Carnegie Mellon University

Laboratory Safety and Hazardous Waste Generator Information

1. Laboratory Safety

a. Introductory Information

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

b. The OSHA Applicable Regulations

i. The OSHA Lab Standard

The United States Occupational Safety and Health Administration (OSHA) has promulgated a regulation that is applicable to all employees who work in a laboratory with hazardous chemicals. It is entitled "Occupational exposure to hazardous chemicals in laboratories" and is generally spoken of 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 in cases of potential over-exposures to hazardous chemicals
6. Identify the hazards of the chemicals employees work with
7. Identify respirator use and limitations

Information on each of these items will be presented in this handout and in the Lab Safety training class.

ii. Emergency Response

Another OSHA regulation, "Hazardous waste operations and emergency response", also addresses workers in laboratory areas. All persons who work with hazardous chemicals may have a responsibility in the event of a spill or leak of a hazardous chemical. This regulation requires that such persons be trained in the proper actions, should this occur. These response procedures will be addressed later in this handout and in the Lab Safety class.

c. The Chemical Hygiene Officer

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

i. The EHS website
ii. From the EHS office, FMS Building, third floor

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 (EH&S) performs 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.

This training is REQUIRED once for all new or re-assigned lab employees. Completing a refresher module (performed electronically) is required every three years as well.

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.

2. Identifying and Understanding the Hazards of Your Chemicals

a. Identifying a Chemical's Hazards

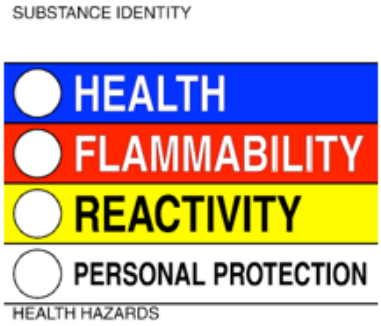
When you work with a chemical material in the laboratory, it is important to know whether the material is hazardous, and also to know what those hazards are. There are a number of ways you can obtain this information:

i. One of the requirements manufacturers have when they supply the chemicals you buy is to put a proper and complete label on the container. By law, they must indicate the name of the product and list the hazardous ingredients present. The label must also provide information regarding the hazards associated with using the material. This is often done both with text information as well as with symbols. There are two common symbols used on labels to quickly provide information of the relative hazards of a material. One is called the National Fire Protection Association (NFPA) warning diamond, which appears below as **Figure 1**. The other is the Hazard Materials Information System (HMIS) system,

which appears below as **Figure 2**. Both systems use a numerical rating of hazards in each of three colored sections (health hazard, fire/flammability hazard and reactivity hazard).

Figure 1

Figure 2



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

ii. There are two applicable rules for us regarding the labeling of chemical containers:

1. You 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 different storage container we 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.

In March of 2012, OSHA revised its Hazard Communication Standard. While this regulation does not DIRECTLY affect laboratory workers, portions of it will impact you. One of these revisions addresses a different set of pictograms or symbols to indicate a particular hazard of a chemical or other hazardous material.

b. Safety Data Sheets (formerly, Material 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 making such products are required by OSHA to send you an SDS when you first order the product and for subsequent orders if the information on the SDS has changed since the previous shipment. **[NOTE: as of March 2012, the term "Safety Data Sheet" has replaced the term "Material Safety Data Sheet," to make the document compatible with world-wide systems of hazard information.]**

i. OSHA requires that employers save all SDS received and make them available to the applicable employees. EHS maintains the SDS that they receive; each individual laboratory must also do this.

ii. Carnegie Mellon further requires the laboratory supervisor or principal investigator to ensure that an SDS for all chemicals in the inventory is available to lab employees either through the web or as a paper copy kept in or near the laboratory. SDS links are provided for most manufacturers on the EHS website, www.cmu.edu/msdslinks.htm. In addition, it is also very easy to locate an SDS by going to an internet search engine (such as Google, or Yahoo) and type the name of the chemical and "MSDS" in the search box. Employees working with any hazardous chemical are to read its SDS prior to working with the material. One exception: In the case of Particularly Hazardous Substances (PHS) materials (see page 14 of this document), a paper copy of the SDS must be in the laboratory where the material is used; you may not rely on the web for these special hazards.

The SDSs generally contain a lot of information, some of which may not be clear to you when you read it. **Figure 3** and **Figure 4** contain some information that should be of help to you in understanding the SDS. The 16 sections are standard among all SDSs.

