Laboratory Safety

WASHINGTON STATE UNIVERSITY HEALTH SCIENCES SPOKANE

Why is lab safety training required ***before*** working in a laboratory?

Chemical Hazards

In the 1980s, a postdoctoral researcher was involved in a chemical explosion in the UCSB Chemistry building. He inappropriately mixed a strong oxidizing acid (nitric acid) with organic solvents inside a waste container within a fume hood. He walked away from the hood (fortunately) at which time the reaction mixture exploded causing a flash fire within the hood. The student was lucky to escape uninjured and the fire was extinguished

Fire Safety

On Dec. 29, 2008, Sheharbano "Sheri" Sangji was working on a chemical synthesis in a lab at the University of California, Los Angeles. One of the reagents she was using was *tert*-butyllithium (*t*-BuLi), which ignites spontaneously in air. It was likely only the second time she had handled such a hazardous substance.

She was transferring a total of 160 mL of *t*-BuLi solution using a 60 mL plastic syringe, according to her lab notebook. For unknown reasons, the plunger came out of the syringe barrel and the *t*-BuLi was exposed to the atmosphere. The *t*-BuLi ignited, along with Sangji's clothes. She wore nitrile gloves, no lab coat, and possibly no eye protection.

"Her clothing from the waist up was largely burned off, and large blisters were forming on her abdomen and hands—the skin seemed to be separating from her hands," the lab supervisor, chemistry professor Patrick Harran, later recalled for investigators. Sangji died from her injuries on Jan. 16, 2009. She was 23 years old.

Biological Hazards

The San Francisco Chronicle reported that for the past several weeks, 25-year-old Richard Din, a biology major working with the Northern California Institute for Research and Education, had been researching the germ Neisseria meningitidis that can cause meningitis and bloodstream disease. The germ causes septicemia and meningitis, officials said. Septicemia is an inflammation of the bloodstream that causes bleeding into the skin and organs and is believed to be the cause of Din's death. 'In his case, the time between the onset of symptoms and death was 17 hours. That's not uncommon with this disease,' Dr Harry Lampiris, chief of infectious disease at the San Francisco VA, told the Chronicle.

