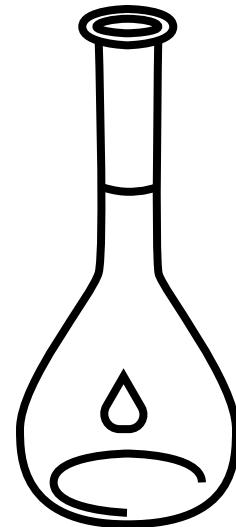
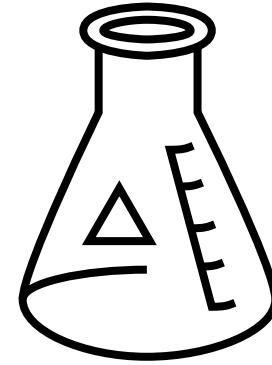
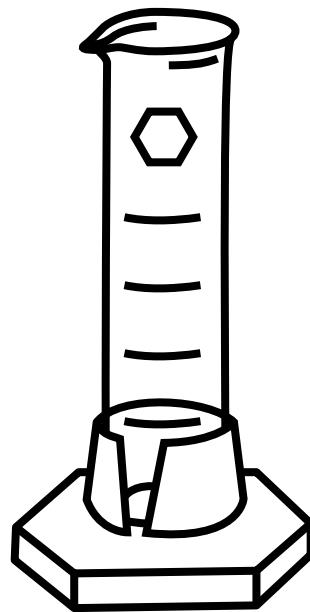
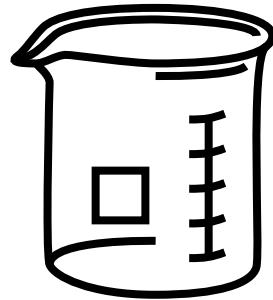


# Welcome Back!

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# Topics

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## PART I

Planning for an Emergency

Emergency Response

Hazard Communication—GHS

Scenarios



# **Emergencies**

---

**At PSU main campus: dial 911**

**PSU emergency line: (503) 725-5911**

**PSU non-emergency: (503) 725-4407**

**At RLSB: dial (503) 494-4444**



# Emergencies

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**Follow the guidance of:**

**SRTC/SB1—Evacuation Wardens  
RLSB—Floor Leaders**

These folks have specialized evacuation training.

They'll be wearing fluorescent orange (or green) vests and carrying flash lights.

Follow their instructions and leave the building!

Treat fire drills as if it were the real deal!



# EMERGENCY PROCEDURES

PORTLAND STATE UNIVERSITY

BUILDING NAME: ..... ROOM #: .....

DEPARTMENT SAFETY CONTACT: ..... EVACUATION LOCATION: .....

<b>PSU ALERT</b> Opt in for text message notifications at <a href="#">banweb.pdx.edu</a>		
<b>MEDICAL</b>  <ul style="list-style-type: none"> <li>Call 911 immediately: report the location, nature of injury or illness, current condition, and any other requested information</li> <li>Provide assistance if medically qualified</li> <li>Stay with the person if possible</li> <li>Do not move the person unless they are in immediate danger</li> <li>For non-life threatening concerns, contact the Center for Student Health and Counseling or your health provider</li> </ul>	<b>ACTIVE THREAT</b>  <p><i>If you encounter an active threat or violent intruder...</i></p> <ul style="list-style-type: none"> <li><b>RUN:</b> Evacuate the area, leaving your belongings behind and keeping your hands visible</li> <li><b>HIDE:</b> Close and secure all doors and windows, shut off lights and silence ALL electronic devices</li> <li><b>FIGHT:</b> Act aggressively and attempt to incapacitate the threat or intruder, find something to use as a weapon</li> </ul>	<b>FIRE</b>  <p><b>IF YOU SEE SMOKE OR FLAMES</b></p> <ul style="list-style-type: none"> <li>Pull the fire alarm</li> <li>Evacuate the building immediately using the closest emergency exit, do not use elevators</li> <li>Call 911 to report the fire</li> </ul> <p><b>WHEN THE FIRE ALARM ACTIVATES</b></p> <ul style="list-style-type: none"> <li>Evacuate the building immediately using the closest emergency exit, do not use elevators</li> <li>Assemble in a designated area</li> <li>Wait for the "all clear" from first responders or PSU Alert before re-entering</li> <li>DO NOT assume any alarm is false</li> </ul>
<b>SHELTER IN PLACE</b>  <p><i>If an unsafe situation occurs OUTSIDE of your building or if instructed by a PSU ALERT...</i></p> <p>Examples: Outdoor hazardous materials spill, law enforcement activity</p> <ul style="list-style-type: none"> <li>Move to an interior space, away from windows</li> <li>Wait for the "all clear" from PSU Alert or first responders before exiting</li> </ul>	<b>NEED HELP?</b> <p>Call or Text <b>911</b></p> <p><b>PSU Emergency</b> <b>503-725-5911</b></p> <p><b>PSU Non-Emergency</b> <b>503-725-4407</b></p>	<b>EVACUATE</b>  <p><i>If an unsafe situation occurs INSIDE your building or if instructed by a PSU ALERT...</i></p> <p>Examples: Fire, indoor hazardous materials spill, power outage</p> <ul style="list-style-type: none"> <li>Proceed safely to the nearest exit, do not use elevators</li> <li>Exit the building and stay clear of the area</li> <li>Wait for the "all clear" from PSU Alert or first responders before re-entering</li> </ul> <p><i>If you are unable to evacuate safely, share your location and needs with someone who can communicate with emergency responders</i></p>
<b>SUSPICIOUS ACTIVITY</b>  <p><b>SUSPICIOUS PERSON(S)</b></p> <ul style="list-style-type: none"> <li>Do not confront the person(s)</li> <li>Do not let the person(s) into a locked building or office</li> <li>Do not prohibit the person(s) from leaving</li> <li>Secure your office or immediate area</li> </ul> <p><b>SUSPICIOUS ITEM(S)</b></p> <ul style="list-style-type: none"> <li>Do not handle or open the item(s)</li> <li>Leave the area and close doors behind you</li> </ul> <p><i>Report suspicious activity to the Campus Public Safety Office: 503-725-5911</i></p>	<b>EARTHQUAKE</b>  <p><i>If you feel shaking...</i></p> <ul style="list-style-type: none"> <li>Drop, Cover, Hold—drop down to the ground, find cover (table, desk, etc.) and hold on!</li> <li>Stay indoors until shaking stops</li> <li>Stay away from glass and windows</li> <li>Be aware: fire alarms and sprinkler systems frequently go off in buildings, even if there is no fire</li> <li>When shaking stops, gather your personal belongings and evacuate the building</li> <li>Expect and prepare for aftershocks</li> </ul>	<b>WINTER WEATHER</b>  <p><b>TRANSPORTATION INFORMATION</b></p> <ul style="list-style-type: none"> <li>Sign up for PSU Alert via Banweb to receive notice of University closures and delays</li> <li>Use only pathways which have been cleared of snow and ice</li> <li>Avoid walking under trees heavy with snow and ice</li> <li>Dress warmly, carry extra layers</li> </ul>

For more information:  
[go.pdx.edu/emergencyprocedures](http://go.pdx.edu/emergencyprocedures)



# PSU ALERT

Opt in for text message notifications at [banweb.pdx.edu](http://banweb.pdx.edu)

## MEDICAL



- Call 911 immediately: report the location, nature of injury or illness, current condition, and any other requested information
- Provide assistance if medically qualified
- Stay with the person if possible
- Do not move the person unless they are in immediate danger
- For non-life threatening concerns, contact the Center for Student Health and Counseling or your health provider

## ACTIVE THREAT



*If you encounter an active threat or violent intruder...*

- **RUN:** Evacuate the area, leaving your belongings behind and keeping your hands visible
- **HIDE:** Close and secure all doors and windows, shut off lights and silence ALL electronic devices
- **FIGHT:** Act aggressively and attempt to incapacitate the threat or intruder; find something to use as a weapon

## FIRE



### IF YOU SEE SMOKE OR FLAMES

- Pull the fire alarm
- Evacuate the building immediately using the closest emergency exit, do not use elevators
- Call 911 to report the fire

### WHEN THE FIRE ALARM ACTIVATES

- Evacuate the building immediately using the closest emergency exit, do not use elevators
- Assemble in a designated area
- Wait for the "all clear" from first responders or PSU Alert before re-entering
- DO NOT assume any alarm is false

## SHELTER IN PLACE



*If an unsafe situation occurs OUTSIDE of your building or if instructed by a PSU ALERT...*

Examples: Outdoor hazardous materials spill, law enforcement activity

- Move to an interior space, away from windows
- Wait for the “all clear” from PSU Alert or first responders before exiting

## NEED HELP?

Call or Text  
**911**

PSU Emergency  
**503-725-5911**

PSU Non-Emergency  
**503-725-4407**

## EVACUATE

*If an unsafe situation occurs INSIDE your building or if instructed by a PSU ALERT...*



Examples: Fire, indoor hazardous materials spill, power outage

- Proceed safely to the nearest exit, do not use elevators
- Exit the building and stay clear of the area
- Wait for the “all clear” from PSU Alert or first responders before re-entering

*If you are unable to evacuate safely, share your location and needs with someone who can communicate with emergency responders*

## SUSPICIOUS ACTIVITY



### SUSPICIOUS PERSON(S)

- Do not confront the person(s)
- Do not let the person(s) into a locked building or office
- Do not prohibit the person(s) from leaving
- Secure your office or immediate area

### SUSPICIOUS ITEM(S)

- Do not handle or open the item(s)
- Leave the area and close doors behind you

**Report suspicious activity to the Campus Public Safety Office:**  
**503-725-5911**

For more information:  
[go.pdx.edu/emergencyprocedures](http://go.pdx.edu/emergencyprocedures)

## EARTHQUAKE

### *If you feel shaking...*

- Drop, Cover, Hold—drop down to the ground, find cover (table, desk, etc.) and hold on!
- Stay indoors until shaking stops
- Stay away from glass and windows
- Be aware: fire alarms and sprinkler systems frequently go off in buildings, even if there is no fire
- When shaking stops, gather your personal belongings and evacuate the building
- Expect and prepare for aftershocks

## WINTER WEATHER



- Sign up for PSU Alert via Banweb to receive notice of University closures and delays
- Use only pathways which have been cleared of snow and ice
- Avoid walking under trees heavy with snow and ice
- Dress warmly, carry extra layers

### TRANSPORTATION INFORMATION

- TriMet Alerts: [trimet.org/m/alerts/](http://trimet.org/m/alerts/)
- PBOT Alerts: [twitter.com/PBOTinfo](http://twitter.com/PBOTinfo)
- ODOT TripCheck: [tripcheck.com/](http://tripcheck.com/)



# **Emergency Plan**

---

Emergency Contacts

Lab Hazard Assessment

Safety Shower/Eyewash

Fire Extinguisher

Evacuation

Spill and Emergency Procedures

Reporting Pathways

What will you do?



