

Good practice  
in the prevention  
of occupational risks

## Laboratory Safety Manual

TECHNICAL GUIDE ISSGA



XUNTA DE GALICIA

2.ª Edition - 2017

Edition:

Instituto Galego de Seguridade e Saúde Laboral (ISSGA) -  
Galician Institute for Occupational Safety and Health  
Xunta de Galicia

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Photography:

11<sup>th</sup> page, Ozarch; 14<sup>th</sup> page, Decom; 24<sup>th</sup>, 25<sup>th</sup>, 25<sup>th</sup>, 27<sup>th</sup> and 29<sup>th</sup>, by courtesy of JP Selecta.

Impression:

Lugami Artes Gráficas, S. L.

Legal Deposit: C 1193-2017

Santiago de Compostela, 2017



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Laboratory Safety Manual

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Good practice in the prevention of occupational risks

# **Laboratory Safety Manual**

ISSGA TECHNICAL GUIDANCE

**XUNTA DE GALICIA**

Instituto Galego de Seguridade e Saúde Laboral - Galician Institute for Occupational Safety and Health  
Santiago de Compostela  
2017



## **Introduction**

This manual provides basic information in order to develop laboratory work under proper safety conditions according to the current legislation as regards the Prevention of Occupational Risks. In addition to referring to the main hazards and risks, it also includes standards of conduct, working regulations and action protocols in case of an accident. The risks produced in a laboratory, where an exposure to chemical agents exists, are fundamentally taken into account.

This document should be available for all people belonging to the staff and it is the starting point for proper working behaviour. The employer, who has the responsibility for the safety and health of the employees, must designate a person in charge (usually the director/person in charge of the laboratory) of adding the specific information for each laboratory in order to make it a safe working place.

It is necessary to remember that in those laboratories where radioactive materials are used (radioactive sources or generators of ionizing radiations), the control of the exposure of the workers is competence of the Nuclear Safety Council who does it by means of the services and technical units of radiological protection.



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## **1. GENERAL SAFETY PROCEDURES**

### **1.1. Correct habits in the laboratory**

#### **1.1.1. Hygienic habits**

- It is very important to wash the hands to avoid exposures, which may pass unnoticed, to toxic substances. Hands should be washed:
  - whenever there is contact with a chemical product.
  - after taking off dirty/contaminated protective clothes.
  - before entering the staff rest room.
  - before eating, drinking or smoking.
  - before leaving the laboratory (even when gloves are used).
- Laboratory coat must be used during worktime. It must be long, cross from one side to the other to protect chest and abdomen, with long sleeves tightly fitting the cuffs and made of cotton. It would be better to treat it with fire retardants. It should be taken off easily.
- Laboratory coats and gloves must always be taken off before leaving the laboratory.
- Personal objects cannot be left on tables or on shelves.
- Do not consume food or drink in the laboratory.
- Food or drinks cannot be kept in the laboratory refrigerators.
- Laboratory containers will never be used to contain drinks or food and chemical products will never be put inside foodstuff containers.
- Any type of wound (especially on hands) must be covered, even when gloves are used for work.

#### **1.1.2. Other personal habits**

- Footwear must cover the foot and it must be properly tight. The sole has to be slip resistant.
- The use of contact lenses must be avoided. The effect of chemical products is much bigger when they get between the lens and the cornea.

- The staff must regularly use safety glasses (prescription glasses or those which permit the use of glasses for the correction of vision underneath, if necessary).
- Short trousers, short skirts, sandals, open-toed shoes, etc. must be avoided owing to skin protection reasons.
- Piercings (especially on the tongue and lips) cannot be worn.
- Hair must be tied back (due to a possible contamination and to the easiness of getting caught on mechanical devices). Rings, chains or necklaces (particularly rings or watches which protrude and long necklaces) should not be worn.
- Do not wear bracelets, pendants or wide sleeves which may get caught on the setups.
- Gloves must be worn every time corrosive and toxic products via dermic process are handled.

### **1.1.3. Working habits**

- The laboratory must be kept tidy and clean. All dumping, no matter how small, must be collected.
- Before using them, products and materials must always be checked, using only those being in good conditions.
- You should never work alone in the laboratory.
- Test tube racks and bases must be used all the time.
- Test tubes or products must never be taken in the pockets.
- Chemical products must never be touched with the hands or tasted.
- The pipette will never be used with the mouth.
- Concerning glass materials:
  - Before starting work all pieces must be checked, in order to replace those which have some fault.
  - It is necessary to provide a collector for the exclusive disposal or rejected glass materials in the laboratory.
  - Any anomaly detected in the material must be communicated to the person in charge.
  - When breakages happen, glass pieces should not be picked up with hands. Brooms or similar objects must be used instead. If the cutting materials broke in the sink and it happened to be necessary to hand-pick the pieces, it is obligatory to use mechanical protective gloves due to possible cuts.
  - Dismiss any material which has received a consistent stroke, although no crack or breaking signals can be seen.
  - Do not subject it to sudden changes of temperature. For example, do not heat it directly with a flame. A material capable of diffusing heat (for example a metallic grid) should be inserted.
  - Do not heat liquids in glass containers which are not heat-resistant (like test tubes, volumetric flasks, bottles, etc.)
  - Plastic tops should be used whenever possible.
  - Anti-cutting gloves and face protection must be worn to unblock the pieces.
- Regarding the cleaning of glass material:

Never accumulate an excessive quantity of material in the cleaning area (sink).

- Unless it is strictly necessary, avoid using chemical products for the cleaning of glass material. If it is necessary, the features of the used products have to be well known and personal protective equipment (PPE) for that case has to be worn.
- Flammable organic solvents as acetone will be used for cleaning in slight quantities with all due precautions.
- Acids and solvents will not be dumped to the drainpipes during the cleaning. They must be collected for the proper treatment and disposal.
- Use the fume cupboard whenever possible and when working with substances which emit harmful vapours (toxic and irritating vapours) and when an operation in which dangerous vapours or fumes are produced is carried out.
- Keep all chemical products in use inside their packages and avoid transfers.
- When solutions are made in containers, these must be identified by means of the labelling on the containers.
- All chemical products used in the laboratory must clearly indicate the chemical names of the hazardous components; they must carry the pictograms and Hazard statement and the H and P statements (hazard statement and precautionary statements) according to the new regulation, referring to the preparation.
- If the laboratory has not got appropriate extraction/ventilation systems breathing protectors must be worn during risky procedures. These protectors are properly selected according to chemical products to which someone could be exposed by inhalation.
- Flammable substances must be used and kept in indispensable quantities.
- Laboratory fume cupboards are a means of collective protection and they must not be used to store products.
- In order to light flames, long piezo-electrical lighters must be used, not matches nor cigarette lighters.
- Make sure that the materials got cold before taking them with the hands.
- When heating test tubes use test tube tongs to hold the tubes near the top, where the liquid reaches. Tilt the tube while heating. Never hold the tube from the bottom part. If not done this way it might shoot out violently. Be very careful not to turn the entry of the test tube to our face or to the faces of our laboratory colleagues.
- When an acid has to be diluted, never add water to the acid, but on the contrary, add the acid to the water slowly and shaking.
- When a task or operation is finished:
  - The table must be cleaned,
  - The used reagents must be organized,
  - The equipment must be unplugged (unless there is an order contrary to it),Gas and water valves must be turned off.



## 2. CONSIDERATIONS CONCERNING THE STRUCTURE, DESIGN AND DISTRIBUTION OF LABORATORIES

Laboratories must be properly divided into sectors, depending on the different risks to avoid therefore spread of fire or other types of accidents or incidents (leaks, fumes, spills...).

Laboratory equipment will never be placed in the corridors. Escape routes cannot be blocked.

The ventilation system must be independent from the one existing in the rest of the building.

There must be storage room for chemical products.

**It is appropriate to have a well-ventilated place outdoors for the pressurized gas facilities** (gas cylinder cage). If this is not possible, the location for it must have suitable ventilation. These facilities must be executed by installers properly authorised by the competent body concerning industry and they have to be checked periodically with record keeping.

Working with carcinogens and mutagens, biological agents and ionising radiation is ruled by specific legislation which may imply requirements of separated and marked areas.

Areas like offices, dining rooms, general restrooms or public toilets, which are used or visited by staff that does not belong to the laboratories, cannot be incorporated to the laboratory departments. These rooms will constitute ancillary areas to the laboratory department.

There is the possibility of having a scalesroom (places without vibrations, airflow or important variations of humidity and temperature). It will be well lit according to the task and it will always be cleaned by aspiration (creation of dust). It should be separated from the laboratory by an antechamber, especially if gases or corrosive vapours are generated.

The furniture (tables, chairs, cupboards) is subject to some minimum requirements regarding functionality and comfort, paying special attention to ergonomic aspects, especially when using computers and microscopes and other instruments that require special design for the working place. The working tables will have drawers which can be locked and the furniture will allow the proper storage of laboratory material and documents.

There must be fire safety storage cabinets with at least a fire resistance factor 15 (RF-15) for the storage of flammable liquids (it is highly recommended when more than 38 l including waste are stored, and always taking into account the risk assessment).

## 2.1. Laboratory ventilation

Ventilation is a particularly important aspect in the laboratory, because in addition to providing proper temperature and humidity conditions, it prevents the ambient concentration of a chemical agent generated during work to increase continuously in the room. Appropriate ventilation may be enough to stop ambient concentrations that could present a risk of inhalation to the worker.

All work places (especially those where hazardous chemical agents exist) are subject to some minimum requirements regarding ventilation established in the RD 486/1997, that establishes the minimum safety and health requirements at work places mentioned textually in Annex III.

«...the minimal air renovation in working rooms will be 30 cubic metres of clean air an hour per worker, in the case of sedentary work in rooms that are nor hot nor polluted with cigarette smoke, and 50 cubic metres in the rest of the cases, in order to avoid a foul atmosphere and unpleasant smells».

The environmental control of the laboratory demands two different actions:

- removing of contaminants and
- air renovation.

Although the simple air renovation of the room allows to control up to a point the level of ambient concentration (reduction of smells and dilution of the contaminants concentration), it is unable to eliminate efficiently contaminants generated in the laboratory. It is necessary to insist on the fact that **the effective resource to eliminate the generated chemical contamination due to the laboratory activity is the located extraction** (fume cupboards and extraction hoods).

**Ventilation by means of dilution** (to renew the air by means of the supply of a quantity of clean air and removing a similar quantity of contaminated air), can be obtained naturally (opening doors and windows) or in a forced way (supply system and air extractors). Natural ventilation is only feasible during certain times of the year and it may produce airflows that interfere with the laboratory activity (with the correct working of the fume cupboards among others). Anyway, ventilation by means of dilution is only recommended to control the risk if a series of circumstances come to happen:

- Working with low toxicity substances by inhalation.
- Workers are not near the source.
- There is no pollution caused by dust.
- No flammable or explosive substances are used.
- The dispersion of the contaminant is uniform.

**In case a conditioning system for the laboratory is designed, it will have to be independent and exclusive**, and it must be capable of:

- Removing the energy released from the different laboratory areas (Kcal/h that different devices can release).
- Generating and keeping a suitable climate in each one of them.

- Compensating with clean and treated air the volume of air that has been removed by the extractor systems.

Regardless of the adopted system to renovate the laboratory ambient, the withdrawal of extracted air demands a suitable distribution of the air intakes and outlets. If all of them are on the facades of the building, the intakes will be placed on facades with a different orientation with regard to the outlets. If both must be put on the roof, prevailing winds and the relative heights have to be taken into account.

**The laboratory air must not be recirculated, except in very special cases and provided that a previous in-depth treatment has been used.**

## 2.2. Storage of chemical products

### 2.2.1. General considerations

The specific regulation about the storage of chemical products is not applicable on the whole to the usual conditions of laboratories, where generally small quantities of a wide range of chemical products are stored. Moreover, storage and gas facilities and storage of flammable products in large quantities must be considered in the design of specific storage rooms.

Prolonged storage of chemical products constitutes a risk by itself, because due to the intrinsic reactivity of chemical products different transformations can occur:

- Formation of peroxides (explosion).
- Polymerization of the substance (explosion).
- The container of the product may suffer damage by the product itself and break.
- Slow decomposition of the substance producing gas whose accumulation can make the container explode.

### 2.2.2. Basic actions to reduce the risk

#### a) Reduce stock to a minimum:

- Managing the stock in order to guarantee the supplies within short time-limits.
- Doing frequent orders to suppliers to avoid the prolonged storage.
- Keeping in the laboratory essential products of daily use.

#### b) Establish separations of incompatible substances:

The storage criteria must never follow the alphabetical order, do it only within the compatible groups. It is suitable to separate the following types of compounds:



GHS06



GHS08

- Very toxic substances (pictograms GHS06 –acute toxicity–, or GHS08, –systemic toxicity– see section 9 of this manual) and carcinogenic substances H350, H351, H340, H341 (if there is no incompatibility).

- Flammable organic products and organic acids.
- Organic bases and other organic compounds.
- Inorganic acids and inorganic oxidants (it may be necessary to make an additional separation due to the special reactivity characteristics).
- Inorganic bases, reducers and salts.

Special incompatibilities must be taken into account (for example, nitric acid with chromic acid, nitric acid with organic compounds...)

EXAMPLES OF INCOMPATIBLE AGENTS	
Oxidants with:	Flammables, carbides, nitrides, hydrides, sulphides, alkylmetals
Reducers with:	Nitrates, chlorates, bromates, oxides, peroxides, fluoride
Strong acids with:	Strong bases
Sulphuric acid with:	Cellulose, perchloric acid, potassium permanganate, chlorates

EXAMPLES OF UNSTABLE AGENTS	
Products whose prolonged storage implies the possibility of decomposition	Alkaline amides, certain types of diazonium salts
Easily peroxidable substances	Allylic compounds, vinyl compounds, styrene
Compounds that react violently in contact with air	Phosphides, hydrides
Monomers that polymerize quickly	Vinyl acetate, styrene, acrylonitrile

EXAMPLES OF AGENTS THAT REACT DANGEROUSLY	
with water:	alkaline metals, inorganic peroxides, carbides, phosphides
with hydrochloric acid:	sulphides, hypochlorites, cyanides
with nitric acid:	Some metals
with sulphuric acid:	Formic acid, oxalic acid, ethyl alcohol

In Annex 1, there is a list of chemical substances with their corresponding incompatibilities, that was taken from NTP 479 «*Prevención de riesgo en el laboratorio químico: reactividad de los productos químicos (II)*» (Risk prevention in the chemical laboratory: reactivity of chemical products (II)), which can be consulted on the following link <http://goo.gl/wHAhmW>

c) Make sure that all products are correctly labelled (updated register).

d) Isolate or confine certain products:

- Very toxic or poisonous products, substances that may explode due to movement, friction or heat or through contact with the air, and drugs that may create addiction, must be kept locked up.
- Storage cupboards of carcinogenic substances must be marked.
- Peroxidable products (ethyl ether, isopropyl ether) which may cause detonations after being stored for a long time, must not be kept open for over 6 months after being opened for the first time, unless

they have an effective inhibitor. The label must contain the date of reception and opening of the package.

- Keep flammable liquids in cupboards of at least RF 15 (specially recommended when more than 38 l, including wastes, are stored, and always taking into account the risk assessment).
- Flammable substances that require refrigeration in refrigerators cannot be kept in household fridges.
- Fume cupboards cannot be used to store products. They alter the correct air flow and they eliminate working space.
- Volatile and odoriferous compounds must be kept in well ventilated places or in cupboards with ventilation.

**e) Take into account the installations and disposition of the substances in them.**

- The most hazardous products must always be kept in the lower part of the shelves (corrosive, very toxic, flammable substances).

**2.2.3. Other instructions/recommendations**

- Chemical products storerooms must be revised periodically and expired or not used products must be removed. At the same time update manufacturer's instructions (at least once a year).
- It is obligatory to read and follow the manufacturer's instructions.
- Transfer of products is not recommendable. Each package that will be used again will have to be labelled correctly. The label must contain the concrete name of the substance or preparation that is inside, the preparation date and the name of the person who prepared it. When considered appropriate, all necessary warnings about storage precautions, manipulation or other aspects will be mentioned.
- Each stored substance in the refrigerator must be in a perfectly sealed covered container.
- Do not use the reagents refrigerator to store food.
- Fume cupboards must not be used to store products. They alter the correct air flow and they eliminate working space.
- Do not use bottles of more than 4 l capacity to store reagents.
- Small bottles must be transported in boxes or leak-proof containers and must never be hold by the bottleneck or embraced. Bottles of more than 4 l capacity must be transported on carts or special trolleys.
- The laboratory manager must designate one person or more who will be in charge of the management of the chemical products storeroom.
- More information regarding this at NTP 725: «*Seguridad en el laboratorio: almacenamiento de productos químicos*» (Laboratory safety: Chemical storage): <http://goo.gl/7ZHvVq>



### 3. SAFETY CONSIDERATIONS CONCERNING THE INSTALLATIONS

#### 3.1. Electrical installation

It must be designed according to the current «Reglamento electrotécnico de baja tensión» (REBT) (low voltage electro technical regulations), and according to the working lines, the types of used equipment and in view of the future laboratory needs. This aspect has to be considered in all modifications that will be made.

The addition of new equipment must take their electric requirements into account.

Electric conductors must be protected all over the route and their section must be sufficient to avoid voltage drop or heating. There must be enough power supplies for general use and conveniently distributed in order to avoid temporary facilities.

In rooms or areas where flammable liquids are used, the electrical installation will be of increased safety or flameproof, and it must comply the specific regulations of REBT ITCBT-29 concerning particular requirements for installations in spaces with fire and explosion risk.

Among the different equipment which has electrical connection, it is advisable to have specific lines for high consumption devices.

#### 3.1.1. Control of the risks derived from the use of electrical equipment and installations

- Do not permanently use extension cords and multi connectors (multi-socket adapters).
- Major repairs or alterations in the electrical system cannot be done without authorization and supervision of the maintenance service.
- Extension cables will not be used permanently in areas with a lot of movement.
- Keep electrical outlets and sockets of the electronic devices in good conditions, as well as the corresponding connection cables.
- In case of fuse damage of a device, replace it by another one with exactly the same characteristics.

