Laboratory Safety Pocket Handbook

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Author/Editor
Paul Mercier

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Table of Contents

INTRODUCTION

— In This Chapter —

Meet Samantha
Safety in a Changing World
About This Guide

Meet Samantha

Hi! I'm Samantha, but people around here call me Sam. I've been working in laboratories for 15 years. I began as a lab technician for a hometown hospital, and I switched to an industrial research and development facility ten years ago. Now, I'm a member of the safety committee, and I recently became the Chemical Hygiene Officer.

I enjoy my work, and I'm very good at it. I'm proud of the fact that I've never had an accident, in spite of a few close calls. My training and awareness of hazards and appropriate responses has certainly come in handy.

People working in labs often take safety for granted. This is true for the PhDs who design the experiments and tests, the technicians who carry them out, and the support staff who maintain the facilities. Taking safety for granted, by being careless or by forgetting or ignoring proper precautions, can endanger your health and quality of life. Here are some examples . . .

. . . A woman I work with lost the sight in her right eye. She didn't think she needed goggles while washing out some glassware.

. . . Another co-worker has a permanent scar on his face and was out of work for several months because of a chemical burn. He could have avoided the injury if he had inspected his equipment before beginning his work.

. . . My uncle contracted hepatitis B from improperly handling a blood sample.

CHEMICAL HAZARD COMMUNICATION

— ***In This Chapter*** —

Each year over 50,000 people die of illnesses caused by exposure to chemicals in the workplace. That's almost 150 deaths per day! Laboratory employees are constantly exposed to chemicals, so it's vital to your health and safety that you know how chemicals might harm you, how to recognize a dangerous exposure situation, and what precautions to take.

Federal law requires each laboratory to have its own system for communicating chemical hazard information to employees. This includes an inventory of the chemicals used and a material safety data sheet (MSDS) for each chemical. Your laboratory will also have reference materials, the lab's safety policies, and a written Chemical Hygiene Plan. Each laboratory also has signs and a labeling system to communicate various hazards and safety information.

Definition of a Chemical Hazard

In a broad sense, a substance is hazardous if *it is capable* of causing harmful effects on your health and safety. This does not mean that you *will* be harmed each time you are exposed. "Hazard" refers to level of risk. The greater the hazard, the greater the risk. In the *Hazard Communication Standard*, 29 CFR 1910.1200, OSHA considers a chemical to be hazardous if it meets *any* of the following conditions:

- It is cancer-causing, toxic, corrosive, an irritant, a strong sensitizer, flammable, or reactive, and thus poses a threat

PROTECTION

— In This Chapter —

Types of protective devices usually found in laboratories.

Engineering Controls:
- The Laboratory Layout
- Protective Equipment:
  - Hoods and Other Ventilating Systems
  - Biological Safety Cabinets
  - Safety Shields

Personal Protective Equipment (PPE):
- Eye and Face Protection
- Hand Protection – Gloves
- Protective Clothing and Other Garments
- Respiratory Protection

Working safely with chemicals is your biggest concern. Fortunately, there are a series of barriers that give you different levels of protection. These barriers are the engineering controls and the personal protective equipment (PPE) you use while working in the lab. Each protective device is important, but doesn't work alone. You need the right combination of protective measures to block chemicals from reaching your otherwise vulnerable routes of entry. Your lab has its own combinations of protective devices to take care of specific hazards.

Engineering Controls: Protection by Design

Engineering controls are designed to protect you. Some controls are built right into the workplace. There are also specific types of equipment, such as shields and hoods, that are used for protection.

The Laboratory Layout

I'll bet you didn't realize that the laboratory you work in is actually the biggest "engineering control" you have. Laboratories are designed and built with safety in mind.

The layout is key to safety. There are separate areas for receiving and storing chemicals, for storing waste for disposal, and for doing your work. Larger labs may have different rooms for each activity, while smaller labs may have designated areas within one or two rooms.

OSHA'S LABORATORY STANDARD

— In This Chapter —

The Purpose of OSHA's Laboratory Standard

On May 1, 1990 OSHA put into effect a new federal law covering laboratory safety, known as 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories," or the *Laboratory Standard*. You should know how this law applies to you, and your employer will inform you as part of your training.

The *Laboratory Standard* is flexible. It allows your employer to assess the hazards in your laboratory and develop a program for your particular needs. As part of your training, your employer will give you specific information and instructions that apply directly to your circumstances. No two laboratories are alike, and no two programs are alike. There may be some variations between your program and what I describe here. If so, follow the instructions given by your employer and your immediate supervisor. After all, they know your program and the hazards you face.

Scope and Application. As its full name implies, the *Laboratory Standard* is intended to reduce your exposure to the hazardous chemicals handled in your laboratory. It also requires exposure levels be kept well below acceptable limits.