# Emergency Contacts

What information can you make available to passersby and emergency responders?

What information is important?

At what scale might the response be?

When is it important to post this information?

Does this responsibility get shared with others in the research group?

Where do you post this information?

How can you also protect your privacy?

Also, get a Hazard Assessment!

## EMERGENCY NOTIFICATION

Building Name: \_\_\_\_\_  
Room Number: \_\_\_\_\_

Principal Investigator: \_\_\_\_\_  
After Hours Phone: \_\_\_\_\_

Alternate #1: \_\_\_\_\_  
After Hours Phone: \_\_\_\_\_

Alternate #2: \_\_\_\_\_  
After Hours Phone: \_\_\_\_\_

After hours contact UAB Police 934-3535 to page Health and Safety

## CAUTION

This is a laboratory using chemicals  
Personnel entering this room during a fire or other emergency must take precautions.  
This room may contain quantities of one or more of the following:



FLAMMABLES



CORROSIVES



REACTIVES



OXIDIZERS



TOXINS



COMPRESSED GAS

UAB Department of Occupational Health and Safety Required Signage  
12/18/2013



# Laboratory Emergency Information

**Authorized Personnel Only**

Department of Chemistry PI: Dr. Doo Little

**CAUTION:** The following hazards are present in this space:



Explosives  
Peroxides



Corrosives



Flammables  
Pyrophorics



Acute Toxics



Oxidizers



Environmental  
Hazards



Compressed  
Gases



Carcinogens

Other:



## **Emergency Contact Information:**

**Police/Fire/Medical: 911**

**CPSO: 503-725-5911**

**Primary Contact:** 503-512-5555

**Secondary Contact:** 503-525-5555

# Lab Hazard Assessment

What hazards are present that pose an immediate danger to persons in the laboratory?

What might the scale of the Hazard be?

What chemical hazards?

What storage hazards?

What electrical hazards?

What temperature hazards?

What structural hazards?

Prepare yourself with lab assessments!

Reach out to EHS/CHC for an assessment.

→ [Chemical Hazard Assessment](#)



# Safety Shower and Eyewash

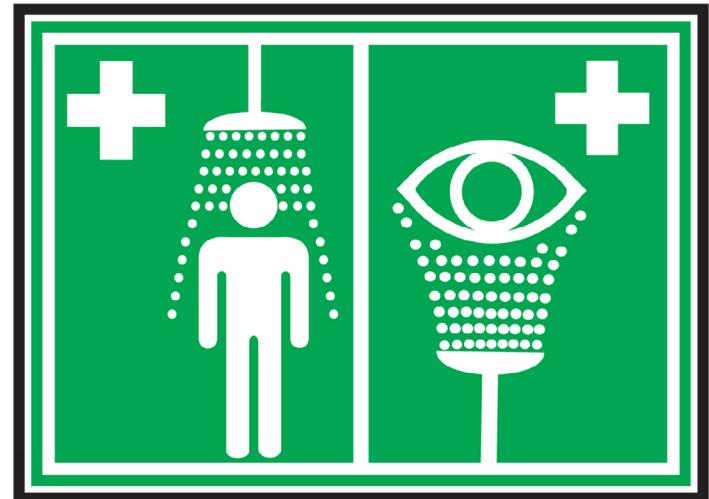
Know where the eyewash and safety shower are located in your lab space(s).

They are checked monthly by EHS.

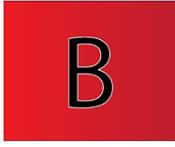
Be prepared to use them and to know the appropriate times to use either of them.

For small spills on hands or arms, perhaps the tap water at the sink will be appropriate.

Don't Forget: *dilution is the solution.*



# Fire Extinguisher

	A 		Ordinary Combustibles	Wood, Paper, Cloth, Etc.
Standard Lab Extinguisher	B 		Flammable Liquids	Grease, Oil, Paint, Solvents
	C 		Live Electrical Equipment	Electrical Panel, Motor, Wiring, Etc.
	D 		Combustible Metal	Magnesium, Aluminum, Etc.
	K 		Commercial Cooking Equipment	Cooking Oils, Animal Fats, Vegetable Oils



# Remember P.A.S.S.



## PULL

Pull the pin.



## AIM

Aim the nozzle at the base of the fire, starting at 10ft away.



## SQUEEZE

Squeeze the operating handle to release the extinguishing agent.



## SWEEP

Sweep from side to side at the base of the fire until it goes out.

- Test extinguisher before approaching fire.
- Keep low and approach with the wind to your back.
- Back away, watching for rekindle.

# Evacuation

What is the scale of the emergency?

What building am I in?

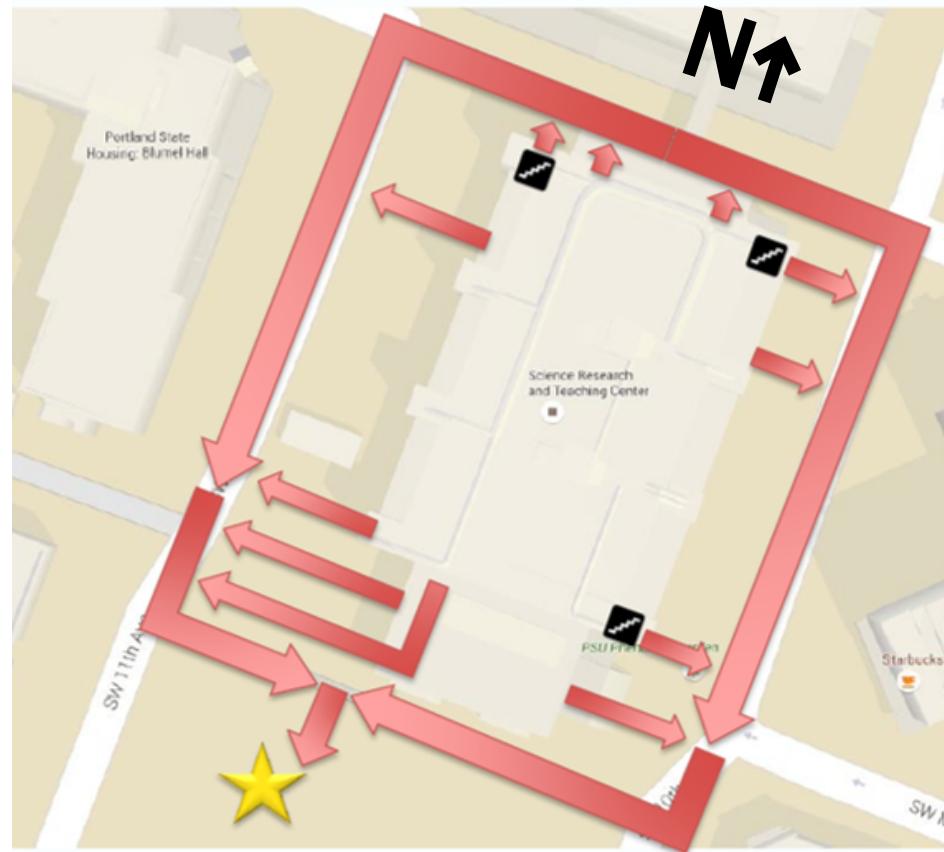
Where is the nearest exit—from the lab, and/or from the building?

What is an alternate route?

Always be aware of your surroundings and make sure that entrances and exits are not obstructed.

