GLOVE SELECTION GUIDANCE

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1. INTRODUCTION

Protection against contact with hazardous materials is important for health and safety. Many chemicals can cause skin damage or provoke allergic reactions. Some toxic chemicals can be absorbed through the skin. Skin can be damaged by friction or from extremes of heat. In biological work, skin contamination can lead to infection.

Given the wide range of work being done in College no single glove will meet the needs of everyone. Gloves must be selected on the basis of the materials being handled and the type of work undertaken

2. WHEN SHOULD GLOVES BE WORN

Gloves should be worn when handling:

- Hazardous materials
- Toxic chemicals
- Corrosive materials
- Materials with sharp or rough edges
- Very hot or very cold materials

They 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.

However, by selecting the right glove for the task at hand, by understanding the limitations of the selected glove and by knowing how to use them, gloves can help eliminate most dangerous exposures.

3. DISPOSABLE VS REUSABLE GLOVES

Disposable gloves are thin, generally 4 - 8 mils thick. This allows the user to retain good touch sensitivity and dexterity but they have poor chemical resistance. They are designed to protect against incidental rather than intentional contact with chemicals and should be changed after any splash. They are designed for single use only and should never be re-used
Disposable gloves are not suitable for handling some aggressive or highly hazardous chemicals. They provide little useful protection against physical hazards as they easily tear or puncture if snagged.

Re-usable gloves are 18 - 28 mils thick. They offer greater protection than disposables against abrasion and other physical hazards, are less likely to tear in use and will resist chemical attack for longer. However, they interfere more with dexterity and touch sensitivity and can still be damaged or penetrated by many chemicals. They need to be looked after to prolong there usefulness.

Re-usable gloves usually have a longer cuff length than a disposable glove made with the same material, and so offer better protection against liquid slopping over the top of the glove

Care of reusable gloves

Re-useable gloves need to washed and dried after work to avoid accidental skin contamination when next putting the gloves on. This is especially important if the work has involved immersion or handling of chemicals that can permeate the glove material.
If frequently re-used the gloves should periodically be turned inside out and the inner surface washed and rinsed off. Re-useable gloves should be inspected before each use for discoloration, cracking at flexion points or damage and should be discarded if found. They must also be discarded if the inside becomes contaminated.

4. 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 e.g., 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. There is therefore relatively lengthy 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.

5. GLOVING MATERIALS

There are a number of gloving materials available. Each glove type has its own advantages and disadvantages.

Figure 1 lists the different gloving materials available for protection against chemical & biological hazards. It is meant as a general guide only and does not replace the need for a documented risk assessment for significant hazards.
Gloving materials to protect against mechanical and physical hazards are considered in Section 8.

Figure 1: Gloving Materials

Glove material	Advantages and disadvantages
POLYVINYL CHLORIDE (PVC) (This is the standard **vinyl** glove)	• Good for acids, bases, oils, fats, peroxides, and amines • Good resistance to abrasions • Poor for most organic solvents. • Plasticizers in glove may contaminate solvents • **Avoid:** intentional contact with ketones and aromatic solvents • Inexpensive • The **best choice** for protection against soiling, low hazard chemicals, or for food hygiene use
NITRILE	• Good for solvents, oils, greases, hydrocarbons and some acids and bases • Good alternative to latex for biochemical work • Clear indication of tears and breaks • **Avoid:** intentional contact with ketones, oxidizing acids and organic compounds containing nitrogen • The **best choice** for splash protection against chemicals
LATEX (**natural rubber**)	• Good for biohazard protection (infection risks) • Good for inorganic chemicals • Poor for organic solvents • **Avoid:** Oils, grease and hydrocarbon derivatives • Hard to detect puncture holes • Can cause or trigger latex allergies. • Requires written risk assessment justifying use
BUTYL RUBBER	• Good for ketones and esters • Poor for gasoline and aliphatic, aromatic, and halogenated hydrocarbons • Expensive • Only available as re-useable • Poor touch sensitivity
NEOPRENE	• Good for acids, bases, alcohols, fuels, peroxides, hydrocarbons, and phenols • Poor for halogenated and aromatic hydrocarbons
VITON	• Good for chlorinated and aromatic solvents • Low surface tension repels most liquids • Good resistance to cuts and abrasions • Poor for ketones • Expensive • Only available as re-useable • Poor touch sensitivity
VINYL - **Polyvinyl alcohol** (PVA)	• Good for aromatic and chlorinated solvents • Poor for water-based solutions (dissolves in water) • **Avoid:** Contact with water or water-based solutions, water solubles • Only available as re-useable • Poor touch sensitivity

