Health and safety at the CNRS

Useful information for new agents

Secretariat general

General inspection of health and safety

DECEMBER 2002

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Foreward

Research is a fascinating but not risk-free activity. As a new member of the CNRS team, you must be acutely aware of this reality; prevention must become a permanent part of your daily activities.

The present guide, which you should read carefully, was designed to help you better understand your role in prevention.

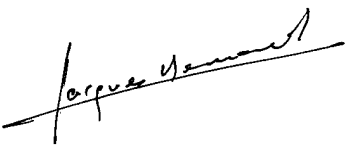
The guide presents different types of hazard, information being the first step of prevention; you will learn the appropriate steps to take to fight against these hazards.

For complete information, this booklet is only an introduction to prevention, you should get in contact with the Agent in charge of the health and safety regulations in your unit (ACMO) who will provide you with a detailed description of the specific hazards in your unit and the different measures of prevention; it would also be useful to participate in special training sessions that will be proposed, particularly if your activity exposes you to specific hazards.

The safety of people and equipment as well as environmental protection are permanent goals of the CNRS direction. Prevention must be a common action shared by all. I am counting on your participation in our joint effort to preserve the personal safety of you and your colleagues.

JACQUES BERNARD

Secretary general



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OPERATIONAL STRUCTURES FOR CONTROL AND GUIDANCE

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NATIONAL INSTITUTE LEVEL

- Institute inspection of health and safety
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REGIONAL LEVEL

- Regional inspection of health and safety
  (see each delegation)

CNRS safety policy

The rules of health, safety, and preventive medicine applied in public services in France – and thus in all public facilities working in scientific and technological domains – are set out in decree n° 82-453 enacted on May 28, 1982 and decree n° 95-680 enacted on May 9, 1995. Detailed rules of application are presented in the inter-ministry memorandum of January 24, 1996 (FP/4 n° 1871).

All of these regulatory instruments are applicable to the CNRS. Specific definitions of this application have been reiterated in two general instructions for internal use signed by the general director on July 4, 1996, the first concerning health and safety, the second concerning preventive medicine. All these fundamental documents can be found in a special issue of the CNRS Official Bulletin dated September 1996.

In general, the rules applied at the CNRS are set out in the French Statutes of Labour Law *(Code du travail, titre III, livre II)*. Certain aspects concerning public services are detailed in decrees, others in internal instructions.

Each **research unit director** thus has a health and safety remit for all of the personnel working under his/her direction. To assure this remit, the director is assisted by a designated agent (**ACMO**, *agent chargé de la mise en œuvre*) working under his/her authority who is in charge of health and safety rules.

The application of the regulations is verified by a **control and guidance agent** in each delegation. These regional inspectors (IRHS), who work independently, are attach to the general inspection which reports directly to the general director. In certain cases, **outside inspectors** may be called in.

A **preventive medicine physician** monitors the personnel's health and evaluates workplace hazards. All personnel attend a mandatory medical consultation every five years. Shorter intervals between consultations may be defined by the physician for agents working at a post particularly exposed to risk or those with a particular health problem.

Measures taken to improve safety are determined by the managment and the personnel working together in **committees for health and safety (CHS)**: the special health and safety committee for each unit and for each institution, as well as for each research unit whenever warranted by the number of agents or the level of risk. Representatives of the personnel, designated by the most representative worker's union, participate in these committees. Questions of safety are debated regularly within these committees which propose solutions to the appropriate authorities; the circumstances of workplace accidents are also examined and preventive measures are studied.

Finally, it should be recalled that any agent may leave his/her specific post if he/she believes there is **a serious and imminent danger**. This agent must, of course, inform his supervisor of his absence which should not lead to even greater danger. The director of the unit, accompanied by a member of the health and safety committee will investigate the situation immediately. The director will then take the measures necessary to resolve the situation.

Likewise, if a member of the health and safety committee becomes aware of a cause of danger, he/she will advise the head of the service and demand an inquiry, and, in the case of a conflict of opinion concerning the reality of the danger, demand a meeting of the competent health and safety committee within twenty-four hours.

Accident prevention

Lack of experience, insufficient knowledge of equipment and operating procedures, and hasty execution of tasks are frequent causes of accidents.

A large number of dangerous situations can be avoided by the correct application of guidelines and operating procedures.

Preventing accidents involves:

Education

Agents can learn from unit heads or colleagues, from the different safety agents (ACMO, IRHS, CHS members…), or from documents describing the hazards of the manipulation to be performed.

Information sessions are organised for new agents. These sessions may be organised within the framework of the general information days organised by the CNRS delegations or specifically to discuss the health and safety problems of a given unit. In the latter case, the sessions are organised within the unit under the direction of the ACMO.

Health and safety training sessions are also organised by the CNRS. These sessions are devoted to specific hazards, or to general methods for analysing workplace hazards and their prevention.

Information

Agents are called upon to draw to the attention of their fellow workers any danger which may result from specific manipulations.

A notice of hazardous situations must be posted but, to be efficient, must be clear and realistic and removed as soon as the danger has been alleviated.

Any incident or accident must be reported, whatever circumstances, to the ACMO or the IRHS.

It is the collective duty of all agents to participate in the prevention programme of the CNRS.

Verification

Before a manipulation, equipment to be used (glassware, detection devices,

shields, extraction hoods, safety equipment…) must be checked and tested.

For chemical products, all doubtful or soiled products, old products susceptible to decomposition (peroxides, etc.) must be tested and eliminated. Special attention should be given to stabilised products, products stocked for a long period, or redistilled products since stabilising agents may deteriorate or become ineffective. Warnings on labels must be respected and non-stabilised products must not be stored for prolonged periods.

All products which have been transferred to another container as well as all new mixtures must be labelled correctly (standard name or abbreviation of the product or mixture, date, name of the person who made the mixture). A notice giving the appropriate emergency phone numbers (physician, emergency squad, fire department, etc.) must be posted near the workstation.

Protection

Appropriate equipment must be available in each laboratory, for the protection of personnel and the laboratory in general, during the course of normal activity as well as during particularly hazardous circumstances (accident, incident).

Each agent should learn how to use protection equipment (extraction hoods, detection devices, etc.) and localise emergency showers, protective blankets, fire hydrants, first-aid kit, extinguishers, etc.

