Selection & Use of Gloves for Protection Against Hazardous Substances

Update April 2012
Due to recent developments in manufacturing processes, single use Nitrile gloves are now available in a range of different thicknesses. Users should be aware that this will affect the breakthrough times, degradation resistance and tensile strength properties of the gloves. It is recommended that only gloves with a minimum thickness of 0.13mm [finger] and 0.11mm [palm] for work with hazardous chemical substances. If this information is not clear on the glove data sheets please check with the supplier.

1 Introduction

Many substances handled within the University can result in harm by causing skin damage or infection. One way of reducing the risk of such damage occurring is to wear an appropriate type of glove. The type of glove selected will depend on the substances being handled and the type of work being undertaken.

Gloves are used throughout the organisation to provide protection to the worker when handling:

- Harmful & Toxic Substances
- Corrosive substances
- Infectious substances

They are also widely used to provide protection for the substance or material being handled e.g. for certain laboratory applications and for food safety reasons.

It should be noted that gloves are a control measure of last resort and should always be used in conjunction with other measures. This is because:

- Gloves only protect the wearer – they do not remove the contaminant from the workplace environment.
- If protective gloves are used incorrectly, or badly maintained, the wearer may not be protected - when gloves fail they fail to danger which exposes the user to the contaminant.
- Gloves themselves can cause skin problems.
- Wearing gloves interferes with the wearer’s sense of touch.
- The extent of protection depends on good fit.
- Some types of glove are inconvenient and interfere with the way people work.
2 Selecting the right glove for the job

There are four factors to consider when deciding which glove is suitable for your work:

1. The nature of the hazard (chemical, infectious substance etc.)
2. The task
3. The user (size and fit, state of health, etc.)
4. The workplace conditions (ergonomics, temperature, wet or dry, etc.)

These factors should not be considered in isolation to one another as it the combined interaction that will influence choice. For this reason risk assessments must specify the type of glove to be used and if should also detail the other control measures used to avoid or limit contact and any specific requirements necessary to ensure the protection provided by a glove is maintained (e.g. specifying the frequency and circumstances in which gloves should be changed, any action necessary if a glove fails to prevent contact).

If you specify latex, your risk assessment must justify this choice.

2.1 Nature of the hazard

There are 2 main type of hazards associated with substances for which gloves are used to protect against.

(i) Chemical Hazard

No single type of glove material can offer complete protection from all substances/chemicals. Each is liable to damage or failure by degradation or permeation by some chemicals.

- Degradation

Degradation is damage caused by changes in one or more physical properties of the glove upon contact with a chemical. Signs of degradation are usually visible in the form of swelling, loss of flexibility, tackiness etc. Resistance to degradation is usually rated on a poor to excellent scale.

- Permeation

Permeation is where a chemical can pass through an intact glove by diffusion, without damaging the glove. Permeation performance is expressed as the breakthrough time.

This is the measure of how quickly a chemical can permeate a glove and will be specific for the particular model of glove used in the test. Thinner gloves made from the same material will have a shorter break-through time.
For tasks with inevitable contact, the breakthrough time is the maximum time the glove may be used for before it should be discarded. If the work lasts for longer than the breakthrough time, gloves should be changed part-way through. You should allow a safety margin: stretching of gloves during use may mean that breakthrough occurs quicker than in a test environment. Do not rely on touch to detect breakthrough. Skin exposure will occur long before any perceptible feeling of wetness on the inner surface of the glove.

If re-useable gloves are used for direct handling of chemicals that can permeate the glove, they should always be thoroughly washed after use. They may also need to be discarded before the total use-time exceeds the breakthrough time, as permeation through to the inner surface can continue even after the glove is washed.

Breakthrough time will also be shorter if the chemicals handled are above ambient temperature, or are used at higher concentration than usual.

**Gloves for work with mixtures of chemicals**

Each chemical needs to be looked at to determine which glove material should be used.

Where different chemicals have different recommended glove material the one that best withstands the chemical with the fastest breakthrough time will usually be the best choice.

If one chemical is significantly more dangerous than others then this may dictate which glove material to choose. If you are uncertain over which should take priority (i.e. shortest breakthrough time or highest toxicity), contact the Safety Office for advice.

