

CEU

BASIC RULES ON SAFETY AND HEALTH IN LABORATORIES (5th Edition)



FUNDACIÓN UNIVERSITARIA SAN PABLO CEU
Corporate Personnel Management Department.
Area of Health Promotion, Safety and Welfare at Work.

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Introduction

Since its first edition, written by the Risk Prevention Unit of the School of Experimental and Technical Sciences of Universidad San Pablo CEU, this document has been continuously reviewed and updated to adapt it to the evolution of the most avant-gard technique and procedures that must be applied in the field of risk prevention.

The revision and update of the content of the 2nd and 3rd editions were carried out by the Laboratory Prevention Unit (with dedication to the Institute of Technology and the School of Experimental and Health Sciences originating from the Schools of Pharmacy and Medicine of Universidad San Pablo CEU). All versions until the 3rd were approved by the Occupational Risk Prevention Service of Fundación Universitaria San Pablo CEU.



The 4th edition, previous to the current one, was revised and updated, broadening very significantly its annexes (signs and pictograms, and protection equipment). The Basic Health and Safety Standards in Laboratories Training Unit of the School of Pharmacy, whose members are Professors with broad knowledge on chemical and biological risks, was responsible for this. Prof. Dr. Pablo Redondo Martín (Full Professor of Chemical Engineering), the coordinator, was in charge of the editing.

The current 5th edition has been revised and updated by the same Professor. He has accepted its authorship and edition, as he has been the coordinator and supervisor of the document and its content for more than a decade. The guide maintains the same objective as previous editions of risk prevention in laboratories, aimed at students, although on this occasion it is aimed at those students who carry out their laboratory practices in the universities, campuses, and centres of Fundación Universitaria San Pablo CEU.

Prof. Dr. Pablo Redondo Martín

Achieving the objectives related to an appropriate general training, information and awareness for the prevention and protection regarding the risks that may affect safety and health in relation to the laboratory practice is a task in which bachelor's degrees students, in universities, campuses and centres of Fundación Universitaria San Pablo CEU, are involved. Knowledge of their obligations and strict compliance with certain basic rules established and set out in this document will help to reduce the risk, and therefore reduce the possibility of accident and/or illness.

Due to the variety of activities carried out in the different laboratories or facilities, can generate very different risks, so that in this document those that could affect scientific laboratories in general have been gathered; leaving training and information on the more specific risks of each laboratory integrated into established practices and procedures.

The compulsory reading of this document by students, in addition to the compulsory attendance of new students in the first year to the corresponding training and awareness seminar, will contribute to the prevention and adequate protection of risks that may cause accidents and/or illnesses, as the objective of the internship is to respect and comply with the basic rules described therein.

Fundación Universitaria San Pablo CEU Corporate
Personnel Management Direction
Area for Health Promotion,
Safety and Welfare at Work

1. General principles of work in laboratories

Organisation of activities

- ▶ The laboratory's organisation must be studied in depth in order to make sure that it is appropriate for the maintenance of a preventive level. Cleaning and order are key to this respect. Facilities, tools, and instruments must be kept in perfect condition. The exit doors and spaces reserved for handling, must always be kept free.
- ▶ In the laboratory, if a person works alone during non-standard hours, he/she should never work alone, at night or in operations that imply risk.
- ▶ In case of carrying out risky operations, all persons must be informed, even those that do not participate in them.
- ▶ It is forbidden to carry out work in the laboratories other than that authorised by those directly responsible. Likewise, it is forbidden to remove products or materials from the laboratory without express authorisation.
- ▶ The facilities, devices, and instruments that must be repaired, shall be sent perfectly clean and free from chemical substances or harmful elements.
- ▶ A suitable temperature and relative humidity should be maintained. Adequate ventilation must be maintained in the laboratories to prevent the accumulation of products which could lead to subsequent accidents.
- ▶ The handling of toxic and/or flammable products shall be carried out in fume cupboards, which have been monitored and maintained to ensure that they are in perfect working order at all times.
- ▶ Benches, display cases, and shelves shall be kept clean.
- ▶ Chemical reagents shall be stored in the laboratory in a suitable place, protected from the sun, and on shelves not too high. They shall be labelled and kept in essential quantities.
- ▶ Flammable and highly reactive compounds shall remain on the workbenches for the minimum time necessary for their use; they shall then be removed to their storage place outside the work area. Before use, ensure that there are no lighted lighters, heaters, or other sources of ignition in the vicinity.
- ▶ Flammable products that require a low temperature maintenance, shall not be kept in conventional refrigerators if they have not been modified to reduce the risk of sparks.
- ▶ Chemical reactions, in general, shall be monitored at all times.
- ▶ The handling of ionising radiation emitting compounds shall comply with the specifications contained in the Facility Operating Regulations, which shall be controlled by the Facility Supervisor. It is expressly forbidden for all personnel who do not have the necessary accreditation for their use to handle them.

- ▶ Unauthorised persons who have not been duly informed of the risks inherent in the laboratories are not permitted in the laboratories. Where appropriate, the information available at the entrance to each laboratory shall be taken into account.

Personal habits

The following rules shall be observed in the performance of the laboratory work:

- ▶ It is forbidden to smoke, eat and drink in the laboratories.
- ▶ Work shall be carried out with gowns fastened at all times.
- ▶ Gowns shall not be worn in public spaces (libraries, cafeterias, meeting rooms, canteens, etc.).
- ▶ It is not advisable to keep street clothes in the laboratory and lockers or cupboards shall be provided outside the work area.
- ▶ Personal items (bags, books, etc.) shall not be abandoned on worktables.
- ▶ No food or drink shall be stored in laboratory refrigerators.
- ▶ Any action that causes transfer of chemical or biological agents to the mouth (sticking labels, biting pens, etc.) shall be avoided. Mouth pipetting shall be avoided and manual or automatic pipettors shall be used for this purpose.
- ▶ No substance or mixture shall be sniffed in an attempt to identify it as its aspiration may be hazardous and may be: toxic, infectious, mutagenic, carcinogenic and/or sensitising.
- ▶ It is mandatory to use safety goggles (even when wearing prescription glasses), whenever handling chemical or biological products that pose a risk to the handler.
- ▶ It is not advisable to wear contact lenses while working in the laboratory because in the event of a splash or vapour accident, they may melt and the time required to remove them may increase the risk of eye injury. In addition, organic compounds tend to accumulate between the contact lens and the eye. The use of prescription glasses is recommended.
- ▶ The wearing of bracelets, rings, pendants, or wide sleeves which could become entangled in or entangle working objects or mountings shall be avoided. Hair shall be worn in an upright position. Hands should be washed:
 - After any operation that implies contact with caustic, toxic, infectious, mutagenic, carcinogenic and/or sensitising material.
 - Whenever protective gloves are removed. Before leaving the laboratory.
- ▶ For drying hands, the use of disposable paper or air dryers is preferable to the use of towels.