Figure 3: Globally Harmonized System Pictograms

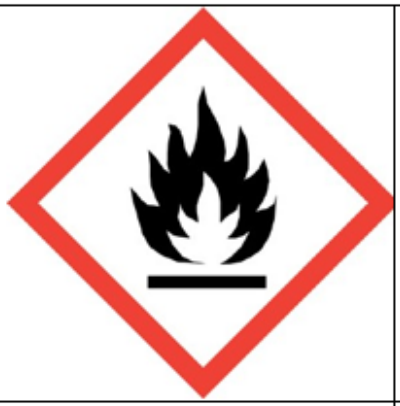
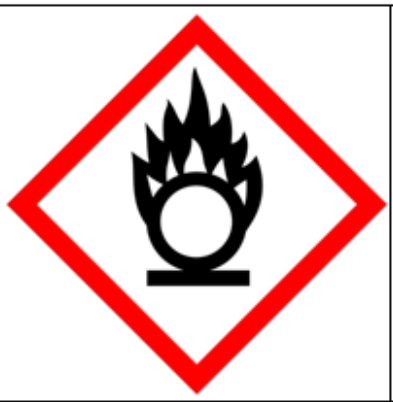
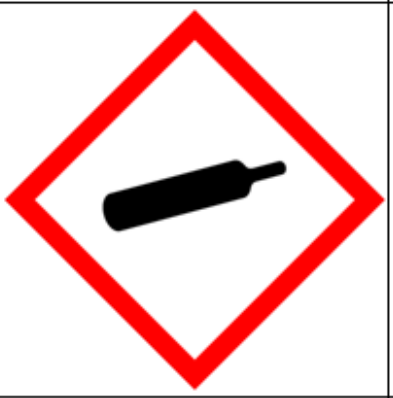
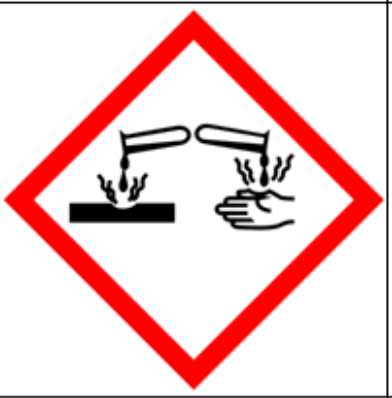
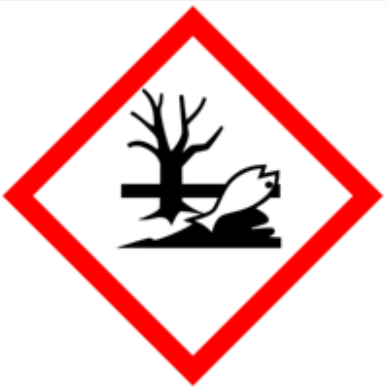
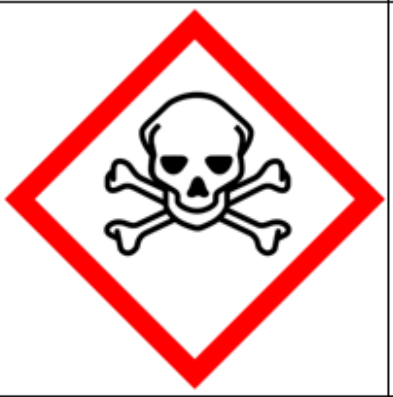
		
