FACT Sheet - Glove Selection

Introduction

OSHA requires review and documentation of your selection and rationale for personal protective equipment you select for use at work. Furthermore, glove selection should be part of the ISM approach to planning and reviewing your work at the Laboratory.

Questions

1. Why do I need to protect my hands from exposure to chemicals?
2. How is chemical protective glove selection part of safety reviews and work plans?
3. What are the most common disposable gloves on site and how do they differ?
4. What are the differences between other chemical and liquid resistant gloves?
5. What single glove material is suitable for all chemicals?
6. Where can I find more information?

1. Why do I need to protect my hands from exposure to chemicals?

A principal function of the skin is to protect the internal organs from exposure to potentially harmful components of the external environment. It does this remarkably well, but direct contact with chemicals can pose a significant challenge to the skin. Possible reactions include:

- The skin will act as an effective barrier and no detrimental effect from contact will occur;
- The skin will suffer injury such as a burn, dermatitis, or chapping due to the extraction of moisture and body oils;
- The chemical will penetrate the skin, react with tissues causing irritation, or enter the bloodstream to be circulated throughout the body (systemic exposure). Health effects depend on the chemical, its concentration, and duration of contact;
- The skin will become sensitized. Once skin is sensitized, contact with a very small quantity of the chemical can produce an allergic reaction with possible serious health effects. Some chemicals are both irritants and sensitizers.

Perspiration on the hands can interfere with one's ability to sense that contact with a chemical has occurred. Therefore contact time can increase, which can result in greater injury or chemical absorption.

Adverse effects from chemical contact with skin can account for up to 70% of occupational disease cases.

2. How is chemical protective glove selection part of safety reviews and work plans?

Define the scope of the work, identify and analyze the hazards, select protective gloves when planning the work, perform work safely using the protective gloves, and evaluate performance of the gloves selected.

Work planning requires review and documentation of your selection and rationale for personal protective equipment you select for use at work. Furthermore, glove selection should be part of the ISM approach to planning and reviewing your work at the Laboratory.

1. **Define the scope of the work**

Can potential skin exposure be eliminated through another means, such as engineering, substitution, or administrative controls? Use gloves as a last resort. If you can't eliminate exposure, during which tasks do you know you need to protect your skin?

How often will you need to wear the protective gloves? This may affect whether you select a disposable or reusable glove.

Who else will wear the gloves? You may want to include them in selecting gloves.

2. **Identify and analyze the hazards — Do you need to protect your research materials from contamination? Or do YOU need protection from the materials?**

From what materials do your hands need protection? Chemical, biological, radioactive, a combination, unknowns? A glove must perform sufficiently for each component of a mixture.

Review hazards on the SDS. If unsure, confer with your ESH coordinator or ESQ industrial hygienist.

Do you need protection during sustained contact with the hazard, or just from accidental contact?

Are there other conditions that may stress the integrity and protection of the glove? For example, heat and abrasion will accelerate glove degradation.

3. **Select protective gloves *when planning* work**

Many types of gloves are available to protect hands against chemicals. Like the skin, however, gloves can be attacked or penetrated by chemicals.

To be effective, gloves must be selected for each type of chemical, while you also consider the work to be done and the frequency and duration of contact expected. Although thicker gloves provide more mechanical strength and a lower permeation rate than thinner ones, they may not provide sufficient dexterity for the task. Because poorly fitting gloves interfere with task performance, many gloves now come in several sizes.

- Glove manufacturers usually provide selection guides. The same glove material from different manufacturers may perform differently. In addition, gloves of the same material may be available in various thicknesses.

- Glove materials with higher ratings should be chosen when the chemical of concern is very concentrated, very toxic, or when contact is expected to be frequent and/or of long duration. Likewise, lower ratings for glove material can be considered when chemical solutions are very dilute, or when only accidental splash protection against small quantities is required.

- Evaluate and select before ordering. Most gloves are ordered through AMOS, but the website does not provide selection guides directly from that intranet location.

- See manufacturers' websites, or see the list of available resources under question 6: "Where can I find more information?"

- Document your selection, proposed use, and rationale.

What are the properties of the material?

- State
- Concentration
- Particle size
- pH
- Temperature
- Toxicity: local (skin), allergic, systemic, infective

What are your requirements for glove use?

- Immersion or splash protection
- Dexterity & tactility
- Double gloving
- Frequency/duration of use
- Abrasion resistance
- High/low temps
- Disposable or reusable

Glove characteristics

- Material composition
- Thickness (mil)
- Cotton liners
- Permeation testing data
- Sizes
- ASTM standards
- Gauntlet length

4. **Perform work safely using the protective gloves**

Use only the glove that was specifically selected for the work you perform. You may need more than one type of glove to cover a variety of tasks.

Check disposable gloves for integrity before use. Vinyl gloves have a high failure rate right out of the box. Latex gloves degrade over time in open boxes.

Change gloves more frequently rather than disinfecting a glove you're already using. Disinfectants accelerate deterioration of the protective glove material.

