

Chapter 12 CHEMICAL SAFETY

Introduction

The following sections provide chemical safety guidelines and procedures. This chapter covers the following topics:

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General Safety Guidelines

Almost everyone works with or around chemicals and chemical products every day. Many of these materials have properties that make them hazardous: they can create physical (fire, explosion) and/or health hazards (toxicity, chemical burns). However, there are many ways to work with chemicals which can both reduce the probability of an accident to a negligible level and reduce the consequences to minimum levels should an accident occur. Risk minimization depends on safe practices, appropriate engineering controls for chemical containment, the proper use of personnel protective equipment, the use of the least quantity of material necessary, and substitution of a less hazardous chemical for the more hazardous one. Before beginning an operation, ask "What would happen if . . .?" The answer to this question requires an understanding of the hazards associated with the chemicals, equipment and procedures involved. The hazardous properties of the material and intended use will dictate the precautions to be taken.

Another important distinction is the difference between hazard and risk. The two terms are sometimes used as synonyms. In fact, hazard is a much more complex concept because it includes conditions of use. The hazard presented by a chemical has two components: (1) its inherent capacity to do harm by virtue of its toxicity, flammability, explosiveness, corrosiveness, etc.; and (2) the ease with which the chemical can come into contact with a person or other object of concern. The two components together determine risk (the likelihood or probability that a chemical will cause harm). Thus, an extremely toxic chemical, such as strychnine, cannot cause poisoning if it is in a sealed container and does not contact the handler. In contrast, a chemical that is not highly toxic can be lethal if a large amount is ingested.

Chemical safety is inherently linked to other safety issues including laboratory procedures, personal protective equipment, electrical safety, fire safety, and hazardous waste disposal. Refer to other chapters in this manual for more information on these topics.

Knowledge + Common Sense + Caution = Chemical Safety

Not all chemicals are considered as hazardous. Examples of nonhazardous chemicals include buffers, sugars, starches, agar, and naturally occurring amino acids.

The following sections provide general guidelines for chemical safety.

Chemical Safety Guidelines

Always follow these guidelines when working with chemicals:

- Assume that any unfamiliar chemical is hazardous.
- Know all the hazards of the chemicals with which you work. For example, perchloric acid is a corrosive, an oxidizer, and a reactive. Benzene is an irritant that is also flammable, toxic, and carcinogenic.
- Consider any mixture to be at least as hazardous as its most hazardous component.
- Never use any substance that is not properly labeled.
- Follow all chemical safety instructions precisely.
- Minimize your exposure to any chemical, regardless of its hazard rating.
- Use personal protective equipment, as appropriate.
- Use common sense at all times.

The five prudent practices of chemical safety sum up these safety guidelines:

1. Treat all chemicals as if they were hazardous.
2. Minimize your exposure to any chemical.
3. Avoid repeated exposure to any chemical.
4. Never underestimate the potential hazard of any chemical or combination of chemicals.
5. Assume that a mixture or reaction product is more hazardous than any component or reactant.

Material Safety Data Sheets

Before using any chemical, read the container label and the appropriate Material Safety Data Sheets (“MSDSs”). Container labels and MSDSs are good sources of information for chemical safety. They provide the following information:

- Hazardous ingredients
- Exposure limits
- Physical and chemical characteristics, including the following:

Boiling point
Vapor pressure

- Physical hazards, including the following:

Flammability
Explosiveness
Reactivity

- Health hazards, including chemicals that are:

Toxic
Carcinogens
Irritants

- First-aid procedures
- Proper leak, spill, and disposal techniques
- Proper storage and handling procedures
- Other special provisions

Safe Handling Guidelines

Employees should treat all chemicals and equipment with caution and respect.

When working with chemicals, remember to do the following:

- Remove and use only the amount of chemicals needed for the immediate job at hand.
- Properly seal, label, and store chemicals in appropriate containers. Keep the containers clearly marked and in a well-ventilated area.
- Check stored chemicals for deterioration and broken containers.
- Learn how to dispose of chemicals safely and legally. Follow UTPB Hazardous Waste Management requirements (Chapter 13 of this manual).
- Clean up spills and leaks immediately.
- Know what to do in an emergency.

