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Health and Safety

Protection Against Hazardous substances:

Guidance for the Selection & Use of Protective Gloves against Chemical and Biohazardous substances

SAF-GUI-GLOVE

Document Control

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Contents

1. Introduction

A wide range of substances used within the university can result in substantial harm, either through direct skin contact with the agent, or indirectly through other means. The most common way of reducing the direct risk related to these substances is through the wearing of an appropriate type of glove.

Employers in the UK are legally required to provide suitable personal protective equipment (PPE) to employees and contracted workers, ensure it is properly maintained and replaced, and provide adequate training on its use, while employees must use the provided PPE in accordance with their employer's instructions.
This is described in The Personal Protective Equipment at Work Regulations 1992.

Gloves are commonly used throughout the university to provide protection to users, specifically when they are handling:

- Harmful and Toxic substances
- Infectious substances (Biological agents)
- Corrosive substances

This guidance applies to university staff and students who may come into contact with the abovementioned hazardous substances, and this will mainly be users of chemical or biological labs. Gloves may be needed as a control for other hazards not included in this guidance, such as extreme temperature and radioactive materials.

An important note is that gloves are a control measure of last resort. They should **always** be used in conjunction with other measures. Gloves alone are not a robust control measure as:

- Gloves will only protect the wearer and they do not remove contaminants from the workplace environment.
- Gloves can be incorrectly or badly maintained, leading to a lack of user protection.
- Gloves may contain allergens (latex) and cause skin irritation.
- The wearing of gloves can decrease dexterity.
- The extent of protection is highly dependent on how well the glove fits.
- The gloves need to be used in the correct scenario to be effective in their role.

2. Chemical resistance of protective gloves

Gloves are available in a wide variety of natural or synthetic materials. There is, however, no single glove material which may provide an indefinite resistance to any individual, or combination of, chemical or biological agents.

The three main ways by which a glove will fail to protect the wearer are:

1. **Permeation:** The process through which a chemical migrates through the protective glove at the molecular level.

2. **Penetration:** The flow of a chemical agent through imperfections, pores, seams, and pinholes at a bulk level in the protective glove.

3. **Degradation:** A change in the protective, physical properties of the glove because of exposure to a chemical or biological agent. This may occur through exposure of the gloves to, for example, sweat and hand creams.

3. Selecting suitable protective gloves

Selecting a suitable protective glove is not always easy as, in general, each material may offer a unique set of protective characteristics. Furthermore, certain gloves will be designed to be worn for longer than others, so the nature of the work must be taken into account.

The two main types of gloves are “thin” and “thick” gloves, although there will be many different varieties of each of these types. The main differences are given below:

Thin Gloves:

These are designed to be single use for short duration tasks. They should be replaced every 20 minutes. They are generally more suitable where greater dexterity is needed. They are generally not recommended for use with hazardous materials.

Thick Gloves:

These generally have a minimum palm thickness of 0.11mm and are designed to be worn for extended periods of up to 2 hours. **They are still single use** and are recommended for use in research labs when working with hazardous materials.

The manufacturer or distributor of each type of glove should be able to provide the user with the test data for specific substances and by what means the duress of the glove has been tested. Further, you should consult the Material Safety Data Sheet (MSDS) of the chemical you are using; this may recommend a particular glove material. If in doubt, always seek expert help from the manufacturer or distributor of either the substance you are working or the glove supplier.

Identifying Hazards related to the use and handling of a substance and risk assessing.

There are four requirements to be met when selecting a suitable type of glove. Considerations for each of these are given in upcoming sections of the document.

1. **Risk(s)** and conditions where is it used.
    a. They must suit the nature of the hazards (chemical, potential of infectious agent, extreme temperatures, physical hazards, such as sharps etc.)
2. **Ergonomic** requirements of the situation.
    a. Do the gloves significantly impact the dexterity of the user?
    b. Do the physical properties of the gloves change the perception of other hazards i.e., will the user notice heat or moisture exchange between the substance and the hand?
3. **Fit:** The glove must fit the wearer correctly to ensure protection to the manufacturer-quoted standards.
4. **Appropriateness:** The glove must be able to prevent or control the risk involved without increasing the overall risk i.e., the selection of the glove must be justifiable compared to other considerable measures. The length of the task to be completed must also be considered, as thin gloves are generally only suitable for 20 minutes of continued use, compared to 1.5-2 hours for thicker gloves.

These requirements should be judged as a whole, and not in isolation to one another. They must all be suitably considered within a risk assessment, where any shortcomings of a particular glove must be fully justified where other, more practicable, alternatives are not possible.

