

Advice for newcomers

Prevention guide

Health • Safety • Environment



advancing the frontiers

Foreword



Research activity, however diverse and exciting it may be, is not without its risks for the health and safety of personnel. The management of CNRS has long done all it can to limit and control these risks. Offering everyone the safest possible working environment is a priority for the establishment. But safety is everyone's business, and as a newcomer you also have a part to play in this collective effort and need to incorporate safety into everything you do.

It is essential that you familiarise yourself with the information in this guide, which was written for your benefit.

It explains the different types of risks you may face within the facility where you work; these risks could be linked directly to the activity.

you are engaged in, or they could be risks you might be exposed to because of unfamiliarity with your immediate environment. This guide sets out the principles and best practices of health and safety in a wide range of situations commonly encountered in our establishment.

However, it is not exhaustive. It is therefore important for you to talk to the health and safety officer, who can explain to you the particular risks in your unit and who may add specific instructions to the information you have already been given.

The health and safety policy at CNRS can only be effectively implemented with the involvement of everyone. Your participation is therefore crucial.

A. K

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General information

ORGANISATION OF OCCUPATIONAL HEALTH AND SAFETY AT CNRS

LEVEL	NATIONAL	REGIONAL	LOCAL
Authority	President ¹	Regional representative	Unit director
Safety	PSST ²	• National prevention and safety coordinator • Specific risk officers	• Health and safety officer • Specific risk advisers
Occupational health		National occupational health physician	• Regional occupational health physician • Occupational health physicians
Control	Occupational health and safety inspectors		
Body	• Technical committee • Central health, safety and working conditions committee	Regional health, safety and working conditions committee	Consultation body or laboratory council

¹ Supported by the Chief Resources Officer

² Occupational Health and Safety Centre

These texts can be downloaded from here:

<http://www.dgdr.cnrs.fr/SST/CNPS/textes/reglementationCNRS.htm>

Regulatory framework

The principles governing health and safety at work for public sector employees – and therefore at publicly run science and technology institutions – are laid down by [decree 82-453 of 28 May 1982](#), amended by [decree 2011-774 of 28 June 2011](#). Clarifications concerning the implementation of this decree are contained in a [circular of 9 August 2011](#), amended on [9 November 2011 \(MFPF1122325C\)](#).

These regulatory requirements apply in their entirety to CNRS. However, definitions specific to this application and the organisation of health, safety and working conditions at CNRS are set out in a [general internal instruction](#) signed by the President on 1 December 2012.

Generally speaking, the rules in force at CNRS are those defined in [Part 4 of the Labour Code, Books I to V](#). However, the decree specifies some rules that apply only to the public sector (particularly concerning the setting up of a health, safety and working conditions committee - CHSCT). Other rules stem from internal instructions or memos.

Key players

The **heads of the research units** are responsible for the health and safety of the workers under their authority. They are assisted in this by one or more (**APs: health and safety officers**). The APs' role is to advise the head of unit on risk assessment and on implementing a health and safety policy within the unit. The outcome of this work is a single workplace risk assessment document, which has to be updated once a year.

To assist them in implementing the regulations, the heads of unit and APs can seek advice from the **IRPSs (regional health and safety engineers)** at each regional office.

Occupational health physicians provide medical monitoring for workers and carry out risk assessments for particular jobs. All staff must have a medical once every five years. For staff doing jobs associated with particular risks, and for staff whose state of health demands it, the frequency of these medicals (at least once a year) is defined by the physician.

The work of IRPSs and occupational health physicians is guided nationally by the **CNPS (National Prevention and Safety Coordination Unit)** and the **CNMP (National Department**

for Occupational Health) respectively. Together these organisations form the **PSST (Occupational Health and Safety Centre)**, which reports directly to the **DGD-R (chief resource officer)** of the CNRS.

Compliance with the regulations on health and safety is regularly monitored by a team of **ISSTs (occupational health and safety inspectors)** from the Ministry of Education, Higher Education and Research.

Consultation on improving health, safety and working conditions takes place between management and staff in **CHSCTs (health, safety and working conditions committee)**: the CNRS' central health, safety and working conditions committee (CCHSCT) chaired by the DGD-R, and the regional health, safety and working conditions committees at each regional office. In the research units, when the number of workers or the magnitude of risk justifies it, a CHSCT-type consultation committee may be set up. These committees meet periodically to discuss health and safety-related issues. The circumstances of accidents at work (serious or repeated accidents in particular) are examined and suggestions are made for measures to prevent them from recurring.

Finally, it should be remembered that everyone has a responsibility for their own safety and that of others (colleagues, external contractors, students) and for making sure they are familiar with good working practices, know what to do in the event of an accident or injury and are aware of their own responsibilities. All staff are entitled to leave a working situation where they feel they are in grave and imminent danger. They must of course inform their supervisor, and their departure must not give rise to an even more serious risk. An investigation, which may involve the relevant CHSCT, must be carried out and, if the danger is proven, the necessary measures must be taken to remedy the situation.

Safety is everyone's business!

General information

Among the factors responsible for accidents, lack of experience, unfamiliarity with installations and task organisation and haste all play a significant role.

Compliance with the procedures, required behaviour and recommended best practices set out in this chapter can prevent many hazardous situations.

ACCIDENT PREVENTION

Being aware, getting trained

- Find out about the risks associated with the task you are preparing to undertake, from:
 - > heads of unit or team managers,
 - > colleagues with experience in the area,
 - > risk prevention experts (APs, IRPSs, etc.),
- Read publications, documents or the bibliography related to the task.
- Attend information sessions for newcomers on the risks encountered in a research laboratory and how to prevent them. These are often held as part of awareness days organised by the regional offices of the CNRS.
Additionally, specific information on the safety issues linked to the unit's activities is provided by the AP in most units.
- Attend the health and safety training courses organised by CNRS.
These focus on the knowledge of particular risks (chemical, biological, lasers, etc.) and their prevention. Some of them are provided as a regulatory requirement (electrical certification, radiation safety officer, autoclave operation, etc.).

Informing others

- Draw the attention of those around you to the risks involved in the tasks being carried out.
- Cordon off experiments in progress.

PLEASE NOTE

For people to take them seriously, any cordonning must be clear, measured and justified. It should be removed as soon as the risk is no longer present.

- Inform the AP and/or IRPS of all the circumstances of any incident or accident.

Checking

Before carrying out any task, you must test and inspect the condition of the equipment to be used (glassware in good repair, effectiveness of detection devices, protective devices on equipment, safety devices such as fume hoods, etc.).

Check and dispose of any chemicals you are not sure about or that are soiled, as well as any unknown mixtures or old chemicals that are liable to decompose (e.g. peroxides).

TAKE CARE WITH STABILISED CHEMICALS THAT HAVE BEEN STORED FOR A LONG TIME OR RE-DISTILLED

Stabilisers may have disappeared or become ineffective. Follow instructions on labels and avoid the prolonged storage of unstable chemicals.

Correctly label any chemicals transferred to a different container, any mixtures (standard symbols, name of chemical or mixture, packaging date, name of user).

Check that there is a notice close to where you are working giving internal and external emergency numbers to call: physician, fire brigade, etc.

Protecting yourself

For both routine research activities and specific types of situation (accidents or incidents), there is personal and collective protective equipment available in every laboratory.

- Everyone has to know how to use collective protective equipment (fume hoods, detection devices, etc.) and has to know where safety showers, fire blankets, water supplies, first aid boxes and fire extinguishers are located.

- Instructions for the use of personal protective equipment (goggles, gloves, masks, shoes, screens, etc.) must be followed.

TAKE CARE WHEN CHOOSING PERSONAL PROTECTIVE EQUIPMENT

- For instance -

- > Cartridge masks can only be used for low gas concentrations (maximum 2% volume) where the type of gas is known. The cartridges must be chosen accordingly. In the event of an accident, a self-contained breathing mask must be used instead.
- > Not all gloves are resistant to all chemicals. You need to select them carefully and you may need to wear two pairs, particularly when handling certain carcinogenic chemicals (nitrosamines, etc.).



NOTE

REMEMBER TO PROTECT:

- **Your eyes** by wearing protective goggles in laboratories, workshops or anywhere where there is a risk of splashes or explosions.
- **Your hands** by wearing gloves when handling harmful chemicals, and also by using a thick cloth when inserting glass tubes, thermometers, etc. into rubber stoppers; and of course dispose of chipped or cracked glassware.
- **Your feet** in workshops and during handling procedures, by wearing safety footwear.

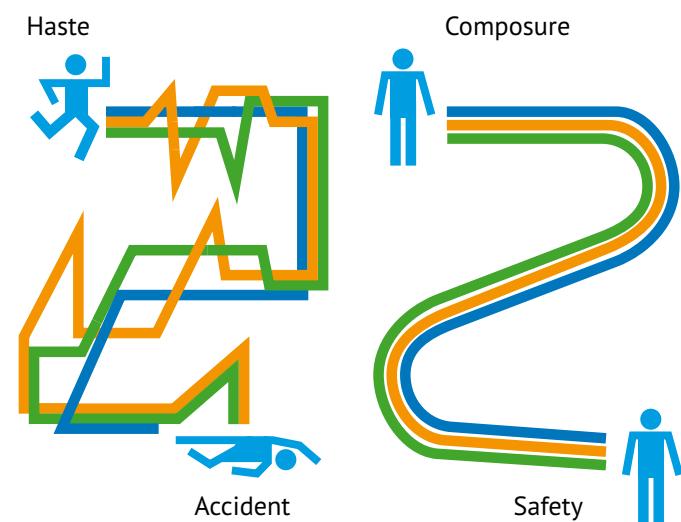
• Organising your work and identifying hazardous situations

Before setting up any experiment or performing any task, check whether the workstation is already occupied and what kind of operations are being carried out there. Any workstation where several different tasks are being carried out constitutes a potentially hazardous situation.

Any task where different steps are carried out at different workstations, which is often the case, also constitutes a potentially hazardous situation.

Concentration procedures carried out under vacuum or under pressure (extraction, distillation, rectification), and the heating of chemicals, are dangerous. They should be carried out in a calm environment and any abnormal or specific circumstances should be taken into account (excessively high concentration, task interrupted then resumed several hours or days later).

- Recreate the ‘safety environment’ necessary for each task, even if partial.
- Return the workstation to its original condition once the task is finished (put away apparatus, dispose of chemicals, apply labels, clean the workstation, etc.), no matter how much or little time was spent on the experiment.
- Never leave large or hazardous items of equipment in passageways or escape routes.
- Never store or consume food or drinks in hazardous experiment areas.



***Warning symbols indicate the risks encountered in research activities.
They are shown in this guide.
Learn to recognise them!***

General information

Despite the preventive measures taken, accidents are still possible. The first response can prove decisive; some basic knowledge is essential to ensure the right action is taken. This can be acquired by attending one of the first aid training courses regularly held by the regional offices.

The knowledge and skills acquired during these training courses are useful not only in the workplace but also in everyday life.

WHAT TO DO IN THE EVENT OF A SERIOUS INJURY

First aid principles

Protect

- If the area remains hazardous, remove the victim and any bystanders.
- Before you act, it is important that you do not put yourself in danger and that you avoid causing further accidents (e.g. use a self-contained breathing mask if there are toxic fumes, shut off the electricity supply in the event of electric shock).



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Alert

- Call an ambulance (15 or 112), the fire brigade (18) or the local emergency services, giving all the information you can, in particular:
 - > the exact location of the accident,
 - > the number and condition of the casualties,
 - > the circumstances of the accident.
- Alert workplace first aid officers and the occupational health team, if necessary.
- Arrange for someone to meet the emergency services so that they can be directed to the location of the accident as quickly as possible (check the procedure for this at your host establishment).

Assist

Arrange for first aid to be given by calling workplace first aid officer while waiting for the emergency services to arrive.

Specific instructions

Person catching fire

- Do not run: quickly immobilise the victim by laying them on the ground (protect your hands and forearms).
- Smother the flames (protect the victim's head and neck as a priority) using a blanket, an item of clothing or a cotton lab coat (never use synthetic fabrics) and take the person to the nearest safety shower or water supply.
- If possible, remove any synthetic garments, which continue to burn (but do not remove the layer of garments in direct contact with the skin).
- Lay the victim down wrapped in a clean sheet, reassure them, cover them up, but do not give them anything to eat or drink while you wait for the emergency services. If required, perform or have someone else perform first aid.

Corrosive chemical splashes

- On the skin:

Wash immediately for a prolonged period (more than 15 minutes), preferably with water, having removed any soiled garments, without attempting to neutralise the chemical.

In the case of hydrofluoric (HF) acid burns, wash and then apply a thick layer of calcium gluconate gel.

- In the eyes:

Wash immediately for a prolonged period, preferably with water, under a tap or with an eyewash fountain, without attempting to neutralise the chemical.

Electric shock

- Never touch the victim unless you are sure they are no longer in contact with the source of electricity.
- Switch off the electricity supply. Be prepared for the possibility of the victim falling when the electricity is switched off.
- If you cannot switch off the electricity supply and it is a medium voltage supply, insulate yourself from the ground (by standing on a stool) and pull the victim away using their clothes or a non-conductive object (e.g. a wooden broom handle).

- For high voltage supplies, use maintenance equipment (insulating platform, rescue hook).

- Perform or have someone else perform first aid.

Poisoning

- Do not make the person vomit; do not give anything by mouth.
- Perform or have someone else perform first aid (making sure you do not inhale the air exhaled by the casualty).
- Warning: if you suspect cyanide poisoning, do not attempt mouth-to-mouth resuscitation.
- Check the safety data sheet (SDS).
- Have someone call a poison control centre to ascertain the action to take.

Radioactive contamination

- Be careful not to spread the contamination if you have to move the casualty.
- Report the risk to the emergency teams.

