How can I use Safety Data Sheets to protect my employees?

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CENTRAL MICHIGAN UNIVERSITY

Michigan Safety Conference

“Basic” – Target those with less than 3 years experience.

The early years…

Dow Chemical – R & D, Antimicrobial group

Upjohn Pharmaceutical – Biotechnology Department

Environmental Service Laboratories – Field technician group

Argonne National Lab – Environmental Research Division, Bioremediation Group

Superfund National Priorities List

Your career path may morph over time in many exciting and unexpected ways.

425 Registered Lab/Shop/Studio Spaces

Types of Hazards

Chemical

Biological

- *Animals and associated allergens*
- *Pathogens*

Physical

- *Radiation*
- *Laser*
- *Electrical*
- *Maneuvering, Ergonomics (working at heights, slip and falls, etc.)*
- *Industrial (saws, lathes, foundry, kilns, etc.)*

Field work

My team has 4 primary goals each year

1. Prepare/educate students to be safe, responsible, marketable researchers, educators, workers (employed with sharp safety skills)
2. Anticipate, recognize, evaluate, and control hazards to support safe, healthy activities and environments
3. Ensure compliance with regulations and best practices (stay current and relevant)
4. Create processes to make it easy for workers to work safely

What is really important to the workers?

OSHA required training is in place but . . .

- What specifically should they do in an emergency involving chemicals and what is a chemical emergency . . .
- What protection is in place for standard, non-emergency use of chemicals and the WHY behind each control . . .

Sometimes we don’t care until we *have to* care.

Methylene Chloride

Amazing solvent for chemical analytical work

Has some hazardous properties, but flammability isn't one of them

What I Can Offer

Personal rookie experience

34 years witnessing rookie experience

34 years witnessing human nature

Outline

Industrial Hygiene principles

OSHA Hazard Communication

Safety Data Sheets

Supplemental resources

Scenarios

Industrial Hygiene

Anticipate

Recognize

Evaluate

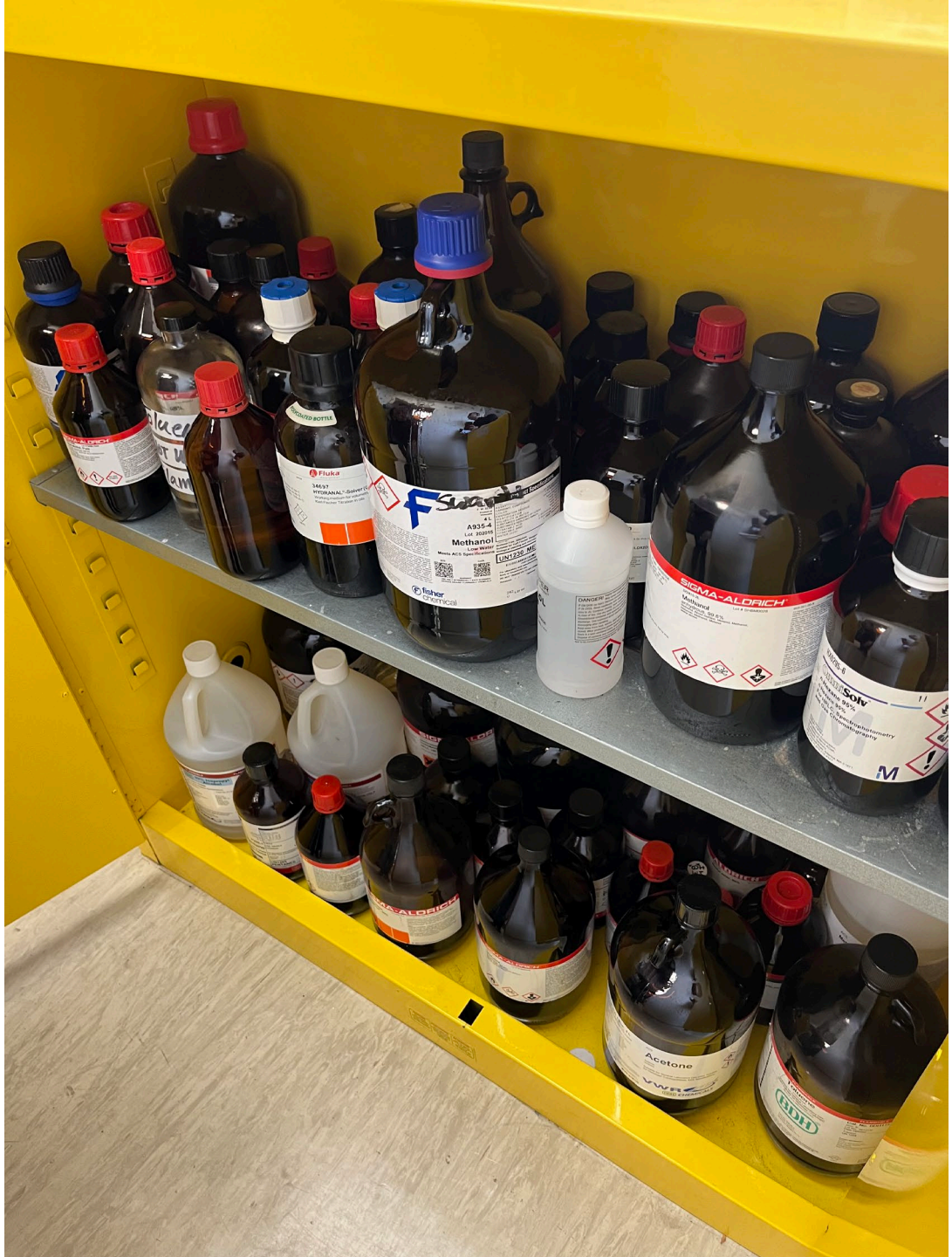
Control

…chemical hazards

The SDS is a starting point to achieving this goal.

Industrial Hygiene Approach

1. Generate a complete inventory, inclusive of raw materials, intermediates, byproducts, waste products.
2. Compile SDS for every chemical.
3. Determine the toxicities and hazards.


Fluka
346/97
HYDRANAL-Solvent
A935-4
Methanol
Low Water
UN1230 ME
fisher chemical
SIGMA-ALDRICH
Methanol
Solv
Acetone
VWR
BDH

Toxicity vs. Hazard vs. Risk

Toxicity is the ability of the chemical to cause damage to living tissue.

Hazard is the source of potential damage or harm to an individual's health or life under certain conditions.

Risk is the chance or probability of a person being harmed or experiencing an adverse health effect if exposed to a hazard. **Risk** = likelihood x severity