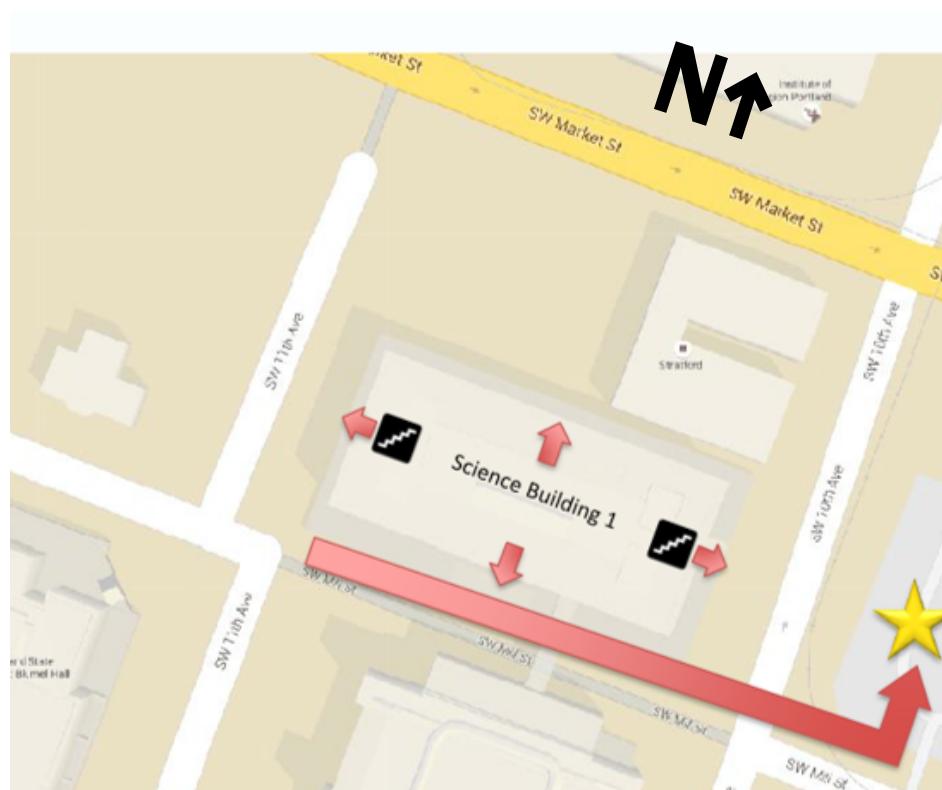


# Evacuation Maps



Science Research and Teaching Center:  
Assemble on Montgomery Field

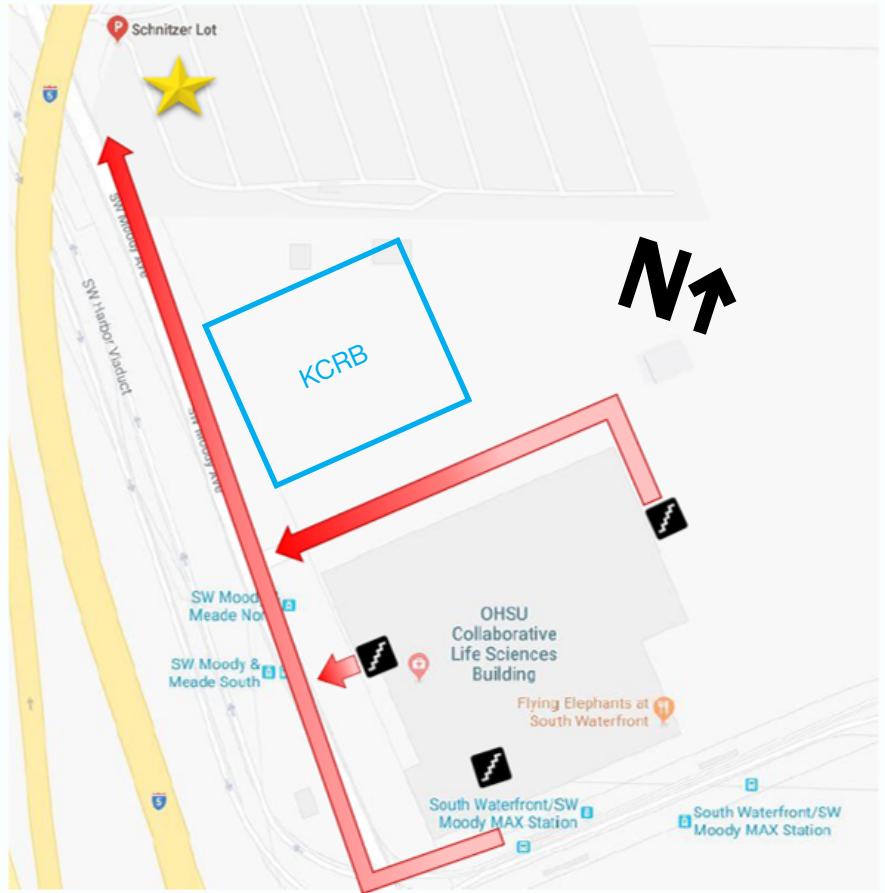
# Evacuation Maps



Science Building I:  
Assemble at Parkmill Lot

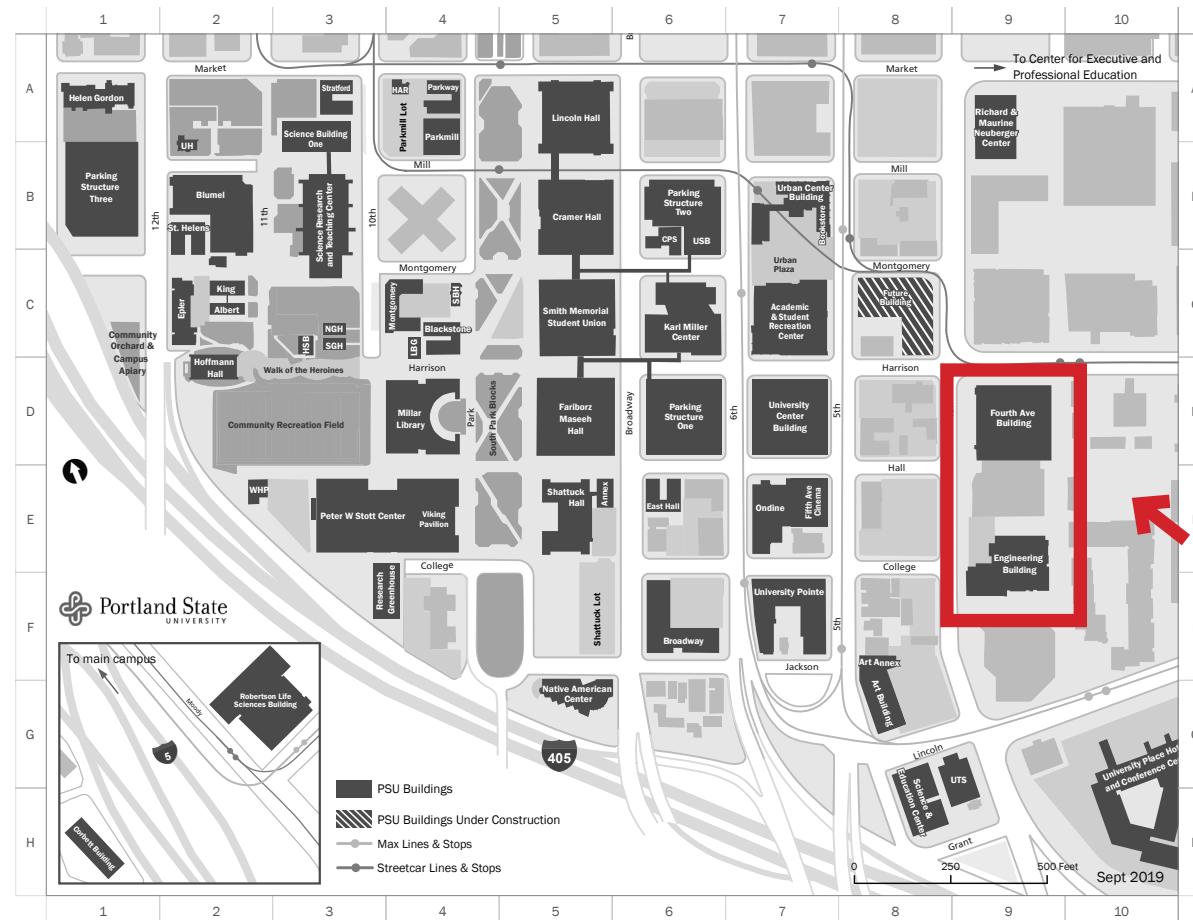


# Evacuation Maps



Robertson Life Science Building:  
Assemble at Schnitzer Lot  
(North of Knight Cancer Research Bldg)

# Evacuation Maps



Fourth Avenue and Engineering Buildings  
Assemble at Lovejoy Fountain  
Other [Assembly Areas](#)



# Spill and Emergency Procedures

Life over Property. Always.  
Whether fire, chemical spill, or other!

Don't put yourself in danger to save another.  
Call 911.

When do you make the decision that a spill is out of  
your control? Scale?

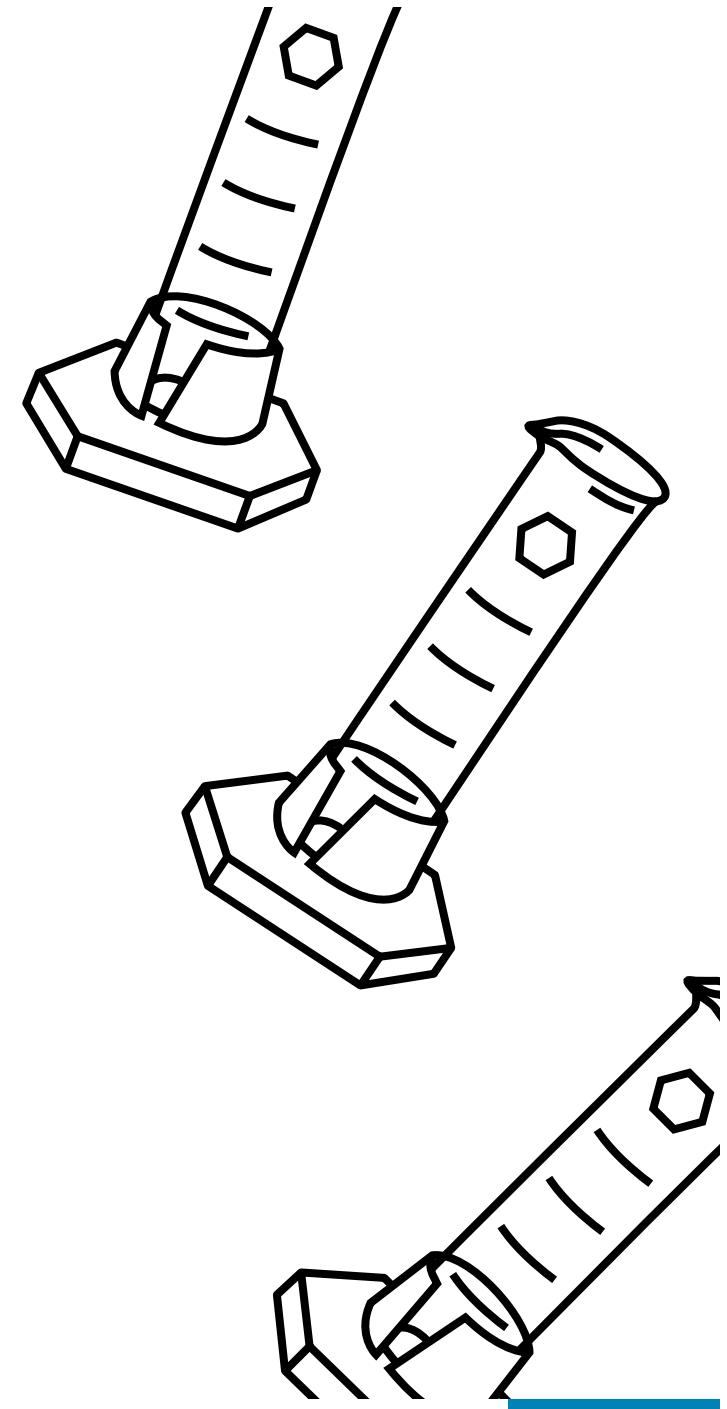
Do not fight fires unless you absolutely have to!  
Forthcoming: Fire Extinguisher Training.

Stabilize what you are working on—if you can.

Vapors? Open Hoods,  
activate the Emergency Mode button!

Fires? Close hoods, starve the fire of oxygen.

Call 911.