Please refer to Tables 1, 2 and 3 for a general overview of the comparative properties of single-use gloves, as well as the advantages and disadvantages they offer compared to reusable gloves.

Identifying the effects of substance exposure to the glove

When considering what type of glove is required for a particular task, one must consider the extent of the exposure to the substance. This can be used to determine when, for example, a user will want to use a thin, dexterous glove compared to a thicker glove.

This can be broken down into two categories: Incidental and Extended Contact.

1. Incidental contact

Refers to occasional splashing or contact through small spillages i.e. non-intentional contact. Depending on the chemicals being used, here it may be justifiable to use less-costly single-use, natural rubber gloves provided they are changed immediately after a splash or spill occurs.

2. Extended contact

Refers to contact with the substance for extended periods of time – this is usually intentional. Some examples of this may include:

- Deliberate immersion of hands in liquids
- Direct handling of a substance rather than its container.
- Handling of materials coated or saturated with the substance e.g., a cleaning rag.
- Direct handling of human tissue

If the user is going to be exposed to the substance for an extended period, they must be certain that the glove will offer a good resistance to permeation from the substance in question, and they must also regularly check for signs of degradation or damage which may lead to chemical penetration. Here, they may consider using a thicker, reusable glove, although the material itself may depend on the substances being used.

Other considerations to make when selecting gloves:

1. Dexterity requirements

Thicker gloves offer greater resistance to chemicals or mechanical damage but may impair grip and dexterity. If, for example, a user is handling glassware or expensive equipment, these may compromise on safety and alternatives must be considered.

Alternatively, certain glove manufacturers may offer a smooth or textured surface at the finger and palm of the glove. The textured surface can provide a more secure grip when working in wet or oily conditions.

If there are multiple steps within the standard work protocol which allows for different degrees of dexterity, then it may be necessary to consider using different types of gloves at different parts of the procedure.

2. Glove length

Standard disposable gloves usually cut off just above the wrist bone and may therefore lead to exposure between the top of the glove and the lab coat sleeve. Here, one may consider using a Howie-style lab coat and/or longer gloves, as these may be required to ensure lower arm protection when working with toxic or irritant chemicals, pathogens etc.

3. Mechanical requirements

Most standard disposable gloves offer little to no protection against physical of mechanical hazards, such as sharps. Consider using a thicker, reusable glove where there may be high risks of cuts and abrasions. Sometimes, however, the compromise of dexterity hinders the ability to perform certain tasks e.g., precise incisions. This must be fully justified within a risk assessment.

4. Hand size

The size of the glove is another important consideration. A glove that is too small will restrict movement and cause fatigue in the hands and fingers, reducing dexterity. Gloves that are too large are prone to snagging and may rub against the skin causing irritation.

It is important to provide an appropriate range of sizes so that the users can fully benefit from the protection the gloves can offer.

5. Skin conditions

Pre-existing skin conditions, such as eczema or psoriasis, may need additional attention when selecting gloves, as any moisture that builds up on the inside lining of the glove can irritate the skin. Thin cotton liners may be inserted inside the glove to avoid moisture build-up, and these can be washed regularly and then reused.

Further, any unhealed cuts of skin lesions should be covered with a waterproof dressing before putting on gloves.

Any changes to the condition of the hands because of usage of gloves should be reported to Occupational Health via the user's manager/supervisor.

6. Allergies

When selecting a glove, any allergies for the worker or any nearby users must be considered. Anybody with a suspected allergy to any glove material should report this to their line manager/ PI who should refer them to Occupational Health to monitor their condition.

Latex is only permitted provided that:

- It provides a distinct advantage over alternative glove materials.
- No person working within the area that has a pre-existing allergy to latex. Advice must be sought from Occupational Health if there is anybody with an allergy and the use of latex is a necessary requirement for a given task.

The justification for selecting latex must be documented and fully justified in a risk assessment prior to first use.

For the HSE summary of suitable gloves for different chemicals classes, as well as the properties, advantages and disadvantages of the materials, please refer to Tables 1-3.

4. Glove Types and Identification

Within the UK, a certain standard of performance for gloves is defined within the 'Protective gloves against dangerous chemicals and micro-organisms' British Standard (BS EN 374).

The subcomponents of BS EN 374 specify the performance requirements for protective gloves against a variety of chemical and biological risks, and defines a mechanism by which the penetration, permeation and degradation of the gloves is tested.

