# SAFETY STANDARDS IN RESEARCH LABORATORIES

*Text approved by the Executive Committee on 23 February 1999*

These rules constitute **a minimum set of recommendations and obligations** that must be known and complied with by all persons working in the laboratories of the department.

**The Director of Research is the person directly responsible for the safety of everyone working under his or her responsibility**. He or she shall inform them of these rules and obtain their compliance by signing a bulletin which shall be deposited with the secretary's office of the Department.

It should be noted that the legal provisions referring to laboratory accidents largely involve the teachers, who do not exempt themselves from their responsibility just by warning the student about compliance with the safety rules but **must make use of their authority to ensure that they are complied with** (Law 31/95, BOE of 10 November 1995, p. 32590).

## INDEX

# THE USE OF THE LABORATORY

## Safety Elements

Before starting work in the laboratory, you should familiarise yourself with the safety elements available. You need to locate all the ***exits***, emergency or otherwise, in case of a possible evacuation due to fire or any other incident. You need to know the exact location of fire extinguishers, ***fire blankets***, ***safety showers*** and ***eyewash facilities***. The Director of Investigation, or the person delegated by him/her, will show you how they work.

***Gas masks*** and the different types of filters must be known, which obviously have to be suitable for each need. However, ***face shields*** for transferring acids or any other corrosive substance.

The ***fume cupboard*** is the appropriate place for any hazardous operation where toxic or flammable vapours are given off: never a place to store products. ***Electrical sockets*** must be in perfect condition; if any damage is observed, they must be repaired immediately.

**Never work alone in a laboratory**

## The condition of the work area

Always keep the work area clean and tidy, free of books and coats, bags, spilled chemicals, excess product containers, unnecessary equipment or useless things. All spilled chemicals must be cleaned up immediately.

## Conduct inside the laboratory

It must be correct: no horseplay, running, running, playing, shouting, etc. If you listen to music, try to keep the volume down to avoid disturbing others.

## Handling chemicals

Chemicals can be dangerous because of their toxic, corrosive, flammable or explosive properties. All of them must be handled with great care. You can find all the information in **the safety data sheets of the reagents**:

Sources of information Þ internet (http://www.mtas.es/insht/ipcsnspn/spanish.htm)

Þ CD's from supliers

Most containers with pictograms indicate the type of risk associated with the substance they contain. On the other hand, chemical catalogues provide information on the hazards associated with each of the compounds and give some advice on their handling. The most common is the use of so-called R-phrases (risk phrases) and S-phrases (safety advice), which are usually found on the front pages of catalogues (see Aldrich, Panreac, Sigma, Fluka, etc.). Of course, you must know the meaning of the pictograms and interpret the R- and S-phrases.

Do not inhale chemical vapours and work whenever possible in fume cupboards, especially when handling toxic, irritant, corrosive or tear gas products.

Avoid skin contact with chemicals, especially those that are toxic and corrosive; in these cases, it is recommended that you wear disposable gloves.

Always use special equipment for pipetting liquids; do not do it directly with your mouth.

At the end of any work or operation, tidy up the materials and reagents used, avoiding their accumulation outside the specific places for storing them; make sure to disconnect equipment, running water, gases, etc.

# PERSONAL PROTECTION

## Eye protection

***The use of safety glasses is mandatory whenever you are in the laboratory***.

Do not wear contact lenses, as in the event of an accident, chemicals splashed into your eyes, or their vapours can quickly pass behind the lenses and damage your eyes before you can remove them. We recommend that you wear prescription glasses or closed safety glasses.

Where there is an immediate risk of splashes or splashes, e.g., when transferring acids, alkali or cryogenic liquids, a full-face shield should be worn.

## Clothing

***The use of a gown*** (cotton) is mandatory, as no matter how carefully you work, chemical splashes are unavoidable.

The main advantage of the gown is that it is easy to take off, which makes its protection against splashes and spills obvious. It is totally inappropriate to wear gowns with buttons at the back. Gowns should always be worn buttoned up to prevent them from getting caught on labware and equipment.

It is advisable not to wear mini-skirts, shorts or tights, as these are made of synthetic fibres and will stick to the skin when in contact with certain chemicals, and it is recommended to wear closed shoes rather than sandals.

Long hair is a risk that you can easily avoid if you tie it up in a ponytail.

It is counterproductive to wear high heels (they do not allow you to run in case of fire), watches, bracelets, rings and any other type of jewellery (solvents and toxic products can remain between these pieces and the skin; they can get caught on protruding parts, causing cans to spill or delaying the escape in case of danger).