## Reporting Pathways

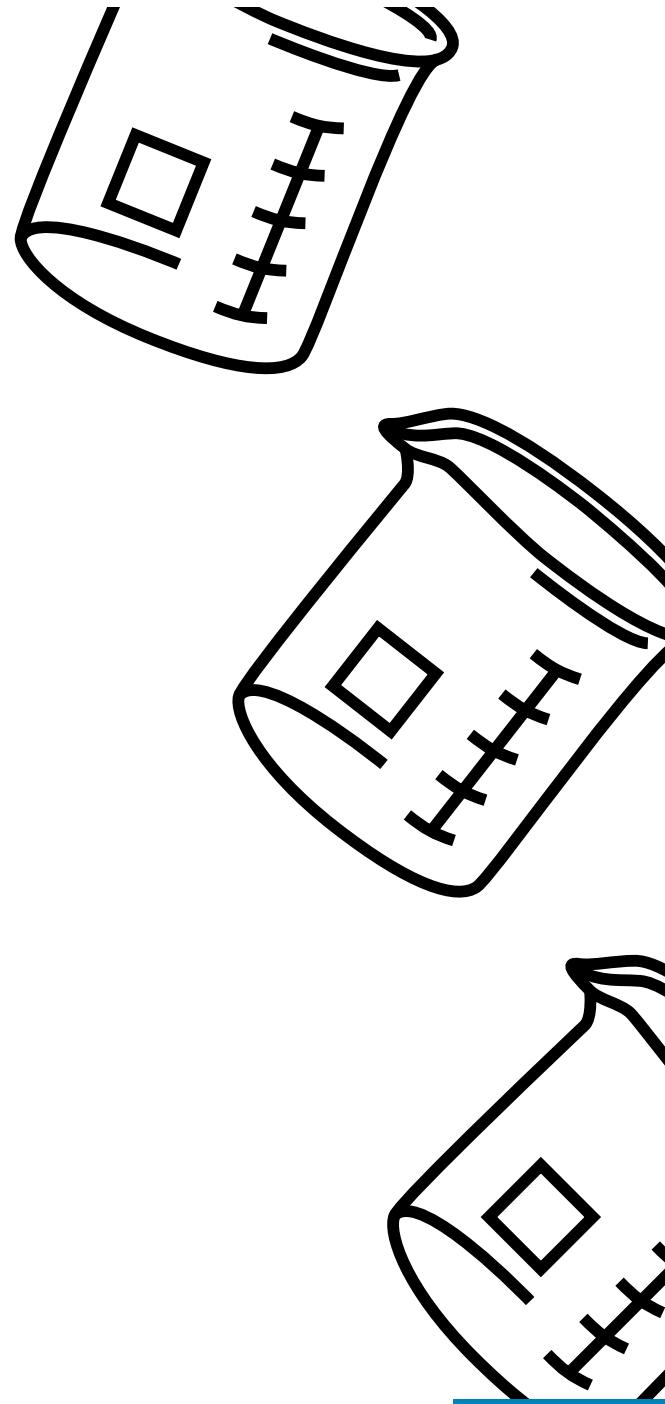
Emergency—if possible, stabilize the area, evacuate the room, dial 911. Tell neighboring labs. If you are affected by the incident, call for help as well.

EHS, CPSO will be notified and respond.

Smaller spill, non-emergency—if you have spill material and can handle it on your own, you can. You can also let the Stockroom or EHS know and they can respond.

Call the work Order Center (725-2FIX) or the EHS or Stockroom offices.

After the incident, as soon as you are able, please fill out the Near-Miss and Incident Reporting Form!



# What will you do?

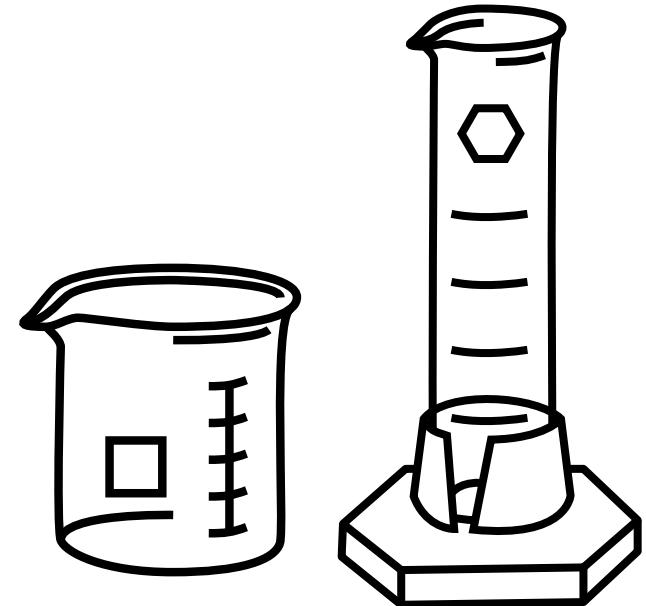
Are you physically affected by the incident?

Always weigh the safety of yourself and others.

Do not rush into a potentially dangerous situation without proper training or protective equipment.

No one expects you to be a first responder and you would need more extensive training to be one.

There are professionals to help!



# **Hazard Communication**

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Globally Harmonized System

Hazard Classes

Scenarios



# **Globally Harmonized System**

---

GHS

It's mission is: *The Right to Understand*

Health, Physical, and Environmental Hazards

Signal Words + Hazard Statements

Pictograms

Safety Data Sheets



# Globally Harmonized System

---



# Globally Harmonized System

---



Physical



Health



Environmental

# NFPA Diamond

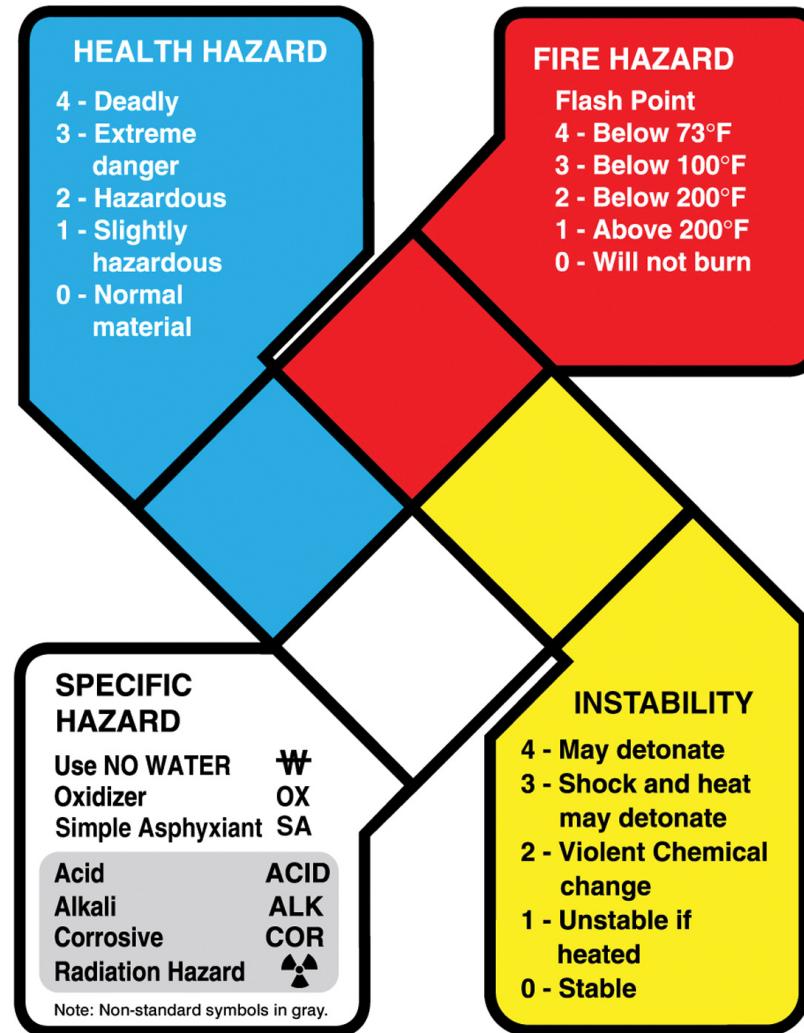
What is the function of this system?

Can you identify each diamond?

How does it compare to GHS?