It is important to understand what the British Standard symbols mean, and what you should be looking for when purchasing the correct glove. The symbols, their meaning and any related information is given in the section below. For further information, the British standards encompassing Chemical and Biological risks can be found by following the links below:

For Chemical risks: BS EN ISO 374-1:2016

For Biological risks: BS EN ISO 374-5:2016

Glove Type by Permeation Performance (for Chemicals)

Chemical protective gloves are classified into three types according to their permeation performance (measured by *breakthrough time,* which is the time it takes for the substance to migrate through the glove) and how many test chemicals they are effective against.

Please see Table 4 for correspondence between breakthrough time and performance level and see Table 5 for the list of test chemicals the gloves are tested against.

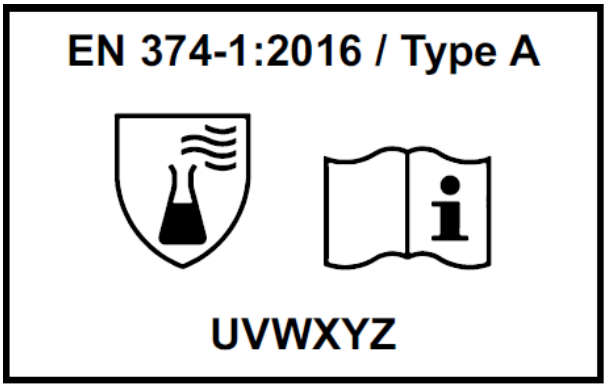
Chemical gloves must also be tested for resistance to degradation, where the degradation resistance (DR) should be reported in the user instructions provided with the glove. The DR indicates a percentage of the resistance of damage to the glove after exposure to a given chemical.

For gloves longer than 400mm, certain providers include information detailing the level of protection the cuff offers compared to the palm, as these may sometimes be different. In the interest of the symbols given below, the lowest performance level of the two will be indicated on the product specifications.

The three types of marked gloves users should look out for are:

Type A – Protective gloves that comply with a permeation performance of at least **level 2** and are tested against at least **6 test chemicals**. These gloves offer the highest level of protection.

Here, the 6 chemicals the glove has been tested against, and have been deemed safe to work with, may be identified from their code letters (see Table 5) at the bottom of the pictogram. Certain other chemicals not identified in Table 5 may also be tested but not indicated on the pictogram. This will be provided on the user instructions. If in doubt, always contact the supplier or manufacturer.

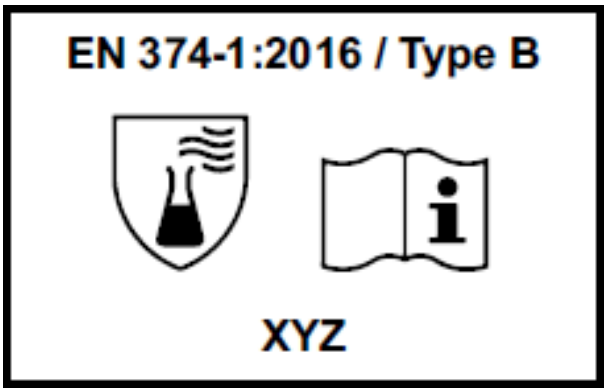


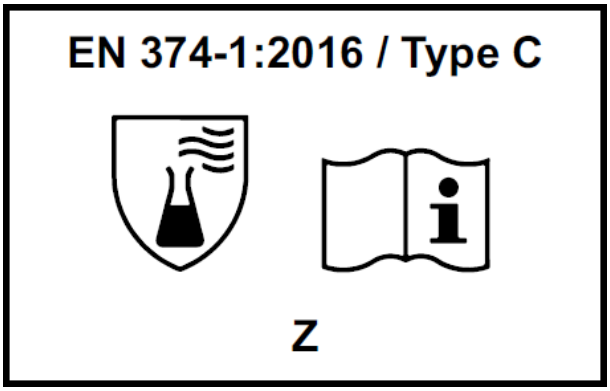
Type B – Protective gloves that comply with a permeation performance of at least **level 2** and are tested against at least **3 test chemicals**.

Note that these gloves may sometimes be tested for up to 5 chemicals. The level of permeation protection offered is the same as a Type A glove, thus it is reasonable to use these if only a small number of chemicals are being used.

Type C – Protective gloves that comply with a permeation performance of at least **level 1** and are tested against at least **1 test chemical**.

Please note that Type C gloves offer the lowest level of protection against the smallest number of chemicals, compared to Type A and B gloves, as well as having the lowest potential permeation performance.





