Employees
Students
Contractors
All visitors

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

117

Chemical
SAFETY AND SECURITY TRAINING



Faculty/Principal Investigator

has the responsibility

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

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

118

Chemical
SAFETY AND SECURITY TRAINING



Principal Investigator CSS Responsibilities

- ▶ Develop procedures with CSSO for unique hazards and chemicals (e.g. carcinogens)
- ▶ Develop proper control practices with CSSO
- ▶ Participate in developing CSS Plan, CSS Committee, accident investigations
- ▶ Ensure CSS documents and records are maintained
- ▶ Maintain local chemical inventory for their lab
- ▶ Ensure (M)SDS are available in the laboratory
- ▶ Facilitate compliance with policies, guidelines and regulations

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

119

Chemical
SAFETY AND SECURITY TRAINING



CSS Responsibilities Principal Investigator, cont'd.

- ▶ Ensure students/workers know and follow policies and practices
- ▶ Ensure equipment and controls are properly maintained
- ▶ Ensure all students/workers received proper training and refreshers
- ▶ Ensure new students/workers receive proper training before starting work
- ▶ Inform CSSO of any accidents and incidents
- ▶ Follow-up on accidents and incidents

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

120

Chemical
SAFETY AND SECURITY TRAINING



Employees and students

have a responsibility

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




121




Employee/Student CSS Responsibilities

- ▶ Follow policies/rules
- ▶ Wear Personal Protective Equipment (PPE)
- ▶ Report accidents, incidents/near misses, problems
- ▶ Learn about hazards of specific chemicals
- ▶ Suggest changes and improvements
- ▶ Work safely
- ▶ Do not put others at risk
- ▶ Encourage good safety and security
- ▶ Behave responsibly




122




Employee/Student CSS Responsibilities

- ▶ Understand and act in accordance with policies and practices
- ▶ Wear and maintain proper PPE
- ▶ Use engineering controls properly
- ▶ Follow good chemical safety practices
- ▶ Participate in required training
- ▶ Read & understand CSS related documents
- ▶ Report accidents, incidents
- ▶ Suggest improvements and changes to the CSS Program
- ▶ Participate in the CSS Program




123




Chemical Safety and Security Officer

has the responsibility

to provide expertise and information
so that
a safe and healthy workplace
is present



124





CSSO Training, Experience, Skills

- **Physics**
 - Ventilation
 - Radiation (ionizing/non-ionizing)
 - Electrical
- **Biology**
 - Biosafety
 - Recombinant DNA
 - Blood borne pathogens
- **Administration**
- **Writing**
- **Speaking/presentations/training**
- **Chemistry**
 - Nomenclature
 - Physical properties
 - Reactivities
 - Chemical compatibilities
- **Health and Safety (industrial hygiene)**
- **Security**
 - Facility
 - Chemicals
 - Equipment
 - Personnel
- **Psychology**
 - Dealing with people



125




CSSO Responsibilities

- ▶ Report directly to higher management
- ▶ Provide leadership in safety and security
- ▶ Draft a budget
- ▶ Ensure Plans and Manuals are written and updated
- ▶ Advise administration, staff, employees, students
- ▶ Conduct inspections and audits
- ▶ Investigate accidents and incidents
- ▶ Respond to problems and concerns
- ▶ Participate in Chemical Safety and Security Committee(s)
- ▶ Ensure documentation, records and metrics are maintained
- ▶ Develop CSS Training plans
- ▶ Know legal regulations and ensure compliance




126




The Function of the CSSO is to Act as a Co-Worker, *NOT* as a Policeman



127




Chemical Safety and Security Committee

has the responsibility

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



128





Chemical Safety and Security Committee Responsibilities

- ▶ Reports directly to senior management
- ▶ Endorses policies
- ▶ Meets regularly (2 - 4 times/yr) with agendas
- ▶ Reviews accidents and incidents, may investigate, write reports with recommendations
- ▶ Establishes appropriate subcommittees on specific topics



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

129

Chemical
SAFETY AND SECURITY TRAINING



Chemical Safety and Security Committee Composition

- ▶ Chaired by committed staff
- ▶ CSSO is ex-officio member
- ▶ Includes representatives from:
 - Facilities Management
 - Security
 - Administration
 - Faculty/Staff
 - Teaching Assistants/Graduate Students
 - Shops/Unions
- ▶ Representatives should rotate after a few years

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

130

Chemical
SAFETY AND SECURITY TRAINING



Management CSS Responsibilities

<p>Commitment:</p> <ul style="list-style-type: none"> ▶ Establish a formal CSS Program ▶ Announce formation of a CSS Program ▶ Create a written policy statement ▶ Designate a Chemical Safety and Security Officer ▶ Endorse a written CSS Plan (Manual) ▶ Participate and intervene as needed 	<p>Support:</p> <ul style="list-style-type: none"> ▶ Financial support (budget) ▶ Staffing ▶ Response/resolution of problems by <ul style="list-style-type: none"> ◦ Establishing a CSS Committee ▶ Stipulates CSS is part of everyone's job <ul style="list-style-type: none"> ◦ CSS applies to everyone ◦ Specifies CSS orientation for new employees ▶ Supports CSS staff
--	---

