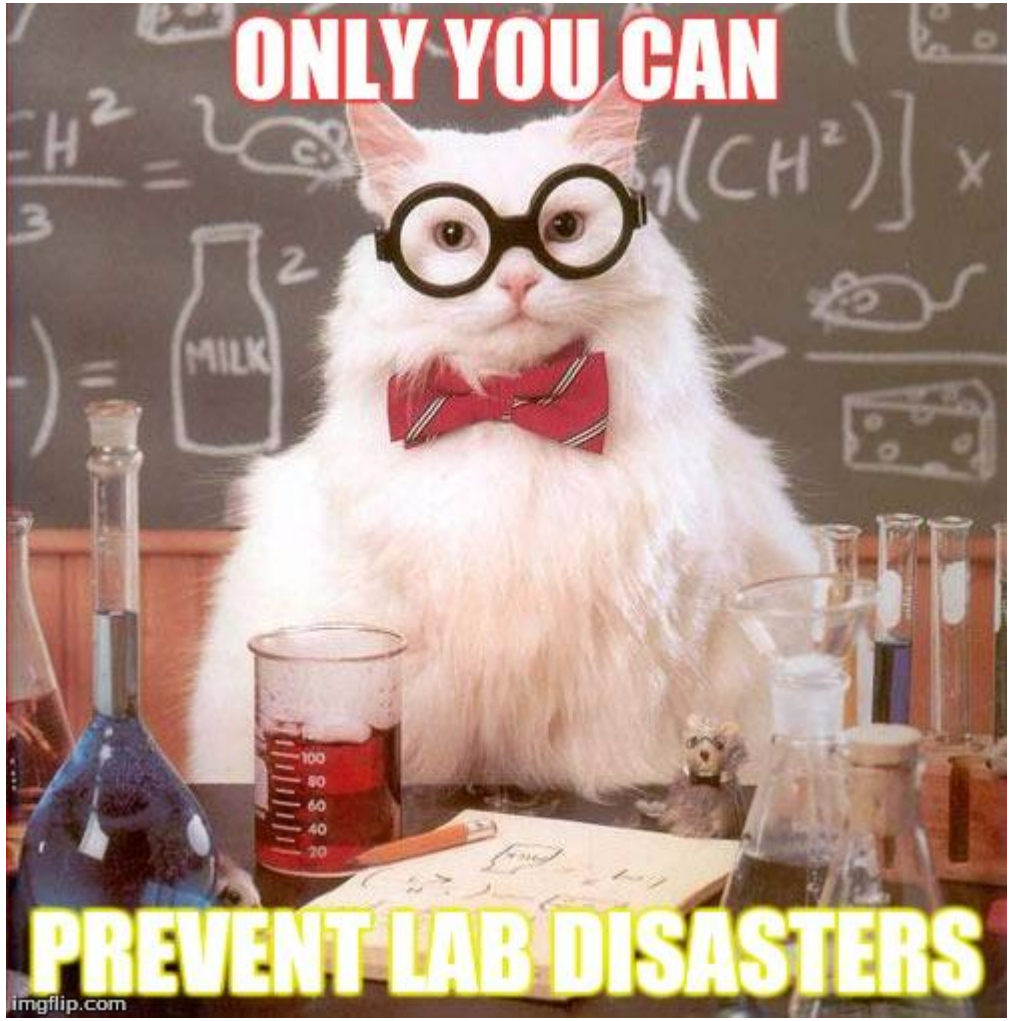

Laboratory Safety

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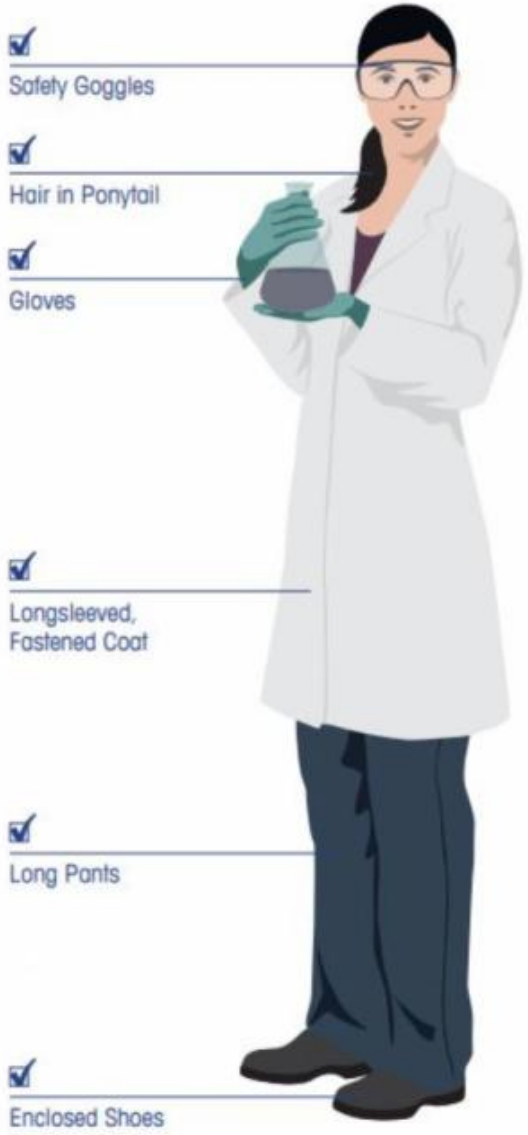
CONTENTS

- ✓ Personal Protective Equipment (PPE)
- ✓ Safe Working Practices
- ✓ Chemical Safety
- ✓ Hazardous Waste
- ✓ Gas Safety
- ✓ Fire Safety
- ✓ Electrical Safety
- ✓ Laser Safety
- ✓ Radiation Safety



Personal Protective Equipment (PPE)

Must be worn at ALL times in the laboratory

PPE: Eye Protection Options

✓ Get anti-fogging eyewear, Wear over specs, Must have side shield

Safety Glasses

- Protect from mechanical and impact hazards
- Works for all labs

Chemical Splash Goggles

- Protect from liquid hazards
- Needed for labs storing chemicals

Face Shields

- Protect from voluminous hazards, needed OVER splash goggles
- For fuming or extremely dangerous chemicals: HF, liq.N2 etc.

Personal Protective Equipment (PPE)

Must be worn at ALL times in the laboratory

PPE: Gloves

Thin nitrile

- General purpose, < 2 mil thick
- Works for solvents and biological samples

Thick nitrile

- 2-4 mil thick
- Works for corrosive chemicals, Acids & bases, Toxins

Heat-resistant silicone

- Used for Ovens, Furnaces, Hot surfaces

Cryogen gloves

- Used for N2, He etc

PPE: Gloves – Do and Don’ts

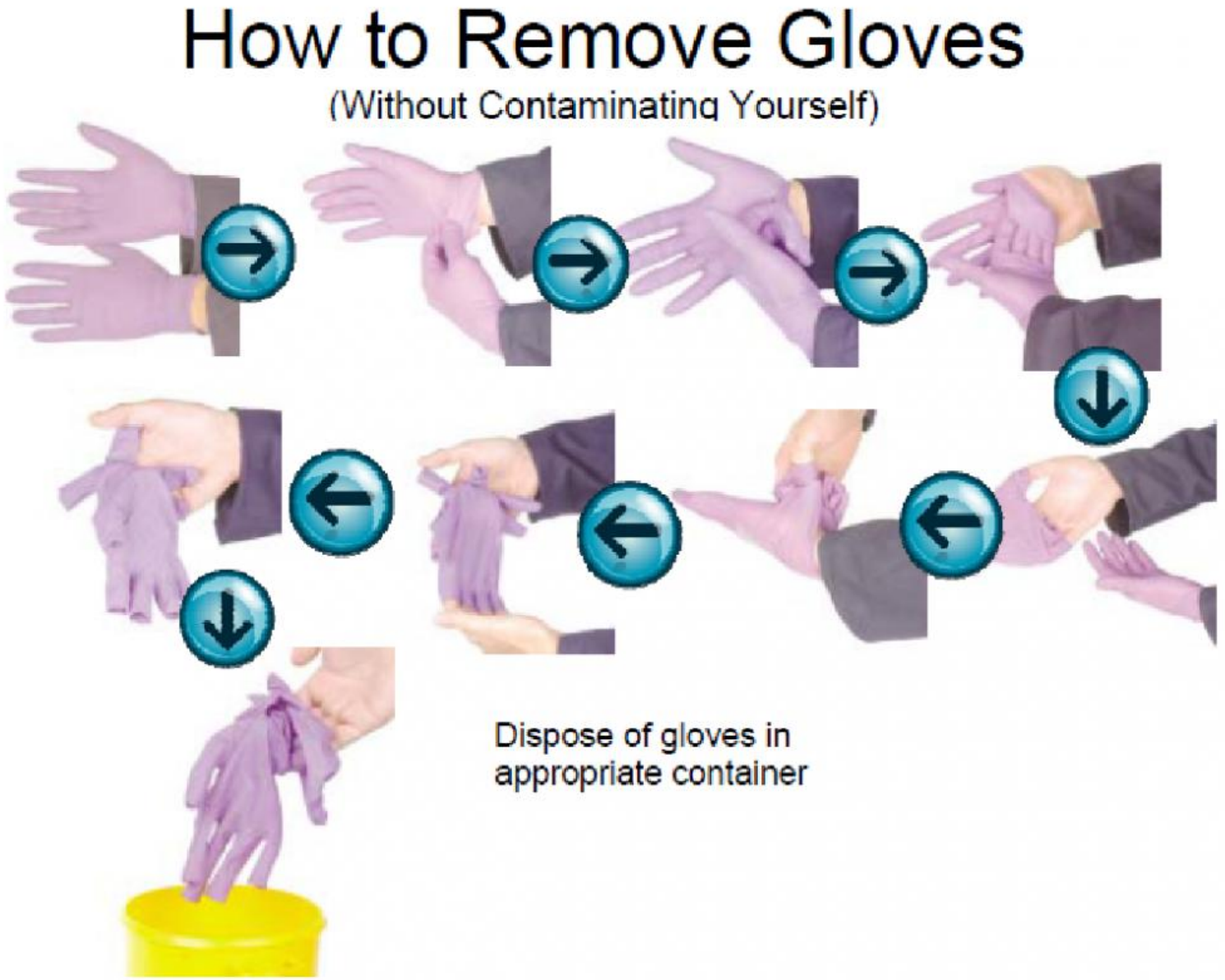
Do

- Check gloves for holes or tear
- Replace a torn glove
- Dispose gloves in lab solid waste before leaving lab
- Wash hands after gloves

Don’t

- Re-use disposable gloves - Increase risk for contamination

Continue using a torn glove



Always wash your hands with soap after leaving the lab!