Likewise, when working with chemicals, remember the following:

- Do not store chemicals near heat or sunlight or near substances which might initiate a dangerous reaction.
- Do not transport unprotected chemicals between the work area and other areas. Use a tray, rack, cart or rubber carrier. Always use a secondary container when transporting hazardous or highly odorous chemicals on an elevator.
- Do not pour hazardous chemicals down the sink.
- Do not put fellow workers or yourself in danger.

Hygiene and Chemical Safety

Good personal hygiene will help minimize exposure to hazardous chemicals.

When working with chemicals, follow these guidelines:

- Wash hands frequently and before leaving the laboratory. Also, wash hands before eating, drinking, smoking, or applying makeup.
- Remove contaminated clothing immediately. Do not use the clothing again until it has been properly decontaminated.
- Follow any special precautions for the chemicals in use.

In addition, follow these special precautions:

- Do not eat, drink, smoke, or apply makeup around chemicals.
- Do not wear contact lenses near chemicals, especially corrosives or volatile solvents.
- Do not keep food or food containers anywhere near chemicals.
- Do not use laboratory equipment to serve or store food or drinks.
- Do not sniff or taste chemicals.

Hazard Communication Program

This UTPB Hazard Communication Program complies with OSHA standards and the Texas Hazard Communication Act for hazardous chemicals. This program is available from the Safety & Health Office. It requires the following:

- Employee training (including recognition of signs of exposure)
- Labeling procedures
- MSDSs for chemicals at each workplace
- Instructions on how to read and interpret MSDSs
- Chemical inventory reporting procedures
- Record keeping requirements
- Emergency response procedures

Refer to the UTPB Hazard Communication Program and other sections in this manual for detailed information on these topics.

An integral part of hazard communication is hazard identification. Everyone who works with hazardous chemicals should know how to read and interpret hazard information. Signs, like the NFPA diamond in the illustration below, alert employees to the known hazards in a particular location.

The following is a detailed explanation of the NFPA hazard classification codes:

Health (Blue):

- | | |
|---|---|
| 4 | Can cause death or major injury despite medical treatment |
| 3 | Can cause serious injury despite medical treatment |
| 2 | Can cause injury. Requires prompt medical treatment |
| 1 | Can cause irritation if not treated |
| 0 | No hazard |

Flammability (Red):

- | | |
|---|--------------------------------------|
| 4 | Very flammable gases or liquids |
| 3 | Can ignite at normal temperatures |
| 2 | Ignites with moderate heat |
| 1 | Ignites with considerable preheating |
| 0 | Will not burn |

Reactivity (Yellow):

- | | |
|---|--|
| 4 | Readily detonates or explodes |
| 3 | May detonate or explode with strong initiating force or heat under confinement |
| 2 | Normally unstable, but will not detonate |
| 1 | Normally stable. Unstable at high temperature and pressure. |
| 0 | Normally stable and not reactive with water. |

Specific Hazard (White):

- Oxidizer - OX
- Acid - ACID
- Alkali - ALK
- Corrosive - COR
- Use No Water - W

Corrosives

A corrosive chemical destroys or damages living tissue by direct contact. Some acids, bases, dehydrating agents, oxidizing agents, and organics are corrosives.

Examples of Corrosives

Examples of acidic corrosives include the following:

- Hydrochloric acid
- Sulfuric acid

Examples of alkaline corrosives include the following:

- Sodium hydroxide (lye)
- Potassium hydroxide

Examples of corrosive dehydrating agents include the following:

- Phosphorous pentoxide
- Calcium oxide

Examples of corrosive oxidizing agents include the following:

- Halogen gases
- Perchloric acid

Examples of organic corrosives include the following:

- Phenol
- Acetic acid

NOTE:

Concentrated acids can cause painful burns that are often superficial. However, hydrofluoric acid can cause serious skin and deep tissue damage which may not be immediately apparent or painful. Inorganic hydroxides can cause serious damage to skin tissues because a protective protein layer does not form. Even a dilute solution, such as sodium or potassium hydroxide, can saponify fat and attack skin. At first, skin contact with phenol may not be painful, but the exposed area may turn white due to the severe burn. Systemic poisoning may also result from dermal exposure.