Agents must comply with recommendations for the use of personal protection devices (protective glasses and goggles, gloves, masks, shoes, screens, etc.).

Protect your

- **eyes**: wear safety glasses in the laboratory, workshops, or whenever there is a possible risk of explosion;
- **hands**: wear gloves when manipulating aggressive substances, or use a thick cloth, to insert glass tube, thermometers, etc. in rubber stoppers; throw away all broken or damaged glassware.
- **feet**: wear safety shoes in workshops or handling units.

Organisation of working procedures and identification of dangerous situations

Before starting a procedure or a manipulation, identify all the operations and working areas involved. More than one operation going on in a single working area is a potentially dangerous situation. Operations requiring more than one working area, a frequent situation, also create potential danger.

Concentration procedures (extraction, distillation, rectification) conducted under vacuum or pressure or with heated chemical substances create dangerous situations. These procedures should be conducted in a quiet setting taking into account the possibility of anomalous situations (excessive concentration, manipulation interrupted then continued a few hours or days later).

Create the "safety environment" required for each, even incomplete, manipulation: tidy the working area at the end of the manipulation (shelf devices, reagents, evacuate used products, label new mixtures, etc.).

Never leave cumbersome or dangerous material in evacuation areas. Never store or consume food or beverages in dangerous experimental areas.

Personal protection

Select personal protection devices carefully. Cartridge masks can be used only for low gas concentrations (max 2% v/v) of known nature. Masks should be chosen appropriately; in case of an accident, use an independent mask.

All gloves are not impermeable to divers chemical substances. Gloves must be chosen with care, using two pairs at the same time if needed, particularly when manipulating carcinogenic substances (nitrosamine…).

Serious accident with human injury

Despite prevention measures, accidents do happen. All agents must have a basic knowledge of how to give indispensable first aid.

This knowledge is acquired by attending first aid courses organised regularly in the laboratories or by the delegation. The concepts taught during these sessions are useful not only at the workplace but also in everyday life.

The main topics are presented below.

Alert

Call the emergency services (SAMU, dial 15 or 112), or the fire department or the local security team, giving the essential information:

- the exact location of the accident
- the status of the victim(s)
- the circumstances of the accident.

Alert the first aid assistants and the medical service and prepare to direct them to the site of the accident upon their arrival.

First aid

Before giving first aid, it is important to be sure you are not putting yourself in danger (use an isolating respiratory device in case of a toxic atmosphere, switch off the electricity if needed…). If the zone remains dangerous, remove the victim from the zone and keep bystanders away.

Have the victim examined.

Specific cases

FIRE

- You are on fire

– Do not run.

– Roll over on the ground or floor as quickly as possible, several times; if possible extinguish the flames with a thick blanket or with the emergency shower if it is nearby.

– Remove any nylon clothing that continues to burn.

- Burning clothes on another person

– Immediately immobilise the victim, rolling him/her on the ground or floor

(protect your hands and arms).

– Smother the flames (protect the victim's head and neck first) with a blanket, a piece of clothing, a cotton lab coat (never synthetic material), or a nearby shower or source of water.

– Remove all synthetic clothing that continues to burn (do not take off clothing in direct contact with the skin). Lay the victim down and cover him/her in a sterile sheet. Calm the victim with reassuring words but never give the victim anything to drink before the emergency services arrives. If required, initiate lifesaving measures.

Projection of corrosive products

• Onto the skin

Rinse immediately and abundantly (for more than fifteen minutes) with water only. Soiled clothing should be removed. Do not try to neutralise the product (in case of burn due to hydrofluoric acid, apply a calcium gluconate gel after rinsing).

• Into the eyes

Rinse eyes with water only, immediately and abundantly, placing the victim under the water tap or using an eye fountain. Do not try to neutralise the product.

Electrical shock

• If the victim is still in contact with the source of electrical current, do not touch him/her until the power has been switched off. Beware that the victim may fall when the current is cut off.

• If the electricity cannot be switched off, and the current is of moderate power, isolate yourself from the floor (use a stool) and pull on the victim's clothes. If a high-power line is concerned, use a instrument (isolating stool, pole).

• Initiate lifesaving measures if required.

Intoxication

• Do not try to make the victim vomit. Do not give the victim anything to swallow.

• Perform, emergency resuscitation measures (being careful not to inhale air expired by the victim).

• Phone the anti-poison centre for advice on the appropriate measures.

Radioactivity spill

Beware of spreading contamination if the victim has to be transported. Inform the emergency services of the risk.

WOUNDS

- Minor wound: rinse with soap and water.
- Wound with soil: wash with oxygenated water. Check for tetanus innoculation.
- Wound with risk of infection: wash the wound and disinfect with 70° alcohol or diluted chlorinated water (Dakin). Consult the infirmary.

BLEEDING

If the victim is bleeding abundantly, apply pressure on wound; use your hand or a dressing.

In case of loss of a limb, place a compressive dressing on the stump, preserve the amputated segment in a sealed plastic bag which is placed on a mixture of ice and water (never place the segment directly on ice). Initiate life-saving measures.

FRACTURES

If possible, and except in life threatening situations, do not move a victim with a possible spinal fracture.

In case of a limb fracture, try to immobilise the limb but do not try to reduce the fracture.

Fire protection

A small uncontrolled flame can become a major fire and cause serious damage if inflammable products are near, a situation which is frequent in laboratories where many products are highly inflammable and explosive.

Prevent fires from spreading

It is the duty of every worker to:

- maintain a tidy workplace and avoid carelessness and negligence;
- limit storage of materials and inflammable products;
- avoid stocking paper and packaging material in technical cabinets;
- check the quality of electrical circuits.

Stop the fire before it spreads

Workers must:

- act promptly in an orderly manner;
- alert others (see below);
- use available means of extinction.

Three types of fire extinguishers are generally available in the laboratories:

- Pulverisers using water and additives, generally used for dry fires, i.e. burning solid material. Never use these extinguishers for electrical fires if the power is on.
- Powder extinguishers, used for liquid or hydrocarbon or gas fires.
- Carbon dioxide extinguishers, generally used for liquid fires, but also for electronic material and computers. The material is not covered with powder with this type of extinguisher.

