Chapter 6
Personal Safety Provisions

Providing a safe laboratory environment involves a combination of many efforts. In addition to proper training, procedures, ventilation, and emergency equipment, it is important to provide the laboratory worker with proper personal protection.

6.1 General Guidelines for Dress in a Laboratory

Prudent practice suggests that laboratory workers should not wear loose, skimpy, or torn clothing, unrestrained long hair, or hosiery. Loose or torn clothing can easily catch fire, be drawn across or dipped into chemicals, or become ensnared in apparatus and moving machinery. Clothing provides layers of protection to the skin and allows you to remove much of the contamination with the clothing. Skimpy clothing offers little protection to the skin in the event of chemical splash. Hosiery should not be worn since it will react with acids and some other chemicals, trapping the chemicals next to the skin. Trapped chemicals would increase the likelihood of severe chemical burn. If the possibility of chemical contamination exists, personal clothing that will be worn home should be covered by protective apparel.

Finger rings should be removed if working with equipment that has moving parts or with chemicals. Rings can react with chemicals or puncture laboratory gloves. Some chemicals can get trapped under rings and irritate the skin. Shoes should be worn at all times in buildings where chemicals are stored or used. Perforated or open-toed shoes, sandals, or cloth sneakers should not be worn in laboratories as they do not offer protection against spilled chemicals.

6.2 Protective Apparel

It is advisable that protective apparel be worn over street clothes in teaching laboratories when chemicals are in use. Laboratory coats and aprons each have a place in laboratories depending on the hazards involved. Laboratory coats are intended to prevent contact with dirt and the minor chemical splashes or spills encountered in laboratory work. The cloth laboratory coat is, however, primarily a protection for clothing and may itself present a hazard (e.g., combustibility) to the wearer. Cotton and synthetic materials that offer fire resistance are satisfactory, but rayon and polyesters are not. Laboratory coats do not significantly resist penetration by organic liquids and, if significantly contaminated by them, should be removed immediately.

Plastic or rubber aprons provide better protection from corrosion or irritating liquids but can complicate injuries in the event of a fire. Furthermore, a plastic apron can accumulate a considerable charge of static electricity and should be avoided in areas where flammable solvents or other materials could be ignited by a static discharge. Laboratory aprons have the advantage of being easily cleaned readily if contacted by chemicals, while lab coats may need to be laundered.

6.3 Contact Lenses in a Laboratory

The wearing of contact lenses in laboratories is a controversial issue, especially when some students who wear contacts do not own eyeglasses. Of 37 academic institutions (generally universities) responding to a SafetyNet inquiry, not one institution permitted free use of contact lenses, 16 forbade use, and 21 allowed contacts with certain restrictions.

Safety in Academic Chemistry Laboratories, an inexpensive, highly distributed booklet published by the American Chemical Society (ACS), provides a prudent and historically common response to the wearing of contacts:

Wearing of contact lenses in a 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. An article in *Chemical Health and Safety*, also published by ACS, reported on a study by Rengstorff and Black, which generally found that contact lenses minimized injuries or protected the eyes from more serious injury in accidents involving metal particles, painting fumes, and chemical splashes from solvents and acids. In the same article, the author agreed that the difficulty of removing contacts in the case of splash is a major concern but suggested that, if contact lens wearers are identified and medical and first-aid personnel are properly trained, the risk can be minimized. In another article in the same issue of *Chemical Health and Safety*, the author addresses the problem of contacts and chemical fumes:

It is improbable that the corneal response to volatile substances would be affected significantly by the wearing of a rigid contact lens, because these substances would be eliminated rapidly by tear flow; however, water-soluble gases, fumes, and substances capable of binding to, or being absorbed into, hydrogel lens materials would be expected to produce prolonged exposure resulting in more severe or chronic response. Contact lens wearers who experience symptoms should not wear their lenses in such environments and ensure that their lenses are properly cleaned and rinsed before reuse. Severely soiled lenses must be replaced. If a chemical enters the eye, emergency treatment (flushing with water) must begin immediately (section 3.2.2). For washing to be effective for contact lens wearers, the lens must be removed quickly. Therefore, it is extremely important to be aware of those persons who wear contact lenses. If students are allowed to wear contacts, it is recommended that a list of all students who wear contacts be available in the lab.