PPE: Footwear

MRC Provide shoes at entry for all the visitors ☺
Enter only with MRC shoes !

PPE: Working with Cryogens

Mandatory PPE for filling liquid N_2, Ar, and He tanks

B: Safe Work Practice (SWP)
SWP: No Food in lab

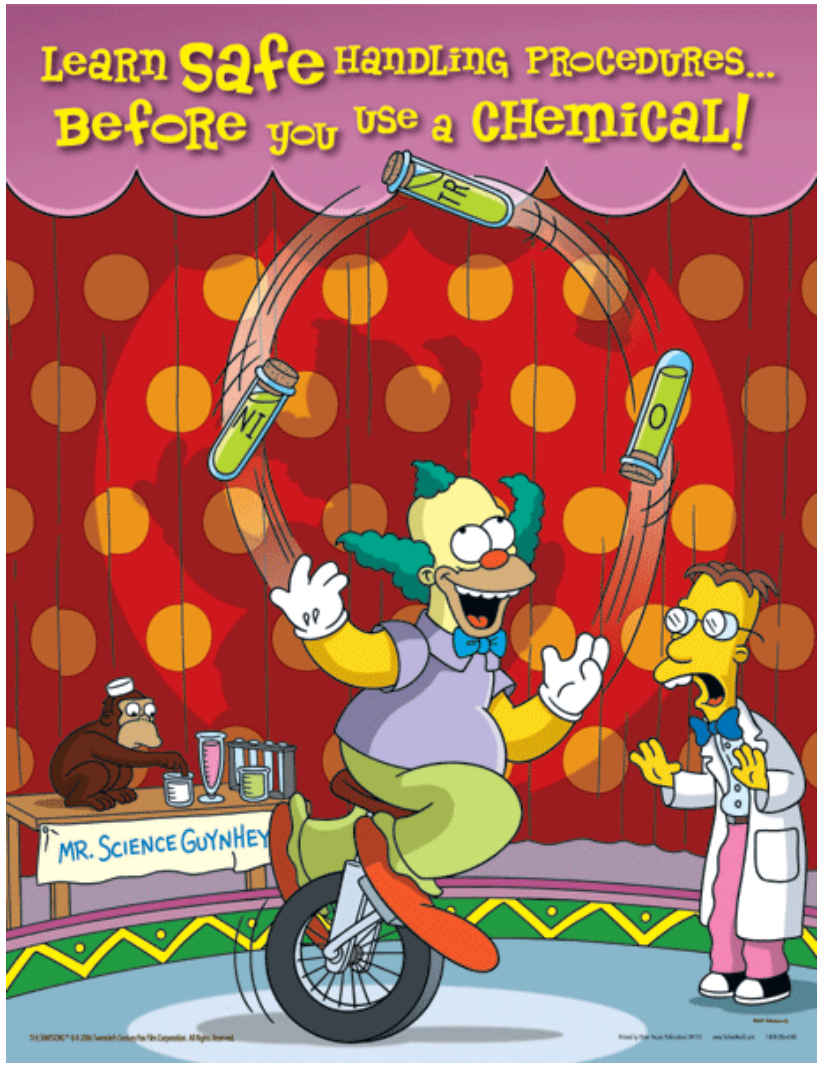
Don’t eat/drink in lab

- No Chai, coffee
- No mugs
- No lunchboxes
- No chewing

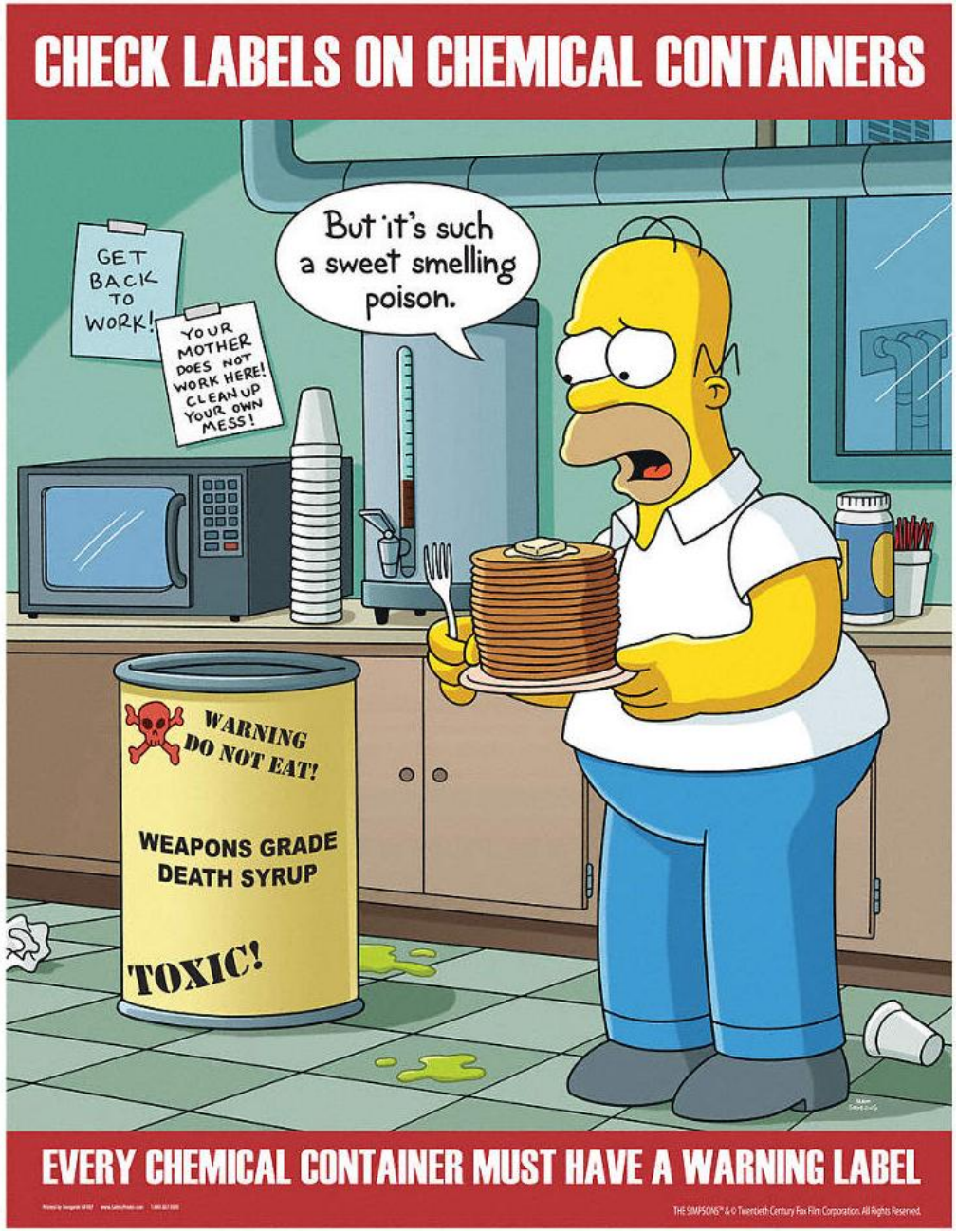
Don’t store food in lab fridge

C: Chemical Safety (CS)