An extinguisher must be used properly to be effective. Periodically, the IRHS organises sessions on how to use extinguishers.

If the fire has started to spread

- Alert fellow workers and the safety service; keep calm.
- Use the extinguisher appropriately, in the direction of the air flow to keep out of the smoke; aim at the base of the flame, moving back and forth and advancing progressively.

• If the fire get out of hand, close the doors and windows in the room; stop ventilators (unless they are to be left open during fires); close gas valves and, after taking the necessary precautions (evacuate lifts for example), switch off the electricity; spray water on the doors.

• If the smoke is too thick for evacuation, lie on the floor keeping as close to the floor as possible.

• When they arrive, show the fire fighters the site of the fire and give any other useful information.

Fundamental rules

– Read the safety notices posted in the laboratories and keep emergency numbers immediately available.

– Read the instructions for use on the fire extinguishers.

– Identify the safety exits or evacuation routes.

Electrical hazards

Use of electrical energy creates hazards which can have serious consequences:

• for the manipulator

Passage of electrical current through the body, called electricization, can, in certain circumstances, be fatal.

The electrical arc causes burns, due to the arc itself and due to projection of metal or melted isolation material.

• for the environment and the installations

Fires can be caused by overly heated electrical cables or by sparks produced by short circuits.

Proper installations complying with safety standards, together with correct protection, upkeep, and use, can prevent such incidents.

Personal injury

Contact with two pieces of metal with a difference of potential of more than 48 volts (24 volts in moist surroundings) can cause personal injury. Contact can be **direct** (with a component normally conducting current when power is on) or **indirect** (pieces of metal accidentally connected to the power line due to the defective isolation of electrical circuits).

Effect of electrical current

Depending on the power and the site of the passage through the body, electrical current can:

• cause reflex movements which may, under certain circumstances, lead to falls or contusions;

• provoke muscle contractions in the hand, making it impossible to release grasp on the conducting element;

• block respiration, even to asphyxia, with a complete disruption of the heart cycle leading to cardiac arrest.

Above a certain power level, electrothermal burns are observed at the points of entry and along the passage of the electrical current.

An electrical arc can cause severe burns due to projections and the intense heat produced.

PREVENTIVE MEASURES

Electrical hazards can be prevented by follow a few simple rules.

• Turn power off before working on or repairing electrical appliances. If the electrical current must be maintained, apply the safety instructions scrupulously.

• Insulate bare components, terminals.

• Disconnect the power source before working on or repairing electrical equipment:

– **remove** the installation or equipment from any possible source of electrical power

– **block** the separating device(s) in the open position;

– **make sure** the power is off.

• Locate the power switch (circuit breaker, safety switch). Make it easy to access and use.

• Only use equipment with a correctly installed ground line (class I) or double-insulated equipment (class II).

• Check that the equipment is used in a compatible environment; strict rules must be applied for work in humid or other conducting areas (very low power, class III).

IN CASE OF AN ACCIDENT

• Turn off the power. Beware that an electrocuted person may fall.

NF standardisation labels

The French standardisation label "NF" certifies that the material has undergone safety trials in an approved laboratory and is in compliance with all safety standards. This label is awarded when a prototype has successfully passed all the safety tests designated by the standard.

CLASSES OF MATERIAL

Symbol	Designation
	Class I material
	Class II material
	Class III material

Class I: material constructed so that all metal parts can be connected to the ground line.

Class II: material with protection against indirect contacts ensured by double-insulation or reinforced isolation.

Class III: material with a protection against electrical shocks when used under low power (50 or 25 volts).

• Call the emergency services, call for first aid assistance

• If the victim is unconscious, initiate lifesaving measures:

– in case of respiratory asphyxia alone, initiate mouth-to-mouth resuscitation

– in case of cardiac arrest: initiate respiratory assistance and external cardiac massage (two persons) until the emergency services arrive.

In case of fire

In case of a defect in an electrical installation (short circuit, overload, water in contact with an electrical appliance, leak through worn insulation), the electrical power should be cut off immediately (circuit breaker, safety switch)

If the power is not cut off (defective, deteriorated or poorly adapted equipment), a power line carrying more current than it was designed for may overheat or produce sparks.

These effects can lead to fire or explosion if inflammable materials are in the vicinity.

ELEMENTARY PRECAUTIONS

• Do not touch or modify circuit breakers or fuses (in particules never downgrade their sensitivity).

• Do not overload sockets with multiple plugs.

• Do not use damaged equipment.

• Do not install extensions to existing power lines (this must be done by authorised personnel in compliance with strict safety rules).

FOR MORE INFORMATION…

• Institut National de Recherche et de Sécurité (INRS – 30 rue Olivier Noyer, 75680 Paris 14). *Advice on safety for interventions on low-power electrical equipment and installations.* Fascicule n° 359.

• D. FOLLIOT. *Les accidents d'origine électrique – Leur prévention.* Masson, 1982.

• R. CHOQUET, J. C. GILLET. *Vade-mecum Sécurité électrique.* RGS Edition, Société Alpine de Publication, Grenoble, 1991.

In general, these documents can be consulted at the CNRS Regional Inspection for Health and Safety.

Radioactive hazards

There is a risk of external and/or internal exposure to radioactivity when manipulating radioactive substances in non-sealed sources, using sealed sources, working around electrical generators of ionising radiation such as particle accelerators, isotope separators, implanters, x-ray tubes…

This hazard can lead to exposure of the human body to radioactive energy which can, depending on the dose absorbed (directly related to the amount of energy emitted), produce more or less significant biological effects. It is important to learn about the hazards relating to the sources of ionising energy used in the laboratory and how to implement protective measures.

Protective measures

Limitation on the use of sources of radiation and protective measures to be implemented are defined in official regulations:

- establishment of a controlled area and monitored zones marked by standardised signs: green cloverleaf and grey-blue cloverleaf on a white background;
- dose equivalents and limits on annual exposure not to be exceeded;
- indispensable medical surveillance and definition of an aptitude chart for occupationally exposed workers in category A (risk of exposure greater than 3/10 annual upper limit), and possible monitoring of workers in category B (risk of exposure between the "public" limit and the category A limit) with a special "B" card used at the CNRS;
- designation of a competent person, trained by an authorised organisation, who has knowledge of the operating methods providing the best safety guarantee and who can intervene in case of an accident.