Safe Handling Guidelines for Corrosives

To ensure safe handling of corrosives, the following special handling procedures should be used:

- Always store corrosives properly. Refer to the MSDSs and the Chemical Storage section of this manual for more information.
- Always wear gloves and face and eye protection when working with corrosives. Wear other personal protective equipment, as appropriate.
- To dilute acids, add the acid to the water, not the water to the acid.
- Corrosives, especially inorganic bases (e.g., sodium hydroxide), may be very slippery; handle these chemicals with care and clean any spills, leaks, or dribbles immediately.
- Use a chemical fume hood when handling fuming acids or volatile irritants (e.g., ammonium hydroxide).

- A continuous flow eye wash station should be in every work area where corrosives are present. An emergency shower should also be within 100 feet of the area.

Corrosive Example: Perchloric Acid

Perchloric acid is a corrosive oxidizer that can be dangerously reactive. At elevated temperatures, it is a strong oxidizing agent and a strong dehydrating reagent. Perchloric acid reacts violently with organic materials. When combined with combustible material, heated perchloric acid may cause a fire or explosion. Cold perchloric acid at less than 70% concentration is not a very strong oxidizer, but its oxidizing strength increases significantly at concentrations higher than 70%. Anhydrous perchloric acid (>85%) is very unstable and can decompose spontaneously and violently.

If possible, purchase 60% perchloric acid instead of a more concentrated grade. Always wear gloves and goggles while using perchloric acid. Be thoroughly familiar with the special hazards associated with perchloric acid before using it.

Heated digestions with perchloric acid require a special fume hood with a wash-down system.

Flammables

A flammable chemical is any solid, liquid, vapor, or gas that ignites easily and burns rapidly in air. Consult the appropriate MSDSs before beginning work with flammables.

Flashpoint, Boiling Point, Ignition Temperature, and Class

Flammable chemicals are classified according to flashpoint, boiling point, and ignition temperature. Flashpoint (FP) is the lowest temperature at which a flammable liquid gives off sufficient vapor to ignite. Boiling point (BP) is the temperature at which the vapor pressure of a liquid is equal to the atmospheric pressure under which the liquid vaporizes. Flammable liquids with low BPs generally present special fire hazards. The FPs and BPs of certain chemicals are closely linked to their ignition temperature — the lowest temperature at which a chemical will ignite and burn independently of its heat source.

The following table illustrates flammable class characteristics:

CLASS	FLASHPOINT (°F)	BOILING POINT (°F)	EXAMPLES
1A	<73	<100	Ethyl ether "Flammable" aerosols
1B	<73	≥100	Acetone Gasoline Toluene
1C	≥73	<100	Butyl alcohol Methyl isobutyl ketone Turpentine
2	100 - 140	---	Cyclohexane Kerosene Mineral spirits
3A	140 - 199	---	Butyl cellosolve
3B	≥200	---	Cellosolve Ethylene glycol Hexylene glycol

The following table provides examples of common flammables and their flashpoint and class.

CHEMICAL	FLASHPOINT (°F)	CLASS
Acetone	0	1B
Benzene	12	1B
Butyl Acetate	<72	1C
Carbon Disulfide	-22	1B
Cyclohexane	-4	1B
Diethylene Glycol	225	3B
Diethyl Ether	-49	1A
Ethanol	55	1B
Heptane	25	1B
Isopropyl Alcohol	53	1B
Methanol	52	1B
Pentane	<-40	1A
Toluene	40	1B

Conditions for a Fire

Improper use of flammable liquids can cause a fire. The following conditions must exist for a fire to occur:

- Flammable material must be present in sufficient concentration to support a fire (i.e., fuel).
- Oxygen or another oxidizer must be present.
- An ignition source must be present (i.e., heat, spark, etc.).

When working with flammables, always take care to minimize vapors which act as fuel.

Safe Handling Guidelines for Flammables

Follow these guidelines when working with flammable chemicals:

- Handle flammable chemicals in areas free from ignition sources.
- Never heat flammable chemicals with an open flame. Use a water bath, oil bath, heating mantle, hot air bath, etc.
- Use ground straps when transferring flammable chemicals between metal containers to avoid generating static sparks.
- Use a fume hood when there is a possibility of dangerous vapors. (Ventilation will help reduce dangerous vapor concentrations.)
- Restrict the amount of stored flammables, and minimize the amount of flammables present in a work area.
- Remove from storage only the amount of chemical needed for a particular experiment or task.