- ▶ The last person to leave the laboratory at the end of the day, must check that devices are off or controlled, that gas, vacuum, and water lines are closed, and that lighting is switched off to avoid fire hazards.

Protection measures

- ▶ Each laboratory depending on its own risks, must have specific instructions in case of fire. General recommendations described in the first section -organisation/arrangement of activities- shall be taken into account.
- ▶ The location and operation of fire extinguishing equipment must be known and regularly maintained to ensure that it is in perfect condition.
- ▶ Emergency signage must be known to avoid misunderstandings or indecision in the event of an accident or fire.
- ▶ There is a first aid kit and the teacher in charge knows the guidelines to follow when requesting external help (emergency telephone numbers, etc...).
- ▶ It is necessary to know the functioning and the location of emergency showers and eyewashes.
- ▶ The following points shall be considered in relation to laboratory coats:
 - The cuffs should be close-fitting at the wrist, and it is desirable that they be closed at the front and collar.
 - If powdery products with a strong biological action are handled, gowns without pockets should be used, as these can serve as a reservoir for dirt and dust.
 - In hazardous works, account shall be taken of the composition of the fabric from which they are made.
 - Washing of these working clothes should be avoided together with street clothes.
- ▶ Safety goggles should always be worn and should be for individual use (see annexes, personal protective equipment).
- ▶ Suitable gloves shall be worn depending on the task to be performed (see annexes, personal protective equipment).

2. Handling in the laboratories

Glass handling

Inappropriate handling of glass materials can lead to serious accidents in the laboratory.

- ▶ It is important to know the kind of glass that is being handled: soda glass, which cannot withstand high temperatures, or borosilicate (pyrex glass), which is the only glass that can be heated.
- ▶ Before heating the glass, the material shall be checked for cracks or scratches and shall be discarded if it is defective or has been subjected to severe impact, even if no fractures are visible.
- ▶ Glass looks the same when it is cold as when it is very hot. Before touching containers or connectors which have been subjected to heat, their temperature shall be carefully checked.
- ▶ Do not use your hands directly to force closed caps, keys, and ground-glass seals. The opening of sealed ground-glass seals and closed ampoules shall be carried out wearing face protection, thick gloves, in a fume cupboard, and on a tray or container compatible with the contents of the bottle or ampoule.
- ▶ When cover slips are used, the working table shall be carefully checked.
- ▶ To cut a glass rod, the rod shall be held with a cloth near the mark. The cutting ends shall be moulded in the flame.
- ▶ Long rods must be transported in an upright position.
- ▶ When inserting a glass rod into a bung hole, protect hands with suitable gloves or a cloth and lubricate the bung with water. The insertion shall never be forced.
- ▶ Coolant rubbers shall be cut when they cannot easily remove.
- ▶ Glass containers shall not be flame-heated directly without a grid.
- ▶ Broken glass fragments and defective parts shall be disposed of in containers specifically for glass and never wrapped in paper.

Equipment handling

- ▶ Equipment shall never be operated without full knowledge of its operation and without supervision as determined in each case.

- ▶ Electrical equipment must always be connected to earth. The proximity of cables to heat sources and the possible contact of the equipment with water must be monitored.
- ▶ Ultraviolet lamps can cause eye injuries and sometimes skin burns. Avoid looking directly into the lamp or wear special goggles.
- ▶ The oil in vacuum pumps must be changed at appropriate intervals. Suitable traps shall be installed in vacuum systems to prevent debris from clogging the lines and damaging the pump.
- ▶ Centrifuges must be correctly balanced considering the characteristics of the centrifuges. The tubes must always be weighed for balancing. Special care shall be taken to clean the equipment at the end of the work, especially the rotor.
- ▶ In the event of detecting any anomaly during the operation of any equipment or apparatus, the laboratory manager or the teacher in charge shall be notified.

Gases handling

- ▶ Liquefied gases and liquid air may only be handled by trained personnel, always wearing protective goggles and gloves and in well-ventilated areas.
- ▶ Gas cylinders shall be handled by persons authorised to do so. The dismantling of valves and the use of gases and gas cylinders for purposes other than those stipulated are prohibited.
- ▶ The markings affixed by the supplier shall not be changed or removed.
- ▶ Smoking is prohibited during the handling of cylinders containing flammable gases and in the vicinity of cages containing bales of such gases. This prohibition shall be appropriately signposted.
- ▶ Bales in laboratories shall be flanged to the wall.

Animals handling

- ▶ All animals used in the laboratory undergo strict controls to ensure their proper health status.
- ▶ The handling of the animals shall be carried out under certain guidelines that guarantee the minimum stress to the animals and thus avoid aggressive responses. For this reason, the recommendations of the teaching personnel or the person in charge of the laboratory shall always be followed.
- ▶ Any incident caused during animals handling shall be reported to the Professor or person responsible for the laboratory to take appropriate action.
- ▶ Waste arising from work with animals shall be dealt with as determined by the person in charge of the laboratory from whom disposal instructions shall be obtained.

Identification of Areas and Products

All areas that may represent any kind of potential danger shall be clearly and comprehensibly signposted. All users, students and personnel in general must strictly respect the safety regulations corresponding to each of these areas. The symbols identifying the different areas are shown in the annexes.

- ▶ Areas with radioactive sources: They shall be demarcated by coloured trefoil symbols with internationally recognised designators and shall be marked with text indicating whether the area is a monitored area, a controlled area, a restricted area, or a no-entry area. A distinction shall also be made between risk of external exposure or risk of contamination.
- ▶ Areas with strong magnetic fields (Nuclear Magnetic Resonance Equipment): They shall be indicated by a sign with a red border and explanatory text. In particular, the person in charge of the MR Equipment shall be informed in advance of the entry into the MRE laboratory of any person who is not a regular user of the MR Equipment.
- ▶ Areas prohibited to wear cardiac stimulators or pacemakers: These shall be indicated by a sign with a red border and explanatory text.
- ▶ Areas of biological risk: They shall be delimited by an international symbol and explanatory text indicating, where appropriate, the specific type of risk.
- ▶ Areas with fire hazards, due to the proximity of flammable substances: They shall be indicated by appropriate signs.
- ▶ Explosion-hazardous areas: To be indicated by appropriate signs.

All laboratory products, stored in containers or bottles, shall be adequately labelled in order to inform about their content. Likewise, there is a safety data sheet indicating what to do in the event of an accident.

