

LABORATORY SAFETY
CEEG 340, Bucknell University
From Laboratory Research in Environmental Engineering, by Monroe
Weber Shirk, Cornell University

Introduction

Safety is a collective responsibility that requires the full cooperation of everyone in the laboratory. However, the ultimate responsibility for safety rests with the person carrying out a given procedure. In the case of an academic laboratory, that person is usually the student. Accidents often result from an indifferent attitude, failure to use common sense, or failure to follow instructions. Each student should be aware of what the other students are doing because all can be victims of one individual's mistake. Do not hesitate to point out to other students that they are engaging in unsafe practices or operations. If necessary, report it to the instructor. In the final assessment, students have the greatest responsibility to ensure their own personal safety.

This guide provides a list of do's and don'ts to minimize safety and health problems associated with experimental laboratory work. It also provides, where possible, the ideas and concepts that underlie the practical suggestions. However, you are expected to become involved and to contribute to the overall solutions.

The following are general guidelines for all laboratory workers:

- 1) Follow all safety instructions carefully.
- 2) Become thoroughly acquainted with the location and use of safety facilities such as safety showers, exits and eyewash fountains.
- 3) Become familiar with the hazards of the chemicals being used, and know the safety precautions and emergency procedures before undertaking any work.
- 4) Become familiar with the chemical operations and the hazards involved before beginning an operation.

Personal Protection

Eye Protection

All people in the laboratory including visitors must wear eye protection at all times, even when not performing a chemical operation. Wearing of contact lenses in the laboratory is normally forbidden because contact lenses can hold foreign materials against the cornea. Furthermore, they may be difficult to remove in the case of a splash. Soft contact lenses present a particular hazard because they can absorb and retain chemical vapors. If the use of contact lenses is required for therapeutic reasons fitted goggles must also be worn. In

addition, approved standing shields and face shields that protect the neck and ears as well as the face should be used when appropriate for work at reduced pressure or where there is a potential for explosions, implosions or splashing. Normal prescription eyeglasses, though meeting the Food and Drug Administration's standards for shatter resistance, do not provide appropriate laboratory eye protection.

Clothing

Clothing worn in the laboratory should offer protection from splashes and spills, should be easily removable in case of accident. Lab jackets or coats should have snap fasteners rather than buttons so that they can be readily removed.

High-heeled or open-toed shoes, sandals, or shoes made of woven material should not be worn in the laboratory. Shorts, cutoffs and miniskirts are also inappropriate. Long hair and loose clothing should be constrained. Jewelry such as rings, bracelets, and watches should not be worn in order to prevent chemical seepage under the jewelry, contact with electrical sources, catching on equipment, and damage to the jewelry.

Gloves

Gloves can serve as an important part of personal protection when they are used correctly. Check to ensure the absence of cracks or small holes in the gloves before each use. In order to prevent the unintentional spread of chemicals, gloves should be removed before leaving the work area and before handling such things as telephones, doorknobs, writing instruments, computers, and laboratory notebooks. Gloves may be reused, cleaned, or discarded, consistent with their use and contamination.

A wide variety of gloves is available to protect against chemical exposure. Because the permeability of gloves of the same or similar material varies from manufacturer to manufacturer, no specific recommendations are given here. Be aware that if a chemical diffuses through a glove, that chemical is held against the worker's hand and the individual may then be more exposed to the chemical than if the glove had not been worn.

Everyone working in a chemistry laboratory should be aware of the dangers of ingesting chemicals. These common sense precautions will minimize the possibility of such exposure:

- 1) Do not prepare, store (even temporarily), or consume food or beverages in any chemical laboratory.
- 2) Do not smoke in any chemical laboratory. Additionally, be aware that tobacco products in opened packages can absorb chemical vapors.
- 3) Do not apply cosmetics in a laboratory.
- 4) Wash hands and arms thoroughly before leaving the laboratory, even if gloves have been worn.
- 5) Wash separately from personal laundry, lab coats or jackets on which chemicals

- have been spilled.
- 6) Never wear or bring lab coats or jackets into areas where food is consumed.
 - 7) Never pipette by mouth. Always use a pipette aid or suction bulb.

Laboratory Protocol

The chemistry laboratory is a place for serious learning and working. Horseplay cannot be tolerated. Variations in procedures including changes in quantities or reagents may be dangerous. Such alterations may only be made with the knowledge and approval of the instructor.

Housekeeping

In the laboratory, keeping things clean and neat generally leads to a safer environment. Avoid unnecessary hazards by keeping drawers and cabinets closed while working. Never store materials, especially chemicals, on the floor, even temporarily. Work spaces and storage areas should be kept clear of broken glassware, leftover chemicals and scraps of paper. Keep aisles free of obstructions such as chairs, boxes and waste receptacles. Avoid slipping hazards by keeping the floor clear of ice, stoppers, glass beads or rods, other small items, and spilled liquids. Use the required procedure for the proper disposal of chemical wastes and solvents.

