Northwestern | OFFICE FOR RESEARCH SAFETY

Lab Safety Fundamentals: Personal Protective Equipment
Course Transcript

Introduction to Personal Protective Equipment

Personal protective equipment, or simply PPE, may be among the first items you put on in the lab to protect yourself, but it also represents the last line of defense. Laboratory coats, eye and face protection, and gloves, combined with proper dress, are all part of an appropriate safety ensemble.

It may seem a little surprising, but your first lab safety decisions of the day take place well before you reach your research building. What you decide to wear will either enhance or compromise your personal safety.

Appropriate attire for the lab includes:

- Covering your legs with pants or slacks. Shorts, skirts, dresses, and other such garments leave skin unprotected, even with a lab coat.
- 100% cotton garments are inherently flame resistant. Most synthetics are inherently flammable and will melt to the skin if ignited.
- Wearing enclosed, substantial footwear with socks. Sandals, flip-flops and flats are not appropriate. As a best practice, keep a dedicated set of sturdy shoes for the lab in your office or locker.
- If you have long hair, tie it back or otherwise restrain it. Likewise, do not wear loose or dangling jewelry.

The reference section provides guidelines for selecting PPE.

Eye and Face Protection

Approximately 2,000 work-related eye injuries occur in the American workplace every day. Ten to twenty percent of these injuries involve temporary or permanent vision loss.

Vision experts believe that 90% of all eye injuries can be lessened or prevented with proper eye protection.

Years of experience demonstrate that the most effective safety programs require eye protection 100% of the time.

Eye injuries in the laboratory may result from flying objects (penetrating), blunt trauma, and chemical injuries from spray and splash. UV and other spectra can also cause serious injury.

It may seem obvious, but eye protection only works if it is worn.

Prescription Glasses

Conventional prescription eyewear is NOT approved eye protection.

Prescription safety glasses match impact-resistant lenses with an impact-resistant frame. The frame must wrap around the orbit of the eye or have side shields on each side to help prevent indirect exposure.

Each component of prescription safety glasses—the frame, lenses, and side shields must be certified and clearly marked—anything less is not approved safety eyewear.

Safety Glasses

Polycarbonate safety glasses provide the most convenient and flexible form of eye protection, and they provide impact resistance, and limited splash protection—and, polycarbonate plastic is inherently UV-resistant. Polycarbonate safety glasses can be additionally treated for greater UV protection.

Wearing your safety glasses at all times while in the laboratory is a best practice.

Because comfort and fit is an important factor in everyday use, safety glasses come in a wide variety of styles and sizes. There are narrow frames for smaller faces, safety glasses with adjustable nose bridges, and even glasses with reading lenses.

A practical, low-cost solution to prescription safety glasses is an “over the glasses” design. Over the glasses designs allow protection without removing conventional prescription eyewear.

Splash Goggles

Chemical splash goggles provide a higher level of protection against eye injuries by combining the impact resistance of safety glasses with a flexible, complete seal around the eyes.

Chemical splash goggles today have curved, spherical lenses. This provides an improved field of view with less eyestrain. They are also indirectly vented for comfort.

Chemical splash goggles are required when working with corrosive, reactive, or flammable chemicals. They should be worn when working on systems that operate at high or low pressures, temperatures, or steam.

Chemical Eye Injuries

Strong corrosives, even in very small amounts, can cause serious eye injuries including the permanent loss of sight.

Caustic chemicals are known to cause immediate, deep, painful, and potentially widespread damage.

Acids, while slightly less damaging than caustics (except Hydroflouric), will coagulate proteins on the surface of the eye. These injuries are also immediate and painful.

Chemical splash goggles provide the greatest protection. For work involving one liter or more of any strong corrosives, supplement your use of chemical splash goggles with the addition of a full-face shield.

Eye Protection Certification

When selecting eye protection, look for specific certifications to ensure the proper type.

Look for an internationally recognized certification such as:

- Z87—USA
- Z94—Canada
- CEN/TC 85—EU

Polycarbonate safety glasses can be additionally treated for scratch and fog resistance.

These same criteria apply to prescription safety eyewear.

Face Protection

Safety glasses or splash goggles alone do not protect the face and neck. A face shield alone does not provide adequate eye protection.

When worn together, a certified face shield with chemical splash goggles provides both eye and face protection. This is the ideal combination for higher risk, energetic experiments.

Features to protect the neck are found on many face shield designs.

Contact Lenses

A widely held misconception is that contact lenses cannot be worn in a laboratory.

Contact lenses are acceptable in the laboratory, provided that eye protection is worn at all times while in the lab.