Solutions prepared in the laboratory shall be appropriately labelled. If a container is reused, the possibility of misleading as to its contents shall be avoided by removing the original label. Food containers shall not be reused to contain chemicals.

Laboratories where chemical risk is present

General work in the chemical laboratory

- ▶ Before carrying out any operation of which the students are not completely sure, they should ask their Professor or laboratory manager.
- ▶ Work shall not be carried out too far away from the table or shelf.
- ▶ At the end of a task, equipment and materials shall be cleared away, avoiding unnecessary accumulation of items in the work area.
- ▶ Cleanliness shall be observed especially in the weighing area. In general, no chemical reaction should be left unattended.

Chemical products

- ▶ Any person handling a chemical shall be aware of its physico-chemical characteristics and toxicity.
- ▶ As a general rule, chemical products shall be handled inside fume cupboards. Specially, work shall always be carried out in a fume cupboard with fumes, foul-smelling substances, gases and vapours which may be dangerous to inhale: toxic, mutagenic, carcinogenic and/or sensitising substances; also work shall be carried out in a fume cupboard for the incineration of combustible or flammable substances.
- ▶ Jars that contain chemical substances shall be opened carefully and slowly, ensuring that there is no violent detachment. After use, **SPECIAL CARE SHOULD BE TAKEN TO CLOSE BOTTLES AND JARS**, especially if they contain flammable substances.
- ▶ When liquids are poured into a container, splashing should be avoided by allowing the liquid to slide down the wall of the container.
- ▶ The remaining original container shall not be returned.
- ▶ For handling substances in open containers, it shall be ensured that the openings in the container are on the opposite side of the container from the operator and other persons present in the laboratory.
- ▶ Substances whose dissolution is exothermic, which means, that it releases heat, shall dissolve in portions, stirring and cooling continuously. In particular, acids shall be diluted by pouring them over water and **NEVER** by pouring water over concentrated acids.
- ▶ A product shall not be smelt without being properly informed. In this case, shake with your hand over the top of the container.
- ▶ Chemical products shall never be touched with hands nor shall they be tasted.
- ▶ Nothing shall be pipetted with the mouth. Rubber bulbs or automatic pipettors shall be used.

Pipes

- ▶ Pipes shall be held with the fingers, not with the hands. They shall not be filled more than two or three cm., and racks and brackets shall always be used. If they are to be heated, they should be heated sideways and using tongs.
- ▶ In the lab coats pockets, pipes chemicals or sharp objects shall not be carried.

Heating

- ▶ The containers or systems totally closed shall never be heated.
- ▶ When low-boiling substances are distilled, the circulation of water through the coolant shall be checked frequently and the rubber hoses shall not be choked. This distillation shall be kept away from any open flame.
- ▶ Lighters cannot be left on and unattended.
- ▶ Before lighting a lighter, it shall be verified that there are NO FLAMMABLE SUBSTANCES IN THE AREA.

Leakages and contamination

- ▶ If chemical flammable substances are spilled, lighters and the lab electrical power shall be turned off. An efficient ventilation shall be assured, and the area shall be cleaned using appropriate means in each case. Those persons that do not participate in the decontamination shall abandon the place/venue until the cleanliness of the area is ensured.
- ▶ Every person in the laboratory shall be aware of the location and functioning of eyewashes and emergency showers.
- ▶ Contact with any part of the body, materials or instruments with contaminated gloves shall be avoided.

Transport and storage of substances and material

- ▶ Products shall be transported in trays or containers to avoid leakages in case of breakages.
- ▶ Jars or containers shall not be transported by grabbing them by the lid or plug.
- ▶ The products obtained in a reaction shall be labelled and stored in an appropriate place.

Transfers

- ▶ Whenever possible, liquids shall be transferred inside a fume cupboard, and in the smallest possible quantities.
- ▶ Before transferring flammable substances, it must be ensured that there are no sources of heat in the vicinity.
- ▶ Suitable funnels, dispensers or siphons shall be used to prevent spillage.

Laboratories of biological risk

Good laboratory practice is essential for safety, so knowledge of the basic rules for handling infectious materials is essential, and the use of specialised equipment or materials does not necessarily guarantee personal safety.

Even if the organism or biological sample is known to be non-pathogenic, it should be treated as if it is potentially infectious or toxic. This is particularly important with poorly characterised organisms.

In the work carried out in this type of laboratory, the general recommendations set out in the first section 'Organisation of Activities' should be considered. However, it is necessary to emphasise the following aspects:

- ▶ Manipulations of agents or samples potentially infectious, shall be carried out in laboratories or special areas in which the international sign of biological risk will be signposted (see annexes).
- ▶ ACCESS to working areas shall be RESTRICTED when experiments with known pathogens are being carried out.
- ▶ Single-use gloves shall be used for all work involving direct accidental contact with blood, infectious material, or infected animals. Gloves shall be aseptically removed and autoclaved with other laboratory waste before disposal. Finally, hands shall be washed.
- ▶ All leakages, accidents, and actual or potential exposure to infectious material are to be IMMEDIATELY NOTIFIED to the Professor or laboratory manager.
- ▶ After any handling of infectious material or animals, hands shall be strictly cleaned, as well as when leaving the laboratory.
- ▶ CLEANING of work surfaces shall be strict, with decontamination at least once a day and in the event of spillage of potentially hazardous substances, especially in common use areas.
- ▶ The handling of big quantities of mild infectious agents or small quantities of severe infectious agents shall be done in biological safety hoods.
- ▶ Micro-organisms shall not be handled with wounded hands. When strictly necessary, the wound must be protected, and gloves must be worn.
- ▶ All containers containing biological cultures shall be labelled for identification,

particularly those present in common areas.

- ▶ Biological cell cultures shall not be pipetted under no circumstances with the mouth. Aerosols shall be avoided when working, if necessary in a fume cupboard.
- ▶ Hypodermic syringes and glass or sharp materials shall be disposed of in special containers immediately after use.
- ▶ All presumably contaminated liquids or solids shall be decontaminated before disposal or reuse. Materials to be decontaminated outside the laboratory, whether by autoclaving or incineration, shall be placed in resistant containers which shall be covered before removal from the laboratory.
- ▶ Micro-organisms cell cultures must be kept conveniently sealed.
- ▶ It is recommended that ongoing or stored crops are checked frequently. If contamination occurs, it should be removed as quickly and properly as possible.

Each laboratory information and instructions for waste disposal in the laboratory must be available. In addition, the local legal regulations for waste disposal must be taken into account at all times. The correct disposal of waste is not only an unavoidable ecological commitment, but also an obligation that we all have to fulfil.