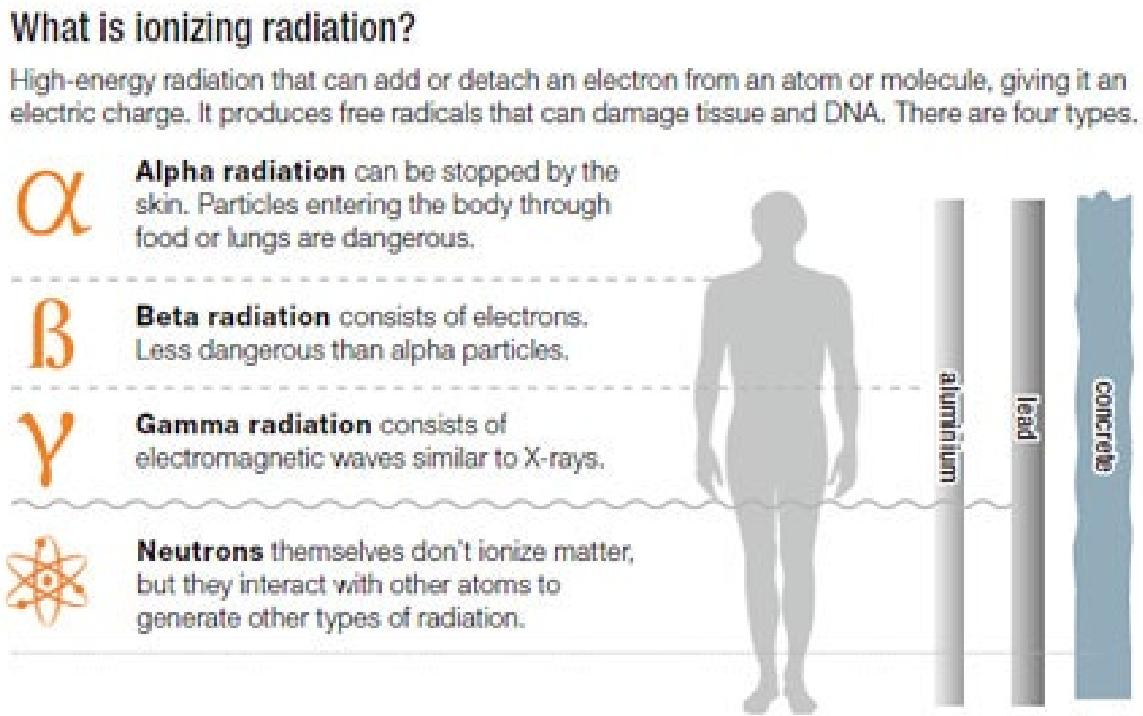
Equipment Safety

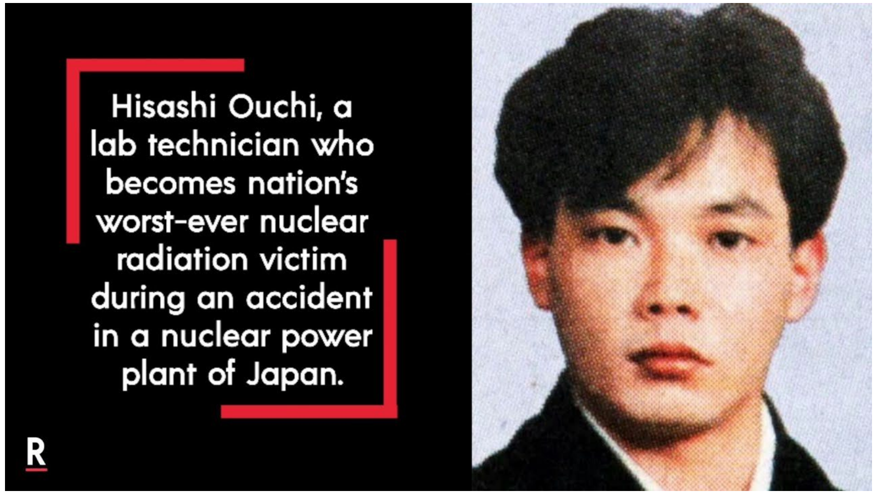
A Death in the Machine Shop

On April 12th, 2011, Michele Dufault's life came to a heartwrenchingly tragic end. The 22-year-old Yale physics student was up late at night working alone in the chemistry department's machine shop, using an industrial lathe. Sadly, nobody was around to help Dufault when her hair became tangled in the rapidly spinning tool, which wrapped around her neck in a deadly instant. She died of strangulation, just weeks away from graduation.

A subsequent review found that the lathe lacked necessary safety features, such as an emergency stop button.

Radiation Safety





Lab accidents are regrettably too frequent. So that their memory is never forgotten, the Laboratory Safety Institute maintains this list of those who have lost their lives in lab accidents.

https://www.labsafety.org/memorial-wall

Creating a Lab Safety Culture

Occupational Health and Safety Act of 1970 (OSHA)

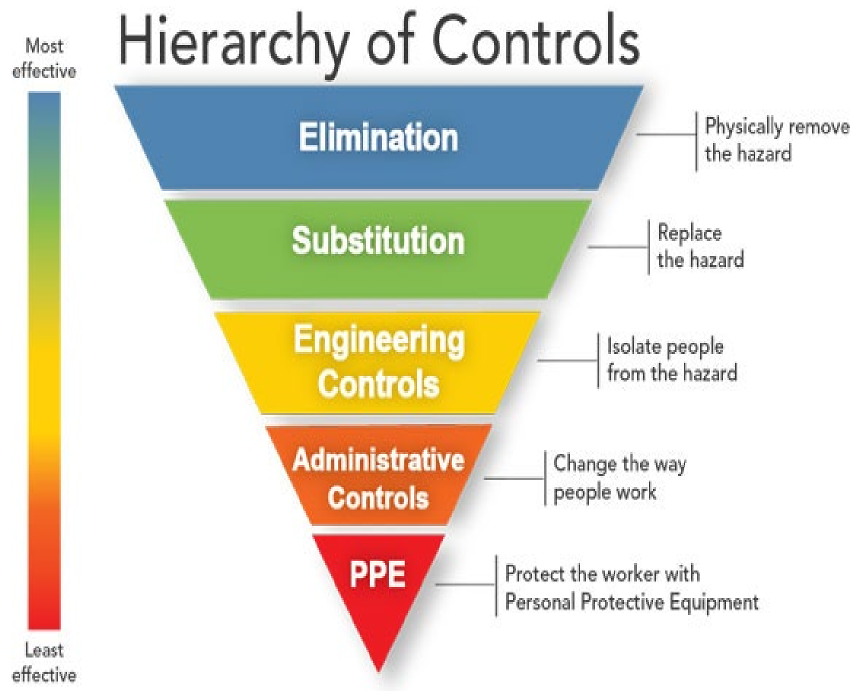
The purpose is to assure safe and healthful working conditions for working men and women; by authorizing enforcement of the standards developed under the Act; by assisting and encouraging the States in their efforts to assure safe and healthful working conditions; but providing for research, information, education, and training in the field of occupational safety and health.

- Occupational Exposure to Hazardous Chemicals in Laboratories standard (29 CFR 1910.1450)
- Hazard Communication standard (29 CFR 1910.1200)
- Bloodborne Pathogens standard (29 CFR 1910.1030)
- Personal Protective Equipment (PPE) standard (29 CFR 1910.132)
- Eye and Face Protection standard (29 CFR 1910.133)
- Respiratory Protection standard (29 CFR 1910. 134)
- Hand Protection standard (29 CFR 1910.138
- Control of Hazardous Energy standard (29 CFR 1910.147)

Hierarchy of Controls

Prioritizes intervention strategies based on the premise that the best way to control a hazard is to systematically remove it from the workplace rather than relying on workers to reduce their exposure

- Elimination
- Substitution
- Engineering Controls
- Administrative Controls
- Personal Protective Equipment (PPE)



Laboratory Safety Manual

The WSU Laboratory Safety Manual and Risk Assessment forms provide guidance for the laboratories and can be found on the WSU-Spokane Lab Safety website.

