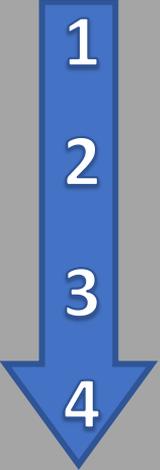


Personal protective equipment (PPE)

Protection measures against the various hazards and risks :

Workers' activity involves a number of hazards (of a physical, chemical and biological nature) which may adversely affect their health and that of others. In order to protect workers from these potential dangers, a general principle of safety at work has been implemented: it's the "S-T-O-P" principle.

Priority Level	Meaning		Principle
	Type of measure		Examples
	S	Substitution	Replacing substances, installation and work processes with harmless (o safer) methods and equipment in order to eliminate (or reduce) the risk.
	T	Technique	Implementing and/or using technical protection devices (safety guards, safety nets, aspiration, sas, etc.).
	O	Organisation	Limiting the duration of exposure (through a change of activity, implementation of breaks, etc.), training and establishing the skills, monitoring, etc.
	P	Protection	Wearing PPE in the event of direct or likely exposure.

This principle sums up and outlines the 4 defense guidelines for workers, allowing them (or their supervisors) to implement security measures to protect their health and that of others. **In general, more the implementation of the measure takes place upstream of the risk, more the worker is protected.** Here, it should be recalled that workers' protection must be developed according to the "S-T-O-P" principle and not just straight away through the use of individual protection equipment (without evaluation of the potential implementation of measures S, T and O).



Indeed, wearing **personal protective equipment is the last defense for workers** (when hazards cannot be eliminated by substitutive, technical and organizational measures) and must be considered as a last resort.

Definition of personal protection equipment (PPE) :



The definition of "personal protection (PPE) equipment" includes all equipment carried by a person or connected to them in order to protect them against hazards which may pose a threat to their health.

PPE legal bases :

The use of PPE is regulated by different laws and ordinances, including:

- Law on Accident Insurance (**LAA** in French, CC 832.20)
- Labor Law (**LTr** in French, CC 822.11) and its Ordinance 3 (**OLT3** in French, CC 822.113)
- Radiological Protection Act (RPA, CC 814.50)
- Ordinance on the prevention of accidents and occupational diseases (**OPA** in French, CC 832.30), in particular articles 5 and 38
- Ordinance on construction works (**OTConst** in French, CC 832.311.141), in particular article 5
- Ordinance of the Federal Department of Home Affairs on technical measures for the prevention of occupational diseases caused by chemicals (in French, CC 832.321.11)
- Ordinance on the protection of workers against the risks associated with microorganisms (**OPTM** in French, CC 832.321)



Very generally, the use of necessary PPE is defined within a legal framework, valid both for the employer, who is required to provide it, as well as for the worker, who must wear it when necessary.

General rules for the use of PPE :

Wearing PPE is needed when it is impossible to eliminate risks to health through technical and organizational measures.



Two conditions are necessary to ensure a proper use of PPE:

- 1) The identification of potential risks and
- 2) Knowledge of PPE and training for its use.



GUIDELINES



Workers are required to check the compliance of PPE and to ensure its proper functioning prior to each use.



The PPE must be adapted to the features of the worker to ensure its protective operation.



Workers must be trained in the use of PPE and must understand its operation in order to avoid any problem linked to the inadequate use of the latter.



The supervisor must ensure that workers are trained and respect the rules for the use of PPE.



The documentation from the PPE manufacturer must be available, consulted and understood. Where necessary, the manufacturer (or provider) shall be contacted for more information.



PPE must be stored and maintained properly and according to the instructions of the manufacturer (or provider).