Principles of protection

The guiding principle behind radiation protection is that occupational exposure to radiation should be kept "As Low As Reasonably Achievable" (ALARA). In order to avoid unnecessary exposure, abide by the indications on the posted notices and rules established for each installation.

Means of protection against external exposure

When working with electrical generators of ionising radiation, sealed sources or certain non-sealed sources, the absorbed dose must be held as low as compatible with the manipulations to be performed. This can be achieved by the following means: use of radiation-absorbing **screens** (plexiglass, aluminum for beta emissions, lead for gamma emissions, polyethylene cement for neutrons); increasing the manipulating **distance** (remote handling equipment); decreasing the **time of exposure**.

In the controlled zone for workers in category A, the dose absorbed is monitored passively with a regulatory badge (photographic film) and actively (electronic dosimetry with immediate readout) or by operational dosimetry. These data are recorded and transmitted to the OPRI.

Absorbed doses are measured with portable devices (ionisation chamber, Geiger counter) appropriate for the radiation under consideration.

Means of protection against internal exposure

When manipulating radioactive substances from a non-sealed source, the radioactive material itself can penetrate the organism by inhalation of gas, aerosols, or powders or by accidental ingestion or contamination of the skin (hands). It is then eliminated more or less rapidly depending on the physical properties of the substance and its metabolism in the human organism.

The following items are helpful in limiting the risk:

- consult the INRS / OPRI documents
- wear gloves and a lab coat;
- identify material reserved for use with radioactive substances;
- do not smoke, drink, or eat in zones reserved for manipulations;
- work under an exhaust hood or use a box with ventilated gloves equipped with filters;
- systematically check the absence of surface contamination (skin, clothes, installation, surroundings) before leaving the workplace;
- undergo the radiotoxilogical analyses ordered by the preventive medicine physician.

In case of an accident leading to a radioactive spill:

- alert the person responsible for radiation protection in the laboratory;
- delimit the contaminated area;
- mark the area and prohibit any person from entering the area;
- take off protective clothing; measure your own contamination and eliminate it if possible under the guidance

of a knowledgeable person or the medical service.

Treatment of radioactive waste

Any manipulation of radioisotopes from a non-sealed source produces contaminated material that must be eliminated in compliance with strict decontamination rules. For maximal safety and environmental protection, read the laboratory's internal rules which describe how to use the available means for sorting the different types of wastes by radionucleide, which should be identified and quantified.

To learn more…

• Decree n° 86-113, October 2, 1986, as modified, relative to the protection of workers against hazards of ionising radiation, and the application memoranda.

• Radiation protection sheets periodically edited by the INRS in *Cahiers de notes documentaires*.

• CNRS directives on the manipulation of non-sealed sources and on the use of x-ray machines.

• Directives from the national agency for radioactive waste (ANDRA).

• CNRS directives on the treatment of radioactive waste;

• Decree n° 66-450, June 20, 1966, as modified concerning the guiding principles of protection.

• Decree n° 75-306, April 28, 1975, as modified, relative to the protection of workers in Nuclear Base Installations (INB).

• *Official Journal* of the European Union, L159, June 29, 1996: Council directive 96/29, May 13, 1996 relative to new standards.

Chemical hazards

Chemical products, widely used in research laboratories, must be handled with caution in order to avoid accidents that can be serious. The first thing to do when handling a new product for the first time is to identify possible hazards in order to avoid dangerous situations for yourself and others.

Information is available mainly from:

- bottle labelling (standard pictograms and safety precautions) and safety notices provided by the manufacturer;
- catalogues edited by the manufacturer, where information can be checked;
- specialised safety documents provided by the ACMO and the IRHS (toxicological notices from the National Research Institute on safety, dangerous chemical reactions, list of carcinogenic substances…);
- knowledgeable colleagues and specialised data banks.

In general, safety problems raised by chemical substances involve their use, storage and elimination. Chemical hazards are related to the dangerous nature of these products:

- inflammability;
- instability: risk of explosion, an inherent property of the product, or consecutive to energy input (shock, heat…) or a reaction (explosive particles composing the molecule);
- aggressiveness: irritation, asphyxia, deleterious effects on the nervous, digestive, hepatorenal systems, genotoxic effects.

Basic rules of prevention

During use

- A **laboratory coat** is mandatory for protection against spills; this coat should be made of cotton or a non-inflammatory material; it should not be stored outside the laboratory.
- Protective **glasses** or **goggles** are mandatory in laboratories, distillation rooms, and in any work area where the eyes could be in danger.
- Wear **gloves** when manipulating corrosive or highly toxic products (contact allergens…).

• **Exhaust hoods** are required for volatile products that are toxic when inhaled or when performing any reaction which may produce dangerous fumes.

• Use automatic **pipettes** for sampling.

• Use protective **screens** or headwear with a facial screen (polycarbonate) when performing an unknown reaction that could be potentially dangerous. The quantities of reagents used for reactions of this type should be kept as small as possible.

• Strict compliance with the laboratory rules is mandatory for any experiment which is to be continued without the presence of the technician (over night, week-end…).

STORAGE

All recipients containing a chemical product must be properly labelled. The label must indicate the nature of the product and any specific risks; double labelling is strictly prohibited (especially if commercial containers are used for another product).

• Whenever possible, the quantity of products on the laboratory bench should be limited to the amount needed for the day's work; for inflammable solvents, the maximum amount present in the laboratory should be determined in proportion to the total amount in the building. Use of metallic safety containers is recommended for very volatile solvents (particularly for diethylic ether).

• Products should be stored away from sources of heat and never stored near the exits; if inflammable products are to be placed in cold storage, they should be held in refrigerators or freezers equipped with an electrical safety device (prevention of sparks inside the refrigerator or freezer).

• New products should be stored, if possible, in a storage area outside the building, otherwise in a suitably isolated and ventilated room. Never store products in cabinets containing service lines.

WASTE DISPOSAL

• Do not dispose of solvents in the sink. Solvents should be collected in special containers, taking into account incompatibilities, and transferred to the specialised disposal service.