5. **Evaluate performance of gloves you select**

Are the gloves you're already using really up to the job? No glove is perfect! Do they tear easily? Crack, stiffen, bubble, change color during use? These are signs that you need a different glove, or that you need to change them more frequently.

Gloves should be inspected, tested, cleaned, or replaced commensurate with the chemical hazard, use schedule, and durability of the glove material selected. Visually inspect gloves each time they're worn. Look for tears, cracks, discoloration, bubbling, or other defects in the material. If there is any doubt about the integrity of a glove material, discard the glove. Gloves can be leak-tested for defects that are difficult to see with the unaided eye. Trap air in the glove, squeeze it to pressurize while it is immersed in a soap solution.

Perspiration inside gloves softens the skin, making it more vulnerable to chemicals. This can be minimalized by limiting the time gloves are worn (when possible), alternating pairs, or using thin cotton gloves as replaceable inner liners. Some glove users experience a rash from the powdered coating used on the inside of certain gloves. Switching to a non-powdered glove should eliminate most of these problems. Rings with prongs and long fingernails can tear gloves made of thinner materials.

Is the right size glove available for every user? Most are available in multiple sizes. Wear the proper size. Tight-fitting gloves can be more vulnerable to tears and cause increased perspiration. Loose fitting gloves impair dexterity and are cumbersome and even hazardous around laboratory equipment.

Do they become too slippery during use? Textured finger and palm surfaces may be available for some chemical-resistant gloves.

Do you experience dermatitis on your hands and think it might be from wearing gloves? In addition to a visit to our Medical Department, you may need a glove with a flocked lining, or a separate cotton liner.

3. What are the most common disposable gloves on site and how do they differ?

The most common disposable gloves are vinyl, latex, and nitrile. Each has properties that are appropriate for specific situations. Manufacturer's information will also indicate for which chemicals the gloves should NOT be used.

Vinyl, disposable

- Pro: non-allergenic, light weight, low cost.
- Con: not designed for chemical resistance, not designed to protect against infectious materials,

high failure rate (>40%), poor puncture resistance, poor elasticity.
- Best uses: food service, protect work materials only, outer protective glove for low- hazard non-reactive particulate material.

Latex, disposable

- Pro: light weight, elastic, relatively low cost, designed to protect against infectious materials including blood borne pathogens.
- Con: not designed for chemical resistance, overused due to comfort and availability, potential for sensitization (allergy) to latex proteins, especially from powdered glove.
- Best uses: protection from biological hazards when chemicals are not an issue.

Nitrile, disposable

- Pro: light weight and fairly elastic, good splash protection against many chemicals, protects against infectious materials, non-allergenic.
- Con: higher cost, not designed for sustained contact with chemicals, not good for certain chemicals.
- Best uses: splash protection against the manufacturer's approved list of chemicals.

4. What are the differences between other chemical- and liquid-resistant gloves?

Chemical- and liquid-resistant gloves are made from rubber (latex, nitrile, or butyl) or a synthetic composition such as neoprene. Here are some frequently used gloves:

- **Butyl Rubber Gloves**: Provide protection from nitric acid, sulfuric acid, hydrofluoric acid, rocket fuels, and peroxides. These gloves are highly impermeable to many gases, chemicals, and aqueous solutions, and resist oxidation and ozone attack. They have high abrasion resistance and remain flexible at low temperatures.
- **Natural Latex or Rubber Gloves**: Provide protection from most aqueous solutions of acids, alkalis, salts, and ketones. They resist abrasions during grinding, sandblasting, and polishing. These general purpose gloves are pliable and comfortable.
- **Neoprene Gloves**: Provide protection from hydraulic fluids, gasoline, alcohols, organic acids, and alkalis. They offer good pliability and finger dexterity, high density, tensile strength, plus high tear resistance.
- **Nitrile Rubber Gloves**: Provide protection from chlorinated solvents, and are intended for jobs requiring dexterity and sensitivity. They resist abrasion, puncturing, snagging, and tearing.
- **N-DEX Gloves**: This popular nitrile glove provides splash and spill protection against a wide variety of chemicals, although it is not intended for extended immersion activities. It is available in several sizes, plus low-powder and powder-free options.
- **PVA Gloves**: Resist strong solvents, such as chlorinated and aromatic solvents. This material is water soluble (polyvinyl alcohol) and cannot be used in water or water-based solutions.
- **PVC Gloves**: Good for handling materials coated or immersed in grease, oil, acids, or caustics. Resists abrasion. Can be purchased lined or unlined depending on dexterity requirements.
- **Viton Gloves**: Resist chlorinated and aromatic solvents, plus many other chemicals. This glove material can be used in water-based solutions.
- **Silvershield Gloves**: Resist a variety of toxic and hazardous chemicals. This lightweight laminate is flexible, but not form-fitting, which affects user dexterity.