Students should acknowledge their awareness of the problems with wearing contact lens in the safety contract.

6.4 Personal Protective Equipment

Appropriate personal protective equipment (PPE) must be worn by students, teachers, and visitors. Following is a discussion of the different types of PPE and their applications and use.

6.4.1 Eye Protection

Industrial quality eye protection is required by state law in all chemical or combined chemical-physical laboratories (section 5.2.1). Eye protection is available in various forms. The type of eye protection must be matched to the hazards present.

- **Chemical splash goggles** provide eye protection from chemical splash and physical impact. They are required where chemicals are being used and a hazard of liquid or dry particle chemicals exists. Unventilated splash goggles, if properly fitted, could reduce fume contact for soft contact wearers. "Visitor's glasses" or other safety glasses do not substitute for chemical splash goggles.
- **Face shields** provide protection (for a greater area of the face) from chemical splash and physical impact. Face shields should not be used in place of chemical splash goggles, but in addition to them since they provide little side, top, and bottom splash protection.

Face shields come in different lengths; only the longest face shields offer protection for the throat which is a vulnerable area.

- **Safety glasses and safety goggles** provide protection from physical impact, not from chemicals. They should be used only in areas such as shops where projectiles may be encountered.
- **Laser safety goggles** provide protection from the high intensity beam of lasers. These goggles are generally specific to certain ranges of wavelengths (section 10.4). Normal prescription eyeglasses do not afford appropriate protection. Most eye protection is now designed to fit over prescription glasses. Prescription safety glasses with side shields are available and are useful for many applications but do not provide proper protection from chemical splashes. It is worth the effort of shopping around to find eye protection that is effective, comfortable to wear, easily cleaned and durable, and meets the ANSI Z87 standard. It is strongly suggested that any already-existing laboratory eye protection that does not have the Z.87 marking be discarded.

6.4.2 Hand Protection

Personal protective equipment for the hands must also be correlated to the types of hazards present. Gloves are available for protection from the following hazards:

- sharp edges / cutting hazards
- abrasions
- chemicals
- cold (cryogenics)
- heat

Consider fit, flexibility, and grip when selecting all gloves. Also take into account the type of chemicals with which the hand will come into contact. Both material used and thickness of the gloves often affect how long the gloves will be effective. Gloves purchased from local grocery or outlet stores should have their labels checked to determine if they are suitable for the intended application. A chemical resistance selection chart for common types of chemical-resistant glove materials follows:

Resistance to Chemicals of Common Glove Materials[5]

(E = Excellent, G = Good, F = Fair, P = Poor)

Chemical	Natural Rubber	Neoprene	Nitrile	Vinyl
Acetaldehyde	G	G	E	G
Acetic acid	E	E	E	E
Acetone	G	G	G	F
Acrylonitrile	P	G	—	F
Ammonium hydroxide (sat)	G	E	E	E
Aniline	F	G	E	G
Benzaldehyde	F	F	E	G
Benzene (a)	P	F	G	F
Benzyl chloride (a)	F	P	G	P
Bromine	G	G	—	G
Butane	P	E	—	P
Butyraldehyde	P	G	—	G
Calcium hypochlorite	P	G	G	G
Carbon disulfide	P	P	G	F