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

131

Chemical
SAFETY AND SECURITY TRAINING



Management CSS Responsibilities

POLICY STATEMENT

Documents and describes the commitment and support from the highest management level for the Chemical Safety and Security Program

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

132

Chemical
SAFETY AND SECURITY TRAINING

Policy Statement Purpose

Establish and provide for maintenance of an effective Chemical Safety and Security Program to protect:

- Employees
- Facility
- Neighbors
- Environment
- Comply with regulations



CSP CHEMICAL SECURITY ENHANCEMENT PROGRAM

133

Chemical SAFETY AND SECURITY TRAINING

Policy Statements

- ▶ By senior management
- ▶ Typically brief
- ▶ Clear goals
- ▶ Commitment
- ▶ Defines employee role
- ▶ Identifies resources and staff
- ▶ Signed by person in authority



CSP CHEMICAL SECURITY ENHANCEMENT PROGRAM

134

Chemical SAFETY AND SECURITY TRAINING

Director/President CSS Responsibilities

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



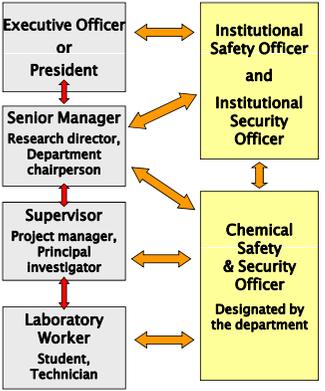
CSP CHEMICAL SECURITY ENHANCEMENT PROGRAM

135

Chemical SAFETY AND SECURITY TRAINING

Chemical Safety and Security Program Ideal Roles

- ▶ Culture of Chemical Safety and Security should exist at all levels of the organization.
- ▶ Top management sets policy, provides resources.
- ▶ Workers, students, researchers must understand and implement.
- ▶ Many organizational interactions are important for chemical safety and security
 - After Fig 1-1 in Prudent Practices in the Laboratory, NRC 1995



CSP CHEMICAL SECURITY ENHANCEMENT PROGRAM

136

Chemical SAFETY AND SECURITY TRAINING



CSS Program Evaluation

- ▶ Management leadership
- ▶ Employee involvement
- ▶ Administrative controls
- ▶ Security controls
 - Access to buildings, materials
- ▶ Engineering controls
- ▶ Accident/incident investigation
- ▶ Training
- ▶ Use of Personal Protective Equipment (PPE)
- ▶ Emergency Response Program
- ▶ Medical Surveillance Program
- ▶ Work site analysis
 - Inspections, surveys, hazard analysis



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

137

Chemical
SAFETY AND SECURITY TRAINING



Chemical Safety and Security Officer Duties

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

138

Chemical
SAFETY AND SECURITY TRAINING



CSSO Duties Include:

Surveys
Job Hazard Analysis
Inspections
Training
Medical Monitoring
Investigations

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

139

Chemical
SAFETY AND SECURITY TRAINING



CSSO Duties

- ▶ Oversee procurement, use, storage & disposal of hazardous materials
- ▶ Set criteria for exposure levels
- ▶ Write and revise CSS Plan
- ▶ Trains, documents and ensures training is performed
- ▶ Performs risk assessment and monitoring
- ▶ Conducts audits and inspections
- ▶ Investigates and reports on accidents, incidents
- ▶ Interacts with staff to correct deficiencies
- ▶ *Follows up* to ensure correction and resolution of issues

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

140

Chemical
SAFETY AND SECURITY TRAINING



CSSO Duties

- ▶ Consult/advise project management on CSS concerns
- ▶ Coordinate with Principal Investigators
- ▶ Coordinate and facilitate medical surveillance
- ▶ Coordinate record keeping
- ▶ Coordinate with BSO, RSO, facilities, administration, security




141



Hazard Survey

- ▶ Baseline
- ▶ Periodic (inspections)
- ▶ Identify potential job hazards, material hazards, and process hazards





142



Hazard Survey Process

- ▶ Prepare survey form
- ▶ Walk-through
- ▶ Take measurements
 - Sample if necessary, monitor exposure (e.g., formaldehyde, radiation)
- ▶ Data analysis
- ▶ Write and deliver report






143



Job Hazard Analysis (JHA)

Hazards associated with a particular task become apparent from a brief survey:

- Compile steps needed to complete job.
- Analyze each step in detail.
 - Could exposure occur?
 - Could an accident occur?
 - Could a change in practice / process create hazard?
- Develop recommendations on precautions to eliminate/minimize hazard.





144



Periodic Lab Inspections

- ▶ Done by CSSO
- ▶ Coordinate with lab supervisor/Chief/PI/occupants/safety representative
- ▶ Team may include:
 - Peers
 - Facilities representative
- ▶ Frequency determined by hazards present and local practices
 - 2 - 4 times/yr
- ▶ Look for:
 - Good and bad practices
 - new hazards
 - new security issues




145




Sample Laboratory Survey/Inspection Checklist

- ▶ Date of Inspection:_____
- ▶ Conducted by:_____
- ▶ Location (room and building):_____
- ▶ Principal Investigator/supervisor:_____



- ▶ Laboratory Work Practices
 - Smoking observed?
 - Food observed/stored. In refrigerators?
 - Mechanical pipetting devices present/used?
 - Hazardous chemicals present/used in designated areas?
 - Lab surfaces cleaned/decontaminated after use?
 - PPE available/properly used, stored, maintained?