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Wounds

- If possible, wash the wound with soap and water.
- Wounds soiled by earth: wash with soap and water and disinfect with an antiseptic. Check with the occupational health team that the person's tetanus vaccination is up to date.
- Wounds with a risk of infection: if the bleeding is minimal, allow the wound to bleed without applying pressure; clean with soap and water and disinfect with an antiseptic. You must have the wound checked by a doctor or a nurse.
- In the case of a wound with blood or biological products of human origin, consideration must be given to whether serological monitoring and/or specific preventive treatment must be given.

Bleeding

- If the victim is bleeding profusely, apply pressure to the bleeding area using the hands or a pressure dressing.
- If an entire limb has been severed, stop the bleeding by applying pressure (call a first aid officer as quickly as possible), and store the severed body part in a sealed plastic bag placed on a mixture of water and ice (never place it directly on ice). If appropriate, perform or have someone else perform first aid.

Fractures

- As far as possible, and except in life-threatening situations, do not move the casualty if there is any risk that they may have fractured their spine.
- For a fractured limb, await the arrival of the emergency services without moving the limb or attempting to straighten it.



First aid skills take training!

To acquire them, become a workplace first aid officer¹ and take regular refresher courses

⁽¹⁾ At least one in every twenty staff members must have first aid training in laboratories where hazardous work is carried out.

Risks

BIOLOGICAL AGENTS

Research in biology laboratories involves exposure to specific risks due to the handling of pathogens (whether genetically modified or not) and biological samples such as blood products, cell cultures, etc. Moreover, the development of multidisciplinary research means that biological material is increasingly being handled by non-biologists. Assessing these risks is not always easy because they have not always been identified (deliberate or unknown exposure).

The consequences of contamination can be infection, poisoning or an allergic reaction, or with some pathogenic agents, cancer.

Factors for assessing risk

Recognise the dangers of biological material:

- the origin of the biological material (human or non-human),
- the type of biological agent:
 - > virus, bacteria, parasite or fungus,
 - > genetically modified organism (GMO),
 - > prion,
 - > cell culture,
 - > biological sample (blood, biopsy, etc.),
- hazard class. There are 4 risk groups defined according to criteria of pathogenicity in humans, of danger to those handling the material, of how easily it spreads and of the existence of prophylaxis or treatment. The groups are graded from 1 for non-pathogenic biological agents to 4 for the most hazardous,
- infectious dose.

Identify the specific or most likely contamination routes:

- respiratory, by inhalation of the aerosols created during experiments or of dust carrying biological agents,



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- through the skin or mucous membranes via wounds (cuts, puncture wounds) or soiling (splashes, aerosol, contact with contaminated objects),
- digestive, through mouth-to-hand contact when smoking, nail-biting, sucking a pen, etc.

Take other factors into account, such as:

- identification of the most high-risk stages of experimental protocols,
- the quantities used,
- stability in the environment,
- health of the person handling the substance, etc.

Implementing preventive measures

Prevention consists of stopping biological agents from entering the human body or being spread in the workplace and the environment by following appropriate containment rules and laboratory best practices (movements, use of personal protective equipment (PPE), validation of disinfection methods, etc.), and by disposing of waste appropriately.

Medical monitoring

Exposure to biological agents requires that specific medical monitoring be undertaken. The occupational health physician checks that the state of health of the person handling the (potentially) pathogenic biological products is compatible with this activity.

Training

Biological risk prevention training must be given before the work starts or following any changes in the activities. It must be supplemented by workstation-based training.

Containment facilities

To prevent them from spreading into the environment, pathogenic agents must be handled in laboratories with different levels of containment based on the level of risk (L2, L3 or L4⁽²⁾). The characteristics of these laboratories (laboratory design, internal facilities, operating practices) are defined in an order dated 16 July 2007. Access to L2 and L3 containment laboratories is strictly limited to authorised, trained personnel.

Equipment

The laboratories are equipped with microbiological safety cabinets (biosafety cabinets or BSCs) of at least type II, which provide protection for the handler, the process and the environment, and with all the equipment needed by those conducting the experiments (centrifuge, lab oven, microscope, automated pipetting system, etc.)

Aerosol reduction

To keep practices likely to create aerosols responsible for airborne contamination to a minimum, particular attention must be paid to the methods (e.g. use of capped test tubes) and the movements (e.g. gentle pipetting) used.

Procedures

Written procedures must be drawn up to describe:

- the working methods and protective and preventive measures deployed, including a list of operations to be performed in a BSC,
- appropriate cleaning and disinfecting equipment and methods,
- what to do in case of an accident or incident.

Personal protective equipment

Whether PPE must be worn is determined by the containment level:

- in all cases different shoes must be worn than those worn outside the laboratory,
- in all cases a sufficiently long lab coat must be worn, properly buttoned up,
- single-use gloves (depending on the risk assessment for L2, mandatory for L3),
- mob cap for L3.

Depending on the stage of the experimental protocol and the nature of the micro-organism being handled, PPE such as goggles or a protective visor and/or filtration mask may be necessary.

⁽²⁾ CNRS does not have any level 4 containment laboratories

Inactivation methods

The inactivation methods used must be approved. They mainly involve a thermal process (sterilisation) or a chemical process (disinfection), taking account of the spectrum of effectiveness, the final concentration (chemical process), the temperature (thermal process) and the action or contact time.

Conditions of access to L2 and L3 areas for non-authorised personnel

Before any technical maintenance work is done in biological containment areas (equipment maintenance, repairs, etc.), a decontamination certificate must be given to the maintenance technician.

Waste disposal

The management of biological waste must meet regulatory requirements as regards:

- construction and layout of storage areas,
- storage conditions and length of storage (freezing and compacting are prohibited),
- treatment and disposal methods, depending on the type of waste, its contamination potential, etc.

LABORATORY BEST PRACTICES

- > Do not drink, eat, apply make-up or smoke.
- > Do not use a pipette with your mouth.
- > Wash your hands before and after each task.
- > Clean and disinfect benches after each task.
- > Wear a lab coat and appropriate PPE.
- > Use preferably single-use equipment.
- > Collect sharps (needles and blades) in a suitable container.
- > Maintain equipment in good condition and have it checked regularly.
- > Know the safety instructions and know what to do in case of an incident or accident.

To control biological risks, risk assessment is the most important step in introducing suitable preventive measures.

> Find out more

- "Risques biologiques" (Biological risk prevention) booklet by CNRS :
<http://www.dgdr.cnrs.fr/SST/CNPS/guides/risquebio.htm>
- "OGM en milieu confiné" (GMOs under containment) guide by the MENESR :
<http://www.enseignementsup-recherche.gouv.fr/cid66776/guide-en-milieu-confine.html>
- "Manuel du HCB pour l'utilisation confinée d'organismes génétiquement modifiés" (HCB manual for the contained use of genetically modified organisms):
<http://www.hautconseildesbiotechnologies.fr/IMG/pdf/manuel2014.pdf>
- ED 6131 by the INRS : "Les risques biologiques liés aux techniques de génie génétique en laboratoire" (The biological risks associated with laboratory genetic engineering techniques)
- ED 6188 de l'INRS : "La désinfection des surfaces en laboratoire de biologie" (Surface disinfection in biological laboratories)
- Base de données des agents biologiques "BAOBAB" de l'INRS ('BAOBAB' biological agents) database by the INRS: <http://www.inrs.fr/accueil/produits/bdd/baabab.html>
- Base de données Eficatt de l'INRS (INRS Eficatt database): <http://www.inrs.fr/accueil/produits/bdd/eficatt.html>

Risks

WORKING ENVIRONMENT

The working environment refers to a number of items, in particular the size of premises, noise, lighting, the thermal environment, ventilation and cleanliness.

Room size

French regulations do not stipulate a minimum area, but the NFX 35-102 standard recommends the following for office workspaces:

- 10 m² for one person,
- 11 m² per person in a shared office (i.e. 22 m² for two people, 33 m² for three, and so on),
- 15 m² per person in a noisy shared space.

Noise

Noise can have many effects, in the short or long-term:

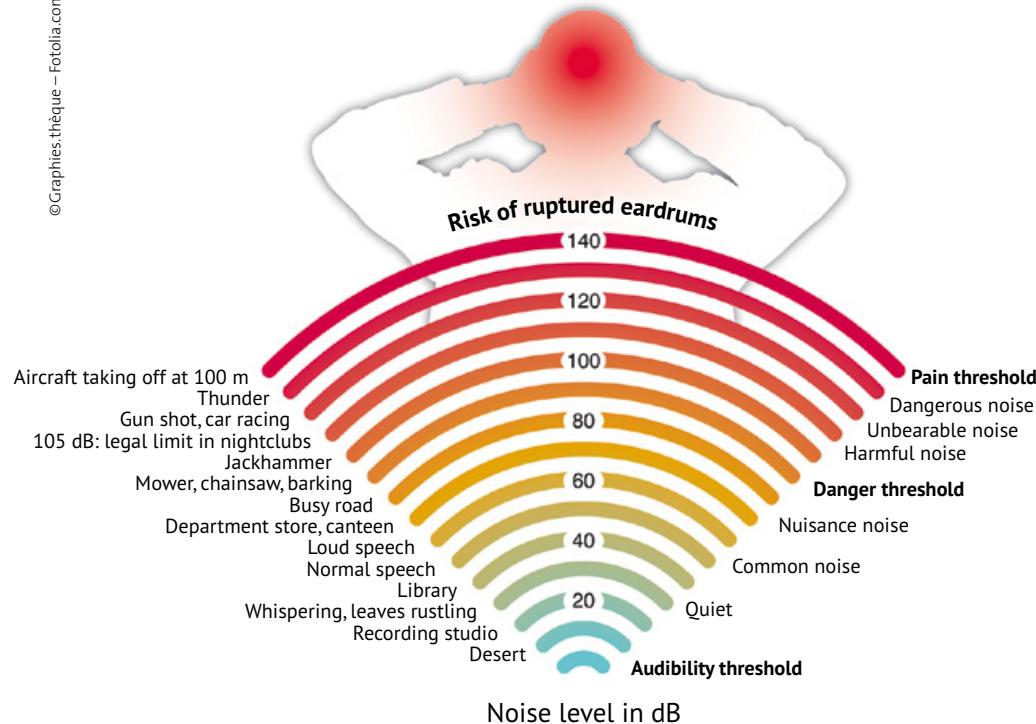
- on the body: fatigue, accelerated heart and breathing rates, high blood pressure, nervousness, anxiety, difficulty in concentrating, reduced alertness, reduced ability to judge distance, sleep and mood disturbances, memory problems, etc.
- on hearing, depending on the case: auditory fatigue, temporary hearing loss, damage causing permanent partial or total deafness.

Noise is generally defined as one or more sounds that are unwanted because they are unexpected, unpleasant or simply annoying.

Sound is an aural sensation produced by the air vibrating around a sound source. The vibration gradually spreads through the surrounding area as a sound wave, producing changes in atmospheric pressure.

The hearing picks up this change in pressure, referred to as acoustic (or sound) pressure.

The ear therefore perceives sound as pressure. Noise level is measured in decibels (dB) (see illustration below) and the pitch of a sound (its frequency) is measured in Hertz (the higher the frequency of a sound, the higher its pitch).



3 noise exposure thresholds are set by the French Labour Code (see table below).

EXPOSURE VALUES	Daily exposure level	Acoustic pressure level
1° Maximum exposure value This value is determined taking into account the attenuation provided by personal ear protection worn by the staff member.	87 dB (A)	140 dB (C)
2° Higher exposure values triggering preventive measures - the area is cordoned off and there are access restrictions in place, - the employer ensures that personal ear protection is actually being worn, - the occupational health physician performs extra medical monitoring.	85 dB (A)	137 dB (C)
3° Lower exposure values triggering preventive measures - appropriate and properly fitting personal ear protection is provided for workers, - at their own request or that of the occupational health physician, workers are given a precautionary hearing test, - employers must make sure that workers receive information and training (on the correct use of personal ear protection, the value and methods of identifying and reporting changes in hearing, etc.).	80 dB (A)	135 dB (C)

Lighting

For visual comfort and health (to prevent sight deterioration and eye strain), lighting levels must be appropriate for the type and precision of the tasks undertaken.



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Lighting concerns not only work areas but also ancillary areas (outdoor areas, passageways, etc.).

The lux is the unit of measurement for lighting (the symbol is lx; 1 lux = 1 candle at a distance of one metre). It characterises the amount of luminous flux received per unit of area.

The French Labour Code sets levels for light measured on a work surface or, failing that, at floor level, in the presence of workers (see table below).



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		Minimum values for lighting (lux)
WORK AREAS and ancillary areas	Internal passageways	40 lx
	Staircases and storerooms	60 lx
	Work areas, cloakrooms, lavatories	120 lx
	Windowless rooms used as permanent work spaces	200 lx
EXTERNAL AREAS	Traffic areas and roads	10 lx
	External areas permanently used for work	40 lx

Thermal environment

'Thermal environment' refers to the temperature, humidity and wind conditions that workers are exposed to. According to regulations, temperature must be adapted to the human body, taking account of the working methods and physical constraints on workers.

There are no regulatory minimum or maximum temperatures.

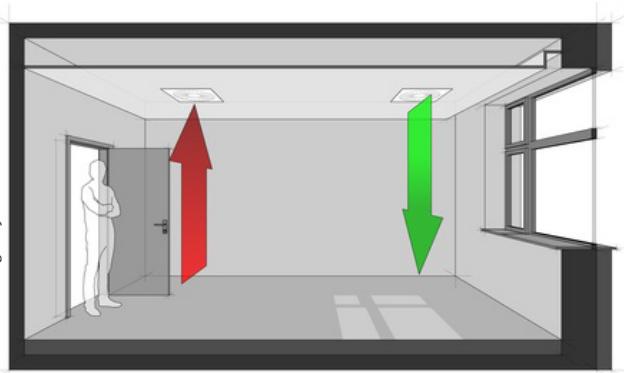
Instead, the NF X35-203 (ISO 7730) standard specifies 'comfort conditions' according to activity:

- 20 to 22°C: in offices,
- 16 to 18°C : in workshops where light physical activity is performed,
- 14 to 16°C: in workshops where heavy physical activity is performed.