3. Rules for the elimination of residues

Elimination of chemical products

- ▶ Acids and slightly corrosive bases can be removed by first diluting with plenty of water and then disposing of them via the normal drainage system. The dilution should be done in such a way that a concentration of 5-10 % is not exceeded.
- ▶ Solids should never be disposed of down the drain. If they are inert, they will be thrown away with the rest of the waste. If they are hazardous to people and/or the environment, instructions shall be requested from the teacher or laboratory manager to dispose of them in the specific containers.
- ▶ Chemicals, especially heavy metals, shall be recovered as far as possible.
- ▶ Uncontaminated containers shall be rinsed before disposal.
- ▶ No paper or cloth soaked in products shall be thrown into litter bins.

Organic solvents

In all laboratories where organic solvents not miscible with water are handled, suitable waste collection containers shall be provided. Halogenated hydrocarbons shall be collected separately. All persons working in these laboratories shall be adequately informed of the use to be made of these containers and of the products to be disposed of in each container. Accumulation of waste containers in the laboratories shall be avoided.

Elimination of biological materials

For the elimination of potentially contaminated material and its containers, this will be classified in the following categories:

- a. Uncontaminated residues that can be disposed of with rubbish.
 - b. Sharp and cutting objects: hypodermic needles, scalpels, blades, broken glass, Pasteur pipettes, etc.
 - c. Reusable contaminated material for autoclave treatment.
 - d. Contaminated material for elimination.
 - e. Anatomical residues: human and animal tissues.
-

Sharp and cutting objects

Needles and cutting objects must be placed in containers with impenetrable walls. These containers must not be totally filled. Once they are three-quarters full, shall first be sterilised in the autoclave if required by the laboratory practice and then disposed of. The same treatment applies to disposable syringes.

Contaminated material for reuse and elimination

- ▶ All cell cultures and contaminated materials are usually sterilised in an autoclave. Depending on their classification (reusable or not), they are subsequently washed or disposed of.
- ▶ In each working area, jars, buckets, or cuvettes preferably unbreakable that contain an adequate disinfectant prepared daily. The waste materials shall remain in contact with the disinfectant for at least 18 hours. The disinfectant can then be poured down a drain and the solid contents autoclaved. Containers for waste material should be autoclaved and washed before reuse.
- ▶ The waste of Microbiology laboratories, samples, culture media, etc., shall first be sterilised in an autoclave and then may be disposed of together with normal waste.

4. Protocol in case of an accident

Individual Accidents

Splashes

- ▶ If they occur on the skin or in the eyes, they shall be washed with plenty of water by shower or eye wash respectively, and in no case shall neutralisation be attempted.
 - ▶ If they occur on clothing, it shall be removed as soon as possible to avoid skin contact.
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Burns

- ▶ If they are caused by acids or strongly oxidising substances, they should be washed with plenty of water. If they are caused by fire or hot surfaces, treatment depends on the depth and extent of the affected area: in mild cases, copious cold water and a dressing with suitable commercial creams may be applied; in more severe cases, medical attention should be sought as soon as possible and oily creams or ointments should not be applied.
 - ▶ It should be borne in mind that materials or substances at very low temperatures (liquefied gases, frozen biological samples, etc.) can also cause burns.
-

Cuts

- ▶ Wash with plenty of cold water to try to stop the bleeding. If the cuts are small, cover with a bandage or dressing and seek medical attention. If they are serious, try to apply a tourniquet and seek medical attention as soon as possible.
- ▶ It is advisable to collect both chemical and biological information about the material from which the cut was made in order to bring it to the attention of the practitioner.

Ingestion

- ▶ The safety data sheet, available in all laboratories, for the product ingested should be consulted as soon as possible or the toxicological information service (telephone number available in all laboratories) should be contacted. As a general rule, do not induce vomiting unless specifically instructed to do so. The medical service shall be contacted with a label of the product.

Inhalation

- ▶ As a general rule, no substance or mixture shall be sniffed for identification, as its inhalation may be hazardous and may be: toxic, infectious, mutagenic, carcinogenic and/or sensitising. In case of inhalation poisoning, the person concerned shall be placed in a ventilated place and proceed as above.
- ▶ In case of doubt about any of these accidents, the safety data sheets of the chemicals involved in the accident shall be consulted.

Telephone numbers of interest and locations in student health care

The corresponding signs at various locations appropriate to the purpose should be observed, so that the level of care required for the situation can be taken as follows: visiting the infirmary, telephoning the infirmary for on-site care or calling outside at the higher level of care (emergency services). In parallel, consideration shall be given as to whether the situation also requires a telephone call according to the 'Evacuation Instructions' signs so that the situation can be assessed and acted upon by the appropriate person.

Global accidents

Fires

The alarm must be raised immediately (note the guidelines on the "Evacuation Instructions" signs!). Water shall not be used to extinguish the fire whenever electrical appliances or sockets are nearby.

If necessary, the fire extinguisher will be used as follows:

- ▶ It shall be taken down and the ring pulled hard.
- ▶ Standing several metres away from the source of the fire and with the extinguisher resting firmly on the hip or on the ground, pull the trigger, focusing on the base of the fire and making a zig-zag sweep.
- ▶ Never to be used on persons.

If clothes are on fire, the individual will get on the floor and roll over. The first external aid will consist of wrapping the person in a fire blanket until the fire is completely extinguished.

If fire doors exist, they shall be closed.

If there are gas cylinders in the vicinity, it should be noted that the temperature will increase their internal pressure, which could cause them to explode. If possible, they shall be cooled with a stream of cold water and those in operation shall be closed.

The lift shall not be used. Instead, use the stairs and emergency exits that, shall be perfectly signposted.

If there is smoke, it is convenient to crawl.

Possible fire hazards include:

- ▶ Sparks of electrical or non-electrical origin.
- ▶ Smoking or keeping a heat source near flammable products.
- ▶ Leave pumps running overnight.
- ▶ Leave lighters, cookers, water baths and other heat sources unattended.

Explosions

Immediately raise the alarm (pay attention to the guidelines indicated on the "Evacuation instructions" signs). Evacuate the laboratory until it is certain that the danger has passed. If fire occurs, act as above.