Most common type of hazard and the most preventable one



CS: Hazard Labels



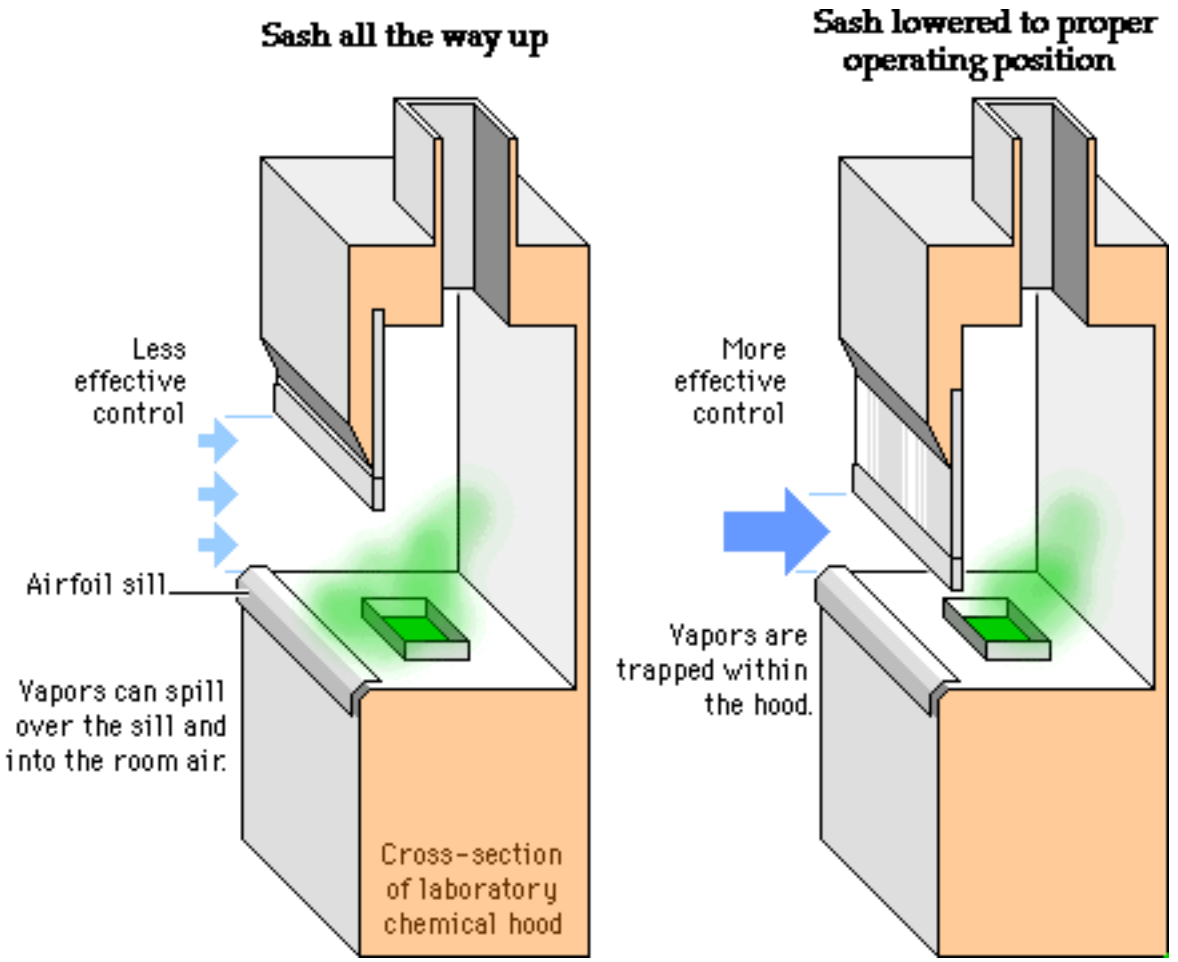
Know standard Hazard Symbols

SWP: Material Safety datasheet (MSDS)

Maintain hardcopy in lab

CS: Chemical Handling

All chemical processing in fume hoods



Keep the sash as low as possible

CS: Fume Hoods

From Dow Corning Safety Presentation

Don’t put face or head inside

From Univ. of Waterloo

Hood is not for storage

CS: Transporting Chemicals

- Don’t carry chemicals with hands.
  - Hazard to you and others

- Use bottle carriers, cart with trays, buckets, etc
- Avoid glass bottles

CS: Storage

- Separate storage for acids; oxidizers; and bases & solvents
  - Acid + solvent are explosive
  - Acid + base is exothermic
  - Oxidizers help combustion

At the very least use secondary containment

Secondary containment

Chemicals stored in rated cupboards.

- Not wooden shelves
- Large solvent cupboards are exhausted

HW: Spill Response

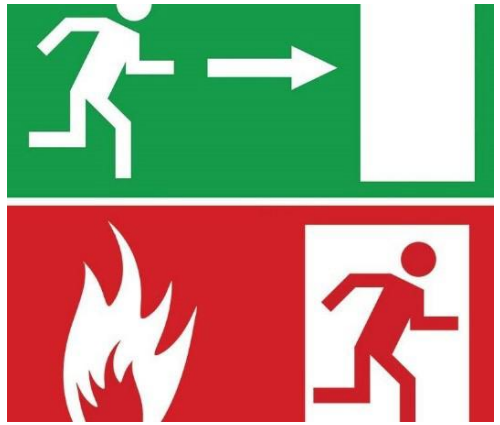
Neutralizing kits

- 10-50 ml spill
- Area must be barricaded and labelled

Large spill kits

- For large spills, 0.1 to 50 liters
- Only by trained staff
- Affected lab to be evacuated

Emergency evacuation



- For significant toxic, explosive or fire hazards
- Evacuate building
- Trip fire alarm

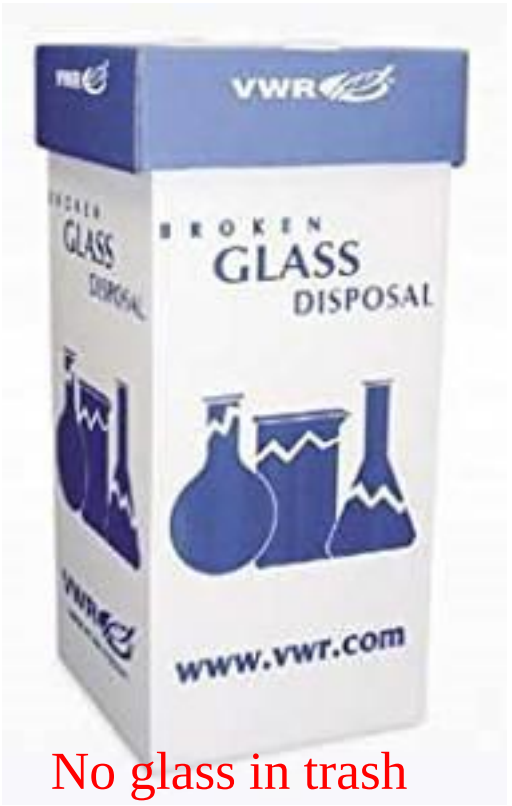
D. Hazardous Waste (HW)

Don’t cook unknown soups

There is no common method of disposal

HW: Segregation

- Don’t throw chemicals in sewage (pH<4 or pH>10)
- Accumulate segregated waste in plastic containers
- Waste collected every month. For free
  - Unknown waste is NOT accepted
  - Most segregated and labelled waste is accepted



No glass in trash


No sharps in trash

Chemical Hazard Always refer to the SDS	Flammable	Acid	Base	Oxidizer	Toxic
Flammable					
Acid					
Base					
Oxidizer					
Toxic					

From ehs.virginia.edu

Chemical Waste Disposal Guideline

Innocuous aqueous waste

- Acid (pH < 4)
- Alkali (pH > 10)
- Harmless soluble inorganic salt
- Alcohol containing salt
- Hypochlorite solution
- Fine (tlc grade) silica and alumina

* These chemicals should be washed down with excess water

Organic Solvent

- Chlorinated

Example: DCM, Chloroform, Chlorobenzene etc.

Non-Cholronated

Example: THF, ethyl acetate, hexane, toluene, methanol, etc

Red List

- Compounds with transitional metals
- Biocides
- Cynides
- Mineral oils and hydrocarbons
- Poisonous organosilicon compounds
- Metal phosphides
- Phosphorus element
- Fluorides and nitrides

Slid Waste

Lightly contaminated

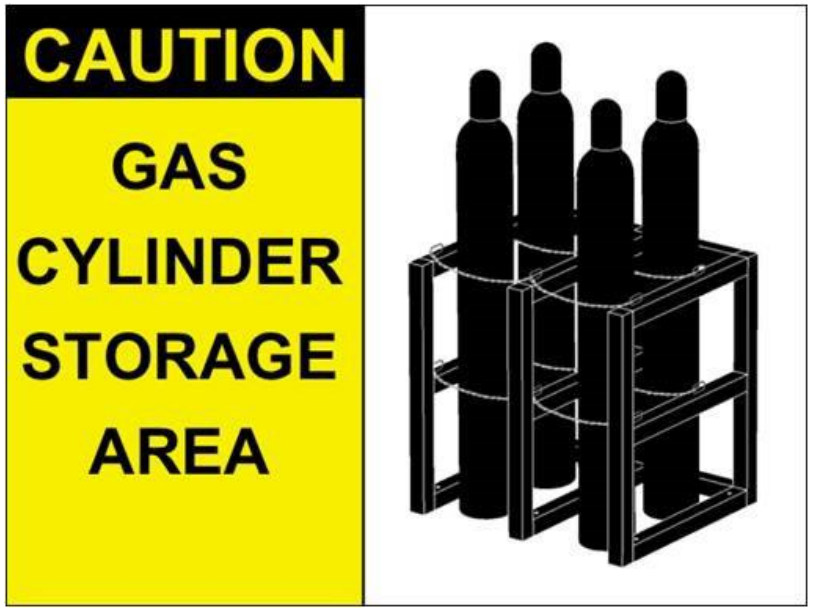
Example: Gloves, empty vials/centrifuge

Broken Glassware

Broken glassware are usually collected in plastic lined cardboard boxes for landfilling. Due to contamination, they are ususallly not suitable for recycling

CAUTION!
Chemical waste area

LABEL your chemical waste



E. Gas Safety (GS)

Chemical hazard combined with high-pressure hazards

GS: Hazards

Hazard	Gasses
Compressed inert gas	N_2, Ar, He, Co_2
Flammable gasses	H_2, CH_4, C_2H_6, C_2H_2, LPG
Oxidizers	O_2, N_2O
Toxic	CO, H_2S, BCl_3, B_2H_6, Si_2Cl_2, GeH_4, NH_3
Pyrophoric (instantly catches fire in air)	SiH_4, PH_3

Compressed gasses

Hazardous gases

Restrain Cylinders

Cylinders must be transported on carts. "NOT ROLLED"

