# Lab Safety Training

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2025 November

# Safety and Health

## General Education and Training

Introduction and basic concepts

(1) Fire, Accident & (2)Emergency

(3) Regulations and Acts

(4) Basic Concepts and (5) Standard Operation Procedures

(6) Spontaneous inspections before, during, and after operation

(7) Case studies

# Is Your laboratory a safe place?

**Recent Lab fire accident in Taipei**

Laboratory Accident - Google

google.com/search?q=實驗室意外&oq=實驗室意外&gs_lcrp=EgZjaHJvbWUyBggAEEUYOdIBCjQxODM1ajBqMTWoAgCwAgA&sourceid=chr...

實驗室意外


Two graduate students suffered burns in a splash accident at National Cheng Kung University's chemistry lab and were sent to…

YouTube · TTV NEWS

1 month ago


Explosion in National Cheng Kung University's Chemical Engineering Laboratory! Two Master's students suffered burns to…

YouTube · TVBS NEWS

1 month ago


National Chung Hsing University: Two fires and laboratory accidents in two consecutive days, injuring three students | TVBS News...

YouTube · TVBS NEWS

1 month ago

上午 10:49
2025/10/21

# Introduction: Is your lab safe

## WHAT would happen IF chemicals are injected into your body

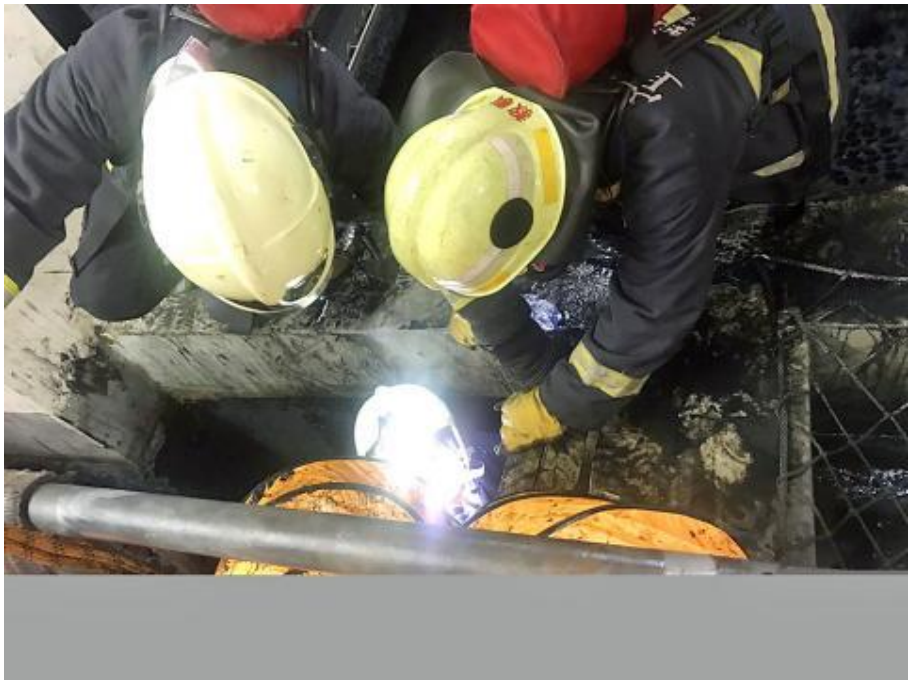


A rough estimate suggests the amount would be less than 100 µL of $CH_2Cl_2$ in the finger

*ACS Cent. Sci.* 2020, 6, 2, 83–86


# Yilan electronics factory accident leaves four dead

**Taipei Times (Staff writer, with CAN, Tue, Jun 27, 2017 )**

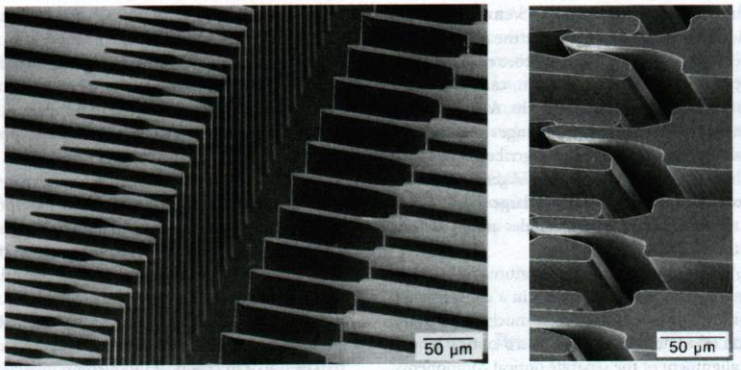


Five workers fell into a wastewater tank during routine maintenance and lost consciousness. Four people working for Unitech Printed Circuit Board Corp died yesterday after an industrial accident at an electronics factory in Yilan County, local firefighters said.

**Figure 1.28** An eye catching example of a LIGA 'product'. The ant holds a Ni gear in its claw. (From Forschungszentrum Karlsruhe GmbH Technik und Umwelt, Projekt Mikrosystemtechnik (PMT). With permission.)

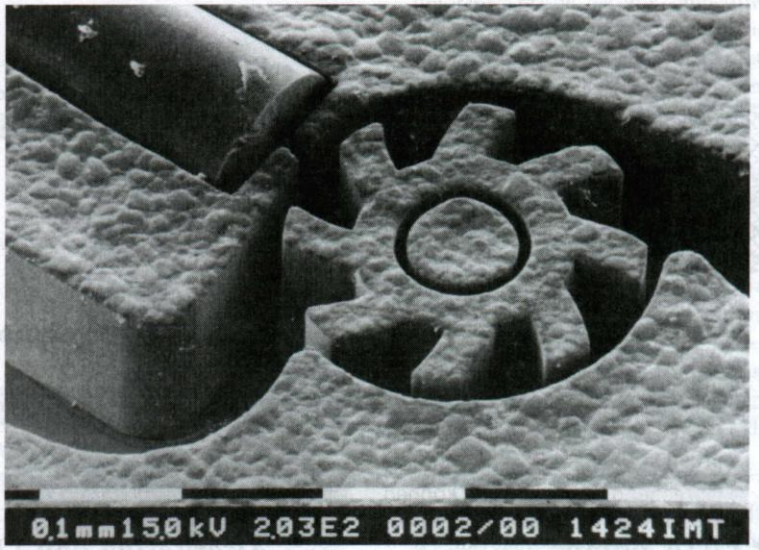
## *Electrical multipin microconnectors*

(From Ehrfeld, W., Proceedings, Micro System Technologies '90, Berlin, 521–528, 1990. With permission.)




## *Turbine rotor with integrated optical fiber*

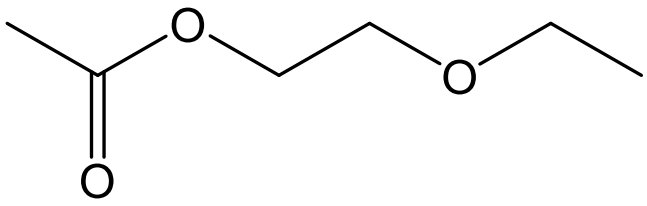
(Courtesy KfK, Karlsruhe, Germany.)



# Information may not be enough in SDS

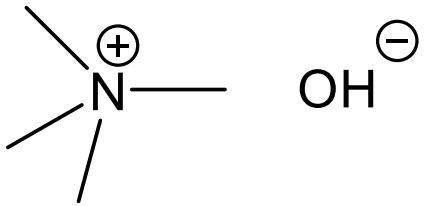
**Are the developers in clean rooms safe?**

Ethylene Glycol Monoethyl Ether Acetate (Cellosolve acetate)



Cellosolve acetate may hurt human reproductive system, damage fertility and unborn child. （Hardin 1983）

Tetramethylammonium hydroxide (TMAH)



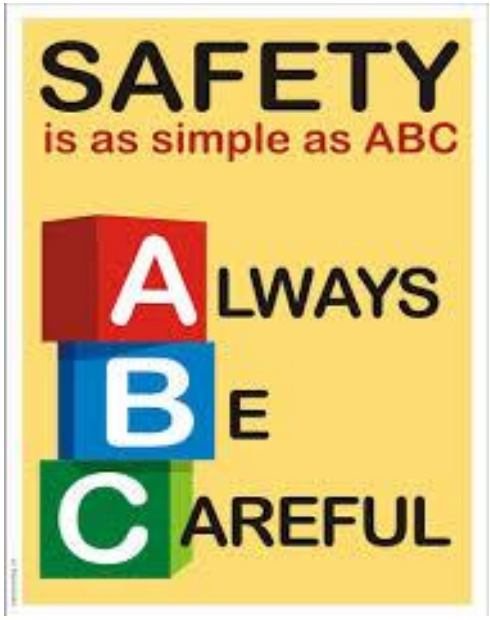
TMAH can be absorbed through skin and attacks nerves and muscles, causing difficulties in breathing, muscular paralysis and possibly death. Fatal injury may occur after getting in touch with 2.5% TMAH.

# Introduction: Major concepts about lab safety

- Research labs are potentially dangerous work environments
- Creating and understanding safety culture is important
- Safety education has to be broad-based, only small group of professional people understanding safety issues is not enough to secure safety

**Safety Guidelines**

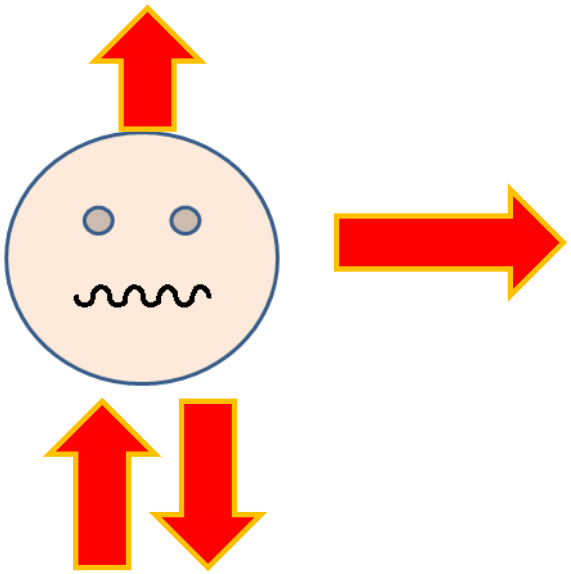
Don’t work alone
Don’t scale-up
Check all precautions and follow standard operating procedures
Protect yourself and call for help




# Fire, Accident &Emergency

# Campus safety: In case of emergency in NTUST

Your Professor or director



Call for help

| | |
|---|---|
| Fire Department/Ambulance | 119 |
| Police/Rescue | 110 |

| | | |
|---|---|---|
| University Security | Front gate | 6177 |
| | Building 1B | 1199 |
| | AAEON | 3799 |
| Security center | | 0800695995 |

**Fire accidents**

- Be familiar with your evacuation plan
- Join fire drill
- Never ignore any fire alarm or warning

# In case of fire accident

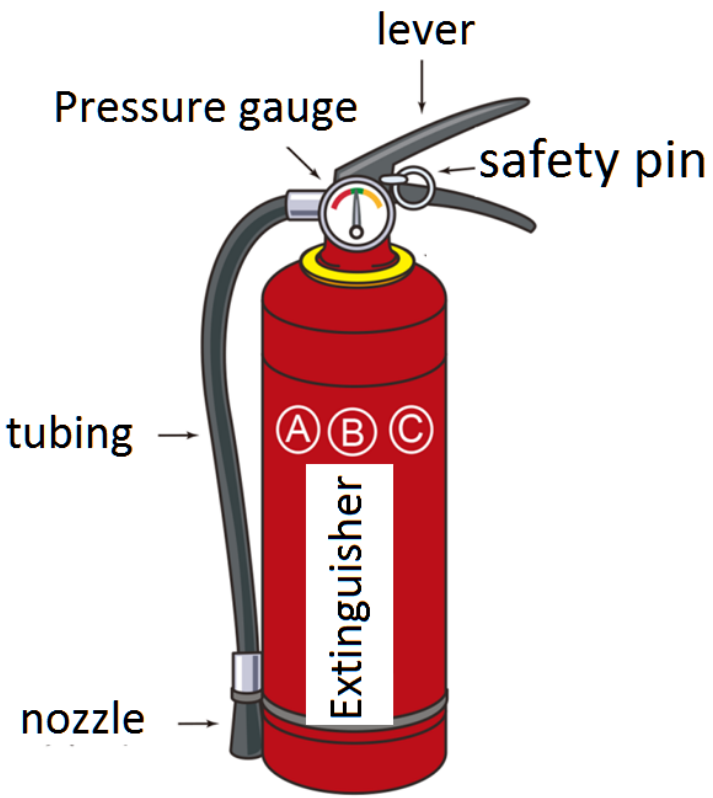
Fire growth develops quickly and can become out of control within five minutes.

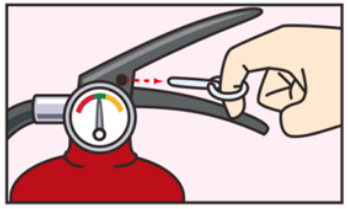
< 5 min

- Equip your lab with portable fire extinguishers
- At the very beginning of a fire accident, you may have good chance to put out the fire promptly.
- Suppress and extinguish the fire by fire extinguishers, fire sand, or blanket.

http://iaff266.com/flashover

# Fire Extinguisher



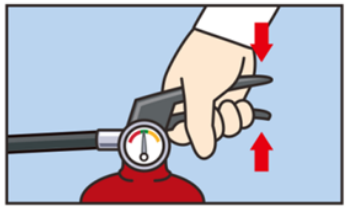



## Pull

Pull out the safety pin

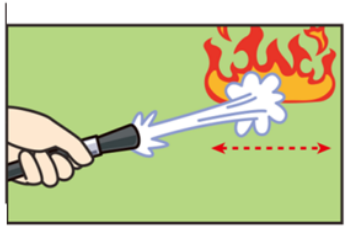
## Aim

Aim the nozzle to smoother the fire at the base.



