Carnegie Mellon University

Laboratory Safety and Hazardous Waste Generator Information

Contents

1. Laboratory Safety

a. Introductory Information

Carnegie Mellon University provides safety instructions to employees who work with hazardous chemicals in laboratories. This document supplements the information provided in the Laboratory Safety training class and is designed to be retained and used as a safety reference by university lab workers.

b. The OSHA Applicable Regulations

The OSHA Lab Standard - The United States Occupational Safety and Health Administration (OSHA) has promulgated a regulation that applies to all employees who work in a laboratory with hazardous chemicals. It is entitled "Occupational exposure to hazardous chemicals in laboratories" and is generally referred to as the "Lab Standard".

The Lab Standard has the following requirements of employers:

1. Prepare a Chemical Hygiene Plan (CHP) outlining how the employer will comply with the requirements of the regulation
2. Maintain employee exposures below the OSHA permissible exposure levels (PELs)
3. Determine employee exposures to hazardous chemicals
4. Provide employees with information and training about hazardous chemicals, their use and their hazards
5. Offer medical consultations on cases of potential over-exposures to hazardous chemicals
6. Identify the hazards of the chemicals that employees work with
7. Identify respirator use and limitations

Information on each of these items is presented in the Laboratory Safety training class and in this handout.

c. The Chemical Hygiene Officer

OSHA requires employers of laboratory workers to name a Chemical Hygiene Officer (CHO) to oversee the requirements of the Lab Standard.

The CHO for Carnegie Mellon University is Jeffrey Harris, Department of Environmental Health and Safety
Phone: 412-268-7501
Email: jjharris@andrew.cmu.edu

d. The Chemical Hygiene Plan

OSHA requires the preparation of a Chemical Hygiene Plan (CHP) to outline how Carnegie Mellon University will comply with the Lab Standard. It outlines procedures and requirements that all laboratory workers must adhere to. This document is available to employees of laboratories in two ways:

i. Using this link for Chemical Hygiene plan
ii. From the EHS office located in the FMCS Building, room 307, and from the EHS office in Mellon Institute 313.

e. Laboratory Safety Training

The Lab Standard mandates that all laboratory workers receive training in the details of the Chemical Hygiene Plan and the OSHA Laboratory Standard. The Carnegie Mellon University Department of Environmental Health and Safety (EHS) offers this training on a regular basis. It is the responsibility of the individual laboratory supervisors and Principal Investigators (PIs) to ensure that all new employees receive this training within 30 days of their employment. Check the EHS website for a schedule of the next lab safety training sessions.2

This training is REQUIRED for all new lab members. Completing a refresher module (performed electronically) is also required at regular intervals.

f. Determining Employee Exposures

The laboratory workers at Carnegie Mellon work with hundreds of different chemicals in scores of different ways. It is not practical to perform air monitoring to evaluate each of these different potential chemical exposures. To ensure that all laboratory chemical exposures remain below applicable limits, the university instead requires laboratory workers to follow the requirements presented in the Chemical Hygiene Plan and in the Laboratory Safety training class. Adherence to these mandates will ensure that employee exposures remain at a safe level. EHS will perform evaluations upon request and when there is a reason to believe that exposure/overexposure has occurred.

2. Identifying and Understanding the Hazards of Your Chemicals

a. Identifying Hazards of Chemicals

When lab members work in the laboratory, they need to know whether the material is hazardous, what those hazards are. There are several ways to obtain this information:

i. From the label on chemical containers: manufacturers are required to properly label each container. By law, the label must indicate the name of the product and list the hazardous ingredients present. It must also provide information regarding the hazards associated with using the material. This is often done both with text information and with symbols.

There are two common systems used on labels to quickly provide information of the relative hazards of a material. The first one is called the National Fire Protection Association (NFPA) warning diamond, which appears below as **Figure 1**. This system uses a numerical rating of hazards in each of three colored sections (health hazard, fire/flammability hazard and reactivity hazard).

Figure 1. NFPA warning diamond

Numbers in these three sections can range from 0 to 4. Use the following guide to help you evaluate the hazard numbers:

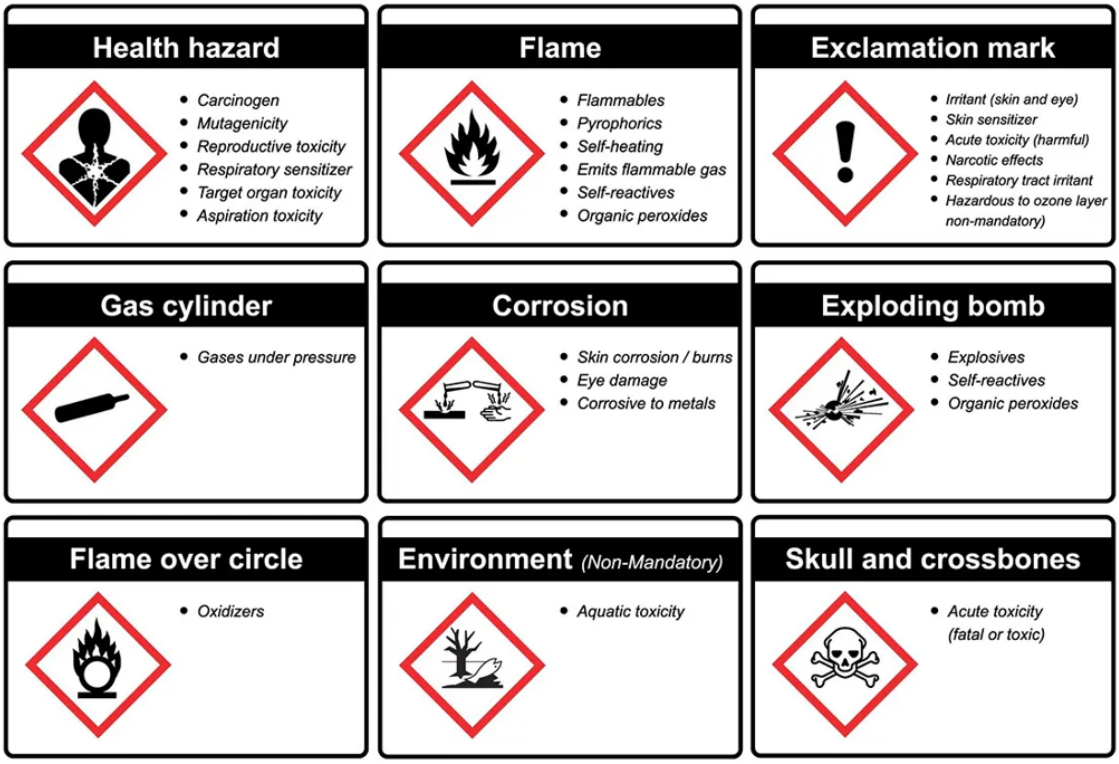
Health hazard (blue portion)	0 - Ordinary combustible hazards in a fire 1 - Slightly hazardous 2 - Hazardous 3 - Extreme danger 4 - Deadly
Fire/flammability Hazard (red portion)	0 - Will not burn 1 - Will ignite if preheated 2 - Will ignite if moderately heated 3 - Will ignite at most ambient conditions 4 - Burns readily at ambient conditions
Reactivity hazard (yellow portion)	0 - Stable and not reactive with water 1 - Unstable if heated 2 - Violent chemical change 3 - Shock and heat may detonate 4 - May detonate
White Portion Used for other hazard warnings	For Example: "**CORR**" - means the material is corrosive "**OXY**" - means the material is an oxidizer