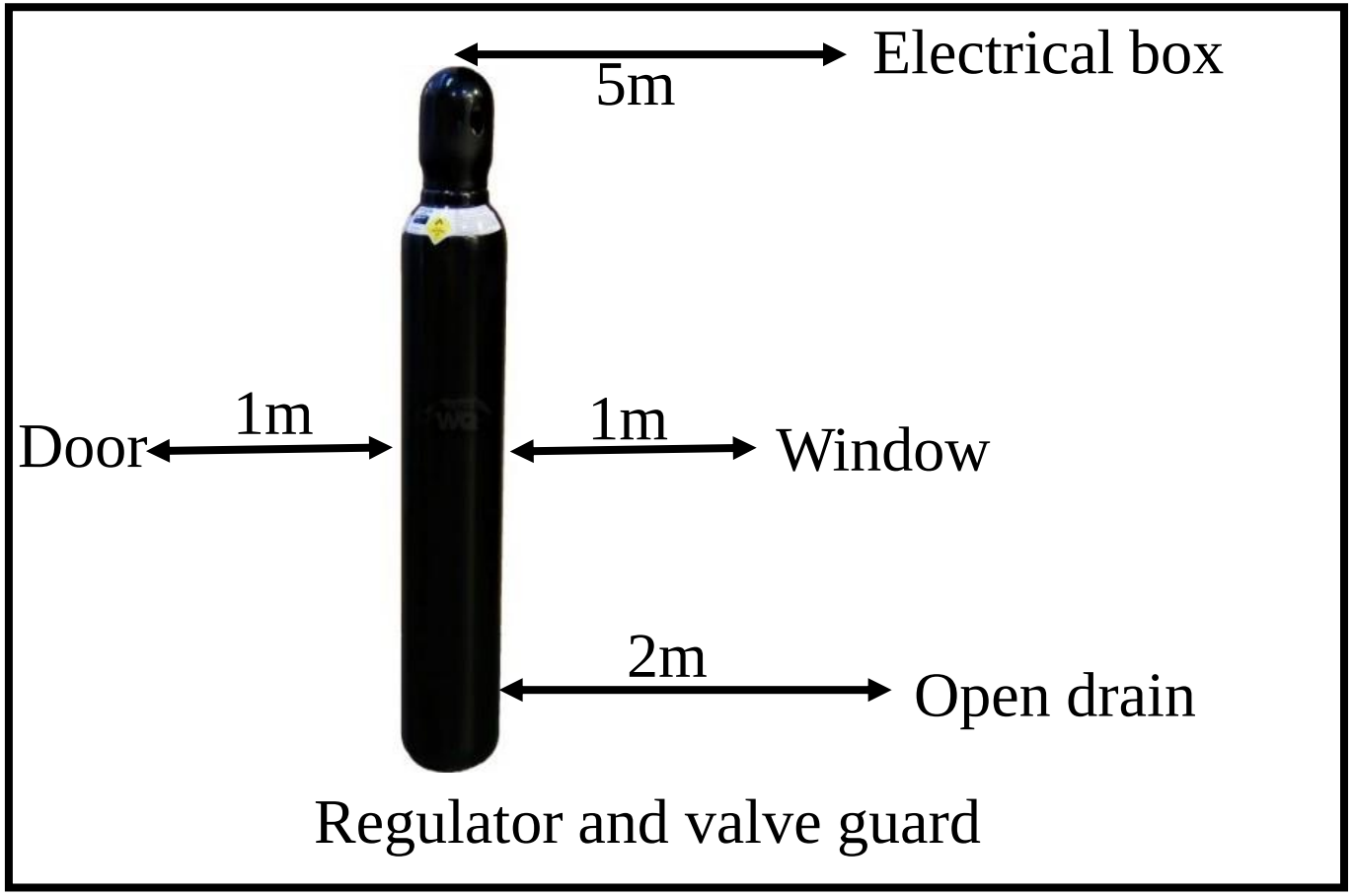
All cylinders must have tags

Al least mention gas name & use status

SWP: Cylinder at Point-of-Use

Regulator and valve guard

All cylinders must be used with correct regulator and have guard



Regulator and valve guard

Cylinder must be placed in lab with enough exclusive zone around it

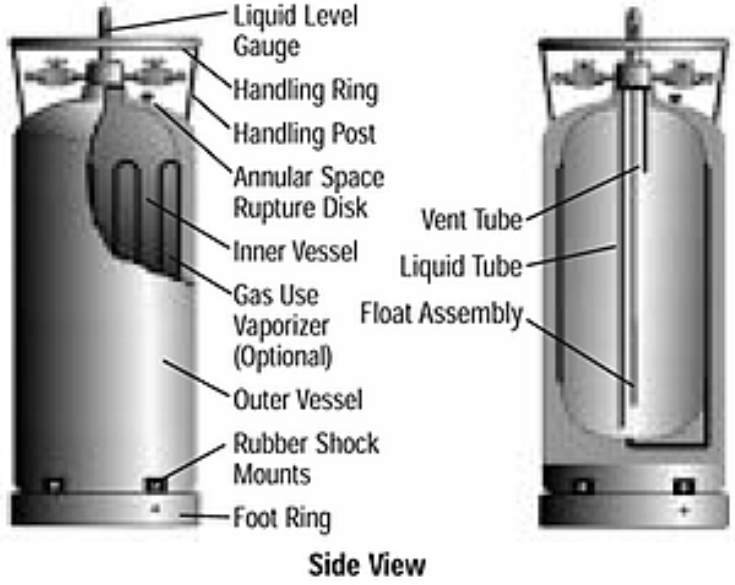
GS: Cryogens

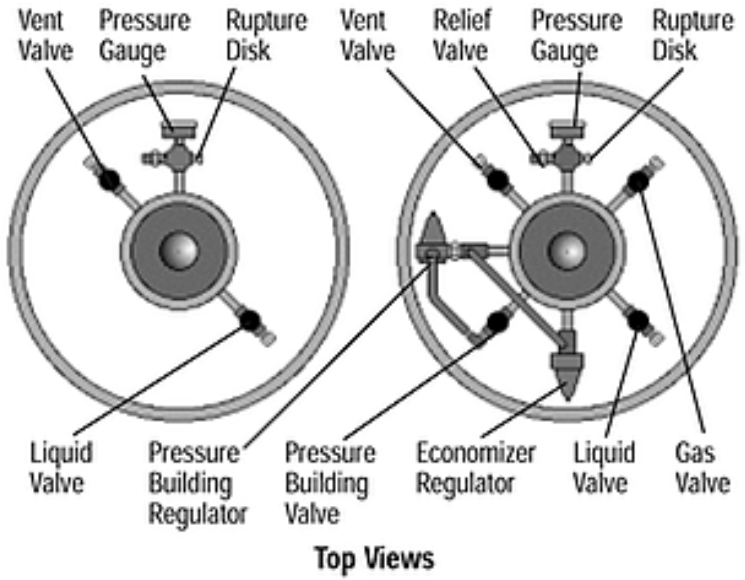
Liquid Oxygen	-297.3 °F (-183 °C)
Liquid Nitrogen	-320.4 °F (-195.8 °C)
Liquid Argon	-302.6 °F (-185.9 °C)

Sublimation Point	
Liquid CO_2	-109.3 °F (-78.5 °C)