- Never eliminate the earth connection of the sockets that have it. In case it is necessary, use adaptors, check that the devices connected to them do not exceed the maximum power established for the outlet.
- Each device must have a good earth connection, which must be checked regularly.
- The inspections, revisions and reparations of the electrical devices must be made by qualified staff from the firm or the suppliers. The people in charge of the devices can only carry out revisions or minor adjustments. An attendant must be present during them. Before the revision, the electrical device must be unplugged from the electrical system.
- Install the electrical devices, especially those with high voltage, in dry spaces, protected from water and reagent splashes.
- As far as possible, keep the electrical devices which are not in use switched off and unplugged, especially the heating blankets and grates, ovens and baths, stoves and similar items.
- Do not manipulate connections and electrical devices with wet hands.

### 3.2. Pressurized gas installation

Cylinders with pressurized gas (compressed gas, liquefied gas and gases that get dissolved) must be handled with extreme care, regardless the size.

In addition to the serious risks if one of these tanks breaks (fire, explosion, intoxication), the sudden pressure decrease due to the release of the content outwards can turn the cylinder into a projectile. The improper use of the bigger cylinders can even produce foot bone fractures and muscle and back injuries.

These cylinders, regardless their size, must be clearly identified. They have different colours according to the type of gas they contain. Furthermore, the cylinder shoulder will be of a different colour depending on the gas.

#### 3.2.1. Colour of the cylinder depending on the type of gas

Gas cylinders must fulfil the colour codification system indicated in ITC EP-6 in order to identify their content and also to distinguish between the bottles of industrial use or medical use. Note: bottles with liquefied petroleum gas and fire extinguishers follow in this aspect a different regulation.

Containers are identified with the letter «N», marked twice on opposite ends on the bottle shoulder and with a different colour from the shoulder's colour. Cryogenic bottles must be of light colours (white, silver, etc.) and they will identify the gas that is inside, marking its name on the bottle body with a minimum type size of 5cm, on two different places, if the space allows it.

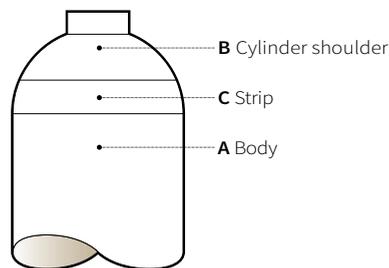


Figure 1

Colour coding according to ITC EP-6 (UNE-EN 1089:3):

COLOUR CODING: SITUATED ON THE CYLINDER SHOULDER		
Group		Colour (fig. 1 part B)
Flammable		Red
Oxidants		Light blue
Inert		Bright green*
Toxic		Yellow
Corrosive		Yellow
Acetylene		Brown
Oxygen		White
Nitrous oxide		Blue
Argon		Dark green
Nitrogen		Black
CO <sub>2</sub>		Grey
Helium		Brown

\* The bright green colour cannot be used for air of medical use or for respiratory application  
 Note: Colours for the gas mixtures that are used for medical use and breathing air are not indicated.  
 In the mixtures with two risk properties, the shoulder has to be painted according to the primary risk factor. The secondary risk factor colour can also be applied on the cylinder shoulder.  
 For example: toxic (and/or corrosive) and flammable YELLOW + RED

### 3.2.2. Recommendations

- Consult and know the physicochemical and toxicological properties of these gases before using them (information given in the label):

Flammable gas (H<sub>2</sub>, ethylene, methane, LPG (liquefied petroleum gases), CO and others)

Toxic gas (NH<sub>3</sub>, CO, NO<sub>2</sub> and others)

Corrosive gas (Cl<sub>2</sub>, HCl and others)

Oxidant gas (O<sub>2</sub>, N<sub>2</sub>O<sub>2</sub>, air and others)

Auto-flammable gas (diborane, trimethylamine and others)

Cryogenic gas (liquid O<sub>2</sub>, liquid N<sub>2</sub> and others)

Inert gas (Ar, He, N<sub>2</sub> and others)

- These cylinders, no matter what size they are, must be clearly identified.
- Do not use the cylinder if there is any doubt about its content. If so, label it on a visible part with «UNKNOWN CONTENT» and remove it from the laboratory. If it is a small container (calibration gas) the information allows us to be cautious of not leaving it in any place.
- Stand in ventilated, dry and clean places, far from heating sources, flames and sparks.

- Flammable gases must be stored in different places or they must be separated by a brick wall.
- Do not smoke nor light fire nor use mobile phones that are switched on, where flammable gases are stored.
- They must be placed in vertical position and be fastened to a wall or a solid surface. The sign with the gas name and the specific risks it has must be placed on each cylinder. They must not occupy the same place as reagents, fats, oil or other materials.
- There must be dry powder fire extinguishers near the storage.
- Transport (regardless the distance) safely, in vertical position, eliminating the possibility of falling, rolling or being struck. They must not be rolled or dragged. For ground-level transport, use carts that are specially designed for that purpose. During the transport, the cylinders must carry the valve protective cap. The breakage of the regulator is as dangerous as the breakage of the main valve, if they happen to fall.
- Cylinders with pressurized gas which require some equipment, as it is the case of chromatographs and spectrometers of atomic absorption, must not be kept inside laboratories. They have to be installed in a separate room, with flat floor and with the storage characteristics mentioned before. The safest way is to install them in an independent shed.
- Do not improvise reparations or accessories on the main cylinder valve, nor on the regulator or on their connections (for example, do not use regulators for flammable gases with oxygen cylinders). Do only use elements that are recommended by the supplier following his technical indications. Do not lubricate the valves.
- Never use cylinders without a suitable regulator.
- Close the main valve of the cylinders when they are not in use and relieve the regulators' pressure.
- Do not completely exhaust the content of the cylinders which are returned to the suppliers for new filling. Put the sign «EMPTY CYLINDER» on empty cylinders or on cylinders with a minimum pressure on a visible place and store them separately.
- Cylinders with toxic gases must be of such a size, that it allows them to be placed inside an fume cupboard during the use.
- Acetylene is a very hazardous substance due to its flammability, instability and the possibility of hazardous reactions. Working with these bottles requires extreme caution.



## 4. SAFETY OF LABORATORY DEVICES

In the laboratory, devices of different kinds are used (centrifuges, baths, ovens, analytical equipment... ). The article 17 of the Act 31/1995 of 8<sup>th</sup> November, concerning the prevention of occupational risks (Ley 31/1997, de 8 de noviembre, de prevención de Riesgos Laborales), states textually «El empresario adoptará las medidas necesarias con el fin de que los equipos de trabajo sean adecuados para el trabajo que deba realizarse y convenientemente adaptados para tal efecto, de forma que garanticen la seguridad y la salud de los trabajadores al utilizarlos» (The employer shall adopt the necessary measures in order to adapt the work equipments to the work which must be carried out so that they guarantee the safety and health of workers on using them).

The Act on Prevention of Occupational Risks (Ley de prevención de Riesgos Laborales) also affects the duties of manufacturers, importers and suppliers, and it particularly refers to machinery, equipment, products, working tools and protective elements of workers, being obliged to fulfil the general and specific current regulation, and by any applicable technical regulation in each case.

The responsibilities regarding the machines that are in a enterprise (in this case in the laboratory) are the following:

### a) Work equipment or safety components that are bought:

- Check the existence of the CE marking.
- File the declaration of conformity that according to the rules accompanies the equipment and the safety components.
- Use the instruction manual (which must be in the official language of the Member State(s) where the substance or mixture is placed on the market).

### b) Machines or safety components that already exist:

#### Bought after 1/1/95:

- Check the existence of the CE marking on the machine.
- File the declaration of conformity that according to the rules accompanies the equipment and the safety components.

- Use the instruction manual.

**Bought before 1/1/95:**

- Adapt the machine to the indications of RD 1215/1997 in the single transitional provision and its annex I. That is to say, the setting in conformity with the applicable laws. It must be accompanied by a document in which this conformity should be documented (for the administration or for the judge).

**4.1. Main risks of various laboratory devices and preventive measures to be taken**

**4.1.1. Devices with flame**

The work with open flame generates fire and explosion risks due to the presence of oxidising or combustible gases, or flammable products in the area near to where they are used.

For the prevention of those risks, these actions are appropriate:

- Suppress the flame or the flammable substance, isolating them, or ensure a proper ventilation to avoid ever reaching the inferior limit of flammability.
- Heat flammable liquids by means of systems that work within a temperature inferior to that of auto ignition (for example water bath).
- Use equipment with safety device which permits to interrupt the gas supply in the event of any anomaly.
- Proper maintenance of the gas installation.
- Pay special attention when filling the burners with alcohol.

**4.1.2. Refrigerators**

Although it is not advisable, household refrigerators can only be used for keeping inert products. Increased safety refrigerators must be used when substances that may present danger of ignition or explosion are kept inside of them.

Flameproof refrigerators must be used when they are situated in an area with flammable atmosphere.

For the prevention of these risks:

- Use increased safety refrigerators that do not have interior electric installation and, preferably, the specially prepared refrigerators for keeping flammable products that are approved.
- Do not keep open containers or containers that are not well sealed.
- Use containers that are able to resist internal overpressure in case of overheating accidentally.
- Control the internal temperature of the fridge permanently.



### 4.1.3. Hot baths and other heating devices

Working risks with these devices:

- Thermal burns.
- Breakage of glass containers with vapour release, overturning, spillage, smoke emission in the oil baths.
- Heat and humidity generation in water baths.
- Indirect electrical contact due to the ageing of materials.



Actions to prevent risks:

- Never fill the bath to the brim.
- Ensure the stability with the help of brackets/holders.
- Do not put common glass containers inside the bath (use Pyrex type).
- Safety thermostat to limit the temperature must be available.
- Use thermal insulation.
- If used regularly, local exhaust must be available.
- Preventive maintenance (revisions, more frequent in the case of devices with wider use and devices of older age).
- Special attention to electrical connections.

### 4.1.4. Refrigerants

Refrigerants work with running water circulation through connections of flexible tubes, although in some cases a closed circuit is used with cooling of the water in a refrigerated bath.

The most frequent risks are:

- Internal breakage with entry of water into the reaction, producing fire, explosion or emission of toxic products.
- Steam leakage due to water supply cut.
- Flood in case of disconnection.

Prevention of these risks:

- Make sure that the tubes are properly fastened.
- Dispose of a safety system that interrupts the heat supply in case of water supply cut.
- Periodic renewal of the tubes.

#### 4.1.5. Laboratory ovens

The risks of these devices are:

- Explosion.
- Fire.
- Intoxication if vapours are released.
- Overheating due to thermostat failure.
- Indirect electrical contact.



The risk control in the use of these devices is based on:

- Using ovens with safety systems of temperature control (for example double thermostat).
- Disposing of an extraction system if they are used to evaporate volatile liquids.
- If the released vapours are flammable, use increased safety ovens or ovens with flameproof installation.
- Proper maintenance. Check the correct state of ground connections and that there are no leakage currents due to the ageing of the material.

#### 4.1.6. Autoclaves

The risks of the devices are:

- Explosion.
- Burns.
- Projections.

Precautions in the use of autoclaves:

The following rules may minimise the risks derived from handling pressure containers:

- 1) Handling and common maintenance must be responsibility of instructed people.
- 2) A preventive maintenance programme must be carried out regularly. It will include the inspection of the enclosure, the sealing of the doors and all gauges and controls (by qualified personnel).
- 3) The water vapour will be saturated and free of chemical substances (as for example, corrosion inhibitors) that could contaminate objects that are being sterilized.
- 4) All materials must be placed in containers that allow an easy evacuation of air and an optimal heat penetration, the enclosure will not be overloaded, so that the vapour can equally reach the whole charge.
- 5) The autoclave will dispose of a safety system that guarantees the total depressurization of the equipment before opening it. Never open them if the manometer is not marking zero.



- 6) When liquids are inserted into the autoclave, the evacuation must be slow, because they may boil due to overheating when they are taken out.
- 7) Workers must wear gloves and suitable protective visors when they open the autoclave, even when the temperature falls below 80°C.
- 8) The filter of the drainage grid of the enclosure (if there is one) must be removed and cleaned every day.
- 9) Make sure that release valves of pressure cooker type autoclaves do not get blocked by paper or another material from the charge.

#### Risk control:

- There must be the corresponding installation plaque that specifically states: maximum working pressure, registration number and testing date.
- They must be validated with suitable methods before being used. They must be certified again regularly, according to the manufacturer's instructions.
- Autoclaves must have manometer and thermostat, as well as a safety valve, a quick disconnection system and the vapour purge will be made to a leak-proof container and with water, never directly to the exterior.
- If they work at very high pressures, they must be situated in spaces prepared for explosion risk.
- The pressure increase must be progressive, as well as the decompression.

#### 4.1.7. Centrifuges

The biggest risks derive, above all, from the pollution from aerosols that are generated during the centrifugation of biological materials, and to a lesser extent, from accidental traumatism.

It is recommended that:

- When biological material, that is potentially infectious, is centrifuged, closed tubes must be used; the centrifuge must have rotors or safety baskets that protect the worker from possible aerosols.
- In case of the breakage of a tube inside the centrifuge, 30 minutes must be waited after stopping, to the complete deposition of the generated aerosols.
- The accidental breakage of a tube and its spillage into the cuvette represents an important incident which immediately has to be communicated to the person in charge of the laboratory safety, so that the safe disinfection/cleaning of the device can be started.
- Do not use old centrifuges which do not have safety lock system, but which all current devices have, do not manipulate centrifuges which can be opened while they are working or before the rotor has completely stopped.
- Never stop a centrifuge manually.
- The centrifuge tubes and the sample containers used for the centrifuge must be made of thick or preferably of plastic, and they must be checked to detect defects before using them.



- Baskets and brackets must be matched by weight and correctly balanced with the tubes in their place.
- When angled head rotors are used, ensure that the tube is not excessively loaded, because there may be liquid leaks.
- The interior of the centrifuge cuvette will be checked every day, in order to observe if there are stains or dirt in the rotor. If there are stains or dirt, the centrifugation protocols must be examined again.

#### **4.1.8. Analytical instruments**

##### **4.1.8.1. Gas chromatograph**

It usually works at high temperatures, sometimes cyclically, and it may produce pollution of the atmosphere when working with non-destructive detectors.

##### **Risks:**

- Thermal discomfort due to the heat released by the device.
- Thermal burns due to contact with the detector, the column or the injector.
- Pollution of the atmosphere.
- Pricks due to the use of syringes.
- Flammable gas leaks (especially H<sub>2</sub>).
- Indirect electrical contact (especially with old devices).

##### **Risk control**

- Appropriate ventilation to dissipate the heat produced by devices.
- Use heat-resistant gloves to handle hot zones.
- Connect the outlet of the flow divider of the capillaries injector and of the non-destructive detectors to the exterior.
- Appropriate preventive maintenance.

Most of these instructions are also applied to mass spectrometers, whether gas chromatographs are used as a preliminary or not.

##### **4.1.8.2. High-performance liquid chromatographs (HPLC)**

##### **Risks**

- Spills and thermal contact in the preparation of the eluent.
- Environmental pollution if the eluents are volatile.

##### **Risk control**

- Handle eluents properly, using gloves if there is thermal contact in transfer operations.
- Use resistant glass material especially in vacuum operations.
- Hinder access of the eluent to the atmosphere by means of rubber and paraffin stoppers at the inflows and outflows of the eluent.

### 4.1.8.3. Atomic absorption spectrophotometer

#### Risks

- Chemical burns when handling acids used in the pre-treatment of the sample (digestion).
- Release of irritating and corrosive vapours.
- Thermal burns with the flame, graphite furnace or any hot zone.
- Gas leakage: acetylene and others.
- Possible formation of hydrogen when the hydrides generation system is used.
- UV radiations.

#### Risk control

- Carry out the acid digestions in fume cupboard.
- Use gloves, glasses and proper personal protective equipment.
- Extraction system over the flame or graphite furnace.
- Good general ventilation when working with a hydrides generator.
- Appropriate precautions when working with acetylene.
- Do not directly look at the flame or emission sources (lamps).

### 4.1.8.4. UV- visible and infrared spectrophotometer, fluorimeter, scales, pH-meter, polarographs and other devices of electro-analysis, auto-analysers, microscopes, stirrers, etc.

#### Procedures to reduce the risk.

- Appropriate installation.
- Effective preventive maintenance.
- Operating instructions and standard working procedures with the appropriate safety instructions that will consider the specificity of each technique. For example: in the case of electrophoresis at high voltage special care must be taken to the electrical risk, in the thin layer chromatography to the risk of cuttings with the edges of the plates, to the risk of strokes on devices with moving parts (be especially careful with the robotization of the clinical analyses laboratories), to the contact with reagents (chemical risk) used in the auto-analysers and with samples (biological risk), etc.





## 5. SAFETY CONSIDERATIONS RELATED TO SOME COMMON OPERATIONS IN LABORATORIES

### 5.1. Transfer of liquids

The transfer of liquids is an operation that must be avoided. When necessary it should be done by free spillage, with siphon or with the help of a pump.

- The fundamental risk is the liquid spillage and intoxication by vapours.

#### Preventive measures:

- Use a pump or siphon for transfers of large amounts.
- Use the necessary PPE (eye protection or face protection when irritating or corrosive products are transferred, protective gloves when acids and bases are transferred, checking that they are suitable for the liquid that is transferred, respiratory protection with an appropriate filter when they are toxic when inhaled...).
- Eliminate sources of heat, flames and sparks near the place where transfers of flammable liquids are carried out. If the quantity of the product to be transferred is important, the operation must be done in a specific place specially prepared for it and with enough ventilation.
- When flammable liquids are transferred by gravity, use funnels, whose neck reaches at least to 1 cm from the bottom of the container that is going to be filled.
- Cover the bottles again once used.
- There must be containing trays underneath the possible spillage points in all transfer operations.

When the transfer operation is done with a siphon or by means of pumping, there may be the risk of an explosion due to excess pressure; the pump can be equipped with safety devices to avoid it. The adequacy of the pump for the product to be transferred must also be checked: compatibility of materials, corrosion, pollution, explosion risk, etc. When large quantities of non-conductive liquids are transferred, the problem of static electricity must always be taken into account.

ALWAYS LABEL THE TRANSFERRED PRODUCT. It must be remembered that the label must clearly show the chemical names of the hazardous components; they will carry pictograms, signal word, hazard statement and precautionary statements (H and P statements) that correspond to the substance or preparation.