The second system is the Globally Harmonized System of Classification and Labelling, which uses pictograms, hazard words, and numerical rating from 1-5, with 1 being the HIGHEST hazard and 5 being the LOWEST (**Figure 2**).

II. There are two applicable rules regarding the labeling of chemical containers:

1. Users are NOT permitted to remove or deface a manufacturer's label from a container until the container has been emptied.
2. All secondary chemical containers (such as wash bottles, containers with specially prepared dilutions or mixtures, or any other storage containers that users have placed hazardous materials into) must be labeled. In other words, ALL containers in the laboratory must be labeled with at least the container contents and hazard word.

Figure 2. GHS pictograms



b. Safety Data Sheets

A Safety Data Sheet (SDS) is a summary of safety-related information for a chemical or other item containing hazardous ingredients. All manufacturers are required by OSHA to provide an SDS when the product is ordered for the first time, and to also provide it for subsequent orders if the information on the SDS has changed since the previous shipment.

Principal investigators and Lab managers must make SDS available to laboratory members either in a paper form or in a digital form. Laboratory members working with any hazardous chemical must read the SDS prior to working with the chemical.

The SDSs generally contain a lot of information, some of which may not be easy to understand. **Figure 3** contains some information that should be of help to you in understanding the SDS. The 16 sections are standard among all SDSs.

Figure 3: How to Read an SDS

Sect	*Title*		*How to Understand This Section*
1	**Product and Company Information**	→	This is the name of the product.
2	**Hazards Identification**	→	This is where you will find pictograms representing hazards. You will learn how to handle the material safely if you use the precautions given in section 7.
3	**Composition/Information on Ingredients**	→	This identifies the hazardous ingredients in the product by percentage range (if it is a mixture). Only hazardous ingredients need to be identified. Trade secrets for chemicals are not always included in an SDS, but a statement must be added to Section 3 of the sheet indicating that a specific chemical identity and/or percentage is being withheld as a trade secret. In the event of a medical emergency, this information must be relayed to medical personnel.
4	**First-Aid Measures**	→	Don't perform first aid unless you are trained to do so. Provide the SDS to the emergency responder.
5	**Fire Fighting Measures**	→	Don't fight the fire unless you are trained to do so. Provide the SDS to the Fire Department.
6	**Accidental Release Measures**	→	Follow the instructions in the Emergency Response Guide (ERG) located next to the door in your space. Use this information in addition to the ERG.
7	**Handling and Storage**	→	This section should be straightforward. It is very important to follow handling and storage rules exactly.
8	**Exposure Controls/Personal Protection**	→	Very important information that will allow you to handle the material without adverse health effects. Frequently refers to need for respiratory protection. In most cases, this is not needed at the exposure levels you will experience.
9	**Physical and Chemical properties**	→	This section is of value to you in understanding the ways you will use the material; things like boiling point and solubility may be very helpful.
10	**Stability/Reactivity**	→	Important information about incompatibility with other chemicals during storage and use. Remember that almost everything forms carbon monoxide and nitrogen oxides during combustion and is not reason for concern.
11	**Toxicological Information**	→	Largely a replay of section 3, but in much more frightening detail. Again, be cautious but don't be too scared to use the material. Proper handling makes all the difference. LD50 is a lethal dose for 50% of the species population. LC50 is the lethal concentration (airborne) for the species population.
12	**Ecological Information**	→	Generally, this won't be of much use to you in the lab.
13	**Disposal Considerations**	→	Identifies whether the material is collected as hazardous waste or not, which is very important to know.

14	**Transport Information**	→	Generally, not important for use of the chemical in the lab.
15	**Regulatory Information**	→	This provides PELs or other standard information and identifies carcinogenic materials.
16	**Other Information**	→	Information that is not included in any other sections.

iii. Other Information Sources

In addition to labels and SDS, additional information about the hazardous chemicals may be found on the EHS website. These references provide information regarding specific types of hazards, such as carcinogens, reactive and explosive materials, compressed gases, as well as information for general laboratory safety.

Please contact the EHS at safety@andrew.cmu.edu to get further information on these additional reference materials.

c. Chemical Inventory—ChemTracker

It is critical that all laboratory employees know which hazardous materials are present in their workplace.

Each laboratory is responsible for preparing and regularly updating an inventory of hazardous chemicals in the work area. This inventory is maintained on the web, through a program called ChemTracker, which is part of SciSure. EHS offers SciSure/ChemTracker training for group members.

When properly prepared, the chemical inventory not only identifies the presence of hazardous materials, but also their quantities, their locations, and some basic safety information about the chemical.