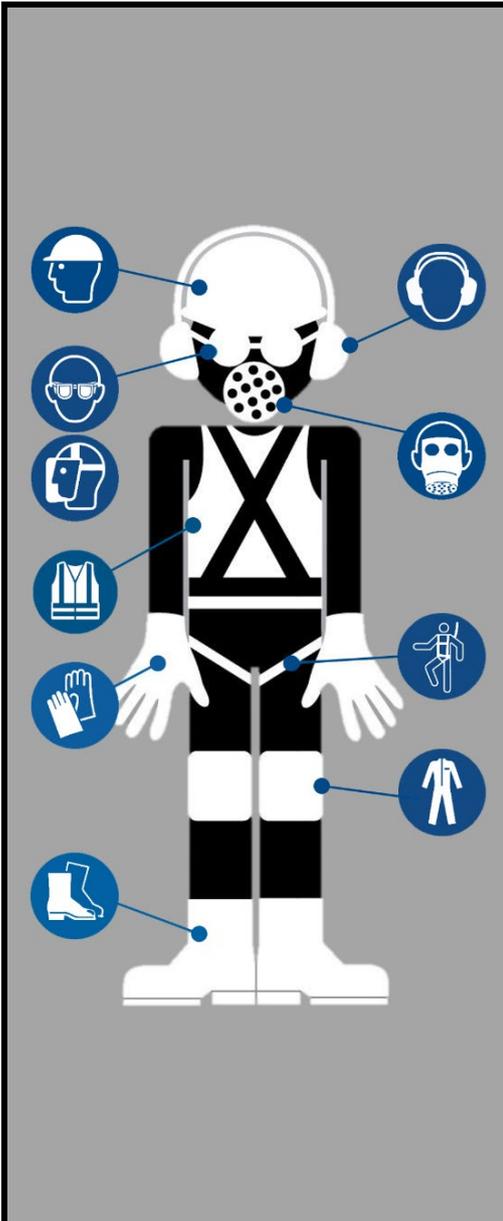


A regular check of PPE is necessary in order to ensure its proper operation. Sometimes, this requires the intervention of specialists.

The various PPEs, from head to feet :

As a general rule, the whole of the body and its organs can and must be protected when a hazard is present. There is a wide variety of PPE depending on the organ, the functions of the body to be protected and the nature and severity of the hazards.

Each category of PPE has a clear pictogram describing it. These pictograms indicate an obligation; they require the worker to use the necessary PPE when they carry out their work. Attention, these pictograms are only rarely used and their absence does not mean a lack of hazard! A risk analysis is therefore still necessary before starting any activity.

	Protection	Examples of PPE	Pictogram of obligation of wearing
	Head	Helmets (with or without chin strap), bump caps, headgear, protective hair covering, caps or hair nets hats	
	Hearing	Ear pads (expandable foam, preformed plastic, to mold or molded), ear protection also called "Pamir" (with or without noise attenuation depending on noise level, communication device, or integrated radio)	
	Eyes and face	Goggles (with or without lateral protection), face shields, shields, screens, visors, mesh	 
	Airways	Full mask, half mask, quarter mask, filter mask, compressed air or flexible tube mask	
	Hands, arms and skin	Gloves with or without cuffs also protecting the forearms. Mittens, three and five fingers gloves, chainmail mesh gloves, thermal protection gloves, chemical protection gloves, microorganisms protection gloves. Also skin protection products. Creams, lotions and emulsions.	 
	Protective clothing	Jackets, hats, pants, suits, blouses	
	Feet	Shoes, boots and protective shells	

SPECIAL PROTECTION :

High visibility clothing	High visibility clothing, fluorescent yellow, orange-red, or red. Reflective harnesses, vests, suits, pants, jackets, shirts.	
Fall arrest	Devices for work at height. Safety lanyards, energy absorbers, belt and strap for support and restraint, ropes, harness, lifeline, mooring hooks, climbing irons, bands, anchoring devices.	
Anti-drowning	Life jackets, buoyancy aids	

Respiratory PPE :

Masks protect against inhalation of harmful agents (dust, gaz, vapors and/or mist) containing hazardous substances (chemicals, radioactive) or harmful microorganisms or enzymes. Respiratory protection devices also allow to cope with lack of oxygen (<17% O₂).

FEATURES :

There are mainly two types of respiratory protective equipment: filtering and insulating devices (equipment independent from ambient atmosphere). At University of Lausanne, mainly filtering PPE respiratory equipment is used. Therefore, hereby we shall focus on such devices. More information on insulating devices is available with the UniSEP-SSTE group or from specialists (see "Sources and links for more information" section).



Filtering devices provide breathable air supply by neutralizing harmful agents in the air. Different filters, however, are only able to neutralize some harmful agents, and within a certain limit. Therefore, it is necessary to know the type of harmful agent and its concentration in the air in order to select the proper filter.

CLASSIFICATION OF FILTERS :

There are mainly two types of filters: **gaz filters** and **particles filters**.