Check NTP 768: «*Trasvase de agentes químicos: medidas básicas de seguridad*» (Transfer of chemical agents: basic safety measures) on the following link: <http://goo.gl/M95KB2>

## **5.2. Vacuum operations**

They include evaporation, distillation, filtration and drying (in desiccators).

The most important risk is the implosion of the device and the projection of material, and the risk of aspiration of a liquid and the unexpected mixture of products that react violently.

### **Risk control:**

- Use special glass containers able to endure vacuum (thick-walled or spherical shapes) and install the device in a place with no risk of undergoing a mechanical shock.
- Cover the container under pressure with an adhesive tape or a metallic net.
- The step from vacuum to atmospheric pressure must be done gradually and slowly.
- Take into account that when a water pump is used for the vacuum, and the supply valve is closed slowly, there may be a return of water to the container where the vacuum is made. If this container has got a product capable of reacting with water, the reaction can be violent. To avoid it, first close the valve which must be placed between the device to vacuum and the water pump. It is also useful to put a safety container between them.

### **5.2.1. Vacuum filtration**

The flasks for the vacuum filtration must be of high quality glass, they must be in good conditions and they must be set solidly avoiding tensions. If the filtration is defective due to the characteristics of the manipulated products, it has to be taken into consideration that an increase of vacuum will not improve the efficiency or the filtration time, but instead the risk of implosion.

### **5.2.2. Vacuum drying**

Desiccators must be set in places that are little exposed to strokes or falling, out of reach of the sunlight, especially when they contain unstable products. If they are vacuum products they must never be transported. When a vacuum desiccator is used, it must be protected by means of metallic nets or it must be made of a material with proven resistance. The contact edges and the keys must be correctly lubricated. Between the desiccator and the vacuum pump there must be a flask or safety bubbler in order to avoid possible water returns, because if there were products that are capable of reacting with it, they could react violently.

### 5.2.3. Extraction with volatile solvents

#### Hot extraction

The hot extraction of liquid-solid or liquid-liquid is a quite routine operation in chemistry laboratories. The most frequent is the extraction with the Soxhlet system. Two flammable volatile liquids are used for it, therefore any excess pressure in the assembly or steam leakage may cause a fire. Take into account that every time such substances are manipulated there is risk of fire and explosion.

The systems to control these risks are:

- Heat the extraction system using a water bath or oil bath at enough temperature, but not higher to ensure the boiling of the solvent.
- Carry out the operation in a fume cupboard.
- Dispose of an action system (suitable hand-operated fire extinguisher, fire blanket, etc.) next to the operation place.
- When it is a long-term extraction it is advisable to have a control system of cooling water, against possible cuts.

#### Liquid-liquid extraction

In most of the processes of liquid-liquid extraction at room temperature, one of the phases is a volatile organic compound, usually a flammable solvent. Therefore general advice must be applied when these already mentioned types of compounds are used.

If a separating funnel with manual stirring is used, there is also the problem of direct contact with the products and the possibility of liquid splashes and inhalation of high concentrations of vapours when the pressure of the funnel is relieved (pressure that is generated by the vaporization during the stirring) through the stopcock valve. In this operation it is recommended to use waterproof gloves, protective clothing and, if the substances of the process have features of high risk, carry out the operation in the fume cupboard, although it is uncomfortable.

#### Solid-liquid extraction

The solid-liquid extraction is increasingly being used. The procedure, due to its characteristics (small amount of sample and, consequently, products to be handled, possibility of automation, etc.) presents few problems.

The most typical risks are those derived from the use of pressure and vacuum in semi-automated systems and the improper use in case of blockage of the cartridge or of the extraction disc.

### 5.3. Mixture or addition of a chemical product

There may be an unexpected reaction followed by a dangerous phenomenon (explosion, projection).

To control this risk it is recommended to dispose of an action and information protocol about the identity and risk of the products that are used. On the other hand, when a reagent is added, the addition speed must be proportional to the produced reaction. It must be especially slow if the reaction is exothermic, causes foam; a fast polymerization happens or might happen, etc.

In general terms, all exothermic reactions are classified as dangerous, because they may be uncontrollable under certain conditions and cause spillage, sudden emission of harmful or flammable vapours or gases,

or cause the explosion of a container. To control these risks when working at a temperature which the substances immediately react to, it is advisable to control the reaction by adding the reagents in small quantities.

Other types of reactions that are considered to be hazardous are the following:

- Compounds that react violently with water.
- Compounds that react violently with air or oxygen (spontaneous ignition).
- Incompatible substances of high affinity.
- Hazardous reactions of acids.
- Formation of peroxides and easily peroxidable substances.
- Reactions of polymerization.
- Reactions of decomposition.

You can consult NTP 479: «*Prevención del riesgo en el laboratorio químico: reactividad de los productos químicos (II)*» (Risk prevention in the chemical laboratory: Reactivity of chemicals (II)), to get detailed information about the substances that may cause hazardous reactions, on the following link: <http://goo.gl/AqvrKO>



## 6. SAFETY EQUIPMENT

### 6.1. Protection elements

#### 6.1.1. Collective protection elements

##### 6.1.1.1. Fume cupboards

In the laboratory there may be different localized extraction devices: fume cupboards, hoods to dissipate the heat of the instruments and eliminate fumes and released vapours. Fume cupboards are distinguished from other extraction devices because they have an enclosure.

Apart from protecting the worker from inhalations, splashing and projections of contaminants, having a fume cupboard may, in some cases, collaborate in the control of the atmosphere of the laboratory, because:

- It allows having a delimited area without ignition sources and with an appropriate design, protected from fire and small explosions.
- It allows, if the supply air is filtered, the entry of clean air in those tasks that require it.
- It facilitates the air exchange of the laboratory.
- It can create a depression in the laboratory, avoiding the exit of contaminants to nearby areas.

When a new fume cupboard is received there are two aspects to be considered:

- The fume cupboard must be suitable for the products which are going to be handled and for the operations that are going to be carried out.
- Its location in the laboratory must be suitable in order to ensure its effectiveness.

Note: Horizontal and vertical airflow cabins («clean air workbenches») are not designed to protect the worker, but to avoid pollution by the product. Biosafety fume cupboards, which are not dealt with in this manual, may offer protection from microorganisms and from volatile chemical compounds; this will be specified in their technical data.

Consult NTP 646: «*Seguridad en el laboratorio: selección y ubicación de vitrinas*» (Laboratory safety: fume cupboard selection and installation) on the following link: <http://goo.gl/uIgyB6> to get more information about the selection and the installation of laboratory fume cupboards.

## Advice on using fume cupboards

- Do not use the fume cupboard as a storage unit.
- Put inside only the needed material to carry out the work to be done and avoid all unnecessary material that hinders the proper functioning of the fume cupboard, as well as unnecessary arm movements.
- Locate the operations which cause pollution at a distance of not less than 15 or 20 cm from the opening level of the fume cupboard.
- Avoid generating contaminants at high speeds.
- Locate the generation zone of pollutants as low as possible in order to enable the exit of contaminants through the lower opening of the rear deflector.
- Avoid the obstruction of the air flow to the rear deflector.
- Use the minimum quantities needed of the product.
- Limit the heat sources to the least needed, because they may disrupt the aspiration of the air from the fume cupboard.
- Reduce its opening to the minimum space compatible with the work that is going to be carried out and it must always be below the maximum operational height. Do not insert the head in the inner enclosure of the fume cupboard.
- Do not operate in the fume cupboard with vertical and horizontal windows, if they are open at the same time.
- Make slow movements in order to avoid turbulence.
- Use suitable protective clothing and equipment (glasses, white coat, gloves).
- If an anomaly is detected in the aspiration, close the guillotine and inform the person in charge of it (laboratory manager, person in charge of maintenance, etc.). Do not use the cupboard and mark it properly as out of use or out of order.



## After using it:

- Keep the fume cupboard clean and tidy.
- Close the guillotine and let it working until the generated pollution has been eliminated.
- Work must be done at least, at 15 cm from the hood frame.

## It must be taken into account that:

- Fume cupboards aspirate and extract the air conditioning from the laboratory, causing considerable energy consumption.
- They do not ensure the protection of the worker against microorganisms and contaminants that are in the laboratory.

## **Maintenance of the fume cupboards**

- The fume cupboard must have a preventive maintenance programme in order to extend equipment life and to keep the worker safe.
- Advice of manufacturer or supplier must be followed and the whole system, from the entry of the fume cupboard to the outlet conduct, must undergo regular inspections, it must be registered and the last revision must be written down.
- In fume cupboards equipped with filters, it is very important to check if they are suitable for the chemical products which are used and it is important to carry out a revision of the saturation point with the frequency required according to the use and their features.

### **Operations that should be carried out every week:**

- Control of the functioning of the flow rate indicator and its alarm.
- Cleaning revision of the interior of the fume cupboard.

### **Operations that should be carried out every six months:**

- Cleaning of the rear deflector.
- General cleaning of the interior of the deflector enclosure with a dilute solution of detergent.
- Check the functioning mechanisms of the guillotine.

### **Operations to be carried out once a year:**

- Visualization of the air streams.
- Control of aspiration (measure of the air speed at the level of the guillotine or the extraction flow rate)
- Detailed inspection of the manoeuvre mechanisms of the guillotine.
- Visual inspection of the extraction duct and its accessories; revision of the aspiration equipment.
- Control of the noise level.
- Lighting level.
- Revision of the conditions of the fluids installations associated to the fume cupboard.

### **Operations to be carried out from time to time:**

- If an anomaly is detected in the aspiration devices, they must be revised.
- If the user considers it appropriate, the behaviour of the fume cupboard may be explored further, analysing its containment and other parameters that are considered important in situ.

Consult more information in NTP 677: «*Seguridad en el laboratorio. Vitrinas de gases de laboratorio: utilización y mantenimiento*» (Laboratory safety. Laboratory fume cupboards: use and maintenance) on the following link: <http://goo.gl/n4TQJv> and NTP 672: «*Extracción localizada en el laboratorio*» (Local exhaust in the laboratory). <http://goo.gl/EYJMiK>

### **6.1.1.2. Local exhaust hoods**

Uses of these devices are:

- They provide the air renewal.
- They eliminate undesirable products from the room atmosphere.

In many cases it is advisable to set up small hoods instead of using fume cupboards. For example, in physicochemical tests which may imply release of fumes, it is better to install some of the mentioned elements than to house devices inside a cupboard disabling it for other uses, apart from the construction cost, which is much higher if cupboards are used.

Hot fumes and gases that come from hot oil and water baths, heating plates, muffles, ovens, gas chromatographs and atomic absorption devices, could be removed by means of a small hood located over them. The fact that the evacuation is natural or forced depends on the features of the generated pollution, of its situation and the situation of the laboratory itself.

The systems of direct application of the located extraction must be installed next to the emission points of pollutants, because with an appropriate capture speed, efficient removals of those are achieved. This is the case of movable hoods connected to an extraction net to carry out located aspirations in operations in which small installations are implied.

Theoretically the needed capture speed depends on the production speed of the contaminant, on its risk, on its temperature, on its density, and on the existence or not of air streams that interfere:

- In general terms, the efficient removal of gases or vapours demands capture speeds of about 0,6-0,7 m/s in its generating zone.
- If it is dust, speeds between 1,5 m/s and 2 m/s are recommended, depending on the characteristics of the dust and how it is generated.
- In special cases, as for example the production of fumes from a hot source and without interference of air streams, a speed around 0,3 m/s is enough.
- If plenty of fumes are produced and they are remarkably dangerous, then even captures of 1 m/s may be required at the generating point.

There is also an essential requirement for the installation of these systems: There cannot be any manipulations between the collector (opening, hood, etc.) and the emission point, nor exist turbulences caused by other devices (for example, air conditioning devices), and of course there cannot be the breathing zone of the worker. This is the inconvenience of doing the capture in an open atmosphere compared with the advantages of carrying it out in an enclosed area, as fume cupboards. The advantages of systems of direct application are the low cost and the efficient removal of contaminants moving relatively low airflows at a higher speed.

### **6.1.2. Personal protective equipment (PPE) and protective clothing**

Protective equipment and clothing that you use in the laboratory is fundamental to protect you from absorption, inhalation or physical contact with hazardous substances. Remember that the clothes that you use in the laboratory protect your clothes against pollution. Each worker is responsible for wearing PPE and appropriate protective clothing when necessary due to the safety.

All PPE must have CE-marking and it must without fail be accompanied by an informative booklet (in the official language). It will clearly indicate all risks against which this PPE protects and the protection level,

the storage conditions, cleaning, needed replacements, as well as an explanation of the marks the product has (if it is the case), among other information.

No other PPE must be acquired which does not fulfil the former requirements: CE marking and informative booklet.

The laboratory manager must photocopy the booklet and hand it with each protection unit that is supplied to the workers.

The clothing as well as the PPE must be kept in good hygienic conditions, cleaning and/or decontaminating them regularly and when it is considered to be necessary. Laboratory coats which are not polluted can be washed by a laundry service, but if there is the suspicion of pollution, a proper method of decontamination must be established.

Laboratory coats will never be taken home for washing.

This section contains the personal protective equipment to be used when it is not clear if the collective protective means offer maximum safety.

### **6.1.2.1. Eye protection**

The eye protection in the laboratory will generally fulfil a threefold function:

#### **a) Avoid eye contact with chemical agents in liquid, solid or gaseous state.**

This contact may be produced:

- By splashing or projections of liquid or solid particles (dust).
- By gas leakages.
- Because there are high concentrations of solid or liquid aerosols or gases or vapours in the working atmosphere; it will usually correspond to the need of using individual breathing protection devices.

Liquid projections may cause severe eye burns and aerosols may originate irritations and conjunctivitis. Some chemical substances may originate inflammation of the optic nerve and some chemical products may cause allergies that appear as conjunctivitis. Furthermore, as the eyes are highly vascularized organs, they can easily absorb many chemical products, being an entry for those contaminants.

#### **b) Avoid the production of mechanical injuries.**

In the laboratory mechanical injuries may be produced (frequently derived from the breakage of glass material for example). Its seriousness may vary from a simple irritation caused by the entry of dust for example, to the total loss of vision caused by the impact of flying objects with speed or large mass.

#### **c) Avoid exposures to radiations (only non-ionising radiations are taken into account).**

#### **d) The effects of the different types of radiations depend on the emitted wavelength and on the energy they transport.**

Some types of radiations do not cause effects when the exposure is short, but they may cause effects when the exposures are repeated along the years (cumulative effects). Exposures to high intensity (solar radiation or laser radiation for example) cause burns on the cornea and retina and injuries on the lens of the eye. The effects produced by the ultraviolet radiation are not immediate, a period of time passes before they appear.

It is very important to always wear suitable eye protection in the laboratory. As a general rule, safety glasses must always be worn in the laboratory. Anyway, its use is obligatory when operations are carried out that imply a greater risk as handling glass material with pressure, using irritating corrosive substances, flammable materials, volatile compounds, sources of infrared or ultraviolet light, lasers, transfer operations or mixing of chemical products, operations of sanding or grinding.

### Useful information which appears on the label of hazardous chemical products:

The label of a chemical product gives us the initial data to know the possible risks we are facing when using it. The label must contain H statements (hazard statement), EUH statements (supplementary statements) and P statements (precautionary statements), among other information.

The following chart shows phrases H, EUH and P statements, which, by appearing on the label, will warn us of the need of using eye protection due to the hazardous features of the product.

H STATEMENTS	MEANING
H318	Causes serious eye damage
H319	Causes serious eye irritation
H314	Causes severe skin burns and eye damage

EUH STATEMENTS (supplementary statements)	MEANING
EUH 070	Toxic by eye contact
EUH 202	Cyanoacrylate. Danger. Bonds skin and eyes in seconds. Keep out of the reach of children.

P STATEMENTS	MEANING
P262	Do not get in eyes, on skin or on clothing
P280	Wear protective gloves / protective clothing / eye protection / face protection
P305	IF IN EYES:
P337	If eye irritation persists:
P338	Remove contact lenses, if present and easy to do. Continue rinsing.
P337+P313	If eye irritation persists: get medical advice / attention.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Note: On the product label, H, EUH and P statements must appear in the official language of the Member State(s) where the substance or mixture is placed on the market

### Characteristics of eye protection

The type of eye protection must be selected according to the expected exposure (of chemical products, radiations, mechanical impact...). A suitable frame and glasses have to be chosen according to the activity or activities which are going to be carried out in the laboratory. It might be necessary to have eye protectors with different features, depending on the task that has to be done. The technician of the preventive service of the enterprise must advise in this selection.

**In any case it must be considered that:**

- The pieces must have «CE» marking and certification
- Consult the informative booklet in which the manufacturer indicates the features (types, protection index and substances that are concerned), as well as the storage requirements, cleaning, sizing, etc.
- The replacement must be planned when time requires it.

Safety glasses **are for personal use**. Each worker is responsible for keeping them in good conditions and decontaminating or cleaning them at appropriate intervals.

A face mask must be used when the whole face has to be protected from projections of liquid or solid material (for example, operations with glass under pressure). Its use will also be necessary as a protection against strong mechanical impacts.

People who use prescription glasses can also wear eye protective glasses over the former ones without disturbing the fitting.

People who use contact lenses in the laboratory must be aware of the possible dangers they imply:

- It will almost be impossible to remove contact lenses from the eyes after the spillage of a chemical substance on the area around the eyes.
- Contact lenses will interfere with the procedures of emergency washing.
- Contact lenses can catch and collect fumes and solid materials in the eye.
- If chemical substances happen to enter and the person faints and is unconscious, the first aid staff will not know if the person is wearing contact lenses.
- Due to all these reasons, the use of contact lenses is not recommended.



**6.1.2.2. Skin protection: gloves**

In the laboratory it is usual to wear gloves for protection:

- From chemical substances that are corrosive, highly toxic or easily penetrate through the skin.
- From hot or cold elements.
- From possible cuts originated by glass objects when there is danger of breakage.

**Chemical protective gloves**

The skin itself is a good protection against exterior aggressions and it is necessary to keep an appropriate hygiene of the hands with water and soap and applying protective cream if necessary.



The following chart contains those H, EUH and P statements, which appear on the label of the product and will indicate the risk of dermal contact and will warn us about what measures have to be taken in its use.

