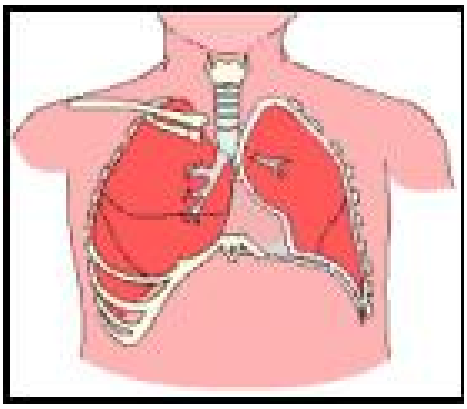
Introduction

More than 32 million workers are potentially exposed to one or more of the estimated 650,000 hazardous chemical products used in America's workplaces. As one of these workers, you have both a need and a right to know the potential health and safety hazards, and the identities of the chemicals to which you may be exposed. You also have a right to know the protective measures that are available to you. The Occupational Health and Safety Administration (OSHA) has a regulation (*OSHA Hazard Communication Standard*) that contains requirements for training on the hazards in your workplace, methods for identifying the hazards, protective measures you can take, and the requirements for using labels and Safety Data Sheets (SDSs).

The term "hazardous chemical" applies to any chemical that is a health hazard (e.g., irritant, sensitizer, carcinogen) or a physical hazard. Chemicals that present health hazards from exposure by direct contact or through the air have the potential to cause acute or chronic health effects in exposed employees. Acute health effects occur immediately or shortly after exposure, and can

range in severity from minor irritation of the skin, eyes, or respiratory tract, to severe incapacitation or death. Chronic health effects may not be evident until years later and are generally associated with repeated exposures to lower concentrations.

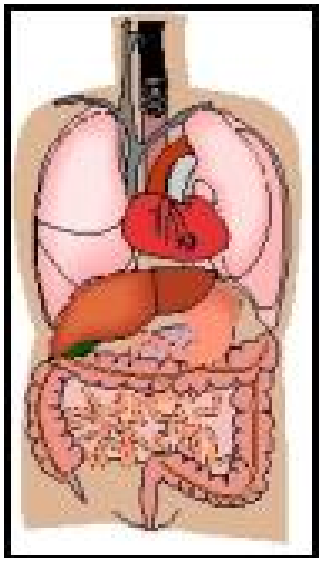
Physical hazards are hazards that cause a dangerous change in the physical environment, such as fires or explosions. Chemicals that pose a physical hazard include combustible liquids, compressed gases, explosives, flammables, corrosives, organic peroxides, oxidizers, pyrophoric compounds (ignite when exposed to air), unstable or water-reactive materials.

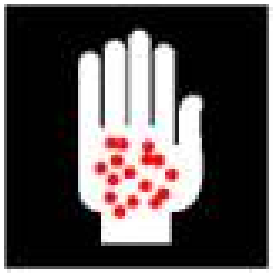


Many substances have established exposure limits and validated sampling methods to measure your exposure. These exposure limits represent conditions under which it is believed nearly all workers may be repeatedly exposed without adverse health effects. OSHA establishes mandatory maximum exposure limits called Permissible Exposure Limits (PELs). The best practice is to maintain concentrations of all atmospheric contaminants as low as reasonably achievable.

Hazardous chemicals can enter your body in four ways, with inhalation being the most common route of exposure. When

examining your lab operations, consider all potential inhalation hazards including breathing in dust, fumes, mists, or vapors from solvents or other gases.





Some chemicals are absorbed into the body through the skin. If a chemical is readily absorbed into the skin, then the notation "skin" will appear along with the occupational exposure limits on the Safety Data Sheet (SDS). To ensure that you do not accidentally ingest the chemicals you work with, be sure to avoid storing, eating, or drinking food or beverages in areas where chemicals are used. Never smoke in areas where chemicals are used, and be sure to wash your hands and face with soap and water before you leave your work area.

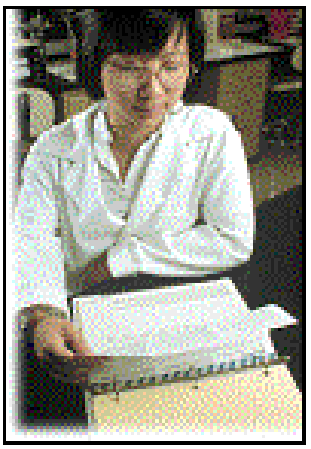
Another exposure route is injection. Syringes with needles are often used to transfer chemicals and other hazardous materials within a research laboratory. An example of an exposure is when a person accidentally injects themselves during the transfer process.