Solvents

Organic solvents are often the most hazardous chemicals in the work place. Solvents such as ether, alcohols, and toluene, for example, are highly volatile or flammable. Chlorinated solvents such as chloroform are nonflammable, but when exposed to heat or flame, may produce carbon monoxide, chlorine, phosgene, or other highly toxic gases.

Always use volatile and flammable solvents in an area with good ventilation or in a fumehood. Never use ether or other highly flammable solvents in a room with open flames or other ignition sources present.

Solvent Exposure Hazards

Health hazards associated with solvents include exposure by the following routes:

- Inhalation:

Inhalation of a solvent may cause bronchial irritation, dizziness, central nervous system depression, nausea, headache, coma, or death. Prolonged exposure to excessive concentrations of solvent vapors may cause liver or kidney damage. The consumption of alcoholic beverages can enhance these effects.

- Skin contact:

Skin contact with solvents may lead to defatting, drying, and skin irritation.

- Ingestion:

Ingestion of a solvent may cause severe toxicological effects. Seek medical attention immediately.

The odor threshold for the following chemicals exceeds acceptable exposure limits. Therefore, if you can smell it, you may be overexposed — increase ventilation immediately.

Chloroform

Benzene

Carbon tetrachloride

Methylene chloride

NOTE:

Do not depend on your sense of smell alone to know when hazardous vapors are present. The odor of some chemicals is so strong that they can be detected at levels far below hazardous concentrations (e.g., xylene).

In addition, some solvents (e.g., benzene) are known or suspected carcinogens.

Reducing Solvent Exposure

To decrease the effects of solvent exposure, substitute hazardous solvents with less toxic or hazardous solvents whenever possible. For example, use hexane instead of diethyl ether, benzene or a chlorinated solvent.

NOTE:

The best all-around solvent is water; use it whenever possible.

The following table outlines possible solvent substitutions:

INSTEAD OF USING	SUBSTITUTE
Benzene	Cyclohexane Toluene Xylene
Halogenated solvents	Nonhalogenated solvents
Aromatic hydrocarbon	Aliphatic hydrocarbon
Trichloroethylene	1,1,1-trichloroethane
Diethyl ether	Hexane Petroleum ether

Solvent Example: DMSO

Dimethyl sulfoxide is unique because it is a good solvent with many water-soluble as well as lipid-soluble solutes. Due to these properties, dimethyl sulfoxide is rapidly absorbed and distributed throughout the body. It can also facilitate absorption of other chemicals such as grease, oils, cosmetics, and other chemicals that may contact the skin.

Toxic Chemicals

The toxicity of a chemical refers to its ability to damage an organ system (kidneys, liver), disrupt a biochemical process (e.g., the blood-forming process), or disturb an enzyme system at some site remote from the site of contact. Toxicity is a property of each chemical that is determined by molecular structure. Any substance can be harmful to living things. But, just as there are degrees of being harmful, there are also degrees of being safe. The biological effects (beneficial, indifferent or toxic) of all chemicals are dependent on a number of factors.

For every chemical, there are conditions in which it can cause harm and, conversely, for every chemical, there are conditions in which it does not. A complex relationship exists between a biologically active chemical and the effect it produces that involves consideration of dose (the amount of a substance to which one is exposed), time (how often, and for how long during a specific time, the exposure occurs), the route of exposure (inhalation, ingestion, absorption through skin or eyes), and many other factors such as gender, reproductive status, age, general health and nutrition, lifestyle factors, previous sensitization, genetic disposition, and exposure to other chemicals.

The most important factor is the dose-time relationship. The dose-time relationship forms the basis for distinguishing between two types of toxicity: acute toxicity and chronic toxicity. The acute toxicity of a chemical refers to its ability to inflict systemic damage as a result (in most cases) of a one-time exposure to relative large amounts of the chemical. In most cases, the exposure is sudden and results in an emergency situation.