146




Survey/Inspection Checklist, cont'd.

- ▶ Hazard Communication
 - Warning signs, required PPE *posted*.
 - (M)SDS available.
 - Signs for storage areas, refrigerators, waste, designated work areas' specific hazards.
 - Label all containers.
 - Access controlled.
- ▶ Personal Protective Equipment
 - Available for each specific hazard.
 - Eye protection available, when & where required & *posted*.
 - Other PPE available as necessary.
 - Visitor PPE available.
 - Visitor requirements for PPE *posted*.



147




Survey/Inspection Checklist, cont'd.

- ▶ Chemical Storage
 - Area secured
 - Chemicals with special security needs present?
 - Chemicals inventoried
 - Incompatible chemicals segregated.
 - Volatile, flammable material keep away from heat.
 - Corrosives, flammables keep below eye level.
 - Limited quantities of flammables, or other hazardous chemicals, stored in lab.
 - Unnecessary, outdated chemicals discarded.
 - Safety carriers available for bottle transport.




148



Survey/Inspection Checklist, cont'd.

- ▶ Compressed Gas Cylinders
 - Properly chained or secured
 - Caps in place, if available
 - Stored away from heat
 - Cylinders properly marked with contents
 - Empty and full separated
 - Flammables separated from non-flammables
 - Lines labeled and in good condition
 - Proper valves used
 - Toxic gases stored securely




CSP CHEMICAL SECURITY
ENHANCEMENT PROGRAM

149

Chemical
SAFETY AND SECURITY TRAINING

Survey/Inspection Checklist, cont'd.

- ▶ Safety Equipment
 - Eyewashes & safety showers present, unobstructed, in good working order, routinely tested and maintained.
 - Fire alarms & telephones appropriately placed and labeled.
 - Adequate number and type of unobstructed, routinely inspected fire extinguishers.
 - Spill kits available, maintained, labeled.
 - Adequate number of fire alarm/ detection devices.
 - Flammable storage cabinets available.
- ▶ General Facility
 - Benches are water/chemical heat resistant.
 - Sturdy furniture.
 - Sinks for hand washing.
 - Exits marked
 - Access controls




CSP CHEMICAL SECURITY
ENHANCEMENT PROGRAM

150

Chemical
SAFETY AND SECURITY TRAINING

Survey/Inspection Checklist, cont'd.

- ▶ Ventilation
 - Hoods available and in good working order.
 - All hoods marked with proper operating height and restrictions for use.
 - Hoods not cluttered with chemical and equipment storage.
- ▶ Housekeeping
 - Lab areas uncluttered.
 - Aisles & exits unobstructed.
 - Work surfaces free from contamination.
 - Spills cleaned up.
 - Electrical cords in good condition, equipment grounded.
 - Heavy objects on lower shelves.
 - Glassware free from defects.



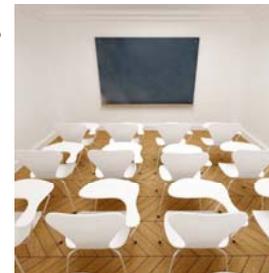
CSP CHEMICAL SECURITY
ENHANCEMENT PROGRAM

151

Chemical
SAFETY AND SECURITY TRAINING

Training Program

- ▶ Determine if training is needed, e.g., JHA
- ▶ Identify needs
- ▶ Identify Goals & Objectives
- ▶ Develop training activities
- ▶ Identify resources
- ▶ Conduct training
- ▶ Evaluate effectiveness
- ▶ Improve program



CSP CHEMICAL SECURITY
ENHANCEMENT PROGRAM

152

Chemical
SAFETY AND SECURITY TRAINING



Employee Training Topics

- ▶ New employee orientation
- ▶ Specialized laboratory equipment and procedures
- ▶ Recognize Occupational Exposure Limits (OEL) for hazardous chemicals; (M)SDS
- ▶ PPE use, storage and maintenance (especially respirators)
- ▶ Fire safety and fire extinguisher use
- ▶ Emergency plans, evacuation procedures & routes
- ▶ Ionizing radiation
- ▶ Non-ionizing radiation, lasers, microwaves
- ▶ Special exposure, e.g., formaldehyde
- ▶ Biosafety, Bloodborne pathogens
- ▶ Facility security requirements
- ▶ Animal Care facilities – use and techniques



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

153

Chemical
SAFETY AND SECURITY TRAINING



Training Documentation: Sample

- ▶ Employee name: _____
- ▶ Department: _____
- ▶ Date: _____
- ▶ Training Subject: _____
- ▶ Training Date: _____
- ▶ Re-instruction date: _____
- ▶ Employee Signature: _____
- ▶ Date Signed: _____
- ▶ Supervisor's signature: _____
- ▶ Date: _____