Ventilation and cleanliness

In closed spaces where staff have to spend long periods of time, the air must be renewed so as to maintain a state of cleanliness that protects the health of workers and avoids excessive temperature increases, unpleasant odours and condensation.

The regulations make a distinction between spaces with non-specific pollution and spaces with specific pollution.



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Spaces with non-specific pollution

Pollution is linked solely to the presence of humans.

Ventilation is either provided by a mechanical ventilation system or by permanent natural ventilation (e.g. a window).

Natural ventilation is permitted when the volume is:

- $\geq 15 \text{ m}^3$ per occupant in offices and areas where light physical work is performed,
- $\geq 24 \text{ m}^3$ per occupant in other areas.

Where ventilation is provided mechanically, the minimum fresh air flow rate (where the air is taken from a pollution-free source) per occupant is dependent upon the activity:

DESCRIPTION OF PREMISES	Minimum flow rate of fresh air per occupant (in cubic metres per hour)
Offices, areas where no physical work is performed	$25 \text{ m}^3/\text{h}$
Catering areas, meeting rooms	$30 \text{ m}^3/\text{h}$
Workshops and areas for light physical work	$45 \text{ m}^3/\text{h}$
Other workshops and areas	$60 \text{ m}^3/\text{h}$

Spaces with specific pollution

Pollution is due to the pollutants emitted by the activity or workstation (lavatories are considered to be spaces with specific pollution).

Ventilation is provided and its flow rate is determined by the type and quantity of pollutants and the amount of heat to be removed.

For some chemical agents, regulations set maximum concentration thresholds in the workers' breathing zone... These are maximum limits for occupational exposure and they are either mandatory or indicative.

The air taken from a space with specific pollution can only be recycled if it has been properly cleaned.

Systems for collection at source (fume hoods, articulated arms, etc.) or strict containment (glove boxes) must be regularly checked and serviced.

Care must be taken when installing ventilation, collection or recycling equipment to ensure that it can be regularly serviced and efficiency checks can be carried out at a later date.

Preventive measures

Organisational

- Integrating safety into the design and refurbishment of buildings.
- Fitting out workstations.
- Limiting the number of workers exposed to noise, heat, cold, etc.
- Reducing length of exposure to noise, heat, etc.

Technical

- Signalling risks.
- Using absorbent materials or acoustic hoods for noisy equipment, sound-proofing, partitioning.
- Measures to protect against heat and cold.
- Room ventilation or capturing pollutants at source.
- Regular servicing and checking of ventilation/collection systems.
- Appropriate personal protective equipment in good condition (earplugs or ear defenders, anti-dust or gas masks, protective clothing, etc.).

Human

- Training and information about the risks associated with work environments and their effects, which can sometimes be permanent.
- Regular breaks while working.

> Find out more

- **Noise' fact file by the INRS:** <http://www.inrs.fr/accueil/risques/phenomene-physique/bruit.html>
- **TJ13 by the INRS:** "Éclairage des lieux de travail" (Lighting in the workplace)
- **TJ5 by the INRS:** "Aération et assainissement des lieux de travail" (Workplace ventilation and cleanliness)
- **ED 984 by the INRS:** "Valeurs limites d'exposition professionnelle aux agents chimiques en France" (Maximum limits for occupational exposure to chemical agents in France)
- **NF X35-203 standard:** "Ergonomie des ambiances thermiques - Détermination analytique et interprétation du confort thermique par le calcul des indices PMV et PPD et par des critères de confort thermique local" (The ergonomics of thermal environments - Analysis and interpretation of thermal comfort by calculating PMV and PPD indices and criteria for local thermal comfort)
- **NF X35-102 standard:** "Conception ergonomique des espaces de travail en bureaux" (Ergonomic design of office workspaces)

Every year at CNRS, people falling over while walking account for around a third of reported accidents, and accidents while travelling in a vehicle or on a bicycle account for approximately one fifth of them.

People falling down stairs, slipping on ice or tripping on obstacles or bumpy ground, and road accidents, can lead to lengthy absences from work and cause serious injuries.



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Accidents while travelling

Regardless of the mode of transport, the highway code must be followed at all times, including by pedestrians. To safeguard against accidents when on the move, you should:

- identify and use the safest routes,
- plan journeys to ensure you have enough time to travel safely.

By car

Even though it is an everyday activity, driving a car is not without risk. You need to remain constantly vigilant, particularly on journeys you do regularly (roads can change at any time).

A number of factors can cause accidents:

- being late, stress, having personal problems or problems at work,
- routine, which can lead to lower vigilance,
- excessive speed or ignoring road signs because the journey is familiar.

Seat belts must always be worn, even on short journeys.

Using a phone is prohibited by the highway code.

Aside from your behaviour at the wheel, you must also make sure the vehicle is in good condition (vehicle inspection, lights, tyres).

On two wheels

In traffic, it can be difficult for other vehicles to see those travelling on two wheels (motorbikes, mopeds or bicycles) and they are therefore very vulnerable because they are very exposed.

On motorbikes and mopeds, an approved helmet, correctly attached, must be worn by law. Wearing clothing with fluorescent or reflective strips can make you more visible.

The French association Prévention routière distributes information leaflets explaining the hazards and helping you anticipate dangerous situations. It recommends that you never overtake on the approach to a junction and that you watch the movement of cars' front wheels, which are the first thing to indicate a change of direction.

On a bicycle, some equipment is mandatory (brakes, a yellow or white front light and a red back light, a bell). Reflective equipment (belts, vests) are highly recommended (and must be used at night or in conditions of poor visibility outside built-up areas), as are cycle helmets, safety wings, etc.

Cyclists must be extremely vigilant and must always follow the rules of the highway code:

- Position yourself correctly in relation to other vehicles, and avoid their blind spots.
- Avoid being trapped between the pavement and a lorry or bus.
- Never overtake on the right.

On foot

For those travelling on foot in the street or on public transport, falls are usually due to something in the surroundings, to the individual themselves or what they are doing, or to the vehicle they are travelling in (train, metro, tram, bus) moving or stopping suddenly. A poor state of repair, unevenness or obstacles on the ground are usually to blame in the first case, and haste or lack of attention in the second. In the third case, it is advisable to hold on tightly to keep your balance.

Recommendations:

- check the weather conditions and wear the right footwear,
- if the ground or streets are slippery, where possible use paths that have been made safe (handrail, gritted pavements, etc.),

- do not walk along carrying large loads that block your view,
- organise your time properly so you do not hurry,
- stay alert when walking: do not read, write text messages, etc.

Getting around a site

Most of the risk factors mentioned for longer journeys can also cause accidents when you are getting around a site.

In addition, there are some rules you must follow while on a site:

- Regardless of how you get around, use only permitted routes.
- When travelling in a motor vehicle, only use authorised roads on the site.
- If paths or roads are icy, only use gritted routes.
- If you notice a surface that is damaged, obstructed or slippery, street lighting that is not working or faulty or inadequate road markings in or immediately surrounding the site, please enter this in the health and safety register so that your comment can be acted upon.

- Always hold the handrail when using stairs.
- Do not read documents or write text messages while walking.
- Arrange your work so as to avoid or reduce the amount of travel by using alternative means (e.g. video-conferencing).
- Plan journeys to give you enough time to move around safely, taking account of breaks, the length of the working day and any foreseeable constraints.

Travel risks account for a third of reported accidents and should therefore not be overlooked. Like any other risk, they require forward planning and common sense.

Find out more

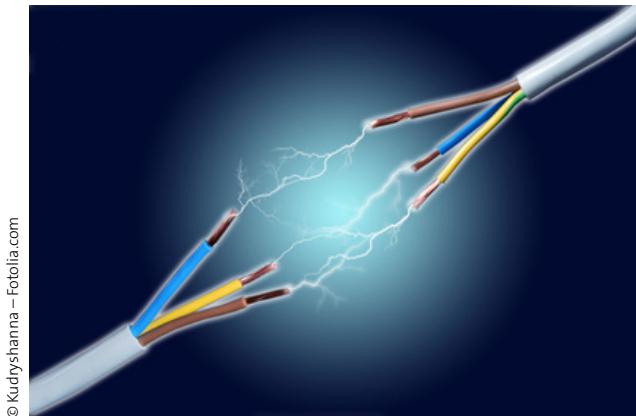
- Prévention routière website: <http://www.preventionroutiere.asso.fr>

Risks

ELECTRICITY

Electricity is everywhere in our working environment and exposes personnel to risks that can have some very serious consequences.

An electrical installation that meets current standards and is properly maintained and used can reduce the risk of electric shock/electrocution as well as the risk of fire.



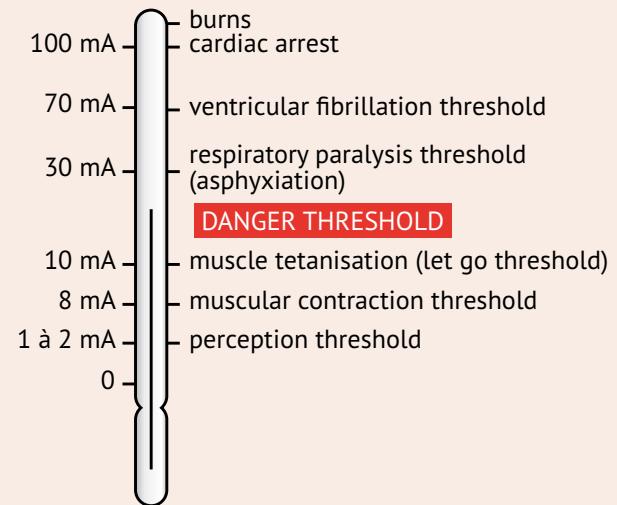
Risks for personnel

Electric shock can occur when there is a difference in potential between two points of the body, generally in the event of contact with something live. An electric shock causes an accident when the difference in potential is greater than 48V (24V in a damp environment). Contact can be direct (contact with parts that are normally live) or indirect (contact with parts that are accidentally live).

NOTE

Effects of electrical current

> The effects of electrical current can vary depending on the level of current, the path it takes through the body, the surface of contact, and so on.



> Electrical burns can also occur where the current entered and left the person's body, as can the destruction of cells along the path of the current within the body. Electric arcs can also result in deep skin burns.

Preventive measures

Any work on electrical installations or in their vicinity must only be undertaken by authorised personnel.

Live work is prohibited.

Electrical installations must be checked once a year to ensure they are still compliant.

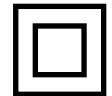
Before doing any work on equipment or installations, you must ensure that the electrical installation is switched off using the following lockout procedure:

- disconnect the installation or equipment from any possible source of electricity;
- padlock the disconnection devices in the open (off) position;
- check that there is no voltage.

Personnel must be familiar with the emergency devices for switching off the electricity supply. The devices must be accessible and easy to manipulate.

All equipment used must be designed to protect the user from electrical hazards.

There are different classes of protection represented by standard symbols:

Class 0	The use of this type of equipment is prohibited in the workplace.	
Class I	Protection is provided by the equipment earthing.	
Class II	Protection is provided by double insulation.	
Class III	Protection is provided by a safety extra-low voltage power supply.	

Electrical certification

Before allowing an employee to carry out work on electrical installations, the employer must check:

- their technical competence to perform the planned activity,
- that they are suitably trained in preventing electrical hazards,
- that there are no medical reasons why they cannot perform this activity.

This process involves them taking a training course. The type of course will depend on the voltage area they will be working in (high voltage, low voltage), and the type of activity (electrical work, lock out, basic maintenance, work in the vicinity of an installation). At the end of this an electrical certification license will be issued by the employer.

Fire risk

20% of fires are electrical in origin and their causes are:

- overheating of cables, particularly where electrical circuits are overloaded,
- short circuits,
- electrical circuits that are not properly insulated,
- loose or rusted connections, which can cause overheating,
- lightning,
- electrostatic discharge.

These events can cause a generalised fire or an explosion if there are flammable materials nearby.

Basic precautions

- Never adjust the setting of circuit breakers or change the rating of fuses, especially to reduce their sensitivity.
- Do not overload sockets with multiple devices.
- Only use equipment that is in good condition and meets current standards.
- If you do not have an electrical certification license issued by your employer, do not modify electrical installations.

IN CASE OF ELECTRIC SHOCK

- > ***Switch off the electricity supply or ask someone else to do so*** (beware, the person who received the shock may fall).
- > ***Call the emergency services or ask someone else to do so.***
- > ***Call an SST (workplace first aid officer).***

Find out more

- **ED 6187 by the INRS:** "La prévention du risque électrique : textes réglementaires relevant du code du travail" (Protecting workers in organisations using electrical current)
- **ED 6127 by the INRS:** "L'habilitation électrique" (Electrical certification)

Risks WORK EQUIPMENT

Units and departments are liable to use machinery and equipment (saws, jointer planers, rotary machine tools, presses, guillotine shears, folding machines, machine tools for working with metal and glass, portable machinery and equipment for manual use, centrifuges, gas-operated machinery and equipment for welding, grinders, etc.) that is potentially dangerous because of the risks of crushing, shearing, cutting, being caught or tangled, shock, perforation or puncturing, abrasion, burns, etc.

Main factors of accidents

- Poor equipment design (take particular care with equipment manufactured or modified in-house).
- Inappropriate or dangerous operation (usage inappropriate for the job to be done, etc.).
- Maintenance during operation.
- Unsuitable working environment, work area too small or untidy.
- Inadequate or non-existent operator training.



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Accident prevention

Machinery-related

- Provide equipment compliant with the regulations.
- Have it checked regularly (including prototypes or modified devices).