Potential explosion hazards include:

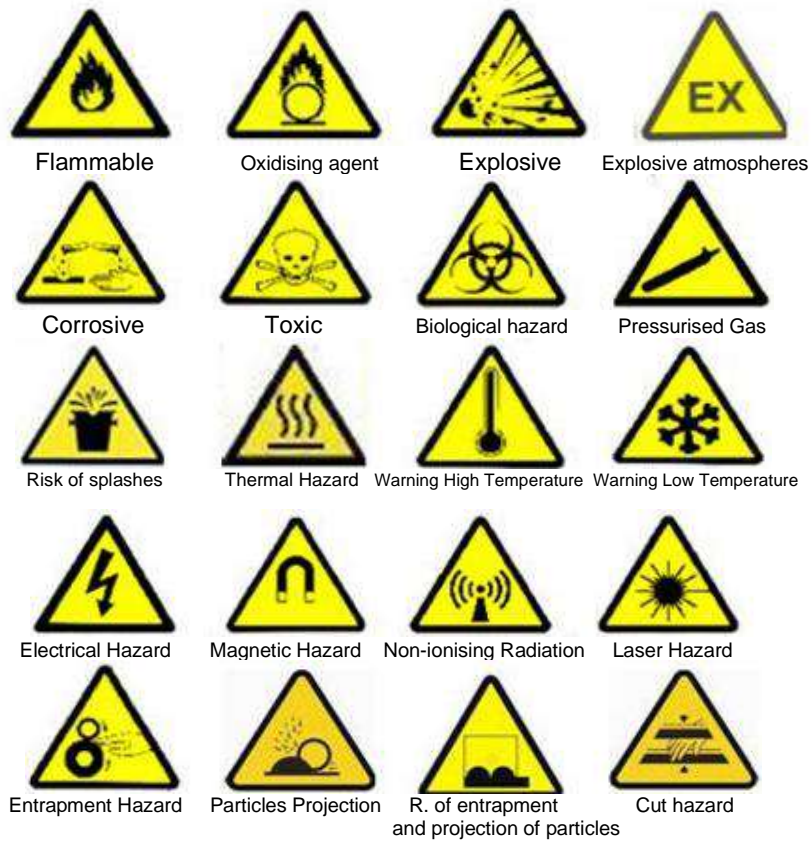
- ▶ Accumulation of gases in enclosed areas usually from evaporation of volatile compounds.
- ▶ Storage of flammable substances near heat sources or in poorly ventilated places.
- ▶ Contact with sodium water or other alkali metals.
- ▶ Breakage of rubber and plastic pipes carrying flammable gases.
- ▶ Escape of flammable gases.

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<http://www.unece.org/trans/danger/publi/ghs/pictograms.html> y diferentes suministradores de equipos y señalética.

Annexes. Signs and pictograms

Warning signs



Prohibition signs



No smoking



No eating and drinking



Non-drinking water



No smoking and fire lightning



No water to extinguish



Do not touch



Entry prohibited to unauthorised persons



No trespassing for pedestrians



No entry with pacemakers



Here, we share oxygen, no smoking

Aquí compartimos
OXIGENO
PROHIBIDO
FUMAR



Use of mobile phones prohibited

Obligation signs



Face masks are required



Respiratory protection must be worn



Use self-contained breathing apparatus



Hand protection must be worn



Hands must be washed



Foot protection must be worn



Eye protection must be worn



Face protection must be worn



Protective clothing must be worn



Hairnets must be worn



Head protection must be worn



Hearing protection must be worn

Signs relating to fire-fighting equipment



Direction that must be followed
(additional indicative sign in addition to the above)



Rescue or distress signs



Emergency Rescue Telephone number [EXIT]



Push bar to open [Emergency Exit]



[First aid kit]

[Emergency shower][Emergency eyewash]

New signs and indications of danger of dangerous substances and preparations

FLAMMABLE GAS,
FLAMMABLE AEROSOL,
FLAMMABLE LIQUID,
FLAMMABLE SOLID,
TRIPOPHORIC LIQUID,
TRIPOPHORIC SOLID,
IN CONTACT WITH WATER
GIVES OFF FLAMMABLE
GASES,
SPONTANEOUS HEATING,
Cat. 1 → 3
SELF-REACTIVE
SUBSTANCES AND
MIXTURES.
ORGANIC PEROXIDES
Type B, Type C and D, Type E
and F



DANGER or CAUTION

EXPOSIBLE.
CHANGEABLE EXPLOSIVE.
Cat. 1.1 → 1.6
SELF-REACTIVE
SUBSTANCES AND
MIXTURES.
ORGANIC PEROXIDES
Type A, Type B



DANGER or CAUTION

OXIDISING GAS
OXIDISING LIQUID
OXIDISING SOLID



DANGER or CAUTION

PRESSURISED GAS
Cat. Compressed
Cat. Liquefied
Cat. refrigerated liquefied
Cat. dissolved



DANGER

New signs and indications of danger of dangerous substances and preparations

CORROSIVE TO METALS
Cat 1.