Risk Assessment

Risk = Likelihood x Severity

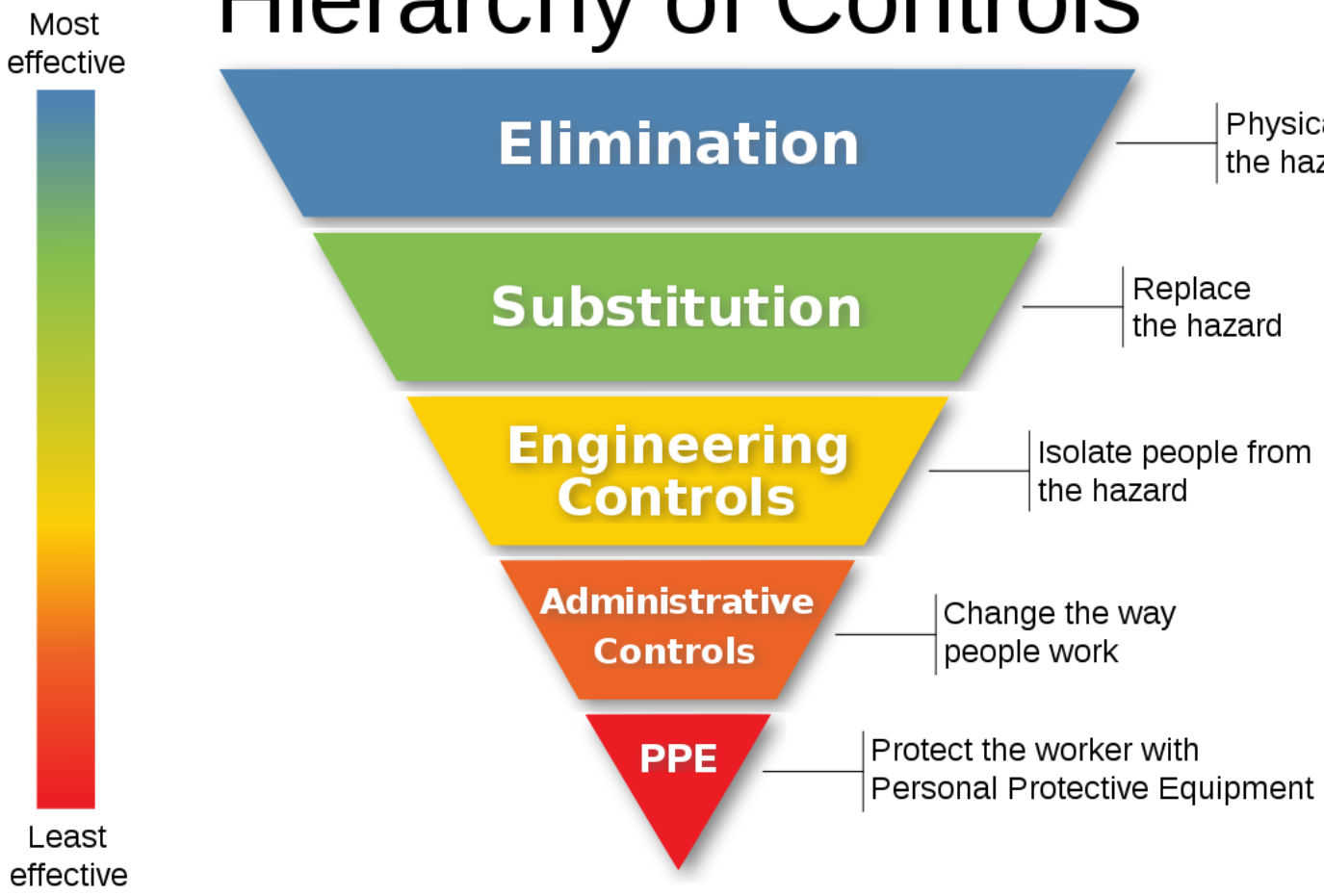
Severity

Likelihood of exposure

RISK MATRIX	Negligible (1)	Minor (2)	Moderate (3)	Major (4)	Extreme (5)
Almost Certain (5)	5	10	15	20	25
Likely (4)	4	8	12	16	20
Possible (3)	3	6	9	12	15
Unlikely (2)	2	4	6	8	10
Rare/Remote (1)	1	2	3	4	5

Conducting a risk assessment involves estimating the risk and then identifying steps to minimize risk using the hierarchy of controls.

Hierarchy of Controls



National Institute of Occupational Safety and Health (NIOSH)
Occupational Safety and Health Administration (OSHA)

Key elements to consider when evaluating a chemical hazard

What is the route of entry of the chemical into the body?

How much of the material must be in contact with a body cell and for how long to produce injury?

What is the probability that the material will be absorbed or come in contact with body cells?

What is the rate of generation of airborne contaminants?

How is the chemical going to be used? What control measures are in place?

Environment (temperature, exposed chemical surface, ventilation, potential chemical concentration)?

Some things about SDS…

OSHA requirement to have them

Employers must ensure that the SDS are readily accessible to employees for all hazardous chemicals in their workplace.

Many stop here…forget to have workers review the SDS and become well-versed on the chemical's properties.

OSHA updated 29 CFR 1910.1200 – Hazard Communication in 2024

Updated to primarily align with Revision 7 of the United Nations' Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

- Hazard classification
  - Health hazards
  - Physical hazards
- Labels
- Safety Data Sheets

Per OSHA 1910.1200, MIOSHA Part 92/430 - Hazard Communication

Chemical is hazardous if it is a health hazard

Health hazard means a chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in Appendix A to § 1910.1200—Health Hazard Criteria.

Per OSHA 1910.1200, MIOSHA Part 92/430 - Hazard Communication

Chemical is hazardous if it is a physical hazard

Physical hazard means a chemical that is classified as posing one of the following hazardous effects: explosive; flammable (gases, liquids, or solids); aerosols; oxidizer (gases, liquids, or solids); self-reactive; pyrophoric (liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or desensitized explosive. The criteria for determining whether a chemical is classified as a physical hazard are detailed in appendix B to this section.

Safety Data Sheet (SDS) Sections

1. Identification
2. **Hazard identification**
3. **Composition/information on ingredients**
4. First aid measures
5. Fire-fighting measures
6. Accidental release measures
7. **Handling and storage**
8. **Exposure controls/personal protection**
9. **Physical and chemical properties**
10. **Stability and reactivity**
11. Toxicological information
12. *Ecological information*
13. *Disposal considerations*
14. *Transport information*
15. *Regulatory information*
16. Other information

SDS Section 2 – Hazard(s) Identification

Classification

Hazardous per OSHA Hazard Communication Standard 29 CFR 1910.1200

OR

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Label elements (signal word, hazard statements, pictograms, precautionary statements)

Hazards not otherwise classified (HNOC)

Note: Must identify the percentage of ingredient(s) of unknown acute toxicity when it is present in a concentration of ≥ 1% (and the classification is not based on testing the mixture as a whole).

SDS Section 2 – Hazard(s) Identification

Signal word – "Danger" or "Warning"

Hazard statements – describe the nature of the hazard(s) of a chemical (200, 300, 400 level H codes)

- H227 – Combustible liquid
- H314 – Causes severe skin burns and eye damage
- H401 – Toxic to aquatic life

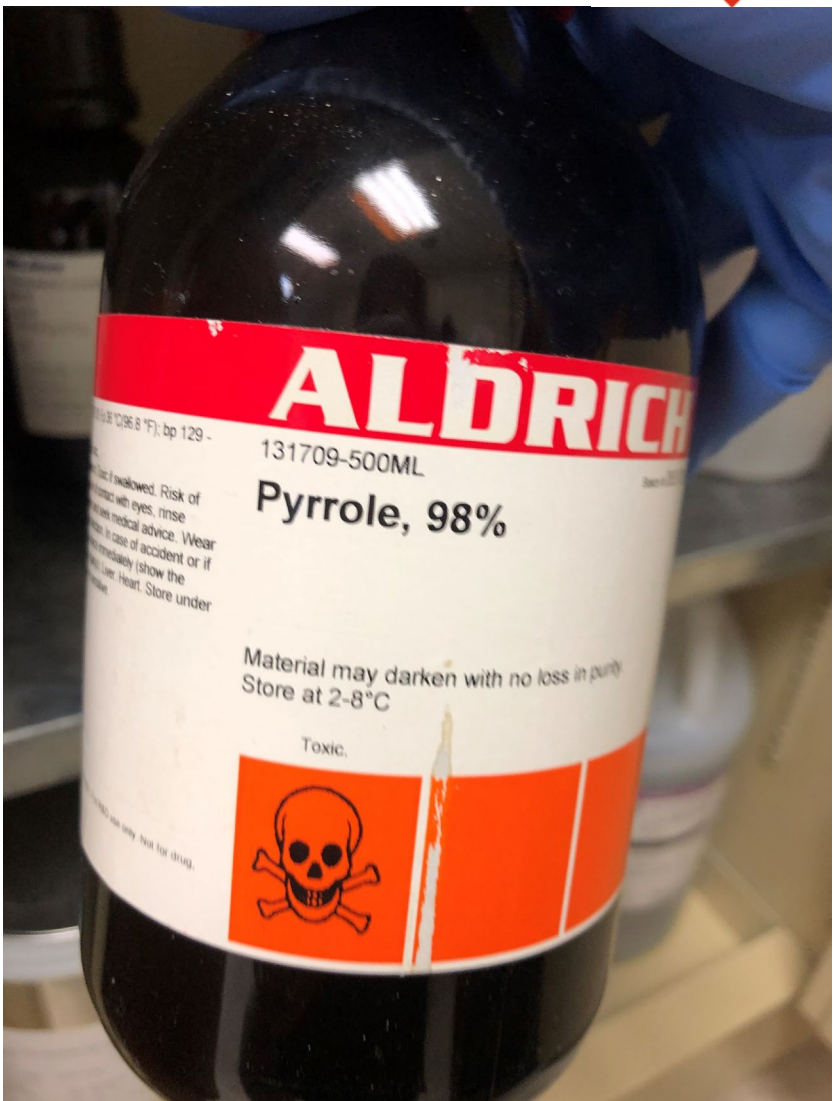
Precautionary statements – describe recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure (prevention, response, storage, disposal)

