PROTECTIVE GLOVES

In many University laboratories, exposure to chemicals, infectious agents, sharp objects, extreme temperatures and other hazards can create a potential for injury to the hand. Wherever practicable, these hazards should be eliminated or reduced through the use of engineering and/or administrative controls. The use of appropriate hand protection can protect against those hazards which continue to exist. The Department of Occupational Health and Safety can assist in making the proper selection.

RESPONSIBILITY

It is the responsibility of all supervisors, instructors and teaching assistants to ensure that all employees, students and visitors wear appropriate protective gloves when involved in a procedure where potential hand and skin hazards exist. It is the responsibility of all persons to wear the appropriate gloves required.

PERSONAL PROTECTIVE GLOVES:

Hand injuries may be prevented by using appropriate protective gloves which protect against the specific hazards presented, and which provide a comfortable and secure fit. Gloves should not be worn around moving machinery.

The following outlines the general types of protective gloves:

1. **Fabric gloves** are made of cotton or fabric blends. They offer moderate abrasion protection. They can help insulate the hands from mild heat or cold. They can also be used to improve grip when handling slippery objects.

2. **Leather gloves** offer good puncture resistance, abrasion resistance and impact absorption. They can be used when handling hot or cold objects, and offer greater thermal protection than cotton or knitted fibres.

3. **Cut resistant gloves** are made from stainless steel, kevlar or spectra mesh fabrics and protect the hands against cuts and scratches. They are commonly used when working with cutting tools or other sharp instruments.

4. **Cryogenic gloves** are generally designed to protect the hands from intense cold or heat.

5. **Chemical resistant gloves** are designed to protect the hands against skin contact or absorption of chemicals and other hazardous materials. Gloves are available in a wide range of natural and synthetic materials, such as latex rubber, neoprene, butyl rubber, polyvinyl chloride (PVC), polyvinyl alcohol (PVA), and nitrile rubber, as well as in a variety of blends of these materials. No single glove material will protect against all chemicals. Glove materials only temporarily resist chemical breakthrough and the contacted chemical will permeate through the glove material over time. An inappropriate choice of glove material can result in worker exposure due to chemical permeation. It is essential to select a glove material which provides an effective barrier against the specific chemical(s) used. In particular, extreme care must be taken in selecting the

appropriate glove material for use with highly toxic substances, particularly for those chemicals which are readily absorbed through the skin and into the bloodstream. In such cases, gloves which have a very high resistance to chemical permeation must be used, such as laminated synthetic gloves.

Proper selection of an appropriate glove material must include:

- an assessment of the workplace hazards, including the specific chemical(s) to be used, the conditions and duration of use, and the specific tasks to be performed;
- consultation of each chemical's material safety data sheet for the recommended glove material to use;
- a review of the glove manufacturer's chemical resistance data on glove degradation and permeation for the specific chemicals to be used with it. A suitable glove must demonstrate no significant degradation, a high breakthrough time and a low permeation rate upon contact with the given chemical.
- **Refer to the Guide to Selection of a Chemical Resistant Glove**

Disposable gloves are usually made of lightweight plastic or rubber materials, and offer greater sensitivity and dexterity to the user. Users should be aware of the limitations of such gloves in protecting against chemical or physical hazards. Disposable gloves are generally intended to provide a barrier to infectious materials and guard against mild chemicals or other materials, and provide little or no protection against many chemicals. Although the need for high dexterity and low cost are often major factors in the selection of gloves, the potential for permeation of toxic materials though the glove must be of prime consideration. Disposable gloves should be replaced frequently, and should never be reused or washed with either water or alcohol, as washing increases the likelihood of permeability.

Hand washing and other personal hygiene practices are important measures for preventing or reducing contact with chemical contaminants. Current evidence tends to indicate that barrier creams and lotions offer little protection against chemical hazards, and often increase the likelihood of contact dermatitis. Such products often contain mineral oil lubricants which can weaken glove materials such as natural rubber latex. When finished the procedure involving the use of chemically resistant gloves, the gloves should be removed and either disposed of properly, or if being reused, decontaminated, dried and stored so as to avoid chemical contamination, sunlight and heat.

Inspection and care of chemical resistant gloves should be conducted routinely. Chemically resistant gloves will break down after repeated chemical exposures, and from heat and sunlight. As a result gloves should be inspected each time they are reused. Reusable gloves should be thoroughly rinsed and allowed to air dry. Gloves should be replaced on a regular and frequent basis. They should be replaced immediately upon signs of degradation, and particularly after contact with toxic chemicals. Once a chemical has been absorbed into the glove material, the chemical can continue to diffuse through the material even after the surface has been washed.

GUIDE TO SELECTION OF A CHEMICAL RESISTANT GLOVE
Chemical Degradation and Permeation Properties

In order to adequately prevent exposure to potentially harmful chemicals, an appropriate protective glove must provide an effective barrier between the chemicals being used and the skin of the hand. This table is intended as a guideline in the selection of the appropriate chemical resistant glove material by informing users of the limitations of glove materials, as well as the type of information that is available to indicate the degree of protection a glove material can provide. An inappropriate choice of glove material can result in worker exposure. In particular, extreme care must be taken in selecting the appropriate glove material for use with highly toxic substances, particularly for those chemicals which are readily absorbed through the skin and into the bloodstream.

The selection of an appropriate glove when working with chemicals must include an assessment of the hazards, related to the specific chemical(s) being used, the conditions of use and the tasks being conducted. The degree of protection from such hazards provided by a protective glove will depend on factors related to the glove material itself, including its chemical make-up, thickness, and method of construction.