Steel dewars

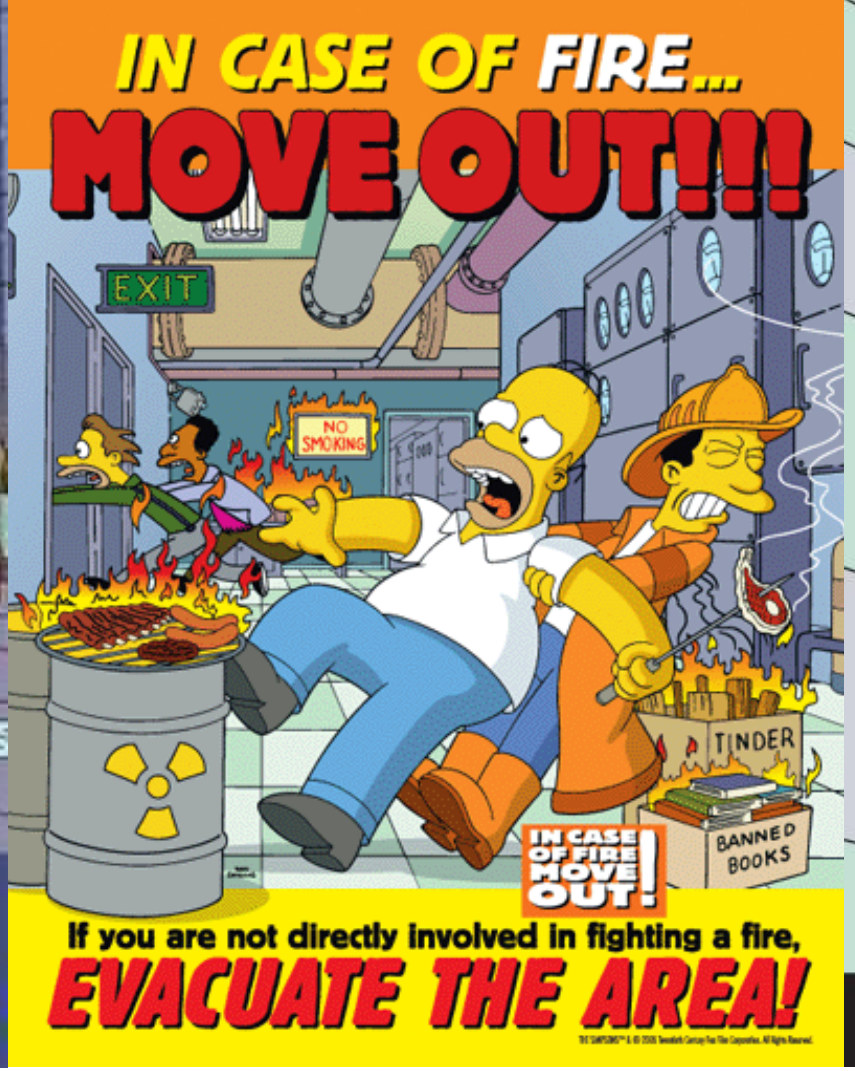
Glass dewars

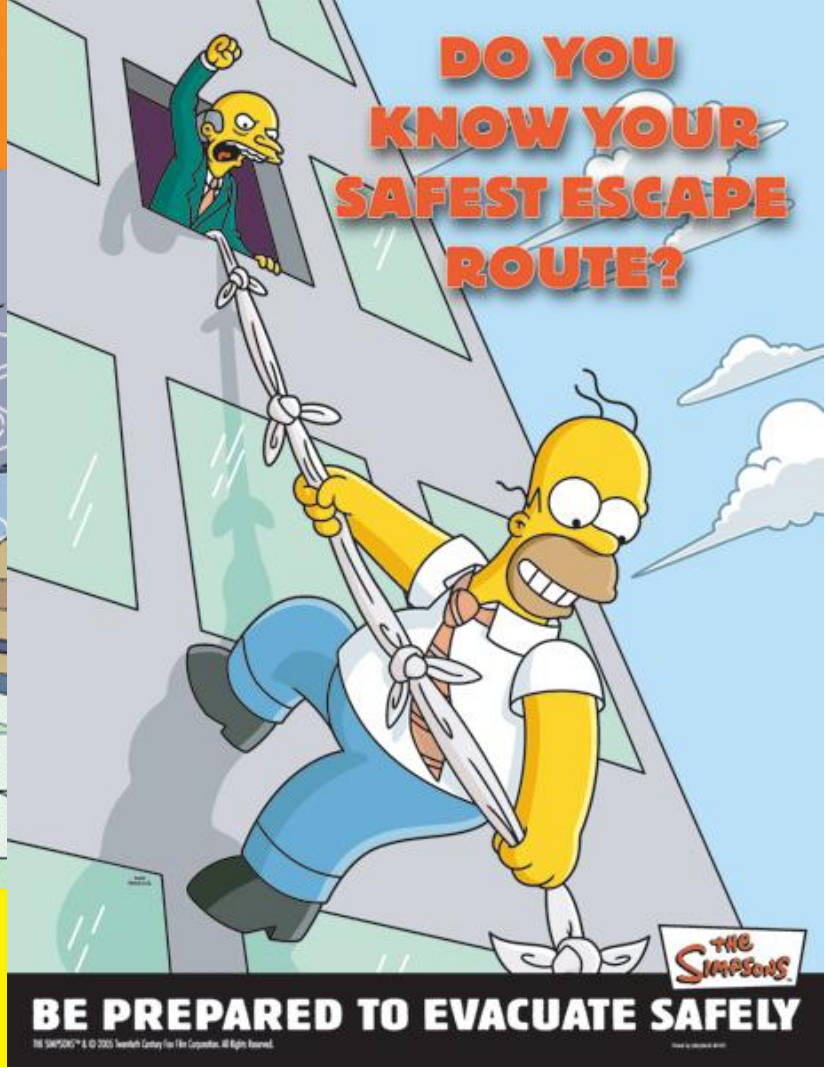




Compressed Cylinders

Cryo-rated PPE





F: Fire safety (FS)

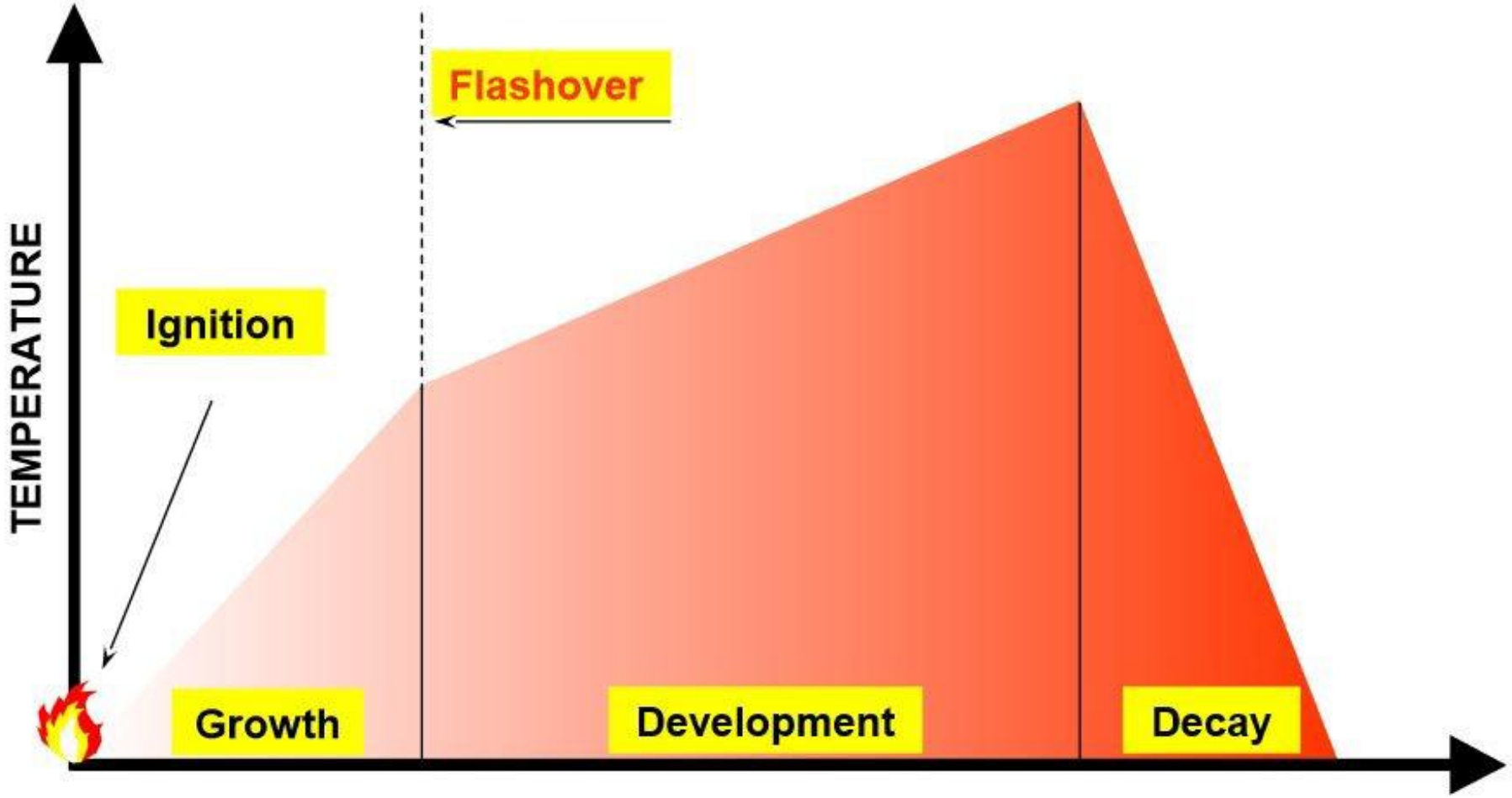
Fire: the combination reaction from interaction of HEAT + FUEL + OXYGEN

Remove any one and fire cannot spread

Do you know what to do in a emergency?