# NFPA Diamond



# Flame

Flammable Gases

Flammable Aerosols

Flammable Solids and Liquids

Self Reactives

Pyrophoric Liquids and Solids

Self-Heating

Water Reactives

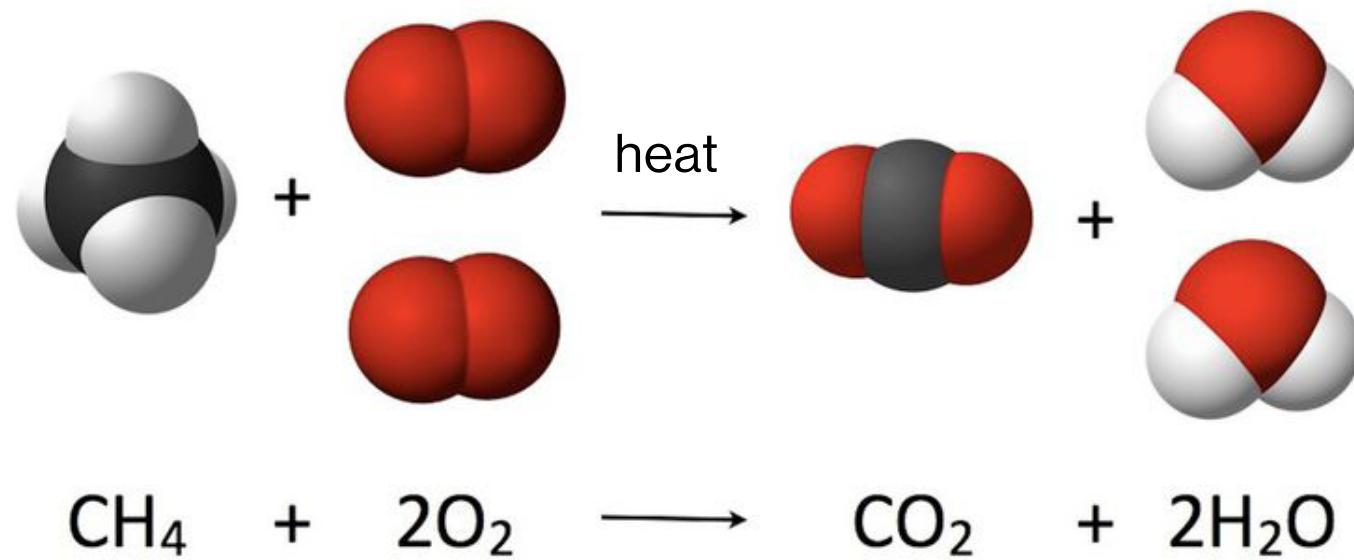
Emits Flammable Gas

Organic Peroxides



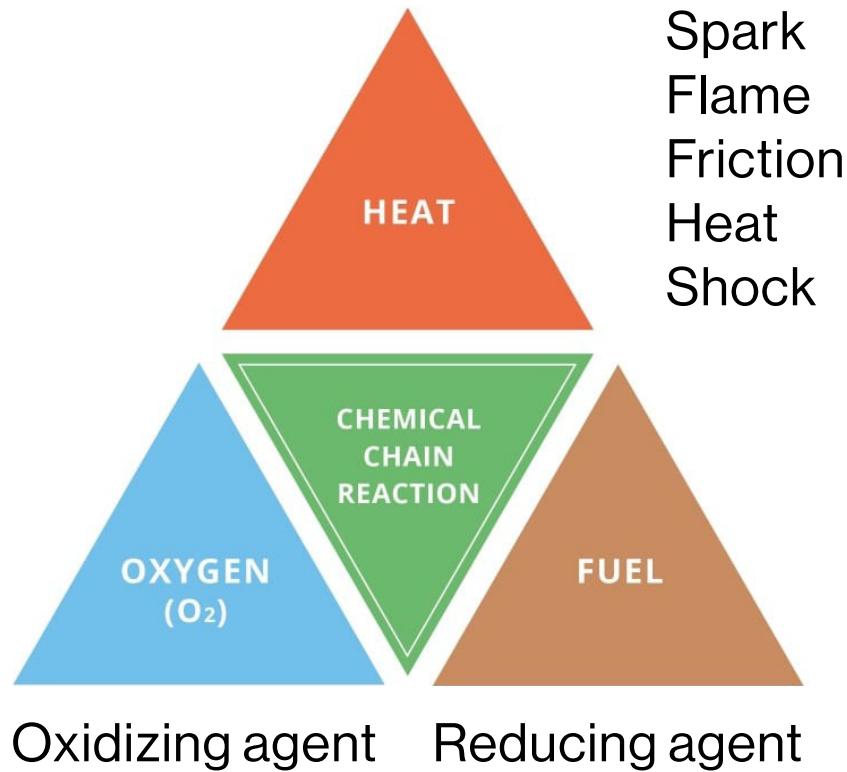
# Flame

Methane Combustion Reaction



# Flame

## Fire Tetrahedron



# Flame

## Flammable Gases

### Class 1:

At 20°C and STP, ignitable in a mixture of 13% or less by volume in air.

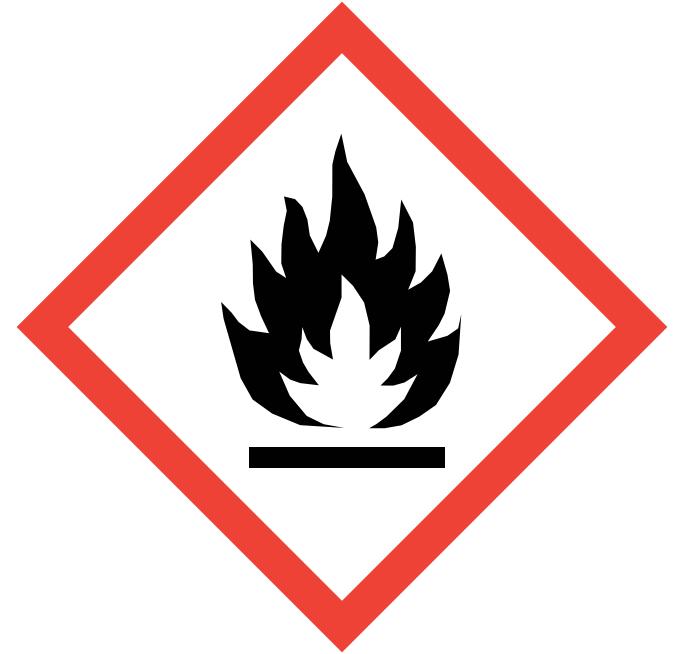
Or have a flammable range of at least 12 percentage points regardless of lower flammable limit.

### Examples:

Hydrogen, Methane, Acetylene

Stored in gas cylinders.

Other risks and hazards involved!



# Flame

## Flammable Liquids

Category 1: Flash point <23°C and initial boiling point ≤35°C

Diethyl Ether

Category 2: Flash point <23°C and initial boiling point >35°C

Acetone, Benzene, Toluene

Category 3: Flash point ≥23°C and initial boiling point ≤60°C

Category 4: Flash point >60°C and initial boiling point ≤93°C

23°C = 74°F     35°C = 95°F     60°C = 140°F     93°C = 200°F

Also consistent with NFPA ratings, but ratings reverse in number!



# Diethyl Ether Safety Data Sheet

b)	Odour	sweet, ether-like
c)	Odour Threshold	No data available
d)	pH	No data available
e)	Melting point/freezing point	Melting point/range: -116 °C (-177 °F)
f)	Initial boiling point and boiling range	34.6 °C (94.3 °F) at 1,013 hPa (760 mmHg)
g)	Flash point	-40 °C (-40 °F) - closed cup - DIN 51755 Part 1
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 48 % (V) Lower explosion limit: 1.8 % (V)
k)	Vapour pressure	189 hPa (142 mmHg) at 0 °C (32 °F) 389 hPa (292 mmHg) at 10 °C (50 °F) 563 hPa (422 mmHg) at 20 °C (68 °F) 863 hPa (647 mmHg) at 30 °C (86 °F) 1,228 hPa (921 mmHg) at 40 °C (104 °F) 2,311 hPa (1,733 mmHg) at 60 °C (140 °F)
l)	Vapour density	2.56 - (Air = 1.0)
m)	Relative density	0.71 g/cm³ at 20 °C (68 °F)
n)	Water solubility	65 g/l at 20 °C (68 °F)
o)	Partition coefficient: n-octanol/water	log Pow: 1.1
p)	Auto-ignition temperature	170 °C (338 °F)
q)	Decomposition temperature	No data available



# Flame

Pyrophoric Liquids and Solids

Ignites within 5 minutes (when added to an inert carrier and exposed to air).

Often water-reactive, too.

Examples:

Alkali Metals—Li, Na, K, Rb, Cs

Metal Hydrides—NaH, LiAlH<sub>4</sub>

Fine Metals—Fe, Al, Mg, Ca

tert-Butyllithium

and many more



# Explosives

Explosive Substances

Self Reactives

Organic Peroxides

“produc(es) gas at such a temperature and pressure and at such a speed as to cause damage to surroundings.”

Acetone peroxide (aka *Mother of Satan*)

Ammonium nitrate

Picric acid

Nitroglycerin

Diacetyl peroxide

Primarily classified as Oxidizers or Flammables. (check SDS)



# Explosives

Rapid Expansion

Evolution of Heat

Rapidity of Reaction

Initiation of Reaction  
(shock, heat, catalyst)

Detonation Velocity  
Acetone peroxide:  
5300m/s or 17384ft/s

Picric acid:  
7350m/s or 24115ft/s



# Explosives

Self Reactives

Reactive substance or mixture that reacts with air and heats up.

Requires quantity and time.



# Explosives

Organic Peroxides (Solid or Liquid)

Derivatives of Hydrogen Peroxide

Exothermic Self-Accelerating  
Decomposition

Explosive decomposition

Burn rapidly

Sensitive to impact or friction

React Dangerously with others



# Explosives

Peroxide Formers:

*Class A—Severe*

Potassium Metal, Sodium Metal,  
Isopropyl Ether, Sodium Amide

*Class B—Concentration Hazard*

Diethyl Ether, 2-Butanol, Dioxanes,  
THF, Cyclohexene

**These are the most common for labs**

*Class C— Auto-polymerizes*

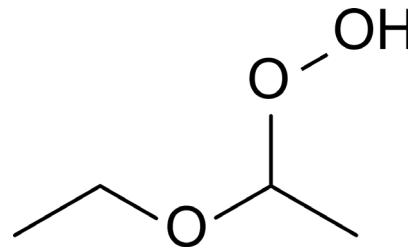
Shock and heat-sensitive  
Acrylic Acid, Acrylonitrile, Styrene,  
Chloroprene



# Explosives

Peroxides and Peroxide Formers

Diethyl Ether Peroxide



Contributing factors to formation:

- Air exposure
- Light exposure
- Time

As a container gets emptied,  
the more contact with air it gets!



# Explosives

Organic Peroxide Safety

Purchase wisely and in small amounts.

Record received-on, opened-on dates.

“Flag” in inventory!

Purchase with an inhibitor

Butylated hydroxytoluene (BHT)—  
not a guarantee!

Purge with nitrogen or argon after use.

Test every 3-6 months

Test strips available from EHS or the  
Chemistry Stockroom.



# Explosives

## Organic Peroxide Test Labels

<p><b>Warning: May Form Explosive Peroxides</b></p> <p>Store in tightly closed original container. Avoid exposure to light, air and heat.</p> <p>If crystals, discoloration or layering is visible, do not move or open; contact EHS immediately.</p> <p>Check for peroxides each time before distilling or concentrating.</p>			
Name of Chemical:			
Date Received:			Date Opened:
<b>Test or Dispose _____ months after receipt, or _____ months after opening</b>			
Test Date:		Peroxides Y N	ppm
Test Date:		Peroxides Y N	ppm
Test Date:		Peroxides Y N	ppm
Test Date:		Peroxides Y N	ppm
<b>Do not use chemical if &gt;100PPM peroxides are detected.</b>			

Date Received:	
Date Opened:	
Test Date:	ppm



# Explosives

Peroxides and Peroxide Formers

Visual Cues:

Solids or crystals in the liquid  
or on the cap—very dangerous if  
exposed to air!

Discoloration of liquid

Liquid stratification

**DO NOT OPEN!**  
**Notify EHS immediately!**



# Explosives

University of Minnesota Incident—  
Aug 2019

Technician “bulking” organic waste.

Empty glass bottle placed into recycling.

Detonation!