## Squeeze

Squeeze the lever firmly to discharge the extinguishing agent



## Sweep

Sweep the hose from side to side until the fire is extinguished.

# Evacuation immediately when the fire is out of control

(a) Cry loudly for help to raise attention

(b) Evacuate the lab (shut the electrical power off if possible)

(c) Close (don't lock) the doors to contain the fire and smoke inside the lab

(d) Press the fire alarm

(e) Evacuate to a safe place

(f) Dial 119 to call the fire station for help

(g) Call your university security. They will guide the firemen to the scene of the accident

(h) Contact your professor


# Evacuation plan


- Don’t take elevator
- Approaching the nearest exit
- Taking the safest route, with the least amount of smoke and heat
- Closing doors on your way out
- Once escape, report immediately to safety officer


**Escape under toxic smoke**

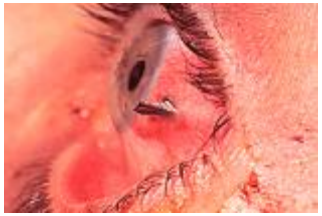
- Getting low and going under the smoke to your exit

**In case you get trapped**

- Sealing yourself in a safe place
- Contact fire department about your location.
- Use anything to seal the door cracks and cover air vents to stop smoke from coming in.
- If possible, open your windows to allow fresh air getting in.

# Emergency Shower and Eyewash

- The **first 10 to 15 seconds** after exposure to a hazardous substance, in particular, a corrosive substance, are critical. Delaying treatment, even for a few seconds, may cause serious injury
- Emergency showers and eyewash stations provide on-the-spot decontamination. Workers can flush away hazardous substances that can cause injury.
- In case of emergency, flushing your eyes with eye washer for at least 30 min. If possible, taking off your contact lens and flushing your eyes thoroughly. At the same time, call an ambulance to send the patient to hospital.



Metal sharp hazards

Chemical splash hazards

# Emergency decontamination for chemical splash

Diphoterine: an emergency rinsing solution for splashes of chemicals, acids or bases (e.g. sulfuric acid, hydroxides, phenols)

Hexafluorine : an emergency rinsing solution for HF splash

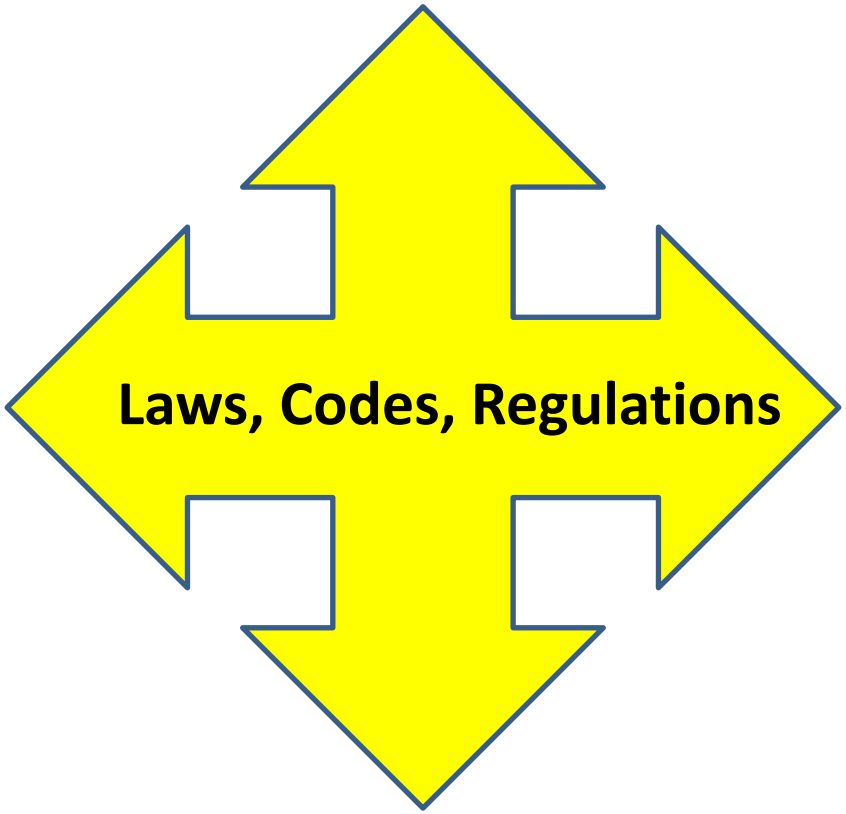
- Emergency treatment within 1 min for decontamination. Flush with water for at least 15 min and send to hospital.
- Diphoterine and Hexafluorine, which are slightly hypnotic to tears, restore the eyes physiological balance. It prevents the aggression from penetration.

# Automated external defibrillator (AED)

An automated external defibrillator (AED) is a portable electronic device that automatically diagnoses the life-threatening heart arrhythmia (irregular heartbeat) and application of electricity which stops the arrhythmia, allowing the heart to re-establish an effective rhythm

# 平面配置圖 | 10607 臺北市大安區基隆路四段43號
No.43, Keelung Rd., Sec.4, Da'an Dist., Taipei 10607, Taiwan

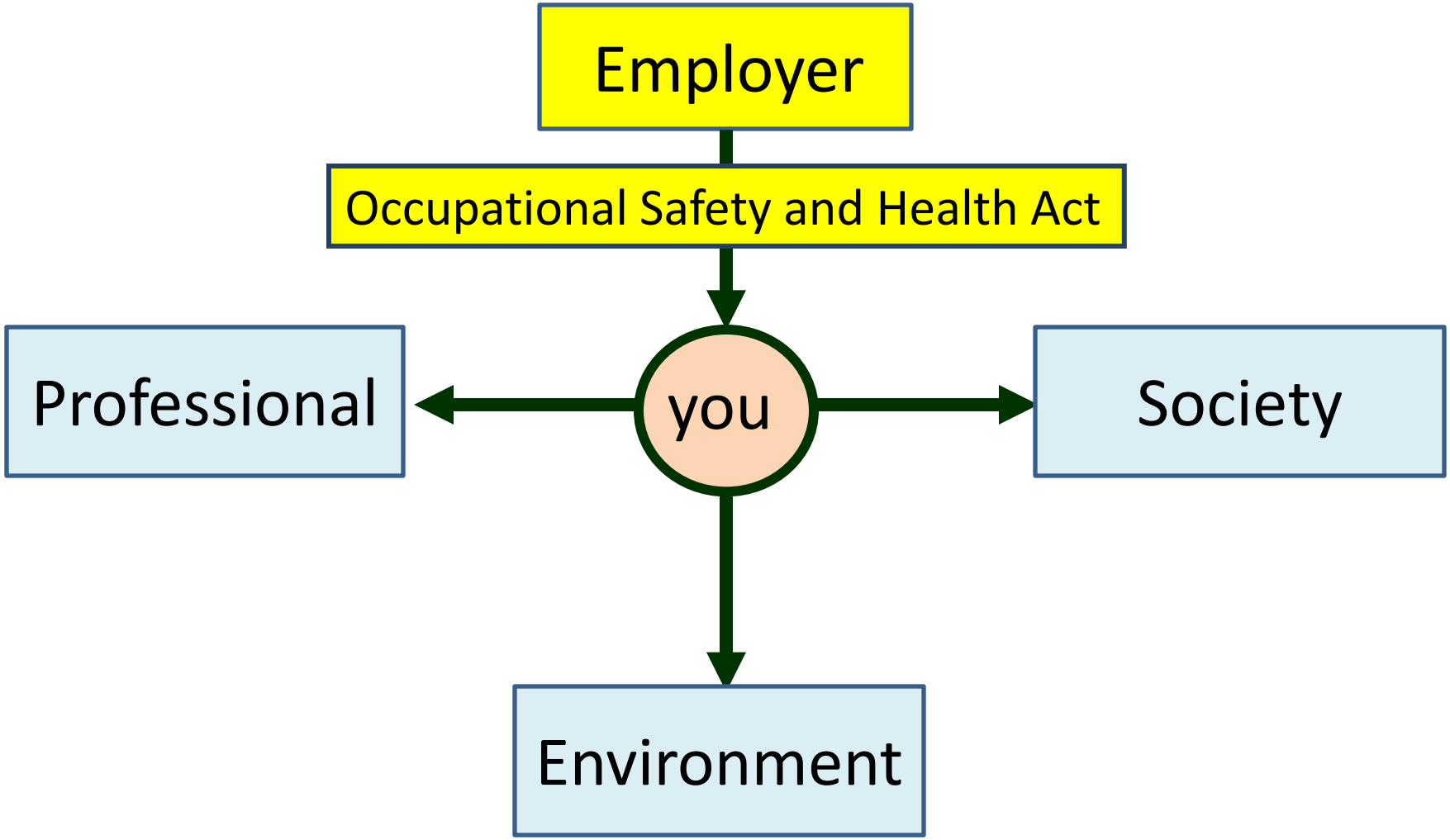
## Layout of Taiwan Tech




Regulations and Acts

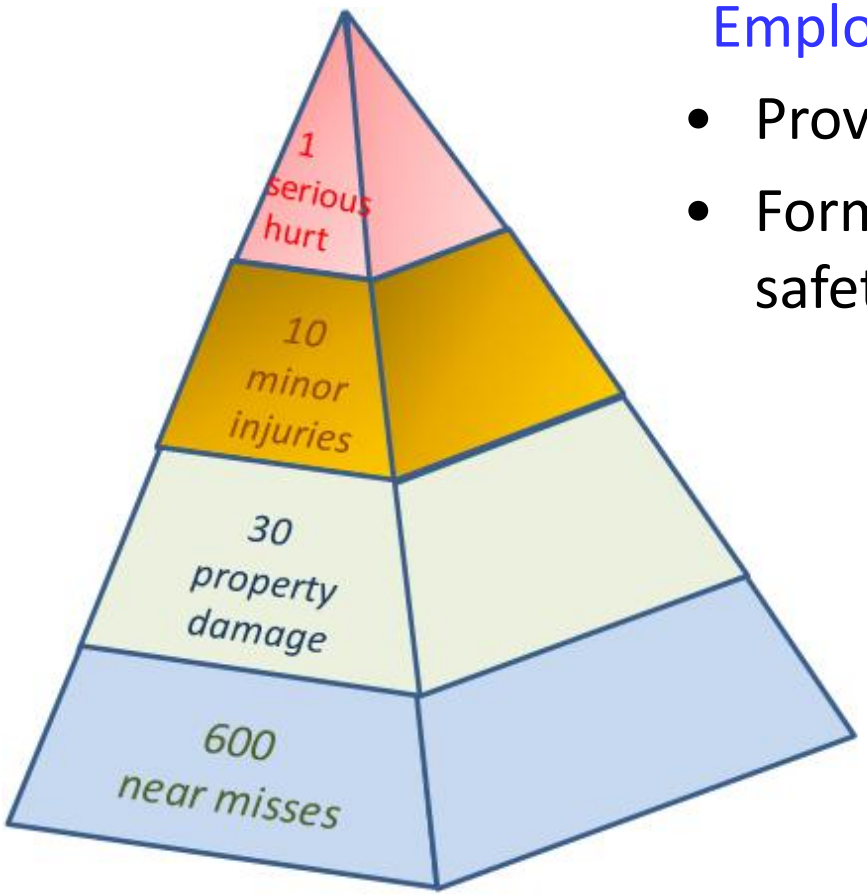
# Laws, Codes, and Regulations

**Lab safety regulations are only basic requirements**



# Occupational Safety and Health Act

Prevention of work and health hazards




## Employer

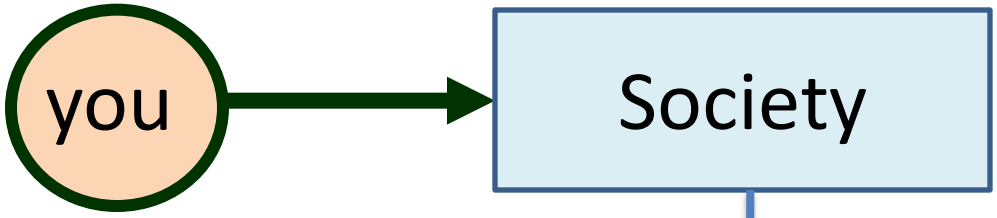
- Provide Safety and Health Facilities
- Formulate, announce, and execute a safety and health management plan