Glove Type by Permeation Performance (for Biological Agents)

Similarly, to chemical protective gloves, the standard that specifies performance of a glove against biological hazards is classified based upon a penetration test during which the glove is exposed to a given type of microorganism. For bacteria and fungi, the test methods used to determine this are given in BS EN 374-2:2014.

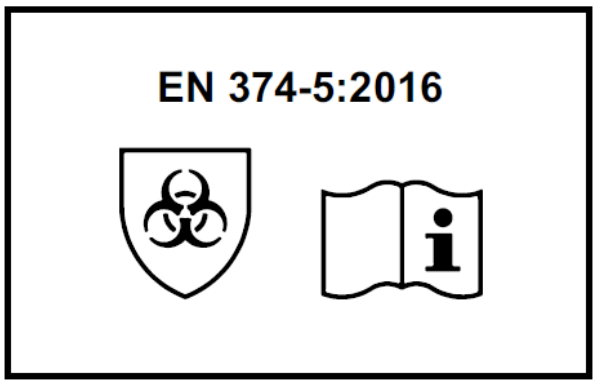
Certain gloves will offer protection against viruses, as well as bacteria and fungi. These will also be subject to additional penetration tests defined in ISO 16604:2004, where the penetration is tested using the Phy-X174 bacteriophage. This is much smaller than blood-borne pathogens such as Herpes, HIV, Hepatitis and Polio, thus is a good method for determining the penetration of a wide array of viruses.

For gloves with cuffs longer than 400mm, and if the glove specifies that the cuff offers protection against microorganisms, the cuff area will also be tested to ISO 16604:2004 standards.

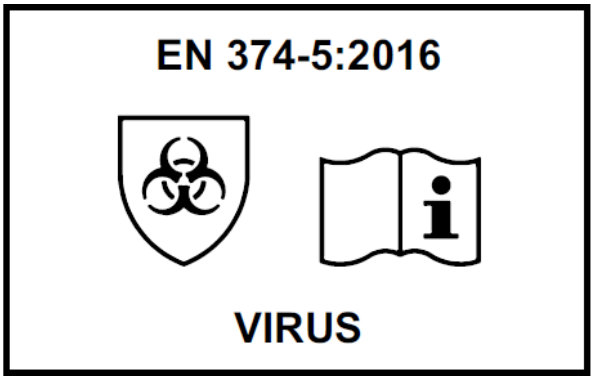
The two symbols of concern when selection gloves for Biological agents are:

1. Gloves protecting against Bacteria and Fungi **ONLY.**

2. Gloves protecting against Bacteria, Fungi **AND** Viruses.



Please note that there are certain symbols that may be seen on older supplies of gloves. These are no longer in use and are highlighted in Appendix C of this document.



5. Glove Usage and Disposal

Checking and reusing gloves

Protective gloves will only serve as intended if the correct procedures are followed. It is recommended that the user undergoes regular inspection of the gloves prior to, and after, usage, where it is safe to do so, as well as employing good practice.

For disposable gloves, the user should:

- Check for rips and punctures before using.
- Remove and replace gloves immediately with new ones when a chemical spills or splashes onto them.
- Remove gloves before touching other common or shared items such as doors, worksurfaces, keyboards/mice etc.
- Where possible, not wear gloves, used or not, in common areas such as corridors/outside.
- **Not** be washing or reusing disposable gloves.
- **Always** wash hands after removing gloves.

For reusable gloves, the user should be:

- Checking for rips or punctures before and after each use.
- Looking for signs of prior contamination before reusing the glove.
- Looking for signs of degradation i.e., change in the colour or texture of the glove.
- Cleaning the glove after removal and drying fully before reusing.
    - Moisture build-up in gloves is common and can cause skin irritation.
- Replacing worn or degrading gloves as soon as it becomes noticeable.
- Following good practice in the lab (see disposable gloves).
- **Always** wash hands after removing gloves.

Disposal of used gloves

Used gloves can contain traces of hazardous waste so must be treated as such and disposed of in the correct manner, as per the Hazardous Waste Regulations 2005.

Each business unit should have measures in place to safely dispose of hazardous waste, this should encompass the disposal of contaminated gloves.

Prior to working with a chemical, you should have a risk assessment which highlights the disposal procedure for gloves if they become contaminated.