Exposures to chemicals can be minimized through the use of good housekeeping, appropriate work practices, and common

sense. Your workplace may also have other hazards from which you need protection. If your work involves potential contact with human blood or body fluids, for example, you must receive adequate training in working with materials that may cause exposure to bloodborne pathogens.

Identifying Hazardous Chemicals

Inventory



Your supervisor has knowledge concerning the identity of all the hazardous chemicals in your work area or that you use in your job. If you discover materials that you no longer use or no longer want, dispose of them according to the waste disposal procedures described in the Chemical Hygiene Plan. If a new hazardous chemical comes into your work area, your supervisor, or the Environmental Health & Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)) can provide information on the hazards of that chemical.

The table below lists hazard categories and common examples of chemicals that may be used at your facility.

Hazard Class	Examples	Warning Properties
Irritants	Mineral acids, organic acids, peroxides, aldehydes, mercaptans formaldehyde, 2-mercaptoethanol	Odor, irritation to respiratory tract
Sensitizers	Formaldehyde, isocyanates, epoxies	Sometimes odors, irritation to respiratory tract, others may cause sensitization below sensory levels
Carcinogens	Acrylamide, arsenic, benzene, formaldehyde	Sometimes odors
Neurotoxin	Acrylamide, hexanes, mercury	Vary
Poisons	Trifluoroacetic acid	Irritating to skin and respiratory tract
Pyrophorics	Silane	Visible flame on contact with air
Reproductive toxins	Carbon disulfide, ethylene glycol monomethyl and ethyl ethers, lead	Vary
Flammable, Combustible	Xylene, toluene, isopropyl alcohol, acetone	Odors

Safety Data Sheet

Part of OSHA's Hazard Communication Standard requires that the chemical manufacturer or distributor/mixer provide a Safety Data Sheet (SDS). This standard requires that the information on the SDS be presented using specific headings in a specified sequence.

The format of the 16-section SDS should include the following sections:

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

- Section 16. Other information, including date of preparation or last revision

The SDS must also contain Sections 12-15, to be consistent with GHS. Although the headings for Sections 12-15 are mandatory, OSHA will not enforce the content of these four sections because these sections are within other agencies' jurisdictions.

SDSs can be obtained from your supervisor or the chemical manufacturer.

Labels

The Hazard Communication Standard requires that once the hazard classification is completed specific information is to be provided for each hazard class and category. Labels will require the following elements:

- **Product Identifier:** Explains how the hazardous chemical is identified. This can be (but is not limited to) the chemical name, product code or batch number. The identifier must appear the same on the label as it does in section 1 (Identification) of the SDS.

- **Name, Address and Telephone Number:** Help quickly identify the manufacturer, distributor or importer.

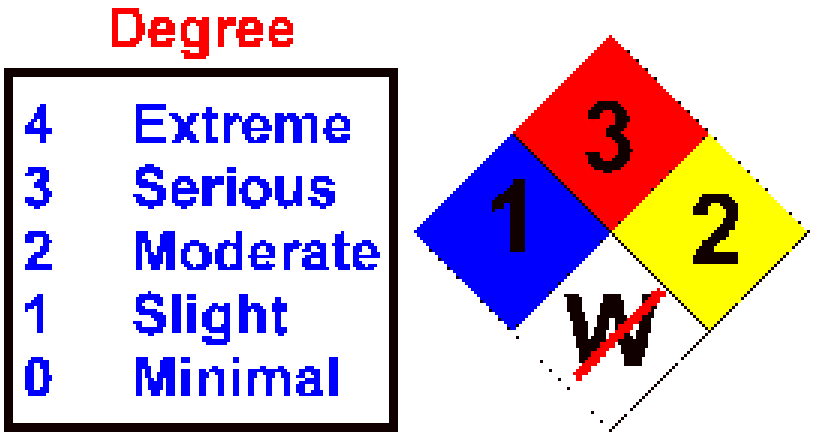
- **Pictogram:** A symbol plus other graphic elements, such as a border, background pattern, or color that is intended to convey specific information about the hazards of a chemical. Each pictogram consists of a different symbol on a white background within a red square frame set on a point (i.e., a red diamond). There are nine pictograms under the Globally Harmonized System (GHS). However, only eight pictograms are required under the Hazard Communication Standard. A table of the nine pictograms is below.