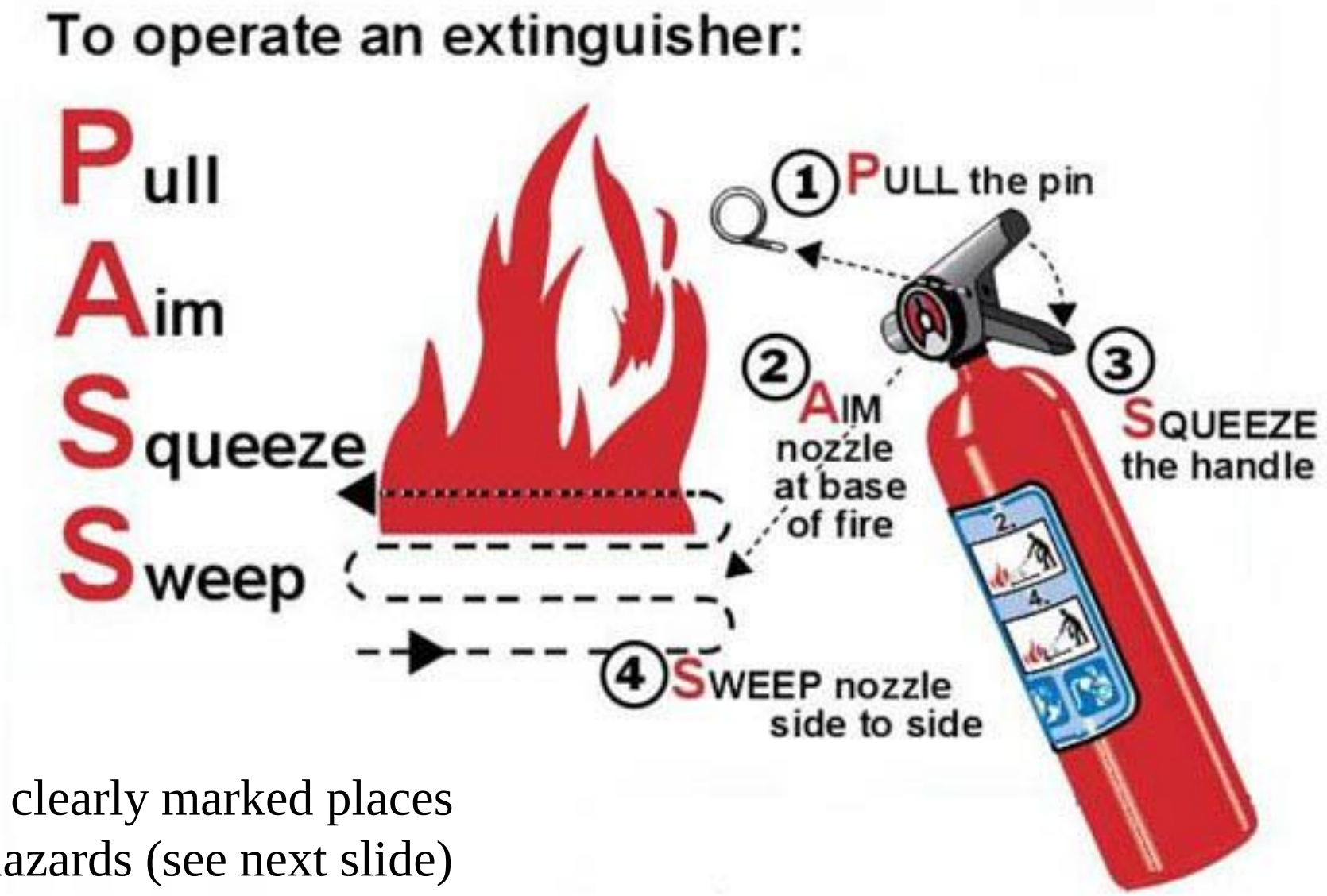
FS: Stages of Fire

Timeline of a Fire



Fires are very difficult to control once it crosses the flashover stage. Therefore, calling fire brigade ASAP makes all the difference

FS: First Extinguishers



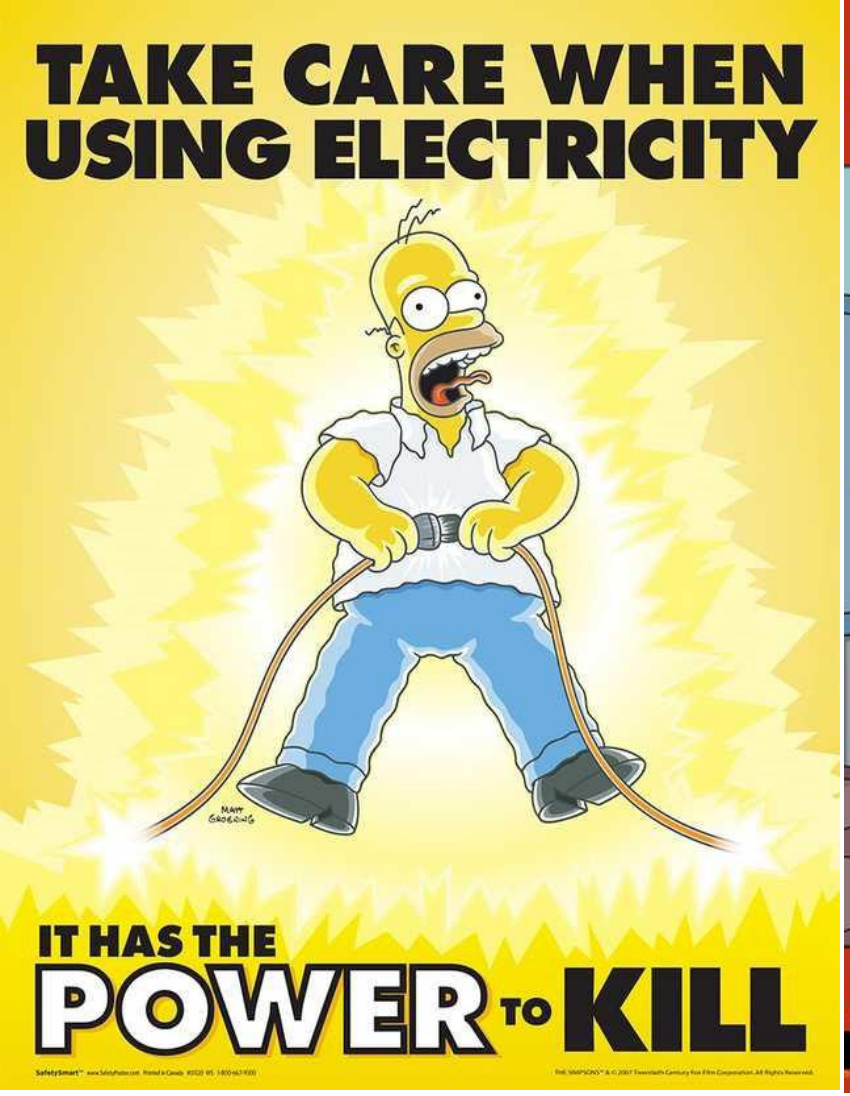
- All labs must have them in clearly marked places
  - One for each class of hazards (see next slide)
- They expire. Make sure to refill/service them
  - Typically need service every 3 years.

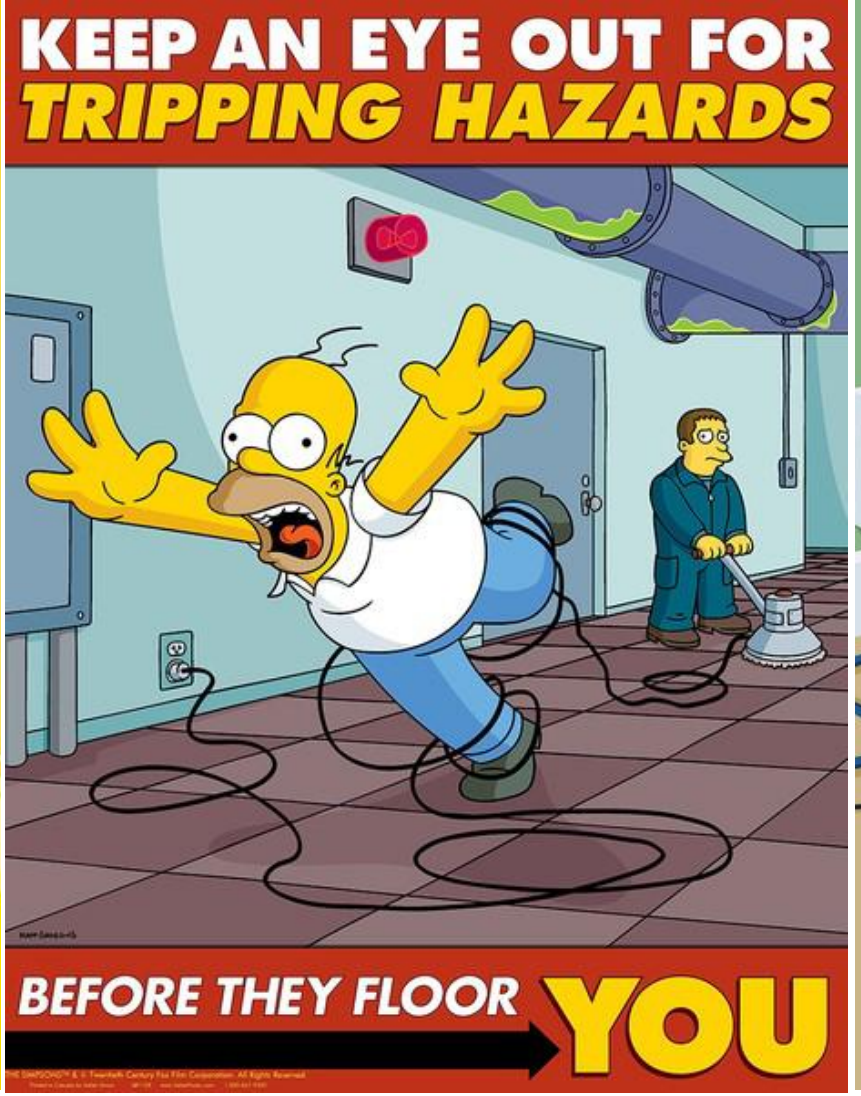
Learn how to use them. Very cheap to organize practical training on test fires