Premises-related

- Work in a clean, tidy area.
- Make sure there is sufficient space and that there is room to pass between machines.

User-related

- Have special training.
- Be properly authorised by a manager to use the equipment.
- Read the instructions, particularly concerning conditions of use (use of mandatory protective devices) and the health and safety measures to be taken.

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- Identify the main parts, emergency stop buttons and potential movements of tools and parts.
- Wear appropriate work clothes that fit properly and are not loose.
- Tie long hair back.
- Wear protective goggles where there is a risk of swarf.
- Never enter or stand in the danger zones of any machine or equipment.
- Find out what to do in case of accident.



- > ***Never improvise the operation of machinery or equipment.***
- > ***Never use a dangerous piece of equipment if working in ‘isolation’.***
- > ***Never operate a machine on your own if you have not received training for it.***

Risks

PRESSURE EQUIPMENT (ESP)

Pressure equipment (ESP) is commonly found in our units. Its use is related to both research activities (autoclaves, gas bottles, etc.) and for running the buildings (boilers, extinguishers, etc.).



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Equipment types

The first category consists of experiments in laboratories that use a fluid under positive or negative pressure.

The second category consists of 'vacuum' devices such as evaporators and desiccators.

Finally, the third consists of pressure devices using either gas pressure (gas bottles and diving bottles, compressors, reaction autoclaves, etc.), steam pressure (sterilisation autoclaves, boilers, etc.), or liquid pressure (hydraulic equipment). Fire extinguishers, whether portable, mobile or fixed, are also pressure equipment.

Identifying the risks

The vast amount of energy stored up by pressure equipment can be dangerous. If this energy is suddenly released, it can cause an explosion - for equipment "under pressure" - or an implosion - for equipment "under vacuum" -, with flying debris or, in some cases, a shock wave.

The risk of explosion, fire or poisoning due to the physical or chemical properties of the product released (whether in gas, liquid or vapour form) may also be linked to this equipment.

Risk prevention

Pressure equipment undergoes initial testing when it is first put into service, and is regularly inspected and re-qualified by approved bodies. It is up to the owners and users of the equipment to ensure these checks are carried out.

If the equipment has a CE mark (replacing the French inspection body's horse's head symbol), this guarantees its compliance with the regulations.

Before each use, the equipment must be visually inspected to detect any problems (leaks, corrosion, overheating, etc.).

All pressure installations must be fitted with one or more safety devices (devices for adjusting or limiting the pressure, rupture disc or safety valve) used to 'relieve' the pressure if it operates abnormally. As far as possible, these devices should be above head height and should not impede passage.

The installation of pressure equipment must take account of user safety in the event of a leak, flying debris or other problems. To achieve this, protective devices must be installed such as polycarbonate screens, flexible metal curtains (with variable mesh sizes) or the equipment must be installed in a room of its own with concrete walls.

Pressure equipment must only be used by competent personnel, i.e. personnel who have been trained to use it and know the risks its use entails.

Pressure equipment must not be used after a lengthy period of non-use without first being inspected.



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Compressed gas bottles

Regulations require the re-qualification of gas bottles (by the owner). The time interval between two re-qualifications depends on the type of fluid.

The risks associated with gas bottles are the tank (body of the bottle) or the valve bursting. If the failure is mechanical, caused for example by the bottle being struck or dropped, the energy released will cause the bottle (or valve) to explode or to propel it at nearly 80 km/h.

To avoid these risks, bottles must be secured at 2/3 of their height and they must only be moved using a special gas bottle trolley.

The bottle cap or tulip cap protects the valve if the bottle is dropped. Under no circumstances must any attempt be made to remove it or to use it to lift the bottle. Any accessories (connections, regulators and hoses) must be removed before transporting the bottle.

Fitting anti-whip cables can prevent hoses from whipping about should they fail due to excessive pressure.

BEST PRACTICES FOR HANDLING GAS BOTTLES

- Wear suitable PPE (gloves, protective goggles, lab coat, safety footwear) when handling bottles.
- Operate valves and regulators by hand. Do not use tools in case you lock or damage the closure device. If there is a flat gasket on the regulator, tighten it with a spanner.
- Never apply oil or grease to connectors because of the risk of fire in the presence of oxidising gas.
- Before fitting a regulator, always check that the valve is closed, i.e. the screw is unscrewed. Move out of range of the regulator when opening the valve.
- Where possible, keep gas bottles outside buildings in a ventilated place protected from sources of heat (sun, flames, sparks, etc.). Place them upright and secure them at 2/3 of their height.
- Store bottles separately according to the type of gas (combustible, oxidising, toxic or corrosive) in a non-corrosive atmosphere.
- Always close empty bottles because changes in temperature or pressure could either expel stagnant gas from the bottle (atmospheric contamination risk) or draw air into the bottle (corrosion risk).

For more information about the specific gases you are using, ask your supplier for the relevant technical data sheets.

> Find out more

- CNRS pressure equipment prevention booklet: <http://www.dgdr.cnrs.fr/SST/CNPS/guides/equipements.htm>

Risks ANIMAL EXPERIMENTS

The presence of animals in the laboratory requires certain precautions to be taken both for the animals' welfare and for the safety of those handling them.

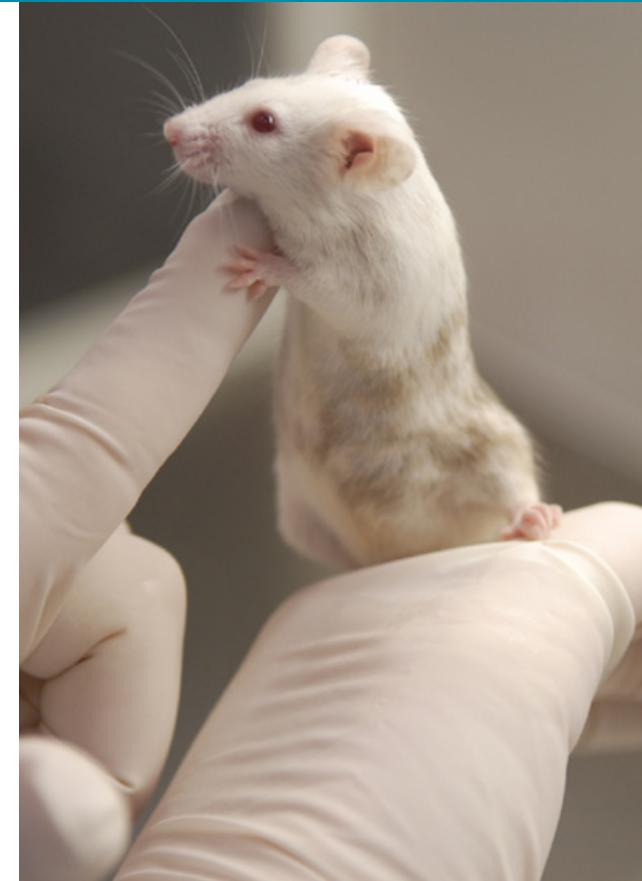
Initial basic training, regular updating of skills, and strict compliance with the internal rules of both laboratory and animal house are essential.

Particular risks due to animals

- Risk of contamination by viruses, bacteria, parasites, fungi, etc.:
 - > through the skin: bites, scratches, punctures by needles, etc.;
 - > through the respiratory or digestive systems.
- Risk of wounds during handling or if attacked by an animal.
- Risk of allergies mainly due to the handling of bedding.

General physical risks

- Electrical risks in damp areas.
- Risk of poisoning related to the use of toxic products: disinfectants, insecticides, anaesthetics, euthanasia drugs.
- Dangerous reactions related to the mixing of incompatible products (e.g. bleach and acids).
- Use of special equipment for which the operating instructions and precautions for use need to be known: autoclaves, washing machines, glass equipment, etc.
- Heavy lifting.



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Preventive measures

Medical measures

- Have all the vaccinations recommended by the occupational health physician.
- Attend any check-ups required by with the occupational health team.
- Immediately report to the occupational health team any accidents (cuts, puncture wounds, bites, etc.) or epizootics detected.

Prophylactic and hygiene measures

- Plan regular visits by a vet.
- Find out the state of health of the animals.
- Follow hygiene rules: bedding change, cleanliness of rooms and equipment, frequent washing of hands.
- Do not eat, drink or smoke in animal houses or laboratories.
- Avoid the transfer of germs by wearing appropriate, properly fitting PPE.
- Identify animals carefully.
- Clean and disinfect equipment regularly.
- Follow authorised procedures.

Handling animals

- Be calm, and observe and be aware of the animal's behaviour.
- Use appropriate restraints if necessary.
- Follow the experiment techniques and procedures.
- For large animals, beware of attacks and behaviour.
- Follow hygiene rules for bacteriological sampling, microsurgery and post-mortems.
- Provide suitable storage for dead animals, with special storage for animals marked with radioelements.
- Follow work safety rules and use the appropriate movements and postures when carrying heavy loads.
- Inform the animal house manager of any abnormal event or behaviour, animals in poor health, minor accidents (cuts, bites), or of any faulty equipment, especially safety devices.

A situation where one works alone, which often occurs in an animal house, represents an aggravating factor for some of these risks.

Find out more

- CNRS Animal Experimentation Office: <http://ethique.ipbs.fr>

All buildings are vulnerable to fire. If a fire starts and is not brought under control immediately, it can very rapidly become out of control. The consequences of this can be tragic, with property or even lives at risk. Preventive measures are taken in the laboratories to control this risk.

How does a fire start?

Combustion requires the following three elements:

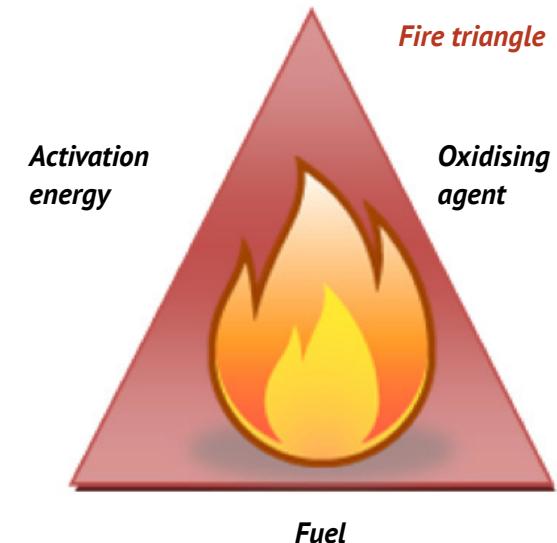
- fuel (flammable liquid, paper, oil-soaked rag, etc.),
- an oxidising agent (generally oxygen from the air),
- activation energy (electrical short circuit, cigarette end, hot tool, spark, naked flame, etc.).

Together these form what is known as the fire triangle (see illustration opposite). If one of these three elements is missing or disappears, the fire cannot continue to burn.

Preventing fires

Fire risk prevention involves the following:

- storage rules for flammable products and combustible materials,
- hot work permits, issued prior to any hot work, detailing the specific preventive measures to be taken,
- instructions for use of electrical equipment,
- keeping work spaces tidy.



Building construction techniques are chosen to limit and slow down the start and spread of fires, taking account of the building type and intended use. These techniques enable the occupants to evacuate the building safely and help the emergency services to act as safely and effectively as possible.

Detecting the start of a fire

Fires can develop very quickly. It is said that to extinguish an incipient dry fire, you need:

- a glass of water in the first minute,
- a bucket of water in the second minute,
- a tank of water after three minutes.

Early detection of the start of a fire is therefore important to be able to act as soon as it breaks out and bring it under control quickly.

Some laboratories are fitted with fire detection systems. The detection systems are programmed to suit the needs of each building: audible alarm sounding (sometimes after a time-out period to check that there is actually a fire), opening smoke vents, fire alarm control panel etc.



Solid materials forming embers

Liquids and liquefiable solids

Gases

Metals

Plant or animal oils and fats

Reacting to a fire starting

When a fire starts, it is important for everyone to react quickly and appropriately.

The first few seconds after the alarm is raised are essential. The spread of the fire needs to be assessed so that a quick decision can be made between fighting the fire, if that is still possible, and quickly evacuating the building.

Knowing fire escape routes, emergency exits, safety instructions, and fire assembly points before a fire starts will greatly enhance the ability to react calmly.

Taking action when a fire starts

If there are flames but no smoke, there may still be time to try to extinguish the fire or prevent it from spreading by fighting it as quickly as possible. But if there is more smoke than flames, the building must be evacuated as quickly as possible.

There are various options for putting out a fire when it is starting, but because each one must only be used in very specific circumstances, it is essential to identify clearly the origin of the fire.

The type of extinguisher that must be used depends on the type of fire to be put out (see illustration opposite).

During fire training, you will learn how to use the extinguishing equipment in the laboratories: fire extinguishers, fire blankets, fluid shut-off valves, automatic gas extinguishing system, etc.

Evacuating in the event of fire

Toxic smoke, which can appear very quickly, can be much more life-threatening than flames. Some 75% of fire deaths are due to asphyxiation.

Evacuation instructions often include the following points:

- if necessary, make the operation safe (shut off fluids, etc.) as quickly as possible,
- leave the room immediately,
- turn off the light (this is a sign that the room is empty for the fire brigade),
- close doors and windows (but do not lock them),
- check that nobody has been left behind,
- follow the instructions given by fire marshals,
- do not use lifts but use the nearest staircase,
- use the nearest emergency exits,
- if there is smoke, keep low: the air is fresher closer to the ground,
- never enter a smoke-filled corridor or stairwell. In this case, stay in a room with a window, and close the door. If possible, wet the door and seal it with damp cloths. Draw attention to your presence at the window,
- never turn back without permission,
- help anyone who has difficulty walking,

- go to the fire assembly point,
- wait for instructions from the person responsible for the evacuation.