**Chemicals hazards outside laboratories**

Chemical hazards will be encountered in other work environments apart from research laboratories. These include

- Engineering
- Building & grounds maintenance,
- Catering and domestic services
- Farming & agriculture

Protective gloves should be chosen using the same principles as for laboratory work. Labels and or Safety Data Sheets will list the hazardous chemicals present in the materials in use.

**ii) Biological Hazards**

Most work in bioscience and medical laboratories involves handling both chemical and biological (infectious) hazards, usually within the same process or procedure. Generally, gloves manufactured for protection from chemicals provide adequate protection against incidental contact with infectious substances including bacteria and viruses. The glove selected must conform to **EN 374:Protective gloves against chemicals and micro-organisms** and have
good resistance to degradation from the chemicals involved in the procedure. Glove failure during handling of cultures or clinical specimens could create infection risks.

Some tasks such as manipulating cultures or micro-surgery require high degree of sensitivity and dexterity. In these circumstances latex may be the best choice to reduce the risk of accident.

**APPENDIX I** gives guidance on the different types of glove – disposable vs. reusable and on the various materials available. This is general guidance and the glove manufacturer’s data should also be consulted.

### 2.2 The Task

The substance being handled will be the main factor in determining the choice of glove material, whilst the actual task will determine the type of glove. The following should be considered.

#### i) Nature of exposure - incidental contact vs. intentional contact

**Incidental contact** refers to tasks where there is no intended direct contact with the hazardous material. Exposure will only occur through a *splash* or *spill*.

Most types of disposable gloves can provide adequate protection provided that, when used to protect against chemical hazards, they are changed immediately after a splash or spill occurs.

**Intentional contact** refers to tasks where contact with the hazardous material is inevitable. Some examples include

- immersing hands in liquids,
- direct handling of a substance rather than its container or
- handling of materials coated or saturated with the hazardous substance(s) e.g. a cleaning rag.
- direct handling of human tissue, rather than using forceps

There is therefore relatively lengthy direct contact with significant amounts of the hazardous substance.

When selecting a glove for protection against intentional contact with chemicals, it is necessary to select a glove made from a material that offers good resistance to attack or permeation from the specific chemicals in use. This will often require a reusable glove.

#### ii) Dexterity requirements

Thick gloves will offer greater resistance to chemicals or mechanical damage, but they can impair grip and dexterity thus compromising safety. Thin gloves however offer poor protection against physical hazards.
If the procedure involves different requirements it may be necessary to use more than one type of glove.

**Cuff length**

The cuff length of standard disposable gloves is short and can result in skin exposure at the gap between the lab coat sleeve and top of the glove, particularly if the work involves reaching forwards, such as might occur when working in a microbiological safety cabinet.

Extra length gloves will be required to ensure lower arm protection when working with toxic or irritant chemicals, handling higher grade pathogens, or when dealing with large volume of liquid which may splash over the top of the glove.

iv) **Grip requirements**

Most glove manufacturers will offer a smooth or textured surface. The latter will provide a more secure grip, which is important when working in wet or oily conditions.

v) **Mechanical requirements.**

Single use disposable gloves offer little if no protection against physical or mechanical hazards. Thicker reusable gloves may be required in cases where there is a risk of cut or abrasion.

2.2 **The User**

i) **Hand size**

It is important to select the correct size of glove. Gloves that are too small will restrict movement and cause fatigue in the hand and fingers. Tight gloves can also cause skin problems. Gloves that are too large interfere with the precision of grip and are liable to snag.

Sizes can vary between manufacturers and between different types of glove. Therefore it is important to have a range of sizes available.

ii) **Skin condition**

Unhealed cuts and skin lesions should be covered with waterproof dressing before putting on gloves.

Pre-existing skin conditions can affect selection or use of gloves. People with eczema or psoriasis may need to use a thin cotton liner inside the glove to avoid irritation from sweat. Liners must be washed regularly and rinsed well to remove soap residues prior to re-use.
Workers should monitor the condition of their hands frequently and report any concerns to Occupational Health Department.

iii) **Latex allergy**

Persons with a latex allergy must not use latex gloves. Where an individual is highly sensitised then other workers in the area may have to avoid using latex gloves to prevent inadvertent exposure of the sensitised individual to traces of latex that can accumulate on items of equipment and door handles etc. It is for this reason that the use of non latex alternatives is strongly encouraged.