H STATEMENTS	MEANING
H310	Fatal in contact with skin
H311	Toxic in contact with skin
H312	Harmful in contact with skin
H314	Causes severe skin burns and eye damage
H315	Causes skin irritation
H317	May cause an allergic skin reaction

EUH STATEMENTS (supplementary statements)	MEANING
EUH 066	Repeated exposure may cause skin dryness or cracking
EUH 202	Cyanoacrylate. Danger. Bond skin and eyes in seconds. Keep out of the reach of children

P STATEMENTS	MEANING
P262	Do not get in eyes, on skin or on clothing
P280	Wear protective gloves / protective clothing / eye protection / face protection
P302	IF ON SKIN:
P303	IF ON SKIN (or hair):

Note: On the product label, H, EUH and P statements must appear in the official language of the Member State(s) where the substance or mixture is placed on the market

The choice of a suitable type of glove is not only made due to the intrinsic hazard of the product. What has also to be taken into account is the risk assessment, which will depend on the quantity of the product, its concentration, duration of the contact... So, this choice concerns the technician of the preventive service.

Chemical protective gloves must always be impermeable although the resistance to permeation will always be limited in time and in addition it depends on the chemical substance with which it contacts. The measure of this relative resistance is expressed in minutes via parameter «passing time». According to this parameter the material is classified in 6 classes being 6 the best one. A glove will be considered of chemical protection when it gets at least class 2 with 3 chemical products from a list concerning the proper UNE-EN standard.

Chemical protective gloves must have the following pictogram:

Reference to the UNE standard about chemical protection it must fulfil

EN 374



A D F

Codes «A», «D», «F» designate the chemical compounds for which determined levels have been achieved in the permeation tests which the UNE standard considers.

When gloves only fulfil the conditions of water and air tightness, but do not fulfil the conditions of permeation resistance of the chemical products that have to be tried, they can have the following pictogram of **low chemical resistance**:

EN 374



When the following pictogram appears:



It will mean that the informative booklet has to be consulted to learn about all the features of the glove as well as the operating instructions, cares, etc.

Take into account that the use of non-impermeable gloves with a product when there is immersion or a significant direct contact will not offer protection but will increase the risk instead.

Listed below will be indicated other protective features regarding gloves which work in laboratory may require.

Consult NTP 748: «*Guantes de protección contra productos químicos*» (Protective gloves against chemical products), on this link: <http://goo.gl/RJz8Qg>

### **Mechanical strength gloves**

It is usually necessary that the glove which is being used has some mechanical strength too.

It will be indicated by the following pictogram:



a b c d

Letters a, b, c, d indicate the feature levels achieved in the tests of abrasion, cutting, tearing and perforation according to UNE EN 388 standard. They range from 1 to 4, being 4 the best, except in the resistance to cutting where the levels range from 1 to 5.

## Thermal resistance gloves

The resistance to heat and coldness will be indicated by the following pictograms:

### Resistance to coldness



a b c

- a. Resistance to convective coldness
- b. Resistance to contact of coldness
- c. Water tightness

The achieved feature levels for these three indexes must be indicated according to the UNE EN 511 standard

### Heat/Fire resistance



a b c d e f

- a. Burning behaviour
- b. Resistance to the contact of heat
- c. Resistance of convective heat
- d. Resistance to radiant heat
- e. Resistance to small splashes of molten metal
- f. Resistance to large masses of metal

It must indicate the achieved protection level for these six indexes according to the UNE EN 407 standard

## Protective gloves against biological agents or microorganisms



They must fulfil the requirements of the UNE-EN 374-2:2004 standard in order to get this pictogram

### Remember:

- Protective gloves are personal protective equipment and they must be certified as such and have CE-marking.
- They must have an informative booklet, which will contain among other information, the information about conditions of maintenance, use, cleaning/disinfection and storage, and the reference of the tests and the achieved results, as well as the expiration date. This booklet must be written in Spanish and it must be understandable. As far as the chemical protection is concerned, it must indicate against which chemical products it has been tested and the achieved results, as well as the reference to the non-chemical tests which have been carried out (as for example mechanical tests).

### 6.1.2.3. Respiratory protective equipment (RPE)

The respiratory protective equipment must only be used when it is impossible to avoid the presence of contaminants by means of collective protective elements.

In this section we are only going to consider those RPE depending on the environment, that is, those which take the air from the atmosphere around the user of the equipment. Whenever the working atmosphere contains less than 17 % (volume) of oxygen, or the concentration of contaminants makes it necessary, RPE that are independent from the environment must be used, these usually take the air from another area that is free from contaminants.

### Respirators (filtering devices)

They use the environment air and purify it, that is, they hold or transform all pollutants in it to make it breathable.

They present two clearly differentiated parts: the mask and the filter. The mask must create a hermetically sealed space around the airways, so that the only access to them is through the filter.

The **disposable half-mask respirator** is a special type of respirator that brings together in one inseparable body the facial adaptor and the filter.

**Types of masks (tight-fitting face-pieces):**

DISPOSABLE HALF-MASK RESPIRATOR		FACIAL ADAPTORS (they are used with different filters)	
For particles	For gases and vapours	Half mask	Full face mask
			

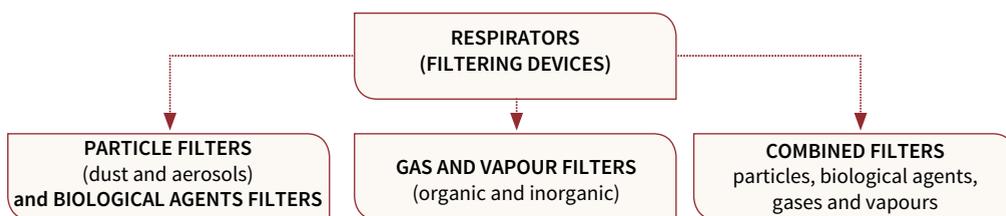
**It is important to highlight that:**

- Masks only exert their effect if they are used properly. Disposable face masks are sold in only one size, so it is important to choose them so that they adapt well to the contour of our face. There cannot be any voids. The beard may be an impediment to adjust it.
- Always choose the equipment which best fits to the personal features of the user.
- The compatibility of glasses and masks must be checked if they are used together.
- Before using them, read the manufacturer's informative booklet concerning the conservation, cleaning, expiration date, expiration date of filters and conditions of use.
- Manufacturer's instructions must be followed regarding the maximum time of use.
- Usually, you should not work with them for more than one continuous hour. When the equipment is light or light work is done with interruptions between the different tasks, they can be used for a longer period of time.
- There are specific situations when their use may be contraindicated (for example, workers with reduced respiratory effectiveness due to different reasons). The health surveillance service must indicate the aptitude of the worker to use a breather.

**Filter types:**

It is very important to choose the filter according to the type of contaminant. Filters which are suitable when the contaminant is in the working atmosphere in the shape of small particles (dust or aerosols) are not suitable for contaminants in the shape of gases or vapours, originated by the evaporation of solids and liquids. There are combined filters which suit for particles, gases and vapours.

The three big groups in which they are classified are shown in the following figure:



At the same time they are subdivided into the following types which are identified with the following codes and colours:

PARTICLE FILTERS	CODE		COLOUR
80 % of retention	P1/FFP1 <sup>(1)</sup>	○	White
94 % of retention	P2/FFP2	○	White
99,95 % of retention	P3/FFP3	○	White
GAS AND VAPOUR FILTERS AN COMBINED FILTERS <sup>(2)</sup>			
Gases and organic vapours; boiling point >65° C	A	●	Brown
Gases and organic vapours, boiling point <65° C	AX	●	Brown
Gases and inorganic vapours	B	●	Grey
SO <sub>2</sub> and other gases and acid vapours; depending on the specifications of the manufacturer	E	●	Yellow
NH <sub>3</sub> and organic derivatives of NH <sub>3</sub> , depending on the specifications of the manufacturer	K	●	Green
Gases and specific vapours	SX <sup>(3)</sup>	●	Violet
Nitrogen oxides	NO-P3	●	Blue
		○	White
Mercury	Hg-P3	●	Red
		○	White
(1) The <b>FFP</b> code is only used for disposable half mask respirators (2) Depending on its capacity (except for types <b>AX</b> , <b>SX</b> , <b>NO-P3</b> and <b>Hg-P3</b> ) they can be of: <b>Class 1:</b> low capacity filters <b>Class 2:</b> medium capacity filters <b>Class 3:</b> high capacity filters (3) The name of the chemical product and the maximum concentrations against which the filter offers protection must appear.			

The choice of a protector will require in any case, a wide knowledge of the working place and its environment. For this reason the choice must be taken by qualified personnel, being the participation and collaboration of the worker also crucial.

#### 6.1.2.4. Clothing in the laboratory

White coats and uniforms are mutually exclusive according to Article 2 of the Real Decreto 773/1997, regarding the definition of «personal protective equipment». Although they are not classified as PPE, its proper use in the laboratory is crucial to avoid pollution on the own clothes and the expansion of the pollution outwards.

As mentioned before, the white coat will always be used in the laboratory. It must be long, reach from one side to the other to protect the chest and abdomen, with long sleeves with tight-fitting cuffs and made of cotton. It is better if it is treated with fire retardants. It must be easy to take off.

It is recommended to wear shoes which completely cover and protect the feet. Sandals, clogs, high heel shoes or open shoes must not be worn in the laboratory. There are laboratory shoes which are closed and white and with non-slip sole.

In operations with risk of splashes (transfer of chemical products, operations with glass under pressure) it may be necessary to use aprons that are suitable for the products which are handled.



## 6.2. Action elements

### 6.2.1. Showers and eye wash stations

Safety showers constitute the most usual emergency system for cases of projections with risk of chemical burns and even the risk that clothes catch fire. Eye wash stations are designed to allow the fast and effective decontamination of eyes.

These systems should:

- Be located at less than 8-10 m from working places, in order to act in less than 15 seconds in a possible projection or splash on eyes.
- Be easily visible and accessible and be properly marked
- Be located far from plugs and electrical devices
- Be located in the direction of the usual exit of the laboratory and free from materials, devices and products
- Be checked once a week.

#### Characteristics of showers

- The shower must provide enough water flow to soak the subject completely and immediately. The supplied water must be drinking water, ensuring that it is not cold (preferably between 20 and 35 °C) to avoid the risk of cooling a burned person in shock and also to avoid the fact that the low level of acceptance of cold water causes an insufficient removal of the pollutant, when the shower time is shortened. Likewise, it is convenient to have a drain (it facilitates the maintenance a lot).
- The showerhead must have a diameter big enough to completely soak the subject (20 cm), with big holes that impede the obstruction due to the formation of calcareous deposits. The distance from the floor to the base of the showerhead must allow to place a person in standing position (for example, from 2 to 2,3 m). The separation from the wall to the showerhead should be enough to place, if needed, two people (for example, not less than



60 cm.). It is also advisable that the distance from the floor to the actuation mechanism should not surpass 2 m.

- The opening valve must be of quick activation, so conventional taps must not be used. You must be able to take the switch/activator with ease. Suitable models are those which have a triangular activator attached to the system by means of a fixed bar (better than with chain). Foot switches are not usually used due to the easiness of stepping on them inadvertently, setting the system unintentionally in operation and being at risk for tripping with them. An exception would be systems which are activated when stepping on a platform.
- Water stopcocks of the installation must be situated in a place that is not accessible for the staff, in order to avoid the permanent supply cut due to the existence of leaks or other problems, which moreover have to be communicated and repaired immediately. Thus, stopcocks will be exclusively closed at the moment of effectuating the repair.
- It is useful to have an acoustic or visual alarm system, which starts up when the equipment is used, and will so allow that the rest of the staff gets to know that there is a problem and they can go to help. Showers situated in the dressing rooms or restrooms can do the subsidiary function of safety showers, especially in laboratories of small surface and for small burns or splashes on clothes, since they are out of sight and allow the affected person to undress without any type of complex.

### Features of eye wash stations

- They are basically constituted by two diffusers or nozzles separated between 10 and 20 cm, capable of providing a safe water jet to wash the eyes or the face, a sink, from 25 to 35 cm, provided with the corresponding drain, a system of floor or wall fixation, and a foot (pedal) or elbow activator.
- The water jet given by the nozzles must be of low pressure to avoid causing unnecessary harm or pain. As mentioned in the case of showers, the water must be safe and it should be warm. With the water stopcocks of the installation the same precautions must be taken as with the safety showers.

### 6.2.2. Fire blankets

They are very efficient in case of small fires and especially when clothes catch fire (alternative to safety showers). In some cases they can avoid the movement of the burning subject.

In the market there are different storage mechanisms which allow its quick use.

An alternative to fire blankets is the use of pieces or textiles which have a low combustible level or are previously moistened.

They must be kept in places where flammable products are worked with.

### 6.2.3. Fire extinguishers

If, due to the situation, characteristics, persistence or extension, it is not possible to control small fires which are produced in the laboratory with fire blankets or soaked textiles, fire extinguishers must be used. Fire extinguishers are devices which contain an extinguishing agent or substance which can be projected on or directed to the fire by means of internal pressure.



Since there are different types of fire, which are classified depending on whether it has to do with solids, liquids, gases or metals, in each case the appropriate extinguishing agent has to be chosen: water spray or jet, powder, polyvalent powder, foam or CO<sub>2</sub>.



For its use in the laboratory, the experience shows that the most practical and universal fire extinguishers are those of CO<sub>2</sub>, because the presence of delicate electrical equipment and reactive chemical products, other extinguishing agents might cause irreparable aggressions to the devices or new fire sources. It must also be taken into account that the portable extinguisher, which must be easy to use and lightweight, can overturn, break or project the glass material which is on the working tables, generating also new fire sources, spillage or unexpected reactions. It is completely inadvisable to use fire extinguishers which are not suitable for the characteristics of the burning material, since they can stimulate the fire development. The use of portable fire extinguishers in laboratories must be considered carefully, especially if it has to do with localized fires which only affect reduced areas. In addition to this, the mentioned disadvantages must be added to the problems of the subsequent cleaning.

FIRE TYPES	EXTINGUISHING AGENTS					
	Hose BIE			Dry powder	Polyvalent powder	Dry ice CO2
	Water jet	Water spray	Foam			
<b>A</b> solids	Good	Good	Good	Acceptable	Good	Acceptable
<b>B</b> liquids	Not Acceptable	Acceptable	Good	Good	Good	Acceptable
<b>C</b> gases	Does not extinguish, it limits fire propagation			Acceptable	Acceptable	Acceptable
<b>D</b> metales	No*	No*	No*	No*	No*	No*

\* Requires special agents.

**The laboratory manager must designate a person in charge of the follow-up of the maintenance programme of action elements.**



## **7. EMERGENCY AND FIRST AID PROCEDURES**

It is advisable that at least two people of the laboratory have training in first aid.

All laboratories must have a well-equipped first aid kit. It must include a series of specially selected articles to perform an emergency treatment in case of cuts, eye injuries or immediate illness. It should be checked periodically ensuring the replacement of the articles which have been used and revising the expiration dates.

A designated person will be in charge of the maintenance of the first aid kit content.

### **7.1. Action in case of personal injury**

#### **7.1.1. In case of clothes catching fire**

It must be acted following this order of priority:

- 1) Use the safety shower or any other type of water source immediately.
- 2) If there is not a safety shower, lie down on the floor and roll the body covering face and eyes with the hands.
- 3) If there is a fire blanket nearby, use it to put out the fire and retire it immediately as soon as there are no flames to impede the accumulation of heat.

If the skin of the burned area is not damaged pour water on it for at least 5 minutes. If the skin is damaged cover the injury with sterile gauze and look immediately for medical assistance.

#### **7.1.2. Inhalation of toxic chemical products**

Take the person to a non-polluted area immediately and ventilate the affected area.

If necessary and having trained personnel, carry out a cardiopulmonary resuscitation (CPR) while medical assistance does not arrive.

If you have the safety data sheet of the inhaled material, this must be given to the medical staff.

Consider the need of using respiratory protection to take the person out of the affected area.

The intoxication by inhalation may lead the person to shock. The state of shock in a person is identified by the following symptoms:

- Agitation or irritability.
- Altered state of consciousness.
- Paleness, coldness, sweating.
- Slow and shallow breathing, sometimes irregular.
- Very weak pulse (peripheral heartbeats may disappear) and faster than usually (more than 100 or 120 heartbeats a minute).

If this state is produced the person must be lain down and see that the person does not get cold, loosen clothes and anything that might be pressing and do not give him/her any food or drink or medication, unless it is prescribed by a doctor.

### **7.1.3. Digestive poisoning**

It must be treated according to the ingested toxic substance, for that reason information must be provided on the label and the safety data sheet. The Service of Toxicological Information 915 62 04 20 must be called, giving them the information regarding first aid that is on the safety data sheet. Prompt medical attention is very important; it will usually require the transfer of the injured person, which will be carried out in the best conditions.

### **7.1.4. Pricks, cuts and wounds**

#### **7.1.4.1. Small cuts and wounds**

- Wash with water and soap.
- Disinfect with hydrogen peroxide and put clean gauze on the wound.
- In puncture wounds it is advisable to promote the bleeding in order to carry away anything that could have entered with the sharp-edged object.

#### **7.1.4.2. Major haemorrhages**

- Press directly on the wound with sterile bandage or gauze, or any type of clean cloth and place the injured part, as far as possible, higher than the heart.
- Call for medical assistance immediately.
- Calm the patient.
- Laying him down reduces the possibilities of fainting.
- DO NOT REMOVE ANY EMBEDDED OBJECT.
- If the haemorrhage is major, elevate the patient's legs and cover him/her with a blanket.
- The tourniquet is an aggressive measure and it must only be used if the benefit of it is bigger than the risk it involves (the haemorrhage can be life threatening for the person). The tourniquet must only be used in case of severe amputations and the person who does it must have appropriate knowledge.

### **7.1.4.3. Severe wounds**

Depending on the extension, depth, location or foreign bodies that are inside:

- Do not disinfect nor clean them, cover them with clean gauze or cloth and transfer the injured person to a medical centre.

### **7.1.5. Burns**

#### **7.1.5.1. Burns due to local heat**

- Cool down the burned part putting it in water (a strong water jet is not advisable).
- Evaluate the burn and if it is necessary go to a health centre. Cover the affected area with clean and slightly damp cloth and transfer the injured person.
- Small blisters can be cured without going to a medical centre. Never puncture blisters.