Cleaning Glassware

Clean glassware at the laboratory sink. Use hot water, if available, and soap or other detergent. If necessary, use a mild scouring powder. Wear appropriate gloves that have been checked to ensure that no holes are present. Use brushes of suitable stiffness and size. Avoid accumulating too many articles in the cleanup area. Usually work space around a sink is limited and piling up dirty or cleaned glassware leads to breakage. Remember that the turbid water in a sink may hide a jagged edge on a piece of broken glassware that was intact when put into the water. A pair of heavy gloves may be useful for removing broken glass, but care must be exercised to prevent glove contamination. To minimize breakage of glassware, sink bottoms should have rubber or plastic mats that do not block the drains.

Unattended Operation of Equipment

Reactions that are left to run unattended overnight or at other times are prime sources for fires, floods and explosions. Do not let equipment such as power stirrers, hot plates, heating mantles, and water condensers run overnight without fail-safe provisions and the instructor's consent. Check unattended reactions periodically. Always leave a note plainly posted with a phone number where you and the instructor can be reached in case of emergency. Remember that in the middle of the night, emergency personnel are entirely dependent on accurate instructions and information.

Fume Hoods and Ventilation

A large number of common substances present acute respiratory hazards and should not be used in a confined area in large amounts. They should be dispensed and handled only where there is adequate ventilation, such as in a hood. Adequate ventilation is defined as ventilation that is sufficient to keep the concentration of a chemical below the threshold limit value or permissible exposure limit. If you smell a chemical, it is obvious that you are inhaling it. However, odor does not necessarily indicate that a dangerous concentration has been reached. By contrast, many chemicals can be present at hazardous concentrations without any noticeable odor.

Working Alone

Avoid working alone in a building or in a laboratory.

Use of Chemicals

Before using any chemical you need to know how to safely handle it. The safety precautions taken are dependent on the exposure routes and the potential harmful effects.

Routes of Exposure

- 1) ingestion
- 2) inhalation
- 3) absorbed through skin
- 4) eye contact

Each potential exposure route requires different precautions. Chemical exposure may have acute (immediate, short term) or chronic (long term potentially cumulative) effects. Information on health hazards can be found on chemical labels and in Material Safety Data Sheets.

Material Safety Data Sheets

MSDS sheets for most chemicals used in the laboratory are located on the bookshelf as you enter the lab through the 364 Breakiron entrance of the Environmental Laboratory. Electronic versions (potentially more current) can be found using the web.

MSDS provide extensive information on safe handling, first aid, toxicity, etc.

Following is a list of terms used in MSDS:

TLV—Threshold Limit Value—are values for airborne toxic materials that are to be used as guides in control of health hazards. They represent concentrations to which nearly all workers (workers without special sensitivities) can be exposed to for long periods of time without harmful effect. TLV's are usually expressed as parts per million (ppm). TLV's are also expressed as mg of dust or vapor/m³ of air.

TDLo—Toxic Dose Low—the lowest dose of a substance introduced by any route, other than inhalation, over any given period of time and reported to produce any toxic effect in humans or to produce carcinogenic or teratogenic effects in animals or humans.

TCLo—Toxic Concentration Low—the lowest concentration of a substance in air to which humans or animals have been exposed for any given period of time and reported to produce any toxic effect in humans or to produce carcinogenic or teratogenic effects in animals or humans.

TDLo—Lethal Dose Low—the lowest dose (other than LD50) of a substance introduced by any route, other than inhalation, over any given period of time in one or more divided portions and reported to have caused death in humans or animals.

LD50—Lethal Dose Fifty—a calculated dose of a substance that is expected to cause the death of 50% of an entire defined experimental animal population. It is determined from the exposure to the substance by any route other than inhalation of a significant number from that population.

Chemical Labels

All chemicals must be labeled. Unlabeled containers of mystery chemicals or chemical solutions are a nightmare for disposal as well as a potential safety hazard. The OSHA Hazard Communication Standard and the OSHA Lab Standard have specific requirements for the labeling of chemicals. In a laboratory covered under the Lab Standard, if a chemical is designated as a hazardous material, that is having the characteristics of corrosivity, ignitability, toxicity (generally meaning a highly toxic material with an LD50 of 50 mg/kg or less), reactivity, etc., and if it is made into a solution or repackaged as a solid or liquid in a concentration greater than 1% (0.1% for a carcinogen) it needs to have a so called Right-To-Know (RTK) label that duplicates the hazard warnings, precautions and first aid steps found on the original label. All other chemicals must have at minimum a label with the full chemical name (not just the chemical formula), concentration, and date prepared. "Right to Know Labels" will be made available for your use when necessary.

One of the best books to get started with regulatory compliance is a publication from the American Chemical Society entitled, "Laboratory Waste Management. A Guidebook."