Explosive atmospheres (ATEX)

In certain conditions, an explosive atmosphere can form when flammable liquids or dust are being handled. When these are mixed with air and ignited, there is violent combustion propagation to the rest of the unburned mixture.

Prevention consists in avoiding these mixtures from occurring as far as possible. If the risk cannot be eliminated completely, measures can be taken as regards the working procedures and the equipment used in the areas where these mixtures might form.



The specific icon identifies an ATEX zone. Certain recommendations have to be followed when working in an ATEX zone: special equipment must be used, you must not have your mobile phone on you, etc.

> On arrival, check the rules concerning fire prevention so you can understand and apply them.

> Take part in fire drills, which are carried out on a regular basis, so you are familiar with what to do.

> Find out the location of fire extinguishing equipment

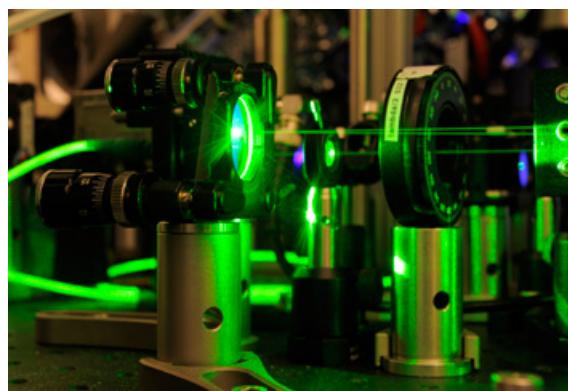
> If a fire starts, immediately raise the alarm in the building, apply internal procedures and follow evacuation instructions.

> Only try to put out the start of a fire if you are not endangering your own life and you feel able to fight the flames.

Risks LASER

The danger of lasers is due mainly to the photon source. Lasers are used in a very wide range of applications such as measurement, ablation, characterisation of and work with materials, health, safety, hologram creation, etc.

There are two main families of risk: beam-related risks and laser device-related risks.



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Beam-related risks

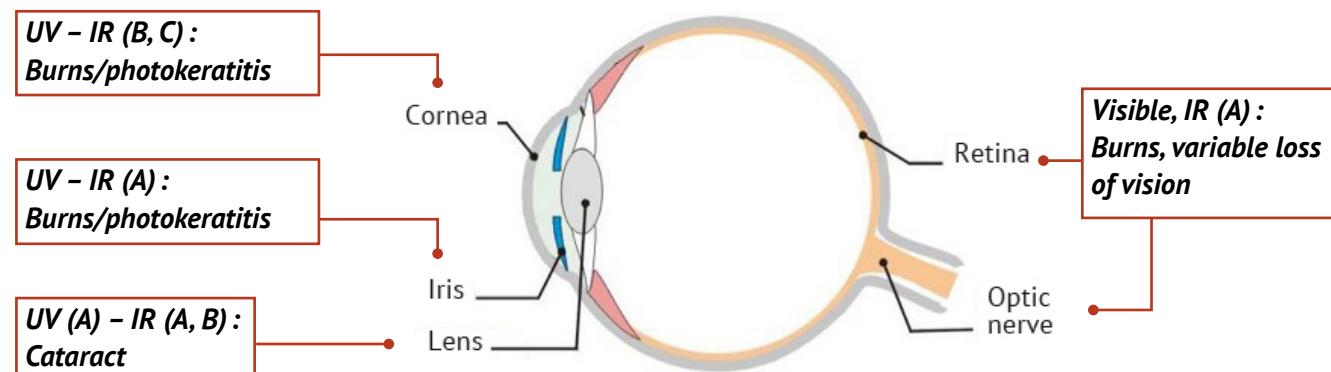
Because the radiation emitted by lasers is highly concentrated (a large amount of energy is deposited in a small area), interaction between the beam and body tissues (the eyes and skin) presents a risk.

The type of damage depends upon the laser characteristics (wavelength (λ), beam diameter, power, energy, etc.) and the body tissues affected. The different types of eye damage according to the wavelength of the radiation are shown below.

Every part of the eye can therefore be damaged by exposure to laser radiation.

The eye problems that can develop range from slight impairment to blindness. Note that damage to the cornea or lens is reversible or treatable, whereas damage to the retina is not. Where the damaged area is very small or is on the periphery of the field of vision, it causes fewer problems because, with binocular vision, the brain compensates.

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Moreover, the effects of radiation on tissue can occur deep in the subcutaneous tissue, depending on its wavelength. Very bright light levels can cause pigmentation, ulceration and scarring of the skin or even damage to underlying organs.

Maximum permissible exposure values (MPE in W/m² or J/m²) are defined for laser radiation in the French Labour Code.

The table below presents the risks according to laser classification:

	Direct exposure	Specular reflection ¹	Diffuse reflection	Fire/Burning
Classe 1	Exposure never dangerous			
Classe 1M	!	!		
Classe 2 ²	! if > 0,25 s	! if > 0,25 s		
Classe 2M	! if > 0,25 s	! if > 0,25 s		
Classe 3R	!	!		
Classe 3B	!!	!!	!	!
Classe 4	!!	!!	!!	!!

! : risk increases if viewing is via an optical instrument

! : dangerous

!! : highly dangerous

Device-related risks

Laser use and maintenance is associated with risks other than those related to using the beam:

- electrical risks: high voltages present in most devices,
- chemical risks: presence of colorants, solvents or cleaning/degreasing products, and gases,
- x radiation risks: production of spurious x-rays with some lasers (high voltage discharge in the cavity, and risk of target activation at high energy levels),
- acoustic risk: laser induced breakdown generating noise greater than 80 dB(A),
- fire risk: use of certain solvents or ignition of a material by the beam,
- flooding risk mainly due to the cooling water circuit,
- risk associated with the storage of gas bottles (pressure equipment, handling).

¹ Specular reflection: there is a single reflected beam and ideally all the incident energy is present.

² Classe 2: 400- 700 nm - Only in the visible light emission spectrum.

Prevention and protection

Collective protective equipment

Housing or beam protection tubing must be installed as close as possible to the emission of the source of radiation.

All optical components, including the laser, must be permanently fixed to the optical table.

Inspections looking for beam 'leaks' must be performed regularly.

Work phases

The different phases of work involving a laser installation carry very different levels of risk: it is essential to distinguish between the optical alignment phase and other activities (maintenance, acquisition). During adjustment, where technically possible:

- replace the laser either with a device emitting visible light or with a less powerful piece of equipment,
- make the main beam less powerful (by adjusting the laser device or changing the optical density at the beam output).

'Normal' work phases must take place with the beam(s) inaccessible if the MPE is exceeded.

Personal protective equipment

Safety goggles (for protection or adjustment) constitute the final barrier between the eyes and the laser beam. They weaken the beam and, to a certain extent, keep out the light from the laser. They are essential because they protect the eyes from accidental exposure and diffuse radiation, but they do not provide absolute protection. Under no circumstances must they be used for deliberately looking directly at a laser beam. They must be replaced if they have been struck by a laser beam or if they are damaged.

They must:

- be compliant with the NF EN 207 standards (for protective goggles) or NF EN 208 (for so-called "alignment" goggles which must only be used for lasers emitting visible light), and be CE marked,
- be the correct type for the wavelength of the laser,
- be the correct type for the type of laser emission, continuous or pulsed (take account of the frequency range of the pulses),
- fit the person properly.

Premises

All dangerous lasers (exceeding the MPE) must be situated in a windowless room or a room with the windows obscured, containing non-reflective surfaces. Appropriate signalling must be installed outside to warn anyone intending to enter the room. This generally consists of (an) indicator light(s) and a 'danger laser' warning sign, stating the type of goggles that must be used.

Near any doors to the room there must be a notice stating the characteristics of the laser source, the classes of laser, the name and the contact details of the person responsible for the laser installation, a map showing the location of the emergency shut-off button, marking of the paths of the beam by non-reflective objects, etc.

The layout of the rooms must make it easy to move around the bench and must not contain any workstations where the eyes would be exposed to the laser beam. Neither the optical table nor the path of the laser beam must be obstructed. The path of the beam must be marked and if possible shielded by fixed parts.

Laser safety adviser (RSL)

Any laboratory using laser radiation must have a member of staff responsible for laser safety advice to define preventive and protective measures, etc.

Training

All newcomers must know who this laser safety adviser is and receive special usage/awareness training before they start work.

Notices positioned close to installations must contain essential information about managing the risks of lasers. There may also be an information notice for each room, explaining the safety rules that apply to all workstations in that room (work wear, associated risks, etc.)

Medical monitoring

Everyone working with lasers must receive appropriate medical monitoring.

Exposure monitoring

An FIE (personal exposure sheet) must be drawn up for everyone exposed to laser radiation and must be sent to the relevant occupational health physician, who will, if necessary, adapt their medical monitoring.

Remember that each beam requires a specific type of protection.

There is no such thing as universal safety goggles.

Find out more

- **Articles R. 4452-1 to R. 4452-31 of the French Labour Code**
- **NF EN 60825-1 standard Safety of laser products:** Part 1 Equipment classification and requirements

Risks

LIFTING AND HANDLING OPERATIONS – LIFTING EQUIPMENT

Anyone who moves heavy objects either manually or mechanically is at risk of injury. According to the CNRS' accident statistics, confirmed by general statistics for accidents, one in three accidents is caused by manual lifting. Occupational diseases attributable to lifting and carrying heavy loads are increasing significantly.

Preventing the risks associated with physical activity must involve:

- the reduction or even complete elimination of physical activities that can cause joint damage in any part of the body,
- the design and equipping of working environments with the health, well-being and efficiency of operators in mind,
- appropriate task organisation,
- the use of equipment to assist with handling operations.

If necessary, training must be given on correct movements and postures.

When lifting a load

Manually

Manual lifting is often the cause of back injuries, particularly in the lumbar region. For this reason the AFNOR NF X 35-109 standard states that men must not lift loads exceeding 30 kg and women must not lift loads exceeding 15 kg. These weights vary according to age. The restrictions laid down in the French Labour Code are not so stringent. The Code states that workers may be required to lift loads exceeding 55 kg for men and 25 kg for women, provided that an occupa-

tional health physician has certified their fitness, though it stipulates that no loads exceeding 105 kg must be lifted.

Mechanically

With light tools or equipment such as mechanical or hydraulic jacks, or even simple levers, always check the condition and positioning of the equipment and that either chock or lock is in position. Reduce the risk of loads slipping by using chocks, e.g. made of wood.

With lifting equipment such as hoists, pulleys, travelling cranes, goods lifts, forklift trucks, pallet trucks, etc.:

- if you have to work with the load suspended: check the condition and positioning of the lifting slings (no direct contact with sharp edges), tension the sling before lifting the load, and avoid lifting tilting loads;
- if you have to lift a load from below, check that the load is balanced, chocked and lashed to its support; always engage both fork arms all the way under the load or its support. With any mechanical lifting equipment, never lift loads greater than the equipment capacity, never stay underneath the load, and comply with servicing and inspection requirements.



When moving a load

To avoid unnecessary handling operations, identify beforehand where you are going to put the load and the route you are going to use.

Passageways must be clear, and floors must be clean and free from obstacles.

Use travelling cranes, ramps on stairs, bridge plates, etc.

Do not rush, keep your pockets free from tools, and use the correct methods according to the object's type of packaging, e.g. ordinary hand trucks, stair-climbing hand trucks, bottle trolleys, drum trolleys, ordinary trolleys, caged trolleys, pallet trucks, etc.

Bear in mind that the product being carried may be explosive, flammable, corrosive, irritant or toxic: check beforehand.

The use of personal protective equipment is always recommended: helmet, gloves, safety footwear.

The load and its environment must be constantly monitored throughout the manoeuvre.



Working at height

Do not use a ladder or steps: these are for access but are not suitable for working from.

Beware of precarious balancing, inappropriate angling, faulty rungs and sudden movements. Before you use a ladder, make sure its feet are properly chocked.

Never attempt to reach somewhere inaccessible other than by moving the ladder.

Wherever possible, use scaffolding or mobile scaffold towers, and make sure they are vertical and cannot move. Fit handrails and do not attempt balancing acts.

Beware of falling objects: do not overload scaffolding platforms and keep them perfectly clean; cordon off the area underneath.

Take care not to touch live electrical installations.

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> ***Always use mechanical means of lifting by preference.***

> ***When choosing your PPE:***

- Take account of the activity and the risks involved;***
- Consult the personnel concerned;***
- Check that the PPE complies with regulations.***

Risks

ASSIGNMENTS

Staff from CNRS go on 50 000 assignments every year, many of them in the field: at altitude, in isolated or hostile areas, at sea, in extreme areas (very hot, very cold), in dangerous countries, etc.

According to regulations, a staff member on assignment is defined as a serving staff member in possession of an assignment order for no more than twelve months, who leaves their home and travels outside of their administrative place of residence and of their home to perform the assignment.



Before you leave

All staff sent on assignment must first be given an assignment order signed by an authorised person. The content of this order is specified in a specific instruction.

If the assignment is to a dangerous country, it is essential to obtain the approval of the FSD (defence and security official).

It is also essential to assess the risks associated with the job, work sites and travel, and to find out in advance the conditions under which it is possible to return home, how healthcare will be paid for, weather conditions, emergency communication methods, etc.

Staff are strongly advised to contact the occupational health team and read the booklet entitled 'Santé, missions et affectations

internationales' (Health and international assignments) for information. In particular, this guide explains simple hygiene and protective measures to avoid diseases (vaccinations, food, malaria drugs, etc.) and provides suggestions for the contents of a first aid kit.

In some cases the risks are associated with the research being done or simply with being a foreigner. Reading the 'Conseils aux voyageurs' (Advice for travellers) guide produced by the Ministry of Foreign Affairs is also recommended, as is the Circular of 20 October 2009 of the Ministry of Higher Education and Research entitled 'Mission scientifique des chercheurs français' (Scientific Assignments for French Researchers).