## Gloves

They can be very helpful if they are used correctly. They should be checked for holes or cuts each time they are used: wearing a glove with a hole in it is more dangerous than not wearing it, as the toxic or abrasive substance is concentrated between the skin and the glove; wearing one that is permeable to a toxic or abrasive product is useless. The permeability of a glove to a given substance depends on the material used in its manufacture.

The usual latex rubber gloves are good against organic acids and acceptable against inorganic acids and bases (except nitric acid); however, they are attacked by aromatic and chlorinated hydrocarbons, and are not recommended for working with carbon sulphide. In order to avoid contamination, they should be washed and removed when leaving the laboratory, when picking up the telephone, when writing in a notebook, etc.

### Hygiene rules

- Never eat or drink in the laboratory because food and drink can be contaminated with chemicals.
- Wash your hands after doing an experiment and also before leaving the laboratory.
- You are not allowed to wear your lab coat to the bar or any other place where food is consumed.
- Smoking is not allowed in the Chemistry Department (C7 even and odd), on any of the floors -1 to 5, or in the laboratories, for health and safety reasons.

# SAFETY ROUTINES

## FIRE PREVENTION

Large quantities of solvents should not be stored in laboratories; the essential ones should be kept in fireproof cabinets.

The use of hot plates is recommended instead of Bunsen burners; if this is not possible, make sure that there are no solvents or flammable products in the vicinity.

Electrical cables should be well insulated; sockets should be protected from splashing or leaking water; electrical appliances should be earthed; motors of mechanical stirrers should not spark or, if this cannot be avoided, should be kept away from backflows and any flammable vapours.

Low ignition temperature solvents must not be brought near cookers, ovens or hotplates. Handle with extreme caution products that can ignite when in contact with water.

## ACCIDENT PREVENTION

**Glass material**

It is obvious that glassware is dangerous because it can break and cause cuts; furthermore, if a glass container breaks in the course of a reaction, chemicals can spill or be projected outside.

Never use damaged glassware. Glass parts of any assembly must be held tightly, but without tension. *Broken glass must be stored in special containers*.

**Transport of chemicals**

The transport of chemicals is a dangerous operation in itself, which is why it must be carried out with great care. The transport of large quantities of (many) products at the same time must be avoided. They should never be worn close to the body. Lifts should not be used; if this cannot be avoided, *products and persons should be carried separately*.

**Liquefied, compressed and dissolved gases**

Gas cylinders must always be kept in their special storage room (rooftop gas house), from which they must be removed only when they are to be used; they must be returned immediately after use. Stored cylinders, even empty ones, must have their cap or protective cap and valve closed; the movable caps protecting the valve must be kept screwed on the cylinder until the moment of use.

Before using a cylinder of liquefied or dissolved gases, ensure that it is in an upright position and securely fastened by chains: these may be fixed or portable; they must be installed in all laboratories where gas cylinders are used and, in the place, where they are most likely to be used.

If valves have difficulty in opening or closing, or are stuck, instructions should be sought from the supplier; lubricants should never be used.

Connections to pipes, regulators and any other apparatus must always be well maintained and watertight in order to prevent leakage; the sleeves used must be in good condition.

The transport of cylinders shall be carried out using special trolleys, which have a safety restraint in the upper third. These trolleys must be in perfect condition: if any defects are detected, they must be removed immediately and repaired.

*Whenever possible, the laboratories on the 5th floor should be used for any work involving toxic, flammable or explosive gases.*

**Liquefied gases (liquid nitrogen)**

In general, liquefied gases are, at atmospheric pressure, boiling at very low temperatures (Nitrogen: -196 °C).

When starting to fill containers and because they are still at room temperature, the boiling is very fast and energetic at the beginning; therefore, splashes of liquefied gas are easily produced, which makes it necessary to protect hands and face.

As for transport, it has to be done in small, covered containers.

Direct contact with cryogenic liquids can cause severe frostbite or cold "burns", with splashes in the eyes being particularly serious. On the other hand, if the skin is the affected part, it has a waxy appearance (pale yellowish colour) when frozen, it is often harmless. However, thawing causes severe pain, swelling, redness and risk of infection.

Insulating gloves made of a dry material that does not shrink or tear easily at low temperatures should be worn; they should be loose enough so that they can be pulled off quickly if cryogenic liquid has penetrated. The sleeves of the gloves must be specially designed to prevent easy penetration of the liquid. Face protection must also be worn when a cryogenic liquid is to be packaged; the usual goggles are incomplete protection.