Why should laboratories have a separate law? What's so special about them? OSHA recognizes that laboratories, and how they operate, are unlike other workplaces. Other standards for handling hazardous and toxic chemicals are designed for manufacturing settings. They don't meet the needs for laboratory safety. The following definitions, included in the *Laboratory Standard*, show these differences.

The term "laboratory" refers to a workplace where there is "laboratory use" of "hazardous chemicals" on a non-production

STANDARD METHODS OF PREVENTION

— In This Chapter —

Standard precautions to follow when handling chemicals and performing routine tasks.

Common Laboratory Safety Practices
Chemical Handling
Glassware Safety
Good Housekeeping
When Prior Approval is Required
Chemical Storage
- Designated Area
- Basic Safety
- Refrigerators
- Flammable and Combustible Liquids

Particularly Hazardous Chemicals

Recognizing chemical hazards in order to protect yourself is important, but it's not enough. There is still one critical element that makes any safety program work, and you hold the key. It's your attitude. You have to be willing to use engineering controls properly, to wear appropriate personal protective equipment, and to follow safe procedures. If you take safety seriously and make it part of your job, and follow these practices, you will reduce the likelihood of injury.

Common Laboratory Safety Practices

Your laboratory will have policies for your specific activities, but all laboratories follow these common safety practices:

1. **Think safety first.** Review the procedures you will use, and look for potential hazards from chemicals and equipment. Plan your work. Determine what protection you need, such as engineering controls and equipment, personal protective equipment, and safe procedures.
2. **Know what you're working with.** Read material safety data sheets (MSDSs) and container labels for all chemicals. Know how the chemicals can hurt you, how to avoid harmful conditions in your work area, and how to respond to an accident.
3. **Think about what you're doing.** It's easy to develop a routine and habits in your work. Even though you've used a particular procedure for years, you should still pay close attention to what you're doing. Accidents are more likely to occur when your level of concentration is low or

especially early in your career, they stay with you, and you're more likely to stay healthy.

4. **Follow all safety procedures.** Obey the warning signs posted in your lab and follow the directions and precautions on chemical labels. Use engineering controls as they are intended. Use a hood if fumes or dust will be released. Use a shield for protection against splashes or explosion. Always wear approved eye protection and the PPE required for the chemicals you are handling.
5. **Practice good housekeeping and personal hygiene.** Keep your work area clean and free of chemical residues. Wash your hands frequently, even if you wear gloves while handling chemicals. Remove protective clothing when you leave the lab (including lab coats and aprons). Make sure all contaminated clothing is properly cleaned.
6. **Report dangerous activities or situations.** Pay attention to the way other workers handle hazardous materials. Someone else's mistake can hurt you. Take care of any frayed wires, spills, non-labeled containers, or malfunctioning equipment. If you can't handle the situation alone, talk to your supervisor. These hazards won't take care of themselves and could lead to injury.

7. **Know emergency responses.** Know your laboratory's policies, the locations of emergency phone numbers, first aid supplies, eye wash stations, showers, fire extinguishers, and escape routes. Your fast response in an accident can significantly reduce injury and damage. Report all injuries and accidents to your supervisor.
8. **If you don't know . . . ASK!** If the safety procedures don't seem to protect you from the hazards, ask questions. Talk to your supervisor immediately if you think you're experiencing symptoms of overexposure to a hazardous material.

Chemical Handling

Review the following list from time to time to check your own knowledge of the safe handling of chemicals:

1. **Be careful.** Watch where you place containers, and close them when you are finished. Read the label to be sure you're working with the right materials. For example, there's a big difference between sodium thiosulfate and sodium thiosulfite. Don't rush – that's when you're more likely to spill or make a mistake.
2. **Stay alert.** Fatigue affects judgment. You need to focus your attention on a number of different procedures and assignments. Often you're rushing to meet deadlines. If you need to work extra hours, take periodic breaks. Be careful not to leave anything unattended if it creates a hazardous situation. If you take prescription medication that causes fatigue, avoid handling hazardous chemicals or equipment. If you are unable to concentrate, or if you feel fatigued or confused, speak to your supervisor immediately. You may be affected by an overexposure and not be aware of it!
3. **Follow directions.** Make sure you know the correct procedures, and any associated hazards, for any analysis you perform or technique you use. Sometimes larger quantities of materials may require additional precautions or different procedures. Some exothermic reactions may generate too much heat or may explode if scaled-up. You may need different equipment or more engineering controls. When working on a new technique or synthesizing a new compound, discuss any new activities with your supervisor.
4. **Heat.** Monitor any reactions you are heating. They may boil over, or the solvent may evaporate. Check water or oil levels in temperature baths. Many different liquids, solids, and gases are flammable. Keep them away from heat, sparks, or flames. Friction from rubbing objects together may produce enough heat or sparks to ignite these materials. If you need to heat flammable solvents, use

boiling chips and apply only the minimum amount of heat you need. Be careful when distilling diethyl ether, silver ammonia, or other solutions that produce explosives when they dry out.