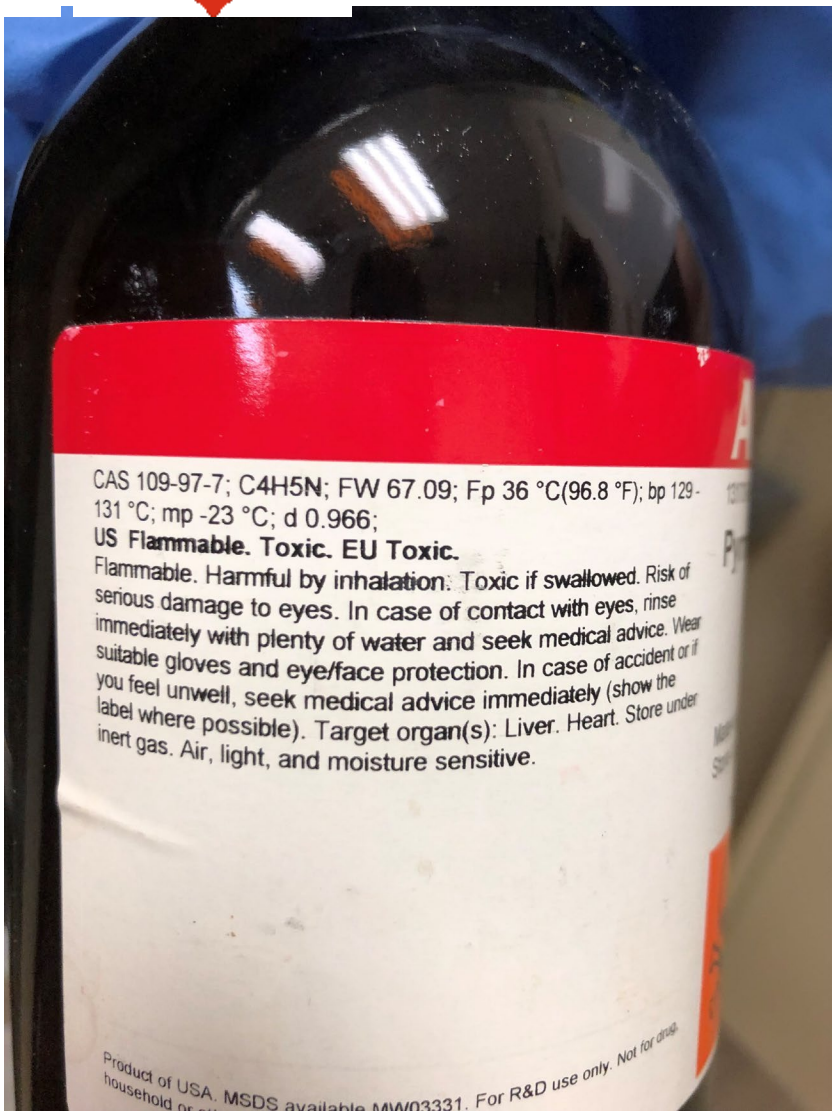
HCS Pictograms and Hazards

Health Hazard  • Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	**Flame**  • Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides • Desensitized Explosives	**Exclamation Mark**  • Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazard Not Otherwise Classified (non-mandatory) • Hazardous to Ozone Layer (non-mandatory)
Gas Cylinder  • Gases Under Pressure • Chemicals Under Pressure	**Corrosion**  • Skin Corrosion/Burns • Eye Damage • Corrosive to Metals	**Exploding Bomb**  • Explosives • Self-Reactives • Organic Peroxides
Flame Over Circle  • Oxidizers	**Environment** (non-mandatory)  • Aquatic Toxicity	**Skull and Crossbones**  • Acute Toxicity (fatal or toxic)

Category 1-4 subranking with 1 being the most severe and 4 being the least severe

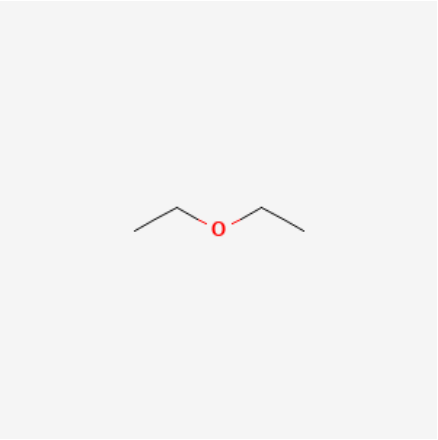
Pyrrole -


ALDRICH
131709-500ML
Pyrrole, 98%
Material may darken with no loss in purity
Store at 2-8°C
Toxic.


CAS 109-97-7; C4H5N; FW 67.09; Fp 36 °C(96.8 °F); bp 129 - 131 °C; mp -23 °C; d 0.966;
US Flammable. Toxic. EU Toxic.
Flammable. Harmful by inhalation. Toxic if swallowed. Risk of serious damage to eyes. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable gloves and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). Target organ(s): Liver. Heart. Store under inert gas. Air, light, and moisture sensitive.
Product of USA. MSDS available MW03331. For R&D use only. Not for drug,

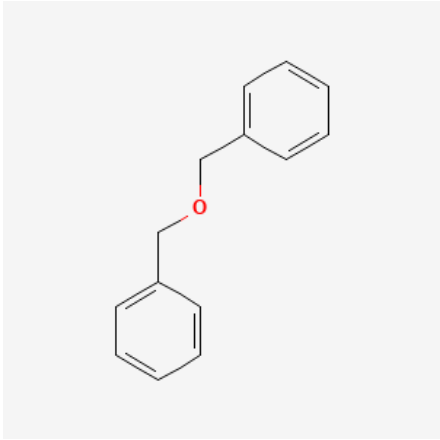
Diethyl Ether vs. Dibenzyl Ether

Molecular Formula – $C_4H_{10}O$



Primarily used as a solvent for liquid-liquid extractions, particularly when extracting organic compounds from aqueous solutions due to its ability to dissolve a wide range of nonpolar substances while being immiscible with water. Also commonly used in reactions involving organometallic reagents because of ability to stabilize the metal center.

Molecular Formula – $C_{14}H_{14}O$



Primarily used as a solvent or reagent in various organic synthesis reactions, particularly when a relatively inert, high boiling point solvent is needed, allowing for reactions to occur at elevated temperatures without significant decomposition of the solvent itself.

Diethyl Ether vs. Dibenzyl Ether

2.1 GHS Classification

Flammable liquids (Category 1), H224

Acute toxicity, oral (Category 4), H302

Specific target organ toxicity – single exposure (Category 3), Central nervous system, H336

2.2 GHS Label Elements

Pictogram

2.1 GHS Classification

Skin sensitization (Sub-category 1B), H317

Short-term (acute) aquatic hazard (category 1), H400

Long-term (chronic) aquatic hazard (category 1), H410

2.2 GHS Label Elements

Pictogram

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Diethyl Ether vs. Dibenzyl Ether

2.2 GHS Label Elements

Signal Word – Danger

Hazard Statements

H224 – Extremely flammable liquid and vapor

H302 – Harmful if swallowed

H336 – May cause drowsiness or dizziness

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

May form explosive peroxides.