6. EN STANDARDS AND WHAT THEY REPRESENT

The relevant glove safety standards for most work in College are EN 374 and EN 388. A third standard EN 455 is used to assess gloves intended for use in health care. Gloves that have been tested against the standards will either be marked with the relevant pictogram (below) or the symbol will appear on the box.

(i) EN 374

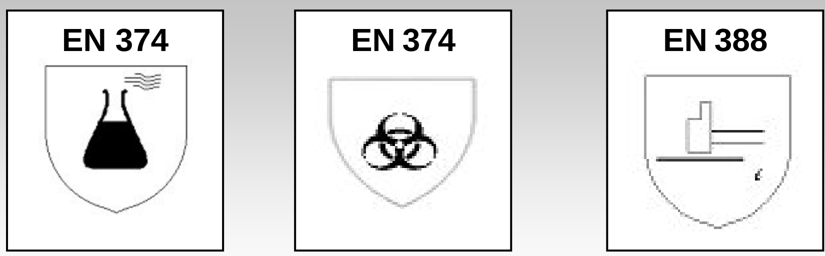
This standard specifies the requirements of gloves for protection against chemicals and/or micro-organisms.
Specific Requirements are that gloves need to be:

- Sealed against penetration of liquids according to method in EN 374-2. This test is a pass/fail test.
- Permeation resistance to chemicals tested according to method EN 374-3. Each combination of glove/chemical is classified according to the time the glove resists to permeation of the chemical.

(ii) EN 388

This standard applies to gloves that protect against physical and mechanical hazards. It specifies requirements for resistance to damage from abrasion, perforation, tearing and cutting.

Figure 2: EN pictograms



(iii) EN 455

Gloves that have been tested according to this standard are assessed for suitability for use in health care. A glove that conforms to EN 455 will provide adequate protection against infection risks, but chemical resistance will not have been assessed.

7. SELECTION OF A SUITABLE GLOVE

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

(a) The type of hazard (chemical, etc.)
(b) The task
(c) The user (size and fit, state of health, etc.)
(d) The workplace conditions (ergonomics, temperature, wet or dry, etc.),
They need to be considered together and not in isolation as it is their interaction that will determine the suitability of the glove.

NB. If your work requires a written risk assessment, simply stating "gloves required" is NOT SUFFICIENT as a risk assessment – the type of glove required must also be specified. Your risk assessment 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 circumstances in which gloves should be changed, any action necessary if a glove fails to prevent contact).
If you specify latex, your risk assessment should also justify this choice - see policy statement on the Occupational health we pages.
Link: https://www.imperial.ac.uk/spectrum/occhealth/advice/glovepolicy.htm

a. THE HAZARD

There are 4 broad categories of hazards for which gloves are used to protect against namely chemical, biological physical & mechanical hazards. Physical & Mechanical hazards are covered in section 8

(i) Chemical Hazard

No single gloving material can offer complete protection from all substances/chemicals. Each are liable to damage or failure by degradation or permeation (see Figure 3) by some chemicals.

Figure 1 summarises the key characteristics the different types of gloving materials offer. In most instances where you need protection against incidental contact, a nitrile glove will be the best choice.