Taking a first aid training course before you leave is also recommended.

During the assignment

Staff must comply with preventive measures put in place and wear personal protective equipment appropriate for the situation. They must also carry useful telephone numbers in case of difficulties.

Doctors' recommendations must be followed (protect yourself from mosquitoes, refuse to have any injections using non-disposable equipment or any non-urgent transfusions, do not walk barefoot on muddy or damp ground in some countries, acclimatise gradually to the sun or altitude, etc.).

The same applies to the FSD's recommendations (respect the formalities and rules of your host country, be vigilant and discreet when establishing contacts, protect confidential data, especially data on the hard drives of laptops, etc.).

When you return

Staff may visit the occupational health physician if they have any health problems.

- > ***Never leave without an assignment order.***
- > ***During your assignment, if you think you will find yourself in a hostile or isolated environment, you may be offered additional first aid (SST etc.) training.***

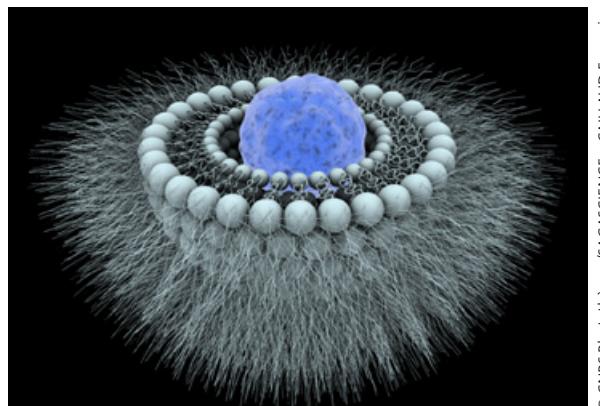
Find out more

- **List of dangerous countries:** <http://www.dgdr.cnrs.fr/FSD/default.htm>
- **Instruction concerning the compensation scheme for temporary travel in France, the French overseas departments and territories and abroad, payable from the CNRS budget of 10 February 2012**
- "Santé, missions et affectations internationales" (Health and international assignments) **CNRS booklet:** <http://www.dgdr.cnrs.fr/SST/CNMP/missions.htm>
- **Dossier "Conseils aux voyageurs" (Advice for travellers) fact file from the Ministry of Foreign Affairs:** <http://www.diplomatie.gouv.fr/fr/conseils-aux-voyageurs>
- **Circular of 20 October 2009 of the Ministry of Higher Education and Research :** http://www.dgdr.cnrs.fr/FSD/securite-echanges/FAQ_mission/CIRCULAIRE_Missions_Etranger.pdf

Risks NANOMATERIALS

A nanomaterial is a material with at least one dimension on a nanometric scale, i.e. between approximately 1 nm and 100 nm.

A distinction is made between nano-objects (particles, threads, tubes) and nano-structured materials (aggregates, agglomerates, nano-composites, nano-porous materials). Nanomaterials can be used in various forms (as liquids, powders, gels, in a matrix).



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Exposure pathways and potential health risks

The respiratory system is the main pathway for nano-objects to penetrate the human body. Whether nano-objects can penetrate the skin is a possibility still under investigation.

Because of their size, inhaled or ingested nano-objects may be capable of crossing biological barriers (in the nose, bronchial tubes, lungs, etc.) and migrating to different organs via the blood and lymphatic system.

Little is known about the toxicity of nano-objects, but the following facts must be borne in mind:

- for an equivalent mass, nanometric objects are more toxic and have a more significant inflammatory effect than microscopic and macroscopic objects of the same chemical type,
- every nano-object has a specific toxic potential.

Exposure to nanomaterials must be kept as low as possible.

Occupational exposure situations

There are many work situations where personnel can be exposed to nanomaterials:

- transfer, sampling, weighing, suspension and incorporation of nanomaterials into a mineral or organic matrix,
- decanting, agitation, mixing and drying of a liquid suspension containing nanomaterials,
- machining of nano-composites (cutting, polishing, sanding, etc.),
- packaging, storage and transport of products,
- cleaning, servicing and maintenance of equipment and premises (cleaning a workbench, cleaning a reactor, changing used filters, etc.),
- collection, packaging, storage and transportation of waste,
- faulty operation or incidents: leak from a reactor or closed system.

Risk prevention

Because little is known about the risks, specific preventive measures need to be taken to keep occupational exposure to a minimum or even to eliminate it entirely. These measures are based on the recommendations applicable to any activity involving exposure to hazardous chemical agents (see the 'Chemicals' section of this guide). Strict compliance with these rules is essential because of the ability of nano-objects to persist in and spread through the atmosphere of the working environment (nano-aerosol formation).

An FIE (personal exposure sheet) must be drawn up for everyone exposed to nanomaterials and must be sent to the relevant occupational health physician, who will adapt medical monitoring if necessary.

Particular care must be taken with cleaning work surfaces and equipment used.

All processes emitting nano-aerosols, and particularly the ones mentioned above, must be carried out using collective protective equipment that meets current standards:

- a laboratory fume hood,
- a laminar flow cabinet adapted for nanomaterials,
- a glove box for nanomaterials classed as carcinogenic, mutagenic or toxic to reproduction (CMR),

- a suction arm, etc. for large equipment,
- a safety weighing cabinet.

Collective protective equipment that recycles filtered air is not suitable for handling nanomaterials.

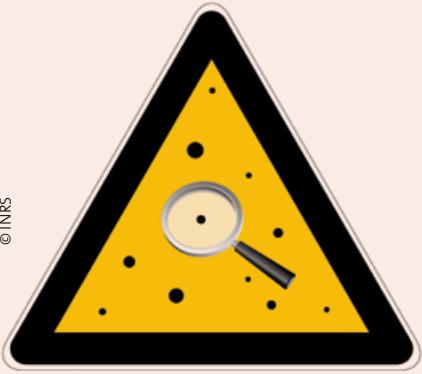
If collective protective equipment is not sufficient, personal protective equipment must also be worn.

- Wear a breathing mask with filtration (class 3 filter) or self-contained breathing mask, a garment to protect against chemicals in particle form (type 5 protection, e.g. tyvek®), gloves (nitrite, vinyl, or even two pairs of gloves for high-exposure work) and goggles if there is a risk of spattering.
- Regularly clean floors, work surfaces and equipment thoroughly with a damp cloth.
- Collect, label and treat waste (hazardous chemical waste).
- Double-wrap waste (in a plastic bag placed in a sealed container) if it could release nano-aerosols.

Specific preventive measures

- Handle nano-objects in a liquid or gel suspension rather than in powdered form.
- Cordon off, identify (with pictograms) and restrict access to the work area so that only those directly involved in handling the nano-objects can enter.
- Optimise the procedure so that as little dust as possible is formed: by preference use closed systems and automated techniques.
- Capture pollutants at the source of emission (fume hood, glove box, suction arm, safety weighing cabinet, etc.) and filter the air before discharging it outside the work area (high-efficiency particulate air - HEPA - filters greater than class H13).

NOTE



Contains nanomaterials

Labelling of rooms, equipment, installations and waste

This pictogram is suggested to signal the presence of nanomaterials (there are no standard pictograms in France or in Europe).

Additional indications such as "Contains nanomaterials" or "Risk of exposure to nanomaterials" may be used.

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- > *Current knowledge of the toxicity of nanomaterials means that safety measures are essential to keep exposure to a minimum.*
- > *If you handle nanomaterials, inform the occupational health physician, who will implement enhanced medical monitoring.*

> *Find out more*

- ED 6115 by the INRS "Nanomatériaux. Prévention des risques dans les laboratoires"
(Nanomaterials. Risk prevention in laboratories)
- **Ministry of Employment:** <http://www.travailler-mieux.gouv.fr/Nanomateriaux.html>

Risks CHEMICALS

Chemicals are widely used in research laboratories. Strict precautions must be taken when handling, storing and disposing of them.



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So as not to expose themselves or those around them to any risks, anyone handling a chemical for the first time must find out about its hazardous properties before doing anything else:

- flammability,
- instability: inherent explosiveness or explosiveness when energy is applied (impact, heat, etc.) or as a result of a reaction (explosophores present in the molecule),
- harmful effects: toxicity, irritation, asphyxia, carcinogenicity, mutagenicity or toxicity to reproduction (CMR), etc.

An FIE (personal exposure sheet) must be drawn up for everyone exposed to hazardous chemicals and must be sent to the relevant occupational health physician, who will adapt their medical monitoring if necessary.

Controlling risks due to chemicals requires examination of the products being handled and analysis of the work situations in which they are used.

Information can be obtained chiefly:

- by reading the labels on the bottles (standardised pictograms, etc.) and the safety data sheets (SDS) produced by the supplier. These documents:
 - > are the primary source of information for the safe handling of chemicals,
 - > give appropriate storage advice for the particular product,
 - > explain what to do in the event of an accident,
 - > give recommendations for disposal.
- by looking at specialist databases (toxicology sheets, INRS studies, lists of CMR chemicals on the EESIS -European chemical Substances Information System - website) and reference publications concerning the dangers of chemicals,
- by talking to colleagues with knowledge and experience in this field.

Before use

- Know about the hazards of the products you are using (physical or chemical, danger to health or the environment).
- Check that equipment is in good condition and that the apparatus is properly assembled (glassware, fixings, etc.).

During use

Follow laboratory best practices:

- a lab coat must be worn: it must be made from cotton or a non-flammable material, be buttoned up and have long sleeves. It must not be worn outside the laboratory,
- goggles (or a face screen) must be worn in all places or situations where the eyes and/or face may be exposed to chemicals (laboratory, storage room, etc.),
- suitable gloves must be worn when handling chemicals: skin contact must be avoided (corrosive chemicals, CMRs, etc.),
- a fume hood (or even glove box) must be used for handling chemicals where there is a risk of inhalation or the release of dangerous gases (toxic, explosive, etc.),
- an automated pipetting system must be used for sampling,
- safety instructions, notices at workstations, etc. must be complied with.

Particular attention must be paid to experimental protocols requiring reaction times longer than the laboratory's opening hours.

THE SPECIFIC CASE OF CRYOGENIC LIQUIDS:

- Wear a long-sleeved lab coat with the buttons done up.
- Wear a face screen during sampling.
- Wear cold-resistant gloves.
- Carry out handling and transfer operations in a ventilated area.
- Use containers specially designed for cryogenic liquids (non-airtight lid, vents).

Disposing of chemicals - waste

Find out about the different waste receptacles available and the disposal procedures used in the site or research unit.

- Chemicals must never be washed down the sink (except where there is a specific protocol for their neutralisation or destruction).
- Chemicals must be collected in special canisters, taking account of any chemical incompatibilities, which are taken away by a specialist chemical treatment company.
- Full canisters are stored in a ventilated area designed specifically for this purpose, consisting of containment bunds of the correct design.

Basic storage rules

- All vessels containing chemicals must be clearly identified:
 - if the chemical is a commercial product that has been transferred from its original bottle, the original label must be reproduced,
 - if the chemical has been synthetically produced, the label must enable the origin of the synthesis to be determined.
- The use of food and drink bottles is strictly prohibited.
- The presence of toxic chemicals and flammable liquids in quantities not justified by the operations, experiments or work in progress is prohibited.
- The use of metal safety canisters for highly volatile solvents (particularly diethyl ether) is recommended.
- Chemicals must be placed as far as possible from sources of heat and exits.
- Flammable products must be stored in ventilated cabinets.
- Flammable products that have to be kept cold must be placed in refrigerators or freezers that are electrically safe (no possibility of sparks inside the cabinet).

>>

- Some categories of chemicals must be stored under lock and key: certain CMR chemicals, highly toxic (T+) chemicals, and category 1 drug precursors. A register enabling the tracking of these chemicals must be located close to the place of storage.
- New chemicals must, if possible, be stored in a bay outside the building or, failing that, in an insulated, ventilated room. Under no circumstances must cupboards through which pipes and cables run be used.
- Products must be stored in accordance with their chemical incompatibilities.

Some chemicals present risks for pregnant and breastfeeding women and they are therefore prohibited from handling these chemicals (category 1 and 2 reproductive toxicants, etc.).

As soon as you are aware of it, report your pregnancy to your occupational health physician so that they can give you advice and adapt your job if necessary.