Carbon tetrachloride (a) P F G F
Chlorine G G — G
Chloroacetone F E — P
Chloroform (a) P F G P
Chromic acid P F F E
Cyclohexane F E — P
Dibenzyl ether F G — P
Dibutyl phthalate F G — P
Diethanolamine F E — E
Diethyl ether F G E P
Dimethyl sulfoxide (b) — — — —
Ethylacetate F G G F
Ethylene dichloride (a) P F G P
Ethylene glycol G G E E
Ethylene trichloride (a) P P — P
Fluorine G G — G
Formaldehyde G E E E
Formic acid G E E E
Glycerol G G E E
Hexane P E — P
Hydrobromic acid (40%) G E — E
Hydrochloric acid (conc) G G G E
Hydrofluoric acid (30%) G G G E
Hydrogen peroxide G G G E
Iodine G G — G
Methylamine G G E E
Methyl cellosolve F E — P
Methyl chloride (a) P E — P
Methyl ethyl ketone F G G P
Methylene chloride (a) F F G F
Monoethanolamine F E — E
Morpholine F E — E
Napthalene (a) G G E G
Nitric acid (conc) P P P G
Perchloric acid F G F E
Phenol G E — E
Phosphoric acid G E — E
Potassium hydroxide (sat) G G G E
Propylene dichloride (a) P F — P
Sodium hydroxide G G G E
Sodium hypochlorite G P F G
Sulfuric acid (conc) G G F G
Toluene (a) P F G F
Trichloroethylene (a) P F G F
Tricresyl phosphate P F - F

Triethanolamine F E E E
Trinitrotoluene P E — P
(a) Aromatic and halogenated hydrocarbons will attack all types of natural and synthetic types of glove materials. Should swelling occur, the user should change to fresh gloves and allow the swollen gloves to dry and return to normal.
(b) No data on the resistance to dimethyl sulfoxide of natural rubber, neoprene, nitrile rubber, or vinyl materials are available; the manufacturer of the substance recommends the use of butyl rubber gloves.

6.4.3 Respiratory Protection

The use of respirators requires a special training program be put into place. The use of respirators by untrained personnel or students is not recommended. If respirators are not fitted and maintained properly, they may provide a false sense of security with no actual protection. If respirators are necessary, professional help should be obtained to help set up the necessary training program.

6.5 Precautions Against Bloodborne Pathogens

Each school should have a plan for management of infectious diseases, including bloodborne pathogens (section 5.3.1). Since cuts are common lab injuries, science teachers and students should be aware of legal requirements for handling and cleaning any materials exposed to blood and other sources of potentially infectious agents. **All blood should be considered infectious regardless of the source.** Avoid contact with any bodily fluids.

Bloodborne pathogens are microorganisms (e.g., viruses or bacteria) present in human blood and may cause disease in humans. Examples of bloodborne pathogens include the human immunodeficiency virus (HIV) which causes AIDS (acquired immunodeficiency syndrome) and hepatitis B virus (HBV) which causes hepatitis B infections. Other bloodborne pathogens include the microorganisms that cause syphilis and malaria.

Bloodborne pathogens can be transmitted if blood or certain body fluids (any human body fluid containing visible blood; semen; vaginal secretions; or fluids surrounding internal organs, the joints, or a fetus) from someone infected with a bloodborne pathogen gets into the mucous membranes (e.g., eyes, nose, mouth) or directly into the bloodstream through skin that is damaged (e.g., scraped, cut, abraded) or punctured (e.g., needlestick injury). HIV and HBV are also transmitted sexually and an infected woman can infect her unborn child before or during birth.

The problem experienced when handling these fluids is that you can't tell if something is infectious. Many people infected with bloodborne pathogens don't even know they have an infection. Their blood and some body fluids (any human body fluid containing visible blood; semen; vaginal secretions; or fluids surrounding internal organs, the joints, or a fetus) are still infectious even if they don't feel sick.

Universal precautions is a concept that is extremely important in reducing the risk of bloodborne pathogen infection. Practicing universal precautions means that you treat all human blood and some body fluids as if they are contaminated with bloodborne pathogens. Body fluids that do not require practice of universal precautions are sweat, sputum, saliva, urine, feces, vomit, or tears **unless** these body fluids are contaminated with visible blood.