Chronic toxicity refers to a chemical's ability to inflict systemic damage as a result of repeated exposures, over a prolonged time period, to relatively low levels of the chemical. Some chemicals are extremely toxic and are known primarily as acute toxins (hydrogen cyanide); some are known primarily as chronic toxins (lead). Other chemicals, such as some of the chlorinated solvents, can cause either acute or chronic effects.

The toxic effects of chemicals can range from mild and reversible (e.g. a headache from a single episode of inhaling the vapors of petroleum naphtha that disappears when the victim gets fresh air) to serious and irreversible (liver or kidney damage from excessive exposures to chlorinated solvents). The toxic effects from chemical exposure depend on the severity of the exposures. Greater exposure and repeated exposure generally lead to more severe effects.

Exposure to toxic chemicals can occur by:

- Inhalation
- Dermal absorption
- Ingestion
- Injection

NOTE:

Inhalation and dermal absorption are the most common methods of chemical exposure in the workplace.

The following sections provide examples and safe handling guidelines for the following types of toxic chemicals:

- Toxicants
- Carcinogens
- Reproductive Toxins
- Sensitizers
- Irritants

IMPORTANT:

Minimize your exposure to any toxic chemical.

Acute Toxins

Acute toxins can cause severe injury or death as a result of short-term, high-level exposure.

Examples of acute toxins include the following:

- Hydrogen cyanide
- Hydrogen sulfide
- Nitrogen dioxide
- Ricin
- Organophosphate pesticides
- Arsenic

Do not work alone when handling acute toxins. Use a fume hood to ensure proper ventilation.

Chronic Toxins

Chronic toxins cause severe injury after repeated exposure.

Examples of chronic toxins include the following:

- Mercury
- Lead
- Formaldehyde

Carcinogens

Carcinogens are materials that can cause cancer in humans or animals. Several agencies including OSHA, NIOSH, and IARC are responsible for identifying carcinogens. There are very few chemicals known to cause cancer in humans, but there are many suspected carcinogens and many substances with properties similar to known carcinogens.

Examples of known carcinogens include the following:

- Asbestos
- Benzene
- Tobacco smoke
- Chromium, hexavalent
- Aflatoxins

Zero exposure should be the goal when working with known or suspected carcinogens. Workers who are routinely exposed to carcinogens should undergo periodic medical examinations.

Reproductive Toxins

Reproductive toxins are chemicals that can produce adverse effects in parents and developing embryos. Chemicals including heavy metals, some aromatic solvents (benzene, toluene, xylenes, etc.), and some therapeutic drugs are capable of causing these effects. In addition, the adverse reproductive potential of ionizing radiation and certain lifestyle factors, including excessive alcohol consumption, cigarette smoking, and the use of illicit drugs, are recognized.

While some factors are known to affect human reproduction, knowledge in this field (especially related to the male) is not as broadly developed as other areas of toxicology. In addition, the developing embryo is most vulnerable during the time before the mother knows she is pregnant. Therefore, it is prudent for all persons with reproductive potential to minimize chemical exposure.

Sensitizers

Sensitizers may cause little or no reaction upon first exposure. Repeated exposures may result in severe allergic reactions.

Examples of sensitizers include the following:

- Isocyanates
- Nickel salts
- Beryllium compounds
- Formaldehyde
- Diazomethane

Irritants

Irritants cause reversible inflammation or irritation to the eyes, respiratory tract, skin, and mucous membranes. Irritants cause inflammation through long-term exposure or high concentration exposure. For the purpose of this section, irritants do not include corrosives.

Examples of irritants include the following:

- Ammonia
- Formaldehyde
- Halogens
- Sulfur dioxide
- Poison ivy
- Phosgene

Reactives and Explosives

Reactive chemicals are sensitive to either friction or shock or they react in the presence of air, water, light, or heat. Explosive chemicals decompose or burn very rapidly when subjected to shock or ignition. Reactive and explosive chemicals produce large amounts of heat and gas; they are extremely dangerous.