Shielding and Supplemental Protection

For systems under high or low pressure, inherently reactive or energetic experiments, or extremes in temperature, place heavy-duty polycarbonate blast shields around critical equipment or systems.

In addition to the use of blast shielding, wear chemical splash goggles and a face shield to provide the greatest measure of protection in high-hazard/high-risk experiments.

Laboratory Coats

After protecting your eyes, the next step is wearing the right lab coat. In low-risk labs, people often ask "Why a lab coat?" At a minimum, a lab coat provides an additional layer of protection and helps protect your clothing from contamination. In biotechnology environments, cell culture and basic microbiology inevitably generate droplets and aerosols.

While largely invisible, most of us would rather not have these materials follow us home or have them come in contact with our food, friends, family, pets or vehicles. In other sciences, salts, buffers, finely divided materials and lubricants can be just as unappealing.

The right lab coat for you depends on your work. You can follow these basic guidelines:

1. Never purchase or wear cotton/polyester lab coats because they burn easily. Stick with 100% cotton or specialty fabrics.
2. For most biomedical and instructional laboratories, a 100% cotton lab coat works well.
3. For work with flammable chemicals, a flame-resistant lab coat—FR rated or made of flame-resistant specialty fabrics like NOMEX®—provides a greater measure of protection.
4. Keep your lab coat fully buttoned or snapped at all times. A fully closed lab coat creates a more protective envelope around your body.
5. Remove your lab coat as you leave the laboratory—never wear a lab coat in common spaces like a kitchen area, classroom or library.
6. Make use of your institution's lab coat washing program. Never take your lab coat home to wash.

Wearing your lab coat is a visible, conscious reminder that laboratory safety is an individual, institutional and shared value.

Facets of Hand Protection

In the laboratory, the hands are at constant risk of cuts, burns, punctures and contact with some combination of biological, chemical or radiological exposure or physical trauma. Contact with, or trauma to, the skin is a primary route of entry of hazardous materials into the body.

Single-use, disposable gloves provide barrier protection against biological, chemical and radiological materials. They also help prevent your skin from causing contamination of lab ware and experiments.

Latex is a naturally occurring elastomer that is known to cause sensitization and allergies in laboratory workers. Use non-latex alternatives such as neoprene, nitrile and vinyl.

Information on latex allergies is included in the reference section of this course.

Glove Selection

No single glove can protect you from every hazard. Gloves have limitations: some chemicals can permeate gloves; choose the right glove type for your experiment.

Watch this video about glove permeation, penetration, and degradation, and look for ways that these elements may affect your choice of glove type.

Video transcript:

This animation on glove permeation, penetration, and degradation was produced by the Northwestern University Office for Research Safety.

The following key terms will be discussed in detail:

- Penetration
- Permeation
- Risk Assessment
- Degradation

Penetration describes how chemicals can pass through a glove material via macroscopic breaks such as tiny holes, cracks, and tears. Mechanical damage such as stretching, cuts, or punctures cause macroscopic breaks. Gloves that are old or poorly made are more likely to fail due to penetration.

This illustrates how molecules of benzene can penetrate through macroscopic breaks in a neoprene glove.

Permeation describes how chemicals can pass through a glove material on the molecular level. Often, this happens without any visible change, sensation (like wetness), or other indication of chemical exposure. This illustrates how molecules of benzene can permeate a neoprene glove.
Chemical permeation can be described in simple terms by comparing what happens to the helium in a balloon after a couple of hours. Even in a tightly sealed balloon the helium inside will permeate through the wall to the atmosphere. This example uses gas permeation. But the principle is similar with liquids and chemicals.

Hazardous chemicals may permeate through the glove, exposing the skin to the chemicals.

Selecting the proper glove for the chemicals you work with in the lab requires a risk assessment. A proper risk assessment considers all of the following:

- the chemicals
- their concentration
- the potential for direct contact, for example by total immersion or splashes
- the frequency and duration of contact
- the length to be protected, which can include the hand, the forearm, or the entire arm.

Based on their composition and the manufacturer’s permeation data, disposable gloves provide only limited chemical protection. Change disposable gloves frequently and whenever there is known or suspected contact.

Take these gloves! Let’s get back to work.

Another important glove concept is degradation. Degradation is a measure of how tough the glove material is when exposed to chemicals. If a hazardous chemical has a significant impact on the physical properties of the glove, then its ability to protect you is compromised, and you risk chemical exposure to your skin. With reusable gloves, replace them when they become discolored, swell, crack, or simply become “funky."