Repeated exposure may cause skin dryness or cracking.

2.2 GHS Label Elements

Signal Word – Warning

Hazard Statements

H317 – May cause an allergic skin reaction

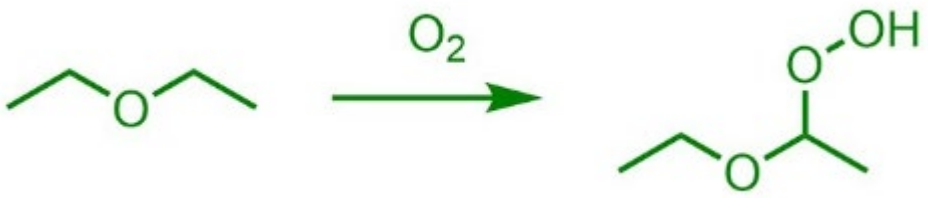
H410 – Very toxic to aquatic life with long lasting effects

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

None

Diethyl ether with peroxides

http://www.ilpi.com/msds/ref/peroxide.html



Diethyl Ether vs. Dibenzyl Ether

3.1 Composition/information on ingredients

Synonyms – Ether, Ethyl ether

CAS-No. – 6029-7

Component and Concentration

Diethyl ether <= 100%

3.1 Composition/information on ingredients

Synonyms – Dibenzyl ether

CAS-No. – 103-50-4

Component and Concentration

Dibenzyl ether <= 100%

Diethyl Ether vs. Dibenzyl Ether

7.0 Handling and Storage

Work under hood. Do not inhale.

Keep away from open flames, hot surfaces and sources of ignition. Take precautionary measures against static discharge.

Test for peroxide formation periodically and before distillation.

7.0 Handling and Storage

References back to 2.2 Precautionary Statements.

Avoid breathing mist or vapors.

Contaminated work clothing must not be allowed out of the workplace.

Wear protective gloves.

If on skin, wash with plenty of soap and water. If skin irritation or rash occurs, get medical attention.

Diethyl Ether vs. Dibenzyl Ether

8.0 Exposure controls/personal protection

Exposure limits – 8-hour TWA 400 ppm (OSHA)

Skin protection

Splash contact – Viton, minimum layer thickness 0.7 mm, break through time 30 min, Material tested: Vitoject (KCL 890/Aldrich Z677698, Size M)

Body protection – Flame retardant antistatic protective clothing.

Respiratory protection – organic vapor cartridge

8.0 Exposure controls/personal protection

Contains no substances with occupational exposure limit values.

Skin protection

Full contact

Material: Butyl-rubber

Minimum layer thickness: 0.7 mm

Break through time: 480 min

Material tested: Butoject (KCL 898)

Splash contact

Material: Nitrile rubber

Minimum layer thickness: 0.4 mm

Break through time: 30 min

Material tested: Camatril (KCL 730/Aldrich Z677442, Size M)

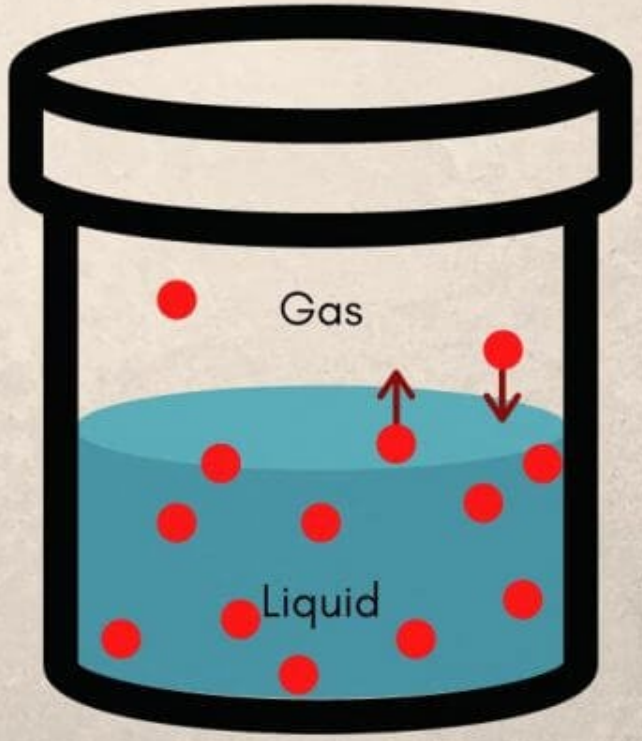
SDS section 9.0 – Physical and Chemical Properties

	Diethyl Ether	Dibenzyl Ether
Appearance	Colorless liquid	Clear, colorless liquid
Odor	Sweet, ether-like	Fruity
Melting/freezing point	-116 ℃ (-177℉)	2.5 ℃ (36 ℉)
Boiling point	34.6 ℃ (94.3 ℉)	298 ℃ (568 ℉)
Flash point	-40 ℃ (-40 ℉)	137 ℃ (279 ℉)
Vapor pressure	422 mmHg @ 68 ℉	No data available

Vapor Pressure

Vapor pressure is the equilibrium pressure of a vapor above its liquid or solid state.

- At equilibrium, the evaporation rate equals the condensation rate.
- Molecules in vapor phase collide with the walls and lid of container, causing pressure.



- Evaporation and condensation occur at the liquid surface.
- Increasing temperature increases the rate of evaporation and increases vapor pressure.