• Highly toxic substances should be destroyed or neutralised before disposal; if this cannot be achieved (heavy metals for example), these products should be stored in labelled containers which are transferred to the specialised disposal service.

Labelling chemical products

The safety label:

- is the primary source of information necessary for safe handling of chemical products;
- provides information on adapted storage;
- indicates the steps to take in case of an accident;
- provides information on appropriate disposal.

This labelling practice is mandatory for all: manufacturers, sellers, importers, heads of the end user facilities.

In case chemical products are treated before final use, the new container or bottle must carry the regulatory label corresponding to the product used (see table on the next page).

To learn more...

- A. PICOT, Ph. GRENOUILLET. *La sécurité en laboratoire de chimie et de biochimie*. Technique and Documentation – Lavoisier Ed. December 1992, 2nd edition.
- CNPP (National Centre for Prevention and Protection – 5 rue Daunou 75002 Paris). AFNOR (French Standardisation Association – Tour Europe, cedex 7, 92049 Paris La Défense), *La sécurité dans les laboratoires* – 1973.
- INRS. *Fiches toxicologiques* edited periodically in *Cahiers de notes documentaires*.
- INRS – J. LELEU. *Réactions chimiques dangereuses*. Editions INRS, ED 6977, December 1987.

LABELS FOR CHEMICAL PRODUCTS

T - Toxic

Xn - Harmful

C - Corrosive

Xi - Irritating

E - Explosive

O - Combustible

F - easily flammable

Dangerous for the environment

Extremely flammable products are labelled with a specific "easily flammable" symbol: F +.

Very toxic products are labelled with a specific "toxic" symbol: T +.

Biological hazards

In biology laboratories there is a combined risk related to the use of chemical and radioactive products and substances and to the manipulation of potentially pathogenic agents (micro-organisms, viruses, prions…), as well as the recognised or suspected hazards of genotoxicity.

BIOLOGICAL DANGER

AUTHORISED PERSONNEL ONLY

Nature of the danger : _____

Person in charge : _____

IN CASE OF EMERGENCY, CALL :

Office phone : _____

Home phone : _____

Other numbers : _____

ACCESS MUST BE AUTHORISED BY THE RESEARCHER DESIGNATED ABOVE

An example of a notice on the outer door of confined laboratories.

Preventing spread of infection

• Compliance with general health and safety measures is mandatory:

– wear a laboratory coat which remains in the laboratory (except for decontamination);

– wear disposable gloves, to be removed before another operation, and in case of risk of spillage, wear protective goggles and a disposable mask;

– wash hands frequently;

– clean work benches and instruments with chlorinated water (12°) or glutaraldehyde (2%);

– use a bulb to pipette, not your mouth;

– do not store, eat food or drink beverages in the laboratory;

– use disposable material; handle used needles and syringes prudently; use the centrifuge with caution.

• Depending on the risk level, and in order to prevent any dissemination, pathogenic agents (classed in groups 1

to 4, for lowest to highest risk) are handled in laboratories (L), glass houses (G) or animal housing facilities (A):

– with different confinements (from 1 to 4);

– under vertical laminar air flow with partial or total recycling (protection during handling) or within a microbiological safety device classed type I (protection for the manipulator and the environment) or type II or III (protection for the manipulation, the manipulator, and the environment);

– with adapted material: automatic double-entry autoclave (L3 and L4), centrifuge equipped with sealed tubes and a free aerosol system (L2-L3-L4).

MANDATORY ELEMENTS

- reinforced measures of personal protection: L2 and above, specific clothing required, with shoe covers for L3-L4;
- personnel training sessions concerning biological hazards and special medical follow-up (L2 to L4);
- limited number of persons allowed in the laboratory (L2 to L4);
- posted notice on steps to take in case of contamination (L2 to L4);
- record of dates of all experiments, the nature of the biological material used, and the name of the person in charge (L3-L4);
- appropriate treatment of all waste and used material with decontaminating solutions (chlorinated water, glutaraldehyde), an autoclave, or (and) incineration. **It is indispensable to check that all means of decontamination have been validated before starting a manipulation.**
- regular control and upkeep of equipment (autoclave, centrifuge…) and installations…

Genetically modified organisms

Manipulation of GMO (microorganisms, viruses, transgenic plants or animals) must be conducted in confined areas adapted to the laboratory class as defined by the commission on genetic engineering.

This classification depends on the hazards related to the biological material in use, but also to the preparation and modification procedures applied to these organisms.

Prions

Prions, recognised causal agents in different infectious and genetic diseases, must be manipulated with prudence. All manipulations must be performed in L2 or L3 confinement (with a type II microbiological safety device), depending on the strains involved.

Classical decontamination methods (alcohol, formol, UV light) are ineffective against these agents. The following decontamination procedures are currently proposed: autoclave at 134°C for at least 1 hour, 1N sodium hydrate for 1 hour at 20°C, 2% sodium hypochloride for 1 hour at 20°C: 250 chlorinated water (48° Cl / 1.750 L water), and dry heat at 175°C for 2 hours.

None of these methods provides guaranteed decontamination.

Waste must be decontaminated before incineration.

Genotoxic products

The risk of contamination may arise when manipulating products with recognised or suspected genotoxic properties (the list of these products is updated regularly and can be consulted in the publications of the international centre for cancer research).

As for other hazards, external and internal contamination must be avoided with care; however, due to the absence of risk thresholds and different levels of individual sensitivity, supplementary precautions must be taken during certain phases of work:

- wear disposable and resistant gloves when handling solutions; if the manipulation is long and involves very penetrating agents, it may be advisable to wear two pairs of gloves at the same time;
- handle pulverised products, particularly when weighing, in a calm area free from electrostatic effects, proceed rigorously and of course wear gloves and a mask. The absence of contamination should be checked after each manipulation, all traces of the product must be cleaned off carefully;
- destroy the product before disposal. High-temperature incineration appears to be the most effective method to destroy certain toxic products.

During transportation, carcinogenic and mutagenic products must be placed in a sealed unbreakable recipient that will not crack if dropped.

Bottles must be properly labelled mentioning "*danger : potentially carcinogenic chemicals*".

This notice must also be posted on cupboard doors, refrigerators, etc. containing the mother solutions.

All personnel should be informed of the steps to take in case of an accident. Detailed guidelines must be defined.