All new chemicals (including compressed gases) must be updated in ChemTracker within 30 days of delivery. This is usually done by Group Safety Coordinators of the lab. If you are Group Safety Coordinator for your lab, please make sure you sign up for the training required (Group Safety Coordinator training and SciSure/ChemTracker training).
The laboratory should create a system to ensure that the inventory is updated regularly. Some labs choose to keep track of purchases and emptied chemical bottles to accomplish this. Each lab can select a system that works best for them. EHS requires that the inventory be reviewed and updated at least once per year and preferably more often, especially for labs with high chemical usage.

d. Understanding the Hazards Present in Your Laboratory

Armed with the information about the chemicals present in their laboratory obtained from the inventory, employees should then review the labels and SDS for the chemicals that they will work with (or be near while other members work with them) to determine the specific hazards that may affect them. In Laboratory Safety training provided by EHS, you learned about *general* hazards of certain classes of chemicals. Some of this information is included in **Figure 4**. You must still investigate information resources (labels, MSDS, etc.) to determine the *specific* hazards in your laboratory.

Figure 4 – General hazards of certain classes of chemicals

Common carcinogens (cancer-causing agents) with laboratory use:

Chromic Acid	Chloroform	Carbon Tetrachloride
Benzene	Ethylene Oxide	Styrene
Methylene Chloride	Arsenic	Cadmium
Formaldehyde	Acrylonitrile	Beryllium
Acrylamide		

Common corrosives (cause acute respiratory, skin or eye damage) with laboratory use:

Nitric acid	Hydrochloric acid	Ammonia
Sulfuric acid	Phenol	Hydrogen peroxide
Sodium hydroxide	Potassium Hydroxide	

Common solvents (may cause irritation as well as long term organ effects) with laboratory use:

Acetone	Hexanes	Toluene
Methanol	Ether	Tetrahydrofuran
Ethanol	Isopropanol	

Common reproductive hazards (may affect reproductive organs or systems) with laboratory use:

Arsenic	Cadmium compounds	Vinyl chloride
Benzene	Lead compounds	Xylene
Ethylene oxide	Mercury compounds	

Common acute toxins (may cause serious, immediate hazards) with laboratory use:

Acrolein	Chlorine	Hydrofluoric acid
Arsine	Cyanides	Sodium azide

Note: *This is not by any means a complete listing of laboratory hazards, but rather a general outline of the types of hazards that may be present in a lab.*

e. Learning the Signs and Symptoms of Overexposure to Hazardous Chemicals

Knowing the hazards of the materials you work with is important so that you know to seek help if you develop signs or symptoms of exposure to those hazards. If you notice such signs or symptoms of overexposure, contact your supervisor IMMEDIATELY.

There are two types of hazards: acute and chronic.

Overexposure to **Acute hazards** will cause development of symptoms immediately or after a short period of time. Some examples are corrosive or irritant materials and acute toxins are examples. **Corrosives** tend to burn skin or eyes quickly after overexposure. **Irritants** produce respiratory irritation almost immediately as well. **Acute toxins** cause severe damage of organs, even death, even in case of a short exposure to small amounts of chemicals. Acute exposures are generally easier to spot but also require quick medical responses.

Other chemicals produce effects that are hard, if not impossible to detect without medical testing. These occur over long periods of overexposure and are called **chronic hazards**. **Carcinogenic** materials may cause cancer many years after exposure. Other chemicals may affect the brain, lungs, heart, liver or other organs, or cause infertility, though immediate symptoms may not be noticeable.

To make matters even more difficult, some materials have both acute and chronic hazards. Many solvents fall into this category; (e.g., benzene may produce irritation in the short term and cancer in the long term.)

It is important to stress that these effects are only going to occur if you are **overexposed** to dangerous chemicals. If you follow safety guidelines in our Chemical Hygiene Plan and training modules, and if you work with chemicals in the lab properly, you will prevent overexposure and any health issues.

f. Permissible Exposure Limits and Air Monitoring

How do you determine whether you are overexposed to a particular chemical and what the safe level for a particular chemical is?

All SDS identify a "safe" exposure level for a chemical, if there is one established. Most often, OSHA specifies these "safe" levels as a Permissible Exposure Limit (PEL), the level to which a person may be exposed for an eight-hour period without expected harm. Other similar standards are also present on the material's SDS. Most laboratories at Carnegie Mellon University have exposures well below these standards, provided that you follow the protective practices specified for chemical use. These practices are outlined in the next section of this document.

If there is reason for you to believe that chemical exposure limit is being exceeded, contact EHS to have the exposure situation evaluated. Air quality monitoring may be performed as part of this evaluation.

g. Medical Monitoring

The OSHA Lab Standard specifies that there are three circumstances in which Carnegie Mellon University is required to offer laboratory workers a medical evaluation for a possible chemical overexposure. They are as follows:

i. If you develop any signs or symptoms of overexposure to a hazardous chemical
ii. If you were involved in a significant leak or spill of a hazardous chemicals
iii. If an air test was taken and the result showed an exposure over the PEL

If any of these situations occur, contact your supervisor **immediately**. The medical evaluation may include testing and treatment, depending on the physician's opinion. All medical information collected is confidential between you and the physician.

h. Detecting Releases of Hazardous Chemicals

It is important to be able to recognize when releases of hazardous chemicals in the laboratory occur. Some releases of chemicals may be obvious--there will be strong odors, irritating fumes, broken bottles or signs of damage to the building or equipment. Leaks of some chemicals may not be as obvious at all, though. For example, one may notice a leak when the level of liquid in a bottle have decreased, or when crystals form on the outside of the container or on other surfaces. Be on the lookout for such clues and report any suspected spills or leaks to your supervisor.

3. Working Safely with Hazardous Materials

a. Working Safely with Hazardous Materials

To protect yourself from the hazards of the chemicals you work with, you must perform work according to standard safety practices. We will discuss some of these standard practices next. Your laboratory supervisors should provide more specific safety practices to you in the laboratory where you use chemicals.

b. Fume Hoods

The primary way to protect you from chemical hazards is using a fume hood. You should perform all work with volatile chemicals in a fume hood.

EHS tests all fume hoods on an annual basis. Properly working hoods are marked with a green label indicating satisfactory performance when the sash is closed to a proper level, as indicated on the side of the fume hood. Unsatisfactory performing hoods are marked with a red label. Red labeled hoods may NOT be used for hazardous chemical use.