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

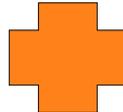
154

Chemical
SAFETY AND SECURITY TRAINING



Medical Surveillance Program

- ▶ Baseline screening
 - Medical history
 - Past illnesses, exposures and diseases
 - Comprehensive physical exam
 - Assessment of limitations
 - Respirator use and other PPE
- ▶ Treatment
 - Emergency
 - Non-emergency (e.g., first aid)
- ▶ Periodic Medical exam
- ▶ Termination exam
- ▶ *Confidential* record keeping
 - Physician, employee

CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

155

Chemical
SAFETY AND SECURITY TRAINING



Biological Monitoring Program

- ▶ Identify employees with potential exposure to specific hazardous chemicals, biological agents, working conditions.
 - Specific signs and symptoms of chemical exposure.
 - Use of respirators.
 - Cardiovascular, hearing (perforated tympanic membrane), neurological (e.g., epilepsy), psychological disorders
 - Working in noisy areas.
 - Working in Biosafety risk areas.
 - Bloodborne pathogens
 - e.g., Human blood and body fluids, hepatitis B (HBV), HIV, AIDS
 - Infectious agents
 - e.g., Zoonosis, animal care, recombinant DNA
- ▶ Determine extent of personal and environmental exposure.
- ▶ Take actions to eliminate/minimize exposure.
- ▶ *Confidential* record keeping .



CSP
CHEMICAL SECURITY
ENHANCEMENT PROGRAM

156

Chemical
SAFETY AND SECURITY TRAINING



Medical Surveillance vs. Biological Monitoring

Medical Surveillance	Biological Monitoring
<ul style="list-style-type: none"> ▶ General program ▶ Establishes baseline ▶ Evaluates employees before potential exposure ▶ Documents past exposure and existing conditions ▶ Simpler, cheaper, less invasive medical testing ▶ May be used in conjunction with biological monitoring 	<ul style="list-style-type: none"> ▶ Chemical specific signs and symptoms ▶ Known exposure levels ▶ Documented exposure ▶ Documented amounts of personal exposure ▶ Documented environmental exposure ▶ Most specific, most expensive, more invasive






157



Guidelines for Incident Investigation



- ▶ Description/report of incident
- ▶ Review of organizational policy
- ▶ Start of investigation
- ▶ Cause of incident
 - Emphasis is prevention, *NOT* blame
 - Timely report with recommendations to all responsible parties including senior management
- ▶ Timely response to recommendations
 - Correction
 - Follow-up
 - Action taken
 - Training




158



Incident Investigation Form: Sample

- ▶ Date of accident/incident_____
- ▶ Time reported_____
- ▶ Location_____
- ▶ Type of incident: fire, explosion, spill, employee exposure, theft, intruder, near-miss _____
- ▶ Date of investigation_____
- ▶ Investigation team members_____

Nature of Incident

- ▶ Incident description, include people, task, chemicals, etc. involved
- ▶ Nature of injuries, exposures, illnesses, damages, losses
- ▶ Determination of potential causes
- ▶ PPE worn at the time
- ▶ Hazard control or access control measures in use




159



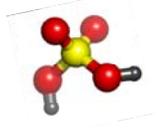
Incident Investigation Form, cont'd.

- ▶ Organizational polices, procedures, etc. that apply
- ▶ Was training proper and up-to-date?
- ▶ How could incident been prevented?
- ▶ Has similar incident occurred in past, when, where, circumstances?

Team recommendations to prevent reoccurrence of such incidents:

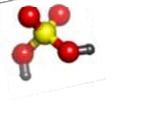



160



Break

161



Chemical Safety and Security Plan

162





First step: Collect information

- ▶ Writing a good CSS plan requires a lot of information
- ▶ Assessment questionnaires can be used to collect such information
- ▶ Distribute to:
 - Pls
 - Management
 - Facilities
 - Security
 - Medical

163





Assessment Questionnaire

- ▶ Who is responsible for CSS compliance?
 - Criteria for exposure control
 - Developing exposure control measures
 - Exposure monitoring
 - Identification of hazardous materials
 - Limited access policy
 - Ventilation maintenance
 - Safety equipment
 - Personal protective equipment
 - Training
 - Hazardous waste management
 - Medical surveillance
 - Emergency response



164




Assessment Questionnaire, cont'd.

- ▶ List individuals (managers, Pls, professionals, technicians) with Safety & Security responsibilities; indicate SO, CSSO, BSO, RSO, etc.
- ▶ Who maintains CSS records?
- ▶ Is there a Safety/Security Committee?
 - Responsibilities
 - Who are the members?
 - How often do they meet?
- ▶ Is there a CSS Manual, Plan?
- ▶ Are there CSS policies?
- ▶ Is there an Emergency Response Plan?
- ▶ Are routine CSS inspections conducted?
 - By whom
 - Details



CSP CHEMICAL SECURITY
MANAGEMENT PROGRAM

165

Chemical
SAFETY AND SECURITY TRAINING

Chemical Safety and Security Plan

- ▶ Includes CSS Policy Statements from senior management.
- ▶ Describes the entire Program.
- ▶ Describes the organization of the Program.
- ▶ Explains everyone's responsibilities.
- ▶ Describes in general terms policy and who, what, where and why a safety or security task or job is performed.
- ▶ Includes references, if necessary.