CAUTION

SKIN CORROSION/SKIN IRRITATION
Cat. 1A, 1B, 1C



DANGER

SKIN CORROSION/IRRITATION
Cat. 2



CAUTION

SERIOUS EYE INJURIES
Cat. 1



DANGER

SEVERE EYE IRRITATION
Cat. 2



WARNING

PELIGROSO PARA LA CAPA DE OZONO

[DANGER FOR THE OZONE LAYER]
DANGER

SUBSTANCES DANGEROUS TO THE AQUATIC ENVIRONMENT
Cat. Acute 1
Cat. Chronic 1 → 4



WARNING

ACUTE TOXICITY
Cat. 1, 2, 3



DANGER

ACUTE TOXICITY
Cat. 4



WARNING

New signs and indications of danger of dangerous substances and preparations

SPECIFIC TARGET ORGAN SYSTEMIC TOXICITY - SINGLE EXPOSURE

Cat.1,2



DANGER or CAUTION

SPECIFIC TARGET ORGAN SYSTEMIC TOXICITY - SINGLE EXPOSURE

Cat.3



CAUTION

SPECIFIC TARGET ORGAN SYSTEMIC TOXICITY - REPEATED EXPOSURES

Cat.1,2



DANGER or CAUTION

TOXICITY FOR REPRODUCTION

Cat.1A,1B,2



DANGER or CAUTION

GERM CELL MUTAGENICITY

Cat.1A,1B,2



DANGER or CAUTION

CARCINOGENICITY

Cat.1A,1B,2



DANGER or CAUTION

ASPIRATION TOXICITY DANGER

Cat.1



DANGER

RESPIRATORY SENSITISATION

Cat.1



DANGER

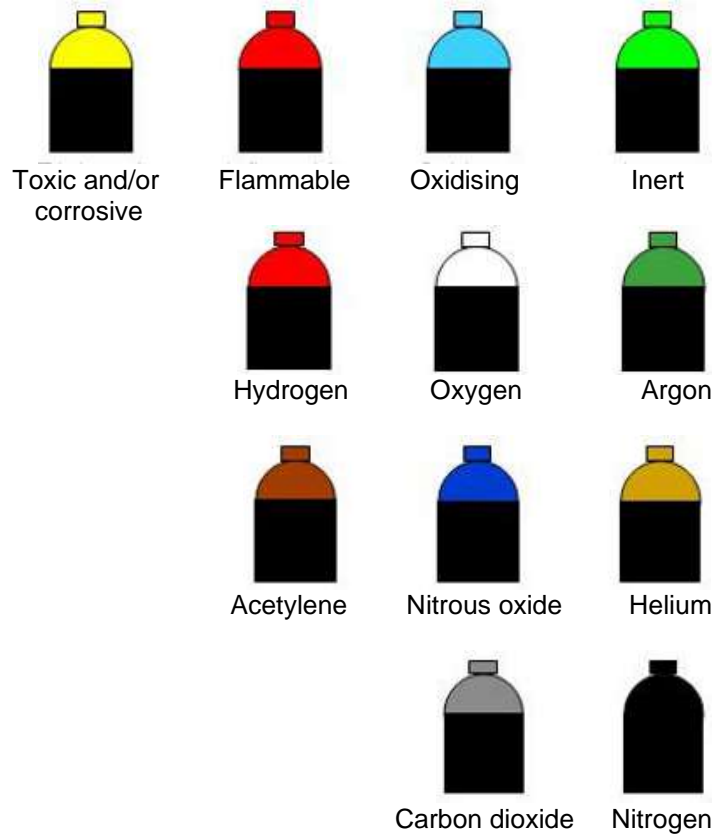
SKIN SENSITISATION

Cat.1

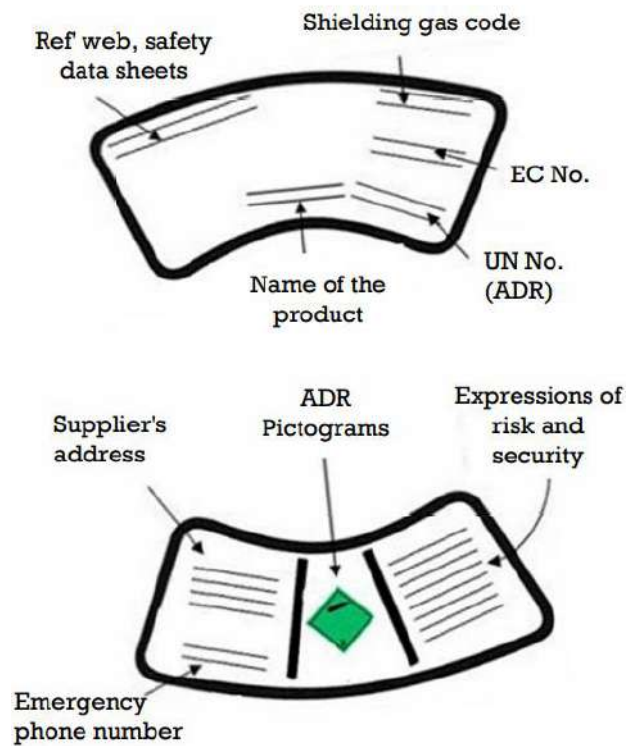


CAUTION

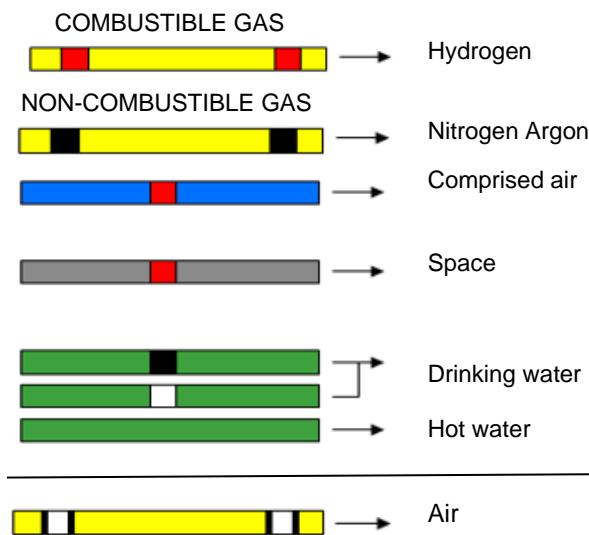
Hazardous gas cylinder colour codes



















Precautionary labelling of gas cylinders



Industrial pipe identification (din 2403)



Identification of industrial pipes (une 1063)

	→	Water
	→	Water steam
	→	Air
	→	Oxygen
	→	Gases
	→	Combustible gases
	→	Non-combustible gases
		
	→	Acids
	→	Bleach
	→	Combustible liquids
		
	→	Non-combustible liquids
		
	→	Fire protection
	→	Danger

Signs in the transport of dangerous goods (ADR)

DANGER
TYPE 1
Explosive substances
and objects



Division 1.1

Division 1.2

Division 1.3



Division 1.4

Division 1.5

Division 1.6

DANGER
TYPE 2.1
Flammable gas



DANGER
TYPE 2.2
Non-flammable
and non-toxic gas



Signs in the transport of dangerous goods (ADR)

DANGER TYPE 2.3
Toxic gases



DANGER Type 3
Flammable Liquids



DANGER
TYPE 4.1
Solid, flammable, self-
reactive and
desensitised explosive
materials



DANGER TYPE
4.2
Substance liable
to spontaneous
ignition



DANGER TYPE 4.3
Material which, on contact with
water, gives off flammable
gases



DANGER TYPE
5.1
Oxidising substance



DANGER TYPE 5.2
Organic peroxides



Signs in the transport of dangerous goods (ADR)