For the fume hood to work properly and protect you, certain guidelines must be followed:

i. The fume hood must be kept clean and uncluttered. An excess of stored items in the hood may impede the airflow that protects you. The items that block the airflow may also produce turbulence that causes hazardous materials to flow out of the hood into your breathing zone.
ii. It is important to ensure that the fume hood is working before you start using it. Most hoods have a flow monitor that sets off an alarm when the airflow is unsafe. If there is no alarm or flow monitor on your hood, please contact EHS. Never use a fume hood that is not operating properly.
iii. Always work at least six inches in from the edge of the fume hood, to enable the hood to properly remove hazardous materials and to prevent chemicals from spilling outside of the fume hood (and potentially on you).
iv. Never modify a fume hood or its associated ductwork without permission from EHS.
v. If a fume hood fails (such as by equipment malfunction or power failure) all work inside MUST be stopped and the sash must be closed. Hood alarms may be silenced at that time.
vi. Contact EHS if there is no test label on your hood, or if the test date is more than a year past.
vii. If your fume hood is not working properly or it has a red label, send a work order for FMCS to perform the repair.

Other engineering controls such as glove boxes or ventilation also help control hazardous materials.

c. Personal Protective Equipment

The second important practice to follow when using hazardous chemicals is to use personal protective equipment as required for your procedure. This equipment may include the following:

i. Protective gloves

Be sure to have protective gloves appropriate for the chemical being used and for the procedure. Thin, disposable gloves are not generally suitable for chemical protection. Check section 8 of SDS for more information. You can also search for glove selection charts available online or contact EHS.

ii. Protective eyewear

Safety glasses are required in laboratories where chemicals or physical hazards are present. Remember that safety glasses protect you from impacts but not from chemical splashes or airborne dust. For these situations, protective goggles are necessary. Goggles must completely seal around your eyes in order to prevent chemicals from reaching your eyes. Many goggles have ventilation holes in various places on their sides. Be sure to use goggles that have ventilation that does not allow splashed material to get to your eyes. Contact EHS with any questions about goggle suitability.

Chemical face shields are also options for protection of your face from chemical splashing.

iii. Respirators

Since most chemicals exposures in laboratories at Carnegie Mellon University are below the OSHA exposure limits when proper work practices and protective equipment are used, use of respirators is not permitted in laboratories WITHOUT approval of EHS. Note that disposable face masks are permitted at any time, though the wearers must understand are not a required protective device against overexposures to any materials.

iv. Lab Coats and Aprons

The use of lab coats in laboratories is strongly encouraged. While these coats will not offer sufficient protection from significant splashes of hazardous chemicals, they do help greatly in protecting one's clothing from smaller exposures. Flame-resistant lab coat is required when working with highly flammable or pyrophoric materials.

If there is a potential for significant chemical splashing, the use of a protective apron (of a material designed for the chemical in question) must be used. An example of this situation is pouring of large quantities (over one quart) of an acid or other corrosive material.

d. Chemical Purchasing, Handling and Storage

A critical element in the safe use of chemicals is to ensure that they are purchased, handled and stored properly. All laboratories are required to follow the Carnegie Mellon University Procurement Services Policies. This includes but is not limited to training requirements, using preferred suppliers, purchase orders only for certain materials & equipment, and hazardous materials purchasing card programs.

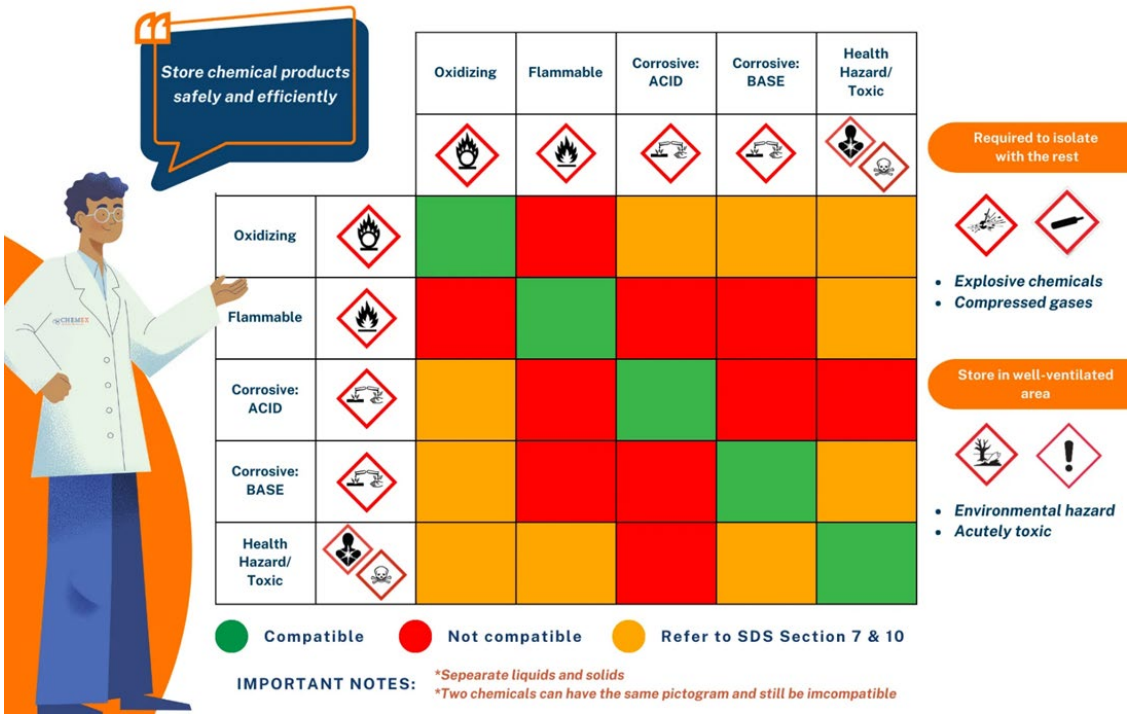
When purchasing chemicals, it is important to order the smallest, most convenient size container. Smaller containers are more easily and safely handled and represent less of a hazard in case of a spill, leak or other accident. This is especially important with highly hazardous materials. When possible, order chemicals in break-resistant packaging. These containers can prevent spills or leaks when dropped or tipped over, while regular containers cannot.