“...shockwave large enough to rip the (recycling) cart in half, blew open the doors in the room, ...damage adjacent rooms, shake the windows in the facility. The technician survived without major injuries.”

Cause: “shock sensitive residue from a peroxide-forming chemical”



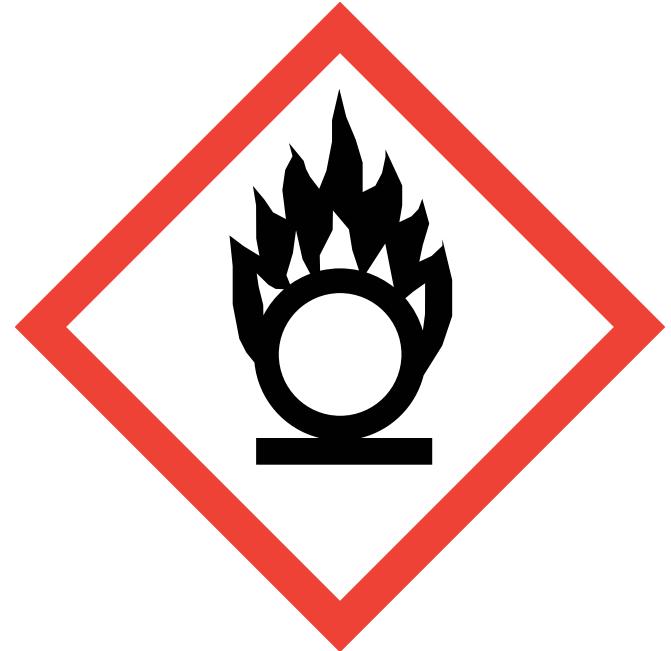
# Flame Over Circle

Oxidizing Gases

Oxidizing Liquids

Oxidizing Solids

Provides Oxygen (which loves electrons), which may cause or contribute to combustion (more than air normally does).



# Flame Over Circle

“What’s in a name?”

Oxidizers can often be discerned by their name or chemical formula.

May contain halogens, nitrogen, and *a lot* of oxygen.

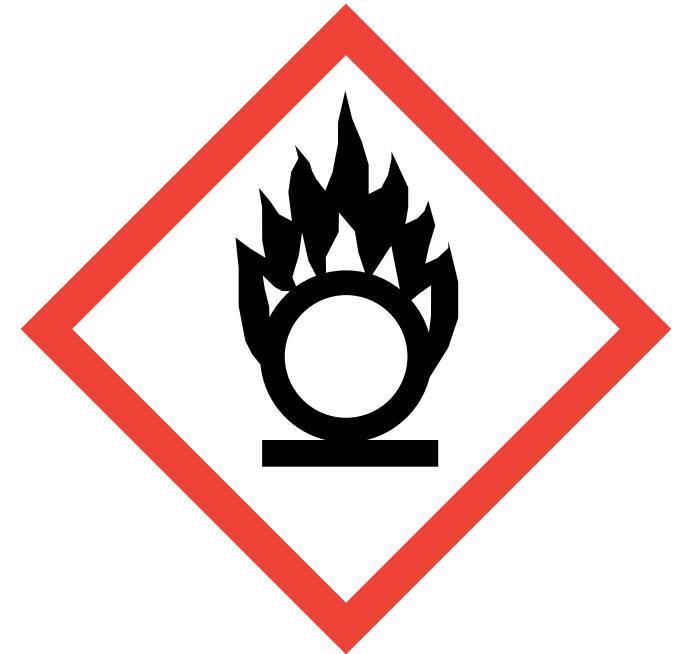
Sometimes contains transition metals.

nitrates, nitrites, nitric, perchlorates, perchlorics, permanganates, peroxides, chromates, bromates,

Perchlorate:  $\text{ClO}_4^-$

Nitric Acid:  $\text{HNO}_3$

Fluorine:  $\text{F}_2$



# Flame Over Circle

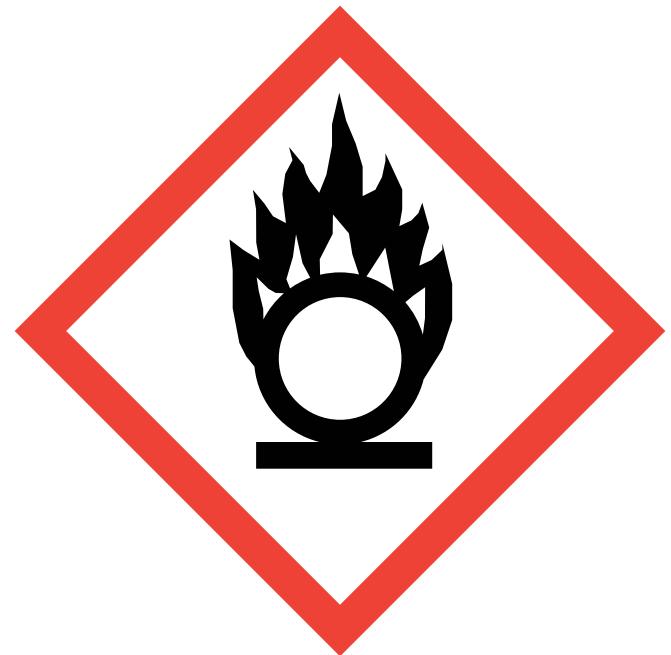
Class 1 Oxidizers:

Can explode when in contact with certain contaminants.

Can explode if exposed to slight heat, shock, or friction.

Will increase the burning rate of combustibles.

Can cause combustibles to ignite spontaneously.



# Flame Over Circle

Class 1 Oxidizer Examples:

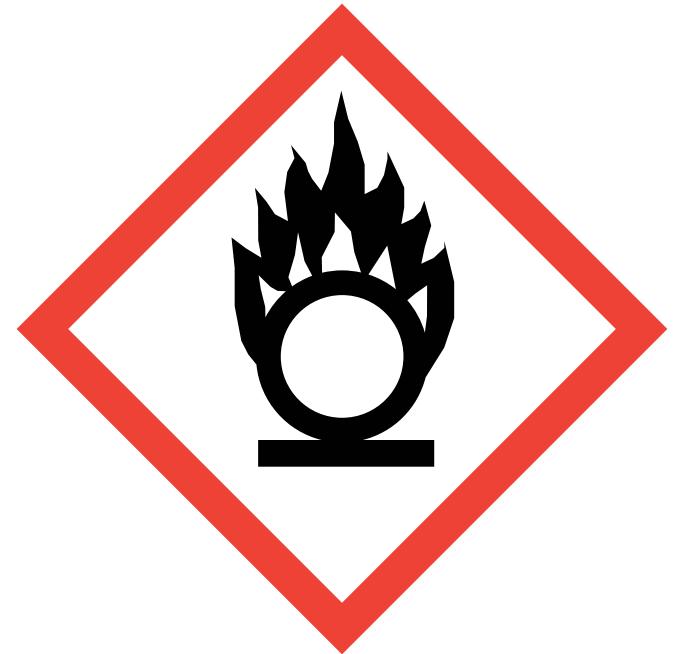
Ammonium perchlorate  
(particle size greater than 15µm)

Ammonium permanganate

Hydrogen peroxide  
(greater than 91% by weight)

Perchloric acid solutions  
(greater than 72.5% by weight)

Tetranitromethane

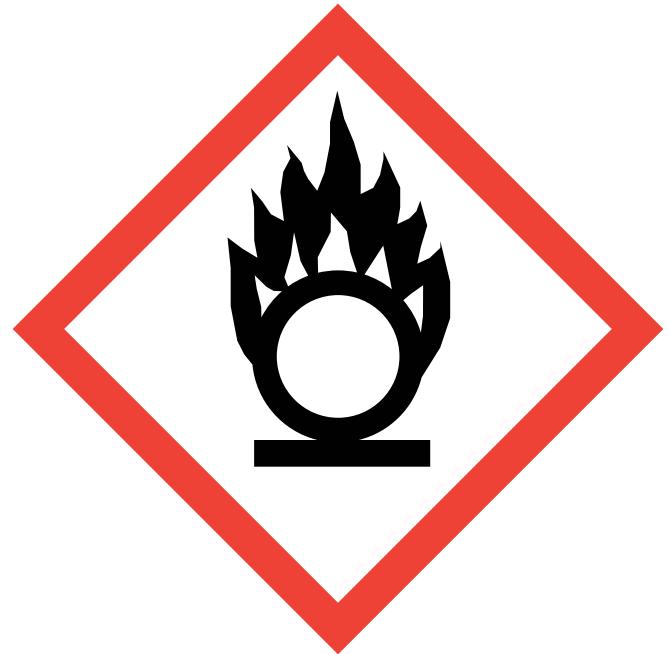


# Flame Over Circle

Class 2 Oxidizers:

Severely increase the burning rate of combustible materials with which they come in contact.

Will cause sustained and vigorous decomposition if contaminated with a combustible material or if exposed to sufficient heat.