Never apply other types of substances as ointment, cream, toothpaste... only water.

#### **7.1.5.2. Severe burns**

- If the person is burning, first put out the flames, as mentioned before.
- Call for medical assistance and while it is arriving:

Loosen clothing without taking off anything that is stuck to the skin. If needed, cut the tie and the belt with scissors to free the body.

Cold clean water can be poured on the burned areas but never pour too much water on the person, because she/he would quickly lose heat and would go into shock.

Remove all metal objects (glasses, chains, belts...) since they keep heat for a long time.

Do not give the injured person anything orally although he/she is conscious.

Cover the person with a clean sheet or cloth and shelter him/her with blankets while medical assistance is arriving.

Calm the person.

#### **7.1.5.3. Chemical burns**

In this case, the burn is produced because of the reaction of the chemical product with the water that is in the skin, entering in it quickly and deeply.

#### **Measures to be taken**

- Wash the skin with plenty of water for at least 15 minutes. Do not use small quantities of water, since the mixture with some corrosive products may increase the effect of the burning. If the burn happened with hydrofluoric acid, only wash for 5 minutes because it requires immediate treatment.
- If the chemical product is spilled on clothes, these must be removed while water is applied or while the person is under the shower, and remove clothing, watches and anything that has been in contact with the chemical product. Do not drag the polluted clothing over the head or legs. It is better to cut it with scissors.

- Cover the burn with clean cloth.
- Go to a medical centre.

Burns with hydrofluoric acid (HF) will only be treated with water for 5 minutes and immediately afterwards apply calcium gluconate gel as antidote to avoid serious damage. Laboratories which work with HF must have this gel in their first-aid kit. The burn with this acid requires medical assistance and the safety data sheet of this product must be provided to the medical staff.

#### **7.1.5.4. Electrical burns**

The passage of electric power through the body can cause burns of varying severity and of similar features to those of thermal burns. In addition to skin burns that are sometimes not very important, internal burns can be produced on nerves, muscles and vessels. Organs can also be damaged due to the passage of electricity, leading even to cardiorespiratory arrest.

#### **Action in case of an electrocution**

- 1) Call for help: ring the alarm so that somebody comes while you help the injured person.
- 2) Rescue or unhook the injured person.
- 3) If the victim is in contact with the conductor separate the person as fast as possible; this could be done by:
  - Cutting the power by activating the general switch.
  - If it is impossible to cut the power, unhook the person using any non-conductive element (board, bar, wooden chair, leather belt...) to separate the injured person from the cable or vice versa.

First aid:

- a) If there is loss of consciousness, but heartbeats and pulse are perceived, it is enough to lay the injured person sideways and monitor breathing and pulse while medical assistance is arriving.
- b) Loss of consciousness and clear symptoms of respiratory arrest (perceptible pulse). Breathing assistance is needed, preferably rescue breathing.
- c) Circulatory arrest, no breathing and lack of heartbeat. It is important to start cardiopulmonary resuscitation manoeuvres (trained people in doing it).

#### **7.1.6. Splashes in eyes**

- 1) In case of wearing contact lenses (although they are completely unadvisable in the laboratory) take them off as quickly as possible.
- 2) Use the eye wash station immediately, considering that:
  - The water must not be applied directly on the eyeball, but on the base of the nose instead, because it provides a more effective eye washing. Make sure to wash from the nose to the ears.
  - The opening of the eyelids must be forced to ensure the washing behind them.
  - Eyes and eyelids must be washed for at least 15 minutes.
- 3) Go to a medical centre.

## 7.2. Action in case of leaks and spillages

### 7.2.1. Liquid spillages

As a general rule the following steps must be carried out:

- 1) Warn the personnel that are in the area where a spillage has been produced.
- 2) Evaluate the toxicity, flammability and other dangerous characteristics of the product, as well as the size and location of it to decide if an evacuation and/or external help are necessary.
- 3) If there are large quantities of volatile, toxic or flammable products:
  - Evacuate the personnel from the area.
  - Put off any possible source of ignition (lighters, motors that are working...).
  - Leave the place where the spillage has taken place and close the door if possible.
  - Call 112.
- 4) If it has to do with small spills or chemical products of low toxicity, proceed as follows:
  - Use neutralizing agents. Neutralizing and absorbing products or necessary absorbing materials will depend on the laboratory activity and on the used products. There must usually be specific agents for acids, bases, organic solvents and mercury, which form the so-called «basic equipment».
  - The prompt action is very important, following this sequence: neutralization, absorption and elimination.
  - Use IPE if necessary. It is generally advisable to use gloves and aprons that are impervious to the product, and safety glasses (it might be necessary to use respiratory mask, suitable for the product).

Depending on the laboratory activity and the used products, there must be specific neutralizing agents for acids, bases and organic solvents.

#### 7.2.1.1. Flammable liquids

- Absorb with activated carbon, sepiolite or other absorbing materials placed on the market.

Never use sawdust due to its flammability.

As an example: the spillage of 500 ml of ethyl ether which are not properly removed in a laboratory of 100 m<sup>3</sup> (supposing that there is no ventilation), could lead to environmental concentrations superior to the occupational exposure limit (valor límite ambiental, VLA) of this product.

#### 7.2.1.2. Acids

- Act as quickly as possible, since direct contact as well as vapours that are generated can cause harm to people, installations and equipment.
- Absorbing-neutralizing products which are placed on the market will be used (they do both functions). In case there are none of these products, sodium bicarbonate can be used for neutralizing.
- Afterwards wash the surface with plenty of water and detergent.

As an example: 20 ml of hydrochloric acid 36 % (12 M), spilled in a laboratory of 100 m<sup>3</sup> can widely surpass VLA (supposing that there is no ventilation).

### **7.2.1.3. Bases**

- Specific products placed on the market will be used for neutralizing and absorbing bases.
- In case there are none of these products, use plenty of water with slightly acid pH. Afterwards wash the surface with plenty of water and detergent.
- Other liquid spills which are not flammable or toxic nor corrosive can be absorbed using sawdust.

### **7.2.1.4. Other types of spillages**

Generally after consulting the safety data sheet, if there is no specific method, proceed as follows:

- Absorption with absorbing products or with proven effective absorbing products (activated carbon, vermiculite, organic or water solutions, etc.) and recommended destruction procedure.
- Elimination: if we collect the product by absorption, it must be eliminated according to the recommended specific procedure or it must be treated as waste to be eliminated according to the established plan of the laboratory.

For more detailed information about the neutralizing procedures of chemical products, consult NTP 399 «*Seguridad en el laboratorio: actuación en caso de fugas y vertidos*» (Laboratory safety: action in case of leaks and spillages) on the following link: <http://goo.gl/9EYv3e>

## **7.2.2. Gas leaks**

The leak can happen while directly operating with compressed gas cylinders or operating with a fixed installation which includes an expansion station. Therefore, greater care should be taken when working directly with cylinders.

The periodic review of cylinder connections, and gas installation, is the most effective preventive measure to prevent leaks which can cause an emergency situation. The review must be carried out by qualified personnel (maintenance contract).

It is fundamental to remember the section «Pressurized gas installation» regarding the knowledge of the physicochemical and toxicological properties of the gases that are worked with in the laboratory and the instructions to follow.

### **Action in case of gas leak from a cylinder. General rule**

- 1) Get close to the cylinder, always having the wind or airflow at the back.
- 2) Check that the gas has not lit (if there is flame act as follows).
- 3) Close the tap if possible.
- 4) Transfer the bottle to an open space, out of reach of people and installations.
- 5) If it is not oxygen or an inert gas, call firefighters (112).
- 6) Indicate the zone with the corresponding hazard indication, preventing the access by people, vehicles, ignition points, etc. depending on each case.
- 7) Control permanently the cylinder until it is completely empty.

8) Inform the supplier.

### **Action in case of gas leak in a fixed gas installation. General rule**

- 1) Close the taps of the cylinder or cylinders which are in the installation.
- 2) Inform the manager of the installation or laboratory about the incident.
- 3) Consider the suitability of emergency actions: evacuation, call the firefighters, isolation of the area...
- 4) Inform the installer in order to carry out relevant checks and repairs before setting the installation again in motion.

### **Action in case of flame on the mouth of a flammable gas cylinder**

Close the tap. If this is not possible:

- If it is in a gas shed and the shed is properly adapted, put out the flame with a fire extinguisher, preferably powder fire extinguisher, mark the zone indicating the danger and cool the tap in order to close it.
- If the cylinder is in the laboratory, evaluate if the risk arising from the flammable gas leak, once the flame is put out, is not bigger than the risk of the flame itself. If the decision is taken of not putting out the flame, act in order to avoid that the flame starts a fire, moving away from the burning cylinder as much as possible. Inform immediately the firefighters, the preventive service and the supplier.

### **If a fire starts in a room with compressed gas cylinders**

- Remove the cylinders as quickly as possible.
- If they cannot be removed, cool them pouring water on them, inform the firefighters, the preventive service and the supplier about the situation.
- After the fire, check the cylinders which have not been removed carefully.

**Remember that acetylene is a very hazardous substance due to its flammability, instability and the possibility of dangerous reactions. Working with these bottles requires being extremely cautious.**



## 8. WASTE MANAGEMENT

### 8.1. General regulations about the handling of waste

- Always avoid direct contact with the waste, using personal protective equipment according to their hazard characteristics. This is especially important in the case of gloves and respiratory protection, since there is no equipment which protects against all products.
- All wastes must be considered hazardous, assuming the highest protection level in case of not knowing their features and characteristics.
- When possible, material must be used that can easily be decontaminated without causing additional risks for the environment. If not, material of single-use will be used which can be eliminated by means of a standard procedure after the contact with the product.
- Never handle wastes alone.
- For liquid wastes, do not use containers bigger than 25 litres in order to facilitate the handling and to avoid unnecessary risks.
- The transport of containers of 25 litres or more will be carried out on wheelbarrows to avoid risks of breakage and spillage. A wheelbarrow will always be used to handle loads for over 10 linear metres and more than 3 kg of weight.
- The deposition of wastes to the corresponding containers must be carried out slowly and in a controlled way. This operation will be interrupted if something unusual is observed, as for example the production of gases or the excessive increase of temperature. To transfer liquids in large quantities, a pump will be used, preferably a manually operated pump, and in case of using an electrical pump, it should be flameproof. In all cases, check the suitability of the pump material for the transferred waste.
- Once the emptying operation is finished, close the container until the next use. Thus the exposure of the staff to the products involved will be reduced.
- Containers must not be filled more than 90% of their volume in order to avoid splashes, spillages or excess pressure.

- Whenever possible, containers must be placed on the floor to prevent falling to a different level. Wastes will not be stored at more than 170 cm of height.
- Inside the laboratory, containers in use will never be left on passing places or places which can cause tripping.

### **This must be taken into account:**

In laboratories small quantities of wastes are generally produced which are very different from a physicochemical and toxicological point of view as well as regarding the toxicity for the environment.

Small quantities of hazardous wastes (SQDW) are not easily manageable through the established channels.

The storage of wastes implies the presence of unnecessary hazardous products, which are also incorrectly identified, stored or packed.

Their generation must be minimized by:

- Re-using or recycling whenever possible.
- Optimizing the stock management of the chemical products so that no expired or spare products are generated.
- Choosing always the products that are less hazardous for the execution of different protocols and tasks of the laboratory.

Never store inside the laboratory chemical products which are not going to be used, especially those which form peroxides (as dioxane or ethyl ether), poly-nitrogenous compounds (as dinitrophenyl hydrazine) or those which react with air or water.

**The director/manager of the laboratory must name a person in charge of the management of wastes generated in the laboratory.**

## **8.2. Management programme of the waste from the laboratory**

It will include:

- 1) Inventory of products that are considered as wastes.
- 2) Appropriate purchase management.
- 3) Implement a selective waste collection according to the established groups with suitable and properly marked bins regarding the characteristics of the wastes.
- 4) Information and training of the staff about the existence and characteristics of the waste management plan.
- 5) Contract an external company authorized for the treatment, collection and disposal of those wastes which cannot be treated or are considered inappropriate to be treated in the laboratory itself.

### **8.2.1. Selective waste collection system**

- 1) Non-hazardous waste (similar to urban waste):
  - Inert waste, paper, cardboard, plastic containers, non-polluted glass, etc. Selective collection or disposal through drains.

2) Hazardous waste:

- Chemical substances, polluted materials...
  - Biological substances
  - Carcinogenic substances
  - Radioactive substances
- } These are subject to the specific regulation

### 8.2.2. Disposal/classification of hazardous wastes

Consider always the possibility of treating the waste in the laboratory itself and of reusing wastes resulting from a process as the raw material of other processes, as far as the installations and the staff are the appropriate ones.

Regarding the elimination of the produced and non-reusable wastes, it is very important to establish groups for their classification.

#### Classification of hazardous wastes

For an appropriate classification the following steps are necessary:

- A study of all activities developed in the laboratory (including cleaning and maintenance activities). This study of activities is carried out from the raw materials used in each activity, following their transformation and mixture with other products.
- A report of wastes generated in all activities and an estimation of quantities is drawn from this study.
- The data are compared with the inventory of accumulated wastes in the laboratory, in case there are some.

From these data and according to the physicochemical properties of the wastes, the possible reactions of incompatibility in case of mixing and their final treatment, groups of classification are established.

In NTP 480: «*La gestión de los residuos con riesgo en los laboratorios universitarios y de investigación*» (Management of hazardous wastes in university and research laboratories) which can be consulted on the following link: <http://goo.gl/PZRMhe>, the following classification groups of hazardous wastes are proposed, based on the experience of the laboratory from the Autonomous University of Barcelona:

Group I: Halogenated solvents

Group II: Non-halogenated solvents

Group III: Aqueous solutions

Group IV: Acids

Group V: Oils

Group VI: Solids

Group VII: Specials

In the previously mentioned NTP the content and subgroups that can be made in each group are detailed. It can be taken as a basis which can be adapted to each laboratory and thus form the correct groups according to de generated wastes.

This technical note has been updated by NTP 767: <http://goo.gl/8c7Nr6> and NTP 793: <http://goo.gl/ePZqou>

## **Carcinogenic and mutagenic wastes**

Wastes of carcinogenic and mutagenic products (statements H340, H341, H350, and H351) must be collected apart. Remember what the RD 665/97 indicates in article 5.1 about the protection of workers against risks dealing with the exposure to carcinogenic agents while working:

«Se debe disponer de medios que permitan la recogida, almacenamiento y eliminación de residuos, en particular mediante la utilización de recipientes herméticos etiquetados de modo claro, inequívoco y legible, y colocar señales de peligro claramente visibles, de conformidad todo eso con la normativa vigente en la materia» (There must be the necessary means that allow the collection, storage and disposal of wastes, especially by means of using airtight containers which are clearly and legibly labelled, and put clearly visible hazard signals, according to the current regulation on this matter).

## **Radioactive wastes**

They can only be managed by a company, authorized by the Nuclear Safety Council which in our country is ENRESA (Empresa Nacional de Residuos Radioactivos S.A.), directly or indirectly.

## **Biological wastes**

In our Autonomous Community it is regulated by the *Decreto 38/2015, de 26 de febrero, de residuos sanitarios de Galicia*, DOG 01/04/2015 (management of bio contaminant wastes).

### **8.2.3. Packaging and labelling**

Containers in use must be approved for the transport. Usually, polyethylene bottles of high density are used (resistant to most of the chemical products) or polyethylene drums of wide mouth for disposable material. Sometimes the original container can be suitable. Very flammable or volatile products or products which produce bad smells may need special safety containers.

All these types of containers can be supplied by the managing company or by specialized companies of the sector.

Containers shall be labeled in accordance with current regulations on hazardous waste:

- Identification code of contained waste (set out in the European List of Waste, Decision 2014/955 / EU and Regulation (EC) 1357/2014).
- Hazard characteristics code and description, indicating the nature of the risks by the pictograms described in the CLP Regulation.
- Waste producer or waste holder identification (name, address and telephone number).
- Packaging dates.

These labels can be elaborated together with the company that manages wastes. The label which identifies the waste producer (enterprise, workplace, unit, manager, dates) is prepared by the enterprise according to its own needs.

General precautions of handling with chemical products will always be taken into account in the packaging operation:

- Use a fume cupboard and, if this is not possible, carry out the filling operation in a suitably ventilated place.

- Use appropriate personal protective equipment (white coat, safety glasses, gloves, and apron and respiratory protection if needed).
- Do not fill together incompatible substances.
- Use proper means for filling the containers in order to avoid spillages (funnels).
- The container will not be filled up to the limit of capacity.

#### **8.2.4. Temporary storage**

Since the waste is generated until it is removed by the managing company, the storage is responsibility of the producer, who must store it correctly considering that the current regulation regarding wastes prohibits storing hazardous wastes for periods of over six months.

Remember that the same precautions must be taken as in the storage of reactive products regarding incompatibilities, flammability and characteristics of the installations and the distribution of the products in them (as mentioned before).

In some cases, depending on the generated quantities and the frequency of collection, in addition to the general storage room, it is advisable to have a specific place for the storage of wastes, which must also fulfil the specific regulation mentioned before.

If the quantities are small or the types of wastes do not carry high risk of fire or toxicity, the bins can be stored next to the producer centres, providing an exclusive space for them or using safety cupboards. The accumulation must be avoided, providing metallic shelves and placing big bins (of 30 litres) on the floor, reserving the upper shelves for small bins (of 1, 2, 5 and 10 litres).

In each department that generates hazardous waste there will be a zone (inside the laboratory) where the bins or bottles of identified hazardous wastes are kept while they are not full. Big quantities of wastes will not be accumulated in the laboratory; instead they will be taken to a storage zone of hazardous wastes once the containers are full.



## 9. INFORMATION ABOUT HAZARD FROM CHEMICAL PRODUCTS

This manual deals with different aspects regarding the risk control in the laboratory, due to the presence of chemical agents, as well as to the use of different equipment and installations of the working place. This section will indicate how to obtain information about the intrinsic hazard from chemical agents, considering that the risk possibility in a laboratory derived from the presence of these agents in addition depends on:

- the frequency or time of exposure,
- the quantity of chemical agent used or present,
- the volatility or dustiness of chemical agent,
- the way of use,
- the type of control measures.

The risk assessment derived from the presence of chemical agents, in view of all variables mentioned before, must be carried out by a competent technician.