## Employee

- Receive the safety training
- Follow the safety regulations
- Health check

violation fine: NT$3000

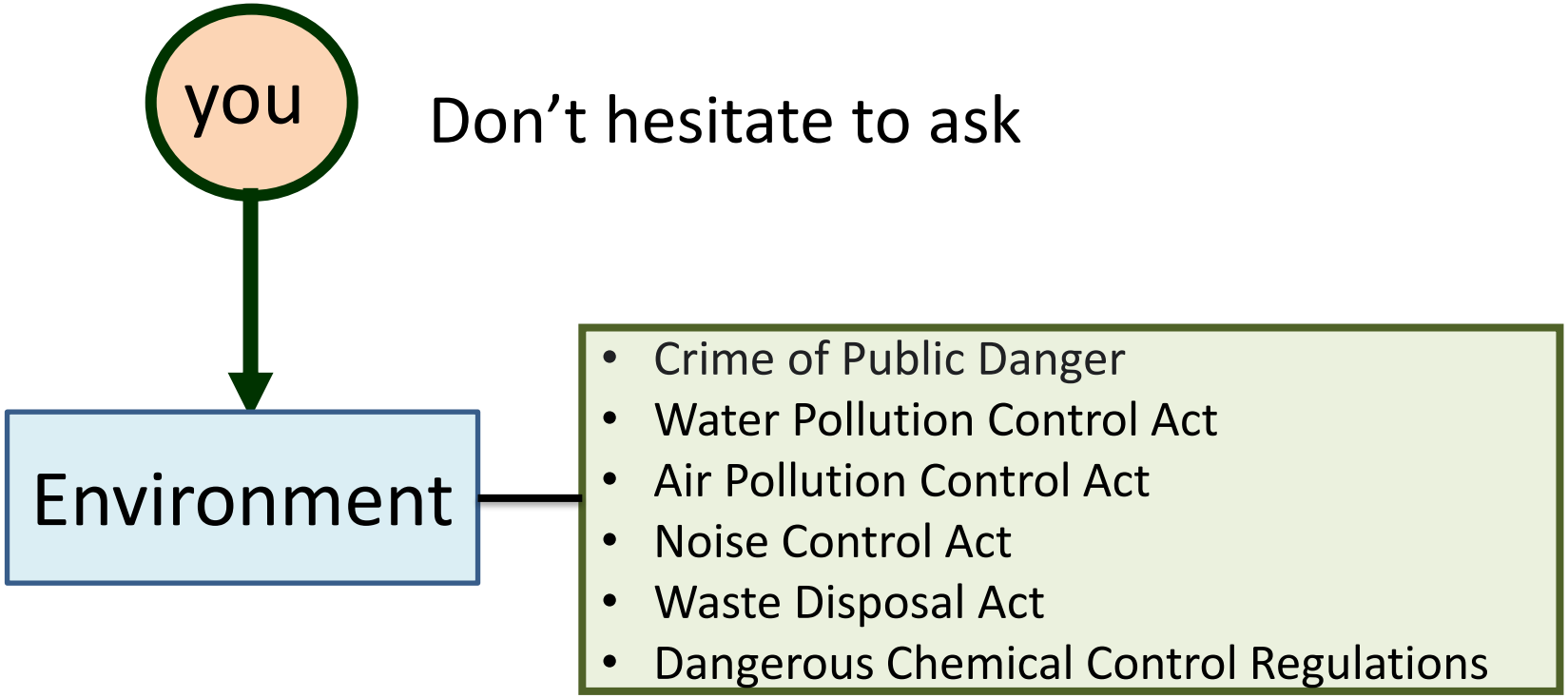
# Laws, Codes, and Regulations



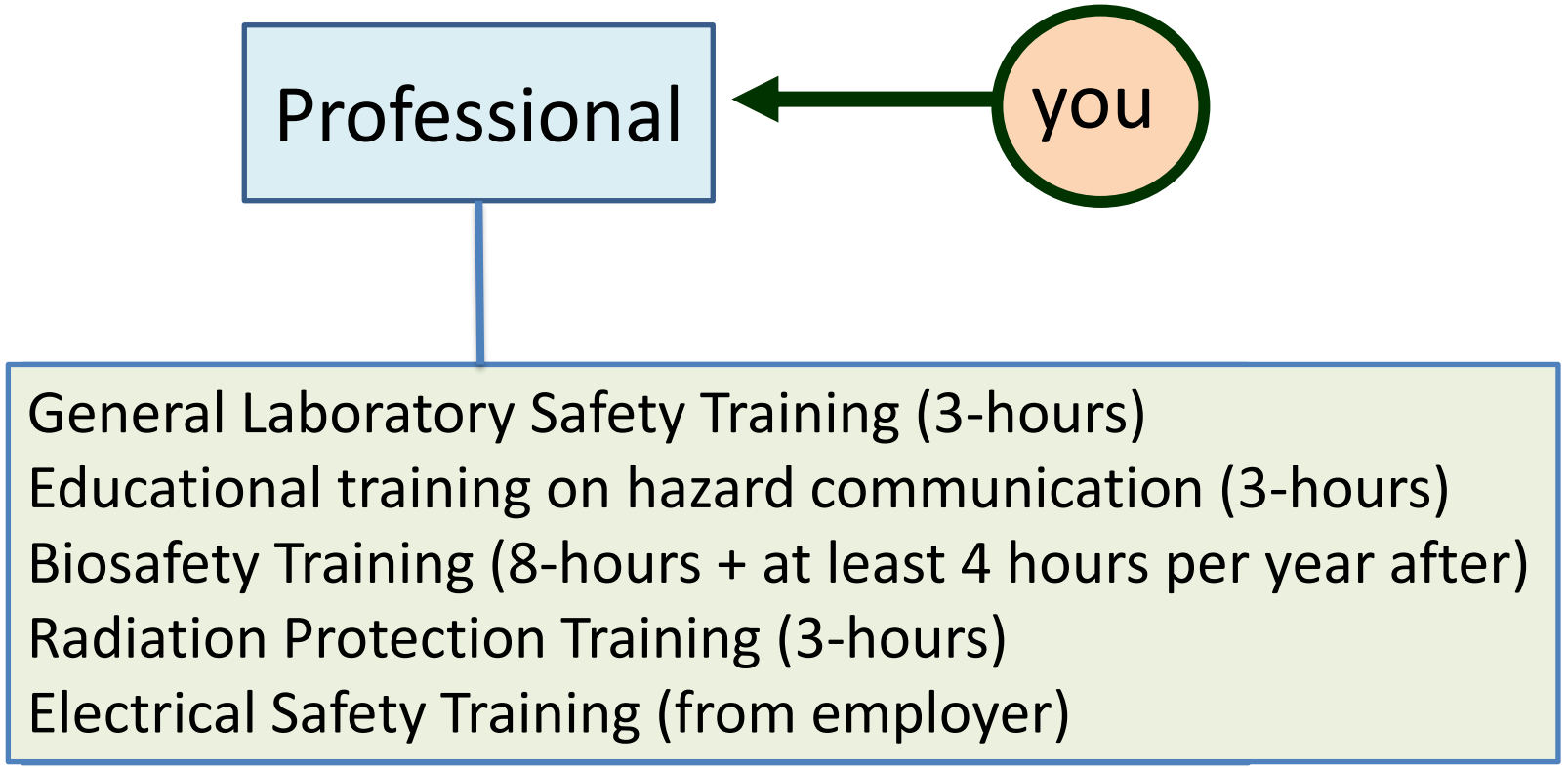

Don’t hesitate to ask

Environment Protection Administration
Ministry of Health and Welfare
National Fire Agency
Atomic Energy Council
Council of Agriculture
Construction Management Office
The Electricity Act

# Laws, Codes, and Regulations



# Laws, Codes, and Regulations




# Safety Guidelines

**Obligation to avoid accidents**

Don’t scale-up

Don’t work alone

Don’t ignore any abnormal signal

Check all cautions

Follow standard operating procedures

Protect yourself and call for help

# Obligation to avoid accidents

**Your obligation:**
**Make every effort to avoid accidents**

- Safety Precautions and Training
- Communication and Discussion
- References, and Notes
- Maintenance and Repairing Records
- Following Guidelines and Standard Operating Procedures
- Arrangements in place to deal with accidents


## Safety Guidelines

Obligation to avoid accidents

**Don’t scale-up**

Don’t work alone

Check all precautions

Follow standard operating procedures

Protect yourself

# Don’t scale-up

**Accidents or Disasters**


http://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/less-is-better.pdf

# Total risk, a function of Severity and Probabilistic risk

Risk in a feasible detrimental outcome of an activity or action is determined by

Total risk (expected loss) = $\Sigma$ f(Severity; Probability)

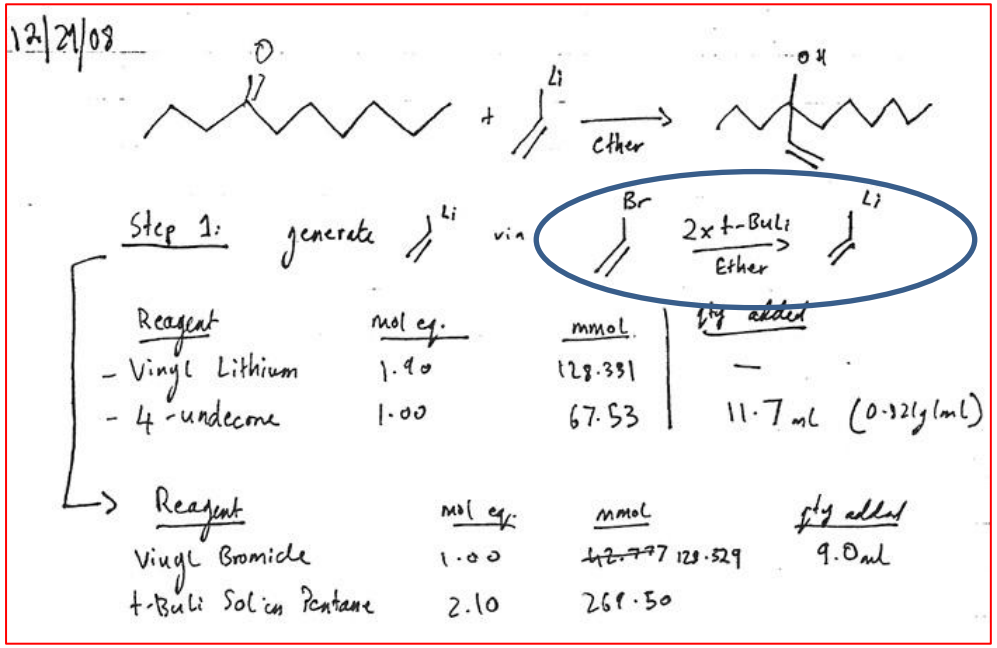
e.g.
Estimated total damage each year = the number of people potentially hurt or killed in each accident x occurrence frequencies

Reduce reaction scale ⟹ Reduce severity in each accident

Follow SOP or guidelines ⟹ Reduce the probability of human errors

# Sheharbano Sangji

*A 23 year old female RA employed in the lab for about 3 months*




- *The fire ignited the gloves and the sweater.*
- *Caused second degree burns on her arms and third degree burns on her hands, a total of about 40% of her body.*
- *Died in the hospital few days later.*

Jyllian N. Kemsley, Chemical and Engineering News. Volume 87 Issue 31 | pp. 29-31, 33-34, August 3, 2009

# Seven most common causes of workplace accidents

- ☹ **Shortcuts** (generating three times of materials at once)
- ☹ **Overconfidence** (carrying out *experiments during the UCLA holiday shutdown)*
- ☹ **Poor, or Lack of Housekeeping** (an open flask of hexane in the hood)
- ☹ **Starting a Task Before Getting All Necessary Information** (not using the emergency shower immediately)
- ☹ **Neglecting Safety Procedures** (not wearing lab coat)
- **Mental Distractions**
- ☹ **Lack of Preparation** (Using a 60 mL syringe to pull up 50 mL of *t*-BuLi )

When students begin a task without thinking through the process beforehand, or hastily start without any planning, they are setting themselves up for failure.

Make sure you plan your work, then work your plan.

http://www.safetypartnersltd.com/7-most-common-causes-of-workplace-accidents/#.ViuOdtIrK9I

# An explosion in an inorganic lab

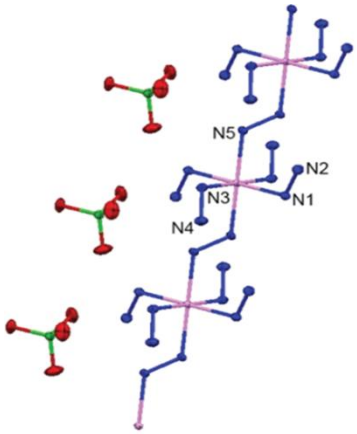
## *Scaling up the process*

**January 2010 Texas Tech Laboratory Accident**

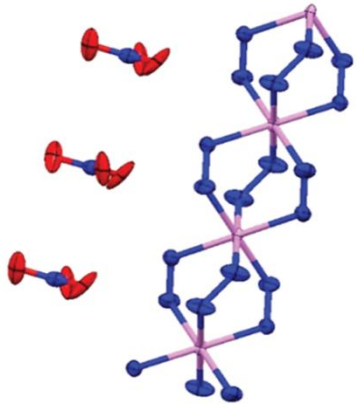
Preston Brown wanted to prepare a derivative of nickel hydrazine perchlorate (NHP). When NHP (5 g) was pressed and grinded, and it detonated

- loss of three fingers,
- cuts and burns to perforation of his eye and other parts of his body

- Had no formal training with the material/hazards
- No personal protection equipment (no shield, on bench top, not even safety glasses)
- Exceeded the 100 mg limit and scaled up to 10 g.
- They had near-misses experience before.




$Ni(N_2H_4)_5(ClO_4)_2$



$Ni(N_2H_4)_3(NO_3)_2$

**RSC : Ionic polymers open door to greener, safer explosives. (JACS 2012, 1422-1425. )**


## Safety Guidelines

Obligation to avoid accidents

Don’t scale-up

**Don’t work alone**

Check all precautions

Follow standard operating procedures

Protect yourself

# Don’t work alone

2011/04/14 Michele Dufault, 22, a senior undergraduate science student majoring in astronomy and physics in Yale University, died from accidental asphyxia by neck compression.

Her hair is thought to have been caught in the machine's rotating drive and dragged her onto it while using a fast-spinning lathe in the student machine shop.

**She worked alone when the accident happened.**

**The lack of emergency brake**

# Another case of Hair Gets Caught in Lathe in Taiwan

2016/02/18
自由時報

The accident occurred in an evening class in an industrial senior high school . The instructor stopped the machine immediately and saved the student.