If the task involves inevitable contact or you are working with chemical classed as toxic, harmful on skin contact or capable of absorption through the skin you should always consult the material safety data sheets for the chemicals used, or a chemical resistance chart to select the most suitable type of glove

Assessing glove performance
Most glove manufacturers provide chemical resistance charts on their websites giving test data on their gloves (see Section 10). They usually provide information on both degradation and permeation performance. They are specific for the brand of glove used in the test but can be used to work out which glove material will provide the best resistance for the chemicals in use.

Figure 3: Degradation & permeation

Degradation is damage through 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-excellent scale.

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** (see text).

Breakthrough time– the measure of how quickly a chemical can permeate a glove– 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 College Safety Department for advice.

Chemicals hazards outside laboratories

Chemical hazards will be encountered in other work environments apart from research laboratories. Figure 4 gives examples.

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.

Figure 4: Examples of Chemical Hazards in College outside a laboratory environment

Area	Example of Hazard
Engineering	Metalworking fluids, oils, solvents, degreasers, adhesives, cement, etc.
Maintenance	Solvents, oils, paint, epoxy resins, degreasers, cement, tar, etc.
Printing	Processing chemicals, inks, plate cleaning solvents, adhesives, etc.
Catering	Dishwasher liquids, oven cleaners, surface cleaning agents, water, etc.
Agriculture	Pesticides, weedkillers, oils, solvents, etc.
Cleaning	Bleaches, cleaning agents, detergents, water, etc.
Janitorial	Cleaning agents, solvents (i.e.: Bleach), etc.
Office	Solvents, glues, cleaning agents, water, etc.

(ii) Biological Hazards

Much work in bioscience and medical laboratories involve handling both chemical and biological (infectious) hazards. Generally, gloves manufactured for protection from chemicals provide adequate protection against infectious hazards including bacteria and viruses.

The glove selected must conform to EN 374: micro-organisms and have good resistance to degradation from chemicals in use. 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.

b. The Task

The material being handled will usually be the key factor determining the choice of glove material. The actual task will determine the type of glove.
Factors that should be looked at are:

i. Dexterity requirements

The thicker the glove material the greater the resistance to chemicals or mechanical damage, but thick gloves can impair grip and dexterity and so compromise safety. Thinner gloves do not offer a high degree of protection against physical hazards.
If different components of the work have greatly differing requirements, you may need to use more than one type of glove in the course of the work.

ii. Cuff length

The cuff of a standard disposable gloves covers only a small area of the wrist. There may be a gap between the sleeve of protective clothing and the top of a glove, especially if the work involves stretching forwards.
Extra-length gloves are essential if you have to ensure protection of the lower arm e.g. during handling of highly irritant chemicals, handling of some high grade pathogens or dealing with large volumes of liquid which may slop over the top of the glove.

iii. Grip requirements and working conditions, e.g. wet or oily

Most glove manufacturers offer a smooth or textured surface. A textured surface provides a more secure grip. When working in wet or oily conditions this is particularly important.

iv. Abrasion-, puncture-, snag-, tear-, and cut-resistance requirements.

Single use disposable gloves do not offer a high degree of protection against physical hazards. Thicker re-usable gloves may be required. See section 8 for more guidance on specific gloves to protect against mechanical hazards.

c. *USER FACTORS*

i. Hand size

Using the correct size of glove is essential to avoid problems. Gloves that are too small bind and cause undue hand fatigue. A tight glove can cause rashes

Gloves that are too large are uncomfortable, interfere with the precision of grip and can snag. Sizes can vary between manufacturers and between different styles of glove. You should have a range of sizes available.

Figure 5: Glove Sizes:

Symbol	Size	Symbol	Size
XS	7"	L	9 - 10"
S	7 - 8"	XL	10"
M	8 - 9"		

The size is hand circumference in inches measured around the knuckles

ii. Latex allergy

Someone with established latex allergy will be unable to use a latex glove and will need to be provided with a suitable alternative glove. If the person is highly sensitised e.g. latex exposure has provoked an asthma attack, anaphylactic reaction, or widespread urticaria (nette rash) then others working in same area may have to avoid using latex gloves to prevent any inadvertent exposure of the allergic person to traces of latex on shared equipment, door handles etc.