DANGER
TYPE 6.1
Toxic Substance



DANGER
TYPE 6.2
Infectious substance



DANGER
TYPE 7
Radioactive substance



Category 1



Category 2



Category 3

DANGER
TYPE 8
Corrosive substance



DANGER
TYPE 9
Environmentally
Hazardous Substance



Protection against ionising radiation: areas signposting



CONTROLLED
ZONE: Radiation risk



CONTROLLED
ZONE:
Contamination risk



CONTROLLED
ZONE:
Contamination and
radiation risk



LIMITED STAY
ZONE: Radiation risk



LIMITED STAY
ZONE:
Contamination risk



LIMITED STAY
ZONE:
Contamination and
radiation risk



REGULATED STAY
AREA: Radiation risk



REGULATED STAY
AREA: Contamination
risk



REGULATED STAY
AREA: Contamination
and radiation risk



NO-ENTRY ZONE:
Radiation risk



NO-ENTRY ZONE:
Contamination risk



NO-ENTRY ZONE:
Contamination and
radiation risk

Annexes. Personal Protective Equipment

Choice and use commensurate with risk

- ▶ Firstly: **CE** conformity marking and category: Cat.I, II or III (Cat.III=maximum level of protection). Furthermore, it is related to its stamping on the personal protective equipment and it is necessary and convenient: the verification of the existence of the declaration of conformity for the PPE by the manufacturer or his representative in the EU; and the accreditation of the passing of the type examination, being both requirements that if not fulfilled, the manufacturer should not put the conformity marking on the personal protective equipment and even less could not specify its category (special attention in categories II and III, as the manufacturer should have presented more demanding technical documentation according to their categories)! *The information on the packaging must also be observed.*
- ▶ Secondly: *European Standard EN###:####* that they comply with (it must be appropriate to its protective function). EN Standards in force (*): see and check for *updated titles and references of harmonised standards* under the personal protective equipment directive.
(*): parts of the following descriptions of protective equipment may change as a result of the withdrawal and replacement of these standards, affecting the following.
- ▶ Thirdly: Observation of the *pictogram of the risk* against which they protect and their technical characteristics in accordance with the *EN standard (protection class)*.
- ▶ Fourthly: Consultation and respect in following what is said about the personal protective equipment in the *information leaflet* that accompanies it. Attention to its correct conservation and storage.
- ▶ In any case, their *expiry date* shall be observed and they shall be replaced!



General Technical Features of various personal protective equipment

Hearing protection equipment

- ▶ Earplugs.
- ▶ Earmuffs.

They are chosen according to the values of:

- ▶ SNR: attenuation value (reduction in the number of dB achieved).
- ▶ Absorption coefficient (α): from 1 to 0 (factor which, multiplied by the sound pressure level in dB, gives the resulting level after attenuation, 0 being the maximum absorption).

Eye and face protection equipment

- ▶ *Eye protectors (glasses).*
- ▶ *Face protectors (screens).*

Collective protection is always best: experiment in a fume cupboard or biological safety cabinet.

Risks against which they specifically protect according to their design:

- ▶ Particle impacts.
- ▶ Liquid splashes (chemical, biological substances, temperature!).
- ▶ Polluted atmospheres (aerosols, smoke, vapour!).
- ▶ Harmful radiation (different EN standards for ultraviolet, infrared, laser radiation, laser adjustment and laser systems...).

Attention to the ocular marking on which the characteristics of the goggle are coded!

Respiratory protection equipment

- ▶ *Filtering equipment* (self-filtering particulate respirators, self-filtering masks with gas or gas and particulate protection valves, half masks, full face masks, particulate filters, ventilation-assisted particulate filtering devices). Three levels of protection from 1 to 3: 3 is the maximum protection; it is also necessary to take into account against which contaminants they protect against: particles, organic vapours of p.eb. greater or less than 65°C, inorganic vapours, acid gases and ammonia (they are colour-coded according to the type of contaminants).

- ▶ *Insulation equipment* (compressed air line breathing apparatus: non-autonomous equipment and autonomous equipment).

Collective protection is always best: experiment in a showcase.

Risks they protect against:

- ▶ Oxygen deficiency in the air.
- ▶ Contaminated air (particles, gases and vapours).
- ▶ If protection against biological agents is required, level 3 filtering equipment should be used. Caution: collective protection using biological safety cabinets is always preferable!

Hand protection equipment (chemical risks)



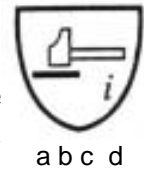
- ▶ *Single-use gloves (disposable)*: depending on the material, they comply with different categories in the CE labelling. For example: latex CE CAT I; PVC CE Cat I; vinyl CE Cat II; nitrile CE Cat III; attention: polyethylene gloves are not personal protective equipment.
- ▶ *Chemical gloves*: all must be CE Cat III, materials can be latex, nitrile, neoprene, PVC, PVA.
- ▶ They are chosen according to the degradation rate of the glove against the substance handled and the permeability of passage through the glove for that substance (time in minutes for the chemical to pass through the glove wall), so that the glove performs well according to both factors.

Hand protection equipment (risks due to micro-organisms)



They protect against the passage of micro-organisms, they are characterised by their resistance to water and air penetration (especially critical is the air leakage test in this case) in a similar way to chemical gloves. The biohazard pictogram appears for the personal protective equipment if it protects against biohazards (Caution: if it is to protect against both chemical and micro-organism hazards at the same time!)

Hand protection equipment (mechanical hazards):



- ▶ *Mechanical resistance gloves*: this is CE personal protective equipment. Cat II. The materials they are made of are usually: Kevlar, Twaron, rough latex, cowhide, and metal mesh.

Risks they must be protected against and according to which characteristics they are chosen:

- ▶ (a) Abrasion: they are characterised in four levels by their resistance in number of cycles (100, 500, 2000 or 8000).
- ▶ (b) Blade cut: 5 levels of protection (5 is the highest).
- ▶ (c) Tearing: they are characterised in four levels according to the force they resist (10, 25, 50 or 75 N).
- ▶ (d) Puncture: four levels according to the force they withstand (20, 60, 100 or 150 N). The risk of puncture by puncture requires special care in the choice of personal protective equipment, and care must be taken in the choice and handling of the object to be used!

Hand protection equipment (impact cutting hazards)



- ▶ *Impact cut protective gloves*: tested in an impact cut test on a mass of 1050 grams dropped from a height of 150 mm.

Hand protection equipment (heat and/or fire hazards)



- ▶ *Thermal resistance gloves*: these are Cat III personal protective equipment as soon as the temperature to be withstood is above 100°C. The materials they are made of are usually: Kevlar, Goretex, Nomex and aluminised Nomex (their resistance is in this order: a b c d e f from lowest to highest).

a b c d e f

Risks they protect against and according to which characteristics they are chosen:

- ▶ (a) Flame behaviour: characterised by post-ignition and post-ignition times (the shorter the time, the greater the protection).
- ▶ (b) Resistance to contact heat: that it takes $t > 15$ seconds for the heat to pass through at four different temperature levels of the object to be touched.
- ▶ (c) Convective heat resistance: four levels according to heat transmission time.
- ▶ (d) Radiant heat resistance: also four levels depending on the heat transmission time.
- ▶ (e) Resistance to small splashes of molten metal: number of drops required for the temperature to rise 40°C.
- ▶ (f) Resistance to large masses of molten metal: four levels according to the grams of molten iron required to cause a surface burn.