sciencenotes.org

VP of water = 17.54 mm Hg at 68°F
VP of Diethyl ether = 422 mm Hg at 68°F

https://sciencenotes.org/vapor-pressure-definition-and-how-to-calculate-it

SDS section 10.0 – Stability and Reactivity

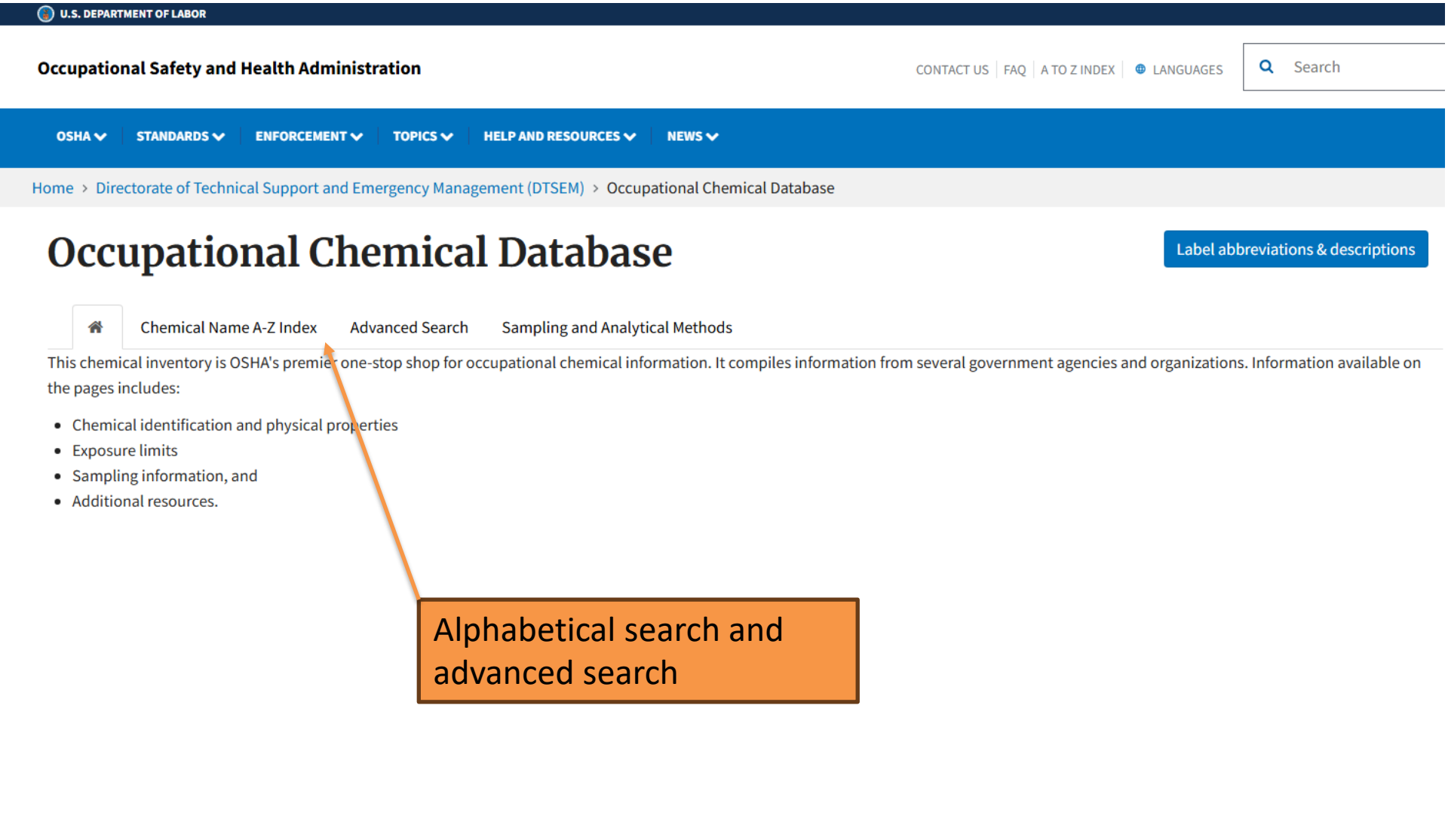
	Diethyl Ether	Dibenzyl Ether
10.1 Reactivity	Formation of peroxides possible.	No data avail.
10.2 Chemical stability	Chemically stable at room temperature. Contains stabilizer – butyl hydroxytoluene (BHT) 1 ppm	No data avail.
10.3 Possibility of hazardous reactions	Risk of ignition or formation of inflammable gases/vapors with: chromyl chloride, peroxides Risk of explosion with: azides, halogens, … Risk of explosion during distillation. Exothermic reaction with: acid halides	Violent reactions possible with strong oxidizing agents
10.4 Conditions to avoid	Light, heat, air, warming, moisture	No data avail.
10.5 Incompatible materials	No data avail.	No data avail.
10.6 Hazardous decomposition products	Peroxides	In the event of fire, see section 5

Spill Scenario

Diethyl Ether vs. Dibenzyl Ether

	Diethyl Ether	Dibenzyl Ether
Appearance	Clear, colorless liquid	Clear, colorless liquid
Flash point	-40 ℃ (-40 ℉)	137 ℃ (279 ℉)
Vapor pressure	422 mmHg @ 68 ℉	No data available
Stability	Stable	Stable
How nasty?		

OSHA.gov/chemicaldata



cdc.gov/niosh/npg

The National Institute for Occupational Safety and Health (NIOSH)

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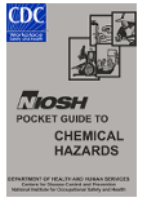
Promoting productive workplaces through safety and health research NIOSH

NIOSH Pocket Guide to Chemical Hazards

Print

Overview



The *NIOSH Pocket Guide to Chemical Hazards* (NPG) informs workers, employers, and occupational health professionals about workplace chemicals and their hazards. The NPG gives general industrial hygiene information for hundreds of chemicals/classes. The NPG clearly presents key data for chemicals or substance groupings (such as cyanides, fluorides, manganese compounds) that are found in workplaces. The guide offers key facts, but does not give all relevant data. The NPG helps users recognize and control workplace chemical hazards.

NIOSH offers four versions of the NPG: print, online, PDF, and mobile web app.

Search the *Online NIOSH Pocket Guide to Chemical Hazards*

Search

Enter search terms separated by spaces.

Cameochemicals.noaa.gov

CAMEO Chemicals

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chemicals: 0
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Predict Reactivity

Mobile Site

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Database of Hazardous Materials

Search

Find response information for thousands of hazardous materials, including fire and explosion hazards, health hazards, firefighting techniques, cleanup procedures, protective clothing, and chemical properties.

MyChemicals

Build a list of chemicals. For example, substances involved in an incident response (such as a train derailment) or chemicals stored in your community.

Reactivity

See what hazards might occur if chemicals in your MyChemicals collection are mixed together.

Get started by finding a substance of interest with a search.

Learn more by checking the help for background information, a glossary of terms, and guidance on using this database.

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Web site owner: Office of Response and Restoration, National Ocean Service, National Oceanic and Atmospheric Administration. USA.gov.

CAMEO Chemicals version 3.1.0 rev 1.

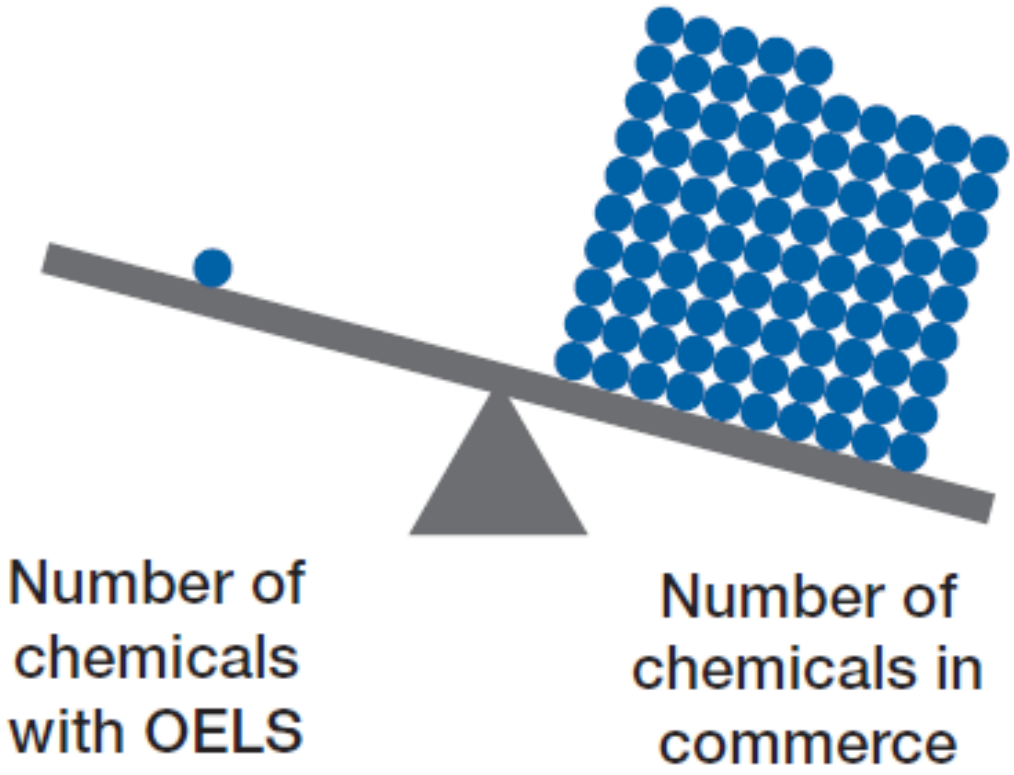
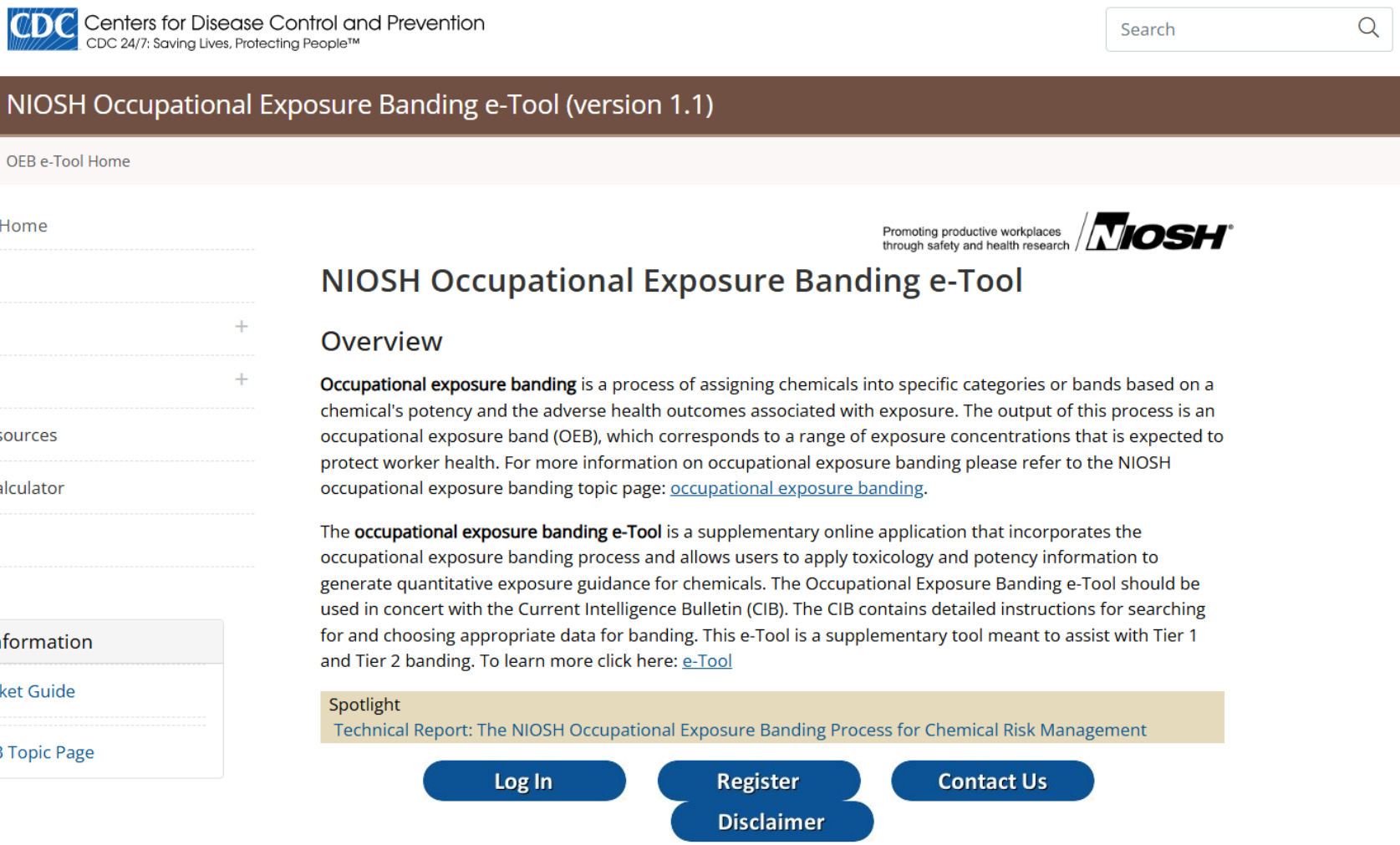