5. **Incompatible materials.** Keep incompatible chemicals away from each other. For example, don't place strong acid solutions near strong bases, peroxides near organic solvents, bleach near chlorine, etc. When mixing materials, such as oxidizers and reducers, or acids and bases, dilute them first.
6. **Avoid contact.** Protect your five routes of entry. Wear suitable PPE. Eye protection must be worn when you handle chemicals. Avoid skin contact. Wear compatible gloves if you are going to use organic solvents or flammable or combustible liquids. Wear an apron when handling corrosive materials. Use appropriate engineering controls, such as a hood, if there is a risk of inhaling fumes or dust. Keep containers tightly sealed.
7. **Hygiene.** Keep yourself clean of chemicals:
   - Keep everything away from your face to prevent contact with your mouth and eyes. No smoking, eating, drinking, or applying makeup or lip balm. No mouth pipeting; attach approved bulbs or other devices to the pipet. Keep pens, pencils, and your fingers away from your face.
   - Assume your hands are contaminated, even if you wear gloves. Wash your hands frequently and upon leaving the laboratory.
   - Clean up chemical spills promptly. They tend to migrate if left alone, and they can contaminate other areas.
   - Remove soiled gloves, lab coats, aprons, etc., before leaving the laboratory.
   - Tie back long hair, clip or remove neckties, and avoid wearing dangling jewelry. You don't want these items to fall into chemicals or touch an open flame. They may also get tangled in vacuum pump motors and other moving parts.
8. **Transporting chemicals.** When transporting chemicals between the storage area and your workplace, put containers in protective carrying devices. Glass bottles can break if they bump against a wall, door, or other obstruction. Carry only what you can hold in your hands. Don't hug several jars or bottles near your body; you may drop something, or someone may walk into you and break a container. If you have a lot to carry, use a cart with a rim on each shelf. Keep containers in protective devices so they won't rattle or tip. Don't transport incompatible chemicals together.

OTHER ASPECTS OF SAFETY

— ***In This Chapter*** —

Review any of the following topics that apply to your lab:

There's a lot more to laboratory safety than protecting yourself from chemical hazards. What other hazards are in your lab, and what protective measures are available? Your safety program and training will emphasize specific safety concepts that fit your needs.

Hazards of Compressed Gases

Almost every laboratory uses compressed gases. They are used as carriers in gas chromatography, for glass blowing, and for numerous research and synthetic procedures. Any gas, even nitrogen, oxygen, and carbon dioxide, the main components in the air you breathe, can be extremely dangerous as a compressed gas.

What is a compressed gas? Gas cylinders come in all sizes and shapes. They can be as small as 18 inches high and 2 inches in diameter, or as large as 5 or 6 feet high and 15 inches in diameter. Larger cylinders can weigh 160 pounds or more, and they're about the size of a person. But cylinders are quite different from people; they're under pressure. The Department of Transportation (DOT) defines a compressed gas

EMERGENCIES

— In This Chapter —

How to respond to different types of emergencies:

Standard Operating Procedures (SOPs)
Determining if an Emergency is Minor or Major
First Aid Kit
Minor Emergencies:
- Simple First Aid
- Cuts
- Burns
- Eye Injuries
- Emergency, or Deluge, Showers
- Chemical Spills
- Small Fires
- Fire Extinguishers

Major Emergencies:
- Evacuation Plan
- Major Spill Response
- First Aid for Serious Injuries

Calling Emergency Responders

Accidents still happen in spite of a good safety program, training, and use of precautions. All of these will help reduce the number and seriousness of accidents, but nothing can prevent all accidents. That's why every safety program includes emergency response.

Standard Operating Procedures (SOPs)

Your laboratory has certain standard operating procedures (SOPs) for major and minor emergencies. Your employer has developed these SOPs to fit the nature of your laboratory and the specific hazards likely to be involved with any emergency. They are described in your laboratory's safety policies and procedures. You should learn and follow them.

In this section, you'll get basic information that can be used as a guideline and reference, but it is not a substitute for the training and information your employer will give you. In addition, procedures that require special training, such as emergency first aid, CPR, how to handle a fire hose, or other procedures used by professional emergency people like EMTs, fire fighters, or chemical spill (HAZWOPER) responders, will not be covered in this book. Most lab employees don't need this type of special training.

WHAT DOES SAFETY MEAN TO YOU?

Only you can answer this question. This guide is filled with advice, tips, and information to help you work safely in your laboratory, and how you use this information will help answer the question.