TO LEARN MORE...

• J. SIMONS, P. SOTTY. *Risques biologiques*. CNRS - INRA - INSERM - Pasteur Institute, 1991.

• X. ROUSSELIN, J. DAYAN-KENIGSBERG, C. PLEVEN, M. CASTEGNARO, A. PICOT and F. ZAJDELA. *Manipulation de substances génotoxiques utilisées au laboratoire*. INRS, 1994.

• STANLEY PRUSINER. *Les maladies à prions*. Pour la science, n° 209, March 1995.

• Law of July 13, 1992 relative to the control of the use and dissemination of GMO (Genetically Modified Organisms) and application memoranda.

• Decree of July 18, 1994 setting out the list of pathogenic biological agents.

• Circular DGS/DH n° 100, December 11, 1995 relative to the precautions to take in surgical and pathology settings in case of risk of transmission of Creutzfeldt-Jakob disease.

• Decree of August 13, 1996 setting out technical preventive and confinement measures for pathogenic biological agents.

• AFNOR standard NFX 42-206 of June 1998: level of confinement of microbiology laboratories, risk zones, physical safety situations and prerequisites.

• Decree of September 7, 1999 relative to the modalities of storage and control of the elimination chain for waste from activities involving an infectious risk and assimilated activities and anatomic specimens (*Journal Officiel* October 3, 1999).

Animal housing

A certain number of precautions must be taken when handling laboratory animals.

Basic training and strict compliance with the laboratories internal rules are indispensable.

Specific hazards

- Risk of contamination by viruses, bacteria, parasites, fungi…;

– via the skin: bites, scratches, syringe needles…;

– via the respiratory or digestive tract.

- Risk of wounds when handling the animals or in case of aggressive behaviour.

General hazards

- Electrical hazards in a humid environment;
- Working alone;
- Use of toxic products, disinfectants, insecticides, anaesthesia agents, euthanasia agents, incompatible agents (chlorinated water, acids)…
- Use of special equipment which must be employed in compliance with operating instructions: autoclaves, washing machines, glassware.

Basic precautions

Medical measures

- maintain vaccination schedule as prescribed by the preventive medicine physician;
- attend all medical consultations;
- alert the medical service immediately in case of an incident (cut, bite…) or disease outbreak.

Prophylaxis

- plan regular veterinary consultations;
- monitor the health status of the animals and apply good laboratory practices: change bedding, keep housing and material clean, wash hands frequently;
- do not eat, drink or smoke in the animal housing facility;

- avoid germ transfers by changing clothes and shoes;
- carefully mark the cages of animals undergoing experimentation;
- clean and disinfect material regularly;
- follow approved procedures for disposal of bedding and droppings.

ANIMAL HANDLING

- handle animals calmly, observe the animal's behaviour;
- use holders for small animals and contention devices as needed;
- comply with the experimental techniques and protocols;
- for large animals, beware of possible aggression, falls from cages;
- comply with good health practices for bacteriological samples, microsurgery, autopsy…;
- set aside a specific area for storage of animal cadavers containing radio-isotopes before final removal from the facility.

Recommendations

Inform the person in charge of any event or abnormal behaviour, poor animal health, minor accident (cut, bite), defective material, particularly involving safety devices.

Non-ionising radiation

There are numerous sources of non-ionising radiation in workshops and laboratories: vibrating and rotating machines, certain electrical appliances, soldering irons, ultraviolet generators, etc.

General hazards can result from:

- direct exposure of the human body;
- interaction between the radiation and technical devices, affecting their function.

The effects on the human body are often conjugated, relate to the intensity of the radiation and the duration of exposure.

Light

Light effects are dose-dependent (amount of energy transmitted); they can be observed whenever a certain threshold is exceeded, for example "sunburn" (UV), burns (UV and IR), and skin ageing. Different effects without a quantifiable threshold can also be observed, e.g. skin cancer.

Different protective measures include:

- An automatic switch cutting off the power to UV generators when someone enters a sterile room or area; mask the light source to limit exposure if total extinction is not feasible.
- In all cases: eye protection (protective goggles appropriate for the wavelength); skin protection (face mask, long sleeved lab coat, gloves…).

Microwaves and radiofrequency waves

The hazard is related to the power density of the beam emitted by the device. Different types of effects can be observed: heat injury, cell effects, cardiovascular effects… Preventive measures include:

- suppression of leaks;
- protection with reflecting or absorbing screens;
- marking dangerous areas with obstacles.

Microwave ovens are frequently found in laboratories; at construction, these devices are sealed and remain so as long as the door is in good

condition. It must be recalled that metal objects (magnetic stirrers, for example) must never be placed in microwave ovens, likewise for sealed bottles which may produce an explosion in the oven or overfusion of the product, with serious consequences.

Sound waves

Sound waves result from variations in pressure in the air by the generating source; physiologically, sound is characterised by its amplitude (pressure of the sound wave), its frequency, and its duration of perception.

The level or pressure of the sound wave is expressed in decibels (db); sound wave frequencies vary from infrasounds (below 20 Hz), to audible sounds (20 - 20 000 Hz) and ultrasounds (above 20 000 Hz).

As the human ear does not exhibit the same sensitivity to all frequencies, a new unit, the decibel A (db A), has been introduced to take into consideration this variability.

Hazards related to audible sounds are related to the sound level, the duration of exposure, the spectral composition of the sound wave, and the type of sound produced. They vary from auditory and nervous fatigue to partial and definitive hearing loss. Infrasounds also have physiological effects: oppression, fatigue, nausea; these effects are observed with compressors or more generally vibrating machines. Infrasounds can be transmitted over long distances via solid structures. Ultrasounds are frequently used in laboratories (cleaning, cell breaking); their biological effect varies greatly with intensity; major burns can result from direct exposure to the source.

General preventive measures:

- never remove the protective shield or screen provided by the constructor;
- maintain shock absorbers on vibrating machines in good condition;
- wear an anti-noise helmet or ear plugs if the source of noise cannot be reduced;
- attend regular medical consul tations.

TO LEARN MORE...

- *Protection against non-ionising radiation.* WHO – Regional Publications – European series n° 10 (1985).
- F. GUELAUD. *Elements d'analyse des conditions de travail - 1 - Le bruit.* CNRS Editions.