Wearing improper gloves puts you at risk of chemical exposure.

Always select gloves based on a careful risk assessment and published information by the manufacturer. Consider the potential for penetration, permeation, or degradation.

Sometimes, the best glove is actually a combination of gloves, for example, a specialty plastic laminate glove worn as a permeation-resistant liner under a heavy-duty outer glove.

In summary, choose the right glove for your needs by considering penetration, permeation, risk assessment and degradation.

Disposable Gloves

Single-use disposable gloves play an important role in the laboratory. Purchase quality gloves from a reputable manufacturer, and always check gloves for holes and tears before you use them. This video demonstrates two techniques for removing gloves without contaminating yourself.

It takes some practice to get the hang of it—the goal is simple—to never touch the outside of the used glove with unprotected skin. Contaminated gloves should be discarded in the container that is designated for the hazard. Uncontaminated gloves may be disposed of as non-hazardous trash. Please do not attempt to reuse disposable gloves.

Change your gloves whenever they become contaminated and between experiments. Please do not touch common surfaces, such as doorknobs, with gloved hands. Also, don't wear gloves outside the lab. Always wash your hands after removing disposable gloves.

Video Transcript:

Who doesn't know how to remove gloves, right? But can you do it without touching the outside of the gloves? Gloves are a physical barrier between you and the substances you're working with. But what good are they if you contaminate yourself while removing them? Try one of these methods to remove those dirty gloves.

The Fold and Tuck: Grab one glove on the palm side and fold over your fingers. Carefully pull the glove off and ball it up with your still gloved hand. Tuck a finger under the other glove and slowly peel your hand away. Or, try the Double Fold.

Start the same way as the fold and tuck, but this time, keep the first glove around your fingers and use it to grab and fold the second glove-and pull.

Alright, you got the gloves off, but now what? Throw them away appropriately. Don't even think about reusing disposable gloves. And wash your hands thoroughly; between your finger, under your nails, and all that good stuff.

Now let's rewind. The gloves did their job, now do yours. Remove those gloves slowly and carefully to keep that physical barrier working for you for that healthy/safe feeling.

Reusable Gloves

Heavy-duty, reusable gloves come in a variety of materials, thicknesses, and lengths.

When properly matched to the task, reusable gloves provide additional protection.

When used in combination with disposable gloves and, when necessary, together with other materials, the combined properties can address multiple hazards.

The most chemically resistant glove material is made of a laminate plastic and is known by its commercial name Silvershield. Silvershield gloves are most effective when worn underneath a heavy-duty glove.

Modern fibers, such as Kevlar®, Nomex®, and Dyneema®, combined with improved manufacturing and testing methods, have led to a new array of cut-resistant gloves with practical applications in research laboratories. For some of these new gloves, in addition to cut resistant, they are also flame resistant.

While no glove is proven “puncture proof," cut-resistant gloves, worn over disposable gloves, provide enhanced hand protection against cuts and lacerations in the laboratory. Long-cuffed Nomex® gloves, worn by military pilots for many years, are well suited for work with highly flammable chemicals such as pyrophorics, ethers, hexane, and other low flash point solvents.

Please take proper care of your reusable gloves. Rinse the outside of each glove thoroughly under running water, before removing them. Allow the gloves to air dry completely and replace the gloves when they become discolored, tacky, cracked, or old.

Specialty grips made of heat resistant silicone are a convenient form of protection when handling hot liquids and glassware.

Respirators

By design, a laboratory fume hood provides dedicated local exhaust ventilation for work with hazardous materials. A respirator is necessary if engineering controls are not sufficient to protect you from the hazard.

A respirator is a type of PPE that is worn over the nose and mouth and is intended to filter out airborne contaminants.

Respirators come in a wide variety of types. Each type is designed for a specific application.

Assuming a recently certified laboratory fume hood is used and the work does not overwhelm the envelope it provides, a respirator should never be needed. Please, do not take it upon yourself to obtain a respirator.

In all cases, speak to your safety advisor before considering, purchasing, or using a respirator.

Masks

A surgical-type mask is sometimes worn to protect your nose and mouth, especially with blood and body fluids.

The two functions of surgical masks are to protect against splash and spray and to lessen the likelihood that expelled droplets become contaminants. For these reasons, they may be useful in a biomedical laboratory.

They provide little to no protection against finely divided chemicals and aerosolized biohazards, and do not at all protect against chemical vapors, gases, or nanoparticles.

Summary

The proper and consistent use of Personal Protective Equipment provides the last line of defense in protecting you against exposure and harm from your use of hazardous materials.