- Review Laboratory Safety Manual
- Review Laboratory Risk Assessment

Working with Chemicals

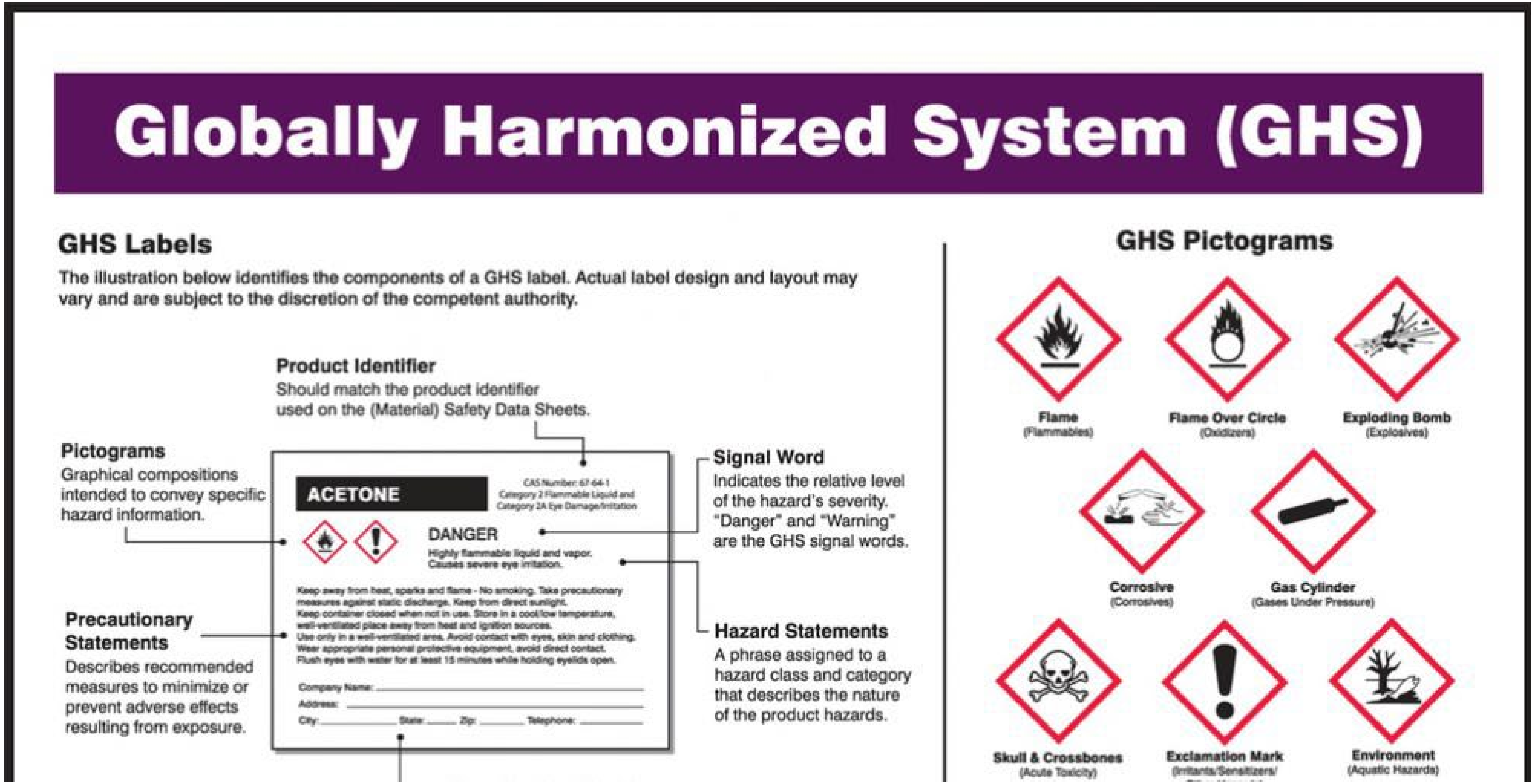
- Each laboratory must have a chemical hygiene plan. The plan must be readily available to lab staff
- Must have a Safety Data Sheet (SDS) for every reagent
- Must have a Standard Operating Procedure (SOP) for working with every hazardous reagent
- Must know how to properly store chemicals
- Each researcher must be trained in how to conduct laboratory procedures, the chemical hygiene plan and associated SOPs, how to read an SDS, and Hazard Communication. Training must be documented.
- Must have training to recognize exposure monitoring, medical consultation and examinations

Chemical Hygiene Plan

- Review of Chemical Hygiene Plan
- Review of Laboratory Inspection Checklist

Safety in the science lab:

"An ounce of prevention is worth a pound of cure"