The intrinsic hazard of chemical agents will depend on their physicochemical properties, directly related to the risk that an accident happens, as well as on their toxicological properties.

The information about the hazardous properties of chemical agents can fundamentally be obtained from the label and the safety data sheet (SDS); in recent years some important changes in the regulations have happened regarding the marketing, classification and labelling of hazardous chemical products. This results in a new system of classification and labelling (new label) and also in some changes in the SDS, which will be described further on.

These changes derive from the adoption of two European legislations (of direct application for all member countries) which have produced important changes affecting placing on the market, classification and labelling of hazardous chemical products:

- Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18<sup>th</sup> December concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency.

- Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16<sup>th</sup> December on classification, labelling and packaging of substances and mixtures (CLP Regulation, from English *Classification, Labelling and Packaging*).

The Reach Regulation legislates on SDS and the CLP Regulation legislates on the label.

## 9.1. Label

All containers of hazardous chemical products placed on the market must be labelled according to a defined model. Only if the product is delivered in bulk, we will not have that label (although, if the product has been transported, it will have a specific labelling for its transport).

From 1<sup>st</sup> June 2015 hazardous chemical products must be placed on the market with the new label according with CLP Regulation. Those mixtures placed in the market with old label (regulated by Directive 199/45/CE) it will have to be re-labelled from **1<sup>st</sup> June 2017**.

The content of the label allows obtaining information about the following points:

- Identification of the chemical product.
- Identification of the manufacturer or supplier.
- Intrinsic hazards of the product due to its properties or effects.

### It includes following data:

Classification of the chemical products according to the 28 defined hazard classes (which are subdivided into 79 categories, divisions or subtypes) (**chart I**). This classification is shown on the label with a combination of symbols (pictograms) and hazard statements (H statements). **Figure II** shows hazard pictograms and hazard classes and categories which are associated to them. In **chart II** information is given about the criteria used for the classification of carcinogenic, mutagenic and reproductive toxicants products into categories 1A, 1B and 2 respectively.

Signal words: they alert about the level of severity of hazards in general:

«**Hazard**», means a signal word indicating the more severe hazard categories and

«**Warning**», means a signal word indicating the less severe hazard categories.

Hazard statements (H statements): they indicate specific risks attributed to substances and mixtures depending on their classification; they are codified by means of the letter H and a number of three digits.

Precautionary statements (P statements): means a phrase assigned to a hazard class and category that describes the nature of the hazards of a hazardous substance or mixture, including, where appropriate, the degree of hazard. They are codified with the letter P and a number of three digits.

**Chart III** indicates label elements for CMR (Carcinogenic, Mutagenic or Reproductive toxicants) classified products according to CLP Regulation.

The information on the label is also on the safety data sheet, where it is extended and complemented with other interesting data.

Figure I. Labelling of hazardous chemical products according to the CLP Regulation.



Figure II. Pictograms according to the CLP Regulation and hazard classes and categories which are associated to them.

Physical hazards	
CLP PICTOGRAMS	HAZARD CLASSES AND CATEGORIES
Exploding bomb  GHS01	-Unstable explosives -Explosives, div. 1.1, 1.2, 1.3 and 1.4 -Self-reactive substances or mixtures, types A and B -Organic peroxides, types A and B
Flame  GHS02	-Flammable gases, cat. 1 -Flammable aerosols, cat. 1 and 2 -Flammable liquids, cat. 1, 2 and 3 -Flammable solids, cat. 1 and 2 -Self-reactive substances or mixtures, type B, C, D, E and F -Pyrophoric liquids, cat. 1 -Pyrophoric solids, cat. 1 -Self-heating substances or mixtures, cat. 1 and 2 -Substances and mixtures which, in contact with water, emit flammable gases; cat. 1, 2 and 3 -Organic peroxides, type B, C, D, E and F
Flame over circle  GHS03	-Oxidising gases, category 1 -Oxidising liquids, categories 1, 2 and 3 -Oxidising solids, categories 1, 2 and 3
Gas cylinder  GHS04	-Compressed gases -Liquefied gases -Refrigerated liquefied gases -Dissolved gases

Continues on the following page

**Figure II. Pictograms according the CLP Regulation and hazard classes and categories which are associated to them (Continuation).**

Physical hazards	
CLP PICTOGRAMS	HAZARD CLASSES AND CATEGORIES
Corrosion  GHS05	-Substance or mixture corrosive to metals, category 1
Health hazards	
PICTOGRAMS CLP	HAZARD CLASSES AND CATEGORIES
Skull and crossbones  GHS06	-Acute toxicity (oral, dermal, inhalation), cat. 1, 2 and 3
Corrosion  GHS05	-Skin corrosion (cat. 1A, 1B and 1C) -Serious eye damage, cat. 1
Exclamation mark  GHS07	- Acute toxicity (oral, dermal, inhalation) cat. 4 -Skin irritation, cat. 2 -Eye irritation, cat. 2 -Skin sensitisation, cat. 1, 1A and 1B -Specific target organ toxicity (single exposure), cat. 3 -Respiratory tract irritation -Narcotic effects
Health hazard  GHS08	-Respiratory sensitisation, cat. 1, 1A and 1B -Germ cell mutagenicity, cat 1A, 1B and 2 -Carcinogenicity, cat. 1A, 1B and 2 -Reproductive toxicity, cat. 1A, 1B and 2 -Specific target organ toxicity (single exposure), cat. 1 and 2 -Specific target organ toxicity (repeated exposures), cat. 1 and 2 -Aspiration hazard, cat. 1
Environment hazards	
CLP PICTOGRAMS	HAZARD CLASSES AND CATEGORIES
Environment  GHS09	-Hazardous to the aquatic environment: -Aquatic acute hazard, cat. 1 -Long-term aquatic hazard, cat. 1 and 2
Exclamation mark  GHS07	-hazard for the ozone layer, cat.1

**Chart I. Definitions of the different hazard classes according to CLP Regulation.**

Physical hazards	
Explosives	An explosive substance or mixture is a solid or liquid substance or mixture of substances which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings. Pyrotechnic substances are included even when they do not evolve gases.
Flammable gases	Flammable gas means a gas or gas mixture having a flammable range with air at 20° C and a standard pressure of 101,3 kPa.
Flammable aerosols	Aerosols, this means aerosol dispensers, are any non-refillable receptacles made of metal, glass or plastics and containing a gas compressed, liquefied or dissolved under pressure, with or without a liquid, paste or powder, and fitted with a release device allowing the contents to be ejected as solid or liquid particles in suspension in a gas, as a foam, paste or powder or in a liquid state or in a gaseous state.
Oxidising gases	Any gas or gas mixture which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does
Gases under pressure	Gases which are contained in a receptacle at a pressure of 200 kPa (gauge) or more at 20° C, or which are liquefied or liquefied and refrigerated. They comprise compressed gases, liquefied gases, dissolved gases and refrigerated liquefied gases.
Flammable liquids	Flammable liquid means a liquid having a flash point of not more than 60° C.
Flammable solids	A solid which is readily combustible, or may cause or contribute to fire through friction.
Self-reactive substances and mixtures	They are thermally unstable liquid or solid substances or mixtures liable to undergo a strongly exothermic decomposition even without participation of oxygen (air). This definition excludes substances and mixtures classified according to this Part as explosives, organic peroxides or as oxidising.
Pyrophoric liquids	A liquid substance or mixture which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.
Pyrophoric solids	A solid substance or mixture which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.
Self-heating substances and mixtures	Liquid or solid substance or mixture, other than a pyrophoric liquid or solid, which, by reaction with air and without energy supply, is liable to self-heat; this substance or mixture differs from a pyrophoric liquid or solid in that it will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).
Substances and mixtures which in contact with water emit flammable gases	Substances or mixtures which, in contact with water, emit flammable gases means solid or liquid substances or mixtures which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.
Oxidising liquids	A liquid substance or mixture which, while in itself not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other material.
Oxidising solids	A solid substance or mixture which, while in itself is not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other material.
Organic peroxides	Liquid or solid organic substances which contain the bivalent -O-O- structure. They are thermally unstable substances or mixtures, which can undergo exothermic self-accelerating decomposition. In addition, they can have one or more of the following properties: (i) be liable to explosive decomposition; (ii) burn rapidly; (iii) be sensitive to impact or friction; (iv) react dangerously with other substances.
Corrosive to metals	A substance or a mixture that is corrosive to metals means a substance or a mixture which by chemical action will materially damage, or even destroy, metals.

Continues on the following page

**Chart I. Definitions of the different hazard classes according to CLP Regulation (Continuation).**

Health hazards	
Acute toxicity	Means those adverse effects occurring following oral or dermal administration of a single dose of a substance or a mixture, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours.
Skin corrosion/irritation	Skin Corrosion means the production of irreversible damage to the skin; namely, visible necrosis through the epidermis and into the dermis, following the application of a test substance for up to 4 hours. Skin Irritation means the production of reversible damage to the skin following the application of a test substance for up to 4 hours
Serious eye damage/ eye irritation	Serious eye damage means the production of tissue damage in the eye, or serious physical decay of vision, following application of a test substance to the anterior surface of the eye, which is not fully reversible within 21 days of application. Eye irritation means the production of changes in the eye following the application of test substance to the anterior surface of the eye, which are fully reversible within 21 days of application.
Respiratory or skin sensitisation	Respiratory sensitiser means a substance that will lead to hypersensitivity of the airways following inhalation of the substance. Skin sensitiser means a substance that will lead to an allergic response following skin contact.
Germ cell mutagenicity	A mutation means a permanent change in the amount or structure of the genetic material in a cell. The term 'mutagenic' and 'mutagen' will be used for agents giving rise to an increased occurrence of mutations in populations of cells and/or organisms
Carcinogenicity	CCarcinogen means a substance or a mixture of substances which induce cancer or increase its incidence.
Reproductive toxicity	Includes adverse effects on sexual function and fertility in adult males and females, as well as developmental toxicity in the offspring.
Specific target organ toxicity (single exposure)	Is defined as specific, non lethal target organ toxicity arising from a single exposure to a substance or mixture. All significant health effects that can impair function, both reversible and irreversible, immediate and/or delayed and not specifically addressed in other sections are included.
Specific target organ toxicity (repeated exposure)	Means specific, target organ toxicity arising from a repeated exposure to a substance or mixture. All significant health effects that can impair function, both reversible and irreversible, immediate and/or delayed are included. However, other specific toxic effects that are specifically addressed in other sections are not included here.
Aspiration hazard	«Aspiration» means the entry of a liquid or solid substance or mixture directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system. Aspiration toxicity includes severe acute effects such as chemical pneumonia, varying degrees of pulmonary injury or death following aspiration.
Environmental hazards	
Hazardous to the aquatic environment	«Acute aquatic toxicity» means the intrinsic property of a substance to be injurious to an aquatic organism in a short- term aquatic exposure to that substance. «Chronic aquatic toxicity» means the intrinsic property of a substance to cause adverse effects to aquatic organisms during aquatic exposures which are determined in relation to the life-cycle of the organism.
Hazardous to the ozone layer	Means a substance which, on the basis of the available evidence concerning its properties and its predicted or observed environmental fate and behaviour may present a danger to the structure and/or the functioning of the stratospheric ozone layer.

## Chart II. Classification of the carcinogenic, mutagenic and reproductive toxicants chemical agents (CLP Regulation).

Carcinogens	
<b>CATEGORY 1</b> Known or presumed human carcinogens	<b>1A</b> Known to have carcinogenic potential for humans, classification is largely based on human evidence,
	<b>1B</b> Presumed to have carcinogenic potential for humans, classification is largely based on animal evidence.
<b>CATEGORY 2</b> Suspected human carcinogens	Evidence obtained from human and/or animal studies, but which is not sufficiently convincing to place the substance in Category 1A or 1B.
Mutagens	
<b>CATEGORY 1</b> Substances known to induce heritable mutations or to be regarded as if they induce heritable mutations in the germ cells of humans.	<b>1A</b> Positive evidence from human epidemiological studies.
	<b>1B</b> Positive result(s) from in vivo heritable germ cell mutagenicity tests in mammals; or Positive result(s) from in vivo somatic cell mutagenicity tests in mammals, in combination with some evidence that the substance has potential to cause mutations to germ cells; or Positive results from tests showing mutagenic effects in the germ cells of humans, without demonstration of transmission to progeny.
<b>CATEGORY 2</b> Substances which cause concern for humans owing to the possibility that they may induce heritable mutations in the germ cells of humans	Positive evidence obtained from experiments in mammals and/or in some cases from in vitro experiments, obtained from: <ul style="list-style-type: none"> <li>- somatic cell mutagenicity tests in vivo, in mammals; or</li> <li>- other in vivo somatic cell genotoxicity tests which are supported by positive results from in vitro mutagenicity assays.</li> </ul>
Reproductive toxicants	
<b>CATEGORY 1</b> Known or presumed human reproductive toxicant	<b>1A</b> Known human reproductive toxicant The classification of a substance in Category 1A is largely based on evidence from humans.
	<b>1B</b> Presumed human reproductive toxicant The classification of a substance in Category 1B is largely based on data from animal studies.
<b>CATEGORY 2</b>	Suspected human reproductive toxicant. There is some evidence from humans or experimental animals, and where the evidence is not sufficiently convincing to place the substance in Category 1.
<b>ADDITIONAL CATEGORY FOR EFFECTS ON OR VIA LACTATION</b>	Substances which are absorbed by women and have been shown to interfere with lactation, or which may be present (including metabolites) in breast milk in amounts sufficient to cause concern for the health of a breastfed child, shall be classified and labelled to indicate this property hazardous to breastfed babies.

Note: All carcinogens and mutagens of category 1A and 1B will be subject to the *REAL DECRETO 665/1997, de 12 de mayo, sobre la protección de los trabajadores contra los riesgos relacionados con la exposición a agentes cancerígenos durante el trabajo*. BOE núm. 124 de 24 de mayo (RD 665/1997 of 12<sup>th</sup> May on the protection of workers against the risks connected with the exposure to carcinogenic agents during work. BOE Number 124 of 24<sup>th</sup> May): <http://goo.gl/VxNz33>

The current scientific knowledge does not allow identifying levels of exposure below of which there is no risk that the mutagenic agents and most of the carcinogenic agents produce their characteristic effects on the health. Nevertheless, the existence of an exposure - probability relationship is admitted regarding the effect that allows the deduction that the lower the exposure to these agents is, the lower will be the risk.

### Chart III. Label of chemical products which are carcinogenic, mutagenic and reproductive toxicants according to CLP Regulation.

Carcinogens		
CLASSIFICATION CLP REGULATION	CATEGORY 1A OR 1B	CATEGORY 2
PICTOGRAM		
Signal word	HAZARD	ATTENTION
Hazard Statement	H350 May cause cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)	H351 Suspected of causing cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
Precautionary Statement Prevention	P201, P202, P281	P201, P202, P281
Precautionary Statement Response	P308+P313	P308+P313
Precautionary Statement Storage	P405	P405
Precautionary Statement Disposal	P501	P501
Mutagens		
CLASSIFICATION CLP REGULATION	CATEGORY 1A OR 1B	CATEGORY 2
PICTOGRAM		
Signal word	HAZARD	WARNING
Hazard statement	H340 May cause genetic defects (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)	H341 Suspected of causing genetic defects (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
Precautionary Statement Prevention	P201, P202, P281	P201, P202, P281
Precautionary Statement Response	P308+P313	P308+P313
Precautionary Statement Storage	P405	P405
Precautionary Statement Disposal	P501	P501

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**Chart III. Label of chemical products which are carcinogenic, mutagenic and reproductive toxicants according to CLP Regulation (Continuation).**

Reproductive toxicants			
CLASSIFICATION CLP REGULATION	CATEGORY 1A OR 1B	CATEGORY 2	ADDITIONAL CATEGORY FOR THE EFFECTS ON THE LACTATION OR THROUGH LACTATION
PICTOGRAM			Without pictogram
Signal word	HAZARD	WARNING	
Hazard statement	H360 May damage fertility or the unborn child (state specific effect if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)	H361 Suspected of damaging fertility or the unborn child (state specific effect if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)	H362 May cause harm to breast-fed children.
Precautionary Statement Prevention	P201, P202, P281	P201, P202, P281	P201, P260, P263, P264, P270
Precautionary Statement Response	P308+P313	P308+P313	P308+P313
Precautionary Statement Storage	P405	P405	
Precautionary Statement Disposal	P501	P501	

## 9.2. Safety data sheet

It is a fundamental element for transmitting appropriate safety information on substances and mixtures which meet the criteria for classification as hazardous. It is designed to provide comprehensive information about a substance or mixture for use in workplace chemical control regulatory frameworks. It complements the label, offering information that might not be included on it.

The CLP Regulation does not legislate directly on the SDS; it is domain of the REACH Regulation (article 31 and Annex II, modified by the Regulation Number 453/2010).

The aim of the SDS is to inform effectively and sufficiently the professional user about the hazard of the product:

- for the health,
- for the safety and
- for the environment.

It is obligatory to supply it:

- For substances that meets the criteria for classification as hazardous on the basis of the criteria established by the CLP Regulation

- Persistent, bioaccumulative and toxic substances, (PBT) and very persistent and very bioaccumulative substances vPvB (Annex XIII REACH).
- Substances of very high concern (candidate List for eventual inclusion in annex XIV REACH).

In addition, the receiver can request the SDS of a mixture which is not classified as hazardous but that contains:

- Hazardous substances ( $\geq 1\%$  weight or  $\geq 0,2\%$  volume).
- Substances of very high concern ( $\geq 0,1\%$  weight).
- Substances which have Community workplace exposure limits (established in the directives).

These files must be written in the official language of the Member State(s) where the substance or mixture is placed on the market and they must indicate the date of compilation.

The files must be updated:

- When there is new information or there is evidence of new hazards.
- When an authorization is granted or refused (REACH Reg.).
- When a restriction has been imposed (REACH Reg.).