CSP CHEMICAL SECURITY
MANAGEMENT PROGRAM

166

Chemical
SAFETY AND SECURITY TRAINING

Parts of a Chemical Safety and Security Plan

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

CSP CHEMICAL SECURITY
MANAGEMENT PROGRAM

167

Chemical
SAFETY AND SECURITY TRAINING

Parts of a Chemical Safety and Security Plan, cont'd.

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





CSP CHEMICAL SECURITY
MANAGEMENT PROGRAM

168

Chemical
SAFETY AND SECURITY TRAINING



Standard Operating Procedures (SOPs)

- ▶ An SOP explains *concisely and precisely* how, where and who performs a task.
- ▶ It does *not* explain why the task is done.
- ▶ The Safety and Security Plan explains policy and why a task is performed

 169 



Standard Operating Procedures (SOPs), cont'd.

- ▶ SOPs are:
 - Dated
 - When issued
 - When reviewed
 - When revised
 - Have: subject, title and identification code
 - Officially reviewed by management
 - Signed by all responsible parties
 - May include forms
 - Written in a consistent and official format with numbered pages



 170 



Standard Operating Procedures (SOPs)

Consider written SOPs on:

- Security clearance and visitor access
- Employee training
- Medical surveillance
- Respiratory protection and fit
- Eye protection
- Ventilation system maintenance
- Storage, receipt, transport and shipping of hazardous materials
- Accident and emergency response including natural disasters
- Spill cleanup
- Waste management
- Hazardous material handling
- Special operations, radiation, biosafety, lasers, infectious agents

 171 



Plan and SOPs Revision Guidelines

- ▶ CSS Plan —————> As needed, every 5 years
- ▶ (M)SDS —————> As received
- ▶ Laboratory Hoods —————> As needed
- ▶ Training records —————> Yearly, and as needed
- ▶ Medical Surveillance records —————> As needed, and every 12–18 months
- ▶ Exposure monitoring } As needed
- ▶ Waste records } As needed

 172 



Record Retention Recommendations

- ▶ Personal records kept by Human Resources for the duration employment + 30 years.
- ▶ Medical records are *confidential* and should be kept by the examining physician for duration of employment + 30 years.
- ▶ Most other records (e.g., routine monitoring, should be kept for 5 years after date of performance).

173




Chemical Safety & Security

Standard Operating Procedures: SOP Exercise



SOP Exercise: Electrophoresis

- ▶ To develop an SOP:
 - focus on **safety portion of SOP**, ask/answer: **mitigation = PPE, engineered controls, operational controls, etc.**
 - what are **reagents** & hazards, and mitigation?
 - what are **products** & hazards, and mitigation?
 - what are **equipment** hazards, and mitigation?
 - what **waste** is generated? Hazards, and mitigation?
 - how to store chemicals?
 - waste reduction?
 - how to dispose of waste?

SOP Exercise





SOP Exercise: Electrophoresis

- ▶ Refer to the incomplete SOP distributed:

Rev/Date: Rev01, 25/01/11	Institute/Dept: INH/DNA Lab	completed by: you	1 of 4
Title: DNA Separation via Electrophoresis	Location: SMF/ L-001	approved by: E. Hoefler	

Briefly explain the procedure for this task: When an electric charge is applied to an agarose gel, DNA migrates through the gel matrix at a rate inversely proportional to the log₁₀ of the number of bases. Super-helical, nicked circular, and linear DNA migrate at different rates relative to each other, and the relative mobility varies depending on many factors. DNA is visualized by the addition of a dye that intercalates between the stacked base pairs of the DNA molecule. Upon exposure to light of a specific wavelength, DNA-dye complexes emit fluorescent or luminescent light. Traditionally ethidium bromide dye has been used.

- consider the experimental setup:
 - equipment
 - typical electrophoresis units operate at ~100 volts
 - power supply
 - connecting leads
 - combs, loading strips, gel trays, buffer chamber, buffer recirculating ports, casting stand, lid
 - UV light illuminator, peristaltic pump
 - samples
 - DNA

SOP Exercise






SOP Exercise: Electrophoresis

- Electrophoresis:
 - consider experimental setup (continued):
 - chemicals in this SOP:
 - agarose
 - Tris-Acetate-EDTA (TAE) = EDTA + Acetic Acid + Tris Base
 - ethidium bromide
 - other chemicals often used with electrophoresis:
 - polyacrylamide (acrylamide: $\text{CH}_2 = \text{CHCONH}_2$)
 - TEMED (*N,N,N,N*-tetramethylethylenediamine)
 - ammonium persulfate
 - CHAPS (3-[(3-cholamidopropyl)-dimethylammonio]-1-propane sulfonate)
 - Bromophenol blue ($\text{C}_{19}\text{H}_{9}\text{Br}_4\text{NaO}_5\text{S}$)
 - Dithiothreitol (DTT, $\text{C}_4\text{H}_{10}\text{O}_2\text{S}_2$)
 - EDTA (Ethylenediaminetetraacetic acid)
 - Tris ($\text{NH}_2\text{C}(\text{CH}_2\text{OH})_3$)
 - phenol
 - formoform