Hand protection equipment (cold hazards)



- ▶ *Cold-resistant gloves*: these are Cat II **CE** personal protective equipment as soon as the temperature to be withstood is below -50°C . The materials of which they are made are usually fibres and polyurethane foam.

a b c

Risks against which they protect and according to which characteristics they are chosen:

- ▶ (a) Contact cold resistance: four levels according to thermal resistance (the higher the value, the greater the resistance to cold).
- ▶ (b) Contact cold resistance: four levels according to thermal resistance (the higher the value, the greater the resistance to cold).
- ▶ (c) Water impermeability: only one level, to withstand at least 30 minutes until the water passes through.

Hand protection equipment (static electricity hazards)



- ▶ *Anti-static electricity accumulation gloves*: personal protective equipment to reduce the risk of static electricity discharge following an accumulation of static electricity. They are to be used in environments where the instantaneous discharge of accumulated static electricity can generate a risk. They are characterised by their electrical resistivity, which must be between 10^6 and 10^9 cm. The corresponding pictogram will appear.

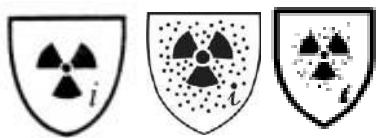
Hand protection equipment (low voltage electrical hazards)



- ▶ *Low voltage electrical protection gloves*: their main property is to be electrically insulating. When they provide protection for voltages lower than 500 V, the pictogram shown on the left will appear, as well as their class, which will be 00.

If a task involving direct electrical contact has to be carried out, the best measure is to remove the electrical voltage from the electrical panel beforehand. The use of low-voltage insulating footwear may be an additional protective measure, and there is always the safety measure of the presence of properly functioning earths and the use of properly connected equipment. As for the electrical differentials that can trip in the event of a fault, only those that operate below a current of 0.01 A can guarantee that nothing will happen to us in the absence of the above measures.

Hand protection equipment (risks from ionising radiation and radioactive contamination)



Protective gloves against ionising radiation and radioactive contamination: first of all, it must be made clear that the risk to be protected must be taken into account, given that the risk of irradiation (exposure to ionising radiation) is not the same as the risk of radioactive contamination (where a distinction must be made between exposure to radioactive substances and exposure to radioactive particles).

The gloves have as a fundamental requirement to be effective in attenuation and to become usual protective material. They must also comply with the performance level, which is characterised by the equivalent thickness of lead with respect to the standard gauge (values: 0; 0.05; 0.1; 0.15; 0.3; 0.35; 0.4; 0.45; 0.5).

Personal protective equipment offering limited protection against external irradiation is designed for electronic (e.g. beta radiation) or photonic (X, gamma) radiation of relatively limited energy. The level of protection must be appropriate to the use. The pictogram corresponding to the risk is marked on the personal protective equipment together with the number of the equivalent thickness of lead in relation to the standard gauge.

Where personal protective equipment provides protection against external radioactive contamination, the materials and other components are intended to protect against dust, gas, radioactive liquids, or mixtures thereof in such a way as to effectively prevent the penetration of contaminants under the required conditions of use. Gloves must be leak-tested and subjected to specific tests in accordance with the standard for their intended use before they can be placed on the market. There may be decontamination measures to be followed for personal protective equipment of this type.

Their level of performance is characterised by different requirements:

- 1) Attenuation efficiency and uniformity of the protective material (the equivalent thickness of lead (9 levels: 0; 0.05; 0.1; 0.15; 0.3; 0.35; 0.4; 0.45; 0.5). The higher the value, the greater the protection, but please note the indication below (*), as this protective equipment requires specialisation for its selection).
- 2) Water vapour permeability which has five levels, the one with the highest value is the most protective.
- 3) Ozone cracking resistance (4 levels depending on whether visible cracks occur at a given elongation).
- 4) Chemical requirements, which have to be in accordance with the user's use and which are relevant for chemical protective gloves.
- 5) Other special requirements that may be defined and agreed between the manufacturer and the user.

The selection of a glove for protection against ionising radiation and radioactive contamination should take into account:

1. The type of radioactive source:
 - X Radiations and Gamma Radiations - γ -.
 - Neutrons.
 - Ionising particles (alfa - α - and beta - β -).

2. The energy of the emitted particles or radiation and the intensity of the source.
3. The radiation level to be achieved, which is usually expressed in dose rate and which must coincide with the legal values existing in the radiological regulations in force.

The calculations necessary to determine the equivalent lead thickness value with respect to the standard gauge, by which the personal protective equipment is to be chosen, must be carried out by personnel specialised in this field(*), see reference made above.

Trunk, abdominal and total body protection equipment

Special clothing against aggressive chemicals: there are six types (the highest tightness is for type 1 and the lowest for type 6).

Risks against which they protect against and according to which characteristics they are chosen:

- ▶ Gases (type 1): (1a) llevan el equipo de protección respiratoria dentro del traje; (1b) llevan el equipo de protección respiratoria en el exterior del traje; (1c) van conectados a una línea de aire comprimido.
- ▶ Vapurs (type 2).
- ▶ Low-pressure liquids (type 3).
- ▶ Pulverised (tipo 4).
- ▶ Particles (type 5).
- ▶ Splash/particles (tipo 6).



1a 1b 1c



2



3



4



5



6

Special clothing against biological agents: they protect against the risk of passing through agents with the function of preventing them from reaching the wearer's skin. It is classified as special clothing against chemical agents, although the type will be indicated by a dash (e.g. type 3-B, 3=low pressure liquid with B=biological agent). They are characterised in the same way by the letter B are characterised by the resistance of the material to penetration by micro-organisms depending on whether the micro-organisms are in liquid medium, liquid aerosols, or a solid agent. The biohazard protection pictogram shall appear next to the identification of its type with the letter B.



3-B

Special clothing against the cold:



Vest/apron/dungarees for use in handling liquefied gases at very low temperatures. Caution: this is **CE** Cat III personal protective equipment.

Risks against which they protect and according to which characteristics they are chosen:

- ▶ They protect against freezing, in addition to **CE** labelling that complies with the appropriate EN standards.



Special clothing against the cold and fire: There are five types depending on the mechanism by which heat is transmitted to the body.

ABCDE

Risks against which they protect and according to which characteristics they are chosen:

- ▶ Limited flame spread (type A): characteristics are no edge destruction, no pinholes, no melting, afterglow time of less than two seconds and afterburning time of less than two seconds.
- ▶ Convection heat resistance (type B): within this type there are five levels according to the resistance offered.
- ▶ Radiant heat resistance (type C): There are also five levels of heat resistance.
- ▶ Projection resistance of cast aluminium (type D): three levels of protection.
- ▶ Cast iron projection resistance (type E): three levels of protection.



Note: the pictogram next to it does not mean that the garment, glove,... is personal protective equipment, but it implies that it is suitable for maintaining hygiene in activities such as catering.