Anyone who suspects they may be allergic to latex should report this to the College Occupational Health Service, who can arrange tests and advise on appropriate precautions.
All persons using latex gloves must be given information on how to recognise and report a possible allergic reaction to latex gloves. See the Occupational Health web pages on Spectrum for more information. This includes a leaflet for users.
Link: https://www.imperial.ac.uk/spectrum/occhealth/advice/glovelatexallergy.htm

iii. Cuts & abrasions

Any unhealed cuts and skin abrasions should be covered with a waterproof dressing before donning gloves. Refer to the hand care information on the Occupational health web pages for further advice and guidance.
Link: https://www.imperial.ac.uk/spectrum/occhealth/advice/glovehandandskin.htm

iv. Pre-existing skin problems

Some pre-existing skin conditions can effect selection or use of gloves. If someone has eczema, they may need to use a cotton liner inside gloves to avoid irritation from sweat. Liners should be washed regularly and rinsed well to remove soap residues before re-use. If they interfere with touch sensitivity the tips can be cut off.

Anyone with eczema should use a moisturiser cream after washing their hands.

d. THE WORKPLACE CONDITIONS

The environment where the work will be done should be considered. Factors that may affect your choice of glove are:

i. Temperature

Temperature can affect comfort. Prolonged exposure to sweat inside a glove can provoke rashes or dermatitis. Gloves may need to be changed frequently and hands dried before donning a fresh pair or a cotton liner used inside the glove to absorb the sweat.

ii. 'Wet' work

A longer cuff may be necessary in wet conditions to reduce the risk of liquids getting into the glove. Gloves will usually need to have a textured surface to help grip..

iii. Repetitive movements

Tasks that involve repetitive movements e.g. pipetting require a glove with good flexibility and elasticity. A good quality disposable nitrile should meet requirements.

8. MECHANICAL AND PHYSICAL HAZARDS

a. MECHANICAL

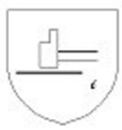
Protection against mechanical hazards– usually requires a fabric-based glove to provide the necessary resistance to damage. The traditional material, leather, has largely been replaced by cotton gloves coated with a polymer to provide waterproofing and chemical protection, or gloves made from high performance synthetic yarns. All are considered re-useable gloves

The available range includes:

- **Nitrile** (on a fabric liner) provides excellent abrasion and puncture resistance whilst retaining flexibility and comfort.
- **Kevlar**^{tm} brand fibre (para aramid fibre) a specialist man-made yarn from which gloves and sleeves are knitted. These have excellent tear, abrasion and cut resistance.
- **Latex** (on a fabric liner) natural rubber is an extremely elastic and flexible material with good physical properties. Depending on the formulation of a particular glove, natural rubber can offer **abrasion, tear and cut resistance.**
- **Polyvinyl Chloride (PVC)** (on a fabric liner) PVC can offer abrasion and puncture resistance, if thick enough it can afford some cut protection. Generally tear resistance is poor.
- **Leather** a natural material modified by tanning to give a range of properties. Leather gloves come in a vast range of thickness and styles which vary widely in their protective capabilities from specialised to very basic general purpose gloves.

For gloves tested against EN388 the numbers underneath the pictogram will indicate the level of protection against abrasion, cut, tear and puncture.

Figure 6: EN Standard pictograms for Mechanical Hazards

Pictogram	Description	Ranking
	a - resistance to abrasion b - Blade cut resistance c - Tear resistance d - Puncture resistance Where 0 is a fail or not tested.	0-4 0-5 0-4 0-4
	Impact cut resistance	Pass
	Antistatic	Pass

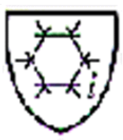
Note: Gloves should never be used as an alternative to the full and proper use of machine or tool guards.

b. THERMAL

Both heat and cold can damage skin. Liquid nitrogen and handling of samples taken from -70 fridges can cause severe cold burns. The appropriate glove choice the type and length of exposure must be taken into account.