SOP Exercise: Electrophoresis

- ▶ Use the MSDS information distributed:
 - **MSDS sections:**
 - Section 2. HAZARDS IDENTIFICATION.
 - OSHA Hazards, Hazard statement(s), Precautionary statement(s), HMIS Classification, NFPA Rating, Potential Health Effects
 - Section 4. FIRST AID MEASURES
 - General advice, if inhaled, in case of skin contact, in case of eye contact, if swallowed
 - Section 5. FIRE-FIGHTING MEASURES
 - Suitable extinguishing media,
 - Section 7. HANDLING AND STORAGE
 - Precautions for safe handling, Conditions for safe storage
 - Section 8. EXPOSURE CONTROLS/PERSONAL PROTECTION
 - OELs, PPE
 - Section 10. STABILITY AND REACTIVITY
 - Chemical stability, Conditions to avoid, Materials to avoid, Hazardous decomposition products
 - Section 12. ECOLOGICAL INFORMATION
 - Toxicity





SOP Exercise: Electrophoresis

- ▶ Complete the SOP:
 - write in general safety/PPE at heading,
 - For acetic acid *and* ethidium bromide:
 - write in the hazards of each step,
 - write in proper waste handling,
 - write mitigation steps where they exist:
 - PPE, engineered controls, procedural controls, substitution/elimination
 - write in suggestions to reduce waste,
 - write in suggestions to improve SOP steps (for safety)




Chemical Safety & Security

Standard Operating Procedures: SOP Exercise





SOP Exercise: Electrophoresis

- ▶ **Hazards in this SOP:**
 - preparation of agarose gel solution
 - formation of super heated solution during heating with microwave.
 - Preparation of Buffer:
 - Acetic acid (glacial) is flammable, strong acid
 - setting up/running electrophoresis system
 - electrical shock.
 - staining of gels
 - ethidium bromide is a known carcinogen
 - waste/disposal
 - dispose of chemicals and gels with ethidium bromide as hazardous waste





SOP Exercise: Electrophoresis

- **Hazards in other electrophoresis SOPs:**
 - preparation of polyacrylamide gel
 - flammable solvents used (isobutanol) in curing gel.
 - chemical exposure to acrylamide, SDS, TEMED and ammonium persulfate
 - acrylamide affects central and peripheral nervous system and reproductive system when swallowed, inhaled or absorbed through skin
 - TEMED, SDS and ammonium persulfate causes irritation to respiratory system, eyes and skin upon inhalation and contact
 - setting up/running electrophoresis system
 - electrical shock
 - SDS electrophoresis buffer may cause irritation to eyes and skin upon contact





SOP Exercise: Electrophoresis

- ▶ **Hazard Controls:**
- ▶ **Substitution:**
 - glacial acetic acid – use:
 - premade/purchased TAE buffer
 - ethidium bromide (known mutagen) – use:
 - SYBR® Safe DNA gel stain (Invitrogen product)
 - SYBR® Green I is for dsDNA, and SYBR® Green II is for RNA and ssDNA
- ▶ **PPE:**
 - lab coat with full sleeves, splash goggles, nitrile gloves (latex is not effective), pants, and closed-toe shoes
 - skin and eye protection for UV radiation work
- ▶ **Waste/disposal:**
 - some gels considered non-hazardous, for example, ethidium bromide <0.4 wt% in non-polyacrylamide gel can be placed into a closed bag, then into trash





SOP Exercise: Electrophoresis

- **Hazard Controls:**
- **Thermal hazard:**
 - Exercise caution when using microwave to liquefy gels – don't use sealed containers, beware of superheated liquids that may froth up unexpectedly. Let hot gel preps cool to 50–60°C before adding stain or pouring into trays. Wear insulated gloves and point the flask opening away from you.
 - Loosen cap of bottle when heating solution. Do not heat for more than 30sec at a time. Heating up agarose solution in intervals using microwave with occasional swirling to mix the solution will help ensure agarose is melted more quickly without the formation super heated solution.
 - Fill solution only 1/3 of bottle volume
 - Standard PPE includes lab coat, gloves and safety glasses.






SOP Exercise: Electrophoresis

- ▶ Hazard Controls:
 - Chemical Hazards:
 - Measure, mix and handle all hazardous powdered chemicals or gel prep mixtures with hazardous components (e.g., acrylamide monomer, ethidium bromide, phenol, ammonium persulfate, and formaldehyde) [in the fume hood](#).
 - Store all organic/flammable solvents in flammable storage cabinets.
 - Purchase pre-made gels or pre-mixed acrylamide and ethidium bromide solutions instead of making your own.





SOP Exercise: Electrophoresis

- ▶ Electrical Hazard Controls:
- ▶ Power supplies:
 - inspect to ensure all switches and indicators are in proper working condition and that power cords and leads are undamaged and properly insulated.
 - label equipment with warning: "Danger Electrical Hazard."
 - connect to ground fault circuit interrupters (GFCIs)
 - use 3-prong plugs.
 - use power supplies with safety features that detect no-load, overload, sudden load change, short circuit, arc or ground leak, etc.
 - place electrophoresis power supply on a elevated position and separated from electrophoresis tank.