Globally Harmonized System (GHS)
GHS Labels
The illustration below identifies the components of a GHS label. Actual label design and layout may vary and are subject to the discretion of the competent authority.
Product Identifier
Should match the product identifier used on the (Material) Safety Data Sheets.
Pictograms
Graphical compositions intended to convey specific hazard information.
ACETONE
CAS Number: 67-64-1
Category 2 Flammable Liquid and
Category 2A Eye Damage/Irritation
DANGER
Highly flammable liquid and vapor.
Causes severe eye irritation.
Keep away from heat, sparks and flame - No smoking. Take precautionary measures against static discharge. Keep from direct sunlight.
Keep container closed when not in use. Store in a cool/low temperature, well-ventilated place away from heat and ignition sources.
Use only in a well-ventilated area. Avoid contact with eyes, skin and clothing.
Wear appropriate personal protective equipment, avoid direct contact.
Flush eyes with water for at least 15 minutes while holding eyelids open.
Company Name:
Address:
City: State: Zip: Telephone:
Signal Word
Indicates the relative level of the hazard's severity. "Danger" and "Warning" are the GHS signal words.
Precautionary Statements
Describes recommended measures to minimize or prevent adverse effects resulting from exposure.
Hazard Statements
A phrase assigned to a hazard class and category that describes the nature of the product hazards.
GHS Pictograms
Flame
(Flammables)
Flame Over Circle
(Oxidizers)
Exploding Bomb
(Explosives)
Corrosive
(Corrosives)
Gas Cylinder
(Gases Under Pressure)
Skull & Crossbones
(Acute Toxicity)
Exclamation Mark
(Irritants/Sensitizers/
Environment
(Aquatic Hazards)

Secondary Labeling

1. Product Identifier
2. Words, pictures, symbols
3. Specific Health or Physical Hazards

Acute Toxicity
(Poison)

Health Hazard
(Cancer, Lung Disease, etc.)

How to Read an SDS

Section 1 identifies the chemical on the SDS as well as its intended use. It also provides the essential contact information of the supplier.

Section 2 outlines the hazards of the chemical and appropriate warning information.

Section 3 identifies the ingredient(s) of the chemical product identified on the SDS, including impurities and stabilizing additives.

Section 4 describes the initial treatment protocol for untrained responders to incidents of chemical exposure.

Section 5 provides recommendations for fighting a fire caused by the chemical.

Section 6 details the appropriate response to chemical spills, leaks, or releases, including containment, and cleanup to prevent or minimize exposure to people, property, or the environment.

How to Read an SDS *(continued)*

Section 7 of the safety data sheet provides guidance on the safe handling practices and conditions for safe storage of chemicals.

Section 8 lists chemical exposure limits, engineering controls, and personal protective measures that can be used to minimize worker exposure.

Section 9 identifies physical and chemical properties associated with the product.

Section 10 describes the reactivity hazards of the chemical and chemical stability information. This section is broken into three parts: reactivity, chemical stability, and other.

Section 11 identifies toxicological and health effects info, if applicable

Section 12 explains the environmental impact of a chemical(s) if released to the environment.

How to Read an SDS *(continued)*

Section 13 covers proper disposal, recycling or reclamation of the chemical(s) or its container, and safe handling practices.

Section 14 explains classification information for shipping and transporting of hazardous chemical(s) by road, air, rail, or sea.

Section 15 of the safety data sheet identifies the safety, health, and environmental regulations specific to the product.

Section 16 tells you when the SDS was originally prepared or the last known revision date. This section of the SDS may also state where changes have been made to the previous version.

Chemical Compatibility

- The single most important rule of chemical storage is to segregate incompatible chemicals to prevent accidental mixing which could cause fire, explosion, or toxic gases.
- Store the following chemical groups separately:

Flammable liquids	Liquid oxidizers
Compressed Gasses	Non-volatile liquid poisons
Volatile poisons	Metal hydrides and pyrophorics
Acids	Dry solids
Liquid bases	

- Containers must be clearly and legibly labeled per the Global Harmonization System (GHS)

Storage

Flammable Liquids (flashpoint <100°F): all alcohols, acetone, acetaldehyde, acetonitrile, amyl acetate, benzene, cyclohexane, dimethyldichlorosilane, dioxane, diethyl ether, ethyl acetate, histoclad, hexane, hydrazine, methyl butane, picoline, piperidine, pyridine, some scintillation liquids, all silances, tetrahydrofuran, toluene, triethylamine, xylene

Storage: Flammable liquids may be stored with volatile poisons or liquid bases, but not with both bases and poisons.

Compressed Gases: oxygen, nitrogen, hydrogen, arsine, acetylene

Storage: Store securely mounted. Segregate oxygen from flammable gases. Store acutely toxic and toxic gases in gas cabinets or fume hoods.

Storage

Volatile Poisons: poisons, toxics, carcinogens such as carbon tetrachloride, chloroform, dimethylformamide, dimethyl sulfate, formamide, formaldehyde, halothane, mercaptoethanol, methylene chloride phenol

Storage: Store in a ventilated cabinet. May be stored with flammable liquids if bases are not present.