GHS Flammable	GHS Oxidizing	GHS Explosive
		
GHS Gas Pressure	GHS Corrosive	GHS Environmental
		
GHS Severe Toxic	GHS Health Danger	GHS Acute Toxic

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 you've bought.
2	**Hazards Identification**	→	Don't let this information scare you; you should be able to handle the material safely as long as 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 a mixture. Only hazardous ingredients need be identified. There may be trade secrets identified, though, 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. Give the SDS to the emergency responder, though.
5	**Fire Fighting Measures**	→	Again, don't fight the fire unless you are trained to do so. Give the SDS to the Fire Department, though.
6	**Accidental Release Measures**	→	Once again, don't attempt a clean-up unless you are trained to do so. If you have training, this should be helpful.
7	**Handling and Storage**	→	This is pretty obvious stuff. And it's very important to follow it exactly.
8	**Exposure Controls/Personal Protection**	→	Very important information that will permit you to handle the material without adverse health effects. Frequently calls for respiratory protection--remember, 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 are probably very helpful.
10	**Stability/Reactivity**	→	Important information about incompatibilities with storage and use. Don't worry; remember that almost everything forms carbon monoxide and nitrogen oxides during combustion!
11	**Toxicological Information**	→	Largely a replay of section 3, but in much more frightening detail. Again, be concerned; don't be too scared to use the material. Proper handling makes the difference! LD50 is lethal dose for 50% of the species population. LC50 is the lethal concentration (airborne) for the same. (We at EH&S just love this section.)
12	**Ecological Information**	→	Generally this won't be of much use to you in the lab.
13	**Disposal Considerations**	→	Good SDS identify whether the material is a hazardous waste or not.
14	**Transport Information**	→	Again, generally not much help to you in the lab.
15	**Regulatory Information**	→	This provides PELs or other standard's information, and also identifies carcinogenic materials. You do remember what PELs are, don't you?
16	**Other Information**	→	Just in case you weren't confused enough, this is one last time they can accomplish this.

c. Other Information Sources

In addition to SDSs and labels, additional information about the hazardous chemicals you use is present in a number of references available in the EHS office. These references provide information regarding specific types of hazards, such as carcinogens, reactives and explosives, compressed gases, as well as for general laboratory safety.

You may contact the EHS office (8-8182) to get further information on these additional reference materials.

d. Chemical Inventory—Chemtracker

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

Each laboratory is responsible to prepare and regularly update an inventory of hazardous chemicals in the work area. This inventory is maintained on the web, through a program called ChemTracker. Information on the use of this program is available at that same link.

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.

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. Others keep paper notes and enter them into the CHEMTRACKER system on a regular basis. Each lab can select a system that works best for them. We require that the inventory be reviewed and updated at least once per year and preferably more often, especially for labs with high chemical usage.

For information and issues concerning CHEMTRACKER, contact EHS after you have read the on-line instructions.

e. Understanding the Hazards Present in YOUR Laboratory

Armed with the information about the chemicals present in your laboratory obtained from the inventory, employees should then review the labels and MSDS for the chemicals that they will work with (and near) to determine the specific hazards that may affect them. In the general training supplied by EHS, you learned about *general* hazards of certain classes of chemicals. Some of this information is supplied 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.*

f. 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 of these hazards. If you notice such signs or symptoms of overexposure, contact your supervisor IMMEDIATELY.

Some signs and symptoms of exposure occur either immediately or in the short term.

These are known as **"acute" hazards**. 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, perhaps death, in the short term. Acute hazards 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 produce cancer over long periods of time. Other chemicals may affect brain, lung, heart, liver or other organ function over long periods of time, 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 UNDERSTAND THAT THESE EFFECTS OCCUR WITH *OVEREXPOSURES* TO HAZARDOUS MATERIALS. WORKING PROPERLY WITH THESE CHEMICALS WILL PREVENT OVEREXPOSURES AND PREVENT THESE EFFECTS FROM OCCURRING TO YOU!

g. Permissible Exposure Limits and Air Monitoring

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

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. An air test is taken to confirm whether an employee is below these standards. Past experience with our laboratories and their chemicals has indicated that our laboratory exposures are well below these standards provided you follow the protective practices specified for chemical use. These practices are outlined in the next section of this document.

If there is reason to believe that any chemical exposure limits is being exceeded, contact EHS to have the exposure situation evaluated. Air tests may be performed as part of this evaluation.

h. Medical Monitoring

The OSHA Lab Standard specifies that there are three circumstances in which Carnegie Mellon is required to offer you, the employee and 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.

i. Detecting Releases of Hazardous Chemicals

It is important to be able to know when there have been releases of hazardous chemicals in the laboratory. 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 contents of a bottle have lowered 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 Safety with Hazardous Materials

a. Working Safety with Hazardous Materials

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

b. Fume Hoods

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

In order for the fume hood to work properly, 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.
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 drawn down all the way. Hood alarms may then be silenced.
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, prepare a work order for FMS to perform the repair.