Examples of reactive compounds include the following:

REACTIVE CLASSIFICATION	CHEMICAL EXAMPLES
Acetylenic compounds	Acetylene Copper(I) acetylide
Azides	Benzenesulfonyl azide Lead (II) azide
Azo compounds	Azomethane Diazomethane
Chloro/perchloro compounds	Lead perchlorate Potassium chlorite Silver chlorate
Fulminates	Copper (II) fulminate Silver fulminate
Nitro compounds	Nitromethane Trinitrotoluene
Nitrogen-containing compounds	Silver amide Silver nitride
Organic peroxide formers	Diethyl ether Isopropyl ether
Picrates	Picric acid (dry) Lead picrate
Peroxides	Diacetyl peroxide Zinc peroxide
Strained ring compounds	Benzvalene Prismane
Polymerizable compounds	Butadiene Vinyl chloride

Cleaning Agents

Many of the chemicals contained in cleaning agents are corrosive. Follow these guidelines when working with any cleaning agent:

- Always read and understand the label instructions or the MSDS before using any cleaning agent.
- Mix solutions to the recommended strength.

- When diluting acid with water, always add the acid to the water, not the water to the acid. (Concentrated acids may splatter when mixed improperly.)
- Wear appropriate eye protection and gloves for the job (e.g., neoprene, nitrile, or rubber).
- Do not leave aerosol cans in direct sunlight or areas where the temperature may exceed 120°F. Heated aerosol cans may explode.

The following table outlines common cleaning agents, their hazards, and safety precautions:

CLEANING AGENT	POSSIBLE HAZARDS	SAFETY MEASURES
Ammonia	-Can cause severe eye and lung irritation. -If mixed with bleach, can form poisonous chlorine gas.	-Use in a well-ventilated area. -Do not mix with bleach. -Wear eye protection.
Bleach	-Can produce a poisonous gas if mixed with other cleaners.	-Never mix with toilet cleaners or ammonia. -Wear gloves and eye protection.
Toilet/Drain Cleaners & Lye	-Can cause serious burns.	-Wear gloves and avoid skin contact. -Never mix with bleach. -Protect eyes from possible splashes.
Cleaning Fluids/Degreasers	-May cause skin and eye irritations. -May contain solvents that can cause headaches, painful cough, dizziness and liver or kidney damage.	-Avoid direct contact. -Only use in well-ventilated areas. -Follow label directions carefully.
Aerosol Sprays	-Can irritate nasal passages if inhaled. -Can cause eye irritation.	-Follow label directions carefully. -Use in well ventilated area.
Floor Waxes & Furniture Polish	-Can irritate skin and nasal passages.	-Use in well ventilated area. -Avoid skin contact.

Fume Hoods

Fume hoods provide primary confinement in a chemical laboratory. They exhaust toxic, flammable, noxious, or hazardous fumes and vapors by capturing, diluting, and removing these materials. Fume hoods also provide physical protection against fire, spills, and explosion. Fume hoods provide the best protection when the fume hood sash is in the closed position. All chemical fume hoods must be ducted to the outside of the building.

Types of Fume Hoods

There are three basic types of fume hoods: (1) standard, (2) bypass, and (3) auxiliary air.

STANDARD FUME HOODS

The face velocity of a standard fume hood is inversely related to the open face area, allowing a constant volume of air to be exhausted. If the sash is lowered, the inflow air velocity increases.

IMPORTANT:

Face velocity that is too high may disturb sensitive apparatus, extinguish Bunsen burners, or create excessive turbulence.

BYPASS FUME HOODS

Bypass fume hoods are also called "balanced air" or "constant volume" fume hoods. As the sash is lowered, bypass fume hoods allow constant exhaust volumes that help keep the room ventilation system balanced. Constant exhaust volumes also eliminate the problem of high face velocity as the sash is lowered.

AUXILIARY AIR FUME HOODS

Auxiliary air fume hoods are also known as "supplied air" hoods. They use an outside air supply for 50% to 70% of the hood's exhaust requirements. This type of hood is designed to reduce utility costs and conserve energy. The face velocity of an auxiliary air fume hood may vary.

Recommended Face Velocities

Average face velocity is determined by taking several measurements across the plane of the sash opening and taking an average.

The following are recommendations for average face velocities according to intended fume hood use.