When handling chemicals, you should move the containers in a safe manner. Use heavy rubber bottle carriers when transporting chemicals within and outside of the laboratory. Always support the bottom of a container with your hand when using "finger holes" on glass bottles. Always re-cap or seal containers after each use.

When storing chemicals, there are many safety precautions to observe. One of the most important is to properly segregate incompatible classes of chemicals. Acids should be separated from bases. Both should be stored in corrosive cabinets (generally made of wood) and separated from oxidizers. Flammable materials should be stored separately in a flammable storage cabinet. Storing chemicals alphabetically NEVER accomplishes the needed segregation. Original chemical containers provide information about their hazard classes to aid in this segregation activity.

Please obtain chemical compatibility chart online, use the one below in **Figure 6**, or reach out to EHS with questions about storage of chemicals.

Figure 6. Chemical compatibility chart



e. Housekeeping and Maintenance

Good housekeeping is essential to a safe laboratory. Some helpful rules to follow are:

i. Put away chemicals, reagents and equipment at the end of each day.
ii. Do not leave chemicals on the edges of countertops.
iii. Position tubing and glassware where they will not be bumped or jostled by people passing.
iv. Clean up spilled chemicals or spilled water immediately. If the spill is large or chemicals are highly toxic, please evacuate the area and contact EHS.
v. Keep bench tops open and free from clutter.
vi. Do not block aisles or doorways.

Remember that good housekeeping is a matter of habit. A few minutes spent cleaning and straightening up your work area each day accomplishes this.

f. General Rules of Work

i. No eating or smoking in the laboratories.
ii. Check glassware and equipment for damage and integrity before use. Damaged glassware may break as reactions or heating occurs. Old or poorly maintained equipment may cause fires or chemical spills.
iii. Avoid horseplay in the laboratory.
iv. Plan new procedures with safety in mind.

g. Compressed Gas Safety

Compressed gases generally present two types of hazards: first, by their compressed state and high pressure, and second, by the hazard of the gas within the cylinder.

All compressed gases are hazardous due to their pressurization. Extreme care must be taken in handling compressed gases to ensure that their valves do not become damaged. Most compressed gas cylinders pose a hazard due to the gas within. For example, chlorine, hydrogen sulfide, and carbon monoxide are poisonous gases. Hydrogen and methane are flammable, and oxygen greatly supports fire. Inert gases, such as argon or helium, can deplete oxygen levels in an area to unsafe levels. Be aware of ALL the hazards of your compressed gases.

Some general rules for compressed gas safety;

i. Follow procurement policies.
ii. Always transport and store cylinders with the protective cap in place over the valve.
iii. Always transport cylinders with gas cylinder carts.
iv. Use gas cabinets (or approved ventilation) for storage & use of corrosive, toxic, and highly reactive gases.
v. Avoid ordering lecture bottles if the material is available in returnable cylinder. Owned gas cylinders should only be to minimize the volume of the hazard.

h. Handling Particularly Hazardous Substances

Particularly hazardous substances (PHS) must be always handled with special precautions, due to their more serious hazard potential. These are chemicals identified by OSHA as either carcinogenic, acutely toxic, a reproductive hazard or an unstable, explosive material. For information on identifying the PHS materials in you lab, visit Particularly Hazardous substances definition page.

If PHSs are used in the lab, members are required to fill out online PHS form. This form can be found under “Forms” on the group page in SciSure. The PHS form is designed to "force" you read SDS, to learn about safe and proper handling of these special hazards, and to anticipate problems or accidents. Each person using a PHS must read the procedure for the material AND be approved by the laboratory PI and EHS to work with the PHS.

i. Prior approval to work, working alone

At Carnegie Mellon University, **all people using hazardous materials, equipment or processes in laboratories must be approved by the laboratory Principal Investigator (PI) to do so**. There should be no unauthorized use of laboratory chemicals by any worker (an unauthorized use is **any** use of a laboratory or chemical in a way not approved by the laboratory PI.)

No one is permitted to work alone with hazardous chemicals, equipment or processes without written permission of the PI. If permission is granted for working alone, procedures should be established to address any problems (spills, exposures, fires) that may occur. Examples of these contingency procedures are to have a neighboring person check in on you, requesting University Police to call or stop by regularly, or setting up a walkie-talkie or similar communication system. Permission to work alone online form can be found under “Forms” on the group page in SciSure. Please Note: some materials may NEVER be used when working alone. Those include, but are not limited to pyrophoric, acutely toxic, and highly reactive materials.

j. Unattended Operations

Unattended operations involving hazardous materials require special procedures to protect people and facilities from accidental exposures. For each such operation, consider the effect of an accident or unplanned incident. Examples include of such incidents are:

i. Power failure
ii. Breakage or rupture of glassware, tubing or other apparatus
iii. Fire
iv. Failure of equipment and equipment controls

For each situation, create plans to address the hazards that may be produced, and arrange for implementation of the plan. For example, power failures generally cause hoods to stop, necessitating the stopping of experiments. If lights go out, evacuation of the room may be needed.

If you cannot ensure the safety of the lab area in the event of these incidents, the operation **may not be left running unattended!**

4. Emergency Response

a. Emergency Awareness

Awareness of the hazards within a laboratory is a primary requirement of good emergency response. All laboratory personnel should be aware of the following items:

i. The types of hazardous materials present and the hazards associated with them. This information should be obtained through one's routine work and the review of the inventory, SDS and labeling.
ii. The outcomes of the emergency
This may include damage to property or injuries/loss of life to fire, explosion, exposure to hazardous chemicals or hazardous byproducts of fire or explosion.
iii. The need for additional resources and the understanding of one's limitations to respond in emergencies. In general, if you have not been trained for certain responses, such as spill clean-up, first aid or fire extinguisher use, do not attempt a response. If you are in doubt, call EHS for help.
iv. What to do in the event of an emergency and whom to call:
Emergency response procedures, contacts and phone numbers are provided in the Emergency Response Guidebooks posted in each laboratory near the exit. In addition, make sure you are familiar with the emergency evacuation route for the laboratory, which should be posted in the lab or adjacent hallway.

