3.16. **Personal Protective Equipment** – Procedures for Selection and Use

Personal protective equipment (PPE) is selected based on the potential hazard presented by the work. Scrutinize each laboratory procedure individually for potential hazards based on the chemicals to be used and the procedure to be performed. The hazard assessment is then used to determine the appropriate personal protective equipment.

Each laboratory group is responsible for assessing the potential hazards presented by their work. The IU Personal Protective Equipment Policy and the Laboratory Chemical Personal Protective Equipment Guidance Form found in Appendix A can be used for this purpose. The potential hazards presented by typical laboratory procedures and the corresponding personal protective equipment are found on the form. The list does not include all laboratory procedures. Additional tasks and personal protective equipment should be added as necessary on the form.

A list of chemicals that require skin protection can be found in Appendix B. These chemicals have been identified by the Occupational Safety and Health Administration (OSHA) and/or the American Conference of Governmental Industrial Hygienists (ACGIH) as chemicals that present a significant risk of skin absorption and subsequent toxicity. Many chemicals not on the list also require the use of gloves and other personal protective equipment. Never underestimate the risk of exposure. Always practice good chemical hygiene and use personal protective equipment.

3.16.1. Hand Protection

No glove is resistant to all chemicals. Consult the glove manufacturer's selection guides for chemical compatibility prior to use. Glove selection guides can also be found at the manufacturer's web sites. For further information contact IUEHS for your respective campus.

3.16.1.1. Selection

When selecting and using gloves always:

- Consider chemical resistance, thickness, length, and dexterity requirements.
- Inspect all gloves before use for signs of swelling, cracking, discoloration, pinholes, etc.
- Consider double gloving (wearing one glove over another) as a precaution.
- Change gloves frequently or as often as needed if they become contaminated.
- Do not wear gloves into the hallways or other common areas.
- Do not touch doorknobs, phones, etc., when wearing gloves. (Remove them before touching anything to prevent leaving chemical residue on the item.)
- Remove gloves by pinching the material in the palm and turning them inside out as the glove is removed over the finger tips (thus keeping contamination on the inside of the removed glove.)
- Rinse thicker reusable gloves after every use.

3.16.1.2. Chemical Resistance

Chemical resistance is based on several characteristics of the glove material. When selecting the appropriate glove, the following properties must be considered:

- Degradation,
- Breakthrough time, and
- Permeation rate.

Degradation is the change in one or more of the physical properties of a glove caused by contact with a chemical. Degradation typically appears as hardening, stiffening, swelling, shrinking or cracking of the glove. Degradation ratings indicate

how well a glove will hold up when exposed to a chemical. When looking at a chemical compatibility chart, degradation is usually reported as E (excellent), G (good), F (fair), P (poor), NR (not recommended) or NT (not tested).

Breakthrough time is the elapsed time between the initial contact of the test chemical on the surface of the glove and the analytical detection of the chemical on the inside of the glove.

Permeation rate is the rate at which the test chemical passes through the glove material once breakthrough has occurred and equilibrium is reached. Permeation involves absorption of the chemical on the surface of the glove, diffusion through the glove, and desorption of the chemical on the inside of the glove. Resistance to permeation rate is usually reported as E (excellent), G (good), F (fair), P (poor), NR (not recommended), or NT (not tested). If chemical breakthrough does not occur, then permeation rate is not measured and is reported ND (none detected).

Manufacturers stress that permeation and degradation tests are done under laboratory test conditions, which can vary significantly from actual conditions in the work environment. Users may decide to conduct their own tests, particularly when working with highly toxic materials or chemicals for which no data can be found. This must always be done carefully in a fume hood with PPE and without touching the chemicals or contaminated materials with the hands (e.g., use forceps).

For mixtures, it is recommended that the glove material be selected based on the shortest breakthrough time.

The following table shows the typical glove materials and their general uses.

Glove Material	General Uses
Butyl	Offers the highest resistance to permeation by most gases and water vapor. Especially suitable for use with esters and ketones.
Neoprene	Provides moderate abrasion resistance but good tensile strength and heat resistance. Compatible with many acids, caustics and oils.
Nitrile	Excellent general duty glove. Provides protection from a wide variety of solvents, oils, petroleum products and some corrosives. Excellent resistance to cuts, snags, punctures and abrasions.
PVC	Provides excellent abrasion resistance and protection from most fats, acids, and petroleum hydrocarbons.
PVA	Highly impermeable to gases. Excellent protection from aromatic and chlorinated solvents. Cannot be used in water or water-based solutions.
Viton	Exceptional resistance to chlorinated and aromatic solvents. Good resistance to cuts and abrasions.
Silver Shield	Resists a wide variety of toxic and hazardous chemicals. Provides the highest level of overall chemical resistance.
Natural rubber	Provides flexibility and resistance to a wide variety of acids, caustics, salts, detergents and alcohols. (See Latex Gloves and Related Allergies below).