Non-Volatile Liquid Poisons: acrylamide solutions, Coomassie blue stain, diethylpyrocarbonate, diisopropyl fluorophosphate, uncured epoxy resins, ethidium bromide, triethanolamine. Note: This group contains carcinogens and highly toxic chemicals.

Storage: Store in a normal cabinet preventing contact with other chemicals. May be stored with non-hazardous liquids. Double contain quantities greater than one liter.

Storage

Acids: Segregate acids from chemicals which could generate toxic or flammable gases upon contact (e.g., cyanide salts, metal sulfides, calcium carbide) and reactive metals (e.g., sodium, potassium, magnesium).

Storage: Store in a ventilated corrosive storage cabinet. Store in non-corrosive secondary container. Avoid contact with bases!

Mineral Acids, Oxidizing: sulfuric, nitric, chromic, perchloric

Storage: Store separately from organic acids. Oxidizing mineral acids are highly reactive with most substances and must be double contained. Perchloric acid presents special hazards—isolate it from acetic anhydride, bismuth and its alloys, alcohol, paper, wood, oil, ether, grease, sulfuric acid, and especially acetic acid.

Mineral Acids, Non-Oxidizing: hydrochloric, hydrofluoric, phosphoric, hydroiodic

Storage: Hydrofluoric acid is particularly hazardous and must be handled carefully.

Storage

Liquid Bases: sodium hydroxide, ammonium hydroxide, calcium hydroxide, glutaraldehyde

Storage: Store in tubs or trays in a normal cabinet. Avoid contact with acids. Liquid bases may be stored with flammables in the flammable cabinet if volatile poisons are not present.

Liquid Oxidizers: ammonium persulfate, hydrogen peroxide

Storage: Store in a ventilated storage cabinet. Oxidizing liquids react with nearly everything. They may potentially cause explosions and must be double contained.

Storage

Metal Hydrides and Pyrophorics (air or water reactive): sodium borohydride, calcium hydride, lithium aluminum hydride

Storage: Most metal hydrides react violently with water. A Type D fire extinguisher must be available. Store in waterproof double container in a normal cabinet. May be stored with dry solids.

Dry Solids: All hazardous and non-hazardous powders such as cyanogen bromide, ethylmaleimide, oxalic acid, potassium cyanide, sodium cyanide

Storage: Store dry solids above liquids in a normal cabinet or on open shelves. It is important to keep liquid poisons below cyanide- or sulfide-containing poisons (solids). A spill of aqueous liquid onto cyanide or sulfide containing poisons would cause a reaction that would release poisonous gas. If properly double contained, dry solids can be stored with metal hydrides. Solid picric acid or picric sulfonic acid may be stored with dry solids but should be checked regularly for dryness. When completely dry, picric acid is explosive and may detonate upon shock or friction.

Incompatible Chemical Hazard Groups

Mineral acids	Do NOT store with…acetic acid, acetone, calcium hydroxide, chloroform, hydrochloric acid, hydrogen peroxide, methanol, nitric acid (*keep separate*), phosphoric acid, sodium hydroxide, sulfuric acid
Strong organic acids	Do NOT store with…acetic acid, acetone, acetonitrile, benzene, chloroform, formic acid, hydrogen peroxide, methanol, sodium hydroxide, sulfuric acid
Weak organic acids	These are typically not corrosive and not strongly reactive and can be stored with general liquid lab chemicals. Examples include butyric, maleic, and benzoic acids.

Incompatible Chemical Hazard Groups *(continued)*

Non-flammable chlorinated solvents	Do NOT store with……acetone, carbon tetrachloride, chloroform, ethanol, hexane, hydrogen peroxide, methanol, methylene chloride, nitric acid, trichloroethane
Organic solvents	Do NOT store with……acetone, calcium hydroxide, chromic acid, hydrochloric acid, hydrogen peroxide, methanol, nitric acid, phenol, sodium hydroxide, sulfuric acid, trichlorfluoromethane, xylene
Oxidizers	Do NOT store with……acetone, bromate salts, chromic acid, ethyl ether, hydrogen peroxide, isopropyl alcohol, nitric acid, paper and oily rags, perchloric acid, sodium metal, sodium nitrate, xylene

Bloodborne Pathogens

- Review of Institutional Biosafety Committee (IBC) Manual
  https://biosafety.wsu.edu/documents/2018/01/ibc-manual.pdf/

Bloodborne Pathogen Standard

The Bloodborne Pathogen Standard is designed to protect workers from the health hazards of exposure to bloodborne pathogens.

- Exposure Control Plan
- Exposure Determination
- Engineering and Work Practice Controls
- Personal Protective Equipment
- Housekeeping
- Regulated Wastes
- Training
- Hepatitis B Vaccination and Post-Exposure Evaluation and Follow-Up
- Signs and Labels Warning of the Hazards
- Record Keeping

What Are Bloodborne Pathogens?