For all emergencies, contact University Police at 8-2323 first; do NOT call 911! Provide information about the nature of the incident, the exact location, the names of any

chemicals involved and whether there are any injuries. Remain in a secure area where you can be contacted for further information.

b. Small-scale Spill Response

There should be at least one person in each laboratory able to respond to small-scale chemical spills. Each lab should also have spill response materials of the type and quantity to address all types of hazards present. This may include kits addressing acidic or basic materials, solvents, mercury, formaldehyde or other hazards. Your kit should not only include sorbent and/or neutralizing materials, but also protective items (gloves, goggles, Tyvek suits) and disposal bags as well. For assistance in preparing spill response kits, contact EHS.

In a case of a large spill or spill of a highly toxic or reactive chemical, please evacuate the area, and contact University police and EHS.

Refer to the Emergency Response Guide, posted in all laboratories, for further emergency response information.

c. Laboratory Emergency Response Equipment

There are a few emergency response items present in your laboratory, to be used in the event of a spill or fire.

i. **Safety Eyewash**: To be used when chemicals are spilled into the eye. It is CRITICAL that eyewashes be used for 15 minutes in the event of exposure. It is the laboratory's responsibility to test the eye wash once per month to ensure that it is working properly and that the supply of water remains clean. Please record your testing on the laminated Eyewash form provided by EHS.

ii. **Safety Shower**: To be used when chemicals are spilled on the body. You MUST remove any contaminated clothing in order to remove chemicals effectively. Again, it is CRITICAL that the shower be used for 15 minutes in the event of exposure. Facilities Management & Campus Services (FMCS) tests safety showers annually.

iii. **Fire Extinguisher**: To be used in the event of a fire smaller than a wastebasket. Do not attempt to put out a larger fire yourself, instead pull the fire alarm and evacuate the area. If you have never been trained in fire extinguisher use, this is NOT the time to learn. Let someone else use it.

iv. **Spill Clean-up Kit**: To be used when chemicals are spilled. It is important that only members familiar with spill kit capacity perform it. Trying to clean up a too- large spill or one of very hazardous materials can cause overexposure and dangerous situations. If the spill is larger than the capacity of your spill kit, or the chemical spilled is highly hazardous, evacuate the area and let EHS take care of it.

5. Hazardous Waste Generation

a. Applicability

The practices outlined in this section address hazardous waste generation in laboratories at Carnegie Mellon University by laboratory workers. This document supplements the information provided in the Hazardous Waste Generator training class and is designed to be retained and used as a safety reference by university lab workers.

b. The Regulations

Generation of hazardous waste is regulated by the Environmental Protection Agency (EPA), specifically under the Resource Conservation & Recovery Act (RCRA). Links to this and other regulations may be found on the EHS web page under "Regulated Waste Management" section. The regulations are detailed and specific as to the requirements of you (the generator).

The regulations have as their basis the principle that proper management of hazardous waste is the responsibility of the generator (in this case, Carnegie Mellon University) from cradle to grave. This means that from the time the waste is created at Carnegie Mellon to the time that it is disposed, we are responsible for the waste.

c. Training and Instruction

EPA regulations require training for all hazardous waste generators regarding specific duties and responsibilities. Carnegie Mellon requires that all hazardous waste generators attend an in-person Hazardous Waste Generator training session prior to generating hazardous waste in the lab. Refresher for this training session is required, and members who need it will receive reminders from SciSure.

6. Defining Hazardous Wastes

a. Defining Hazardous Wastes

The EPA defines hazardous waste as a waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment. Many processes done in research or teaching laboratories at Carnegie Mellon often generate waste.

b. Types of Hazardous Wastes

RCRA regulates many different wastes as hazardous waste, including:

- Used or spent chemicals
- Unwanted or abandoned chemicals
- Expired chemicals
- Any contaminated material used in a chemical spill
- Sharps contaminated with chemicals

It's important to note that hazardous waste can be in any physical form as well.

c. Characteristic Waste

Characteristic hazardous wastes are wastes that have one or more of the following characteristic properties:

i. Ignitable (D001)- liquid waste with a flash point of less than 140°F/60°C, ignitable compressed gases and oxidizers, and non-liquids that can cause fire through specific conditions

ii. Corrosive (D002)- liquid waste with a pH less than or equal to 2.0 or greater than or equal to 12.5, or liquid waste that corrodes steel at a rate of 0.25 inches per year

iii. Reactive (D003)- may be unstable under normal conditions, may react with water, may give off toxic gases, and may be capable of detonation or explosion under normal conditions or when heated

iv. Toxic (D004-0043)- wastes that are harmful when ingested or absorbed. Toxic wastes present a concern as they may be able to leach from waste and pollute groundwater. The toxicity of a waste is determined by the Toxicity Characteristic Leaching Procedure (TCLP).

d. Listed Hazardous Wastes

In addition to wastes having these characteristics, the definition of "hazardous waste" includes listed wastes. EPA Lists for Hazardous Waste include F-List, K-List, U-List, and P-List materials. While Characteristic Wastes are more common at Carnegie Mellon, we do generate a small number of Listed Wastes. The definitions for Listed Wastes are as follows:

i. F List- Waste from non-specific sources (spent solvents or mixtures)

ii. K List- Wastes from specific sectors of industry, such as petroleum manufacturing or iron and steel production

iii. P List- Unused, acutely toxic hazardous wastes

iv. U List- Unused, commercial-grade or off-spec product wastes

e. Mixture Rule

When dealing with mixtures of waste, the following rules apply:

- Any amount of non-hazardous waste + any amount of listed hazardous waste = **Listed Hazardous Waste**
- Any amount of non-hazardous waste + any amount of characteristic hazardous waste = **Non-Hazardous Waste**, if the mixture no longer exhibits any characteristic

We recognize that the rules for defining hazardous waste are somewhat complicated and difficult to understand. When in doubt about whether a waste is hazardous, contact EHS, who will be able to make the final determination.

c. Other Waste Items Handled as Regulated Wastes

There are many other waste items produced by laboratories that, though not considered "hazardous waste" by the EPA, can be regulated by the state of Pennsylvania. These items include the following:

Compressed gases*	Compressed gasses have different types of hazards associated with them compared to hazardous waste. The gas itself may or may not also be hazardous, but would still need to be collected by EHS when empty.
Biological wastes*	These items include viruses, cultures, human or animal blood, waste or tissue, and materials contaminated with any of these items.
Radiological wastes	This includes both long-lived and short-lived radionuclides. **Note:** CMU Radiation Safety Training is required before working with any radioactive materials or radiation-producing devices.
Needles, pipette tips and other sharps*	These may cause "stick" injuries if placed in the regular trash. They should be disposed of in a puncture-resistant container, labeled as either biological sharps or chemical sharps.
Broken glass*	This may cause cuts or other injuries if placed in the regular trash. They are collected in a broken glass container if they are not chemically contaminated, and in hazardous solid waste container if they are.