## Safety Guidelines

Obligation to avoid accidents

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Don’t work alone

**Check all cautions**

Follow standard operating procedures

Protect yourself

# Researcher loses arm in Hawaii explosion

Thea Ekins-Coward, postdoctoral researcher, 29, lost an arm and suffered other injuries in a lab explosion at the University of Hawaii

Photos when she was a research associate and PhD student on Low Cost Algae Harvesting Technologies in Newcastle University

*C&EN*, **2016**, *94* (13), pp 6–6March 28, 2016

# Disaster Scene

*These photos, released by the Honolulu Fire Department, illustrate the force of the March 16 explosion and its consequences.*


## Safety Guidelines

Obligation to avoid accidents

Don’t scale-up

Don’t work alone

Check all cautions

**Follow standard operating procedures**

Protect yourself and call for help

# Follow standard operating procedures

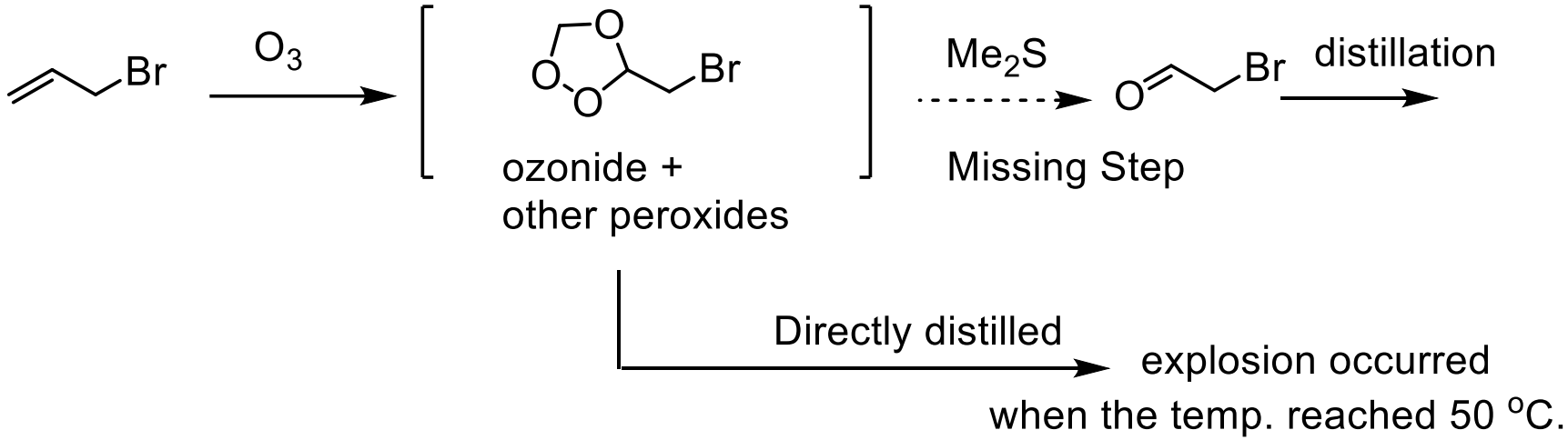
A student did not follow the standard operating procedure (SOP) and attempted to clean a double-horizontal-shaft forced type concrete mixer during operation. His left palm was sucked in, causing bond fracture.

- Ignoring the SOP
- Absence of an interlock system between machine cover and the power supply.
- Absence of an emergency brake.

Double-horizontal-shaft typed mixer

# An explosion in a synthetic organic lab

*An OSU grad. student misunderstanding the operation procedure*




The shattered ceramic top sent chards into the face, chest, shoulders, and hands of the student. One chard hit the left lens of his safety glasses with such force that it shattered but remained within the frame

× Misunderstanding the operation procedure.

× Fumehood Sash open (violate safety guidelines)

√ Safety glasses (save his eye)

***John Herrington***
*Health and Safety Officer , College of Math and Physical Sciences, Ohio State University*
http://www.chemistry.ohio-state.edu/ehs


## Safety Guidelines

Obligation to avoid accidents

Don’t scale-up

Don’t work alone

Check all precautions

Follow standard operating procedures

**Protect yourself**

# Personal protection

# Long hair, tie and bulky clothing are dangerous in lab

• Long hair, tie and bulky clothing can accidentally fall into flames or chemicals.
• Long hair, tie and bulky clothing can be caught in the machine's rotating drive

• Long hair must be pulled back and properly restrained.
• Tie and bulky clothing should be taken off.

# Shoes and Lab coat


Shoes: Generally speaking, **closed toe and heal shoes** are required for lab work. Shoe material should be non-absorbent, such as leather.
Canvas shoes, sandals or slippers, and shoes with ventilation should be avoided.
Safety shoes incorporating steel toe caps are appropriate for machine shop.

Clothing – **long pants or skirts should be worn in the lab, not shorts.** Lab coats should be button front coats so that they can be taken off easily if in case of accidents.
Launder the lab coats frequently somewhere. **Don't use your home washing machine in order to avoid contamination.**
Sweat shirts are inappropriate because they are difficult to be taken off in case of contamination or catching fire.

# Safety Goggles

PI, students, workers, visitors have to wear goggles in the lab.

In particular, for the working area with any subject that has potential threats to your eyes, goggles is necessary.

- Working place having airborne abrasive materials from cutting, grinding, carving, wood and metal shop, and glass shop.
- Working place with high temperature facilities like furnaces, cast molding, welding, laser cutting, and other operations generating high temperature
- High pressure system or projectile
- Working in chemical labs

• Safety glasses must have top and side shields; and should be strong enough to resist impact by flying objects.

• Safety goggles should have a soft, pliable flange that seals around the eyes tightly to protect the eye from a variety of hazards and chemical splash.

• Face-shield is required for handling low temperature liquid like liquid nitrogen or corrosive liquid.

1. Safety Glasses

2. Safety goggles

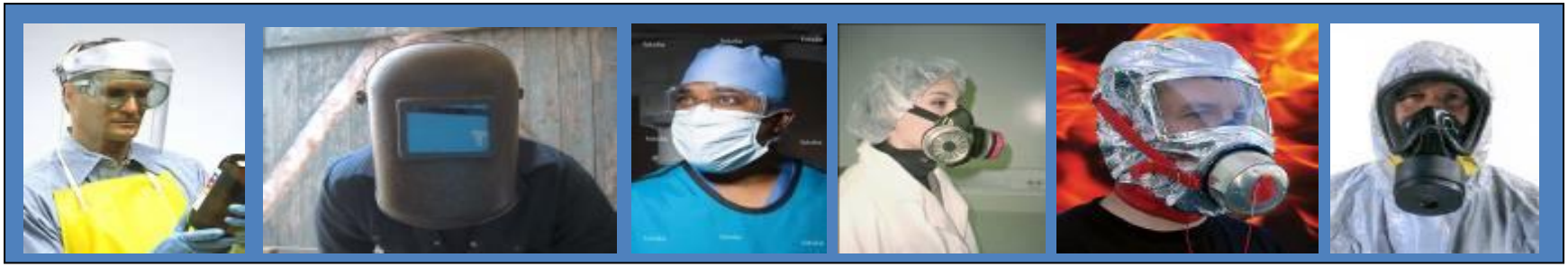
3. Face shield

# Safety Mask

A safety mask can prevent dirt, dust, fumes, vapor, gas, contamination, air-borne droplets (mist), and bacteria from entering the body.

Common hazards: dust, vapor, gas, oxygen-deficient atmospheres.

- The tightness of the seal is the critical factor determining whether a mask will be effective. Please test the mask and monitor the result of fit test and adjust in time, before use.



dirt, dust

fumes, vapor, gas

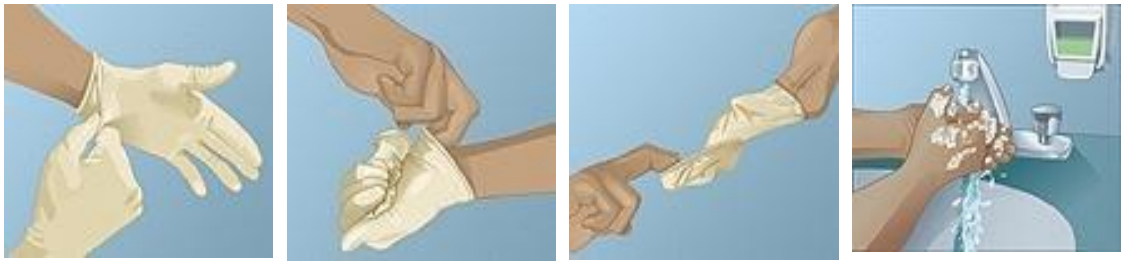
# Safety Gloves

Professor Karen Wetterhahn died of dimethylmercury poisoning Dimethylmercury can in fact rapidly permeate latex gloves within about 15 seconds and enter the skin.

Picture from The Scientist Library

Gloves can only delay the chemical permeation.

- Your latex gloves should be disposed after use.
- When you take off the gloves, you should follow the guideline below to avoid direct touching with you skin.
- Hexafluorine® First Aid treatment for HF accident



# Safety Gloves

## chemical resistant gloves


Nitrile


nitrile hybride


long


Rubber


viton


PVC

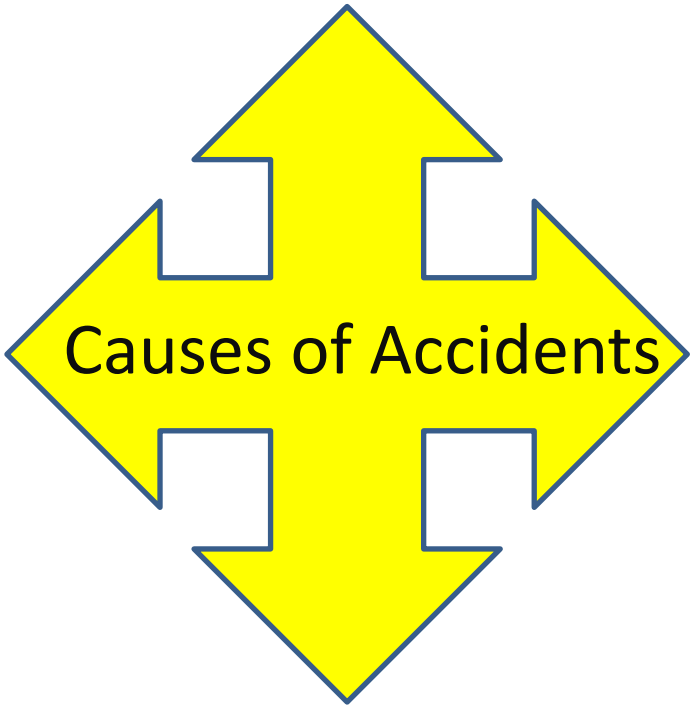
## Surgical and PE gloves


Surgical Gloves


PE Gloves


Duo Gloves

## Nitrile-chemical and solvent resistant




Basic Concepts and Standard Operations

# Why safety being overlooked?


*Accident Pyramid Diagram by the US safety researcher, Frank Bird, 2013-MSHA*

Sometimes when several mistakes happen coincidentally, small mistakes will cause a disaster.
Since the probability is low, many principal investigators (PI) and researchers simply ignore the risk.

However, when all check points go wrong coincidentally, disaster becomes inevitable. If any one of these can be eliminated, tragedies could be prevented.

# The concepts of RAMP

**R** Recognize the hazards

**A** Assess the risks of the hazards

**M** Minimize the risks of the hazards

**P** Prepare for emergencies

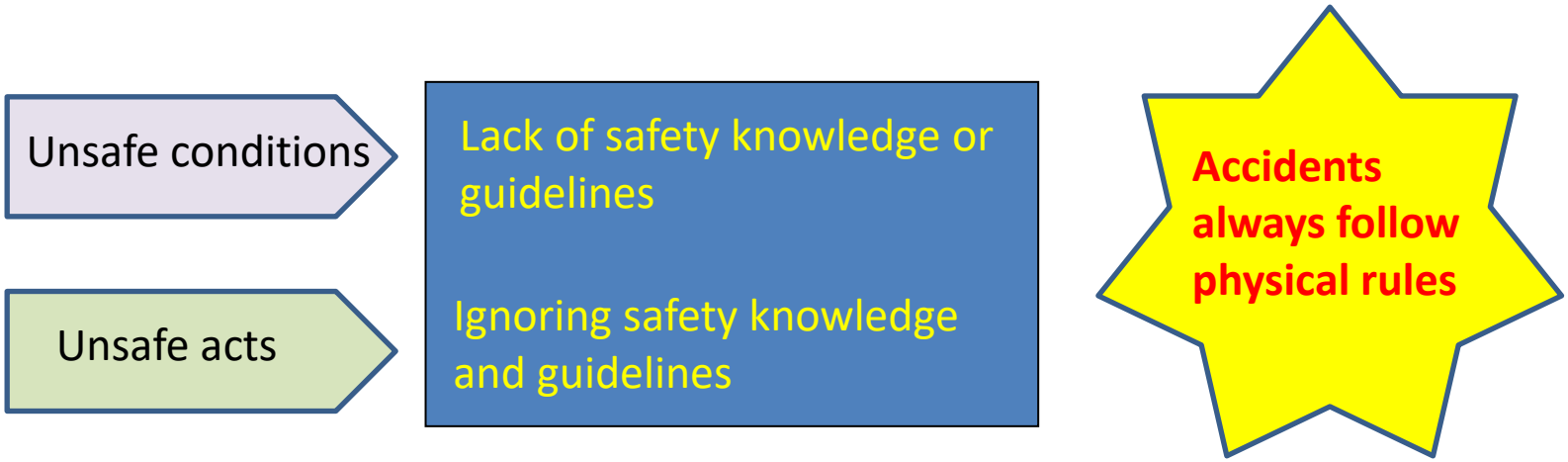
What IF analysis

Personal Attitude

Hill, R. H.; Finster, D. C. Laboratory Safety for Chemistry Students; John Wiley & Sons, Inc.: Hoboken, NJ, 2010; p 1-7.

