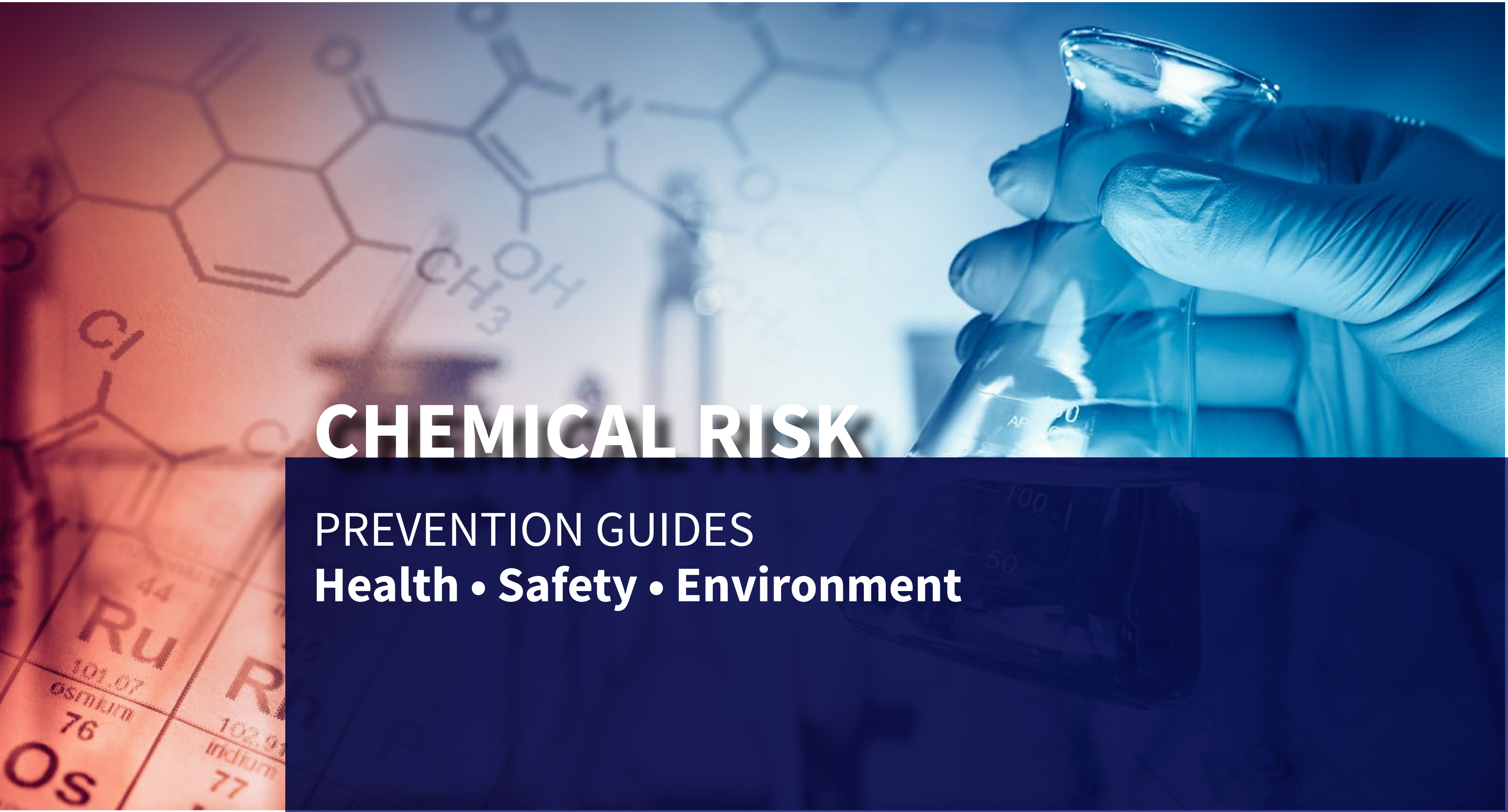

CHEMICAL RISK

PREVENTION GUIDES

Health • Safety • Environment

FOREWORD

1st EDITION • MARCH 2024

There are a number of hazards that experimental scientists face and experiments in chemistry are practically impossible to separate from the concept of risk. Damage and injury relating to chemistry, however rare they may be, are closely linked with the reputation of this discipline in the eyes of both the general public and accomplished chemists. Acute or systemic chemical risk contributes to portraying chemistry, with its incidents and accidents, as a suspect science. The risk casts a dark shadow on all the positive contributions and benefits from chemical research and industry in terms of comfort, health and safety – on a daily basis.

Risk is a combination of hazards and challenges, which must be assessed to be kept in check and minimised. The true value of a preventive approach resides in minimising the hazard and cutting the risk back to an acceptable level. The chemical risk prevention guide you are reading has been produced in that spirit.

This guide is about chemistry, and just chemistry, and it is one of the risk prevention guides published by the CNRS alongside biology, radioactivity, pressure equipment and lasers among others.

It was written by an interdisciplinary work group comprising a member of the health, safety and working conditions committee, a health and safety officer who is also a doctor in chemistry, prevention specialists, occupational physicians, a toxicologist and the list goes on. As such, it is intended primarily for users of chemicals but also for health and safety specialists, and therefore of interest to both chemists and non-chemists.

Chemical research is carried out in laboratories in academia and industry, where its practitioners are particularly exposed to hazards. Which is why this document contributes to active prevention, the aim being to be both a reference source and an operational guide for staff in all units. However, matter can also be handled and transformed in industry sectors that are indirectly associated with chemistry, such as pharmacy, food and cosmetics. Chemical hazards also occur in these settings and health and safety is all the more necessary if those involved are not ready to face them.