Use of disposable non-powdered latex gloves is permitted provided that:

- Latex provides a distinct advantage over alternative gloving materials for the task,
- The justification for selecting latex is documented in a risk assessment, and
- The gloves meet the following quality criteria:
  - The extractable protein level is less than 50 micrograms/gram, and
  - The available residual accelerator is less than 0.1% w/w total residual accelerator.
- Checks are made to ensure that there is no person working within the area that has a pre-existing allergy to latex. If there is anyone with an allergy advice must be sought from Occupational Health before introducing latex into the area.

Anyone who suspects they may be allergic to latex should report this immediately to their line manager and make an appointment at Occupational Health. Additional guidance and information on latex allergy can be found [here](#).

iv) **Workplace conditions**

The following factors in the environment may affect glove choice:

**Temperature** can affect comfort as prolonged exposure to sweat inside a glove can enhance to risk of dermatitis and other skin reactions. Gloves must be changed frequently and hands dried before putting on another pair, cotton liners used to absorb sweat.

‘Wet’ work may require a longer cuff than normal to reduce risk of liquids getting into the glove. Gloves should have a textured surface to improve grip.

**Repetitive movements** such as pipetting require a glove with good flexibility and elasticity. Good quality single use nitrile gloves should meet these requirements.

More detailed guidance on what is considered good practice when wearing gloves can be found [4 Gloving_practice_final.doc](#).
3 Interpreting the standards

3.1 Protective gloves against chemicals and micro-organisms

i) CE Markings

The EU Personal Protective Equipment Directive 89/656 EEC requires manufacturers of personal protective equipment to meet common standards of quality and performance. The Directive specifies 3 classes or categories of glove to meet levels of risk. These categories must not be confused with the hazard categories assigned to biological agents. Employers must ensure that the level of risk is established and a glove of an appropriate class is selected.

Category 1 Gloves of ‘Simple’ design
- Only suitable for low risk activities e.g. use of cleaning materials of weak action.
- Exhibit a simple CE mark
- ‘For minimal risk only’ should be displayed on packaging
- No external validation – manufacturers may ‘self certify’
- No minimum requirement for pin holes

Category 2 Gloves of intermediate design.
- Suitable for intermediate risk activities e.g. general handling gloves requiring good cut, puncture and abrasion performance.
- Exhibit a simple CE mark
- Subject to independent testing and validation by a Notified Body which can issue a CE mark.
- The name and address of the Notified Body that certifies the product must appear on the instructions for use.

Category 3 Gloves of ‘Complex’ design PPE
- Intended to protect against mortal danger, or against dangers that may seriously and irreversibly harm the health of an individual, the immediate effects of which cannot be identified in sufficient time.
- Gloves that provide only limited protection against chemical attack or against ionising radiation
- Exhibit CE mark with 4 digits which identifies the Notified Body* that audits the production and quality system used by the manufacturer.
- Suitable for activities that involve irreversible and mortal risk
- Should have a minimum length of 260mm
*Notified Bodies are organisations designated by the national governments of the member states of the EU as being competent to make independent judgments about whether or not a product complies with the protection (essential safety) requirements laid down by each CE marking directive. In order to be notified, the management structure of the organisation must fulfil certain conditions and the name of the body, along with the details of the scope of its notified activities, must be given (‘notified’) to the European Commission.

ii) The European Standards

**EN 374** specifies the requirements for gloves to protect the user against chemicals and/or micro-organisms and defines the terms to be used.

**EN 420** defines the general requirements and relevant test procedures for glove design and construction, resistance of glove materials to water penetration, innocuousness, comfort and efficiency, marking and information supplied by the manufacturer. Instructions for use should be made available by the supplier when a glove is placed on the market and on a request by the customer. Most manufacturers have this information on their web sites.

What the pictograms mean

Marking requirements are covered by EN 420 and the following pictograms are relevant to gloves used in laboratories:

- This pictogram can be displayed only if a breakthrough time of at least 30 minutes for 3 chemicals out of 12 [see table 1 below]. It is unlikely that single use disposable gloves will meet the minimum requirements to display this pictogram. The code letters for the chemicals are displayed on the pictogram.