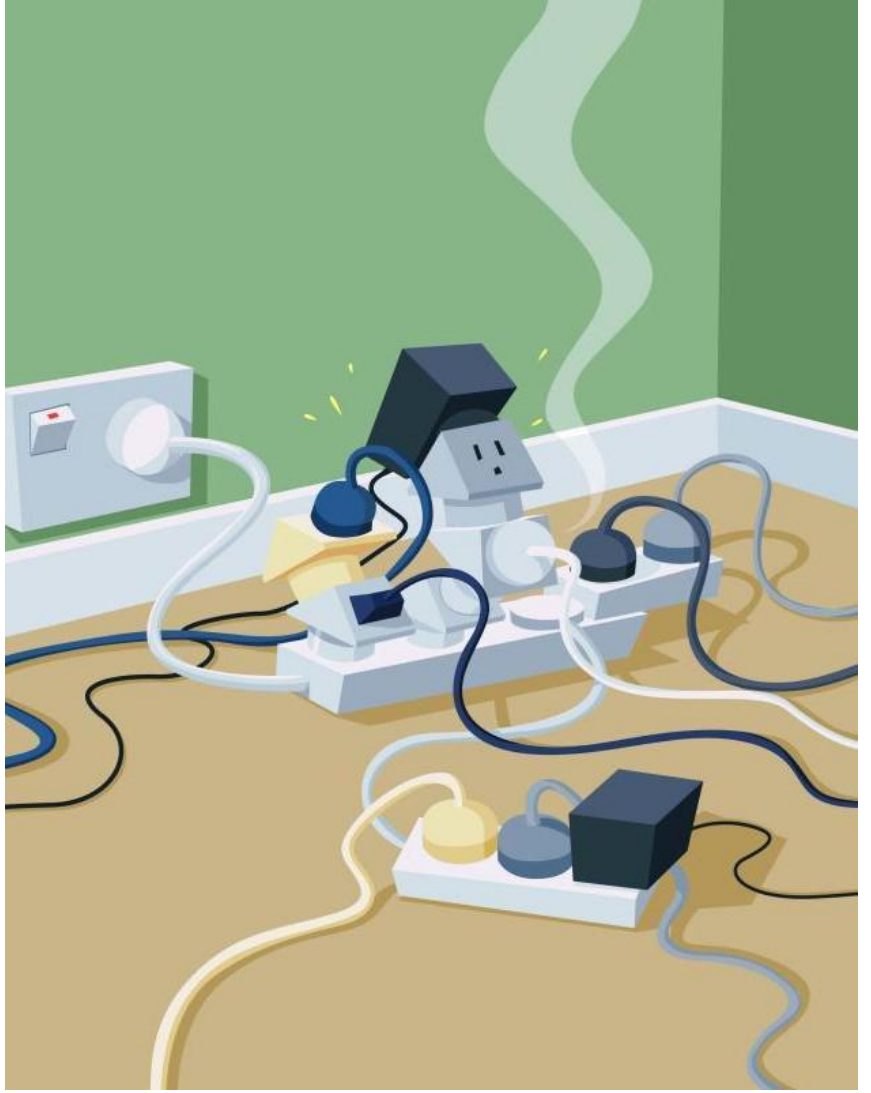
Type of Fire Extinguisher	CLASS A Combustible materials (e.g. paper & wood)	CLASS B Flammable Liquids (e.g. paint & petrol)	CLASS C Flammable gases (e.g. butane and methane)	CLASS D Flammable gases (lithium & potassium)	Electrical Electrical equipment (e.g. computers & generators)	CLASS F Deep fat fryers (e.g. chip pans)	Comments
Water	✓	✗	✗	✗	✗	✗	Do not use on liquid or electric fires
Foam	✓	✓	✗	✗	✗	✗	Not suited to domestic use
Dry Powder	✓	✓	✓	✓	✓	✗	Can be used safely up to 1000 volts
CO_2	✗	✓	✗	✗	✓	✗	Safe on both high and low voltage
Wet Chemical	✓	✗	✗	✗	✗	✓	Use on extremely high temperatures

FS: Fire Response

Shout
“FIRE FIRE FIRE FIRE”



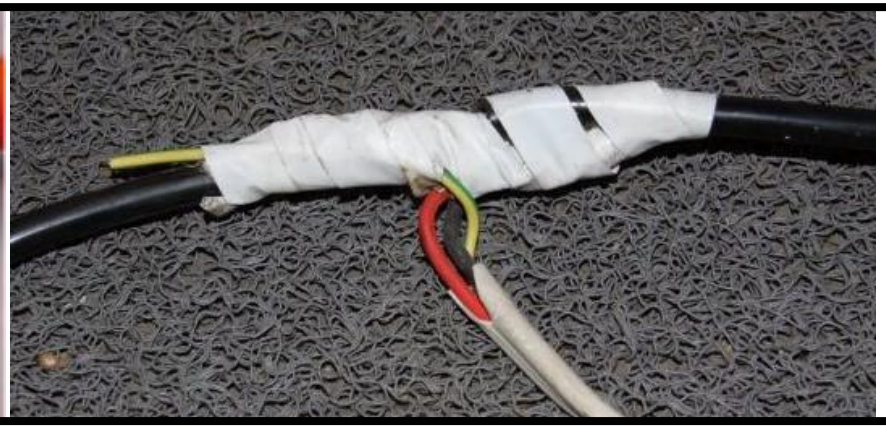




G. Electrical safety (ES)

Grounding, insulation, phase matching, and electrical distribution system

ES: Electrical Hazards & Steps for prevention



1. Replace any worn-out or stripped wires

2. Only use 3-pin plugs

3. Earth all equipment

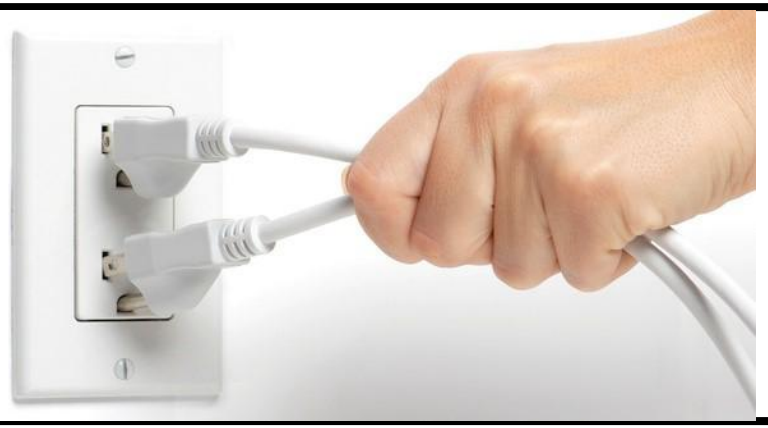
4. Power strips
   - Avoid them
   - Use power strips with fuse
   - Calculate the load

ES: Electrical Hazards & Steps for prevention

5. No trip hazard

6. No water in vicinity

7. No wet hands



8. Don’t pull cord

9. Don’t poke power sockets

10. Switch off

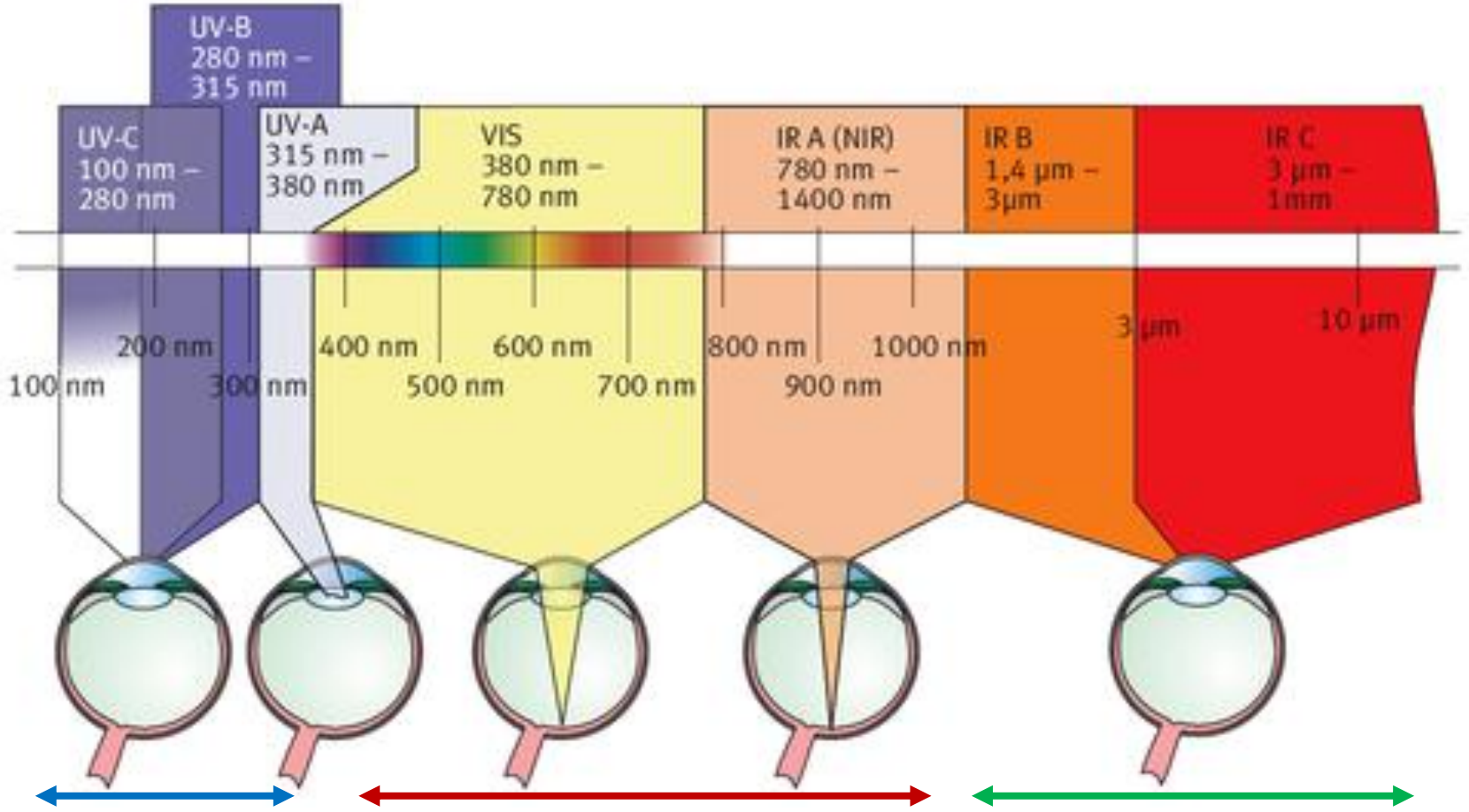
H. Laser safety (LS)

Exposure to laser light can cause significant damage to the skin and eyes

- Typically in the form of burns and direct damage to the retina.

LS: Hazard from Laser

Exposure to laser light can cause significant damage to the skin and eyes- typically in the form of burns and direct damage to the retina.



Corneal/lens damage

Retinal damage

Corneal damage

Retina damage is often permanent and irreparable.

