

Science Education Collection

Proper Personal Protective Equipment

URL: <https://www.jove.com/science-education/10402>

Overview

Robert M. Rioux & William A Elliott, Pennsylvania State University, University Park, PA

Hazards are many and varied in the laboratory, but the right choice of PPE can make the laboratory a safe place to work.

Principles

The purpose of PPE is to protect individuals from hazards during a specific task. PPE should be selected following a hazard assessment of the specific task. When around hazardous chemicals or equipment (even if you are not using them), a minimum level of PPE should be applied. PPE minimizes the chance of harm to the individual from the hazard but does not alter the nature of the hazard itself. A combination of PPE, engineering controls, and administrative controls should be used to ensure a safe work environment. Using PPE does not obviate the need for administrative and engineering controls.

Procedure

1. Minimum PPE

1. When entering a laboratory, a bare minimum of PPE should be worn. This includes safety glasses (discussed later), long pants, and closed-toe shoes. This provides basic protection from general hazards in the laboratory. Additionally, long hair should be tied back and dangling jewelry should not be worn.

2. Gloves

1. Your hands are often the body parts closest to hazards in the lab. Gloves are therefore an essential part of proper PPE. However, it may not always be immediately obvious which gloves are suitable for the task being carried out. A hazard assessment of the task can help to determine the correct pair of gloves to wear. The hazard assessment needs to consider the following:
 1. Chemical: The chemical nature of the hazard is very important in choosing the appropriate gloves. Common materials for chemically resistant gloves include butyl rubber, latex, neoprene, nitrile rubber, polyethylene, polyvinyl alcohol, and polyvinyl chloride. Choosing the appropriate material can often be done easily by consulting a chemical compatibility chart (Ansell Occupational Healthcare, 2008). No material is 100% resistant to a chemical. A chemical will permeate all materials, just at different rates. When consulting a glove chemical compatibility chart, the breakthrough time should be noted. This is the time it takes for a chemical to fully travel through an initially unused glove. Gloves should be changed accordingly when working for periods greater than the breakthrough time. If a glove rips or is punctured, the glove should be removed and replaced immediately. Holes in the glove allow for direct penetration of chemicals through the glove, causing the glove to be ineffective.
 2. Physical: Physical hazards can include cryogenic or elevated temperatures, sharps, and mechanical forces.
 3. Cryogenic temperatures: For cryogenic temperatures, cryogenic gloves are appropriate. Cryogenic gloves range from wrist to shoulder length and are often made of a nylon outer surface and polyester inner surface. The length should be chosen based on further assessments of the task. Handling liquid nitrogen is a common route of exposure to cryogenic temperatures.
 4. Elevated temperatures: For elevated temperatures, heat resistant gloves are appropriate. Heat resistant gloves come in varying shapes, sizes, and materials. Basic heat resistant gloves are often made from cotton, while more advanced heat resistant gloves are made from materials such as nitrile rubber and Kevlar. When choosing heat resistant gloves, ensure the temperature you are working with is within the operating range of the gloves.
 5. Sharps: When handling needles, razors, blades, or any other type of item that could cut or puncture the skin, cut and puncture resistant gloves should be used. Common materials include Kevlar and leather. Cut and puncture resistant gloves often feature inserted plates.
 6. Mechanical forces: Impact resistant gloves should be worn for protection against mechanical forces. Impact resistant gloves are made with added padding, such as foam or gel layers.
 7. Radiation: When handling with or working near radioactive material, radiation attenuation gloves are appropriate. Lead rubber gloves are effective at shielding hands from radiation (better with increasing thickness), but are heavy and difficult to work with. Common alternatives to lead include titanium, bismuth, and tungsten. While not as effective at shielding radiation as lead, the alternative materials do not have to be disposed of as hazardous waste like is required of lead.

3. Face protection

1. Face protection is designed to protect the eyes and lungs from chemical splashes, chemical vapors, airborne powders, flying particles, intense light radiation, heat, and harmful gases. There are various types of protective face-wear that are available to prevent damage to the eyes and lungs, including glasses, goggles, face shields, respirators, and gas masks. Choosing the appropriate face-wear should be done based on the types of hazards associated with the task at hand. Safety glasses are part of the minimum PPE required to enter a lab space.

The safety glasses that are required should adhere to ANSI Standard Z87.1. They should have side shields, be impact resistant, provide protection against flying particles, and provide basic protection against chemical splashes.

Table 1 below presents appropriate choices of protective face-wear for a given hazard. Depending on the severity of the hazard, varying levels of protection can be chosen.

Hazard	Method	Source	Protection
Chemical	Splash	Liquids, acids/bases, solutions	Glasses, goggles, face shield
	Vapor/gas	Volatile solvents/solids, gases	Goggles, full face gas respirator
Dust	Airborne particles	Fine powders, nanoparticles, sanding, sawing	Goggles, goggles with particulate respirator, full face particulate respirator
Impact	Flying particles, fragments, objects	Sawing, nail guns	Glasses, goggles, face shield
Light radiation	UV, IR, visible radiation	Torch welding, arc welding, torch soldering	Welding goggles, welding face shield of appropriate shade
		UV, IR radiation	Glasses
		Glare	Tinted glasses
Heat	Flying particles, fragments, sparks	Grinding, hot working	Glasses, goggles, face shield
	Splash	Molten metal, salts, hot solvents	Goggles, face shield
	Exposure	Flames, hot objects	Glasses, goggles, face shield
Biological	Airborne particles	Biological sample	Glasses, goggles, face shield, goggles with particulate respirator, full face particulate respirator

Table 1: Appropriate selection of eye protection for a given type of hazard.

- Common eye glasses are not appropriate face protection when in the laboratory. Eye glasses provided very limited protection from splashes and are not normally impact resistant. Prescription safety glasses can be obtained or protective face-wear can be worn over eyeglasses.

4. Body

- Lab coats and aprons are worn to protect your body from hazards in the lab. Lab coats should be made from flame retardant material, buttoned up, and well-fitted. Lab coats that are unbuttoned or too loose risk getting caught on things in the lab. When further protection is required, a rubber apron is worn. Rubber aprons will not absorb splashes and provide better protection against heat.

5. Hearing

- Ear protection is necessary when exposed to loud noises or continuous noise for long periods of time. Depending on the noise level, ear plugs or earmuffs should be worn.

References

- Ansell Occupational Healthcare. 2008. Chemical Resistance Guide: Permeation and Degradation Data, 8th edition.
- Standard. 2015. "American National Standard for Occupational and Educational Personal Eye and Face Protection Devices"