Laser

Different types of lasers produce electromagnetic beams situated in the ultra-violet spectrum, the visible spectrum, and the infra-red spectrum.

Hazard classes have been defined as a function of the power level, i.e. the amount of energy emitted by the laser, accessible to the user:

– Class 1: no hazard

– Class 2: risk of visual fatigue after repeated exposure;

– Class 3A: dangerous if viewed through an optic system;

– Class 3B: dangerous if viewed directly;

– Class 4: high-power devices, greater than 0.5 milliWatts in the visible spectrum.

Two types of hazard must be taken into account when using lasers in research laboratories: first, the risk of burns and wounds (particularly eye injury) caused by laser beams themselves, and second, risks of electrocution during maintenance operations due to the high power level of the electrical current. In addition, the risk of fire by accidental radiation of the environment is higher with continuous laser beams.

Diode lasers and optic fibres used for transmission produce the same types of hazards.

Precautions

Against eye injury

- mark the work area to limit access;
- avoid working with beams at the eye level or in a dark room;
- attach the laser device solidly and materialise the beam by an appropriate mark; carefully attach the ends of optic fibre cables.
- work at minimal power when making settings or optical alignments;
- wear specially designed goggles adapted to the wavelength.

Against burns, fire, intoxication

- place non-combustible screens on the direct or predicted trajectory of the laser beam;

• use shields to avoid accidental contact with the beam;

• handle colorants carefully in compliance with the precautions required for chemical products.

AGAINST RISK RELATED TO HIGH-POWER ELECTRICAL CURRENT

• always turn off the power before repairing or adjusting the device;

• leave all safety systems intact; condensers must be discharged; connect the ground line.

TO LEARN MORE…

• CNRS; *Règles de sécurité à observer lors de l'emploi des lasers dans les laboatoires de recherche.* December 1984.

• Syndicat des Industries de Tubes Electroniques et Semi-conducteurs (SITELESC – 17 rue Hamelin, 75783 Paris Cedex 16). *Laser – Mesures de prévention – Recommandations de mise en œuvre.* 4th edition, 1995.

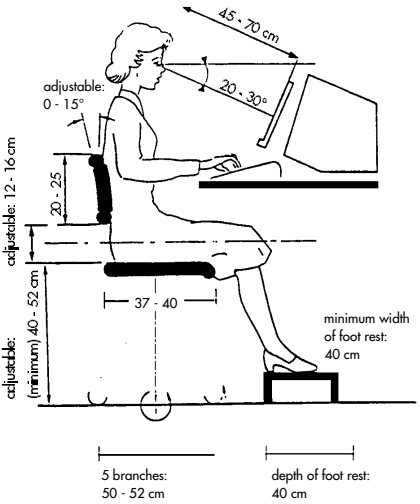
Cathode screens

Working on a cathode screen can lead to different bothersome problems, including:

- blurred vision, strained eyes;
- headache;
- back, shoulder, neck pain.

These inconveniences can be greatly attenuated by a few simple rules:

- wear spectacles or contact lenses to correct for visual defects; follow medical prescriptions;
- use a correct working position, with special attention to light sources: source of daylight parallel to the mean direction of vision, use screens or blinds on windows, use light fixtures with an anti-flutter protection;
- set screen luminosity, contrast, anti-reflection filter to achieve a clear easy-to-read screen display;
- use easy-to-read documents (non-reflecting);
- properly arrange the different elements of the workstation and adopt a correct posture. Take periodic pauses in case of continuous screen work.



TO LEARN MORE...

- Decree n° 91-451, May 14, 1991.
- NF standard NF X 35121/6, 1987.

Handling and transporting materials – Lifting machinery

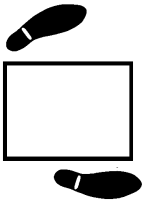
A certain number of physical risks occur when handling or transporting heavy material by hand or with a machine. According to the CNRS accident statistics, which have been confirmed by those published by the National institute for research and safety, one out of three accidents results from manipulations performed at the workstation or when transporting material by hand.

When lifting a heavy object

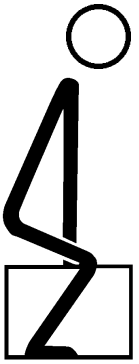
By hand

Many accidents involving the back, particularly the lumbar aera of the spine, occur when lifting an object by hand. Objects weighing more than 30 kg (for men) or 15 kg (for women) should not be lifted by hand (AFNOR standard NF X 35-109).

The following positions are recommended:



Place feet on both sides of the object, one slightly in front of the other.



Bend the knees and hold the back straight. Straighten the arms to grasp and maintain the object but not to lift it. Lift with the legs and thighs.

With a machine

Small tools – hand jack, hydraulic jack, simple levers – should be maintained in good working condition and positioned correctly: block, stable fulcrum. Minimise risk of slippage by using a solid fulcrum (e.g. wood block). When using lifting devices (hoist, pulley, crane, elevator, lifts, etc.):

- work in a suspension position: verify the slings are in the proper position (not in contact with a cutting edge), tighten the sling before lifting;
- if the object is to be lifted from underneath, be sure the load is balanced and fastened well to the support; use both arms of the fork, placing them well under the load or its support. Never attempt to lift loads heavier than the machine's capacity. Abide by the rules of inspection and upkeep.

When moving a heavy object

Avoid unnecessary displacements. Identify the final destination and the passage.

The passage should be cleared, clean floors, no obstacles.

Use:

- protective bridges to cross floor lines;
- ramps for stairs;
- charge bridges, etc.

Work calmly. Do not carry tools in pockets. Use means adapted for the object to be transported (hand truck, trolley, bottle carrier, skid, roller, buddy man, etc.).

Keep in mind the possible explosive, inflammable, corrosive, irritating, or toxic nature of the product being transported: **identify the nature of the product before starting.**

It is advisable to wear personal protection: helmet, gloves, safety shoes.

Be ready to execute an unexpected manoeuvre and protect the environment along the passage.

When moving objects placed in high positions

Use a ladder only for occasional work.

Beware of precarious supports, poor positioning, defective ladders, sudden

movements. Get a good footing on the ladder.

Never attempt to reach an inaccessible point without moving the ladder.