# Accident Analysis - Improvements through tragedy

*U.S. Department of Labor, Mine Safety and Health Administration Safety Manual No. 10 Accident Investigation, 1990*




**WHAT-IF ANALYSIS** A what-if analysis is a structured way to anticipate what might go wrong, and then judge the likelihood of occurrence and the harm that might result from each possible scenario. This technique can be used to analyze existing or new processes or procedures.


**R** Recognize the hazards
**A** Assess the risks of the hazards
**M** Minimize the risks of the hazards
**P** Prepare for emergencies
What IF analysis
**Personal Attitude**

# Just paying lip-service to the concept of safety rather than actually backing it up in practice

2012 survey of safety in US academic laboratories (about 2400 researchers)

- 86% They believed their laboratories were safe places to work.
- 94% Senior researchers felt that appropriate safety
- 80% Working in their laboratory alone at least once a week !!!!
- 54% Sometimes didn't wear a lab coat.
- 40% Not to have received safety training on specific agents or hazards.
- 60% Thought that safety in their chemical laboratories could be improved.
- 30% Aware of at least one 'major' injury occurring in their laboratory.

Safety first? 29 May 2014, by Jon Evans
http://www.rsc.org/chemistryworld/2014/05/safety-first

Dana Ménard and John Trant Nature Chemistry · November 2019

- 25-38% unreported accident
- 27% never conducted risk assessment
- 40% wearing PPE at all times when working.
- 25% had not been trained in the specific hazard

11 hazardous compound were mentioned 107 times in journal articles but only one article provided cautionary information.

# Examples of lab accidents


https://www.cartoonstock.com/directory/l/laboratory_accident.asp



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# Improper Handling of Unwanted Chemicals

University of Wisconsin April 2012

A researcher placed Pd/C into a plastic waste container in the lab. It was fortunate that a member of the custodial staff was near the lab when the fire started and was able to put the fire out before potentially spreading.

Many materials such as Raney Nickel, Pd/C, hydrides, and sodium and potassium used for chemical reactions still remain active after work-up. Pd/C is regularly used as a catalyst in hydrogenations and has been responsible for numerous accidents in academic labs nationwide. These catalysts require special handling and disposal procedures after manipulations, and cannot be simply placed in the trash.

**www.ehs.wisc.edu/chem/HandlingUnwantedChemicals.pdf**

# Arbitrarily mixing incompatible chemicals

Simple chemicals lead to serious damage

- $NaOH/H_2SO_4/HNO_3$ (Corrosive)
- $H_2O_2/H_2SO_4/NaOH$/ catalysis (explosion)
- $KMnO_4/H_2SO_4$/Organic compounds (fire)
- Mixing organic waste with waste acids (explosion)
- Overheated organic solvents (explosion)

Mixing $KMnO_4/H_2SO_4$/toluene causes fire

Extensively use corrosive acids causing electrical short circuit and fire accidents

Mixing organic waste with waste acids causes explosion

# Special-cause variation for Lab Accidents

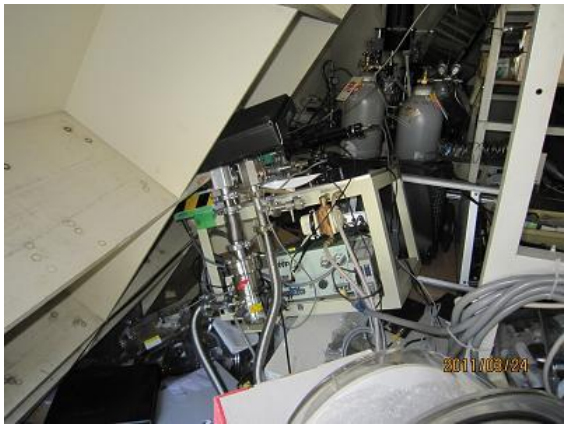
Special-cause always arrives as a surprise

**Special causes**

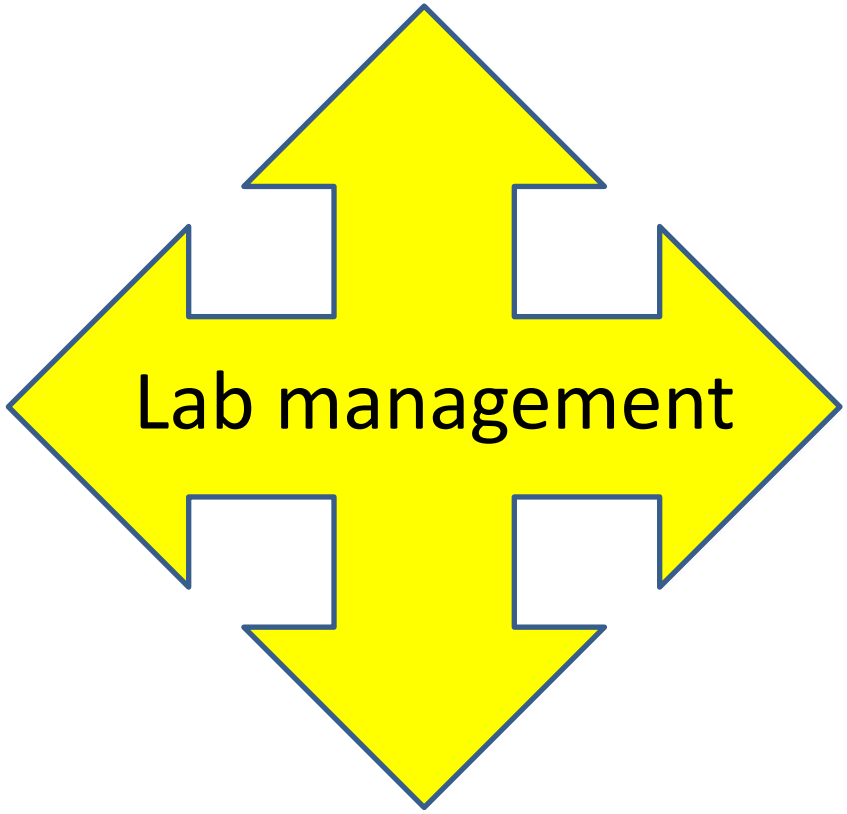
- Faulty Instrument or machine malfunction
- Cabinet in a laboratory falling down
- Power surges
- Earthquake
- Fire accident
- Unexpected water leak or water shut off
- Unexpected outcome from chemical research


*EHS, NTU*

After earthquake

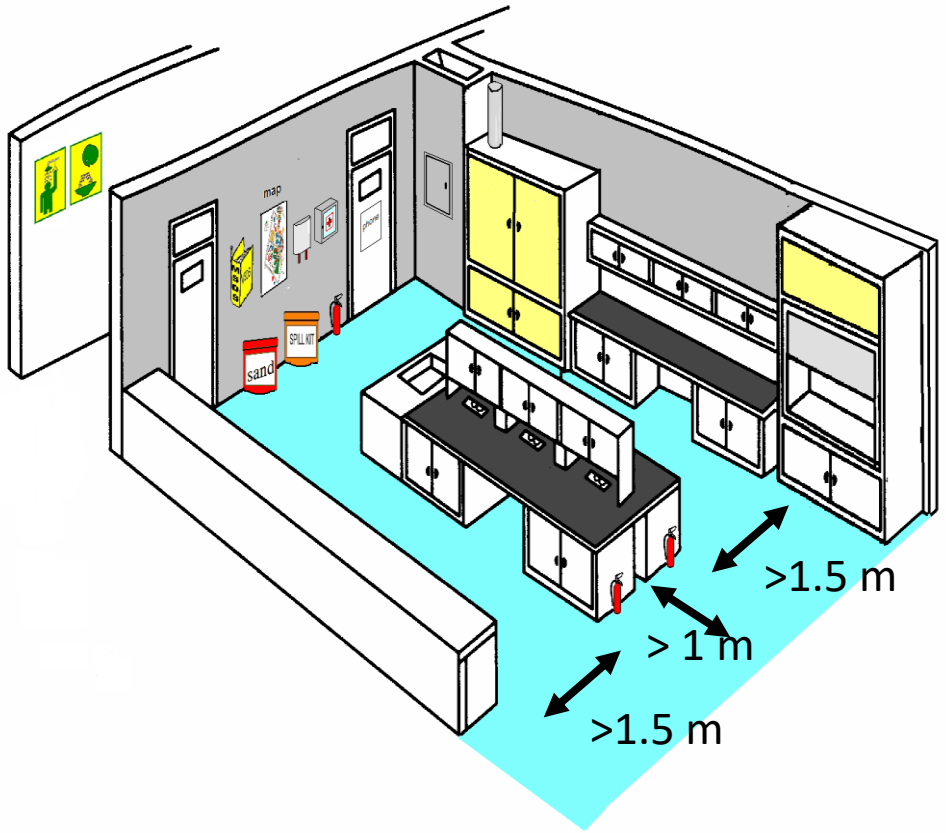


*Tohoku University after earthquake*
*http://cenblog.org/the-safety-zone/2011/03/laboratory-damage-from-japan-earthquake/*
*http://msysb.material.tohoku.ac.jp/english/earthquake_e.htm*


Lab management

# The laboratory

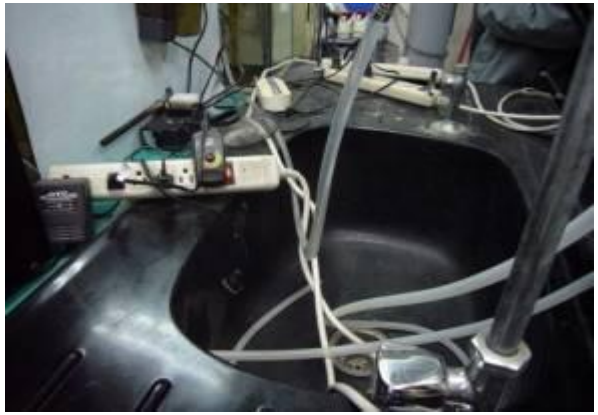

- Keep clear the exit
- Do not handle self-igniting chemicals or inflammable solvents nearby the exits.
- Solvents and chemicals should be stored in cabinets, not in fume-hoods.
- SDS, fire sand bucket, fire blanket, extinguisher, evacuation plan and map, first-aid kit, chemical absorbers, updated emergency phone list should be available and accessible.
- Keep clear the location around emergency showers, eyewashes, electrical panels /breaker panels/ water shut off valves




- Preparation-planning for emergency drills and practices
- Lab inspection
- Risk assessment
- Mandatory **buddy system**

# Ignoring Safety Concerns: Human Reliability Problems

Ignoring safety regulations (slippers)



Inappropriate electrical setups (Near water sink)


Wearing of the drying oven

Drinks in research area

Poor Lab management (blocking the emergency exit)

# Keep the public areas clean

- Collection of garbage is scheduled everyday. Don’t pile up your garbage in the recycling area.
- Clean up the bottles and wash paper lunch boxes before putting them in the corresponding recycling bins


Chemical handling
Basic guidelines

# Chemical Safety Carrier and Transport

- Use safety carrier for chemical transport
- Don’t use the passenger elevators for chemical transport
- Use protective carrier for NMR tube transport
- Don’t ride in the same elevator with filled nitrogen tanks or any kinds of liquefied gases, dry-ice, or liquid chemicals. Warning sign has to be put onto the tanks.

# Safety Data Sheet

ACS Web https://chemicalsafety.com/sds-search/

INSERT COMPANY LOGO HERE

**SAFETY DATA SHEET**

**Creation Date** 02-Oct-2009 **Revision Date** 03-Mar-2014 **Revision Number** 5

## SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

### 1.1. Product identifier

| | |
|---|---|
| **Product Description:** | **Pyridine** |
| **Cat No. :** | **180220000; 180220010; 180220250; 180222500** |
| **Synonyms** | Azine.; Azabenzene |
| **CAS-No** | 110-86-1 |
| **EC-No.** | 203-809-9 |
| **Molecular Formula** | C5 H5 N |
| **Reach Registration Number** | 01-2119493105-40 |

### 1.2. Relevant identified uses of the substance or mixture and uses advised against

| | |
|---|---|
| **Recommended Use** | Laboratory chemicals |
| **Uses advised against** | No Information available |

### 1.3. Details of the supplier of the safety data sheet

| | |
|---|---|
| **Company** | |
| **E-mail address** | begel.sdsdesk@thermofisher.com |

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

# GHS PICTOGRAMS

| | | |
|---|---|---|
| **Health Hazard**<br>Carcinogens, respiratory sensitisers, reproductive toxicity, target organ toxicity, germ cell mutagens<br>  | **Flame**<br>Flammable gases, liquids, & solids; self-reactives; pyrophorics;<br>  | **Exclamation Mark**<br>Irritant, dermal sensitiser, acute toxicity (harmful)<br>  |
| **Gas Cylinder**<br>Compressed gases; liquefied gases; dissolved gases<br>  | **Corrosion**<br>Skin corrosion; serious eye damage<br>  | **Exploding Bomb**<br>Explosives, self-reactives, organic peroxides<br>  |
| **Flame Over Circle**<br>Oxidisers gases, liquids and solids<br>  | **Environment**<br>Aquatic toxicity<br>  | **Skull & Crossbones**<br>Acute toxicity (severe)<br>  |

# Chemicals should be locked and labeled


***Second container with label***

**locked**

# Chemicals should be stored in cabinet

Not on the floor

# Chemicals should have appropriate labels

Chemical should not be kept in the walkway, and without label

Without GHS label and CAS number

# Waste in University

- Lab Waste
  - Household Garbage → Domestic Waste Custodian Company
  - Research Waste
    - General Business Waste
    - Toxic Business Waste

→ Company with Special License

Toxic waste Removal: radioactive waste, infectious waste, liquid chemical waste, solid waste、Outdated chemicals through our EHS center.