Information. Your employer provides you with at least a written safety program, a chemical hygiene plan, and MSDSs for the chemicals you handle. You may also have an exposure control plan, as well as procedures to document hazardous waste disposal or to handle special equipment, radiation, particularly hazardous materials, or other specific hazards in your lab. You may even have a “safety manual” containing policies and other details. Again, how you make use of these tools will help answer the question.

Responsibility. It’s your employer’s responsibility to provide written materials, training, and information about the hazards in your lab. You may even attend regular safety meetings for this purpose. It’s your responsibility to work safely in the laboratory, and how well you carry out these responsibilities provides part of the answer.

Priorities. Is safety a high priority in your laboratory? Now we’re getting somewhere. Your response to this question will help you find the answer. Safety should be your highest priority if you work in a high risk situation, such as a bio-safety level 4 facility, a clinical lab where you are routinely exposed to bloodborne pathogens, or a laboratory where you routinely handle class 4 lasers, high levels of radiation, explosives, known or suspected carcinogens, or other particularly hazardous materials, etc. With high levels of risk, you need to focus more on safety. In other laboratories, where the hazards aren’t as great, you may be more concerned with the results you need or the deadlines you have to meet. But, you should not ignore safety, even if it’s not your highest priority.

Safety is a necessary part of every aspect of your job. It is more than a priority; it should be an integral part of your work. Just how seriously you take safety on the job depends on what safety means to you. This is why you need to answer the original question.

Attitude. The key to your answer is attitude. Your employer’s attitude is already clear. You see it every day in the written programs and policies, and in the training and other ways safety is communicated to you, and your attitude counts. After all, you’re the one doing the work.

APPENDIX A

Table 1. Permissible Exposure Limits

The Transitional Limits promulgated in 1971 are once again the effective exposure limits currently being enforced by OSHA. The Final Rule Limits promulgated in 1989 updated the Transitional Limits from 1971 and established new limits for previously unregulated substances. The U.S. Court of Appeals struck down the more stringent 1989 Final Rule Limits, and these limits are no longer being enforced by OSHA. This decision means that OSHA PELs will revert back to the much less stringent exposure limits issued in 1971. The Final Rule Limits were determined unconstitutional because classes of chemicals were looked at, rather than each chemical individually. However, some states may choose to enforce the Final Rule Limits. Check with your supervisor to find out which limits are used in your facility.

The listing on the following pages contains both the 1989 Final Rule Limits and 1971 Transitional Limits.

[1] The Transitional Limits promulgated in 1971 are the effective exposure limits currently enforced by OSHA. **[2]** The Final Rule Limits promulgated in 1989. **[3]** Transitional PELs are 8-hr TWAs unless otherwise noted; a (C) designation denotes a ceiling limit. They are to be determined from breathing-zone air samples. **[4]** 15-min duration unless otherwise noted. A ceiling limit, the concentration not to exceed at any time, is noted by a (C). **[5]** Parts of vapor or gas per million parts of contaminated air by volume at 25 ˚C and 760 torr. Foot notes are continued on page 167.

GLOSSARY

Acidosis. A condition of decreased alkalinity of the blood and tissues. Symptoms may include sickly sweet breath, headache, nausea, vomiting, visual disturbances; usually the result of excessive acid production. Tissues and CNS functions are disturbed.

Action Level. The exposure level (concentration in air) at which OSHA regulations to protect employees take effect (29 CFR 1910.1001-1047); e.g., workplace air analysis, employee training, medical monitoring, and record keeping. Exposure at or above action level is termed occupational exposure. Exposure below this level can also be harmful. This level is *generally* half the PEL.

Acute Exposure. Exposure of short duration, usually to relatively high concentrations or amounts of material.

Acute Health Effect. An adverse effect on a human or animal body, with symptoms developing rapidly. See Chronic Health Effect.

Acute Lethality. The death of animals immediately or within 14 days after a single dose of or exposure to a toxic substance.

Acute Toxicity. Adverse health effects resulting from brief exposure to a chemical (e.g., seconds, minutes, hours).

Alopecia. Loss of hair.

Anesthesia. Loss of sensation, including loss of touch, pain, vibration and/or temperature senses.

Anorexia. Loss of appetite.

Anosmia. Loss of the sense of smell.

Anoxia. A lack of oxygen in blood or tissues (literally, "without oxygen"). See Hypoxia.

Anuria. Absence or defective excretion of urine.

Apnea. Temporary stoppage of breathing.

Argyria. Local or generalized grey-blue colored impregnation of body (skin) tissue with silver.

Asbestosis. Chronic lung disease caused by inhaling airborne asbestos fibers.

Asphyxia. Lack of oxygen and interference with the oxygenation of the blood. Can lead to unconsciousness and death.

Asthma. A disease characterized by recurrent attacks of dyspnea, wheezing, and perhaps coughing caused by spasmodic contraction of the main airways in the lungs.