Figure 1-1. Chemical substances in commerce vs. chemical substances with occupational exposure limits.

NIOSH Occupational Exposure Banding Tier 1 tool



Limitations

- ✓ Does not address physical hazards
- ✓ Do not use if an OEL is established
- ✓ Trends conservative

Advantages

- ✓ Risk management guidance for chemical substances without OELs
- ✓ Prioritize your chemical emphasis for large chemical inventories
- ✓ Broad application and utility
  - Criteria apply to 9 potential toxicological or human health outcomes
  - Offer target airborne concentration range by OEB
  - Three-tiered assessment process
    - Tier 1 – Qualitative
    - Tier 2 – Semi-quantitative
    - Tier 3 – Expert judgement

NIOSH Occupational Exposure Banding Tier 1 tool

Promoting productive workplaces through safety and health research

About

The rate at which new chemicals are being introduced into commerce significantly outpaces occupational exposure limit (OEL) development, creating a need for risk guidance on thousands of chemicals that lack evidence-based exposure limits. Occupational exposure banding is a process of assigning chemicals into specific categories or banc based on a chemical's potency and the adverse health outcomes associated with exposure. The output of this process is an occupational exposure band (OEB), which corresponds to a range of exposure concentrations that is expected to protect worker health (Figure 1). Not to be confused with control banding (which gives guidance on control measures), the proposed NIOSH occupational exposure banding process uses available, but often limited, toxicological data to determine a potential range of exposure levels to chemicals to guide risk management decisions. For more information on occupational exposure banding please refer to the NIOSH occupational exposure banding topic page: Occupational Exposure Banding.

Figure 1: Occupational Exposure Bands (OEBs) define the range of exposures expected to be protective of worker health. The bands range from band A to band E. Band E represents the lowest range of exposure concentrations, while band A represents the highest range [McKernan et al. 2016].

NIOSH Occupational Exposure Banding Tier 1
Diethyl ether

Tier One Recommendation

Overall Recommended Band

C

Vapor Range: > 1 and < 10 ppm

Particle Range: > 0.1 and < 1 mg/m³

Chemical Name: Diethyl ether CAS#: 60-29-7				
Endpoint		**Hazard Code**	**Hazard Category**	**Endpoint Band**
Acute Toxicity	Oral	302	4	C
Skin Corrosion/Irritation				
Serious Eye Damage/ Eye Irritation				
Respiratory and Skin Sensitization				
Germ Cell Mutagenicity				
Carcinogenicity				
Reproductive Toxicity				
Specific Target Organ Toxicity				
Overall Recommended Band				**C**

Related Information

NIOSH Pocket Guide

NIOSH OEB Topic Page

Note: OSHA 8-hour TWA – 400 ppm

NIOSH Occupational Exposure Banding Tier 1
Dibenzyl Ether

Promoting productive workplaces through safety and health research NIOSH

Tier One Recommendation

Overall Recommended Band

C

Vapor Range: > 1 and < 10 ppm

Particle Range: > 0.1 and < 1 mg/m³

Chemical Name: Dibenzyl ether
CAS#: 103-50-4

Endpoint		Hazard Code	Hazard Category	Endpoint Band
Acute Toxicity	Dermal			
	Oral			
	Inhalation			
Skin Corrosion/Irritation				
Serious Eye Damage/ Eye Irritation				
Respiratory and Skin Sensitization		317	1b (skin)	C
Germ Cell Mutagenicity				
Carcinogenicity				
Reproductive Toxicity				
Specific Target Organ Toxicity				
Overall Recommended Band				C

Note: No OSHA exposure limit

NIOSH Occupational Exposure Banding Tier 1 Formalin

Tier One Recommendation

Overall Recommended Band

E

Vapor Range: ≤ 0.1 ppm

Particle Range: ≤ 0.01 mg/m³

Chemical Name: Formalin CAS#: 50-00-0				
Endpoint		Hazard Code	Hazard Category	Endpoint Band
Acute Toxicity	Oral	302	4	C
	Inhalation	332	4	C
Skin Corrosion/Irritation				
Serious Eye Damage/ Eye Irritation				
Respiratory and Skin Sensitization		317	1 (skin)	D
Germ Cell Mutagenicity		341	2	D
Carcinogenicity		350	1b	E
Reproductive Toxicity				
Specific Target Organ Toxicity				
Overall Recommended Band				**E**

Note: OSHA 8-hour TWA – 0.75 ppm

NIOSH Occupational Exposure Banding Tier 1
Hydrofluoric Acid, 50%

Tier One Recommendation

Overall Recommended Band

E

Vapor Range: ≤ 0.1 ppm

Particle Range: ≤ 0.01 mg/m³

Chemical Name: Hydrofluoric acid
CAS#:

Endpoint		Hazard Code	Hazard Category	Endpoint Band
Acute Toxicity	Oral	300	2	D
	Dermal	310	1	E
	Inhalation	330	2	D
Skin Corrosion/Irritation		314	1a	E
Serious Eye Damage/ Eye Irritation		318	1	E
Respiratory and Skin Sensitization				
Germ Cell Mutagenicity				
Carcinogenicity				
Reproductive Toxicity				
Specific Target Organ Toxicity				
Overall Recommended Band				**E**

Note: OSHA 8-hour TWA – 3 ppm

Why you don't store liquid chemicals above eye level and over a workstation with no secondary containment

TBE Buffer

Concentrated boric acid

Category 1B reproductive toxin

Leaking shipment of new chemical

Trifluoromethanesulfonic anhydride

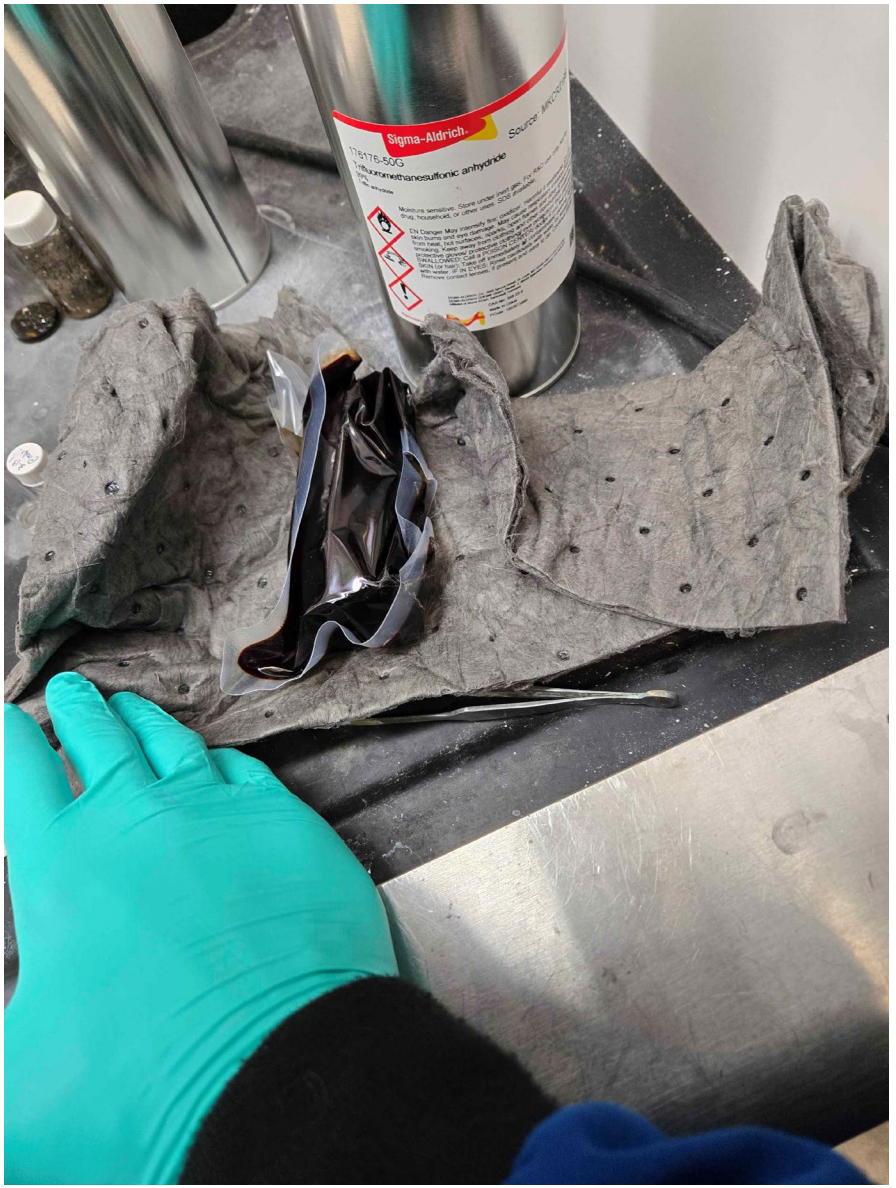
Oxidizer

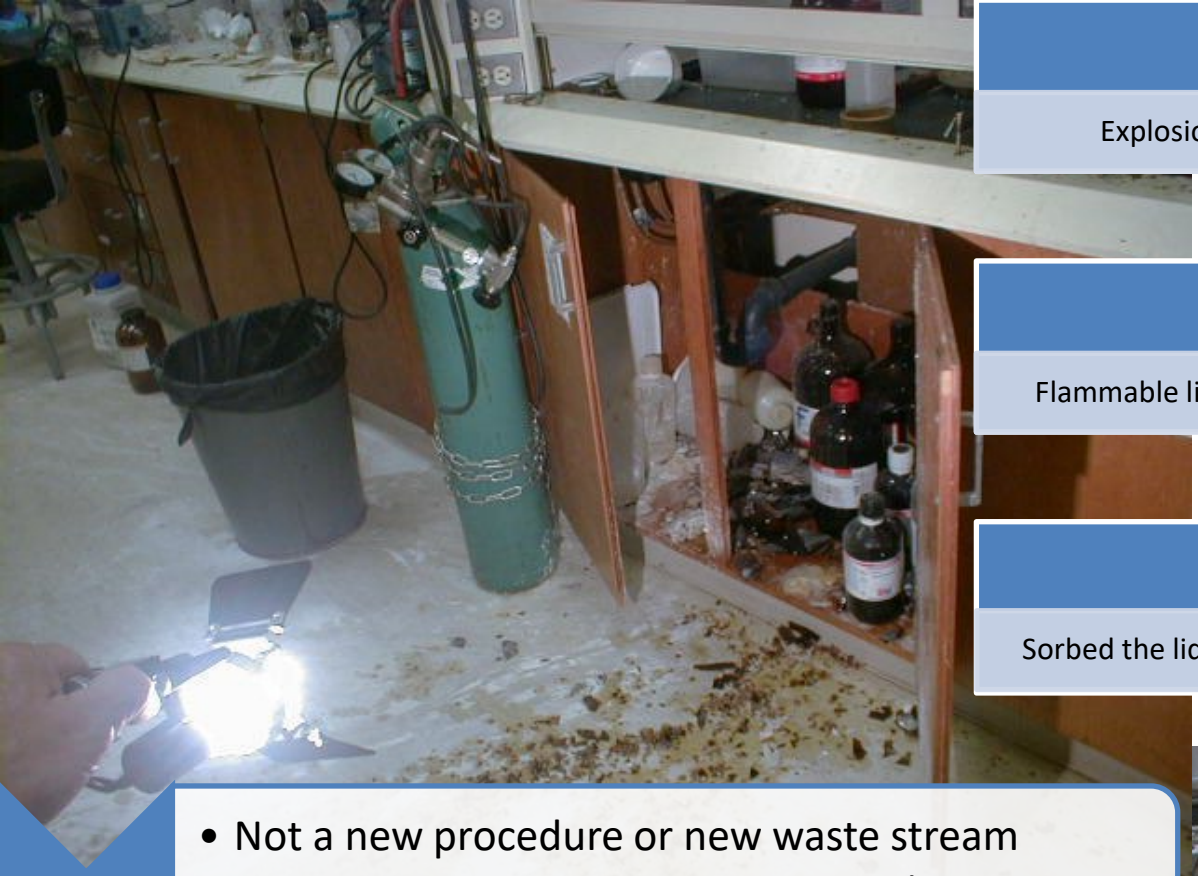
Acute toxicity, oral

Skin corrosion

Serious eye damage

STOT, respiratory, single exposure





Building evacuation

Explosion, smoke	Broken bottle on floor

Hazmat team – 1st entry

Flammable liquid inventory	Floor plan and sketch

Hazmat team – 2nd entry

Sorbed the liquid	Solids stuck to floor	Slippery residue

Procedure

- Not a new procedure or new waste stream
- Waste container over pressurization/explosion