5. What single glove material is suitable for all chemicals?

None. No glove is perfect. Protective gloves, like any safety product, must be selected and used properly, recognizing facts that can reduce their effectiveness. Glove limitations include:

- No single glove material is suitable for all chemicals.
- Thin disposable gloves with welded seams are not recommended for immersion in chemicals, and offer splash protection at most.
- A chemical mixture may have a different overall permeation rate for a particular glove material than the rates for the individual components.
- Increased temperatures of chemical solutions increases glove permeation and decreases breakthrough time.
- A suitable glove for a chemical may not be acceptable for that chemical with a second and different type of hazardous material dissolved in it. For example, a glove used for acetone should not be assumed suitable for acetone containing a carcinogen, since a much smaller amount of the latter substance would constitute a hazard.
- Thin gloves provide less protection than thick ones of the same material. Permeation rate is inversely proportional to thickness. Breakthrough time is directly proportional to the square of the thickness. Selecting a glove with twice the thickness theoretically halves the permeation rate and quadruples the time until breakthrough.
- The effect of penetration of materials through different individual's skin varies greatly, so that penetration of equal amounts of a substance through a glove can have very different results. Skin that is cut, chapped, abraded, or has a rash, is more easily penetrated.
- Once chemical contact has occurred, permeation into the glove may continue to occur, causing chemicals diffused in the glove material to spread toward the inside, even though the chemical on the outside surface has been removed. This is more likely to happen with repeated contact. Heavy exposure of the gloves generally requires more frequent replacement.

Did you know disposable nitrile gloves MAY NOT BE GOOD for quite a few chemicals even if the chemical contacts the glove material only briefly? Are you over-applying the use of your disposable nitrile gloves? Look at this list of 75 chemicals that one manufacturer tested and found that disposable nitrile gloves are **NOT** recommended:

Acetaldehyde
Acetone
Acetonitrile
Amyl acetate
Aniline
Benzene
Bromoform
Butanol
Butyl acetate
Butyl acrylate
Carbolic acid
Carbon tetrachloride
Cellosolve acetate
Chlorobenzene
Chloroform
Cumene
Cyclohexanone
1,2-dichloroethane
Dichloromethane
Diethylamine
Diethylene oxide
Dimethyl sulfate
2,4-dinitrotoluene
1,4-dioxane
2-ethoxyethanol
(selected)
Methanol
Methyl acetate
Methyl cellosolve
Methyl chloroform
Methyl ethyl ketone
Methyl iodide
Methyl isobutyl ketone
Methyl methacrylate
Methylene chloride
Morpholine
Nitric acid 70%
Nitro propane
Nitrobenzene
Nitromethane
2-nitropropane
N-methyl pyrrolidone
N-propanol o-toluidine
1,1-oxybisbenzene
Pentane
Pentanone-2
Perchloroethylene
Propyl acetate
Propyl cellosolve solvent
Propyl dipropanol solvent

Ethyl acetate
Ethyl benzene
Ethyl butanol
Ethyl ether
Ethylene glycol ether
Ethylene glycol Monopropyl ether
Gasoline, unleaded
Iodomethane
Isoamyl acetate
Isoamyl alcohol
Isorpropyl acetate
Lacquer thinners
Propylene oxide
Pyridine
Styrene
Sulfuric acid 97%
Tetrachloroethylene
Tetrahydrofuran 1,2,4-Trichlorobenzene 1,1,1-trichloroethane
Trichloroethylene
Vinyl acetate
Vinyl benzene
Vinylidine chloride

6. Where can I find more information?

For more information, see the resources below or contact your supervisor, ESH coordinator, or ESQ Worker Safety & Health Program group (ESQ-WSH).

- Ordering: AMOS website
  Gloves are not stocked through Stores. They can be ordered through AMOS-Automated Materials Ordering System, 2-2924, by the person in your division authorized to place AMOS orders. If you cannot find the gloves you wish to order, call AMOS and they will direct you to the AMOS contracts administrator.

- SDS: Chemical Ordering, Reporting, and Attributes Library website - (SDSs provide useful health hazard information; however, the protective glove recommendations are often very non-specific)

- Further assistance in selecting gloves, locating information on chemical substances, deciding which glove to use for a chemical mixture, or evaluation of chemical exposure potential can be obtained from the ESQ-Worker Safety & Health Program group, Building 201, 2-3310.

- Ansell - Chemical Resistance Guide, Permeation & Degradation Data

- NIOSH Recommendations for Chemical Protective Clothing

- Best Glove, Inc. Chemical resistance test data by chemical or CAS#, CHEMREST Chemical Guide or "What is the Best Glove for me?"

- University of South Carolina, Glove Selection Chart

- University of Maryland Environmental Safety, Glove Chemical Resistance Guide

- CDC website on occupational latex allergies

- OSHA PPE standard

- OSHA PPE standard Appendix B, Selection of PPE

- Argonne laboratory safety presentation, University's Michael Blayney presented "Dimethylmercury and the Tragic Death of Karen Wetterhahn" at a special safety presentation. Watch the video »