* ***These items will be discussed later in this document***

7. Accumulating Hazardous Waste

a. Accumulation Requirements

Carnegie Mellon University maintains Central Accumulation Areas in accordance with EPA Regulations. Accumulation points are protected and secure rooms where waste is to be kept for a limited amount of time until it leaves campus. These CAAs are only accessible by members of EHS or those who have received the necessary training required to enter the space. Because it would be difficult to send hazardous waste from your lab to the Accumulation Points daily, the EPA allows **Satellite Accumulation Areas** at or near the point of waste generation (i.e., your lab).

b. Satellite accumulation requirements are:

i. You can accumulate up to 55 gallons of hazardous waste, or 1-quart of acutely toxic hazardous waste in your satellite accumulation area at one time. At any given time, 55 gallons is the maximum for all combined hazardous waste in your lab. Upon reaching the maximum waste allowed, generators must notify EHS, who has 72 hours to move the excess over 55 gallons to the Central Accumulation Point.

ii. Waste must remain in the location that it is generated in. You are NOT permitted to take hazardous waste to an adjacent room, even if it is just across the hall.

iii. Every container of hazardous waste must be labeled with the words "Hazardous Waste". The container must also be labeled with the characteristics of the mixture, all constituents, and the approximate percentage of each constituent.

iv. Containers used to accumulate the waste must be in good condition, be of a compatible material with the waste that will go inside and must have a screw cap lid. No corks, glass or rubber stoppers, or parafilm are permitted as a lid.

v. The waste accumulation container itself must be kept in a secondary containment bin. Secondary containment is any bin or tub that will hold the contents of the main container, should it break or leak, and prevent the waste contents from entering the drain. Bins are available from EHS.

vi. Containers holding hazardous waste must always be kept closed, except when adding or removing waste. Remove the funnel from the container and cap the bottle after pouring waste into it.

vii. It is acceptable to reuse empty bottles to accumulate hazardous waste. However, the bottle must be RCRA empty before doing so. RCRA empty means that the bottle has not one last drop and has been aired out for a day, to make sure that it is completely empty. The old label must be removed or defaced before the waste is added.

viii. Any waste placed into a container MUST be compatible with the other waste already in the container. This prevents dangerous reactions between the contents of the container that could lead to an explosion or the leaking of the waste. If you are at all unsure of the contents of a waste container, DO NOT PUT ANY OTHER MATERIAL IN IT.

ix. Do not fill any container more than 90% of its capacity. This allows 10% expansion of space in case the container is subjected to temperature extremes or pressure buildup.

8. Removal of Hazardous Waste from the Lab

a. Correct Identification of Hazardous Waste

As we stated earlier, the EPA holds the generator responsible for proper handling of hazardous waste. The first step in this process is the correct identification of the waste. Identification can be made in one of two ways:

i. The generator can identify the contents or constituents of the waste in a container by personal knowledge.
ii. The waste in a container may be tested to identify its contents.

By far the easiest and most effective way to identify waste is for generators to identify it. Many labs assign individual people to use and identify their own waste bottles to help with this process. Others allow multiple users to accumulate waste in the same bottle. In either case, individuals must be aware of the specific contents for each collection container. Incompatible materials must be watched very closely as violent reactions between incompatible waste are potential accidents and have occurred numerous times on campus.

Occasionally you may find a container whose contents are unidentified, or unidentifiable. Try your best to identify the material. Contact other researchers who are (or have been) working in the area to see if they can help identify the material. If you cannot identify the material, label it as "unknown" and EHS will have the contents identified. Unknown materials indicate mismanagement of the chemical inventory. Note: labs that routinely submit unknown waste may be charged directly for the costs of the profile testing.

b. Hazardous Waste Tags

Every container of hazardous waste that is removed from a laboratory MUST have a Carnegie Mellon Hazardous Waste Certification and Disposal tag attached. The waste tag MUST be completed by a person with knowledge of the content of the container. All applicable information on the waste tag must be completed for the waste to be removed by the lab. The waste tag requires the following information:

i. The name of the Principal Investigator or researcher
ii. The department
iii. The building and room where the waste was generated
iv. The telephone number of the person completing the tag, the lab, or the department
v. The date when the waste is submitted for pick-up. (This should be the date of the online pickup request).

vi. The components of the waste (use the complete chemical name--**no formulas**!) include ALL components in the waste, even non-hazardous materials.
vii. The percentage (or ppm) of the component. Total components should add up to 100%.
viii. Printed name of the person submitting the waste.
ix. The signature of the person submitting the waste (Note: this signature states that you are certifying the contents of the container).

Attach the tag to the container with the wire ties provided. DO NOT tape the tag to the container. Untagged containers will NOT be picked up. Incomplete or improperly completed tags will be rejected for pickup until properly completed.

c. Waste Pick-ups

Once the waste containers are tagged, place an on-line request for a waste pick-up. This is done visiting EHS website and selecting "Regulated Waste Management". On this page is a link to a request form, along with instructions for submitting the form. You will be asked to identify yourself and where the material is located. Please provide a brief description of the waste to be removed. You don't have to identify the exact contents of each container on this request form. However please indicate the number and size of bottles. If there is any waste that requires special handling (such as refrigeration for unstable waste), provide that information in the "comments" section. This information helps the pick-up personnel properly plan to make the pick-up. DO NOT CALL EHS OR ANY PARTICULAR EHS EMPLOYEE TO REQUEST A PICK-UP. ALL WASTE PICK-UP REQUESTS **MUST** BE MADE ON THE WEBSITE. Special pickups can be arranged, but only after an on-line request has been submitted.