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

Environmental Health and Safety (EHS) tests all fume hoods on a regular basis. Properly working hoods are marked with a green label indicating satisfactory performance when the sash is in the location of the label. Unsatisfactory performing hoods are marked with a red label. Red labeled hoods may NOT be used for hazardous chemical use.

c. Protective Equipment

The second important practice to follow when using hazardous chemicals is to use 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 the way you will use it. Thin, disposable gloves are not generally suitable for chemical protection. Check the safety supply catalogs when selecting an appropriate chemically resistant glove for a given chemical. EHS has a fact sheet to assist in this process, as well.

ii. **Protective eyewear**

Safety glasses are required in laboratories where chemicals or physical hazards are present. Remember that safety glasses at best protect you only somewhat from the hazards you may be exposed to. They are not suitable to protect you from chemical splashes or airborne dusts. For these situations, protective goggles are necessary. These goggles must completely seal around your eyes, to prevent splashed material from getting inside. Many goggles have ventilation holes various places on the goggle 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 of goggle suitability. Chemical splash shields are also options for eye protection from chemical splashing.

iii. **Respirators**

Since we are confident that chemicals exposures in the laboratories will be below the OSHA exposure limits when proper work practices and protective equipment are uses, Carnegie Mellon does not permit the use of respirators in the laboratory. Contact EHS if you feel that you need a respirator to perform your work safely. Note that disposable facemasks are permitted at any time, though the wearers must understand that these facemasks are for comfort only and 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 small and random exposures. Wear a flame-resistant lab coat 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 with the 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 ensuring that they are purchased, handled and stored properly.

When purchasing chemicals, it is important to order the smallest, convenient size of container. Small sizes are more easily and safely handled, and also offer less of a hazardous material to be present in an area should a spill, leak or other accident occur. This is especially important with materials of high hazard. Also, when possible, order chemicals in break-resistant packaging. These containers often prevent spills or leaks when dropped or tipped over, while regular containers do not.

When handling chemicals, you should move the containers in a safe manner. Use heavy rubber bottle carriers for all but the briefest moves of glass containers, such as any moving of liquids 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. Most original chemical containers provide information about their hazard class, to aid in this segregation activity.

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
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 in cleaning and straightening up your work area each day easily 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 using 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 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. This may create a "missile" of the cylinder, due to a sudden release of pressure. Additionally, 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 a fire. Inert gases, such as argon or helium, can deplete oxygen levels in an area to unsafe levels. Be aware of ALL of the hazards of your compressed gases. Some general rules of compressed gas safety:

i. Always transport and store cylinders with the protective cap in place over the valve.
ii. Always transport cylinder in cylinder carts designed for this purpose and no other way.
iii. Be sure that all gas cylinders are secured to a sturdy surface, such as a wall or bench top, at all times.
iv. Use gas cabinets for toxic gases.
v. Do not order lecture bottles, if the material is available in a returnable cylinder. This makes the removal of old cylinders much easier and more cost effective.

h. Handling Particularly Hazardous Substances

Particularly hazardous substances (PHS) must be handled with special precautions at all times, 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, go to the EHS website.

A PHS procedure form must be completed for each PHS that is used by a laboratory. The form and information on its completion are available on the above website. The procedure form is designed to "force" you to look at 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 to work with the PHS.

One special requirement here at Carnegie Mellon is that a laboratory must have a paper copy of the SDS/MSDS for all PHS materials present in the lab. In the event of an accident involving these materials, you do not want to take the time to locate a web version of the SDS/MSDS.

i. Prior approval to work, working alone

At Carnegie Mellon, **all persons using hazardous materials, equipment or processes in laboratories must be approved by the laboratory PI to do so**. There should be no unauthorized use of laboratory chemicals by any employee. (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" form is available from the EHS web.

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 loss of people to fire, explosion, exposure to hazardous chemicals or hazardous byproducts of fire or explosion.
iii. The need for additional resources; the understanding of one's limitations in responding. 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 in doubt, call 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. Also, determine the emergency evacuation route for the laboratory, which should be posted in the lab or adjacent hallway.

For emergencies, contact University Police at 8-2323; do NOT call 911! Tell them the nature of the incident, the exact location, the names of any chemicals involved and whether there are any injuries. University Police will take care of responses at that point. 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 protective items (gloves, goggles, tyvek suits) and disposal bags as well. For assistance in preparing spill response kits, contact EHS (8-8182).

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

Spill response procedures are present on the EHS website Spill response training is available from EHS.

c. Laboratory Emergency Response Equipment

There are a number of 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 the eyewash be used for 15 minutes in the event of an exposure. It is the laboratory's responsibility to test the eye wash frequently (i.e., once per month) to ensure that it is working properly and that the supply water remains clean.

ii. **Safety Shower**: To be used when chemicals are spilled on the body. You MUST remove any contaminated clothing for this activity to work! Again, it is CRITICAL that the shower be used for 15 minutes in the event of an exposure. Facilities Management Services (FMS) 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. If you've 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 CRITICAL that only persons trained in this activity perform it. Trying to clean up a too- large spill or one of a very hazardous material can cause more of a problem that the original spill.