Find out more

- **ED 6041 de l'INRS :** "Étiquettes de produits chimiques. Attention, ça change!"
(Warning: Labelling of chemicals is changing!)
- **A. PICOT, Ph. GRENOUILLET.** "La sécurité en laboratoire de chimie et de biochimie"
(Safety in chemistry and biochemistry laboratories) New edition, 2013
- **"150 CNRS fact sheets: Sécurité des produits chimiques au laboratoire"**
(Safety of chemicals in the laboratory) 4th edition, 2014
- **ED 697 by the INRS:** "Réactions chimiques dangereuses" (Dangerous chemical reactions)
- **ED 6015 by the INRS:** "Le stockage des produits chimiques au laboratoire" (Storing chemicals in the laboratory)
- **ED 954 by the INRS:** "La fiche de données de sécurité" (Safety data sheets)
- **FT0 by the INRS:** "À propos des fiches toxicologiques" (About toxicology data sheets)
- **ED 753 by the INRS:** "Stockage et transfert des produits chimiques dangereux"
(Storage and transfer of hazardous chemicals)
- **European chemicals agency (ECHA) :** <http://echa.europa.eu/fr>
- **Safety regulation concerning fire and panic risks in buildings with public access, order of 13 January 2004**



SGH01

Symbol: Exploding bomb

- Unstable explosives
- Explosives in divisions 1.1, 1.2, 1.3, 1.4
- Self-reactive mixtures, types A, B
- Organic peroxides



SGH02

Symbol: flame

- Flammable gases, cat.*1
- Flammable aerosols, cat. 1, 2
- Flammable liquids, cat. 1, 2, 3
- Flammable solids, cat. 1, 2
- Self-reactive substances and mixtures, types B, C, D, E, F
- Pyrophoric liquids, cat. 1
- Pyrophoric solids, cat. 1
- Self-heating substances and mixtures, cat. 1, 2
- Substances and mixtures which in contact with water emit flammable gases, cat. 1, 2, 3
- Organic peroxides, types B, C, D, E, F



SGH03

Symbol: flame over a circle

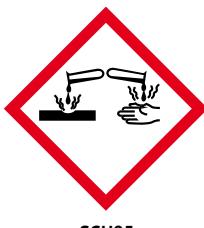
- Oxidising gases, cat. 1
- Oxidising liquids, cat. 1, 2, 3
- Oxidising solids, cat. 1, 2, 3



SGH04

Symbol: gas bottle

- Compressed gases
- Liquefied gases
- Refrigerated liquefied gases
- Dissolved gases



SGH05

Symbol: corrosion

- Corrosive to metals cat. 1
- Skin corrosion, cat. 1A, 1B, 1C
- Serious eye damage, cat. 1



SGH06

Symbol: skull and cross- bones

- Acute toxicity (oral, dermal, inhalation), cat. 1, 2, 3



SGH07

Symbol: exclamation mark

- Acute toxicity (oral, dermal, inhalation), cat. 4
- Skin irritation, cat. 2
- Eye irritation, cat. 2
- Skin sensitisation, cat. 1
- Specific target organ toxicity - Single exposure, cat. 3
- Respiratory tract irritation
- Narcotic effects



SGH08

Symbol: health hazard

- Respiratory sensitisation, cat. 1
- Germ cell mutagenicity, cat. 1A, 1B, 2
- Carcinogenicity, cat. 1A, 1B, 2
- Reproductive toxicity, cat. 1A, 1B, 2
- Specific target organ toxicity - Single exposure, cat. 1, 2
- Specific target organ toxicity - Repeated exposure, cat. 1, 2
- Aspiration hazard, cat. 1



SGH09

Symbol: environment

- Hazardous to the aquatic environment
 - Acute hazard, cat. 1
 - Chronic hazard, cat. 1, 2

*Cat.: Hazard category.

Please refer to Annex V of Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.

Risks IONISING RADIATION

Ionising radiation is electromagnetic radiation (X, gamma) and particle radiation (alpha, beta, neutron, etc.) carrying sufficient energy to damage living tissues.

Depending on the amount of energy imparted to the organism, the biological effects are:

- systematic and quick-acting at high doses (death, acute burns, etc.),
- unpredictable and long-term at low doses (development of cancer, cataracts, cardiovascular disease, etc.),
- absent (no detectable consequences).

Sources and methods of exposure

The sources of ionising radiation encountered in the laboratory are:

- radioactive sources in the form of sealed sources (non-dispersible), unsealed sources (liquids, gases, friable solids) or activated material,
- electrical devices emitting ionising radiation, such as particle accelerators or x-ray generators.

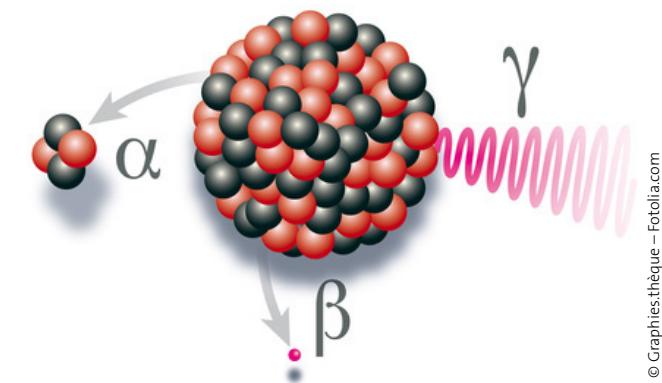
Sealed sources and devices that emit ionising radiation lead to so-called external exposure of the body. It may affect the whole body or be limited to certain parts of the body, depending on the operation carried out (hands, forearms, eyes).

With unsealed sources, exposure can also be internal (by inhalation or ingestion), or cutaneous.

Laboratory radiation protection measures

Three main principles guide the keeping and use of sources of ionising radiation:

- justification: any use must be justified in terms of the benefits it could bring over the disadvantages that could result from it,



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- optimisation: exposure must be kept as low as reasonably possible,
- limitation: exposure must remain below regulatory limits, which are much lower than the lowest doses causing detectable effects in humans.

Laboratories using sources of ionising radiation require permission or a declaration from the French Nuclear Safety Authority (ASN).

The main radiation protection personnel at CNRS are:

- the nuclear activity manager: often the head of unit who has overall responsibility for health and safety in the laboratory,
- the PCR (radiation protection officer): this person advises management, trains personnel, controls the sources and installations and takes action in the event of an accident,

- the occupational health physician, who declares whether someone is fit to do a particular job and provides appropriate medical monitoring.

General preventive measures

A risk assessment enables radiation protection zoning to be defined. Access rules are defined for each zone according to the dose likely to be received. The zones are marked by signs and access instructions are displayed at the entrance. Only personnel declared fit by the occupational health physician, trained by the PCR and fitted with suitable dose monitoring equipment are permitted to enter them.

Job analyses are used to assess the doses likely to be received. A summary of the results is given in the FIERI (personal ionising radiation exposure sheet), which is used notably to define appropriate dosimetric and medical monitoring.

For external exposure, the dose received is monitored using 'passive' dosimetry with deferred reading. This type of dosimetry is complemented by 'active' or operational dosimetry (the dose rate is displayed in real time) in zones where the risk is highest.

For internal exposure, additional measurements can be taken (whole body counting, urine analysis, etc.).

There must be particular vigilance as regards pregnant or breastfeeding women.

SCALES AND UNITS

Activity: number of radioactive decays per second. The unit of measurement is the Becquerel (1 Bq = 1 decay per second).

Absorbed dose: energy absorbed per unit mass. The unit of measurement is the Gray (1 Gy = 1 J.kg⁻¹)

Equivalent dose: the product of the absorbed dose multiplied by a factor linked to the type of radiation. The unit of measurement is the Sievert (Sv).

Effective dose: sum of the equivalent doses weighted by factors associated with the sensitivity of the exposed tissues.

This unit is used to quantify the risk. The regulatory maximum permitted exposure due to human activity (excluding medical exposure) over 12 months is:

- 1 mSv for the public,
- 20 mSv for workers (except students and pregnant women).



Pictogram signalling the presence of a source of ionising radiation



Monitored zone

Even at permanent workstations, exposure is low (between 1 and 6 mSv per year); however access to these zones is regulated.



Controlled zones

(different colours and descriptions of the exposure method). Exposure is higher here (between 6 and 20 mSv over 1 year). Access is specially regulated. There is enhanced dose monitoring (operational dosimetry) and some categories of people are not allowed to enter these zones (students, fixed-term and temporary workers are not permitted to go beyond the yellow zone).



'Red' zone: access is prohibited. It must be kept locked. The exposure of personnel entering a red zone could exceed regulatory limits.

Practical protective measures

All potential sources of exposure must be identified.

TO LIMIT EXTERNAL EXPOSURE:

- keep the source at a distance because the dose received is inversely proportional to the square of the distance: handle radioactive sources with tongs, etc.,
- keep the exposure time to a minimum: practice with a dummy run, write up notes outside the zone, etc.,
- install suitable protective shields.

TO LIMIT INTERNAL OR SKIN EXPOSURE:

- handle in a fume hood, glove box, etc.,
- wear suitable personal protective equipment: lab coat, gloves, shoe covers, etc.,
- do not eat, drink or smoke in the room,
- check work areas before and after each operation using instruments for measuring radiation, and check yourself whenever you leave the zone,
- collect and package waste and effluent in suitable and distinctive marked containers.

What to do in an emergency

IN THE EVENT OF EXTERNAL EXPOSURE:

- move away from the source,
- if a piece of electrical equipment is involved, switch off the electricity supply,
- cordon off the zone and prohibit access to it,
- protect the irradiated parts of the body,
- alert the PCR,
- consult the occupational health physician.

IN THE EVENT OF CONTAMINATION:

- immediately remove any contaminated garments,
- limit the contaminated zone if it spreads,
- cordon off the zone and prohibit access to it,
- alert the PCR,
- consult the occupational health physician.

IF INTERNAL EXPOSURE IS SUSPECTED (INGESTION, INHALATION, SKIN PENETRATION):

- alert the PCR,
- consult the occupational health physician.



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Treatment of radioactive waste

The use of unsealed sources generates radioactive waste and effluent. Disposal methods vary according to the physical, chemical and radiological characteristics of the waste.

Identify the PCR (radiation protection officer) in your unit and seek their assistance whenever necessary.

Find out more

- Articles L.1333-1 ff. and Articles R.1333-1 ff. of the Public Health Code. Articles R.4451-1 ff. of the Labour Code and their implementing acts.
- ASN : <http://www.asn.fr>
- IRSN : <http://www.irsn.fr>
- INRS : <http://www.inrs.fr>

Risks

NON-IONISING RADIATION

Non-ionising radiation is electromagnetic waves that do not have enough energy to convert atoms to ions. The types of non-ionising radiation are:

- optical radiation from 1 mm to 100 nm, from infrared (IR) to ultraviolet (UV),
- microwaves and radio frequencies,
- static fields (magnets).

Non-coherent artificial optical radiation

By definition, artificial optical radiation (AOR), apart from lasers, is known as 'non-coherent'. Its effects can be seen in the eyes and on the skin. The consequences of exposure depend on the dose, and they can be acute (if a threshold for im-



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mediate damage is exceeded - erythema) or long-term (repeated exposure - skin ageing).

There are many sources of optical radiation in workshops and laboratories:

- lighting, display screens,
- ultraviolet lights/generators, arc welding equipment in the workshops, glasswork in furnaces, etc.

AOR-specific regulations require that every measure is taken to eliminate or, failing that, reduce the risks of exposure. There are regulatory maximum permissible exposure (MPE) values, which reflect the conditions under which personnel may be exposed repeatedly without harmful effects (in periods of 8 hours a day). These MPEs must never be exceeded.

Existing protection are devices for automatic shut-off when someone enters a room containing a UV generator, the wearing of protective screens suitable for the type of radiation, and skin protection (garments that cover the skin, gloves, etc.).

Radio frequencies including microwaves

Radio frequencies and hyper frequencies are used in processes that use induction, the dielectric effect, microwave ovens, radar, and also any telecommunications devices (wifi terminal, mobile phone, etc.). This electromagnetic radiation can be absorbed by human tissues. The energy absorbed can produce a temperature increase in exposed tissues depending on the frequency and intensity.

At high frequencies (100 kHz to 10 GHz), a measure known as the specific absorption rate (SAR), expressed in Watts per kilogram (W/kg), is used to quantify the maximum limits. There are also reference levels for fields, which can be used for comparisons with the field values measured at the site.

Several prevention techniques can be used for electromagnetic radiation:

- leak elimination, screen protection, Faraday cages,
- cordoning off after field measurements, safety instructions,
- best practices for wifi and mobile phones (purchase of phones with low SAR ratings, wifi terminals mounted high up in passageways, etc.).

Static fields: magnetic fields

DC field non-ionising radiation generates intense magnetic fields with electromagnets used in nuclear magnetic resonance (NMR) equipment or magnetic resonance imaging (MRI). Electrolytic tanks are also used in laboratories.

The strength of the magnetic field is directly proportional to the strength of the current and decreases exponentially as the distance from the source decreases. It is expressed in Tesla (T) or Gauss (G) where $1\text{ T} = 10\,000\text{ G}$.

Magnetic fields disturb any ferromagnetic item, especially materials containing iron. They disrupt electronic systems and magnetic media containing data. Static magnetic fields can cause metal objects to move, turn them into projectiles and thus cause injury and damage.

In France there are no regulations covering worker exposure to magnetic fields.

However, zoning should be applied with different access restrictions:

- 5 G (0.5 mT): maximum value for the public, anyone with a prosthesis/cardiac pacemaker, pregnant women,
- 30 G (3 mT): value above which ferromagnetic objects can be moved,
- 2 kG (0.2 T): value above which access is prohibited, except with special permission and subject to medical approval.

The main preventive measure is (three-dimensional) marking of these zones (especially of the 5G areas), with safety instructions and access restrictions allowing only authorised personnel without clinical contraindication to enter. The prohibition on access for personnel with cardiac pacemakers and metal prostheses must be clearly displayed.

Sound waves are covered in the 'working environment' section.

Do the right thing: Identify non ionising radiation emission sources in your environment and their emission level.

Risks

PSYCHOSOCIAL RISKS (RPS)

There is currently no legal or statistical definition for work-related psychosocial risks (RPS). They lie at the interface between a person and their work situation, hence the name.

They include stress, but also internal violence (psychological and sexual harassment) and external violence (by those outside the organisation against its employees) - *Source : Employment Ministry*.

It is said that 'what makes a work-related health risk psychosocial is not its manifestation but its origin: psychosocial risks will be defined as risks to a person's mental, physical and social health caused by working conditions and organisatio-

nal and relational factors that could interact with their mental functioning' - *Source : Gollac report*.

According to this report, the main factors of psychosocial risks can be grouped into six dimensions:

- workload and working time,
- emotional demands,
- autonomy,
- social relationships,
- conflicts of values,
- job insecurity.

Prevention

There are three levels to prevention:

- primary prevention, which aims to deal with the risk at source by removing or reducing the factors of psychosocial risks (assessing risk factors/diagnosis, etc.),

WORK **PRIVATE LIFE**



- secondary prevention, which consists of trying to moderate the effect of risk factors by working with personnel who might be affected (information/training, etc.),
- tertiary prevention, which deals with any situations that arise and assists the staff concerned.