Whenever possible, use scaffolding, making sure it is vertical and immobilised. Beware of falls: set up safety barriers and stay on balance.

Falling objects can be dangerous: never overload the scaffolding which must be maintained in perfect working order; mark the floor area used.

Beware of the risk of contact with electrical installations.

TO LEARN MORE…

• INRS and OPPBTP. *Hygiène et sécurité dans les tra - vaux du bâtiment.* April 1993.

Dangerous machinery and equipment

Work accident statistics show that most machines and equipment used in everyday working are potentially dangerous. Consequently, special regulations have been promulgated in compliance with European standards for the prevention of accidents.

These regulations concern:

• **very dangerous machines and equipment,** including wood working equipment (saws, trimmers, slotters, jointers, rotating machines); presses and guillotine shears for cold metal works;

• **dangerous machines and equipment,** including edge cutters and folders used in the printing industry, machine tools for metal and glass works; portable machines and hand tools; centrifuges; acetylene and soldering tools; blenders and grinders.

No one should use these machines or equipment without first:

• obtaining the permission of the person in charge;

• reading the instructions for use indicating good practices (mandatory protective devices) and health and safety measures to be taken;

• identifying the main controls of the machine, emergency stop, and possible displacements of the tools and pieces.

Work clothes should be well adjusted and not loose. Beware of long hair. Protective goggles should be worn whenever there is a risk of projection or production of metal shavings.

Never enter or stand in dangerous zones around machines and equipment.

TO LEARN MORE…

• INRS, *Machines and équipement de travail. Mise en conformité*. ED 770.

Pressurised equipment

In our facilities, many machines used in research laboratories or in the buildings or safety units, operate under pressure.

Hazards

Poor maintenance or improper manipulation can lead to explosion, implosion, or rupture of weaker elements (joints, port holes, expansion valves); this can produce high velocity projections, shock waves, liquid or gas spills.

Other hazards are related to the pressure itself. For certain devices, the risk depends on the nature of the product under pressure: intoxication, flammability, explosion.

Types of equipment

- Pressurised equipment

– vapour pressure (sterilisation autoclaves, boilers…),

– gas pressure (reaction autoclaves, gas cylinders, compressors, synthesis reactors…)

– hydraulic pressure.

- Vacuum equipment: (evaporators, lysophylators, experimental chambers, dessicators…)

Controls

Equipment operating under pressure must undergo an initial inspection before service delivery, then regular inspections and controls performed by official organisms. This equipment is also re-tested periodically in compliance with current regulations.

Training

This equipment must be operated by trained personnel only: autoclaves, manipulation of extinguishers…

Special precautions

In order to protect against possible projections subsequent to an accident, devices used in research laboratories are equipped with protection shields or fine-screen metal envelopes.

Before operating pressurised equipment, the user must verify by visual inspection the good condition of this protection system: absence of corrosion, abnormal heating, leakage……

GAS CYLINDERS

• Purchase only the quantities needed for use.

• Pressurised gas cylinders must be transported in a specially designed carrier. The cylinders must be firmly attached to prevent the bottles from falling. Avoid violent shocks. When using a lift, cylinders containing toxic gas are left alone in the lift.

• Gas cylinders are stored in a specific well ventilated area, away from a source of heat or sunlight. They are attached and held in a vertical position.

• When using a cylinder of compressed gas, attach it with chains to prevent shocks and falls which could injure the user. A gas cylinder equipped with an expansion valve can become a violent missile if the valve breaks during a fall. The fall can transfer enough kinetic energy to the valve to separate it from the cylinder. If ejected it can injure persons in the vicinity.

• When the cylinder has an expansion valve, check for leaks after installation. Never force an expansion valve. The valve will be purged after use; any defective valve must be replaced. Never grease the joints on oxygen tubes, never use copper or acetylene.

• Pressure can rupture feeding lines in gas reaction setups. In this case the lines can become uncontrolled whips.

• Any pressurised setup must be protected by a safety outlet valve in case of expansion valve default. This outlet valve must be directed outside the laboratory.

• Only those cylinders necessary for current experiments are present in the laboratory. The volume of the cylinders can be limited to reduce the amount of gas escaping into the laboratory in case of leakage. Independently of their toxicity, these gases replace oxygen in the air; even an inert gas can cause a fire.

• To avoid any pollution in the laboratory or outside the laboratory, toxic gases must be trapped or neutralised at the end of the reaction setup.

• Cylinders of toxic gas must be held in open air. Seals must be verified at reception. A special line connects the gas to the reaction setup. If small volume cylinders are used, they should be placed in a ventilated hood.

• An independent device, or a filter mask if the protection is sufficient, should be placed near each experiment using toxic gas.

• Use the wrench provided by the supplier to open gas cylinders. Never use another instrument.

RESERVOIRS, VATS, TANKS

Special precautions must be taken to prevent accidents (electrical shock, asphyxia) if a person must enter a reservoir or vat that contained inert, toxic, or inflammable gas.

Warning

Equipment and installations operating under pressure are constructed in compliance with specific regulations and are used under strictly controlled and well-defined conditions (temperature – pressure – nature of the fluid) which all users must apply.

When a device is purchased from a foreign firm, make sure the European regulations (EC label) and French regulations are respected.

TO LEARN MORE...

• Decree n° 99-1046, December 13, 1999 relative to equipment under pressure.

Danger or hazard sign

Flammable product

Explosive product, risk of explosion

Toxic product

Corrosive product

Radioactive product, ionising radiation

Suspended loads

Handling vehicles

Electrical danger

General danger

Laser beam

Combustible product

Non-ionising radiation

Strong magnetic field

Falls

Falls, uneven ground

Biological hazard

Low temperature

Harmful or irritating product

YOUR ADDRESS BOOK

- Emergency squad (SAMU): _____
- Fire fighters: _____
- Anti-poison centre: _____

- General internal alarm: _____
- Medical service, infirmary: _____
  _____
- Workplace first aid: _____
  _____
- ACMO : _____
  _____
- Appointed electrician: _____
  _____
- Person in charge of radiation protection: _____
  _____
- Regional inspector of health and safety: _____
  _____
- Representatives of the personnel on the unit's health and safety committee: _____
  _____
  _____

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