- This pictogram is for waterproof & low chemical protection that **do not** achieve a breakthrough time of at least 30 minutes against at least 3 chemicals in Table 1. The « ? » encourages the user to seek chemical permeation data from the manufacturer.
Table 1

<table>
<thead>
<tr>
<th>Code letter</th>
<th>Chemical</th>
<th>CAS N°</th>
<th>Class of compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Methanol</td>
<td>67-56-1</td>
<td>Primary alcohol</td>
</tr>
<tr>
<td>B</td>
<td>Acetone</td>
<td>67-64-1</td>
<td>Ketone</td>
</tr>
<tr>
<td>C</td>
<td>Acetonitrile</td>
<td>75-05-8</td>
<td>Nitrile Compound</td>
</tr>
<tr>
<td>D</td>
<td>Dichloromethane</td>
<td>75-09-2</td>
<td>Chlorinated paraffin</td>
</tr>
<tr>
<td>E</td>
<td>Carbon disulphide</td>
<td>75-15-0</td>
<td>Sulphur containing organic compound</td>
</tr>
<tr>
<td>F</td>
<td>Toluene</td>
<td>108-88-3</td>
<td>Aromatic hydrocarbon</td>
</tr>
<tr>
<td>G</td>
<td>Diethylamine</td>
<td>109-89-7</td>
<td>Amine</td>
</tr>
<tr>
<td>H</td>
<td>Tetrahydrofurane</td>
<td>109-99-9</td>
<td>Heterocyclic and ether compound</td>
</tr>
<tr>
<td>I</td>
<td>Ethyl acetate</td>
<td>141-78-6</td>
<td>Ester</td>
</tr>
<tr>
<td>J</td>
<td>n-Heptane</td>
<td>142-85-5</td>
<td>Saturated hydrocarbon</td>
</tr>
<tr>
<td>K</td>
<td>Sodium hydroxide</td>
<td>1310-73-2</td>
<td>Inorganic base</td>
</tr>
<tr>
<td></td>
<td>40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Sulphuric acid 96%</td>
<td>7664-93-9</td>
<td>Inorganic mineral acid</td>
</tr>
</tbody>
</table>

Biological Hazards

**EN 374 2**

- Indicates suitability for protection against biohazards
- The manufacturer must have tested a defined number of gloves to assess the Accepted Quality Level (AQL) for pinholes.
- Level 2 indicates an AQL < 1.5 which is the minimum for Category 3 PPE

Protection against blood borne viruses

The term micro-organism resistant in EN 374 applies to fungi and bacteria but not to viruses, therefore, following risk assessment, it may be advisable to use a glove that has passed the viral penetration test ASTM F1671 for direct and intentional contact with material at hazard group 2 and above. This is a standard test method for evaluating resistance of materials to penetration by blood borne pathogens using Phi-X174 phage which is non hazardous and significantly smaller that most virus, including Herpes, HIV, Hepatitis and Polio.
3.2 Medical Devices EN 455

- Non-sterile medical examination gloves are considered Class 1 medical devices and will bear the adjacent mark.
- **Their primary role is in patient care** and they have not undergone any independent validation test in respect of protection of the worker.
- Such gloves offer **minimal protection** against chemical or biological hazards but do offer adequate protection against low infection risks where contact is **incidental**.
## GUIDANCE ON SELECTION OF GLOVE MATERIALS

### Comparative features of Disposable and Reusable gloves

<table>
<thead>
<tr>
<th>Disposable, single use</th>
<th>Reusable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROS</strong></td>
<td><strong>PROS</strong></td>
</tr>
<tr>
<td>• Provide good touch sensitivity and dexterity</td>
<td>• Offer better protection against abrasion and other physical hazards.</td>
</tr>
<tr>
<td>• Designed for incidental exposure</td>
<td>• Resist chemical attack for longer</td>
</tr>
<tr>
<td>• Designed for single use – MUST NEVER BE RE-USED</td>
<td>• Less likely to tear</td>
</tr>
<tr>
<td><strong>CONS</strong></td>
<td><strong>CONS</strong></td>
</tr>
<tr>
<td>• Poor chemical resistance.</td>
<td>• Usually have longer cuff length than disposable so offer better protection when working with large volumes of liquid.</td>
</tr>
<tr>
<td>• Not suitable for intentional contact with hazardous substances</td>
<td>• Interfere with dexterity and touch sensitivity.</td>
</tr>
<tr>
<td>• Not suitable for some aggressive or highly hazardous chemicals.</td>
<td>• Can still be damaged and penetrated by many chemicals</td>
</tr>
<tr>
<td></td>
<td>• Must be looked after correctly to prolong their usefulness</td>
</tr>
</tbody>
</table>