At CNRS, there is an action plan for working conditions and psychosocial risk prevention. This plan focuses on three areas, which reflect these prevention levels: preventing for primary prevention, detecting for secondary prevention, and treating for tertiary prevention.

In addition, two circulars have been adopted on dealing with harassment in the workplace: psychological harassment in 2011 and sexual harassment in 2013.

The regional offices ensure the implementation of this action plan in their regions.

**Preventing psychosocial risks
relies on a range of players from
different 'professional families'.**

Find out more

- **The Gollac Report:** http://www.travailler-mieux.gouv.fr/IMG/pdf/rapport_SRPST_definitif_rectifie_11_05_10.pdf
- **Videos by Florence Ballestre, barrister, on psychological harassment:**
http://www.dgdr.cnrs.fr/drh/protect-soc/videos_rps.htm
- **Online fact sheets on the CNRS HR department website:** http://www.dgdr.cnrs.fr/drh/protect-soc/fiches_rps.htm

Goods are considered to be dangerous when they present a risk to humans or the environment. They can be a material, an object, a solution, a mixture, a preparation or waste.

The risk associated with the transport of dangerous goods is that of containment failure, which can happen as a result of:

- a traffic accident,
- a package breaking because it was dropped,
- a package being opened accidentally or handled incorrectly,
- lack of knowledge of the rules on sending or receiving a product that presents risks for the health of workers.

Such events expose the handlers of the package to risk but can also have an impact on public health and the environment.

All dangerous goods being carried are covered by a UN (international identification) number. This number defines the obligations prior to dispatch (packaging, labelling, documents to be drawn up, mode of transport, specific instructions for loading/unloading/handling the product, etc.).

To prevent these potential risks and enable products of this kind to be carried on public highways, various rules have been laid down. They are set out in a number of regulations for the different modes of transport:

- IATA for air transport,
- IMDG for maritime transport,
- RID for rail transport,
- ADNR for waterways,
- ADR for road transport.

Classification of dangers

There are thirteen possible classes of dangerous goods (class 1 /explosives, class 2/gases, class 3/flammable liquid, [...], class 6.1/toxic substances, class 6.2/infectious substances, class 7/radioactive material, etc.).

For commercially marketed chemicals, the UN number is indicated in section 14 of the safety data sheet (SDS). This section explains the rules to be followed as regards transport and sets out all the special precautions to be taken or understood by users for the transport of goods inside or outside their facilities.

For any product manufactured in a laboratory (synthetic molecule, GMO, etc.), an estimate of the danger it poses should be used to determine its classification and a generic UN number should be assigned to it.

Obligations

The sender (the head of unit) is entirely responsible for compliance with the regulatory requirements concerning any package he or she hands to the carrier, for completing the relevant shipping documents, for complying with the packaging and labelling rules, etc.

In any unit sending—or receiving—dangerous goods, the head of unit must consult an adviser on the safety of the transport of dangerous goods (CSTM) more commonly known as a ‘safety adviser’. The safety adviser’s role is to advise and inform the sender, to explain the relevant rules on transport and to check that these requirements have been followed.

WARNING

Personnel who have to send or receive dangerous products or goods must undergo training, which must be updated regularly.

WARNING - prohibitions

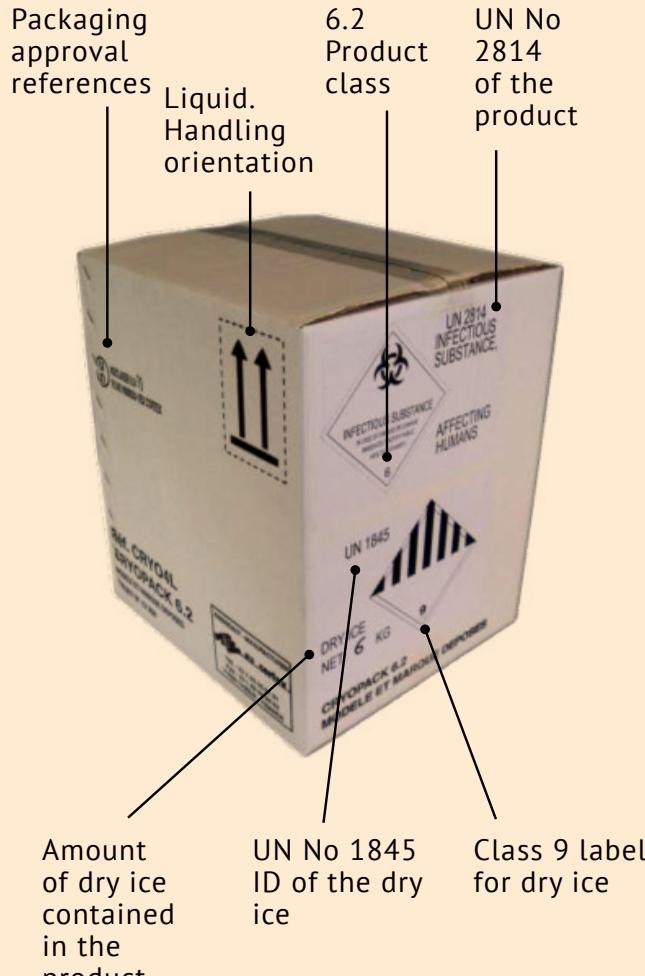
- Sending dangerous goods by post is strictly prohibited.
- The transport of dangerous goods is banned on all forms of public transport (metro, bus, train, ferry).
- The transport of dangerous goods in a private vehicle is prohibited (except in a transport vehicle that meets the regulations).

Safety adviser

CNRS appoints a national safety adviser for the transport of dangerous goods. This adviser coordinates, advises on and approves all TDG operations.



Example of the packaging of infectious material with dry ice



Packaging

The regulations include instructions for packaging and marking parcels. The integrity of the packaging if the parcel is dropped, perforated or compressed must be guaranteed.

The marking must include information about the contents of the parcel, the type of risk(s) and the packaging standards used.

One or more specific hazard labels are affixed to the outside of each parcel for all dangerous goods to be shipped.

> ***The transport of dangerous goods is subject to complex rules, the approval of procedures from a safety adviser must always be sought.***

> ***CNRS has an international logistics unit, 'Service and support for experiments' (ULISSE) to assist the units.***

Find out more

- **ADR:** <http://www.unece.org/fr/trans/danger/publi/adr/adr2007/07contentsf.html>
- **ULISSE:** <http://ulisse.cnrs.fr/>
- **Memo from the CNRS Director and 131514DAJ Circular of 10 July 2013 on the transport of dangerous goods (TDG)**

Risks

WORKING WITH A SCREEN

Working with a screen for hours without a break can cause various health problems such as:

- **Eye strain** (prickly eyes, blurred vision, heavy eyes, headaches, etc.).

N.B. All these symptoms disappear with rest.

- **Muscle problems, musculoskeletal disorders** leading to muscle, tendon and nerve problems (tendinitis, carpal tunnel syndrome, etc.).

N.B. These symptoms will not appear on the first day but will develop gradually over time if posture is poor for an extended period of time.

- **Stress**

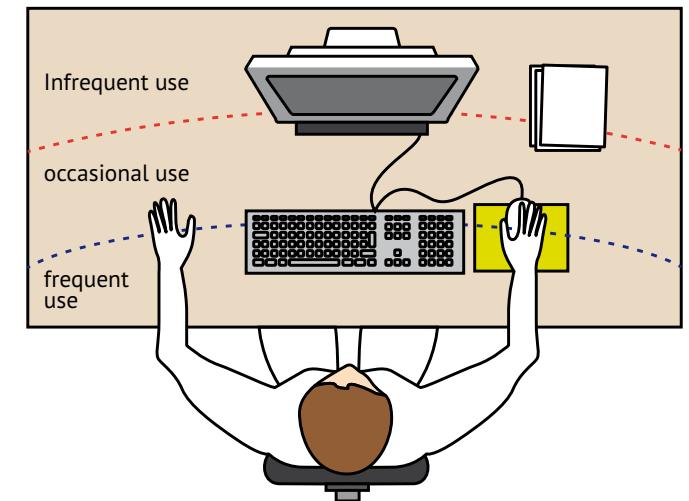
These health effects can be reduced by taking preventive measures such as:

Arranging your workspace correctly

- Adopt a comfortable posture (thighs should be parallel to the ground, feet flat on the floor or on a foot rest, back straight and supported, etc.).
- Arrange the items on your desk to suit you (keyboard in front of the operator, mouse next to the keyboard, document holder next to the screen).
- Choose a standard slim keyboard and adapt the size of your mouse to your hand.
- Obtain a headset if you need to use the keyboard while on the telephone.
- Take account of the frequency of use of the items on your desk.

Adjusting your screen

- Keep your body facing the screen.
- Place the top of the screen at eye level.
- Stay at a comfortable distance for reading (around 70 cm).
- Adjust the screen brightness and contrast.
- Display the items on the screen preferably on a light background.



Lighting

- Place the screen so that it is perpendicular to the main light source (window or lights).
- Use blinds or curtains.
- Use preferably a desk lamp for reading documents on paper.

CHOICE OF OFFICE EQUIPMENT

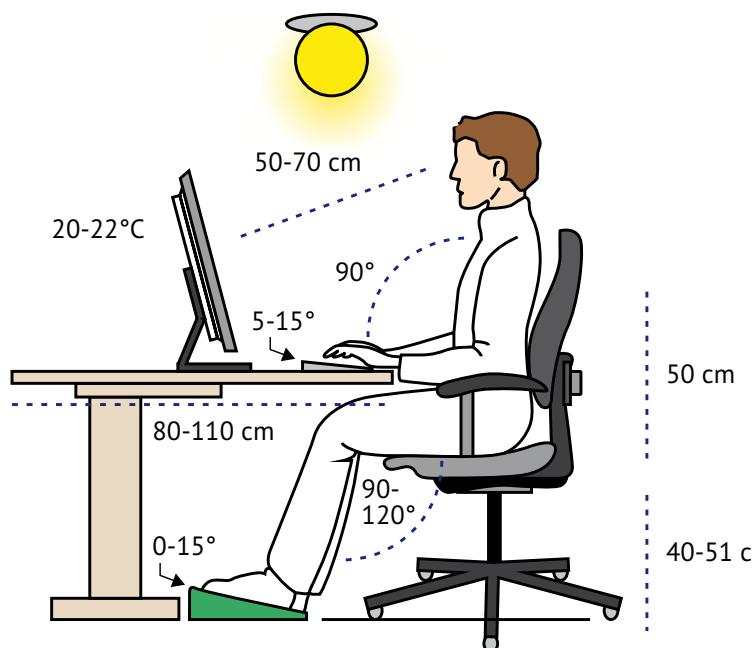
- Where possible, choose adjustable furniture (stand or docking station for laptops).
- Choose an ergonomic chair comprising:
 - > a tilting backrest and height-adjustable seat for good lumbar support,
 - > height-adjustable armrests,
 - > a 5-spoke base with castors.

ENVIRONMENT

- Ensure the ambient temperature is correct (it should be between 20°C and 22°C).
- Adjust the heating or air conditioning accordingly.
- Ventilate the room.

Adverse effects on health can be reduced by taking regular breaks, alternating tasks, stretching the lower limbs, doing eye exercises and relaxation exercises with the wrists and fingers.

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Appendices

RISK OR HAZARD WARNING SIGNS



Flammable



Explosive,
explosion risk



Toxic



Harmful or irritant



Corrosive



Oxidising

These pictograms will no longer be used by suppliers from 1 June 2015. Only the pictograms in Regulation (EC) No 1272/2008, known as the CLP Regulation, will be used.

See 'Chemicals' section.



Radioactive material,
ionising radiation



Non-ionising
radiation



Biohazard



Electrical danger



Magnetic field



Laser radiation



Potential danger



Explosive atmosphere



Trip hazard



Falling hazard



Truck driving



Suspended load



Cold



Safety marking

Appendices

YOUR ADDRESS BOOK

Ambulance:

Fire Brigade:

Poison Control Centre:

Internal Emergency Services / Security:

Medical Service - Sick Bay:

Workplace First Aid Officers (SSTs):

Prevention Officer (AP):

Authorised Electrician:

Radiation Protection Officer (PCR):

Laser Safety Adviser (RSL):

Other safety advisers on specific risks:

Regional Health and Safety Engineer (IRPS):

Staff Representatives from the unit's consultation body:

Occupational Health and Safety Inspector (ISST):

Appendices

ABBREVIATIONS AND ACRONYMS

AOR	Artificial Optical Radiation	IRPS	Regional Health and Safety Engineer
AP	Health and Safety Officer	ISST	Occupational Health and Safety Inspector
ACD	Hazardous Chemical	MPE	Maximum Permissible Exposure
ASN	French Nuclear Safety Authority	MRI	Magnetic Resonance Imaging
CCHSCT	Central Health, Safety and Working Conditions Committee	NMR	Nuclear Magnetic Resonance
CHSCT	Health, Safety and Working Conditions Committee	OGM	Genetically Modified Organism
CMR	Carcinogenic, Mutagenic, toxic to Reproduction	PCR	Radiation Protection Officer
CNMP	National Department for Occupational Health	PPE	Personal Protective Equipment
CNPS	National Prevention and Safety Coordination Unit	PSST	Occupational Health and Safety Centre
CRHSCT	Regional Health, Safety and Working Conditions Committee	RPS	Psychosocial Risks
CSTMID	Adviser on the Safety of the Transport of Dangerous Goods	RSL	Laser Safety Adviser
DGD-R	Chief Resources Officer	SAR	Specific Absorption Rate
ESP	Pressure Equipment	SDS	Safety Data Sheet
FIE	Personal Exposure Sheet	SST	Workplace First Aid Officer
FIERI	Personal Ionising Radiation Exposure Sheet	TDG	Transport of Dangerous Goods
FSD	Defence and Security Official	TMS	Musculo-Skeletal Disorders

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