Gloves for protection against cold are tested against EN 511. Gloves for heat are tested against EN407.

Figure 7: EN Standard pictograms for Thermal Hazards

Pictogram	Description	Rank
	a - Resistance to convective cold b - Resistance to contact cold c - Permeability to water Where 0 is a fail	0-4 0-4 0-1
Pictogram	**Description**	**Rank**
	a - Resistance to Flammability b - Resistance to contact heat c - Resistance to convection heat d - Resistance to radiant heat e - Resistance to small pieces of molten metal f - Resistance to large splashes of molten metal	0-4 0-4 0-3 0-4 0-4 0-4

The available range includes:

- **Aluminised Gloves**[1] help reflect heat and can be used in areas where radiant heat is the main hazard and products reach extremely high temperatures. Materials that can be aluminised include **Kevlar**^{tm} brand fibre and leather.
- **Leather** generally provides good protection against cold, so long as the glove does not get wet. Leather is also used in the composition of heat resistant gloves e.g. welding gloves as it does not melt or burn unlike some synthetic materials.
- **Kevlar**^{tm} brand fibre - This material was originally developed for the aerospace industry to offer the heat resistance necessary for re-entering the earth's atmosphere. **Kevlar**^{tm} brand fibre is also used in the manufacturing of gloves where temperature extremes are a problem.
- **Cotton** a natural material, cotton provides only moderate resistance to heat and cold. In order to give adequate protection, the material has to be thick which may impede dexterity.

c. ELECTRICAL

Specially designed gloves are required for protection against electrical hazards. This is not a hazard which should be commonplace in the College environment as control of such hazards would normally be by methods of "lock off" and/or "safe systems of work". However, if assessing gloves for electrical hazards, the voltage and conditions in which the hazard exists must be considered to ensure maximum glove performance.

Protective gloves for high voltage electrical work must conform to BS EN60903. They need to be periodically re-tested to guard against performance loss through degradation of the latex rubber they are made from
Standard laboratory or domestic-grade rubber gloves—Marigolds— are not tested for electrical safety

9. Useful contacts

In College

The Occupational Health Service can advise on any skin problems in work, latex allergy and hand care
Web link: https://www.imperial.ac.uk/spectrum/occhealth/

The Safety Department can advise on glove selection for specialist work:
Web link: https://www.imperial.ac.uk/spectrum/safety/

Purchasing should be contacted regarding order information and pricing:
Web link: http://www.purchasing.ad.ic.ac.uk/

Chemical compatibility information

The following links can be used to find more information on chemical compatibility of gloving materials – find the glove for the chemical:

Kimberly Clarke: http://www.safeskin.com/ChemResist/direct.asp

Ansell: http://www.ansellpro.com/specware/guide.asp

Marigold industrial: http://www.marigoldindustrial.com/GB/index.html

[1] Speak with Anton: what are the best choices for cold work. List these first

10. FAQ's

Q. Why is a glove with a shorter breakthrough time sometimes given a better rating than one with a longer breakthrough time?

A. The risk posed by a chemical permeating a glove related not just to the speed at which it can diffuse through, but the flow rate also. A combination of a short breakthrough time and a low permeation rate may expose a glove wearer to less chemical than a combination of a longer breakthrough time and a much higher breakthrough rate, if the glove is not changed frequently enough.

Q. Why should I wear disposable gloves for handling food?

A. Disposable gloves help protect both catering staff and patrons from food borne diseases. If gloves are worn on clean hands and changed properly, they can significantly reduce the risk of transmitting disease from a worker to a patron during food handling. They can also prevent cross-contamination during food preparation and protect the worker's hands while performing general preparation of sanitation activities.

This section will be developed over time.