### Care of Reusable gloves

- Inspect carefully before each use for discoloration, cracking or damage. Discard if such defects are found or if the inside becomes contaminated.

- Must be washed and dried after work to remove residual chemical from the surface of the glove which could continue to degrade the glove material.

- Periodically turn inside out and wash inner surface then rinse well and dry.

**Table 1** below summarises the features of glove materials that commonly are used for disposable gloves. The detail would also apply to re-usable gloves made out of the materials shown.

**Table 2** below gives the main features of glove materials that are only available as re-useable gloves.
## Table 1: Summary of main features of materials for single use, disposable gloves

<table>
<thead>
<tr>
<th>Material</th>
<th>Tensile strength</th>
<th>Elasticity</th>
<th>Durability</th>
<th>Fit &amp; Comfort</th>
<th>Chemical resistance for incidental exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrile</td>
<td>Excellent strength and puncture resistance</td>
<td>Medium to high, conforms to users hand with use.</td>
<td>Highly resistant to punctures. Tears and breaks clearly visible and quickly spreads. In use fail rates 1 to 3%</td>
<td>Good to excellent – conforms to hand. Sometimes feels stiff – depends on manufacturer.</td>
<td>Good protection against a broad range of chemicals including alkalis, fuels, many solvents, greases, animal fats etc.</td>
</tr>
<tr>
<td>Neoprene</td>
<td>Excellent strength properties</td>
<td>Generally higher elasticity than nitrile and closer to latex.</td>
<td>Fair puncture resistance</td>
<td>Good though has high stiffness</td>
<td>Resistant to many chemicals including oils, acids and large range of solvents.</td>
</tr>
<tr>
<td>Latex</td>
<td>Excellent</td>
<td>High level of memory, elasticity and elongation</td>
<td>Highly resistant to tears and punctures. Hard to detect puncture holes. In use failure rates reported to be 0% to 9%</td>
<td>Excellent – conforms to hand</td>
<td>Fair protection with water based chemicals, alkalis and alcohols.</td>
</tr>
<tr>
<td>Vinyl</td>
<td>Limited strength</td>
<td>Low to medium with moderate flexibility.</td>
<td>In use fail rates of 26 – 61% in long term /rigorous use.</td>
<td>Fair – not as good as nitrile/latex</td>
<td>Generally poor but some protection against petroleum based produces. OK for low soiling, low hazard chemicals or food hygiene applications.</td>
</tr>
</tbody>
</table>

Main Source – Laboratory News 2008 Article ‘The First Line of Defence’ by Cisco Robles General Manager SHIELD Scientific
Table 2  
Features of materials only available as re-useable gloves

<table>
<thead>
<tr>
<th>Material</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyl Rubber</td>
<td>• Good for ketones and esters</td>
<td>• Poor for gasoline, aliphatic, aromatic and halogenated compounds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Only available as re-useable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Poor touch sensitivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Expensive</td>
</tr>
<tr>
<td>Viton</td>
<td>• Chlorinated and aromatic solvents</td>
<td>• Poor for ketones</td>
</tr>
<tr>
<td></td>
<td>• Low surface tension repels most liquids</td>
<td>• Expensive</td>
</tr>
<tr>
<td></td>
<td>• Good resistance to cuts and abrasions</td>
<td>• Only available as re-useable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Poor touch sensitivity</td>
</tr>
<tr>
<td>Vinyl - Polyvinyl alcohol (PVA)</td>
<td>• Good for aromatic and chlorinated solvents</td>
<td>• Poor for water-based solutions (dissolves in water)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Avoid:</strong> Contact with water or water-based solutions, water solubles.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Only available as re-useable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Poor touch sensitivity</td>
</tr>
</tbody>
</table>