SOP Exercise: Electrophoresis

- Electrical Hazard Controls (continued):
- Connecting leads:
 - turn off main power supply before connecting or disconnecting electrical leads.
 - with dry gloved hands, connect one lead at a time using one hand only.
 - be sure that leads/banana plugs are fully seated.
- Using equipment:
 - don't run equipment unattended.
 - keep equipment clear of unintentional grounding points and conductors (e.g., sinks or other water sources, metal plates, jewelry, aluminum foil, pipes or other electrical/metal equipment).
 - gel chamber must have a lid or cover with safety interlocks to prevent accidental contact with energized electrodes or buffer solutions.
 - gel chamber exterior must be dry with no spills. Check for leaks.
 - ensure SDS electrophoresis buffer is not beyond the max fill line.





SOP Exercise: Electrophoresis

- ▶ Emergency event:
 - inform supervisor, coworkers and first aid officer.
 - for major emergencies dial xxx.
 - nearest first aid kit in room xxx.
 - nearest safety shower in room xxx.
 - nearest fire extinguishers:
 - CO2 fire extinguisher in rooms xxx and yyy;
 - dry chemical extinguisher beside store room.
 - evacuate per evacuation plan and gather in front of xxx Building.

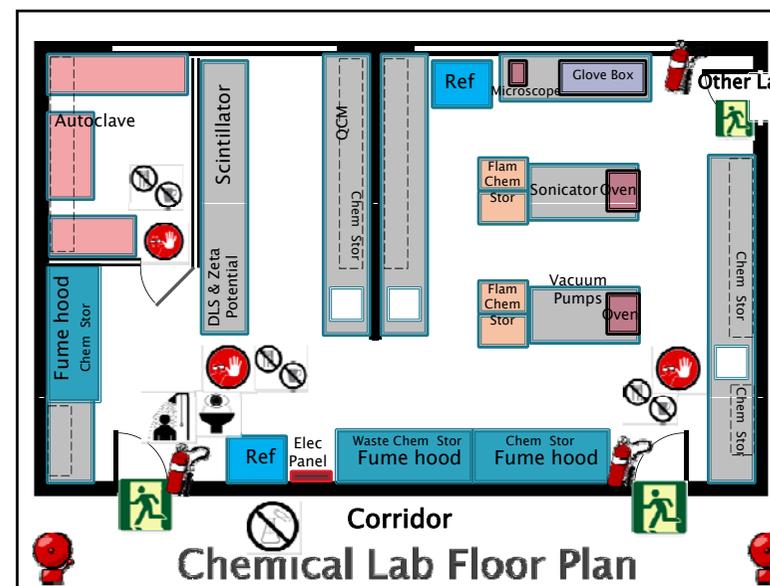
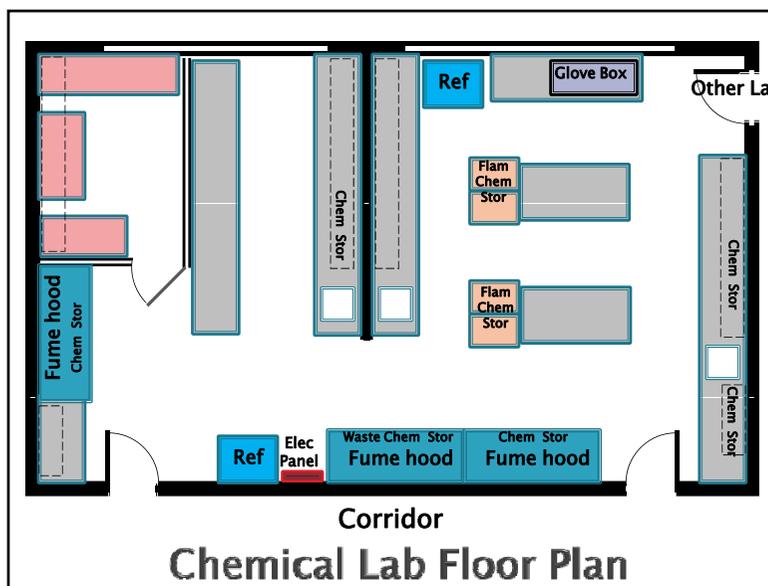
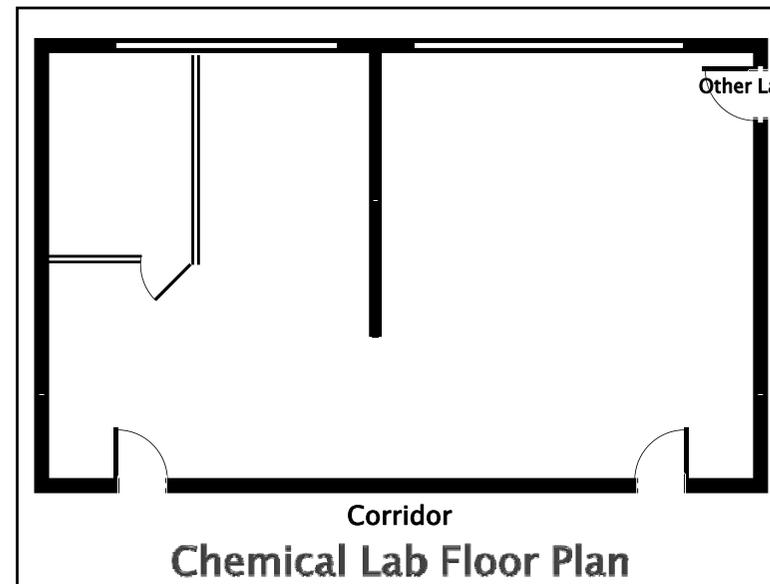