The extensive information of the SDS must be structured in these 16 sections as the REACH indicates:

<b>SDS structure</b>	
<p><b>SECTION 1:</b> Identification of the substance/mixture and of the company/ undertaking</p> <ul style="list-style-type: none"> <li>1.1. Product identifier</li> <li>1.2. Relevant identified uses of the substance or mixture and uses advised against</li> <li>1.3. Details of the supplier of the safety data sheet</li> <li>1.4. Emergency telephone number</li> </ul>	<p><b>SECTION 9:</b> Physical and chemical properties</p> <ul style="list-style-type: none"> <li>9.1. Information on basic physical and chemical properties</li> <li>9.2. Other information</li> </ul>
<p><b>SECTION 2:</b> Hazards identification</p> <ul style="list-style-type: none"> <li>2.1. Classification of the substance or mixture</li> <li>2.2. Label elements</li> <li>2.3. Other hazards</li> </ul>	<p><b>SECTION 10:</b> Stability and reactivity</p> <ul style="list-style-type: none"> <li>10.1. Reactivity</li> <li>10.2. Chemical stability</li> <li>10.3. Possibility of hazardous reactions</li> <li>10.4. Conditions to avoid</li> <li>10.5. Incompatible materials</li> <li>10.6. Hazardous decomposition products</li> </ul>
<p><b>SECTION 3:</b> Composition/information on ingredients</p> <ul style="list-style-type: none"> <li>3.1. Substances</li> <li>3.2. Mixtures</li> </ul>	<p><b>SECTION 11:</b> Toxicological information</p> <ul style="list-style-type: none"> <li>11.1. Information on toxicological effects</li> </ul>
<p><b>SECTION 4:</b> First aid measures</p> <ul style="list-style-type: none"> <li>4.1. Description of first aid measures</li> <li>4.2. Most important symptoms and effects, both acute and delayed</li> <li>4.3. Indication of any immediate medical attention and special treatment needed</li> </ul>	<p><b>SECTION 12:</b> Ecological information</p> <ul style="list-style-type: none"> <li>12.1. Toxicity</li> <li>12.2. Persistence and degradability</li> <li>12.3. Bioaccumulative potential</li> <li>12.4. Mobility in soil</li> <li>12.5. Results of PBT and vPvB assessment</li> <li>12.6. Other adverse effects</li> </ul>
<p><b>SECTION 5:</b> Firefighting measures</p> <ul style="list-style-type: none"> <li>5.1. Extinguishing media</li> <li>5.2. Special hazards arising from the substance or mixture</li> <li>5.3. Advice for firefighters</li> </ul>	<p><b>SECTION 13:</b> Disposal considerations</p> <ul style="list-style-type: none"> <li>13.1. Waste treatment methods</li> </ul>
<p><b>SECTION 6:</b> Accidental release measures</p> <ul style="list-style-type: none"> <li>6.1. Personal precautions, protective equipment and emergency procedures</li> <li>6.2. Environmental precautions</li> <li>6.3. Methods and material for containment and cleaning up</li> <li>6.4. Reference to other sections</li> </ul>	<p><b>SECTION 14:</b> Transport information</p> <ul style="list-style-type: none"> <li>14.1. UN number</li> <li>14.2. UN proper shipping name</li> <li>14.3. Transport hazard class(es)</li> <li>14.4. Packing group</li> <li>14.5. Environmental hazards</li> <li>14.6. Special precautions for user</li> <li>14.7. Transport in bulk according to Annex II of Marpol and the IBC Code</li> </ul>
<p><b>SECTION 7:</b> Handling and storage</p> <ul style="list-style-type: none"> <li>7.1. Precautions for safe handling</li> <li>7.2. Conditions for safe storage, including any incompatibilities</li> <li>7.3. Specific end use(s)</li> </ul>	<p><b>SECTION 15:</b> Regulatory information</p> <ul style="list-style-type: none"> <li>15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture</li> <li>15.2. Chemical safety assessment</li> </ul>
<p><b>SECTION 8:</b> Exposure controls/personal protection</p> <ul style="list-style-type: none"> <li>8.1. Control parameters</li> <li>8.2. Exposure controls</li> </ul>	<p><b>SECTION 16:</b> Other information</p>
<b>ANNEXES: EXPOSURE SCENARIOS WHERE APPROPRIATE</b>	

The «exposure scenarios» must be prepared for all substances and mixtures that meet the criteria to be classified as hazardous and which are placed on the market over 10 t/year:

- a) They do an estimation of the expected theoretical exposure (risk of generating adverse effects) bearing in mind the potential effects of the substance and the using conditions. This must be done for each of the uses that the manufacturer identifies. They are annexed to the SDS.
- b) They must have a brief title from which a general description of the use is given.
- c) They must describe the process/processes, the applied risk control measures and the risk management measures recommended by the manufacturer.
- d) The user must verify if the use he/she gives to the substance is contemplated by the manufacturer or importer and, consequently, the corresponding exposure scenario which includes all the risks associated to each specific use of the substance and the corresponding prevention and protection measures to be applied.

Due to the importance of the SDS, there must be a suitable management of them in the laboratory looking for their best use and exploitation:

- a) Create and keep an updated record of the SDS corresponding to the different chemical products used in the laboratory, for which the necessary contact with the suppliers will be kept, even to request necessary information about products of which there is no SDS.
- b) Contrast the information contained in the SDS with the labelling of the chemical products and the conditions of their use in the laboratory; this comparison will be obligatory whenever it is a new SDS or a new version of the SDS.
- c) Use the information contained in the SDS for:
  - Worker information/training.
  - Giving safety instructions.
  - Elaborating emergency procedures (included the suitable information for the external emergency services).
- d) Make them available for the preventive service to use them when dealing with the risk assessment and the health monitoring and with their possible advice on emergency procedures.
- e) Have always the SDS ready to be consulted by workers or by their representatives.

### **9.3. Some considerations about the toxicity of chemical agents**

The complex relationship between a potentially toxic chemical agent and the biological effect produced in human beings is related to the duration, the frequency and intensity of the exposure, its way of entry and other factors as it can be the sex, previous known allergies, age, way of life of the worker, etc.

Without seeking to enter in depth in terms of occupational toxicology, it is necessary to mention some basic aspects.

### 9.3.1. Penetration ways of chemical agents

- Through respiratory way or inhalation.
- Through skin contact (or through the eyes which absorb vapours easily).
- Through ingestion.
- Parenteral way (cuts or pricks).

The main routes of entry in the occupational exposure to chemical agents are the respiratory way and through the skin. Working safely with toxic chemical agents (when it is needed) implies avoiding the penetration of them into the organism. So this manual repeatedly insist on how to avoid the penetration through the different routes adopting different safety measures (habits in the laboratory, protection elements, working procedures ...). Both the label and the safety data sheet make reference to the toxicity of the substances through the different routes.

In any case, according to the current legislation, inhalation exposure risk assessment of a hazardous chemical agent must include air monitoring (measuring the amount of a substance in a worker's breathing zone). Results must be compared with occupational exposure limit for the chemical agent. Occupational exposure limits are reference values for preventing adverse health effects on workers caused by occupational exposure to chemical substances, represent the maximum concentration of an airborne substance averaged over a reference period to which employees may be exposed by inhalation.

### 9.3.2. Legally recognized occupational exposure limit values in Spain (valor límite ambiental, VLA)

- Those which are in the Annex I of «Real decreto 374/2001» (RD of chemical agents), <http://goo.gl/faENIX>
- Those annually published by the «Instituto Nacional de Seguridad e Higiene en el Trabajo» (INSHT) (National Institute for Occupational Health and Safety) in «Documento sobre Límites de Exposición Profesional para Agentes Químicos en España» («Document on the limits to occupational exposure to chemical agents in Spain»), <http://goo.gl/vk7TII>
- Those which are in the «Real decreto 665/97» (RD about carcinogenic agents), <http://goo.gl/VxNz33>
- Those which are in the «RD 396/2006», del 31 de marzo, por el que se establecen las disposiciones mínimas de seguridad y salud aplicables a los trabajos con riesgo de exposición al amianto" (RD 396/2006 of 31<sup>st</sup> March, establishing the minimum safety and health requirements applied to works with asbestos exposition risk), <http://goo.gl/TXIVqk>
- Any other occupational exposure values recognized in a specific regulation.

If VLA doesn't exist for one chemical agent, internationally recognized occupational exposure limit values can be used.

The current legislation also indicates that monitoring will not be necessary when it is clearly demonstrated by other evaluation methods that a suitable prevention and protection of the workers has been achieved.

### 9.3.3. Effects

It is useful to know that as soon as the exposure to the chemical agent happens the resulting toxic effects can be of different kinds:

- **Acute and/or chronic effects:** acute effects are those when in short-term exposures the effects are clearly evident as it happens with irritating compounds; on the contrary, chronic effects are those detected after repeated exposures (damage to different organs, nervous system...).
- **Reversible and irreversible effects:** reversible effects are those biological changes that revert when the exposure stops, the previous status is recovered; on the contrary, when the effects are irreversible the produced changes do not recede (completely or partially).
- **Stochastic and non-stochastic effects:** the effects are stochastic when the probability of being produced increases with the received dose; this is the case of carcinogens, mutagens and male and female reproductive toxicants; the effects are not stochastic when the intensity of the severity depends directly on the received dose, as it happens with irritant or systemic toxic effects.
- **Organism accumulation-related effects:**

**Cumulative agents:** agents with negligible or zero speed of elimination that can be accumulated in different organs.

**Non-cumulative agents:** agents with high speed of elimination like many solvents which are already eliminated through the same route of entry and later rapidly through the urine.

**Partially cumulative agents:** these agents are slowly eliminated as it happens with metals. The speed of elimination may not be enough for the daily exposure rate producing an accumulation that will only be mitigated during long periods of rest.

- **Worker sensitisation-related agents:**

Sensitiser chemical agents are substances and preparations that, by inhalation or by skin contact, could cause a hypersensitivity reaction, so that a further exposure to this substance or preparation will cause characteristic negative effects. The exposures to these agents can be produced by the respiratory route, dermal tracts or conjunctiva, and can cause local reactions in exposure routes. Initially, human response to a sensitiser compound can be small or non-existent. Nevertheless, after one person is sensitised, the following exposure can produce intense responses, even to very low concentrations. For some sensitised people, the only way of preventing the immune response to sensitiser agents and to their analogous structural agents is to completely avoid the exposure, in the workplace as well as outside of it.

### 9.3.4. Toxicity information

Although in the laboratory usually small quantities of substances are handled and the exposition is not extended to whole working day, it is very important to know substances toxicological properties and to be extremely cautious when working:

- With substances that present acute toxicity or toxicity in target organs according to the CLP (see corresponding pictograms in the **figure II**).\*
- Carcinogenic, mutagenic or reproductive toxicants (see identification: **figure II**).

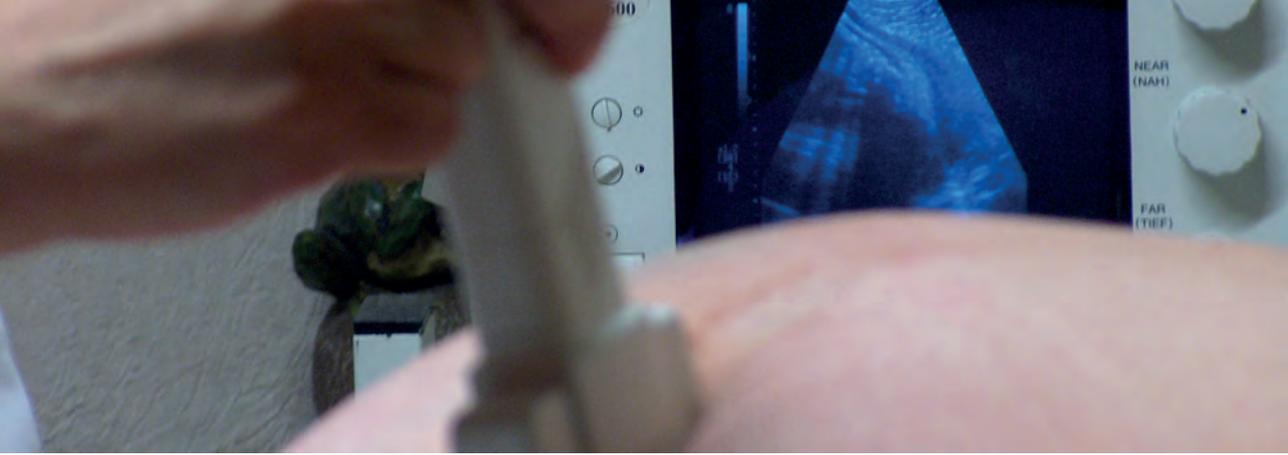
- Inhalation or skin contact sensitisers (H334 statement: May cause allergy or asthma symptoms or breathing difficulties if inhaled, H317 statement: May cause an allergic skin reaction). In addition to it, pictogram GHS07 for skin sensitisation and pictogram GHS8 for respiratory sensitisation.
- Substances which present cumulative effects hazard (H373: May cause damage to organs through prolonged or repeated exposure).
- Substances which can cause irreversible effects (H371: May cause damage to organs).
- Substances which can cause very serious irreversible effects (H370: Causes damage to organs).

In the following chart (Chart IV) there is a classification of chemical substances divided into 5 categories (A, B, C, D and E) according to their intrinsic hazard when they are inhaled. This classification is done depending on the H statements which must appear on the product and on their corresponding safety data sheet. As mentioned before, the risk assessment for workers depends on other factors besides the intrinsic hazard of the products that are used and it must be realized by a qualified technician.

**Chart IV. Intrinsic hazard by inhalation of chemical substances<sup>1</sup>**

A	B	C	D	E
H303, H304, H305, H313, H315, H316, H318, H319, H320, H333, H336 and all H-numbers not otherwise listed	H302, H312, H332, H371	H301, H311, H314, H317, H318, H331, H335, H370, H373	H300, H310, H330, H351, H360, H361, H362, H372	H334, H340, H341, H350

1) The hazard level grows from A to E (taken from COSHH essentials method, Health and Safety Executive).



## 10. SPECIFIC INFORMATION FOR FEMALE WORKERS DURING THEIR FERTILE PERIOD CONSIDERING THE SPECIFIC RISKS DURING PREGNANCY AND BREAST-FEEDING

In the community area, the maternity, in a wider sense, is included in Council Directive 92/85/CEE, of 19<sup>th</sup> October, on the introduction of measures to encourage improvements in the safety and health at work of pregnant workers and workers who have recently given birth or are breastfeeding. <http://goo.gl/YxoGMs>

The mentioned directive is transposed to the Spanish legislation with «Ley 39/1999, de 5 de noviembre, para promover la conciliación de la vida familiar y laboral de las personas trabajadoras» (Act 39/1999 of 5<sup>th</sup> November, to promote the conciliation of family and working life of working people). This act also modified the Article 26 of «Ley 31/1995 de prevención de Riesgos Laborales» (Act 31/1995 on Prevention of Occupational Risks), entirely dedicated to the protection of maternity.

The Annexes of the Directive are transposed by means of the Real Decreto 298/2009, which modified the Reglamento de los Servicios de Prevención (Regulations for Prevention services), clarifying and defining the occupational risk factors that can affect pregnant or breastfeeding workers. Two groups of situations are taken into consideration, according to the risk level, which is detailed in two annexes:

- **Annex VII.** Agents, procedures and working conditions that can influence negatively the health of pregnant workers (non-exhaustive list).
- **Annex VIII.** Agents and working conditions which will have no exposure risk for pregnant workers or in period of breastfeeding.

## 10.1. Chemical agents in Annex VII

They may have a negative effect on the health of pregnant or breastfeeding workers, of the unborn or breastfeeding child.

### 10.1.1. Substances labelled with the following H statements

Note: the corresponding pictogram is also shown:

	H350 May cause cancer H350i May cause cancer if inhaled H351 Suspected of causing cancer H340 May cause genetic defects H341 Suspected of causing genetic defects H361f Suspected of damaging fertility H361d Suspected of damaging the unborn child H361fd Suspected of damaging fertility. Suspected of damaging the unborn child.	CLP Regulation
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Note: The substances and mixtures labelled with the H361f statement (Suspected of damaging fertility) and H360F (May damage fertility) warn about the toxicity for the reproduction (male or female) regarding the fertility. This type of toxicity includes the negative effects on the libido and /or sexual behaviour and /or any aspect of the spermatogenesis or oogenesis, or on the hormonal activity or the physiological response which could interfere:

with the ability to fertilize, or

with the fertilization process itself or the development of the fertilized egg until the implantation phase, including the latter.

### 10.1.2. Other compounds which may involve health risks for the pregnant woman and for the unborn child

- Mercury and mercury derivatives: organic compounds of mercury can have harmful effects to the unborn child (they can stop the growth and affect the nervous system, and in addition organic mercury passes from blood into breast milk).
- Antimitotic drugs (cytotoxic): occupational exposure limits are not known, so the exposure must be avoided or reduced.
- Carbon monoxide: even an occasional exposure might be harmful since CO crosses the placenta and can deprive the unborn child of oxygen.
- Chemical agents of known and dangerous percutaneous absorption (some pesticides are included). H statements: H312, H311 and H310. Take special precautions to avoid this way of exposure.

### 10.1.3. Working procedures

- Manufacture of auramine
- Work involving exposure to aromatic polycyclic hydrocarbons present in coal soots, tar, pitch, fumes or dust
- Work involving exposure to dusts, fumes and sprays produced during the roasting and electro-refining of cupro-nickel mattes
- Strong acid process in the manufacture of isopropyl alcohol
- Work that involves exposure to hardwood dust

## 10.2. Chemical agents in Annex VIII

«Zero» level of exposure must be ensured.

### 10.2.1. Substances labelled with the following H statements

Note: the corresponding pictogram is also shown:

	<p>H360F May damage fertility H360D May damage the unborn child H360FD May damage fertility. May damage the unborn child H360Fd May damage fertility. Suspected of damaging the unborn child H360Df May damage the unborn child. Suspected of damaging fertility *H362 May cause harm to breast-fed children.</p>	CLP Regulation
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\*Note that this phrase only refers to the effects on breastfeeding and it has not an associated pictogram

### 10.2.2. Other compounds

- Lead and lead derivatives as far as they are capable of being absorbed by the human organism.

There is clear evidence that the exposure to lead, both intrauterine as well as after the childbirth, brings problems of development, especially of the nervous system and of the organs of blood formation. The women, new-born babies and small children are more sensitive to lead than male adults; and in addition, lead passes from blood to breast milk with the consequent risk if the woman had suffered an important exposure before and during pregnancy.

- CMR that have not an occupational exposure limit (VLA).