- **Signal words:** Used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label. The signal words used are "danger" and "warning." "Danger" is used for the more severe hazards, while "warning" is used for less severe hazards. There will only be one signal word per label. If there are minimal hazards a signal word may not be required.

- **Hazard Statement:** A statement assigned to a hazard class and category that describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard.

- **Precautionary Statement:** A phrase that describes recommended measures to be taken to minimize or prevent adverse effects resulting from exposure to a hazardous chemical or improper storage or handling of a hazardous chemical.

Secondary containers are those that you fill. These also need to be labeled with chemical name, hazard, and target organ. If you need help preparing the label, contact your supervisor or the Environmental Health & Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)).



Another common label is the National Fire Protection Association (NFPA) diamond (shown above). This simple but effective system provides a quick and easy-to-understand categorization of health, fire, and instability hazards on a 0-4 scale, with 4 being the most hazardous. The white diamond at the bottom center is reserved for special hazards like water reactivity (indicated by the "W" with a line through it). These NFPA diamonds must be posted on all main entries to labs, and are often seen on chemical containers.

Non-Routine Work

There are times when you may be performing non-routine tasks that may have the potential for other chemical exposures. Prior to beginning these tasks, let your supervisor know what you are about to do and discuss the potential exposures, ways to detect exposure, and control methods to prevent exposure. If you have questions, please call the Environmental Health & Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)).

Pictograms

There are nine pictograms under the GHS to convey the health, physical and environmental hazards. The final Hazard Communication Standard requires eight of these pictograms, the exception being the environmental pictogram, as environmental hazards are not within OSHA's jurisdiction. The hazard pictograms and their corresponding hazards are shown in the table below.

Health Hazard 	Flame 	Exclamation Mark 
• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	• Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non Mandatory)
Gas Cylinder 	Corrosion 	Exploding Bomb 
• Gases under Pressure	• Skin Corrosion/ burns • Eye Damage • Corrosive to Metals	• Explosives • Self-Reactives • Organic Peroxides
Flame over Circle 	Environment (Non Mandatory) 	Skull and Crossbones 
• Oxidizers	• Aquatic Toxicity	• Acute Toxicity (fatal or toxic)

Identifying Personal Protective Equipment

Personal protective equipment (PPE) is designed to protect you from serious injury or illness resulting from contact with workplace hazards. While PPE is often essential, it is generally your last line of defense against exposure and should only be used in conjunction with engineering controls, administrative controls, good hygiene, and sound work practices. It is important that the PPE you select is appropriate for the hazard and that the PPE fits well. For example, the gloves you would select for protection against organic solvents would generally be Nitrile rubber, not latex. If you have any questions or if a new hazard is present, contact your supervisor or call Environmental Health & Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)).

Eye and Face Protection

Eye or face protection is necessary when hazards are present from particles, liquid chemicals, acids or caustic liquids, chemical

gases or vapors, or potentially injurious UV or infrared light radiation. While safety glasses are perhaps the most widely used type of eye protection, they afford little protection from liquids and vapors. Prescription glasses (with or without side shields) are not an acceptable substitution for safety glasses. Prescription safety glasses are available.

Safety goggles give you more protection than safety glasses because they fit closer to your face. Because goggles surround the eye area, they give you more protection in situations where you might encounter splashing liquids, fumes, vapors, powders, dusts, or mists. Face shields are intended to protect the entire face from a variety of chemical hazards, but are considered secondary protection and must be used in addition to safety goggles to provide adequate protection. Face shields protect the eyes, face, and neck from chemical splashes and sprays as well as flying particles. Face shields are necessary anytime there is a severe risk of splash or spray, or if the materials in use are highly hazardous (e.g., highly corrosive acid and alkaline material).

Sometimes UV light, infrared light, or lasers present a hazard. In these cases, it is important that you select PPE that is specific to protecting you from the particular hazard and the intensity of the source. If you have questions about determining the best PPE in these situations, your supervisor or the Environmental Health &

Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)) can assist you.

Skin Protection

Gloves are necessary when your hands are exposed to hazards such as harmful substances that could be absorbed; sharp instruments or needles; caustic chemicals; and harmful temperature extremes. Selection of the appropriate glove type requires that you assess performance characteristics of gloves relative to the task(s) to be performed, conditions present, duration of use, and the hazards and potential hazards identified.