- Viruses, bacteria and other microorganisms that are carried in the bloodstream and can cause disease.
- The most common bloodborne pathogens are:
  - Human Immunodeficiency Virus (HIV)
  - Hepatitis B (HBV)
  - Hepatitis C (HCV)

Human Immunodeficiency Virus (HIV)

- HIV is the virus that leads to AIDS. HIV depletes the immune system.
- HIV does not survive well outside the body. There is no threat of contracting HIV through casual contact.

Hepatitis B

- Hepatitis B is a disease that attacks the liver. The disease can be prevented by a Hepatitis B vaccine.
- Symptoms include fatigue, stomach pain, nausea, loss of appetite, jaundice, and darkened urine. Though, sometimes the disease doesn’t present any symptoms.

Hepatitis C

- Hepatitis C is also a disease that attacks the liver. However, the disease cannot be prevented by a vaccine.
- Signs and symptoms of the disease include fatigue, weight loss, nausea, and depression. The majority of people don’t have any symptoms.

Fluids NOT Considered a Risk for BBP Exposure

- Vomit
- Feces
- Urine
- Sweat
- Nasal discharges
- Saliva (not dental)
- Tears

EXCEPTION: Any body fluid visibly contaminated with blood

Universal Precautions

1. Use barrier protection to prevent skin and mucous membrane contact with blood or other body fluids
2. Wear gloves to prevent contact with blood, infectious materials, or other potentially contaminated surfaces or items.
3. Wear face protection if blood or bodily fluid droplets may be generated during a procedure.
4. Wear protective clothing if blood or bodily fluid may be splashed during a procedure.

Universal Precautions *(continued)*

5. Wash hands and skin immediately and thoroughly if contaminated with blood or bodily fluids.
6. Wash hands immediately after gloves are removed.
7. Use care when using or handling sharp instruments and needles. Place used sharps in labeled, puncture-resistant containers.
8. If you have sustained an exposure or puncture wound, immediately flush the exposed area and notify your supervisor.

Laboratory Equipment

Fume Hoods

A chemical fume hood is the most important piece of safety equipment in the lab but also has the potential for the most dangerous accidents (fire, chemical spill, explosion).

Required PPE: Flame resistant lab coat, gloves, safety glasses

- The sash opening should be no higher than the operating height when in use.
- Chemicals and equipment should be at least 6” from the front edge.
- Minimize the amount of bottles, beakers and equipment used and stored in the hood
- Do not store chemicals in the hood
- Do not extend your head inside the hood when in use
- Monitor the hood daily for proper air movement
- Hoods must be certified annually, when moved, or when air movement is incorrect
- Specially designed hoods are required for use with perchloric acid.

Autoclaves

An autoclave is used to sterilize equipment using steam heat and pressure. The potential hazard is burns.

Required PPE: Lab coat, heat resistant gloves, face protection

Loading:

- Check the interior for items left behind
- Make sure all materials used are autoclave compatible
- Verify that bottle are not overfilled
- Always check and loosen bottle caps
- Use secondary containment trays
- Make sure materials and instruments are not touching the walls or floors of the autoclave
- Make sure autoclave is not overloaded
- Run all pre-checks including checking the drain strainer and that doors are properly sealed
- Choose the correct cycle for the load (liquid, gravity, vacuum)

Autoclaves *(continued)*

Unloading:

- Always make sure the chamber pressure has returned to zero before opening
- Wear PPE to retrieve the load
- Open the door slowly and carefully, standing behind it
- Allow for the steam to be released; wait 30 seconds before opening the door completely
- Wait for autoclaved materials to cool down before removing them from the autoclave. This is especially important while autoclaving liquids.

NOTE:

Never autoclave animal carcasses or flammable, corrosive, or radioactive materials

Centrifuges

A centrifuge uses centrifugal force to separate heterogeneous mixtures. Unbalanced centrifuge rotors can result in injury or death. Sample container breakage can release aerosols that are harmful if inhaled.

Required PPE: Lab coat, gloves, face protection

- Wipe the unit with 70% ethanol
- Volume of suspension in the tubes should not exceed 75%
- Insert the appropriate adaptors in the adaptor bucket
- Place test tubes in the adaptors; balance the tubes in the rotor
- Place the rotor cover on the rotor base
- Program in the appropriate run time, speed and temperature
- Once cycle is complete, wait for it to come to a complete stop
- Wipe the unit with 70% ethanol
- Open the tubes in a fume hood or safety cabinet.

-80° Freezers

The potential hazard is skin damage due to the high temperature

Required PPE: Lab coat, temperature resistant gloves

- Check the temperature of the unit daily
- The unit is not a "rapid freeze" device. Add room temperature material gradually.
- Avoid opening the door for extended periods of time
- Clean the condenser every 6 months
- Clean the condenser filters every 2 to 3 months
- Check the gaskets every 2-3 months for punctures or tears
- Defrost the freezer once a year or whenever ice buildup exceeds 3/8"
- Check the battery every 12 months

Gas Cylinders

The hazards involved in compressed gas use include oxygen displacement (inert gas use), fires, explosions, and toxic exposures to the physical hazards of high pressurization.