It is preferable to avoid the need for personal protective equipment (PPE) through engineering controls and safe work practices. Examples of engineering controls in a chemistry laboratory include providing sinks for hand washing, "sharps" containers for broken glass and other sharp objects, and equipment and supplies such as pre-polished sections of glass tubing which minimize the chance of cuts. Examples of work practices include proper training on insertion of tubing in stoppers and other procedures that would minimize the chances of students or janitorial staff cutting themselves.

Personal protective equipment should be readily available so that, if there is for any reason a release of body fluids, the body fluid can be safely cleaned up or if there is need for first-aid, the responder can be protected from body fluids. This PPE may include gloves (e.g., disposable surgical gloves), mouthpieces, resuscitation bags, pocket masks, or other equipment that does not permit blood or other potentially infectious materials to reach or pass through to the responder's street clothes, undergarments, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time the protective equipment will be used.

Any surfaces contaminated by body fluids should be cleaned up with an appropriate disinfectant (e.g., freshly made 1:10 household bleach/water dilution) while wearing protective gloves. Follow label directions for blood cleanup, especially the amount of time the disinfectant should be allowed to remain on the surface. Contaminated articles such as broken glassware should be picked up by mechanical means, such as by dustpan rather than by hand.

Unless materials used for cleanup are dripping blood or appear as if they would drip blood if squeezed, the waste materials may be disposed in the regular waste stream. As long as the blood is contained within the material used to clean it up, it cannot be released and transmit any infectious agents. If the material is dripping or looks as if it would drip if squeezed, place this material in a closed plastic bag and label it as biohazardous material. The biohazardous material must be treated (e.g., autoclaving or incineration) and disposed of as potentially infectious medical waste, which is regulated by the Illinois Environmental Protection Agency. It is preferable to avoid creating biohazardous waste by using excess amounts of absorbent material to collect blood so that all the blood is contained within the absorbent material and will not drip.

If you are administering first aid, gloves, mouthpieces, resuscitation bags, or pocket masks can help minimize contact with body fluids. Immediately or as soon as feasible after removing gloves, the responder should wash hands and any skin that came in contact with blood or other potentially infectious materials with soap and water. If you voluntarily choose to respond to an accident in a laboratory and to provide first aid, your response is called a "Good Samaritan" act. You should be aware of the risks of exposure to blood and some body fluids and should follow the precautions outlined above for your own protection, but your response is not mandated or regulated. However, if your job requires you to provide first aid and/or to handle blood and body fluids, your employer is required to train you and provide some additional protection, and you are required to follow certain procedures to protect yourself.

6.6 Medical Consultation

Medical consultation should be sought for any symptoms thought to arise from chemical overexposure, any event such as a major spill, leak, or explosion that may have resulted in an overexposure, or a bloodbone pathogen exposure incident. Employees are entitled to medical evaluation if there has been an accident, if routine monitoring shows levels of hazardous materials above the permissible exposure limits (PEL), or if there are signs and symptoms of exposure.

6.7 References

1. Committee on Hazardous Substances in the Laboratory. Assembly of Mathematical and Physical Sciences. National Research Council., ed. 1981. *Prudent Practices for Handling Hazardous Chemicals In Laboratories*, p. 161. Washington, D.C.: National Academy Press

2. Committee on Chemical Safety. 1990. *Safety in Academic Chemistry Laboratories*, p. 3. Washington, D.C.: American Chemical Society. 5th ed.

3. Segal, E. B. 1995. Contact Lenses and Chemicals: An Update. *Chemical Health and Safety* Jan/Feb:19

4. Cullen, A. P. 1995. Contact Lens Emergencies. *Chemical Health and Safety* Jan/Feb:23-24

5. Committee on Hazardous Substances in the Laboratory. Assembly of Mathematical and Physical Sciences. National Research Council., ed. 1981. *Prudent Practices for Handling Hazardous Chemicals In Laboratories*, pp. 159-60. Washington, D.C.: National Academy Press