Cornea and lens damage can heal although the injury is incredible painful

LS: Safe practices

Use appropriate safety eyewear whenever working near laser beams with non-negligible powers

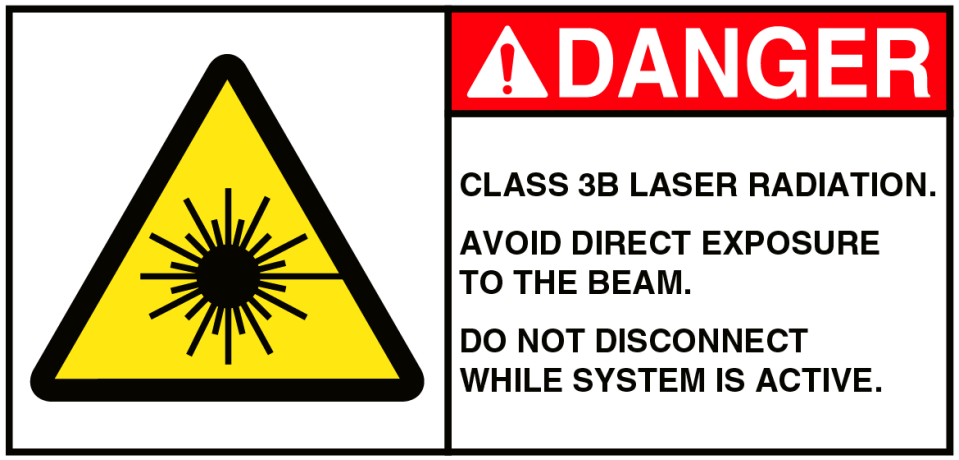
-> Class 2 for visible lasers

-> Class 1 for invisible lasers

- Even if you personally are not using the laser

Use laser safety curtains, laser barriers and laser-blocks to prevent direct or reflected light from leaving the experimental area.

Post appropriate warning signs or labels near laser setups or rooms



I: Radiation safety (RS)

X-rays, Magnetic field, Radioactivity, etc

RS: X-ray Protection Practices

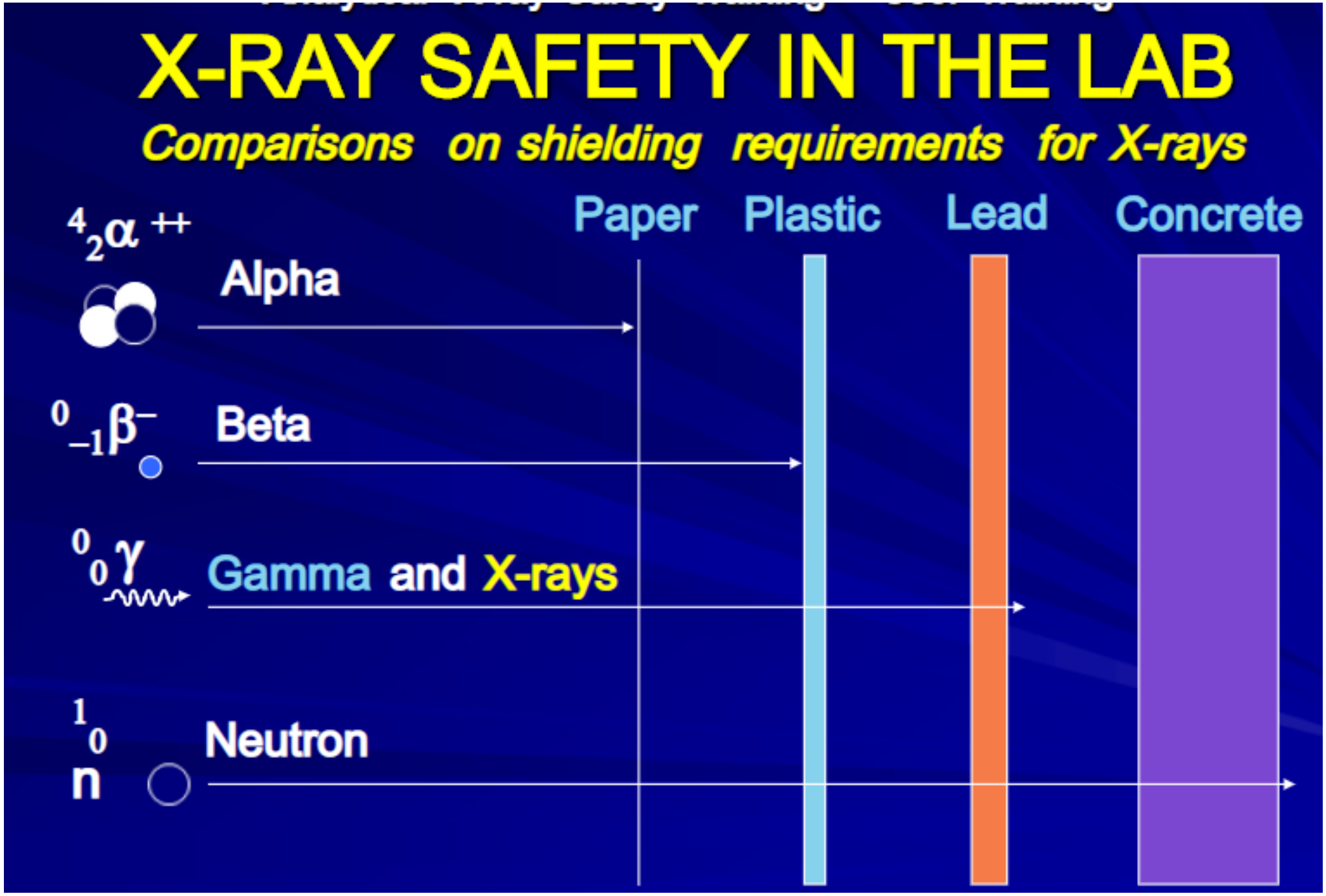
As Low As Reasonably Achievable (ALARA)

Time	Distance	Shielding
• Reduce time spent with X-rays on • Track per day exposure	• Keep as far as possible • Don’t loiter	• Reduce radiation to < milli roentgens hr.

Exposed X-ray sources and self-designed equipment may need to be registered with AERB on eLORA

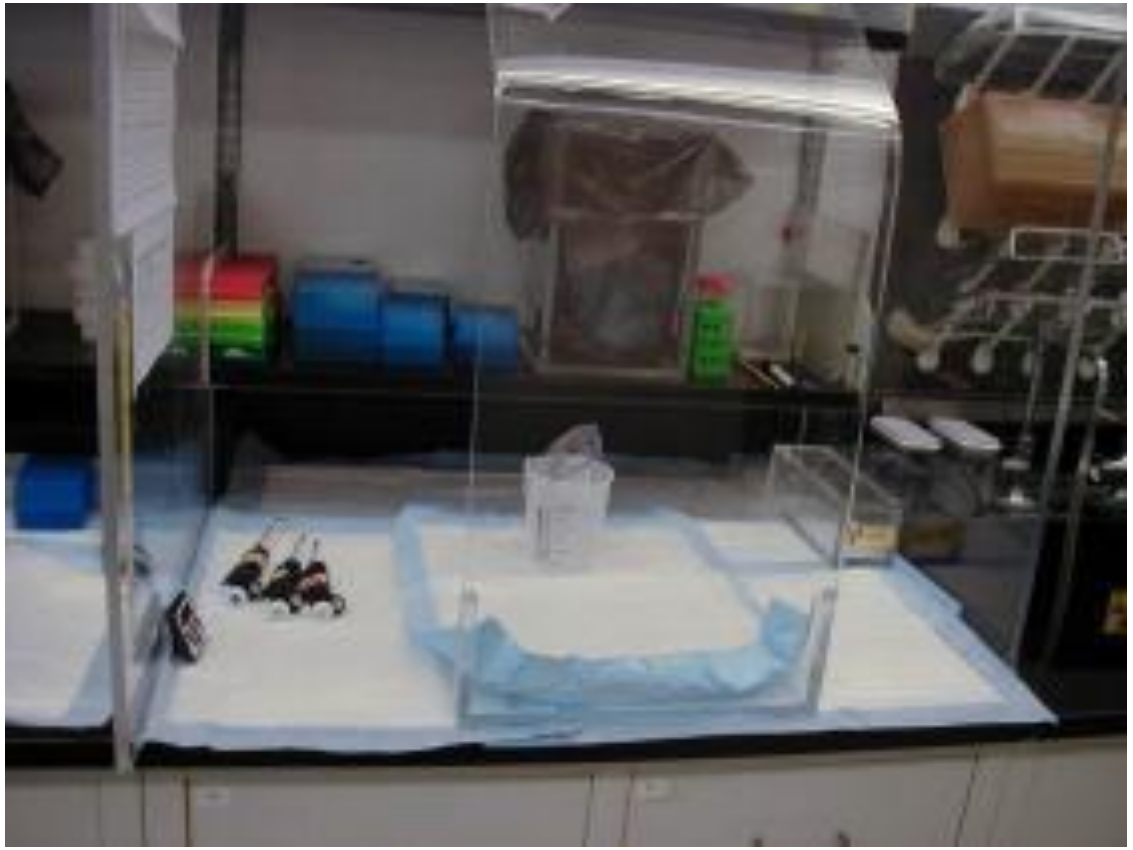
Depending on the instrument, may need thermoluminescent dosimeter (TLD), a type of radiation dosimeter

RS: Shielding



RS: Radioactive Materials

From Princeton.edu



- Use absorbent paper on all surfaces
- Use appropriate shielding
- Use dedicated equipment
- Clearly label everything

- Store material under lock and key
- Keep a track of usage
- Supervise visitors
- Segregate waste