3.16.1.3. Latex Gloves and Related Allergies

Allergic reactions to natural rubber latex can sometimes occur. The term "latex" refers to natural rubber latex and includes products made from dry natural rubber. Natural rubber latex is found in many products including disposable gloves and other personal protective equipment.

Several chemicals are added to this fluid during the processing and manufacture of commercial latex. Some proteins in latex can cause a range of mild to severe allergic reactions. The chemicals added during processing may also cause skin rashes.

Latex exposure symptoms include skin rash and inflammation, respiratory irritation, asthma and shock. The amount of exposure needed to sensitize an individual to natural rubber latex is not known, but when exposures are reduced, sensitization decreases.

In addition to skin contact with the latex allergens, inhalation is another potential route of exposure. The proteins responsible for latex allergies have been shown to fasten to powder that is used on some latex gloves. Latex proteins may be released into the air along with the powders used to lubricate the interior of the glove.

The following actions are recommended to reduce exposure to latex:

- Whenever possible, substitute another glove material.
- If latex gloves must be used, choose reduced-protein, powder-free latex gloves.
- Wash hands with mild soap and water after removing latex gloves.

Once a worker becomes allergic to latex, special precautions are needed to prevent exposures during work. Certain medications may reduce the allergy symptoms, but complete latex avoidance is the most effective approach.

3.16.2. Protective Eyewear

Protective eyewear is *required* whenever there is a reasonable probability that the eyes could be exposed to chemicals. The type of eyewear required depends on the hazard classification of the area and procedure to be performed. Please refer to the IU Eye and Face Protection Program for additional guidance.

3.16.2.1. Types of Protective Eyewear

3.16.2.1.1. Safety Glasses

Safety glasses have shatter resistant lenses made of materials like polycarbonate plastic with side shields attached to the temples that meet the specifications of the American National Standards Institute Standard Z87.1-1989. Safety glasses are designed to stop physical objects or harmful radiation such a laser light from entering the eyes and provide little or no protection from vapors or liquids.

3.16.2.1.2. Goggles

Properly vented safety goggles are the preferred eye protection to be worn when chemicals are handled in the laboratory. These should be worn *over* prescription glasses.

Goggles come in two types: vented and non-vented. Non-vented goggles are used to protect your eyes from vapors, mists, fumes, or other eye hazards that require complete eye coverage with no leaks or perforations.

Vented goggles are used where there are moderate quantities of liquids being used but no vapors or mists are involved. There are several types of vented goggles. The type of vented goggles made for laboratory use has a series of

buttons embedded into the plastic. These buttons house a baffle plate that allows air to pass but presents a physical barrier to liquids. Do not use the common vented goggle with simple holes drilled in the sides. This type of vented goggle will not stop liquids from coming in through the holes and is not suitable for laboratory work.

3.16.2.1.3. Face Shields

Face shields are designed to augment other types of eye protection and are not meant to be a stand-alone form of eye protection. Face shields are used to protect your entire face to catch any liquids that might splash onto the face.

3.16.2.2. Hazard Classifications

Areas and operations within research buildings can be classified into three types of hazardous areas based on the following definitions. It is important to recognize that the procedure is classified as well as the area. If a procedure creates a greater hazard than the laboratory classification would indicate, eye and face protection appropriate for the hazard shall be worn. It would be possible to have a Class 3 operation in a Class 2 area. Appropriate additional protection would be required.

3.16.2.2.1. Class 1 – Eye Protection Not Required

This classification includes laboratories that do not use chemicals, biological materials, or physically hazardous materials. Hazards requiring eye protection are seldom encountered in this area. These areas are exempt from the requirement that occupants and visitors must wear industrial safety glasses. Examples include computer or imaging laboratories and other areas such as:

- Offices including enclosed offices within laboratories or protected desk areas. To comply with this requirement there must be a line of sight barrier (for example an office partition) between personnel and any chemicals or any chemical process in the laboratory;
- Conference rooms;
- Libraries and reading rooms;
- Corridors, lobbies, elevators, and stairwells;
- Locker and rest rooms;
- Mail and copier rooms;
- Computer and computer user rooms; and
- Lounges and break rooms.