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 "Hazardous Waste" section. The regulations are detailed and specific as to the requirements of you (the generator). EPA – RCRA, 40 CFR Parts 240-271

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) from cradle to grave. That is to say, forever, even if the material is resting comfortably in a landfill far from Pittsburgh! This requires us to take special precautions as to how hazardous waste is stored, removed, transported and disposed.

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 this training session prior to generating hazardous waste in the lab. Refresher training information is provided on the EHS website. Please review this information on an annual basis.

6. Defining Hazardous Wastes

a. Defining Hazardous Wastes

The EPA defines a waste as any material that is no longer used, nor is anticipated to be used. Most of us would agree that our research or teaching experiments often generate waste materials during or after the process and that these are clearly "wastes". However, the following are also considered waste materials by the EPA:

Spilled chemicals, including materials that build up around your balance or on the outside of chemical bottles	You are not going to scrape them up and use them are you? Then, the EPA considers them wastes!
Unknown chemicals, including materials that have no identification label	EPA considers an unlabeled container an unknown, and you can't be planning to use unknown chemical can you?
Old chemicals that you don't plan to use.	Sure they may be worth a lot of money and may be perfectly fine for someone else to use, but if you don't have any plans for them, they are considered waste by the EPA.

The EPA defines a Hazardous Waste as any waste having one or any combination of the following characteristics:

- Ignitable- having a flash point of less than 140° F (60° C) or defined as an oxidizer, or burns easily (such as metal dusts, chemically contaminated filter paper, etc)
- Corrosive- having a pH <2.0 or >12.5, or corrodes steel at a rate at a rate of 0.25 inches per year, or burns human tissue
- Reactive- unstable, reacts violently w/ water, generates toxic gases, vapors, or fumes, and/or explosive
- Toxic- having failed the toxic characteristic leaching procedure (TCLP), and/or contains a listed contaminant at or above the set concentration
  Examples: Arsenic (5 mg/L), Barium (100 mg/L), Benzene (0.5 mg/L), Chloroform (6 mg/L), Chromium (5 mg/L), Lead (5 mg/L), Mercury (0.2 mg/L), Methyl Ethyl Ketone (200 mg/L), Silver (5 mg/L), 2,4,6-Trichlorophenol (2 mg/L), or Vinyl Chloride (0.2 mg/L).

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. These are general not applicable to our labs, except the P-list, which addresses acutely hazardous materials, such as cyanide or carbon disulfide.

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 a hazardous waste are rather complicated and difficult to understand, and frankly, we don't expect you to go too deeply into them. When in doubt about whether a waste is hazardous, contact EHS, who will be able to make the final determination.

b. Other Waste Items Handled as Hazardous Wastes

There are many other waste items produced by laboratories that, though not considered "hazardous wastes" by the EPA, are nevertheless items we don't want to put in the regular trash. These items include the following:

Carcinogenic materials	Carnegie Mellon policy is to handle these as hazardous waste regardless of whether they meet the EPA's definition-- common examples are cobalt and acrylamide.
Compressed gases*	These are handled specially due to their compressed nature. The gas itself may or may not also be hazardous.

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, so we do not do that! (These things go into a bio waste plastic container.)
Broken glass*	This may cause cuts or other injuries if placed in the regular trash, so we do not do that either! (These things go in a broken glass container.)

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

7. Accumulating Hazardous Waste

a. Accumulation Requirements

EPA regulations relating to the accumulation of hazardous wastes are especially critical for lab workers.

Carnegie Mellon University (site owner) maintains Accumulation points in accordance with EPA Regulations. Accumulation points are protected and secure vaults where waste it to be kept for a limited amount of time until it leaves campus. Because it would be difficult to send hazardous waste from your lab to the Accumulation Points daily, the EPA allows Satellite Accumulation Points at or near the point of waste generation (i.e., your lab)

b. Satellite accumulation requirements are:

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

ii. Up to 55 gallons of hazardous waste, or 1-quart of acute hazardous waste may be accumulated at the satellite accumulation point. At any given time, 55 gallons is the maximum for all combined hazardous wastes in your lab. Upon reaching the maximum waste allowed, generators have 72 hours to move the excess over 55 gallons to the central Accumulation Point.

iii. Every container of hazardous waste must be labeled with the words "Hazardous Waste". The container must also be labeled with the contents, either by specific chemical or by chemical class (such as "chlorinated solvents".) List all components by percent (%) or concentration (ppm), including non-hazardous ingredients like water as well.