Appendix A: Glove comparisons and general guidance

Table 1: HSE Glove Recommendations

Chemical Group	Glove Material					
	Natural Rubber (Latex)	Nitrile Rubber	Neoprene	PVC	Butyl (Reusable)	Viton (Reusable)
Water miscible substances	✓	✓	✓	✓	X	X
Weak acids/alkalis	✓	✓	✓	✓	X	X
Oils	X	✓	X	X	X	X
Chlorinated Hydrocarbons	X	X	X	X	X	✓
Aromatic solvents	X	X	X	X	X	✓
Aliphatic Solvents	X	✓	X	X	X	✓
Strong Acids	X	X	X	X	✓	X
Strong Alkalis	X	X	✓	X	X	X
Polychlorinated biphenyls (PCBs)	X	X	X	X	X	✓

Source: https://www.hse.gov.uk/pubns/indg330.pdf

Table 2: Reusable Glove Material Comparisons				
Material	**Tensile strength**	**Elasticity**	**Durability**	**Fit & Comfort**
Nitrile	Excellent strength and puncture resistance.	Medium to high, conforms to user's hand with use.	Highly resistant to punctures. Tears and breaks clearly visible and quickly spreads. In use fail rates 1 to 3%	Good to excellent – conforms to hand. Sometimes feels stiff – depends on manufacturer.
Neoprene	Excellent strength properties	Generally higher elasticity than nitrile and closer to latex.	Fair puncture resistance	Good though has high stiffness
Latex	Excellent	High level of memory, elasticity, and elongation.	Highly resistant to tears and punctures. Hard to detect puncture holes. In-use failure rates reported to be 0% to 9%	Excellent – conforms to hand
Vinyl	Limited strength	Low to medium with moderate flexibility.	In use fail rates of 26 – 61% with long term, rigorous use.	Fair – not as good as nitrile/latex

Table 3: Disposable and Reusable Glove Comparison		
	Disposable, Single Use	**Reusable**
Pros	Provide good touch sensitivity and dexterity Designed for incidental exposure Designed for single use	Offer better protection against abrasion and other physical hazards. Resist chemical attack for longer Less likely to tear Usually have longer cuff length than disposable, so offer better protection when working with large volumes of liquid.
Cons	Poor chemical resistance. Not suitable for intentional, exposed contact with hazardous substances Not suitable for some aggressive or highly hazardous chemicals. **MUST NEVER BE RE-USED**	Interfere with dexterity and touch sensitivity. Can still be damaged and penetrated by many chemicals Must be looked after correctly to prolong their usefulness

Appendix B: Performance Information Tables

Table 4: Permeation Performance Levels

Measured breakthrough time/ min	Permeation level
>10	1
>30	2
>60	3
>120	4
>240	5
>580	6

Table 5: List of Test Chemicals and Code letters

Code Letter	Chemical	CAS No	Class
A	Methanol	67-56-1	Primary alcohol
B	Acetone	67-64-1	Ketone
C	Acetonitrile	75-05-8	Nitrile Compound
D	Dichloromethane	75-09-2	Chlorinated paraffin
E	Carbon disulphide	75-15-0	Sulphur containing organic compound
F	Toluene	108-88-3	Aromatic hydrocarbon
G	Diethylamine	109-89-7	Amine
H	Tetrahydrofuran	109-99-9	Heterocyclic and ether compound
I	Ethyl acetate	141-78-6	Ester
J	n-heptane	142-85-5	Saturated hydrocarbon
K	Sodium Hydroxide (40%)	1310-73-2	Inorganic base
L	Sulphuric Acid (96%)	7664-93-9	Inorganic mineral acid
M	Nitric Acid (65%)	7697-37-2	Inorganic mineral acid, oxidizing
N	Acetic Acid (99%)	64-19-7	Organic acid
O	Ammonium Hydroxide (25%)	1336-21-6	Organic base
P	Hydrogen Peroxide (30%)	7722-84-1	Peroxide
S	Hydrofluoric acid (40%)	7664-39-3	Inorganic mineral acid, contact poison
T	Formaldehyde (37%)	50-00-0	Aldehyde

Appendix C: Outdated symbols

As of 2016, certain British Standard symbols are now no longer in use and have been replaced by the symbols given in the main body of this guidance.

The beaker symbol (below) has previously been used as a means to demonstrate 'low chemical protection'. These do not achieve breakthrough times of at least 30 minutes against at least 3 chemicals so will be below the standard of any of the newly introduced types given in Section 4. If you are currently using a glove displaying the beaker symbol, this should be replaced by a glove now classified as **Type C**.

The biological hazard symbol (below) has been replaced by the EN 374-5 symbols for biological agents given in the main text. These previously indicated the suitability for protection against biohazards, but only applied for fungi and bacteria. Gloves which displayed this symbol could be replaced by a glove non-viral biohazard protection glove.