3.16.2.2.2. Class 2 – Eye Protection Required When Hazards Exist

This classification includes laboratories that use chemicals, biological materials, or physically hazardous materials on an occasional basis. Eye protection must be worn when the hazards exist. Safety eyewear such as industrial safety glasses with side shields are required for workers and visitors in these areas. Examples include laser laboratories and some research laboratories.

3.16.2.2.3. Class 3 – Eye Protection Required At All Times

Specific and predictable eye hazards exist in these areas such as laboratories that routinely use chemicals, biological materials, or machinery. Examples of eye protection required in these areas are acid splash goggles, face shields, welding helmets, and laser goggles. Industrial safety glasses alone may not provide adequate eye protection in these areas. Examples include chemistry teaching laboratories and organic chemistry laboratories.

Note: Contact lenses may complicate treatment in the event of an accident. They

may be allowed or prohibited based on the specific laboratory procedures and policy. The use of contact lenses is only allowed in conjunction with appropriate safety eyewear and the laboratory supervisor's approval. Instructors or supervisors must be aware of those wearing contact lenses.

3.16.2.3. Exemption Procedure

Eye protection may need to be removed while viewing materials through a microscope or similar equipment. Eye protection must be replaced after operation is complete. Microscope and similar equipment must be located in an area where removal of eye protection does not place personnel at risk from other hazards in the area.

3.16.2.3.1. Local Safety Procedure Required

State if eye protection can be removed behind a line of sight barrier. Define the line of sight barrier. Any approved exemptions must be identified on the Personal Protective Equipment Hazard Assessment Form LCS-4 in Appendix A.

3.16.3. Protective Clothing

Protective clothing in the form of lab coats, aprons, and closed-toed shoes are required whenever the possibility of chemical contamination to the body exists. Protective clothing that resists physical and chemical hazards should be worn over street clothes.

Lab coats and aprons should be left in the laboratory and not taken home. This prevents the worker from carrying incidental contamination out of the laboratory and presenting a chemical hazard to co-workers, friends, or family.

Disposable outer garments such as Tyvek suits, aprons, and lab coats may be useful when cleaning and decontamination of reusable clothing is difficult.

Shorts, loose clothing (including ties), or torn clothing are inappropriate for work with hazardous chemicals.

3.16.3.1. Lab Coats

Lab coats are appropriate for minor chemical splashes and spills. They must be worn buttoned with the sleeves covering the arms. Do not roll up the sleeves.

3.16.3.2. Aprons

Rubber or plastic aprons are appropriate for handling corrosives or irritating liquids.

3.16.4. Footwear

Safety shoes or other specialized foot protection are generally not required for most laboratory operations. However, shoes must cover the entire foot. Open toed shoes and sandals are inappropriate footwear in laboratories. Fabric and athletic shoes offer little or no protection from chemical spills. Leather shoes or equivalent (chemically resistant shoes) with slip-resistant soles are required. Shoes may have to be discarded if contaminated with a hazardous material.

Chemical resistant overshoes, boots, or disposable shoe coverings ("booties"), may be used to avoid possible exposure to corrosive chemicals or large quantities of solvents or water that might penetrate normal footwear (e.g., during spill cleanup).

Although generally not required in most laboratories, composite-toed safety shoes may be necessary when there is a risk of heavy objects falling or rolling onto the feet, such as in bottle-washing operations, animal care facilities, or if large quantities of liquids are stored and moved in drums.

Please refer to the IU Foot Protection Program for additional guidance.

3.16.5. Respiratory Protection

Respiratory protection is typically provided by using adequate engineering controls such as chemical fume hoods, canopy hoods, snorkel hoods, glove boxes, and appropriately equipped biological safety cabinets. It should be noted that not all biological safety cabinets provide protection from toxic chemical vapors and fumes. These devices should be carefully selected and used only for their intended purpose.

A respirator may only be used when engineering controls, such as general ventilation or a fume hood, are not feasible or do not reduce the exposure of a chemical to acceptable levels. Respirators can only be used in accordance with the Indiana University Respiratory Protection Program. Contact IUEHS for your respective campus for more information or to obtain a respirator and arrange the required respirator fit test and medical examination.

3.16.6. Head Protection

Head protection may be necessary in industrial type laboratories where overhead hazards exist or fluids may splash onto the head. Appropriate head protection in the form of hard hats or fluid barrier hats should be used in these cases. Hooded disposable coveralls may also be used if necessary.