Gaz filters consist of a material intended to capture one gaz (or a gaz family in the case of mixed filters) in particular, usually active carbon. Active carbon then adsorbs the gaz breathed in and captures it, letting clean air pass. The classification of gaz filters is based on 2 main criteria :

- The **type** of gaz filter (main application area). It features a letter and a color identification (ex: A, brown)
- The **performance** of the gaz filter (category or class). It features an identification number from 1 to 3. The highest the class, the more the level of protection is important.



Filtering facepiece particles (or FFP, also called "anti-aerosol filters") are generally surface structures (fleeces) made of natural or man-made fibers. These fibers capture particles in the air. Depending on their retention capacity, particle filters more or less effectively neutralize particles contained in the air which is breathed in. These filters can adapt to various types of masks (full masks, breathing pads or mouth-nose, half or quarter mask). According to their ability of neutralization (of assimilation) of particles, particle filters fall into 3 categories :

- **P1** : low assimilative capacity
(penetration of particles less than 20%)
- **P2** : average assimilative capacity
(penetration of particles less than 6%)
- **P3** : high assimilative capacity
(penetration of particles less than 0.05%)



Filters (gas or particles) are classified according to a color code and an identification code:

Type of filter		Main field of application	Filter class (performance)
Code	Identification color		
A	Brown	Gases and organic vapors (boiling point > 65 °C)	1, 2, 3
AX	Brown	Gases and organic vapors (boiling point < 65 °C)	Max. 40 min
B	Gray	Gas and inorganic vapors (ex: Chlorine, H ₂ S, HCN)	1, 2, 3
E	Yellow	Acid gas and vapors (ex: H ₂ S, HCl)	1, 2, 3
K	Green	Ammonia and organic derivatives	1, 2, 3
CO	Black	Carbon monoxide (CO)	Special requirements
Hg	Red	Mercury (Hg)	Max 50 h
NO	Blue	Nitrous gases (ex: NO, NO ₂ , NO _x)	Max. 20 min
SX	Violet	Specific compounds designated by the manufacturer	Special requirements
Reactor	Orange	Radioiodine (incl. radioactive methane iodide)	Special requirements
P	White	Dust and particles	1, 2, 3

NOTE : With the exception of CO (black) filters, all these filters do not protect against certain gases such as nitrogen (N₂), carbon dioxide (CO₂) and carbon monoxide (CO).

There are some so-called 'mixed' filter models, combining both filtration of particles and gases. In this case, the particles filter is located upstream of the gas filter in order to neutralize also the toxic gases emitted by the liquid and solid particles. As a general rule, the higher the filtration capacity, the stronger breathing resistance is.

A mixed filter is designated through the juxtaposition of the corresponding code letters and color bands. Example: A2B2E2K2P3 filter.



TYPES OF RESPIRATORY FITTINGS :

One of the main parts of respiratory protection devices is the respiratory connection. This prevents the contact of respiratory organs (or even some parts of the body) with harmful ambient atmosphere. It is used to connect the filter. There are several types of respiratory fittings:

- **Full face masks** : they protect the entire face and therefore, also the eyes.
- **Half masks, quarter masks** : The half mask covers the mouth, the nose and in half-masks, the chin. A quarter mask only the mouth and nose. This type of mask offers protection only against not very harmful agents.



Full face mask



Half mask or quarter mask

PLEASE NOTE :



Wearers of glasses and/or beard

Make sure that the sealing of respiratory protection devices is **guaranteed!** Indeed, it is possible to mount special lenses for people wearing glasses using complete masks, because traditional sunglasses compromise the sealing of the mask.

Surgical masks **DO NOT PROTECT** against gases, aerosols or dust!



Negative pressure sealing test

Negative pressure sealing tests (breathing in, clogged filter) and positive pressure ones (breathing out, clogged valve) are required before use in order to ensure the good operation of the equipment.



Positive pressure sealing test

- Masks must be stored in a closed box placed outside the contamination area.
- Before use, respiratory protection devices must be checked by the worker in order to detect any potential defects. No faulty devices must be used. After use, and due to hygienic reasons, respiratory protection equipment must be cleaned carefully and in accordance with the manufacturer's care instructions.
- **Tip** : the date of commissioning of the filter can be marked on it in order to avoid its expiry.