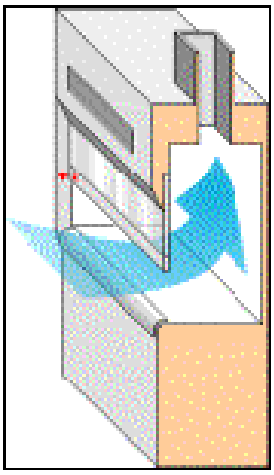
Always wear gloves while working with hazardous chemicals. There is no glove that provides protection against all potential hand hazards, and commonly available glove materials provide only limited protection against many chemicals. Chemicals eventually permeate all glove materials, and gloves should be changed frequently. Discard your gloves whenever they are torn, cracked, or their integrity is otherwise

compromised. Base your selections of gloves on the performance characteristics provided by the manufacturer or check the personal protection section of your SDS.

A lab coat offers some protection to your street clothes against biological and chemical spills and splashes. It may be necessary to wear a chemical resistant apron, if your lab coat does not offer adequate protection against the hazards specific to what you are doing, or if there is significant potential for splashes.

Respirators are used when inhalation hazards are present that can not be controlled by ventilation or other means. Do not use respirators without first contacting your supervisor or the Environmental Health & Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)). The use of respirators is highly regulated. To use respirators safely, you will need to be medically evaluated, trained, and fit-tested. Please call the Environmental Health & Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)) for information regarding respirator selection and fit testing.

Controlling Hazards



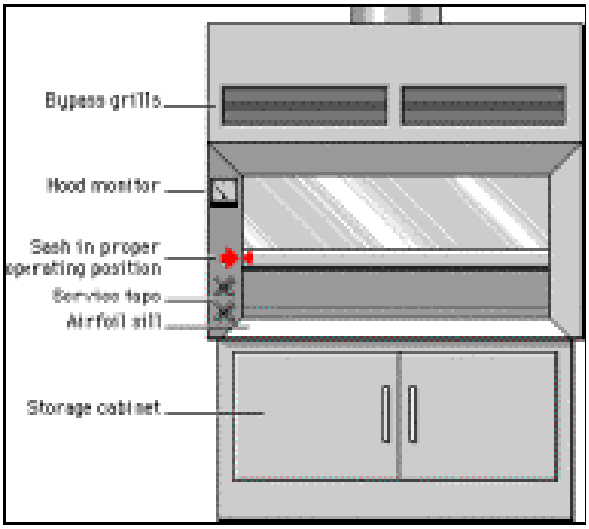
The basic routes for a chemical to enter the body in a laboratory/workplace setting are: inhalation, skin and eye contact, ingestion, and injection. The prevention of entry by any of these routes can be accomplished by engineering controls, administrative controls, and personal protective equipment (PPE), in that order of preference. Examples of engineering controls are fume hoods, ergonomically designed pipetters, and utilization of thick plastic shields when working with certain radioisotopes. Examples of administrative controls are changes in work practices, controlled entry to certain areas, and training. Controlling hazards with PPE includes the use of gloves, faceshields, lab coats, etc. PPE is the last option for controlling hazards and is applied when engineering or administrative controls are not possible.

Inhalation of hazardous chemicals is the most common route of entry to the body in laboratory operations. The American Conference of Governmental Industrial Hygienists (ACGIH) produces a listing of exposure limits that is generally the most up-to-date. These values are voluntary guides, not legal standards and are defined as follows:

- **Threshold Limit Value (TLV)**: Time-weighted average concentration for a normal 8-hour workday to which nearly all workers may be repeatedly exposed without adverse effect. TLVs are published annually by the ACGIH.
- **Short Term Exposure Limit (STEL)**: Maximum concentration to which workers can be exposed for periods of up to 15 minutes. STELs are published annually by the ACGIH.

Regulatory exposure limits are established by the Occupational Safety and Health Administration (OSHA) and are called permissible exposure limits (PELs). These values have the force of law. PELs are defined as follows:

- **Permissible Exposure Limit (PEL):** PEL is an 8-hour time-weighted average concentration that cannot be exceeded.



To avoid significant inhalation exposures and to limit exposure to concentrations below PEL values, there are a number of control measures that can be used. If chemical substitution is not practical, exhaust ventilation should be used to reduce exposure. A number of common

substances present an inhalation hazard and should only be used when adequate local exhaust ventilation, such as a fume hood, is available.

Apply the following basic principles and guidelines to ensure your fume hood is working efficiently and affording you the maximum protection.

Adjust the sash height to the lowest level for convenient operation, or to the marked maximum height level, but never higher. Operating the sash at the lowest possible height will reduce the chance of disturbed airflow and increase the velocity of air at the face of the opening. The sash also serves as a physical barrier in the event of chemical splashes or explosions within the hood. Remember that the capture ability of a fume hood may not be 100% at the front of the hood. Keep your experimental apparatus and sources of contamination at least six inches behind the sash opening to limit disruption of airflow.