# Chemical Waste has to have labels

# Secondary container for spills

Size has to large enough


An **autoclave** is a pressure chamber used to sterilize equipment and supplies by subjecting them to high pressure saturated steam at 121 °C (249°F) for around 15–20 minutes depending on the size of the load and the contents.[

The infectious solid waste should be treated (i.e. disinfected or autoclaved) to make it non-infectious before picking up by the waste treatment company.
Sharps must be treated (i.e. disinfected or autoclaved) and kept in metal container, or ground up to avoid causing any physical hazards.
All waste must be labeled with the generator's name, address and telephone number.

**Autoclave** **Infectious waste containers**


# Minor Chemical Spills

•Alert others in the lab and cordon off the affected area.
•Make sure that you are safe
•Put the goggles and chemically appropriate gloves on, with long closed toe shoes and long sleeved lab coat, before approaching the spill.
•Prevent the hazardous material from reaching the drain, using a boom, sock, or other material
• Use absorbents for neutral chemicals, acids or bases to absorb and carefully wipe up the spills, or gently pour solvent vapor suppressant (activated carbon) over the spill.
• Working from the outer edge to the middle to minimize inhalation hazards. Avoid leaning over the spill when applying the absorbents to prevent from breathing in any off gasses or vapors.
• Place all waste materials in a plastic bag. Once the spill has been fully cleaned, place the waste bag with in the fume hood temporarily. Label the bag as hazardous waste and submit a Chemical Waste Disposal Request form to EHS.
• Remove personal protective equipment (PPE) and thoroughly wash hands.
• Use soap and water to wash the affected area and remove any minor residues that may be left. The waste water has to be collected to the waste bucket.
• Report the spill using the EHS Incident Report form.
• Replenish your spill kit supplies.

# Spill Cleanup Procedures

## Absorbent Pad Spill Kit




1. Place a barrier around the spill
2. Cover completely with appropriate material
3. Clean up
4. Bag and tag for EH&S waste removal



## Floor Dry Spill Kit

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Environmental Health and Safety | 2408 Wanda Daley Drive | Ames, IA 50011-3602 | (515) 294-5359 | www.ehs.iastate.edu

Reviewed 2016

# Any hazardous material has spilled on you

If any hazardous material has spilled on you,

- remove affected clothing immediately
- flush the area with water
- Ask you labmates to get emergency rinsing solution to flush the area for decontamination treatment within 1 min.
- keep flushing the area with water for at least 15 minutes
- Go hospital for emergency treatment.

# Emergency decontamination for chemical splash

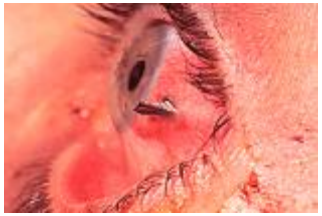
Diphoterine: an emergency rinsing solution for splashes of chemicals, acids or bases (e.g. sulfuric acid, hydroxides, phenols)

Hexafluorine : an emergency rinsing solution for HF splash

- Emergency treatment within 1 min for decontamination. Flush with water for at least 15 min and send to hospital.
- Diphoterine and Hexafluorine, which are slightly hypnotic to tears, restore the eyes physiological balance. It prevents the aggression from penetration.

# Emergency Shower and Eyewash

- The **first 10 to 15 seconds** after exposure to a hazardous substance, in particular, a corrosive substance, are critical. Delaying treatment, even for a few seconds, may cause serious injury
- Emergency showers and eyewash stations provide on-the-spot decontamination. Workers can flush away hazardous substances that can cause injury.
- In case of emergency, flushing your eyes with eye washer for at least 30 min. If possible, taking off your contact lens and flushing your eyes thoroughly. At the same time, call an ambulance to send the patient to hospital.



Metal sharp hazards

Chemical splash hazards

# Fumehood

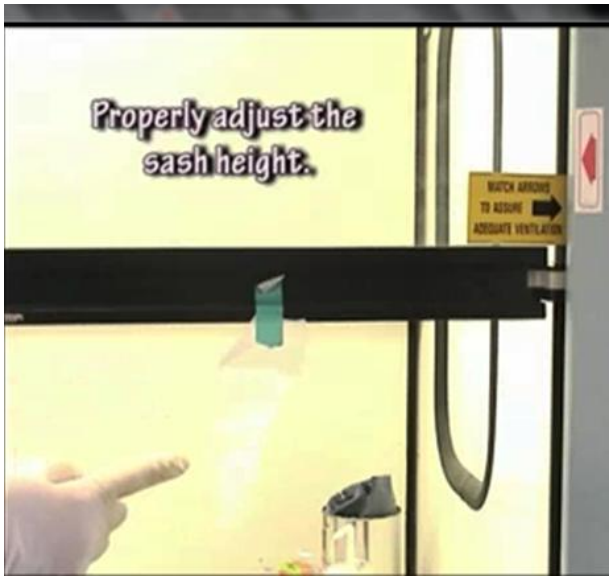
The fume hood is the primary control device for protecting researchers when working with flammable and/or toxic chemicals. The continuous air-flow will bring all contaminants out of the lab. You should be trained to use it properly

- Ensure that the hood is on
- Make sure that the sash function properly
- Never allow your head to enter the plane of the hood opening
- For vertical rising sashes, keep the sash below your face;
- For horizontal sliding sashes, keep the sash positioned in front of you and work around the side of the sash.
- Keep all materials inside the hood at least six inches from the sash opening.
- When not working in the hood, or after finishing the setup for the experiment, close the sash.
- Fume hood is a place of high risk. Don’t keep unused chemicals inside the fume hood.

# A fume hood safety checklist

## Before Use

- Ensure sash is opened to proper height, not too high
- Check the air flow
- Ensure exhaust fan is working appropriately
- No spark source is allowed inside the hood
- Check the air filters




## During Use

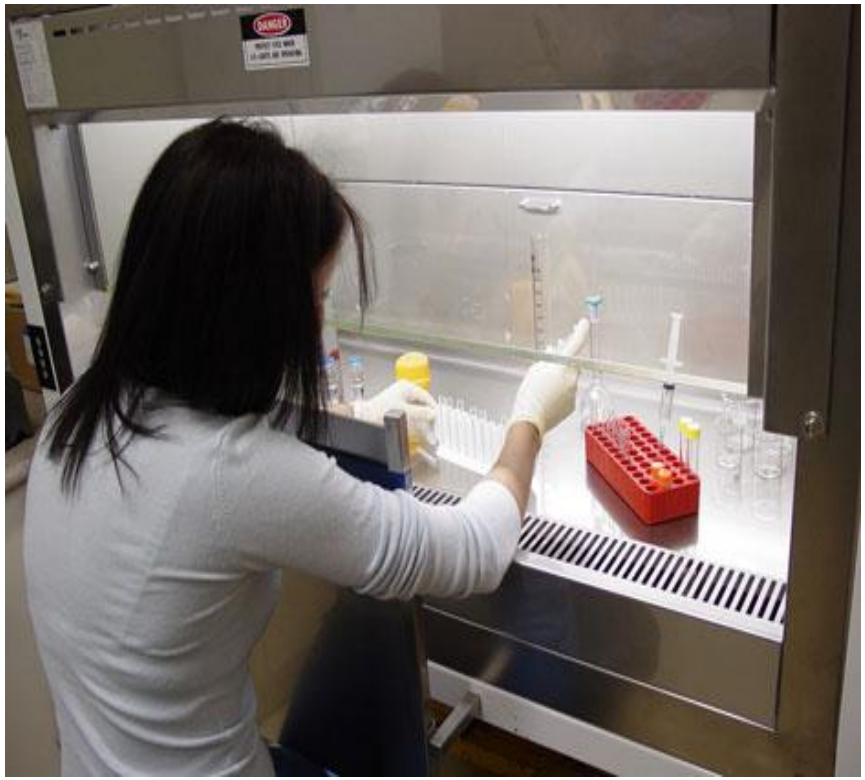
- Eye protection is required
- Make sure traffic around the hood is limited
- Do not block the air inlet
- Keep materials away from sash
- Clean spills immediately

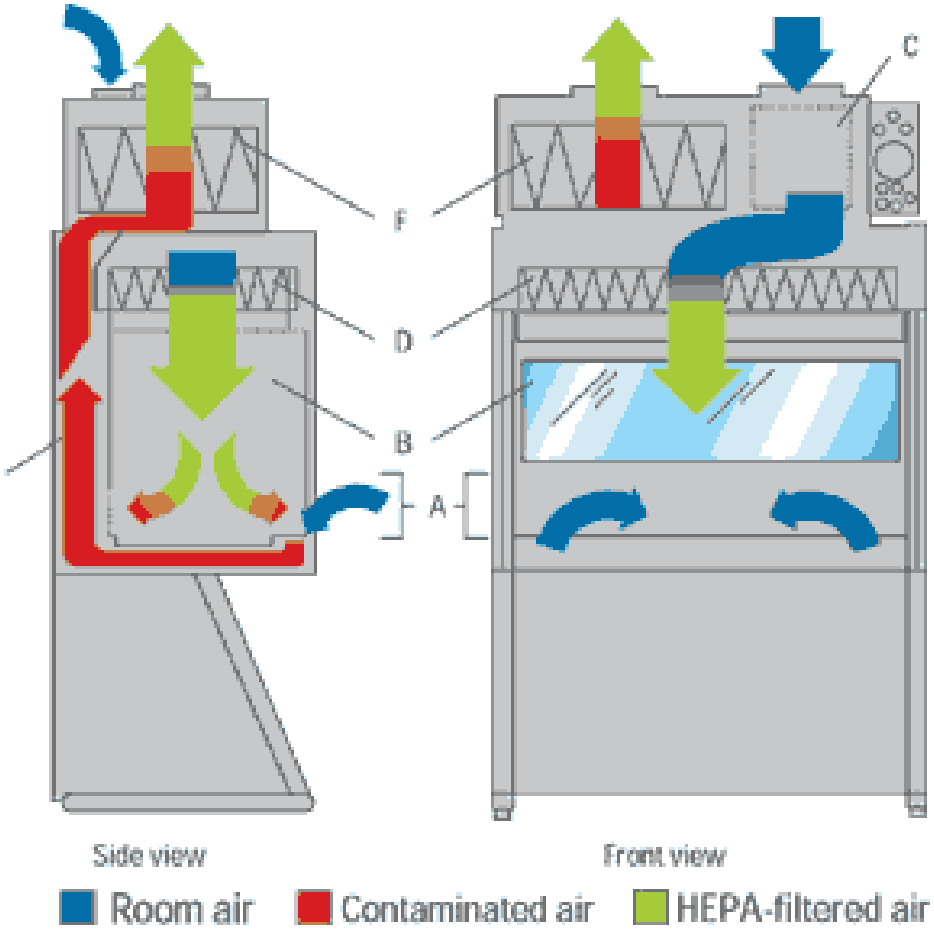
## After Use

- Clean the hood and Close the sash
- Avoid storing chemicals in the hood
- Report any problems

# Biological Safety Cabinets

Checklist for Safe Use of Biological Safety Cabinets






Checklist for Safe Use of Biological Safety Cabinets
https://www.cdc.gov/safelabs/docs/BSC-Checklist.pdf

http://www.labtech-midwest.com/images/photos/biocab.jpg
http://pubs.acs.org/subscribe/archive/mdd/v04/i09/figures/0909_ttb1_toolbox.gif


Case Studies

# Chemical accidents

Explosion during recrystallization without personal protection


# Research worker killed by virus from monkey

Elizabeth R. Griffin, a 22-year-old primate researcher. Miss Griffin was helping to move a caged rhesus monkey infected with the herpes B virus, when the animal flung a tiny drop of fluid -- perhaps urine or feces -- at her face.

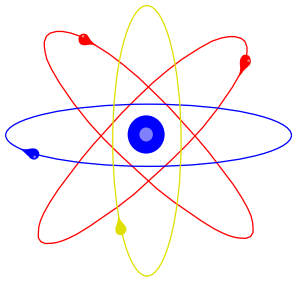
It struck her in the eye.

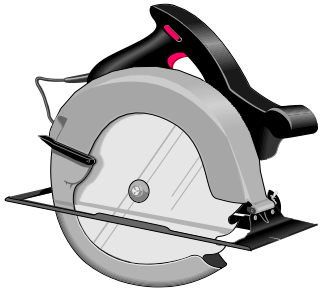
She was paralyzed and weakened, died of complications from herpes B, which is common in primates but rare and deadly, 70 percent of the time, in humans.

# Physical environment and health

Electrical Shock Hazards
Noise pollution
Low temperature hazards
Suffocation hazards
Radiation Hazards
Mechanical Hazards
Dust and fume hazards
Human engineering problem

Oregon State Univ



# Electrical Hazards

- Major lab fires and injuries in universities
- Electrical Shock

Common cases:
- Uncertified installation
- Electrical cords with poor conditions
- Overuse of extension cords
- Poor lab performance

# Electrical issues in laboratories

Croner-i is a comprehensive knowledge and resource platform in UK
https://app.croneri.co.uk/feature-articles/electrical-issues-laboratories

- About 20 people die each year from electric shock or burns at work
- Heat generated from electrical arcing can result in deep-seated, slow-healing burns.
- Serious burn accidents (hundreds) each year arising from unsafe working practices.
- The intense ultraviolet radiation from an electric arc can also cause damage to the eyes.
- Arcing, overheating and electrical leakage currents can result in fires or explosions if flammable materials are present.