One litre of liquid nitrogen produces 690 litres of gaseous nitrogen at 15 °C; adequate ventilation is therefore required where liquefied gases are used in open containers. Nitrogen is harmless, but if the oxygen content by displacement of the nitrogen is reduced below 15%, asphyxiation can occur.

**Hazardous operations**

- refluxing and distillations/reactions: nothing must be heated that is clogged.
- use of vacuum lines
- use of autoclaves
- handling liquid nitrogen
- distillation of solvents/anhydride, etc.

**Storage**

The bunker is a suitable place for storing large quantities of products, which must always remain conveniently tidy. In spite of this and for reasons of convenience, it is customary to store considerable quantities of compounds in laboratories, which can be done with the necessary precautions. In any case, *the following rules must be observed*:

- all products, without exception, must be properly marked and labelled; no one may use a product from a container that is not properly labelled.
- significant quantities of solvents (about 20 litres) may be stored in safety cabinets; it is very dangerous to store different solvent drums in the same room
- corrosive substances may not be placed above eye level
- in principle, waste must have its own storage room (bunker). Substances which react violently on contact with each other (e.g. chlorate derivatives and ammonia, oxidising and reducing agents in general) or release toxic gases (e.g. acids and cyanides) must be stored separately.

**Cold rooms on the 3rd and 4th floors**

1. The cold room is not a warehouse; it is used to store products which, due to their nature, require it. The products must be hermetically sealed in boxes, which should be numbered or marked; it is advisable for each laboratory to have a list of the contents of each box (there should therefore be no products outside the boxes in the cold room, especially if they are toxic or have an unpleasant odour). If this rule is strictly followed, there is no reason whatsoever to have product vapours inside the chamber.
2. *When you want to remove or store a product in the chamber, the following procedure has to be followed:*

- consult the list of each laboratory for the box from which the product is to be removed or stored; in the meantime, the purge button of the chamber can be activated, whereby the red light on the door will turn on.
- once the red light has gone out, the door can be opened, the closed box can be taken out or put in, and then the door can be closed; in doing so, *there is no reason for the chamber to be open for more than 30 seconds.*
- take the closed box to a display case, where it can be opened to take out or sort the product; when finished, close the box again.
- if, at the end of the last operation, 2 minutes have not yet elapsed since the chamber was opened, the door can be opened again to sort the box, without activating the purge system; otherwise, the system must be activated again and wait for the red light to go out.
- At the end of the operation, make sure that both the box and the refrigerator door are perfectly closed. To return the box to its place, the chamber does not need to be open for more than 30 seconds.

This regulation implies that *it is strictly forbidden*:

a) to have products in the chamber outside the boxes.

b) entering the chamber without the purge system having cycled (red light off).

c) to open the boxes inside the chamber.

**Mechanical hazards**

All moving parts of the equipment must be well protected (vacuum pumps). The risk of collapse or implosion is inherent in all vacuum systems; to reduce the danger of flying glass shards in the event of implosion, containers with a volume greater than 1 litre must be protected either by a metal screen or by wrapping them with strong tapes.

## ACTION IN THE EVENT OF AN ACCIDENT

**Telephone numbers:** **emergency: 112**

**campus security: 25 25**

### Fire in the laboratory

Evacuate, even if the fire is not significant. Warn all colleagues without spreading panic and always remain calm.

***Minor fires***

If the fire is small and localised, extinguish it using a suitable extinguisher, sand or by covering the fire with a suitably sized container to smother it. Remove chemicals from around the fire.

Never use water to extinguish a fire caused by the ignition of a solvent.

***Major fires***

Isolate the fire. Use appropriate extinguishers. If the fire cannot be brought under control quickly, evacuate the building. In extreme cases, sprinklers may be used.

**Fire on the body**

- If your clothes catch fire, shout immediately for help; reach down to the ground and roll around to extinguish the flames. Do not run or try to get to the safety shower unless it is very close to you; if you run, the fire may grow.
- It is everyone's responsibility to help someone who is burning. Cover them with a fire blanket, carry them to the safety shower if they are close by or roll them on the ground. Never spray them with a fire extinguisher.
- Do not try to remove the suits that are stuck to the skin, cut them off with scissors.

Once the fire is out, keep the person seated, make sure he/she does not get cold and call for medical assistance.

The fire must be attacked from a position that allows escape. If a fire that has just started is not brought under control quickly enough, it is advisable to flee. Whoever tackles the fire must avoid breathing the gases and dust that are generated.

**Burns**

Small burns caused by hot material, baths, hot plates or blankets, etc., should be treated by washing the affected area with cold water for 10-15 minutes.