9. Waste Minimization

a. Ways to Minimize Waste from a Laboratory

Just as the world doesn't have an infinite capacity to deal with hazardous waste, neither does the university have an infinite budget to pay for it. It is critical that a laboratory does everything it can to reduce the amount of hazardous waste it produces. The following steps will help reduce our generation of hazardous waste. Consider them all when planning or revising your work.

i. Micro-scale experiments whenever possible.
ii. Purchase the smallest quantity of chemicals needed. Unused chemicals turn into hazardous waste, which is nearly always more expensive than any money saved by buying the "larger size".
iii. If you need a small amount of a chemical or just need some to try out an experiment, contact EHS. They will search for the university's inventories and find someone who will be happy to lend you some of the material for your tests.
iv. Substitute less hazardous chemicals for more hazardous items.
v. Minimize the use of heavy metals, as they are particularly expensive to dispose of.
vi. Use older items in your inventory before newer items.
vii. Check your inventory frequently to maintain your materials in good condition.
viii. Eliminate mercury-containing devices, such as thermometers and manometers, replacing them with non-mercury alternatives. Contact EHS for further information on this.

b. Reduce, Reuse, Recycle, Recover

At Carnegie Mellon University, we strive to do our work in the most environmentally sound fashion possible. As a result, we have several programs in place to handle materials that are particularly damaging to the environment or that occupy lots of landfill space. Please look at the "recycling" page of the EHS website and also the Green Practices Committee's website for helpful information. Note that the university collects these common lab materials for special handling: computers, batteries, and used oil.

When you study your lab's waste, consider these four activities in this order:

i. **Reduce**: Can you reduce the amount of waste produced?
ii. **Reuse**: Can you reuse any of the waste produced (perhaps as a cleaning rinse?)
iii. **Recycle**: Can any of the materials be recycled rather than being disposed of?
iv. **Recover**: Can any of the components of the materials be recovered and used again?

10. Other Waste Streams

a. Biological Wastes

Biological waste materials are handled differently from hazardous waste. The following procedure applies to all biological wastes, including any human or animal blood or tissue, any animal waste, any items contaminated with blood, and any infectious or pathological cell cultures, bacteria, or viruses.

i. Line a biohazard waste box with TWO red biohazard bags.
ii. Place the waste into the bag (do not overfill the bags--boxes should never exceed 40 pounds or if it is 2/3rd full.
iii. Tie each bag separately in a knot.
v. Close the box and tape ALL seams with 2" poly tape.
vi. Label all boxes on the top with the building and room number of where the material was generated, and the PI's or lead researcher's name.
vii. Place an online request for pick-up through the EHS website. Requests should be made by5 PM on Tue
viii. The boxes will be picked up from your lab on Wednesdays.
ix. Replacements for what you place for waste will be brought when waste is picked up. If you need additional supplies, add the details of what you need and how many in the comments of your waste ticket. If you need supplies before waste day, contact safety@andrew.cmu.edu

Remember that if you work with biohazards, you must have Biohazard training, available from EHS.

b. Needles, Sharps

Pipette tips or needles of any kind, whether biologically or chemically contaminated or not, are NEVER to be placed in wastebaskets.

Uncontaminated sharp materials should be placed in puncture proof plastic containers (such as laundry detergent bottles or sports drink containers), sealed shut when full, and marked "uncontaminated sharps". Custodial staff can then remove them.

Sharps that are biologically contaminated MUST be placed in red plastic sharps containers available from EHS. They must be labeled as “biological waste”, the top must be snapped/ secured shut and disposed of as biological waste. DO NOT SNAP OFF SYRINGE NEEDLES IN THE SHARPS CONTAINER--this may produce aerosolizing of the contents of the needle.

Chemically contaminated sharps should be placed in puncture proof containers resistant to the chemical present. When the container is full or ready to be disposed of, completely seal the box, tag it, and place an on-line request for pick-up, like any other hazardous waste.

c. Broken Glass

It is **NEVER** permitted to place broken glass in the wastebasket. Broken glass must be placed into a rigid cardboard container. When the container is filled, it must be completely sealed with tape and marked "broken glass". At this point, the custodians will remove the box.

Chemical supply firms offer "broken glass" containers that may be purchased by the lab for this purpose, though any sturdy cardboard box will suffice as well.

Note: **NEVER** use broken glass box for liquid, trash, or any hazardous materials.

d. Compressed Gases

It is very important that you follow all requirements when dealing with compressed gases (note that safety requirements for compressed gases are in the lab safety section of this document).

i. Only order the amount of gas that you need. Gas is delivered twice a week. There should be no reason to order more than your immediate need. Neither
Neither the university nor individual labs can store large quantities of gas cylinders.

ii. Do not order lecture bottles or any non-returnable cylinders for your gases unless necessary. They are very difficult and expensive to dispose of.

iii. Place all gas orders through Mellon Stores, even if you are not located in Mellon. The gases will be delivered for you to pick up in your delivery area. Please notify Mellon Stores of cylinder purchases or rentals from outside vendors or suppliers.

iv. Always pick up and return your gas cylinders promptly.

v. Ensure that the identity of the cylinder contents is always marked clearly.

11. Quick Guide to Laboratory Resources

Call University Police at 8-2323 to report:

- Chemical, radiological or biological spills (except minor ones)
- Accidents or injuries (except minor ones)
- Fires
- Suspicious packages or suspicious persons

Contact EHS for information on:

- Chemical safety
- Materials Safety Data Sheets
- Hazardous waste
- Radiation safety and radiological waste removal
- Biological safety and biological waste removal
- Fire Safety
- Laser Safety
- Asbestos issues
- General safety issues

Call FMCS Service Response 8-2910 to report:

- Utility malfunctions
- Fume hood malfunctions

e. For Further Information

i. Jeffrey Harris, Chemical Safety & Hazardous Materials Senior Manager (Chemical Hygiene Officer)
Phone: 412-268-7501
Email: jjharris@andrew.cmu.edu
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iii. Jelena Micic, Laboratory and Research Safety Specialist
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iv. Kalie Hewitt, Laboratory and Research Safety Specialist
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12. Revisions

Date	Documented Changes	Initials
05/24/2020	Updated Format and Accessibility Update	MAS
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10/21/2024	Reviewed – no updates needed	JJH
5/6/2025	Updated broken links	MAS
10/27/2025	Updated the whole document with new information	JM