# Lucky (near miss) cases

**NTUST** ChE Laboratory caught **Electric shock** on 2013/9/17

- A graduate student, Mr. Lin accidentally **touched the high-voltage transformer** on the floor at 15:40 in the laboratory, and caused **burns on right elbow**.

# How can we prevent from electrical hazards?

- Outlets, plates , covers and switches have to be in good condition.

All switches have to be protected by a cover plate. A student died of electrical shocks when his body touch the 220 V electrical wire.



- Electrical cords have to be in good condition

Cords have two layers of insulation –
a protective coating that wraps around each wire
a larger coating that wraps around all the wrapped wires.

# How can we prevent from electrical hazards?

• Walking areas have to be free of cords that could pose trip hazards

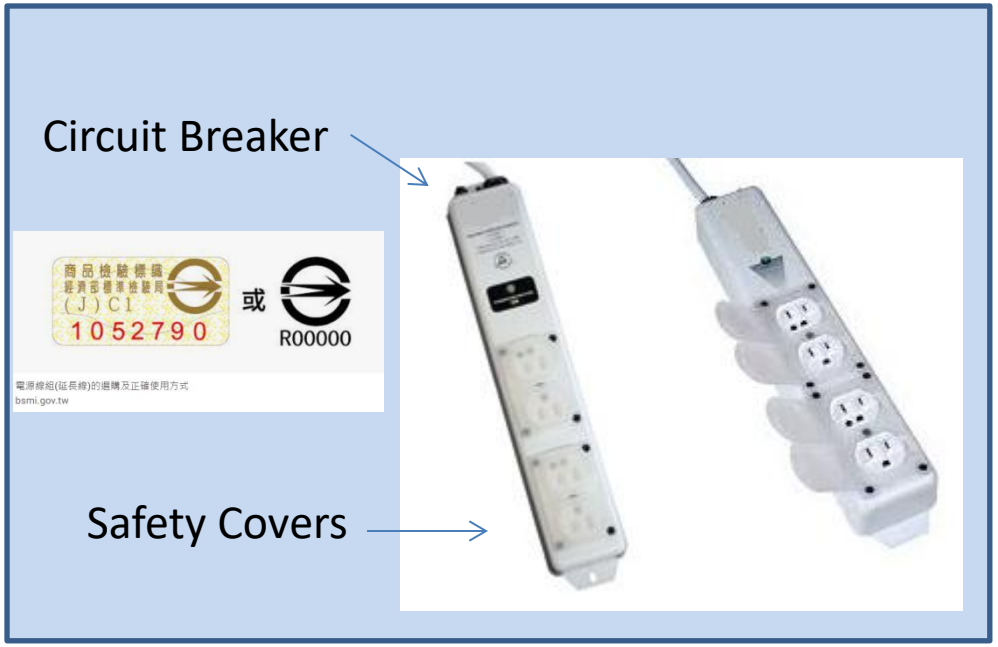
• Cords and connections have to be kept away from water source by at least 1 meter.

• Don’t overuse of extension cords.


# Extension electrical cords

- Extension cords are for temporarily, otherwise you need to have permanently installed outlets .
- Only certified extension cords are allowed to be used in laboratories.
- Extension cords should have circuit breakers for overload protection. It is a potential fire hazard if you are not using a cord equipped with electric circuit breakers.
- The sockets should have safety covers
- Keep away from corrosive chemicals, inflammable solvents and chemicals.



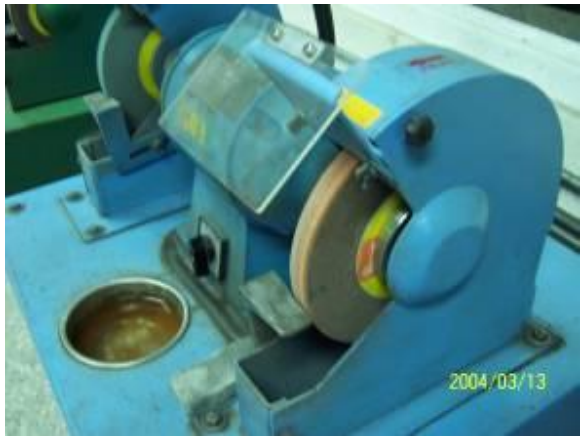


# Mechanical Hazards

## Beware Moving Machinery

Moving machine parts have the potential to cause severe workplace injuries, such as crushed fingers or hands, amputations, burns, or blindness.

• Safeguards and emergency stop button are essential for protecting workers from these preventable injuries

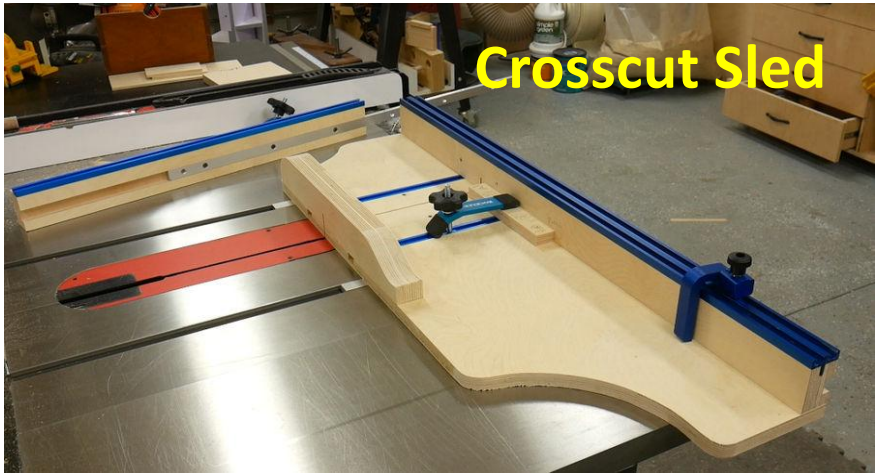


# Mechanical Hazards

1. A protective stop mechanism: referred to automatically stop a slider, a cutter or a ram(hereinafter referred to as the slider) when a press machine or a shear machine detecting dangerous or abnonmal condition.
2. An emergency stop device: referred to stop the slider moving by manual operation when the press or the shear machine detecting dangerous or abnonmal condition.
3. A self-adjusting contact-preventive device: referred to the safetyguard of a hand-fed planer that can automatically open or close with the feeding of processing material to prevent a blade from touching.

# Woodworking circular saws






Circular saw mounted on a table with protective shield. Face shield is required for the operator. Inexperienced students should be supervised by instructor.

# Kickback Incidents

In my middle school shop class, someone was ripping a piece of 2x4. The kickback shot it about 35' across the classroom area of the shop (where all the desks were) and left a huge dent in the chalkboard right behind the teacher's desk. Definitely an important issue! – FreeMan Mar 17 '15 at 20:23 https://woodworking.stackexchange.com/questions/21/how-do-i-prevent-dangerous-kickback-on-a-table-saw#comment142_21

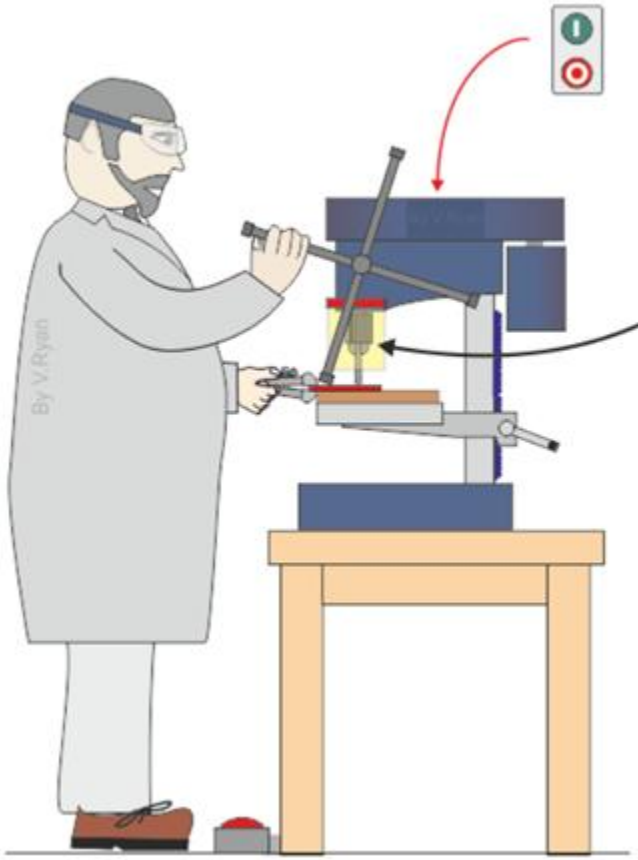
# US Department of Labor **Machine Hazards > Kickbacks**

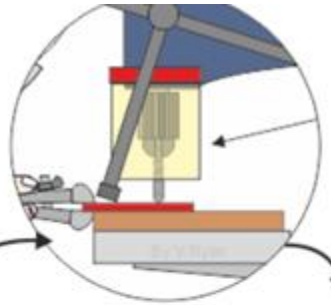
https://www.osha.gov/SLTC/etools/woodworking/kickbacks.html

The major hazard with kickbacks is the stock being hurled back at the operator. Hazards due to kickbacks are most likely when there is a lack of safeguards, such as spreaders, anti-kickback fingers, and gauge or rip fences.

Kickbacks occur when a saw seizes the stock and hurls it back at the operator. This can happen when the stock twists and binds against the side of the blades or is caught in the teeth. A blade that is not sharpened, or that is set at an incorrect height, can cause kickbacks. Poor-quality lumber (in other words, frozen lumber or lumber with many knots or foreign objects such as nails) can also result in kickbacks. Kickbacks occur more often when cutting parallel to the wood grain (ripping) than when cross-cutting.

# Drilling machine





**HAZARD**

Possibility of sharp, extremely hot steel 'swarf', flying at high speed, in the direction of the operator.

**LEVEL OF RISK**

Medium level possibility, due to the physical properties of sheet steel.

**CONTROL MEASURE(S)**

Fit Guard. Ensure guard is in position. Goggles supplied. Foot stop for any emergency. Staff training, so that drilling is controlled correctly by the operator and the risks are understood. Appropriate protective clothing provided.

https://technologystudent.com/prddes1/healthandsaf1.html

# Mechanical Hazards

2011/04/14 Michele Dufault, 22, a senior undergraduate science student majoring in astronomy and physics in Yale University, died from accidental asphyxia by neck compression. Her hair is thought to have been caught in the machine's rotating drive and dragged her onto it while using a fast-spinning lathe in the student machine shop.
She worked alone when the accident happened.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# Low temperature hazards

Cryogenic liquids: liquefied gases at very low temperatures. Dry-ice is low temperature solid $CO_2$. When vaporized, the volume dramatically increase

- Cryogenic liquids and the cold vapors and gases can cause frostbite, similar to a thermal burn of skin.
- Brief exposures might not affect skin immediately but can damage delicate tissues such as the eyes.
- Unprotected skin can stick to metal that is cooled by cryogenic liquids. The skin can then tear when pulled away. Even non-metallic materials are dangerous to touch at low temperatures.
- Prolonged breathing of extremely cold air may damage the lungs.

Personal Protection Equipment :
face-shield, thermal insulated gloves, covered shoes.

! Don't escort the filled nitrogen tank into an elevator.

! Cryogenic liquids and dry-ice can only be used in well ventilated rooms

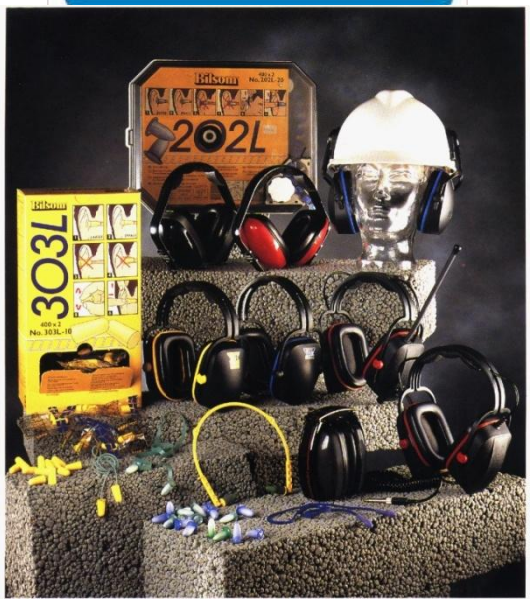

# Noise Hazards

Normally, sounds at normal levels don't damage our hearing. But they can be harmful when they are too loud, even for a short time, or when they are both loud and long-lasting. These sounds can damage sensitive structures in the inner ear and cause noise-induced hearing loss (NIHL)

For working area with average noise level higher than 85 db (level leading to permanent damage), all workers have to be protected by ear protector.

- Noise cancelling headphones with talk through function allows you to talk undisturbed while wearing headphone
- Regular health check
- Noise level monitor





# Laser Hazards

Warning sign outside

Restricted area

Laser safety glasses/googles

Fixed laser source

Safety Shield

- Moderate and high-power lasers are potentially hazardous because they can burn the retina of the eye, or even the skin.
- Damage control according to ANSI Z136 in the US and IEC 60825 internationally.
- Receive training and education before use.

# High pressure gas cylinders, tanks, or vessels

## Handling and Use

- Gas cylinders must be secured by chains or sturdy at all times to prevent tipping.
- Check the pressure gauge regularly. If a leaking cylinder is discovered, move it to a safe place.
- Under no circumstances should any attempt be made to repair a cylinder or valve.
- Cylinders should be placed with the valve accessible at all times. The main cylinder valve should be closed as soon as it is no longer necessary that it be open.
- Temperature of the storage place should not exceed 40°C.