Do not block exhaust ventilation by storing unused equipment or chemicals in hoods. As a general rule, ensure that neither the inside volume nor the floor space is more than 30% full, and never block baffles generally located at the back, bottom of the hood. Avoid turning your fume hood into a storage cabinet for hazardous chemicals. Use the cabinets provided under the fume hood if you need to store chemicals in a vented area. For safe

storage of flammable materials, use a flammables storage cabinet to reduce the potential for fires or explosions.

Your fume hood should always be on and in working order. If your hood malfunctions, shut off gas and vacuum lines, close the sash, and contact your supervisor. If fumes are escaping, leave the area and notify your supervisor. Heating of perchloric acid must be conducted **ONLY** in a specially designed fume hood equipped with a water wash-down system. Without this special wash-down system, perchloric acid vapors may create explosive perchlorate deposits in the ductwork.

For extremely toxic substances, such as those classified as poison inhalation hazards by the Department of Transportation, the use of closed systems such as a glove box may be required.

Chemical Storage and Handling

There are some easy general rules to remember when storing hazardous chemicals.

- Segregate acids and bases.
- Segregate organic acids (e.g., acetic acid, phenol) and oxidizing acids (e.g., nitric acid, chromic acid, sulfuric acid).
- Store flammables away from sources of ignition and in rated cabinets, and segregate them from oxidizing acids and oxidizers.

- Use carts/bottle carriers for transporting bottles, with secondary containment if they contain hazardous chemicals.
- Store oxidizers and pyrophorics (may ignite on contact with air) in a cool dry place, away from flammable and combustible materials (e.g., wood, paper).
- Store light-sensitive chemicals in amber bottles and away from light (e.g., ethyl ether, bromine).
- Label all carcinogens.
- Be aware of reactive chemicals (e.g., peroxide formers) used in your lab, and make sure they are disposed of before expiration dates.

If you have questions about the procedures for handling or storing hazardous materials or wastes, contact your supervisor or the Environmental Health & Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)).

Emergencies

Emergency equipment is provided for your use, as needed. It is important that the equipment is always accessible, and that you have a clear pathway to an exit in the event of an emergency. An unsafe path of travel to an exit places everyone at risk. Remove all items that may become tripping hazards to you and your coworkers, and that may place emergency responders at increased risk. Know the fire emergency response procedures and grouping area for your work area.

Eyewashes and Emergency Showers

Eyewashes and emergency showers are readily available in strategic locations. Make sure you know where the closest eyewash and emergency shower are located. These important pieces of emergency equipment need to be kept accessible at all times. It may be helpful to place tape on the floor as a visual reminder to keep these spaces clear of obstructions.

Spill Kits

A spill kit should be available where hazardous chemicals are used or stored. If you cannot find one,

ask your supervisor where the nearest spill kit is located. Your spill kit should allow you to at least contain and clean up a minor spill, which is defined as a spill that is unlikely to produce a harmful concentration of a chemical in the air. Spill kits are commercially available from most chemical manufacturers, or you can assemble your own. If you assemble your own, be sure to include PPE along with your acid and base neutralizers and absorbent materials. Never ignore a chemical spill. If a spill is large or contains a particularly hazardous chemical, or if you are uncertain, you should contain the spill if you can do so safely, warn others about the spill, evacuate the area, ensure that no one can enter the area (e.g., block or post sign), then call the Environmental Health & Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)) for assistance and notify your supervisor immediately. See your Chemical Hygiene Plan for more details on spill clean-up.

Mercury is one of the most commonly spilled materials in a lab. If there is a mercury spill in your lab, please call the Environmental Health & Safety Department (Worcester 856-3985; Jamaica Plain 617-983-6207; Mattapan 617-474-3004 (internal emergency ext. 511)) as noted above.

Incident Reporting

If you have a work-related injury or illness, the priority is for you to receive prompt and appropriate medical treatment for your incident.

Please note that a work-related injury or illness, does not mean you had to miss work or require medical treatment. If you experience symptoms associated with exposure to a chemical (e.g., eye irritation or coughing from a brief exposure to formaldehyde), then report the incident. It is imperative that your supervisor be informed of all injuries, illnesses, and exposure incidents, so that the knowledge gained from this incident can be used to prevent other injuries.

Useful Links

OSHA Hazard Communication Standard
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10099