Chemical protection gloves :

Amongst the wide range of protective gloves, chemical protection gloves are very important at the University of Lausanne. Here our focus is on the key standards and pictograms for chemical protective gloves. More information on protective gloves is available with the UniSEP-SSTE group or from specialists (see "Sources and links for more information" section).

STANDARDS AND FEATURES :

The main standards for chemical protection gloves are the following :

EN 374



(X)
or
(XYZ)
or
(UVWXYZ)

This pictogram indicates that the glove is resistant to chemicals. A marking of 3 or 6 letters (from A to T) may be present or not: this certifies the impermeability of contact to one or several classes of chemicals.

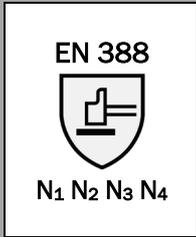
The encoding of the test of impermeability of chemicals according to standard EN 374 contact is as follows :

Code	Chemical substance	# CAS	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 hydrocarbon
E	Carbon sulfide	75-15-0	Organic compound containing sulfur
F	Toluene	108-88-3	Aromatic hydrocarbon
G	Diethylamine	109-89-7	Amine
H	Tetrahydroflurane	109-99-9	Etheric heterocyclic compound
I	Ethyl acetate	141-78-6	Ester
J	n-heptane	142-82-5	Saturated hydrocarbon
K	Caustic soda 40%	1310-73-2	Inorganic base
L	Sulfuric acid 96%	7664-93-9	Inorganic oxidant mineral acid
M	Nitric acid 65%	7697-37-2	Inorganic oxidant mineral acid
N	Acetic acid 99%	64-19-7	Organic acid
O	Ammonia 25%	1336-21-6	Organic base
P	Hydrogen peroxide 30%	7722-84-1	Peroxide
S	Hydrofluoric acid 40%	7664-39-3	Inorganic mineral acid
T	Formaldehyde 37%	50-00-0	Aldehyde

EN 374

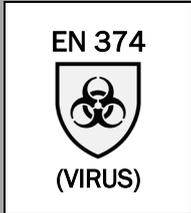


This pictogram indicates that the glove only offers a moderate protection against chemical hazards. This type of glove does not meet the requirement "resistant to chemicals".



This pictogram indicates protection against mechanical risk. A 4-digit marking indicates the level of resistance :

- N₁ (1-4) : Abrasion
- N₂ (1-5) : Cut by blade
- N₃ (1-4) : Tear
- N₄ (1-4) : Puncture



This pictogram indicates that the glove has met the bacterial and fungal penetration test. If the glove also meets the viral penetration test, this is mentioned ("VIRUS" mention).

PLEASE NOTE :

No glove provides universal protection! Different materials are available and provide a more or less effective protection based on the activities and products handled. It is therefore necessary to check compatibility and permeability of the gloves in relation to the products used !

The use of so-called "lab" gloves may be contraindicated when using flames (ex: Bunsen burner).



- (Extremely fine) disposable gloves only protect against accidental splashes of not very hazardous chemicals. Only reusable gloves (thicker) offer real protection when handling dangerous chemicals. Be sure to use the right type of gloves in the presence of the specific risk !
- Reusable gloves must be washed after use, then removed, dried, and stored according to the manufacturer's instructions.
- Vinyl gloves are not recommended because they do not offer sufficient protection against chemicals.
- Latex gloves may produce allergies.



To avoid contamination, gloves must not be worn outside of the handling area (e.g.: computer, telephone, elevator, etc.)

Beware of injection needles! Mechanical protection gloves meeting the requirements of puncture resistance do not necessarily offer protection against sharp objects such as injection needles.



PPE for feet :

Overall, there are three types of PPE footwear :

- **Safety footwear (S)** : equipped with toe-cap resistant to shocks $\geq 200 \text{ J}^*$ and compressive loading $\geq 15 \text{ kN}^{**}$
- **Chaussures de protection (P)** : equipped with toe-cap resistant to shocks $\geq 100 \text{ J}^*$ and compressive loading $\geq 10 \text{ kN}^{**}$.
- **Chaussures de travail (O)** : with at least part of the protective features (e.g.: anti-puncture inserts) but not necessarily with toe-cap

* 200 Joules is the amount of energy released following a shock due to the fall of an object of 20 kg from a height of 1 meter.