# High pressure gas cylinders, tanks, or vessels

- Although different gases are stored in cylinder with different color, the color-coding is not a reliable means of identification. Check the label carefully before use.
- Explosive, corrosive, and toxic gases should be stored separately in a well- ventilated cabinet or area. Sensor and warning alarm are required.
- Oxygen should not be stored with flammable solvents and chemical
- Cylinders containing flammable gases such as hydrogen or acetylene must NOT be stored nearby open flames, areas where electrical sparks are generated, or where other sources of ignition may be present.


# High pressure gas cylinders in laboratory

# High pressure gas cylinders

- Empty and full cylinders should be stored in separate areas.
- The valve cap shall be replaced, the cylinder **clearly marked as "empty"**
- The use of purpose-built trolleys or other suitable devices for gas cylinder transportation.
- Securing the gas cylinder valve, disconnecting and removing associated distribution equipment
- A requirement that only properly trained personnel are permitted to move cylinders
- Laboratory procedures preventing the manual movement of larger gas cylinders


# Biohazards

- **Infection： Virus and Becteria**
- **Allergy**
- **Toxicity**

Human blood and blood products.
Human body fluids, including semen, vaginal secretions, amniotic fluid, and pleural fluid.
Microbiological wastes, including discarded specimen cultures, discarded live and attenuated viruses, and disposable culture dishes.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# Elizabeth R. Griffin

Elizabeth R. Griffin, a 22-year-old primate researcher, completed a double major in biology and psychology and was a paid researcher in the biology department.

She was careful to follow the precautions intended to shield her from the diseased animals she handled. She always wore gloves and a mask, and she was usually separated from the primates by a mesh cage.

Miss Griffin was helping to move a caged rhesus monkey infected with the herpes B virus at the Yerkes Regional Primate Research Center here, when the animal flung a tiny drop of fluid -- perhaps urine or feces -- at her face.

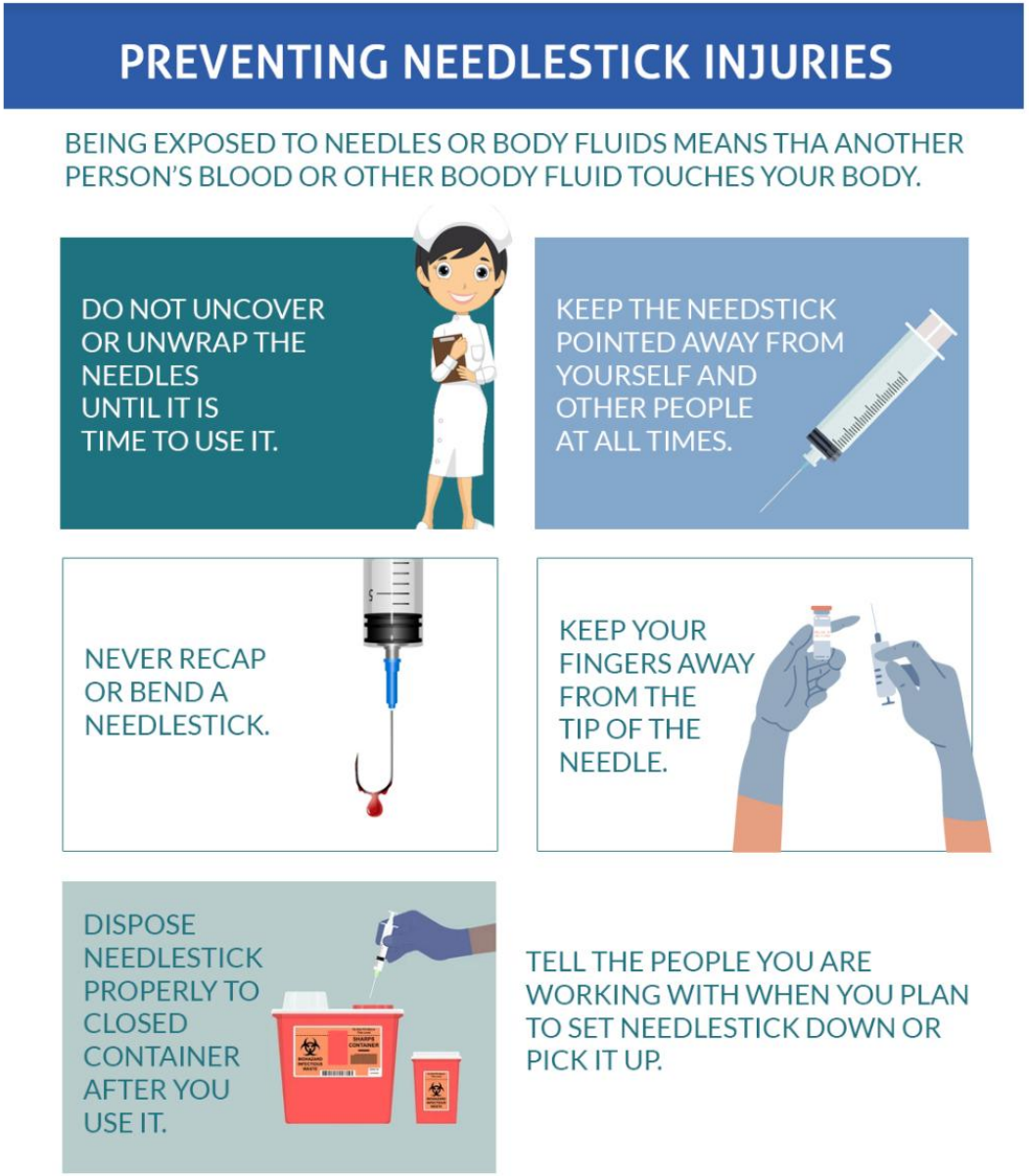
It struck her in the eye. On Wednesday, paralyzed and weakened, she died of complications from herpes B, which is common in primates but rare and deadly, 70 percent of the time, in humans.

# Other investigation statistics

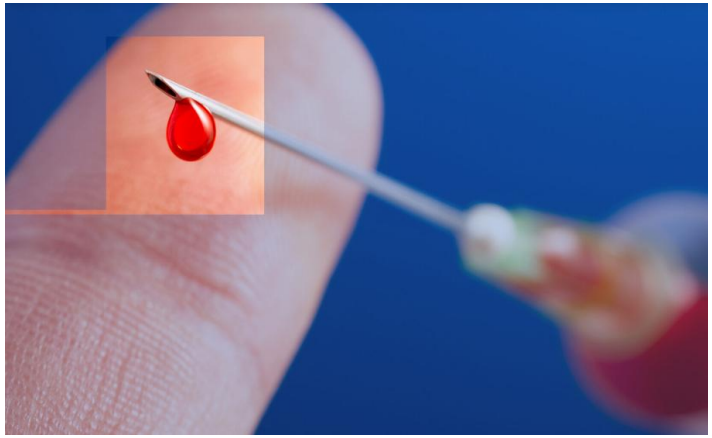
## Scientific American 2011 investigation

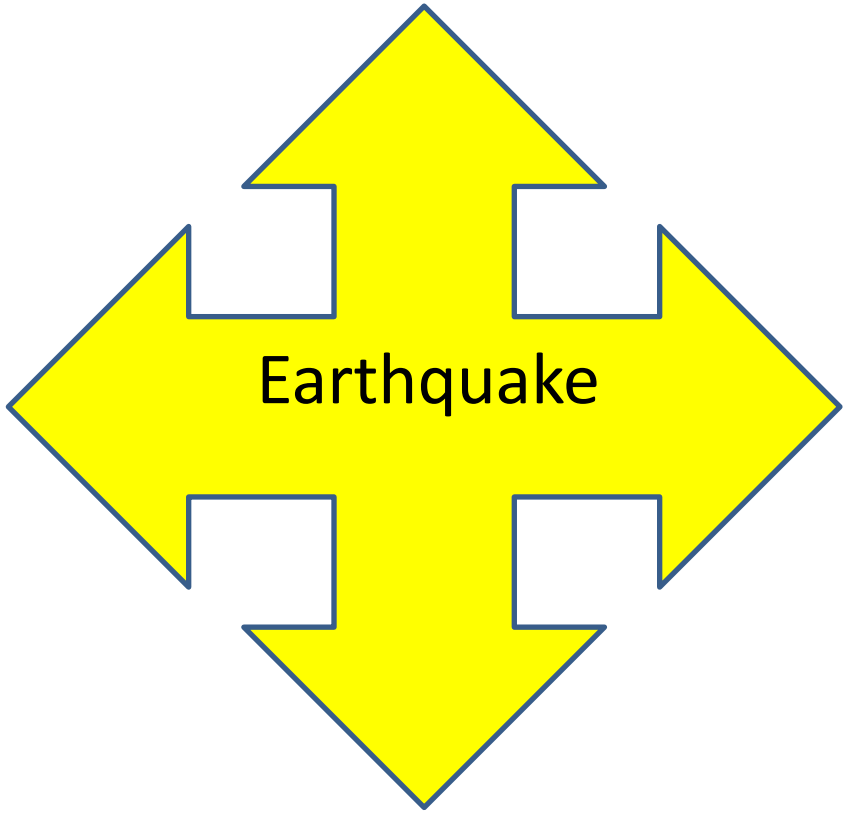
**In USA, 400 cases within 7 years about lab infections or related accidents**

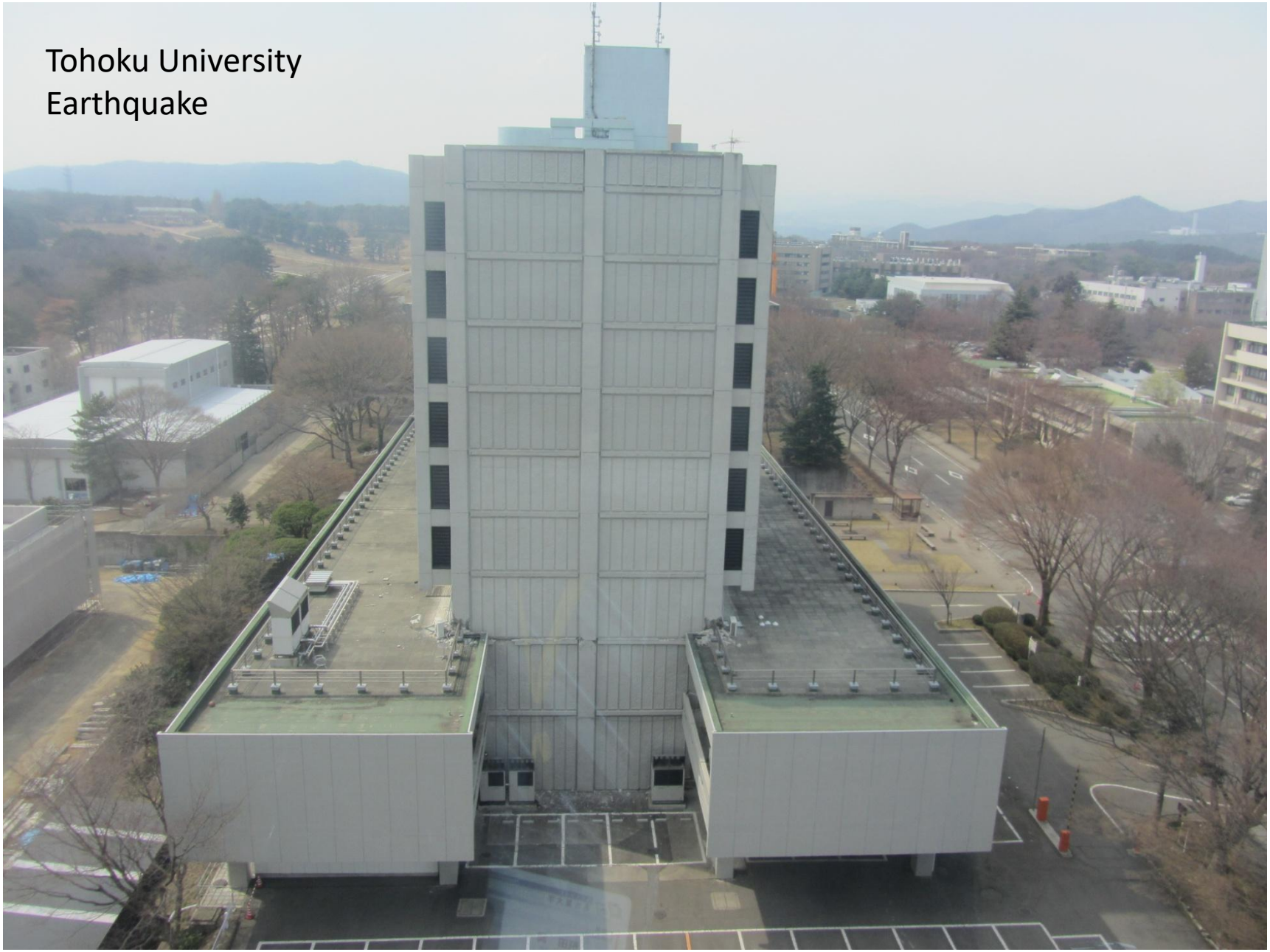
# Needlestick injury prevention




Needlestick injuries are more common causes of the spread of pathogens and fatal infections




Earthquake


Tohoku University
Earthquake


Tohoku University
Earthquake
BRAUN


Tohoku University
Earthquake

# Before you leave checklist

- Overnight experiments are well settled.
- Make sure that the unused items are shut off
  - —Tap-water
  - — Electrical applicants (Air conditioners, light)
  - — Hot plate
  - — Natural Gas
  - — Hood sash
- Lab coat and gloves should be taken off
- Wash your hands
- Lock the door

# Summary

- Research lab may not be safe
- Creating and understanding safety culture is important
- Safety education has to be broad-based, only small group of professional people understanding safety issues is not enough to secure safety

**Safety Guidelines**

Don’t work alone
Don’t scale-up
Check all precautions
Protect yourself and call for help

Protect yourself and you can go further

Thanks for your attention