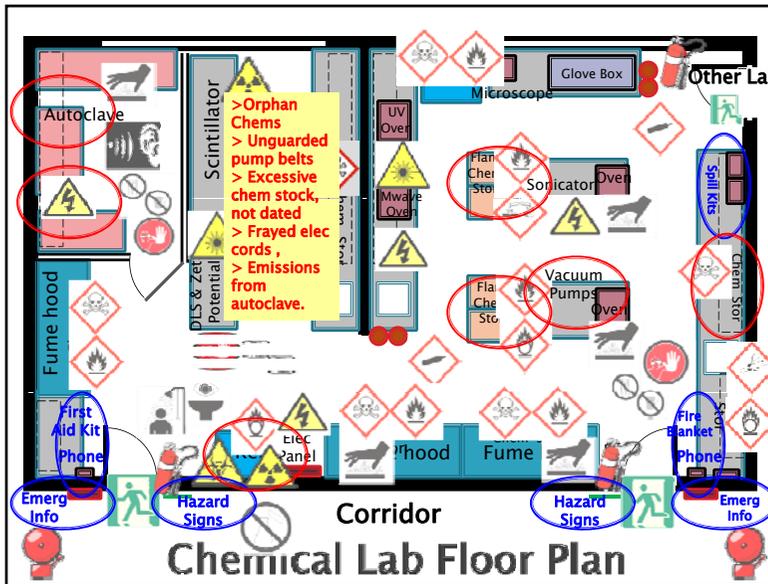
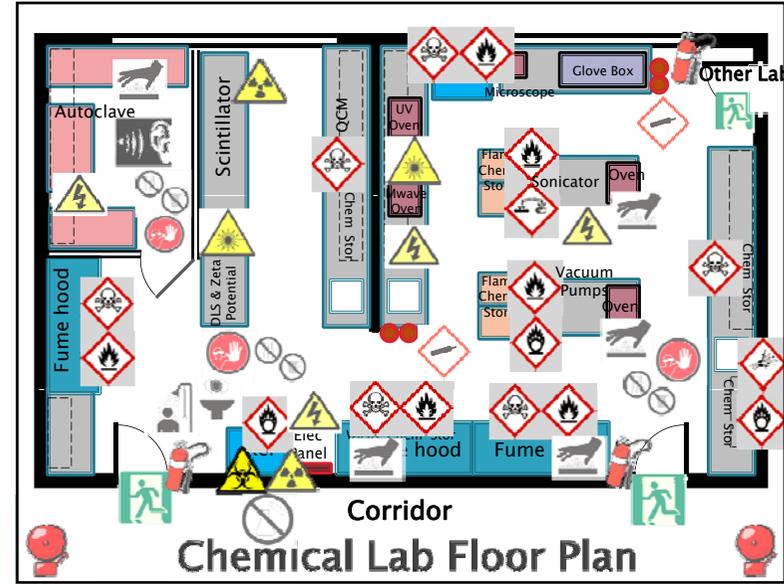
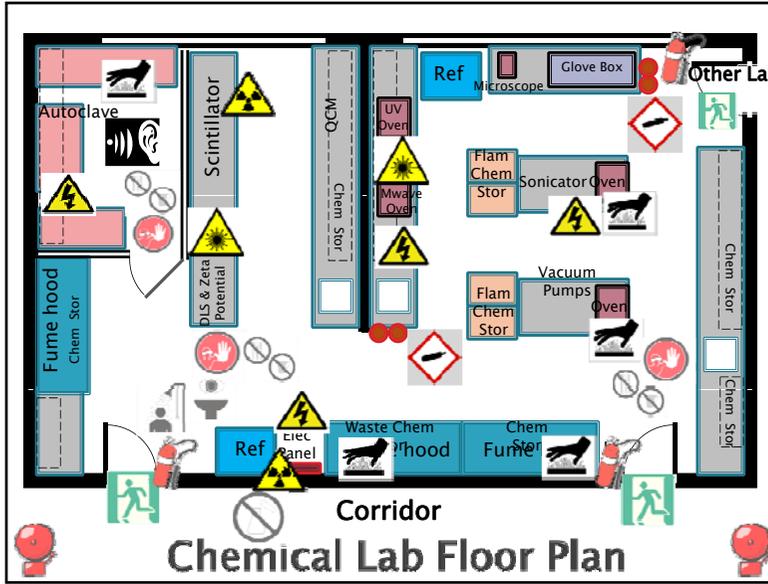



Lab Assessment Exercise

Introduction







**Questions?
Open Discussion**

The slide features a cartoon character with a question mark above its head on the left and an illustration of a meeting on the right. At the bottom, there is a logo for 'CSP Chemical Security Compliance Program' and the number '196'. The text 'Chemical SAFETY AND SECURITY TRAINING' is also visible at the bottom right.