** 15 kN représentent une force effective occasionnée par une charge de 1500 kg

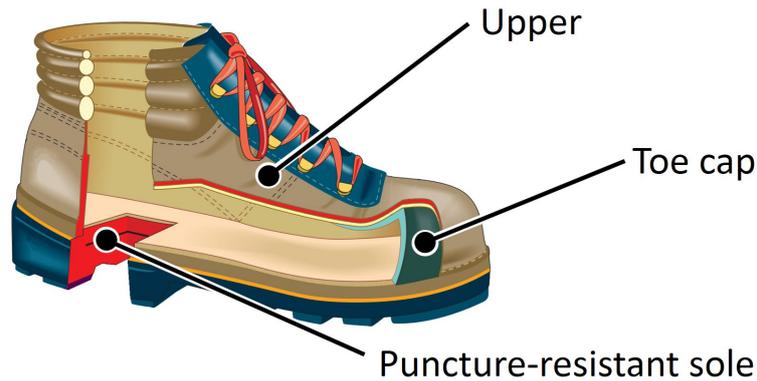
The features of various types of PPE for feet are codified as follows :

Code	Meaning
A	Antistatic (including electrical resistance between 100 k Ω and 1000 M Ω)
C	Conductive (electric resistance < 100 k Ω)
CI	Isolated footing against the cold
CR	Cut resistant
E	Heel energy absorption capacity
FO	Sole resistant to hydrocarbons (i.e. Fuel-Oil, C _x H _y)
HI	Soles isolated against heat
HRO	Sole resistant to heat by direct contact
I	Electrically insulated
M	Toe protection (also called "metatarsus")
P	Puncture-resistant soles
WR	Water resistant. Water repellent uppers (part covering the top of the foot)
WRU	Water resistant. Resistant to immersion

Each type of shoe is classified according to different levels, to meet certain features :

Type	Level	Class		Features				
		1	2	A	E	FO	P	WRU
S	S1	✓		✓	✓	✓		
	S1P	✓		✓	✓	✓	✓	
	S2	✓		✓	✓	✓		✓
	S3	✓		✓	✓	✓	✓	✓
	S4		✓	✓	✓	✓		✓
P	S5		✓	✓	✓	✓	✓	✓
	P1	✓		✓	✓	✓		
	P2	✓		✓	✓	✓		✓
	P3	✓		✓	✓	✓	✓	✓
	P4		✓	✓	✓	✓		✓
O	P5		✓	✓	✓	✓	✓	✓
	O1	✓		✓	✓			
	O2	✓		✓	✓			✓
	O3	✓		✓	✓		✓	✓
	O4		✓	✓	✓			✓
	O5		✓	✓	✓		✓	✓

PPE shoes may also be marked SB, PB or OB, meaning "base" level and only respecting the fundamental requirements of the standard: quality and performance of materials used in the construction, resistance to abrasion, bending, tearing, permeability to water vapor, non-slip sole, etc.



PLEASE NOTE :

Special remarks concerning the laboratories

- Closed shoes are mandatory in any season for laboratory work. However, safety shoes are recommended.
- For transporting or handling heavy loads (e.g.: gas cylinders) and using pallet trucks (or heavy carts), wearing safety shoes (S) is required.



- All PPE shoes do not offer the same protection, the type of shoes to be worn depend on the type of risk.

SOURCES AND LINKS FOR MORE INFORMATION :

- SUVA documents – « Protection des voies respiratoires », « Protection des mains, des bras et de la peau » and « Protection des pieds » (in French, www.suva.ch)
- FCOS Directives 337.9, 337.10 and 337.11 concerning the protection of airways, of hands, arms and skin as well as the protection of feet, respectively (in French, www.directives.cfst.ch)
- INRS – Brochures « Les appareils de protection respiratoire, choix et utilisation », « La main et les produits chimiques », « Lavez-vous les mains pour vous protéger et protéger les autres » and « Les articles chaussants de protection, choix et utilisation » as well as the practical safety sheet « Des gants contre les risques chimiques » (in French, www.inrs.fr)
- Swiss Safety - Swiss Association of PPE companies (in French, www.swiss-safety.ch)
- Sapros – Platform to purchase security products (in French, www.sapros.ch)
- Website : www.2mains.ch (in French)

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