In case of burns caused by chemical products, seek information about their toxicity and act accordingly. Whenever there is inflammation or redness, seek medical advice.

**Injuries in the form of cuts**

Cuts caused by broken glassware are a common laboratory hazard: they should be washed thoroughly with plenty of running water for at least 10 minutes. If they are small and the blood is soon restored, they should be washed with soap and water and wrapped with a suitable bandage or dressing; if they are large and do not stop bleeding, immediate medical assistance should be sought.

If medical attention is required, it is very important to specify which compound or mixture has come into contact with the wound.

**Injuries to the eye caused by corrosive substances**

In this case the time factor is essential (less than 10 seconds); the sooner the eye is washed out, the less serious the damage will be.

- Both eyes should be flushed with plenty of running water for at least 15 minutes in an eyewash; the eyes should be held open with the help of the fingers to facilitate the passage of water under the eyelids.
- Never direct a high-pressure stream of water from a tap directly into the eye, as this could injure the eye.
- Always seek medical attention, even if the injury is small.

**Skin wounds caused by corrosive substances**

- Any chemical that comes into contact with the skin must be washed off immediately with plenty of running water for at least 15 minutes. The safety showers installed in the laboratories should be used in cases where the affected body area is large enough or where the sink in a sink is not sufficient.
- All contaminated clothing should be removed from the affected person as soon as possible under the shower. If jumpers or shirts have to be removed, take care not to contaminate the eyes; if necessary, cut or tear the clothes.
- Go quickly to the emergency room and report the nature of the poisonous product very precisely and make sure that the medical staff understands it correctly (an accident with hydrochloric acid requires a completely different treatment from one with hydrofluoric acid, even though both are hydrazides of the halogen group).

**Cold and frostbite injuries**

- Do not attempt to remove suits that have become stuck to the skin due to freezing moisture, as this could cause serious injury.
- Do not heat the casualty directly; transport him/her to a warm place (approx. 22°C).
- If there is no immediate possibility of qualified medical treatment, appropriate measures should be taken to get the casualty to a hospital as soon as possible. In the meantime, the following should be taken into account:
- Loosen all clothing that may hinder the circulation of blood to the affected part of the body.
- Spray the injured areas with plenty of lukewarm water. CAUTION: contact with hot water (temperature above 42°C) or any other form of heat is dangerous.

- Protect the affected parts by covering them with dry, sterile gauze and do not compress them so as not to impede blood circulation.
- Immobilise the area around the wound.

**Corrosions caused by acids**

Cut or tear acid-soaked clothing as soon as possible; wash the affected area with plenty of running water; neutralise the acidity with sodium hydrogen carbonate for 15-20 minutes; remove the excess paste that has formed in the wound, dry it and apply a lime oil liniment or similar.

**Alkali corrosions**

Wash the affected area with plenty of running water and rinse it with a 1% acetic acid solution; dry it and apply a tannic acid ointment.

**Ingestion of chemicals**

Call for medical assistance before any specific action is taken.
If the patient is unconscious, put him in an inclined position, with his head on one side and stick out his tongue forward; if he is conscious, have him lean against the wall, cover him with a blanket to keep him warm.
Be prepared to give mouth-to-mouth resuscitation; do not leave him in the sun.
Do not give alcoholic drinks hastily without knowing the identity of the product ingested, because alcohol increases the absorption of most toxic substances.
Do not make him vomit if the product ingested is corrosive.

**Chemical inhalation**

- Try to identify the toxic vapour; use the appropriate type of gas mask for the duration of the rescue operation.
- If the mask you have available is not suitable, but you must be in contact with toxic vapours, you should hold your breath for as long as you can.
- Take the affected person immediately to a shady and cool place. Seek medical assistance as soon as possible.
- If you notice a first sign of breathing difficulty, start artificial respiration by mouth (pure oxygen can only be administered by qualified personnel) and continue it until told to do so by a doctor.

**Electric shocks**

- If the casualty remains in contact with the electrical circuit, great care must be taken to ensure that those trying to help him are not caught; the best course of action is to disconnect the current.
- In case of circulatory shock, call a doctor immediately and keep the victim still and comfortable. Do not give any kind of stimulant.

## ALARMS I EVACUATION PLAN

**In the event of an alarm, leave the laboratory and find out the reason for the alarm.**

- In the event of an evacuation warning, turn off the electricity and gas by pressing the red emergency stop button located in each laboratory; do not turn off the water and leave.
- Devices that cannot be left without power should be connected to the UPS beforehand.

## REPORTING AN ACCIDENT

After an accident, you must always report the accident by filling in the relevant forms and depositing them in the secretary's office of the Department.