# Flame Over Circle

Class 2 Oxidizer Examples:

Ammonium dichromate

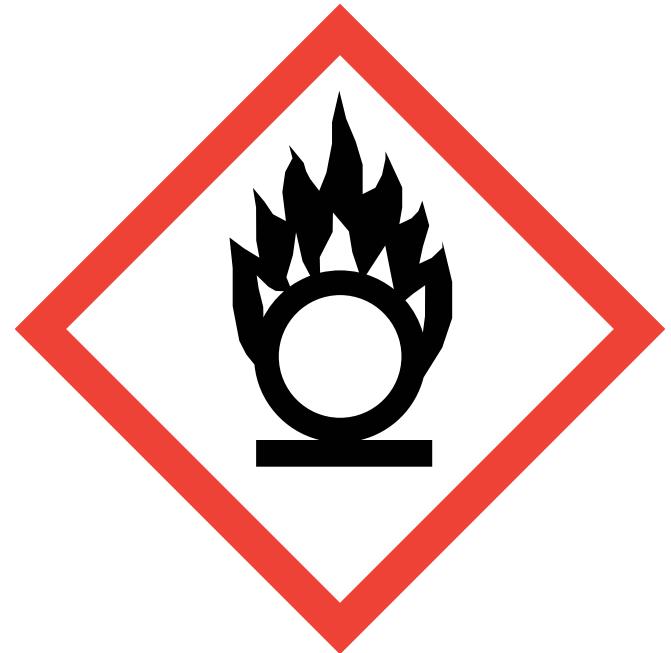
Hydrogen peroxide  
(52 to 91% by weight)

Nitric acid, fuming  
(concentration greater than 86%)

perchloric acid solutions  
(60 to 72% by weight)

potassium bromate

potassium chlorate

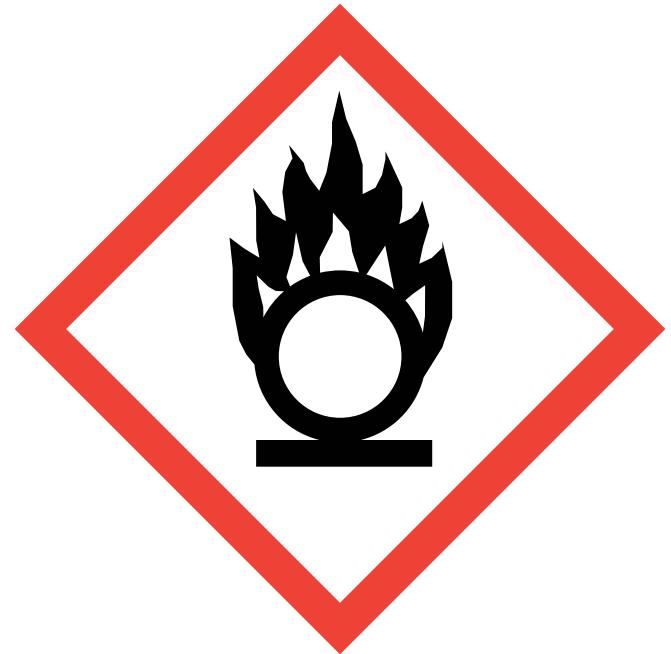


# Flame Over Circle

Class 3 Oxidizers:

Increase the burning rate of combustible materials moderately with which they come in contact.

May cause spontaneous ignition when in contact with a combustible material.



# Flame Over Circle

Class 3 Oxidizer Examples:

Calcium chlorate

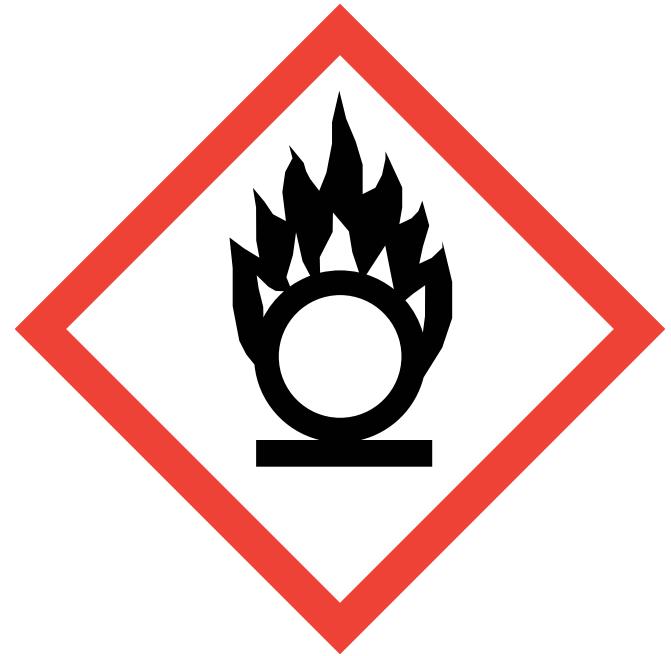
Calcium hypochlorite  
(50% or less by weight)

Chromic acid (chromium trioxide)

Hydrogen peroxide  
(27.5 to 52% by weight)

Magnesium perchlorate

Nitric acid  
(concentration greater than 40%  
but less than 86%)



# Flame Over Circle

Class 3 Oxidizer Examples:

magnesium perchlorate

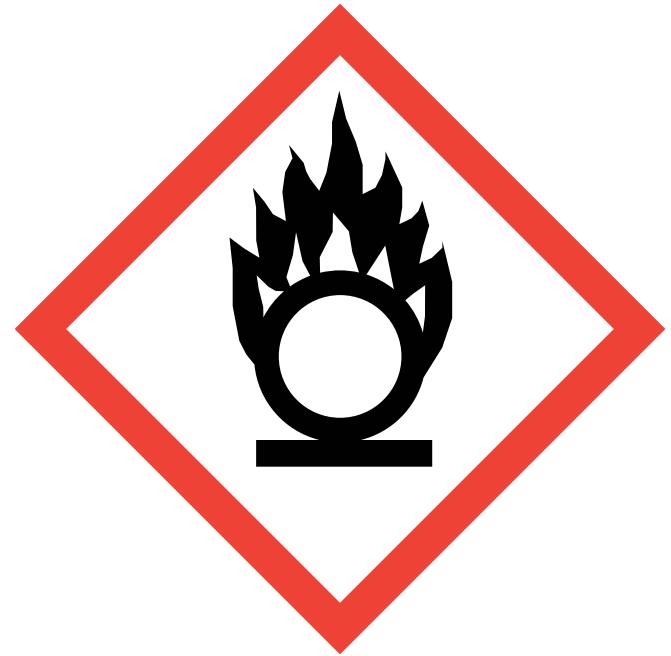
nitric acid (concentration greater than 40%, less than 86%)

potassium permanganate

sodium permanganate

sodium chlorite  
(40% or less by weight)

sodium perchlorate  
(and its monohydrate)

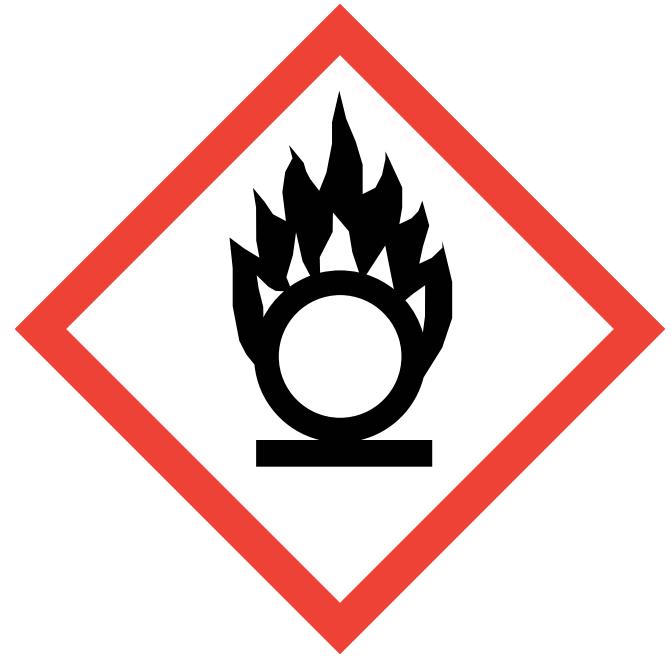


# Flame Over Circle

Class 4 Oxidizers:

Slightly increase the burning rate of combustible materials.

Do not cause spontaneous ignition when they come in contact with them.



# Flame Over Circle

Class 4 Oxidizer Examples:

Aluminum nitrate

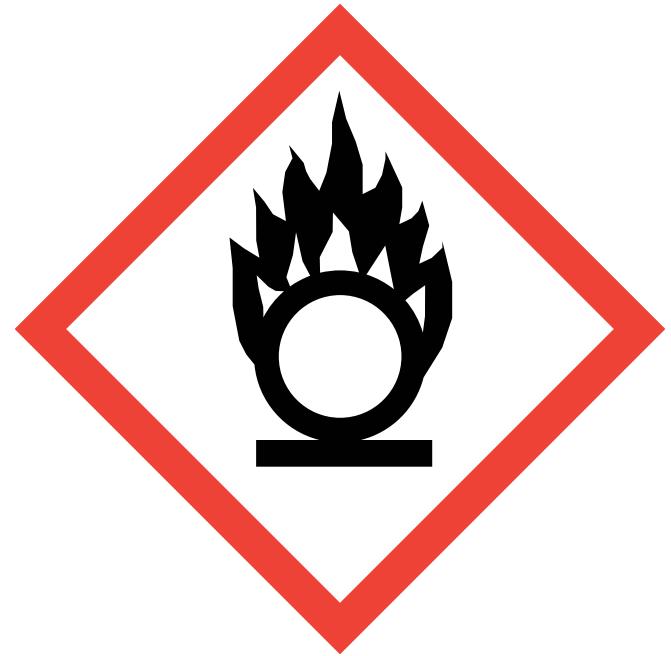
Ammonium persulfate

Barium peroxide

Hydrogen peroxide solutions  
(8% to 27.5% by weight)

Magnesium nitrate

Nitric acid  
(40% concentration or less)



# Flame Over Circle

Class 4 Oxidizer Examples:

Perchloric acid solutions  
(less than 50% by weight)

Potassium dichromate

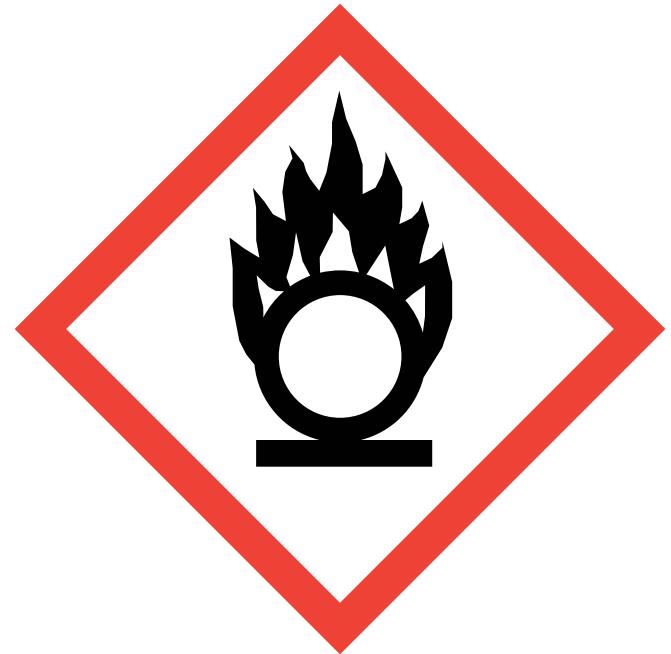
Potassium nitrate

Silver nitrate

Sodium dichromate

Sodium nitrate

Sodium nitrite



# Reducing Agents

## *Electron Donors*

Sodium borohydride

Lithium aluminum hydride

Hydrazine

Iron (II) sulfate

Tin (II) chloride

Hydrogen Peroxide

Carbon Monoxide

Oxalic acid

Formic acid



# Corrosives

Corrosive to Metal

Corrosive to Skin

Corrosive to Eyes

Dual classification as Health Hazards



# Corrosives

Corrosive to Skin

Category 1 (only)

Class 1A: Exposure  $\leq$ 3min

Observation  $\leq$ 1h

Class 1B: Exposure  $>$ 3min  $\leq$ 1h

Observation  $\leq$ 14 days

Class 1C: Exposure  $>$ 1h  $\leq$ 4h



# Corrosives

Acids and Caustics

Corrosives burn skin

Hydrolysis and denaturation

Immediate effect

Vapors—use these chemicals in a hood!