Intended Use	Recommended AFV
highly toxic or volatile materials having a TLV of less than 1 ppm (e.g., tetraethyl lead, beryllium compounds, metal carbonyls, and carcinogens)	115 to 125 fpm with a minimum of 100 fpm at any point
Formaldehyde, chloroform, and phenol	95 to 110 fpm with a minimum of 80 fpm at any point
Materials having a TLV greater than 100 ppm (e.g., ethanol, butanol, and acetone) Operations that create nuisance dust and fumes	75 to 95 fpm with a minimum of 60 fpm at any point

Special Fume Hoods

Special fume hoods are necessary when working with certain chemicals and operations. Examples of special fume hoods include the following:

- Perchloric acid fume hoods:

These fume hoods have a water spray system to wash down the entire length of the exhaust duct, the baffle, and the wall. The water spray is used periodically or after each use to remove any perchloric acid or organic material that may have accumulated.

- Walk-in hoods:

These fume hoods have single vertical sashes or double vertical sashes and an opening that extends to the floor. These hoods are typically used to accommodate large pieces of equipment.

- Radioisotope hoods:

These hoods are labeled for use with radioactive materials. The interior of these hoods is resistant to decontamination chemicals. If special filtration is necessary with these fume hoods, contact the Office of Radiological Safety.

- Canopy hoods:

These hoods capture upward moving contaminants and are good for heat-producing operations. Workers may be exposed to contaminants if they work under the hood, however.

Fume Hood Safety Considerations

The potential for glass breakage, spills, fires, and explosions is great within a fume hood. Due to the chance for fires or explosions, fume hoods should be located towards the back of a laboratory, away from primary and secondary exits. Practice safe work habits when working with fume hoods, including the following:

- Air Flow and Ventilation:

Employee traffic in front of a fume hoods or opening/closing laboratory doors can interfere with hood performance. Ensure that there is sufficient aisle space in front of fume hoods.

- Fume Hood Type:

All fume hoods are not appropriate for all types of work. Ensure that hazardous chemicals are used in the proper type or class of hood. For example, use perchloric acid only in fume hoods specifically designed for perchloric acid.

Fume Hood Use and Care

To ensure safety and proper fume hood performance, follow these guidelines:

- Laboratory hood sashes shall be kept closed whenever possible. When a fume hood is unattended, its sash shall remain fully closed
- Use a fume hood when working with chemicals or procedures that may produce hazardous fumes or vapors.
- Know how to properly operate a fume hood before beginning work. Inspect the fume hood before starting each operation.
- Place equipment and chemicals at least six inches behind the fume hood sash. This practice reduces the chance of exposure to hazardous vapors.
- Do not allow paper or other debris to enter the exhaust duct of the hood.
- Do not store excess chemicals or equipment in fume hoods.
- Do not block the baffle area of the fume hood.
- Elevate any large equipment within the hood at least three inches to allow proper ventilation around the equipment.
- When working in a fume hood, set the sash at the height indicated by the arrow on the inspection sticker. The only time the sash should be completely open is while setting up equipment.
- Wear personal protective equipment, as appropriate.
- Do not alter/modify the fume hood or associated duct work.
- Clean up spills in the hood immediately.

IMPORTANT:

If a power failure or other emergency occurs (e.g., building fire or fire within the fume hood), close the fume hood sash and call for emergency assistance.

Fume Hood Inspections

Fume hoods should be tested at least annually. Fume hoods should also be tested in the following circumstances:

- When an employee requests an inspection
- When a procedural change requires a hood classification upgrade
- After major repair work
- After a fume hood is moved

The Office of Environmental Safety & Health performs fume hood inspections and testing. The test includes an inspection of the hood system, airflow measurements, and an assessment of the use of the fume hood. If you suspect a problem with your fume hood, please contact the Office of Environmental Safety & Health.

Spill Response

Spills are likely whenever chemicals are used. Personnel should be trained and equipped to handle most of the spills in their work area. Contact the Office of Environmental Safety & Health for assistance or advice about a chemical spill.

Spill Prevention and Planning

Prevention is the best safety strategy for any environment. Use safe handling procedures and be aware of the potential hazards associated with chemicals. For example, before working with any chemicals, review the appropriate MSDSs.