Chemical inventory

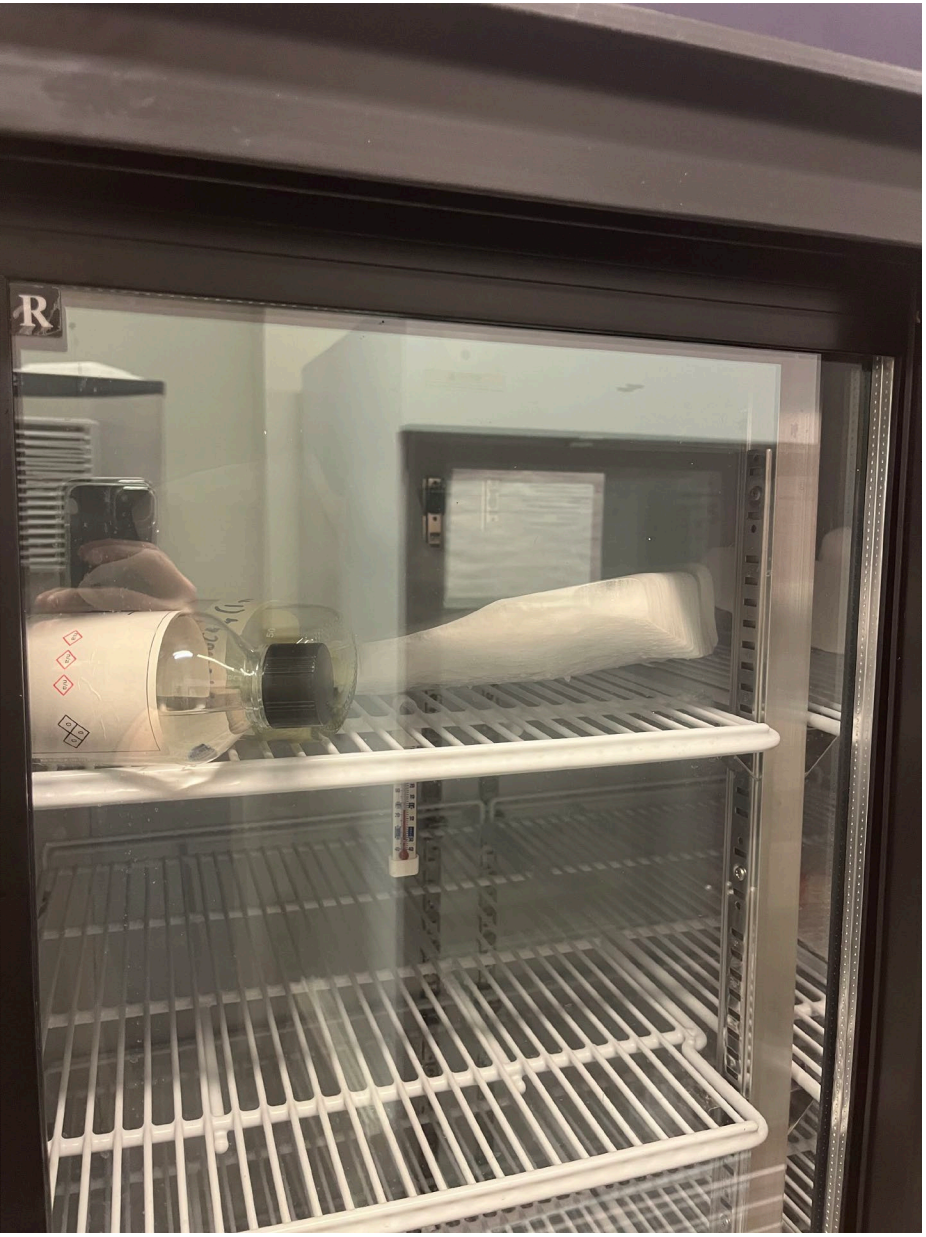
- Acid and base solutions, oxidizers, flammables, waste container, methylene chloride, silicone oil

Gas cylinder

- Anhydrous ammonia

Leaking container with black goo

Fun with refrigeration




CAUTION
SELECT CARCINOGEN
WASTE

Your career path may morph over time in many exciting and unexpected ways.

Before Working with Chemicals Ask Yourself

What are all of the possible hazards, and what are the worst things that could happen?

How can I prepare and minimize risks with standard operating procedures, ventilation, and personal protective equipment?

Do I have an emergency plan and know where the nearest eyewash, emergency shower, spill kits, telephones are located?

American Chemical Society (ACS)

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< The ACS Center for Lab Safety

What Is RAMP?

Education & Training | Safety Basics & RAMP | Hazards | Chemical Enterprise | Get Involved | Incidents & Accidents

In laboratories, experimental hazards can result from a variety of agents, conditions, and/or activities. The fact that a chemical may have an inherent hazard does not mean that it cannot be used in the laboratory as long as the hazard is recognized!

Laboratory hazards and risks can be managed using **RAMP:**

- **R**ecognize hazards,
- **A**ssess risks,
- **M**inimize risks, and
- **P**repare for emergencies

Resources

osha.gov/chemicaldata- OSHA occupational chemical database

osha.gov/hazcom/ghd053107 - OSHA guidance for hazard determination

osha.gov/hazcom/faq- OSHA hazcom FAQ

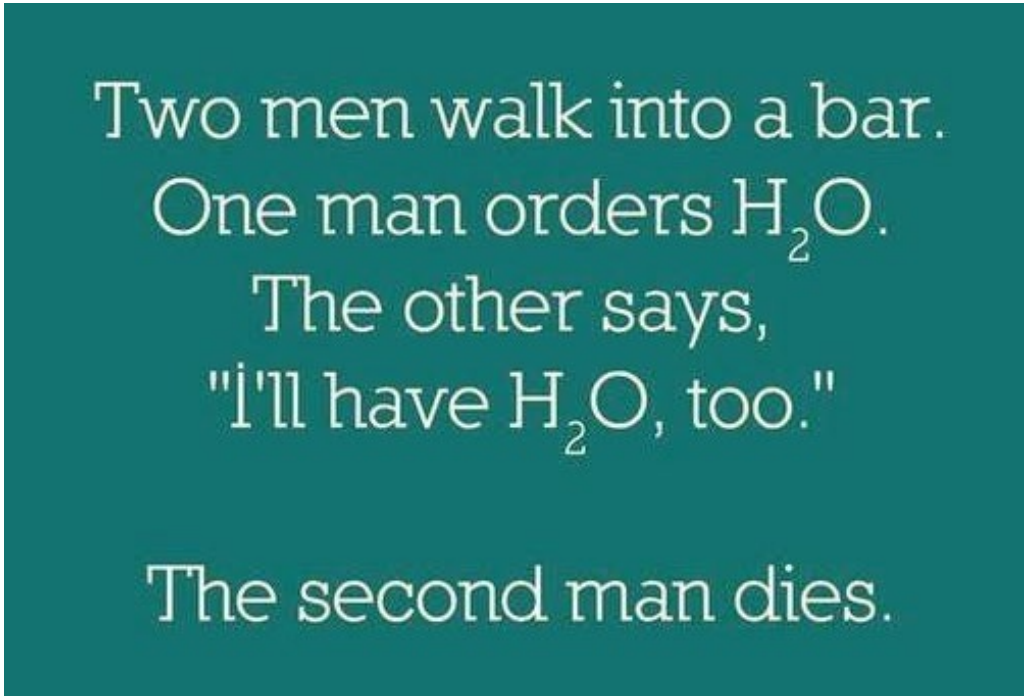
cdc.gov/Niosh-oeb/ - NIOSH Occupational Exposure Banding Tier 1 tool

institute.acs.org/acs-center/lab-safety/safety-basics-and-ramp/what-is-ramp.html - American Chemical Society (ACS) RAMP

cameochemicals.noaa.gov – National Oceanic and Atmospheric Administration (NOAA) database of hazardous materials – CAMEO chemicals

cdc.gov/niosh/npg – NIOSH Pocket Guide to Chemical Hazards

In closing, chemical labeling is important…



Questions?