Have spill material ready at all times!



# Corrosives

Use lab coat, nitrile gloves, and goggles and/or face shield.

Work in a hood.

Have spill material nearby.

Sodium sesquicarbonate (acids)

Citric acid (bases)

**NEVER USE SPILL MATERIAL  
FOR CORROSIVE SPLASH CONTACT  
ON SKIN!**

Use water to rinse skin and eyes from contact with corrosives.

Always know where the sink, safety shower, and eyewash are located.



# Corrosives

Store below eye-level and in vented cabinets.

Regularly check the integrity of caps and bottles.

Segregate acids and bases.

Making solutions is exothermic:  
Always Add Acid to Water, slowly.

Water is your heat sink.

Stirring, cooling, time are necessary to manage heat when making solutions.



# Corrosives

Planning Scenario:

Your lab has only 2.5L of concentrated Hydrochloric acid (stored properly in a corrosive cabinet, of course).

What is the spill material used to neutralize an HCl spill?

Does your lab have enough spill material on-hand for a release of this volume?

How much spill material would you need to neutralize this volume?



# Corrosives

The spill neutralizing materials for acids are Sodium bicarbonate or Sodium sesquicarbonate.

For bases, we use Citric acid.

Let's calculate how much Sodium bicarbonate we will need.

What do we need to know to carry out this calculation?



# Corrosives

Molecular Formulas:

HCl and NaHCO<sub>3</sub>

HCl Molecular Weight: 36.46g/mol

NaHCO<sub>3</sub> MW: 84.01g/mol

Concentrated HCl molarity: 12.1M

Reaction Equation:



1:1 mole ratio



# Corrosives



$$2.5\text{L HCl} \times 12.1 \frac{\text{mol HCl}}{\text{L}} = 30.25 \text{ mol HCl}$$

$$30.25 \text{ mol HCl} \times \frac{1 \text{ mol NaHCO}_3}{1 \text{ mol HCl}} = 30.25 \text{ mol NaHCO}_3$$

$$30.25 \text{ mol NaHCO}_3 \times \frac{84.01\text{g NaHCO}_3}{1 \text{ mol NaHCO}_3} = 2541 \text{ g NaHCO}_3$$

Neutralization of 2.5L of HCl will require ~2.5Kg of NaHCO<sub>3</sub>

Is your lab prepared for a spill of this magnitude?



# Gases Under Pressure

Compressed Gas  
entirely gas at -50°C

Liquified Gas  
critical temperature  
-50 to +65°C  
Carbon dioxide

Refrigerated Liquified Gas  
aka Cryogenics

Dissolved Gas  
acetylene (in acetone)



→ Recommended Viewing:  
[MythBusters Air Cylinder Rocket](#)  
...also on next page.





# Gas Cylinder

An important part of most labs

Heavy and Awkward

Pressure and Potential Energy

Many Hazard Classes

Unique Regulators

Require Care When Moving

Require Tools

Must Be Securely Stored

Gas Density



# Gas Cylinder

Secure the tank AT ALL TIMES

Use metal chains or braided straps.

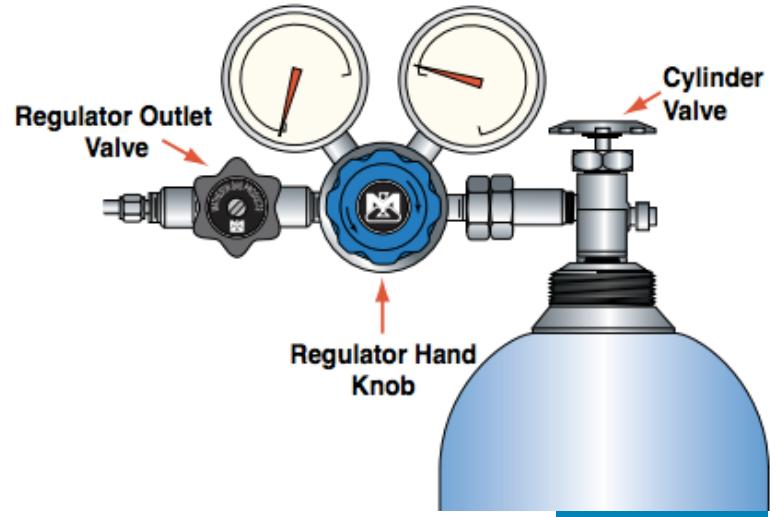
Do NOT move the tank with a regulator attached!

Do NOT move the tank without the cap!

Do NOT roll the tank.

Use a tank cart.

Ask for help.



# Gas Cylinder

## Cryogens

Liquid Nitrogen (b.p. -195.8°C)

Liquid Oxygen (b.p. -183°C)

Liquid Helium (b.p. -270°C)

Dry Ice (s.p. -78.5°C)

Hydrogen (b.p. -252.7°C)

Methane (b.p. -161.4°C)



# Gas Cylinder

Cryogens

Containers are Heavy

Expansion and potential energy

Asphyxiation and toxic hazards

Extreme Cold—causes frost-bite to skin  
and permanent eye damage.

Weakens steel, rubber and plastic.

Mandatory PPE:  
cold gloves, face shield, lab coat.



Recommended Viewing:

→ [Being Safe With Liquid Nitrogen](#)

# Exclamation

Also known as Irritants!

Skin Irritation

Dermal (Skin) Sensitizer

Acute Toxicity (harmful)

Narcotic Effects

Respiratory Tract Irritation



# Health Hazard

Carcinogen

Respiratory Sensitizer

Reproductive Toxicity

Mutagenicity (Germ Cell)

Target Organ Toxicity

Aspiration Toxicity (Oral or Nasal)



# **Skull and Bones**

Acute Toxicity (severe)

Oral, Dermal, Inhalation



# Skull and Bones

Exposure route	Category 1	Category 2	Category 3	Category 4	Category 5
<b>Oral</b> (mg/kg bodyweight) <i>see:</i> Note (a)	5	50	300	2000	5000
<b>Dermal</b> (mg/kg bodyweight) <i>see:</i> Note (a)	50	200	1000	2000	
<b>Gases</b> (ppmV) <i>see:</i> Note (a) Note (b)	100	500	2500	20000	
<b>Vapours</b> (mg/l) <i>see:</i> Note (a) Note (b) Note (c) Note (d)	0.5	2.0	10	20	<i>See detailed criteria in Note (f)</i>
<b>Dusts and Mists</b> (mg/l) <i>see:</i> Note (a) Note (b) Note (e)	0.05	0.5	1.0	5	



# Skull and Bones

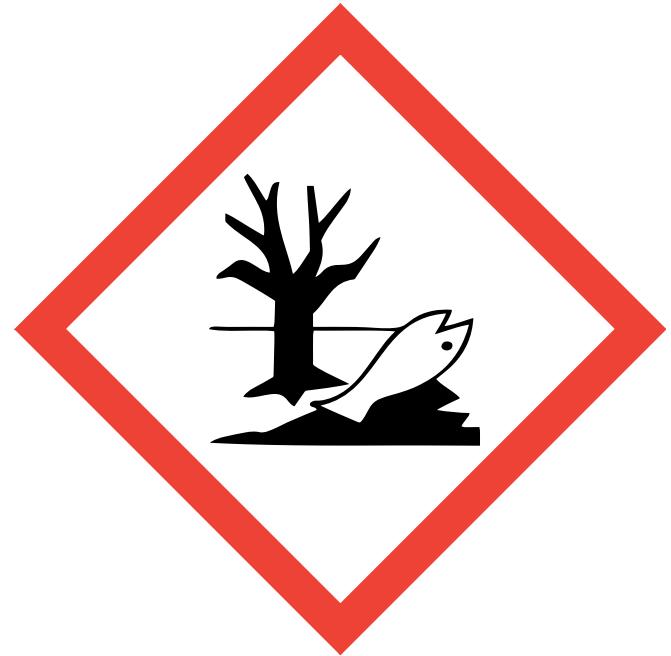
ACUTE ORAL TOXICITY – Annex 1					
	Category 1	Category 2	Category 3	Category 4	Category 5
LD <sub>50</sub>	≤ 5 mg/kg	> 5 < 50 mg/kg	≥ 50 < 300 mg/kg	≥ 300 < 2000 mg/kg	≥ 2000 < 5000 mg/kg
Pictogram					No symbol
Signal word	Danger	Danger	Danger	Warning	Warning
Hazard statement	Fatal if swallowed	Fatal if swallowed	Toxic if swallowed	Harmful if swallowed	May be harmful if swallowed



# **Environment**

Environmental Toxicity

Aquatic Environments



# Scenarios

How can we begin to think about and plan for Hazards in the laboratory?

What are the factors in any given scenario, process, experiment, and situation, etc?

We can use previous incidents and what we've learned in our training to guide our thinking.



# Scenarios

Incidents in the laboratories affect people, places, and things at various scales.

How many people?—0, 1, 2, 3...

What kind of space/place?—is it a Lab, Hood, Bench Top, Lab Classroom, Glass Lab, Field Work, HF room, the Third Floor of SRTC?

What things are involved?—Chemicals, Electricity, Equipment, Pressurized Gases, Heat, Cold, Vacuum Pumps, Stir Plates, syringes, sharps, etc.



# Scenarios

What kinds of preparations for the Hazard have been made?

What PPE and supplemental PPE are used, Spill Material, First Aid, additional observers, notify EHS, Safety Shower, Eyewash located?

What kind of response should you prepare to make?—manage yourself, call Stockroom, call EHS, call 911, Pull Fire Alarm?



# Thank you!

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