### 10.2.3. Working conditions

- Underground mining work.

For any activity that could involve specific risk of exposure to one of the mentioned agents the employers will have to determine the nature, degree and duration of the exposure in order to be able to:

- Notice any risk for the safety or health as well as any effect on pregnancy or breastfeeding of female workers.
- Determine what measures should be taken. It will be considered that the physiological changes that take place during pregnancy can make the use of PPE inappropriate.

## **ANNEXES**

## Annex 1: List of incompatible substances

Chemical substance	Incompatibilities
Acetylene	Chlorine, bromine, copper, fluorine, silver and mercury.
Acetone	Concentrated nitric acid and mixtures with sulphuric acid.
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides and permanganates.
Hydrocyanic acid	Nitric acid and alkalis.
Chromic acid and chromium	Acetic acid, naphthalene, camphor, glycerine, alcohols and flammable liquids in general.
Anhydride hydrofluoric acid	Ammonia, aqueous or anhydrous.
Concentrated nitric acid	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids and gases, copper, brass and some heavy metals.
Oxalic acid	Silver and mercury.
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, fats and oils.
Sulphuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, as sodium and lithium).
Anhydrous ammonia	Mercury (for example in manometers), chlorine, calcium hypochlorite, iodine, bromine, anhydrous hydrofluoric acid.
Aniline	Nitric acid, hydrogen peroxide.
Azides	Acids.
Bromine	See chlorine.
Activated carbon	Calcium hypochlorite and all oxidising agents.
Cyanides	Acids.
Potassium chlorate	Sulphuric acid and other acids.
Chlorates	Ammonium salts, acids, metal dust, sulphur, finely divided combustible or organic materials.
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane, and other gases from petroleum, hydrogen, sodium carbide, benzene, finely divided metals and turpentine.
Copper	Acetylene and hydrogen peroxide.
Chlorine dioxide	Ammonia, methane, phosphorus and hydrogen sulphide.
Phosphorus (white)	Air, oxygen, alkalis and reducing agents.
Fluorine	All the other chemical substances.
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, sodium peroxide.
Cumene hydroperoxide	Organic and inorganic acids.
Hypochlorite	Acids, activated carbon.
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens.
Materials of arsenic	Some reducing agents.
Mercury	Acetylene, fulminic acid and ammonia.
Alkali metals and alkaline earth metals	Water, carbon tetrachloride, chlorinated hydrocarbons, carbon dioxide and halogens.
Ammonium nitrate	Acids, metal dust, flammable liquids, chlorine compounds, nitrites, sulphur, finely divided combustible organic materials.
Nitrates	Sulphuric acid, ammonium nitrate and other ammonium salts.
Sodium nitrite	Acids.
Nitrites	Inorganic bases and amines.

Nitroparaffins	Water.
Calcium oxide	Oils, fats and hydrogen; flammable liquids, solids or gases.
Oxygen	Sulphuric acid and other acids. See also chlorates.
Potassium perchlorate	Glycerine, ethylene glycol, benzaldehyde, sulphuric acid.
Potassium permanganate	Copper, chromium, iron, most of the metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane and combustible materials.
Hydrogen peroxide	Ethyl and methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulphide, glycerine, ethylene glycol, ethyl and methyl acetate, furfural.
Sodium peroxide	Organic and inorganic acids.
Organic peroxides	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid.
Silver	Carbon tetrachloride, carbon dioxide and water.
Potassium	Reducing agents.
Selenides	Carbon tetrachloride, carbon dioxide, water.
Sodium	Fuming nitric acid and oxidising gases.
Hydrogen sulphide	Acids.
Sulphurous	Reducing agents.
Tellurium and its compounds	Sodium.
Carbon tetrachloride	Acetylene, ammonia (aqueous or anhydrous), hydrogen.

## **Annex 2: H statements and EUH statements**

(Labelling elements/supplementary statements for certain substances and mixtures). CLP Regulation

### **PHYSICAL HAZARDS**

#### **Explosives**

- H200 Unstable explosive.
- H201 Explosive; mass explosion hazard.
- H202 Explosive; severe projection hazard.
- H203 Explosive; fire, blast or projection hazard.
- H204 Fire or projection hazard.
- H205 May mass explode in fire.

#### **Flammable gases**

- H220 Extremely flammable gas.
- H221 Flammable gas.

#### **Flammable aerosols**

- H222 Extremely flammable aerosol.
- H223 Flammable aerosol.

#### **Flammable liquids**

- H224 Extremely flammable liquid and vapour.
- H225 Highly flammable liquid and vapour.
- H226 Flammable liquid and vapour.

#### **Flammable solids**

- H228 Flammable solid.

#### **Self-reactive substances and mixtures / organic peroxides**

- H240 Heating may cause an explosion.
- H241 Heating may cause a fire or explosion.
- H242 Heating may cause a fire.

#### **Pyrophoric liquids**

- H250 Catches fire spontaneously if exposed to air.

#### **Self-heating substances and mixtures**

- H251 Self-heating; may catch fire.
- H252 Self-heating in large quantities; may catch fire.

### Substances and mixtures that, in contact with water, emit flammable gases

- H260 In contact with water releases flammable gases which may ignite spontaneously.
- H261 In contact with water releases flammable gases.

### Oxidising gases

- H270 May cause or intensify fire; oxidiser.

### Oxidising liquids

- H271 May cause fire or explosion; strong oxidiser.
- H272 May Intensify fire; oxidiser.

### Gases under pressure

- H280 Contains gas under pressure; may explode if heated.
- H281 Contains refrigerated gas; may cause cryogenic burns or injury.

### Corrosive to metals

- H290 May be corrosive to metals.

## HEALTH HAZARDS

### Acute oral toxicity

- H300 Fatal if swallowed.
- H301 Toxic if swallowed.
- H302 Harmful if swallowed.

### Aspiration hazard

- H304 May be fatal if swallowed and enters airways.

### Acute skin toxicity

- H310 Fatal in contact with skin.
- H311 Toxic in contact with skin.
- H312 Harmful in contact with skin.

### Skin irritation or corrosion

- H314 Causes severe skin burns and eye damage.
- H315 Causes skin irritation.

### Skin sensitisation

- H317 May cause an allergic skin reaction.

### **Serious eye damage or eye irritation**

- H318 Causes serious eye damage.
- H319 Causes serious eye irritation.

### **Acute toxicity (by inhalation)**

- H330 Fatal if inhaled.
- H331 Toxic if inhaled.
- H332 Harmful if inhaled.

### **Respiratory sensitisation**

- H334 May cause allergy or asthma symptoms or breathing difficulties if inhaled.

### **Specific target organ toxicity (single exposure)**

- H335 May cause respiratory irritation.
- H336 May cause drowsiness or dizziness.

### **Germ cell mutagenicity**

- H340 May cause genetic defects (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).
- H341 Suspected of causing genetic defects (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

### **Carcinogenicity**

- H350 May cause cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).
- H351 Suspected of causing cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

### **Reproductive toxicity**

- H360 May damage fertility or the unborn child (state specific effect if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).
- H361 Suspected of damaging fertility or the unborn child (state specific effect if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).
- H362 May cause harm to breast-fed children.

### **Specific target organ toxicity (single exposure)**

- H370 Causes damage to organs (or state all organs affected, if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).
- H371 May cause damage to organs (or state all organs affected, if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

### Specific target organ toxicity (repeated exposures)

- H372 Causes damage to organs <or state all organs affected, if known> through prolonged or repeated exposure <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>.
- H373 May cause damage to organs (or state all organs affected, if known) through prolonged or repeated exposure (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

### Combined hazard statements

- H300 + H310 Fatal if swallowed or in contact with skin.
- H300 + H330 Fatal if swallowed or if inhaled.
- H310 + H330 Fatal in contact with skin or if inhaled.
- H300 + H310 + H330 Fatal if swallowed, in contact with skin or if inhaled.
- H301 + H311 Toxic if swallowed or in contact with skin.
- H301 + H331 Toxic if swallowed or if inhaled.
- H311 + H331 Toxic in contact with skin or if inhaled.
- H301 + H311 + H331 Toxic if swallowed, in contact with skin or if inhaled.
- H302 + H312 Harmful if swallowed or in contact with skin.
- H302 + H332 Harmful if swallowed or if inhaled.
- H312 + H332 Harmful in contact with skin or if inhaled.
- H302 + H312 + H332 Harmful if swallowed, in contact with skin or if inhaled.

### Additional codes (Annex VI)

- H350i May cause cancer by inhalation.
- H360F May damage fertility.
- H360D May damage the unborn child.
- H361f Suspected of damaging fertility.
- H361d Suspected of damaging the unborn child.
- H360FD May damage fertility. May damage the unborn child.
- H361fd Suspected of damaging fertility. Suspected of damaging the unborn child.
- H360Fd May damage fertility. Suspected of damaging the unborn child.
- H360Df May damage the unborn child. Suspected of damaging fertility.

### ENVIRONMENT HAZARDS

- H400 Very toxic to aquatic life.
- H410 Very toxic to aquatic life with long lasting effects.

- H411 Toxic to aquatic life with long lasting effects.
- H412 Harmful to aquatic life with long lasting effects.
- H413 May cause long lasting harmful effects to aquatic life.
- H420 Harms public health and the environment by destroying ozone in the upper atmosphere.

## **SUPPLEMENTARY HAZARD STATEMENTS**

### **Physical properties**

- EUH 001 Explosive when dry
- EUH 006 Explosive with or without contact with air.
- EUH 014 Reacts violently with water.
- EUH 018 In use may form flammable/explosive vapour-air mixture.
- EUH 019 May form explosive peroxides.
- EUH 044 Risk of explosion if heated under confinement.

### **Health properties**

- EUH 029 Contact with water liberates toxic gas.
- EUH 031 Contact with acids liberates toxic gas.
- EUH 032 Contact with acids liberates very toxic gas.
- EUH 066 Repeated exposure may cause skin dryness or cracking.
- EUH 070 Toxic by eye contact.
- EUH 071 Corrosive to the respiratory tract.

### **Supplemental hazard information for certain substances and mixtures**

- EUH 201 Contains lead. Should not be used on surfaces liable to be chewed or sucked by children.
- EUH 201A Warning! Contains lead.
- EUH 202 Cyanoacrylate. Danger. Bonds skin and eyes in seconds. Keep out of the reach of children.
- EUH 203 Contains chromium (VI). May produce an allergic reaction.
- EUH 204 Contains isocyanates. May produce an allergic reaction.
- EUH 205 Contains epoxy constituents. May produce an allergic reaction.
- EUH 206 Warning! Do not use together with other products. May release dangerous gases (chlorine).
- EUH 207 Warning! Contains cadmium. Dangerous fumes are formed during use. See information supplied by the manufacturer. Comply with the safety instructions.
- EUH 208 Contains (name of sensitising substance). May produce an allergic reaction.
- EUH 209 Can become highly flammable in use.

EUH 209A Can become flammable in use.

EUH 210 Safety data sheet available on request.

EUH 401 To avoid risks to human health and the environment, comply with the instructions for use.

### **Annex 3: P statements**

(Precautionary statements). CLP Regulation

#### **General**

- P101 If medical advice is needed, have product container or label at hand.
- P102 Keep out of reach of children.
- P103 Read label before use.

#### **Precautionary Statement: Prevention**

- P201 Obtain special instructions before use.
- P202 Do not handle until all safety precautions have been read and understood.
- P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
- P211 Do not spray on an open flame or other ignition source.
- P220 Keep/Store away from clothing/.../combustible materials.
- P221 Take any precaution to avoid mixing with combustibles/...
- P222 Do not allow contact with air.
- P223 Keep away from any possible contact with water, because of violent reaction and possible flash fire.
- P230 Keep wetted with ...
- P231 Handle under inert gas.
- P232 Protect from moisture.
- P233 Keep container tightly closed.
- P234 Keep only in original container.
- P235 Keep cool.
- P240 Ground/bond container and receiving equipment.
- P241 Use explosion-proof electrical/ventilating/lighting/.../ equipment.
- P242 Use only non-sparking tools.
- P243 Take precautionary measures against static discharge.
- P244 Keep reduction valves free from grease and oil.
- P250 Do not subject to grinding/shock/.../friction.
- P251 Pressurized container: Do not pierce or burn, even after use.
- P260 Do not breathe dust/fume/gas/mist/vapours/spray.
- P261 Avoid breathing dust/fume/gas/mist/vapours/spray.

- P262 Do not get in eyes, on skin, or on clothing.
- P263 Avoid contact during pregnancy/while nursing.
- P264 Wash ... thoroughly after handling.
- P270 Do not eat, drink or smoke when using this product.
- P271 Use only outdoors or in a well-ventilated area.
- P272 Contaminated work clothing should not be allowed out of the workplace.
- P273 Avoid release to the environment.
- P280 Wear protective gloves/protective clothing/eye protection/face protection.
- P281 Use personal protective equipment as required.
- P282 Wear cold insulating gloves/face shield/eye protection.
- P283 Wear fire/flame resistant/retardant clothing.
- P284 Wear respiratory protection.
- P285 In case of inadequate ventilation wear respiratory protection.
- P231+P232 Handle under inert gas. Protect from moisture.
- P235+P410 Keep cool. Protect from sunlight.

**Precautionary Statement: Response**

- P301 IF SWALLOWED:
- P302 IF ON SKIN:
- P303 IF ON SKIN (or hair):
- P304 IF INHALED:
- P305 IF IN EYES:
- P306 IF ON CLOTHING:
- P307 IF exposed:
- P308 IF exposed or concerned:
- P309 IF exposed or if you feel unwell:
- P310 Immediately call a POISON CENTER or doctor/physician.
- P311 Call a POISON CENTER or doctor/physician.
- P312 Call a POISON CENTER or doctor/physician if you feel unwell.
- P313 Get medical advice/attention.
- P314 Get medical advice/attention if you feel unwell.
- P315 Get immediate medical advice/attention.
- P320 Specific treatment is urgent (see ... on this label).

- P321 Specific treatment (see ... on this label).
- P322 Specific measures (see ... on this label).
- P330 Rinse mouth.
- P331 Do NOT induce vomiting.
- P332 If skin irritation occurs:
- P333 If skin irritation or rash occurs:
- P334 Immerse in cool water/wrap in wet bandages.
- P335 Brush off loose particles from skin.
- P336 Thaw frosted parts with lukewarm water. Do not rub affected area.
- P337 If eye irritation persists:
- P338 Remove contact lenses, if present and easy to do. Continue rinsing.
- P340 Remove victim to fresh air and keep at rest in a position comfortable for breathing.
- P341 If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing.
- P342 If experiencing respiratory symptoms:
- P350 Gently wash with plenty of soap and water.
- P351 Rinse cautiously with water for several minutes.
- P352 Wash with plenty of soap and water.
- P353 Rinse skin with water/shower.
- P360 Rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
- P361 Remove/Take off immediately all contaminated clothing.
- P362 Take off contaminated clothing and wash before reuse.
- P363 Wash contaminated clothing before reuse.
- P370 In case of fire:
- P371 In case of major fire and large quantities:
- P372 Explosion risk in case of fire.
- P373 DO NOT fight fire when fire reaches explosives.
- P374 Fight fire with normal precautions from a reasonable distance.
- P375 Fight fire remotely due to the risk of explosion.
- P376 Stop leak if safe to do so.
- P377 Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
- P378 Use ... for extinction.

P380	Evacuate area.
P381	Eliminate all ignition sources if safe to do so.
P390	Absorb spillage to prevent material damage.
P391	Collect spillage.
P301+P310	IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P301+P312	IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
P301+P330 +P331	IF SWALLOWED: rinse mouth. Do NOT induce vomiting.
P302+P334	IF ON SKIN: Immerse in cool water/wrap in wet bandages.
P302+P350	IF ON SKIN: Gently wash with plenty of soap and water.
P302+P352	IF ON SKIN: Wash with plenty of soap and water.
P303+P361+P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P306+P360	IF ON CLOTHING: rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
P307+P311	IF exposed: Call a POISON CENTER or doctor/physician.
P308+P313	IF exposed or concerned: Get medical advice/attention.
P309+P311	IF exposed or if you feel unwell: Call a POISON CENTER or doctor/physician.
P332+P313	If skin irritation occurs: Get medical advice/attention.
P333+P313	If skin irritation or rash occurs: Get medical advice/attention.
P335+P334	Brush off loose particles from skin. Immerse in cool water/wrap in wet bandages.
P337+P313	If eye irritation persists: Get medical advice/attention.
P342+P311	If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician.
P370+P376	In case of fire: Stop leak if safe to do so.
P370+P378	In case of fire: Use ... for extinction.
P370+P380	In case of fire: Evacuate area.
P370+P380+P375	In case of fire: Evacuate area. Fight fire remotely due to the risk of explosion.
P371+P380+P375	In case of major fire and large quantities: Evacuate area. Fight fire remotely due to the risk of explosion.

**Precautionary Statement: Storage**

- P401 Store...
- P402 Store in a dry place.
- P403 Store in a well-ventilated place.
- P404 Store in a closed container.
- P405 Store locked up.
- P406 Store in corrosive resistant/... container with a resistant inner liner.
- P407 Maintain air gap between stacks/pallets.
- P410 Protect from sunlight.
- P411 Store at temperatures not exceeding ...°C/...°F.
- P412 Do not expose to temperatures exceeding 50°C/ 122°F.
- P413 Store bulk masses greater than ... kg/... lbs at temperatures not exceeding ...°C/...°F.
- P420 Store away from other materials.
- P422 Store contents under ...
- P402+P404 Store in a dry place. Store in a closed container.
- P403+P233 Store in a well-ventilated place. Keep container tightly closed.
- P403+P235 Store in a well-ventilated place. Keep cool.
- P410+P403 Protect from sunlight. Store in a well-ventilated place.
- P410+P412 Protect from sunlight. Do not expose to temperatures exceeding 50°C/ 122°F.
- P411+P235 Store at temperatures not exceeding ...°C/...°F. Keep cool.

**Precautionary Statement: Disposal**

- P501 Dispose of contents/container to ...
- P502 Refer to manufacturer/ supplier for information on recovery/recycling

#### **Annex 4: Telephones of general interest**

- Toxicological emergencies 915 620 420
- Emergency call centre / Civil Protection 112
- Healthcare 061
- Enterprise's occupational risk-prevention service [                      ]

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