- Store cylinders properly, separate by type of hazard (e.g.: store oxidizers $\geq$ 20’ from flammable gases)
- Secure cylinders with a chain or strap
- Inspect before moving; use a designated cart
- Use the proper regulation; know how to put it on
- Store empty cylinders properly; leave some residual pressure, replace the protective cap, label as empty and store away from full cylinders

Discussion

- Your research is only as good and as accurate as your equipment.
- Standard Operating Procedures are required for the maintenance of and operation of the equipment.
- Preventative maintenance program must be established that includes documentation of problems and repairs.
- Staff must be trained in the care of and operation of the equipment.
- General care includes:
  1. Establishment of a cleaning schedule per manufacturer recommendations
  2. Regular calibration
  3. Daily check to verify that the equipment is working
  4. Daily cleaning before and after

Waste Collection

Waste Collection

We provide bins and bags in a rainbow of standardized colors and shapes.

This helps researchers dispose of waste properly in any space on campus and helps housekeeping staff know what is appropriate for them to touch and dispose of during their daily routines.

Note: Liquid chemical waste can be kept in a variety of containers as long as the containers are clearly labelled.

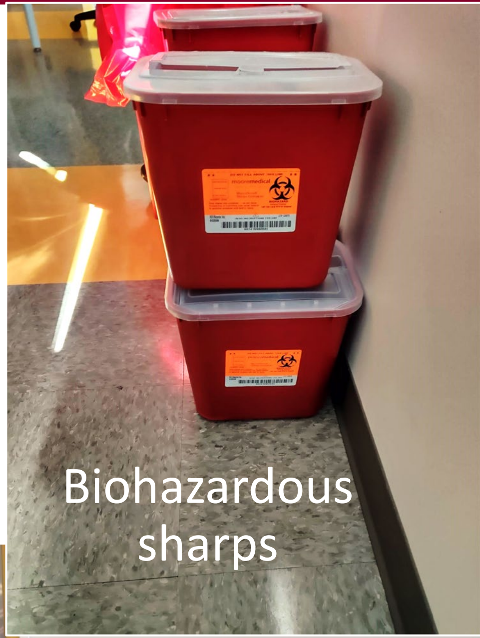
Color:	Waste Type:
Red	**Biohazardous**
Orange	**Pathological**
Yellow	**Radioactive**
Blue	**Broken Glass**
White	**Autoclavable**
Violet	**Solid Chemical**
Black	**Reserved for custodial staff**
Gray	
Green	

Biohazardous Waste

Biohazardous waste is regulated waste. It contains enough blood or other potentially infectious material (OPIM) to potentially spread bloodborne pathogens. This includes:

- Human body fluids such as semen or vaginal secretions, cerebral spinal fluid, peritoneal fluid, or amniotic fluid
- Unfixed human tissue
- Liquid or semiliquid blood
- Contaminated items that would release blood or OPIM if compressed
- Contaminated sharps such as needles or scalpels
- Pathological or microbiological waste containing OPIM

Contact Safety Officer for pickup when containers are three-quarters full

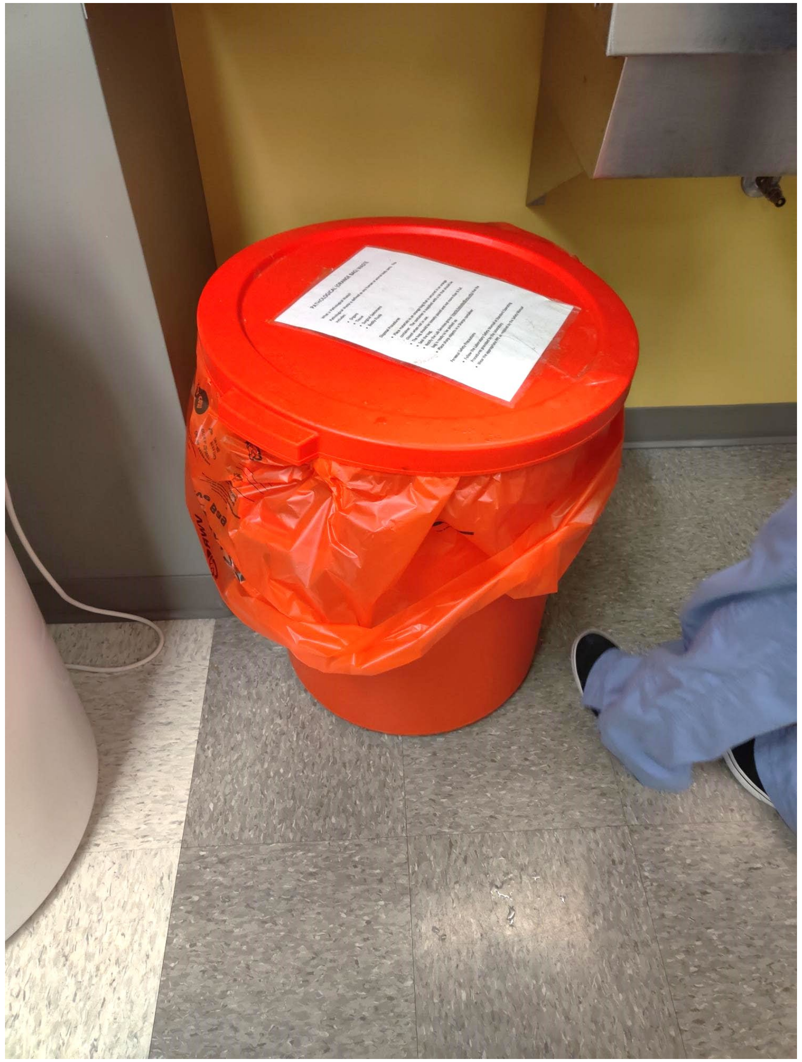


Pathological Waste

Pathological waste is defined as any animal or *fixed* human body part including:

- Organs
- Tissue
- Surgical specimens
- Body fluids

Contact Safety Officer for pickup when containers are three-quarters full



Radioactive Waste

Radioactive waste is handled by the Pullman Office of Radiation

Glassware

Noncontaminated glassware

- Drain glassware and place in the double-lined blue container. Sweep up broken glassware with a dustpan and dispose of in the blue container or sharps container.
- Glassware can be disposed of by placing the secured bag in a cardboard box, taping, and indicating “glassware for disposal.” Place the box with other trash for custodial staff to remove.

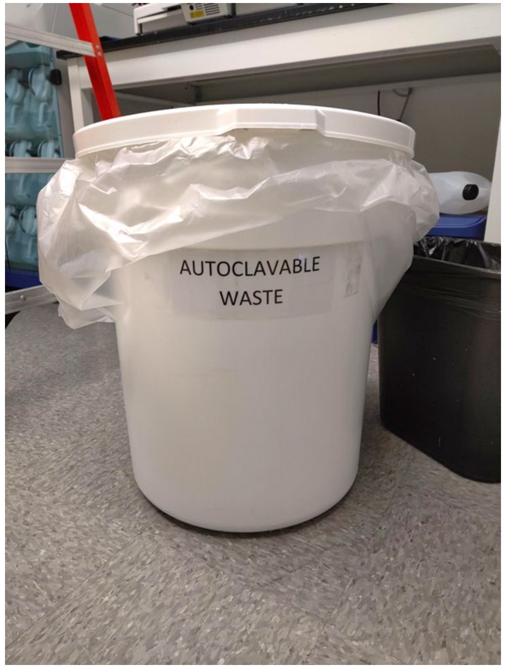
Contaminated glassware

- Contaminated with **infectious materials**: autoclave and dispose of as noncontaminated glassware
- Contaminated with **chemical waste**: place in the lavender solid chemical waste bin, documenting the chemical on the label. Submit a waste collection form when the container is three quarters full.
- Contaminated with **radioactive waste**: dispose of as radioactive waste

Autoclavable Waste

Autoclavable waste is:

- All disposable lab ware contaminated with potentially biohazardous materials (dried blood/body fluids, human and animal cell culture media, bacteria culture media, viruses, recombinant DNA)
- Gloves (whether contaminated or not) and paper towels used for work surface or equipment decontamination
- Cloth containing blood stains, blood-coated cotton balls
- Culture plates
- Culture media
- Live or attenuated vaccines
- Waste from biological toxins
- Tubing, catheters



Autoclavable Waste *(continued)*

When containers are three-quarters full:

- Secure with a twist tie for autoclaving (leave 1” room for bag to vent)
- Place bag in autoclave on a metal or plastic autoclave safe tray
- Autoclave at 121 °C for 45 minutes
- After cooling, dispose of as regular trash to be picked up by custodial staff

WSU Spokane provides large bins next to the autoclave for final disposal.

Solid Chemical Waste

Solid chemical waste is any disposable lab object that comes into contact with chemical hazards, including:

- Gloves
- Weigh boats and weigh paper
- Benchtop absorbent pads
- Pipettes and pipette tips
- Contaminated plasticware

Apply a chemical waste label to the outside of the container.

When the container is three-quarters full, complete the chemical waste collection form to request pickup and seal bag with tape or a closer tie.

Liquid Chemical Waste

Because liquid waste can possess a variety of chemical properties, it is not in the best interest to provide a single container type. Standardized labels are used for liquid chemical disposal. Containers must be marked with the date when waste collection begins. For solid chemical hazards that require individual collection, the same rules apply.

To facilitate proper disposal of liquids, several types of containers are available. This includes solvent safe plastics and amber glass bottles. By using a variety of sizes, waste doesn't accumulate in fume hoods and is picked up regularly. Researchers are welcome to use any appropriate container they have on hand as well.

NEW GUIDELINES: For containers over 4L, the letters must be ½" tall.

Culture of Safety

- Safety is everyone's responsibility.
- WSU is committed to providing a campus environment that supports the health and safety practices of its community (faculty, students, staff, and visitors) and empowers the community to be responsible for the safety of others.
- A safe campus environment is a right of employment for all categories of employees. A safe campus learning environment is a right of all involved in education and research.
- Good science is safe science. Safety is a critical component of scholarly excellence and responsible conduct of research.