Glove Limitations

- No single glove material will protect against all chemicals. Different materials interact differently with different types of chemicals. Natural rubber latex gloves may be suitable for dilute aqueous solutions; however, oils, greases, and many organic solvents will easily permeate latex material. Nitrile gloves may be used for oils and greases but are generally unsatisfactory for use against aromatic or halogenated solvents.
- No glove material is totally impermeable. Glove materials only temporarily resist chemical breakthrough and the chemical will permeate through the glove material over time. Once a chemical has been absorbed into the glove material, the chemical can continue to diffuse through the glove. Even the best chemically resistant glove will break down after repeated chemical exposures.
- Chemical resistance of a particular type of glove material(eg. nitrile) can vary significantly from product to product, and from manufacturer to manufacturer.

Chemical Resistance Properties of Gloves

The selection of a glove material which provides the best protection against a particular chemical should be based on the glove material's resistance to degradation and permeation upon contact with the chemical. When selecting gloves, degradation properties must first be considered. Once a glove material which demonstrates no significant deterioration when in contact with the intended chemical has been selected, its permeation properties in terms of breakthrough time and permeation rate must be considered. Glove manufacturers generally provide chemical resistance charts containing degradation and permeation data on their own products.

1. **Degradation** is the physical deterioration of a glove material due to contact with a chemical. Degradation may cause the glove to soften, swell, stretch, shrink, dissolve, or become hard and brittle. Glove manufacturers frequently conduct degradation tests on their glove products and rate them from poor to excellent. Glove materials having a good to excellent rating should initially be selected, and then evaluated with respect to its permeability characteristics. A glove with a good or excellent degradation rating may perform poorly in terms of chemical permeation and breakthrough.

2. **Permeation** is the process by which a chemical moves through a glove material at the molecular level. The permeation process start with absorption of the chemical at the outside surface of the glove material, followed by diffusion of the chemical through the glove material, and finally desorption of the chemical molecules from the inside surface of the glove. Permeability test data indicate that all glove materials are permeable to some extent, and only temporarily resist chemical breakthrough. Chemical permeation can take place with obvious signs of degradation, swelling or weight changes. Frequently, however, it occurs with little visible physical degradation of the glove material.

In order to characterize the permeation properties of a glove material, permeation tests are conducted in accordance with standards established by agencies such as the American Society for Testing and Materials (ASTM). Permeation testing can provide two important pieces of data that can aid in selecting the best glove material for a particular chemical - breakthrough time and permeation rate. An appropriate glove is one which has an acceptably high breakthrough time and low permeation rate for the conditions of use.

a) **Breakthrough time** is the time from initial contact of a given chemical on the glove exterior to the time it is first detected on the inside surface. The breakthrough time is usually expressed in minutes or hours. A typical test runs for up to 8 hours. If there is no measurable breakthrough after 8 hours, the result is reported as a breakthrough time of >480 minutes or >8 hours.

The breakthrough time is often the most important factor used to indicate the degree of protection a particular glove material will provide, particularly with highly toxic chemicals. In general, the glove material with the highest breakthrough time should be selected. The expected duration for handling the particular chemical should be well within the breakthrough time of the selected glove material. A standard eight-hour breakthrough time is commonly used; otherwise, more frequent changes of the gloves are warranted.

b) **Permeation Rate** is the rate at which a test chemical passes through the glove material. The permeation rate is generally expressed in terms of the amount of a chemical which passes through a given area of clothing per unit time (micrograms per square centimetre per minute). The permeation rate will increase with an increase in the duration of exposure, an increase in the area exposed to the chemical, and a decrease in the thickness of the glove material. Some manufacturers provide descriptive ratings from poor to excellent.

Other Considerations

Other factors that affect the final performance of glove materials and which should be considered when selecting a suitable glove include the following:

Degree of exposure. The performance of glove materials can decrease significantly as chemical exposure increases, such as with the resultant shortening of the breakthrough time with increase in chemical concentration, or with direct immersion into the chemical.

Temperature. In general, permeation rates increase and breakthrough times decrease with increasing temperatures. Permeation test data are obtained at room temperature (20°C to 25°C). If chemicals are being used at temperatures higher than this, glove performance may be significantly affected.

Glove thickness. A thicker glove offers better chemical resistance than a thinner one. In general, permeation rate decreases and breakthrough time increases with increasing thickness of glove material. A general rule of thumb is that double the thickness will quadruple the breakthrough time. Double gloving or choosing a stronger glove material may be necessary for adequate protection. Although thinner gloves offer greater dexterity, some chemical resistance may be sacrificed. Thick gloves can impair grip, dexterity and safety; a good balance needs to be struck.

Manufacturer. Because of variations in the manufacturing process, the permeability characteristics of the same glove material from different manufacturers can vary widely. It is essential to consult a specific manufacturer's test data for their particular glove product, including information on permeability, breakthrough time, and degradation.

Chemical mixtures vs. pure chemicals. Permeation testing is conducted using pure chemicals. Mixtures of chemicals can significantly change the permeation rates and the physical properties of a given glove material. In general, for mixtures of chemicals, a glove having the lowest chemical permeation rates should be chosen. A chemical mixture, however, can have a significantly higher permeation rate than one of its components. Users may need to conduct further evaluation for instances where information is not available.

Physical resistance. The physical properties of a particular glove material must also be considered during glove selection and must be compatible with the conditions of intended use. Penetration of chemicals through a tear or hole in a glove can lead to much greater chemical exposure potential than via molecular permeation. The likelihood of factors such as puncture, tearing, abrasion or snagging should be determined. It may be necessary to wear two different types of gloves - one for its chemical resistance properties, and the other for its physical resistance properties.