Be prepared to respond to a chemical spill. To prepare for a potential spill, follow these guidelines:

- Develop and periodically review written procedures for an emergency response plan.
- Keep a fully stocked chemical spill response kit available.
- Know the location and proper use of cleanup materials.
- Know how to turn off equipment, heat sources, electrical panels, etc.
- Review appropriate MSDSs.

Spill Response Kit

Work areas that contain potentially hazardous chemicals should have a chemical spill response kit. This kit should include the following:

- Disposable laboratory/surgical gloves
- Disposable vinyl gloves
- Safety goggles
- Absorbent (e.g., spill pillows, vermiculite, litter box filler, etc.)
- Plastic scoop
- Plastic trash bags

Responding to Chemical Spills

The following sequence provides a brief overview of proper chemical response procedures:

1. Notify others in the immediate area that a spill has occurred. Evacuate the area if necessary.
2. Attend to injured and exposed people.
3. Identify the spilled chemical(s).
4. Based on the hazards and the personal protective equipment needed (e.g., respiratory protection), determine if you can safely clean the spill or if assistance is necessary. (Most spills can be cleaned safely by the people who were using the chemical.)

If you determine that you can safely clean the spill without emergency assistance, follow these guidelines:

- Wear appropriate protective clothing and equipment.
- Have another person stand by during the cleanup.
- Clean up the spill and collect all wastes for proper disposal.
- Ventilate the area, as necessary, before it is reoccupied.
- Decontaminate reusable cleanup supplies such as scoops, rubber boots, etc.
- Restock the chemical spill kit and return it to the normal storage location.

Do not take unnecessary risks with chemical spills. Call the Office of Environmental Safety & Health whenever a spill involves the following:

- Large volume of spilled material
- Very hazardous material
- Very hazardous conditions (e.g., fire, explosion, toxicity, etc.)
- Strong odor
- Personnel injury or exposure

Chemical Storage

Proper chemical storage is as important to safety as proper chemical handling. Often, seemingly logical storage ideas, such as placing chemicals in alphabetical order, may cause incompatible chemicals to be stored together.

General Guidelines

Follow these guidelines for safe chemical storage:

- Read chemical labels and MSDSs for specific storage instructions.
- Store chemicals in a well-ventilated area; however, do not store chemicals in a fume hood.
- Maintain an inventory of all chemicals in storage.
- Return chemical containers to their proper storage location after use.
- Store glass chemical containers so that they are unlikely to be broken.
- Store all hazardous chemicals below eye level.
- Never store hazardous chemicals in a public area or corridor.

Separating Hazardous Chemicals

In addition to the guidelines above, there are storage requirements for separating hazardous chemicals. Because an alphabetical storage system may place incompatible chemicals next to each other, group chemicals according to their hazard category (i.e., acids, bases, flammables, etc.).

Follow these guidelines to ensure that hazardous chemicals are stored safely:

- Separate acids from bases. Store these chemicals near floor level.
- Isolate perchloric acid from organic materials. Do not store perchloric acid on a wooden shelf.
- Separate highly toxic chemicals and carcinogens from all other chemicals. This storage location should have a warning label and should be locked.
- Separate acids from flammables.
- Do not keep peroxide-forming chemicals longer than twelve months.
- Do not allow picric acid to dry out.
- If flammables need to be chilled, store them in a laboratory-safe refrigerator, not in a standard refrigerator.
- Flammables should be stored in a flammable storage cabinet.

The following table provides examples of incompatible chemicals:

CHEMICAL	INCOMPATIBLE WITH . . .
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric and sulfuric acid mixtures
Alkali metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Cyanide	Acids
Fluorine	Most other chemicals
Nitrates	Sulfuric acid
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Sodium	Carbon tetrachloride, carbon dioxide, water
Sulfides	Acids

Chemical Labels

- Check integrity of chemical labels frequently and replace if necessary.
- Record arrival dates on chemical labels, as well as the date the container is first opened.
- Do not deface original labels.
- Label secondary containers with the chemical name and the appropriate hazard warnings.

Shipping/Receiving Chemicals

The U.S. Department of Transportation regulates the shipment of hazardous materials. Warehouse personnel, shipping and receiving clerks, truck drivers, and other employees who pack or unpack hazardous materials must receive this training. Contact the Office of Environmental Safety & Health for more information on shipping or receiving hazardous chemicals.