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, if it is to be stored anywhere near a drain (such as in a fume hood). 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 (8-8182).

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

vii. It is acceptable to reuse empty bottles to accumulate hazardous waste. However, it is ESSENTIAL that the bottle is completely empty and the old label removed or defaced before the waste is added. (Note: duct tape around glass bottles serves as a dual safety practice in that it defaces the original label and adds protection from a rupture of the bottle.)

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

ix. At a maximum, do not fill any container more than 90% full. This allows 10% expansion space, in case the container is subjected to temperature extremes or pressure build up.

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 wastes. 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 to personally know the contents in a waste bottle. Many labs assign individual people 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 wastes 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 simply 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 unknowns may be charged directly for the costs of the profile testing.

Note: a Legal Document is required for disposal. Accurate and complete identification of the waste by you (the generator) is critical for legal compliance by the university.

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 what is in the container.
All applicable information on the waste tag must be completed for the waste to be removed for 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 the waste is submitted for pick-up. (This should be the date of the on-line request for hazardous waste pickup), check the EHS website, www.cmu.edu/ehs, under "hazardous waste" for your buildings scheduled pickup date
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 by going to the EHS website and selecting "hazardous waste". 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 enter a brief description of the wastes 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 needing to be kept refrigerated), provide that information in the "comments" section. This information helps the pick-up personnel properly plan for making the pick-up. DO NOT CALL EHS OR ANY PARTICULAR EH&S 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 wastes, neither does the university have an infinite budget to pay for them. 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 that any money saved by buying the "larger size".
iii. If you need a small amount of chemical or just need some to try out an experiment, contact EHS. They will search 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 hazardous items
v. Minimize the use of heavy metals as they are particularly expensive to dispose of (a good start is to substitute "No-chromix" for chromic acid.) • Use older items in your inventory before newer items.
vi. Check your inventory frequently to maintain your materials in good condition. Ethyl ether that has expired is MUCH more expensive to get rid of that ethyl ether that has NOT reached its expiration date.
vii. 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, we try to do our work in the most environmentally sound fashion possible. As a result, we have a number of 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 USED OIL

When you look at the things your lab produces as 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 landfilled?
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 than hazardous wastes. 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. Where possible or applicable, autoclave or otherwise sterilize any biological wastes, BEFORE the following steps are taken

ii. Line a biohazard waste box with two red biohazard bags
iii. Place the waste into the bag (do not overfill the bags--boxes should never exceed 35 lbs.)
iv. Tie each bag separately in a knot
v. Close the box and tape ALL seams with packing tape (NOT duct tape)
vi. Label all boxes on the top with the building and room number of where the material was generated, plus the PI or lead researcher's name and their lab or office phone number
vii. Place an on-line request for pick-up, through the EHS website. Requests should be made by 11AM on Wednesdays.
viii. The boxes will be picked up from your lab on Thursday afternoons.
ix. Additional boxes and bags will be supplied when your waste is removed. If you need additional supplies, contact Bio Safety at 8-8405.

Remember that if you work with biohazards, you must have Biohazard training, available from the Bio Safety office (8-8405).

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 containers (such as plastic or heavy cardboard boxed), 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" and disposed of as such See the above section. 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 is to 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.

d. Compressed Gases

The ordering, control and return of compressed gases have been an on-going challenge to the university. It is very important that you follow these 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 year around. There should be no reason to order more than your immediate need. Neither the university nor individual labs have the ability to store large quantities of gas cylinders.
ii. Do not order lecture bottles or any non-returnable cylinders for your gases. 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 usual 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 marked clearly at all times.

Quick Guide to Laboratory Resources

Call Security 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

Call EHS at 8-8182 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 FMS Service Response 8-2910 to report:

- Utility malfunctions
- Fume hood malfunctions

e. For Further Information

Jeffrey Harris, Manager of Chemical Safety (Chemical Hygiene Officer)
Phone: 412-268-7501
Email: jjharris@andrew.cmu.edu

Cell: 412-527-5612

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11. Revisions

Date	Documented Changes	Initials
5/24/2021	Updated Format and Accessibility Update	MAS
11/2/2021	Updated Link	MAS