I am grateful to the authors who have provided those working in laboratories and companies with comprehensive information, including appendices and factsheets, on properly understood health and safety. I congratulate the authors for their talent and commitment to the cause of overcoming hazards and meeting challenges.

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1 • INTRODUCTION


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Clearly, there are many hazards linked to chemicals as the following list reminds us: risk of fire, explosion, burns, acute poisoning, long-term impact on health and so on. Examples of accidents and incidents are sadly still too prevalent, despite the significant progress made at the CNRS regarding health and safety these past few years.
Moreover, using chemicals is a very frequent occurrence in research laboratories and chemists are obviously not the only ones to use them. Chemicals are found in practically all disciplines and the range of products handled is very broad. Their quantities (from µg to kg), the forms they take (liquid, powder, gas, etc.) vary hugely, in countless handling conditions.

Taking all these elements into consideration, being aware of hazards and knowing how to protect yourself is crucial. Hazards are the focus of primary prevention measures.

This document is therefore intended for non-chemists and specialists alike: experimenters, prevention professionals and others.

The following guide – designed by a multidisciplinary work group bringing together prevention engineers, occupational health physicians, a chemical engineer, a health and safety officer, a toxicologist and staff representative – aims to provide readers with all the data currently available. It covers knowledge of the products themselves and their characteristics, exposure methods, prevention and intervention measures, best practices and regulatory and medical aspects.

The guide takes the form of a booklet comprising 7 chapters, together with 21 factsheets and 7 appendices, for more information on a given topic. This document does not, however, deal with environmental impact (**there is a prevention guide on the health and safety in listed installations to protect the environment**), nor does it deal with public health.

2 • LEGISLATION

Most of the legislation which applies to CNRS entities in terms of chemical risk is enshrined in Part 4 of the French Labour Code. The obligations, taken largely from the transposition of European directives into French law, come mainly from three fundamental decrees. They are, respectively, general chemical risk prevention (**Decree 92-1261 of 3 December 1992**), carcinogenic, mutagenic and toxic to reproduction substances (**Decree CMR 2001-97 of 1 February 2001**) and dangerous chemical agents (**Decree 2003-1254 of 23 December 2003**).

The general rules concern:

- risk assessment, especially as written down in the single occupational risk assessment document (DUERP);
- technical and organisational measures, such as removing risk, replacing a dangerous product (or process) with a less dangerous one if removing it is impossible, work process design, ventilation, personal protective equipment, access to premises, hygiene, storage and product handling;
- checking installations, especially collective protective equipment;
- monitoring exposure, regularly measured and compared to occupational exposure limits (OELs) and biological values (BVs), when these exist;
- measures to be taken in the event of accident or incident (alarm system, emergency services, etc.);
- information for workers (training, information, safety data sheets, etc.);
- medical monitoring.

There are more stringent rules on CMR and hazardous chemical substances in addition to the general provisions. They provide further details and reinforce exposure control.

Lastly, specific regulations, like those that govern public buildings (ERP), explosive atmosphere (ATEX) classified installations for environmental protection (ICPE) complete this set of legal instruments (**Factsheet 1**).

In addition, the REACH regulation (Regulation, Evaluation and Authorisation of Chemicals) requires industry professionals to produce information on product hazards before they are on the market. The CNRS encounters this situation very rarely.
Lastly, the Classification, Labelling, Packaging (CLP) rules, which aim towards a globally harmonized system to identify the hazards of chemicals on the market, as well as their labels, apply fully to our units.
For more information on legislation, please refer to **Appendix 1** which lists all the legal instruments.

3 • WHAT ARE THE HAZARDS?

DEFINITIONS

DANGER : intrinsic capacity of a substance, element or situation to produce a harmful impact on humans, the environment and material goods.

HAZARD : probability of a dangerous event occurring, combined with the extent of impact on human health, the environment and goods.

SUBSTANCE : any chemical element and its compounds in its natural state or the product of a manufacturing process. Substances are not limited to organic compounds defined by a single molecular structure. They include pure chemical compounds, as well as any additive required for stability and impurities that may result from the manufacturing process. They exclude solvents and other elements kept from one another which do not affect the substance's stability or modify its composition.

MIXTURE : intentional preparation of substances in the same container. This consists in two or more substances, either prepared in a laboratory or workshop, or purchased.

CHEMICAL PRODUCT OR CHEMICAL : a common name describing chemical substances and mixtures

Substances	Examples
Solvents	Methanol, acetone, petroleum distillate
Metals and metal powders	Aluminium, iron, titanium dioxide
Mineral salts, minerals	Sodium chloride, ferrous sulphate, potassium permanganate
Biological extracts	Essence of turpentine, natural oils, enzymes

Mixtures	Examples
Buffer solutions	Phosphate buffer, acetate buffer, tris buffer
Standard preparations	Selenium standard
Reaction mixtures	Dragendorff's reagent, ninhydrin solutions
Culture media	Bacterial and cell culture media
Preparations	Paint, varnish, detergents

Chemical substances can pose a range of hazards depending on their physical and chemical properties and their reactivity. They can harm a living organism directly, with varyingly severe consequences (poisoning and pollution) and lead to material damage with varying ease (fire, explosions, etc.).

Labels (pictograms and statements) signal the hazards of the chemical in the container (**Chapter 4.2**, **Appendix 2**). Certain products released are also considered to be dangerous (welding fumes, wood chips, certain particles, etc.)

Chemical risk is a variable concept that results from factors including exposure frequency, number of people exposed, product quantity, product hazard (severity of symptoms or damage) and so on. Risk must be assessed so that appropriate prevention and protection methods can be implemented (**Chapter 5**).

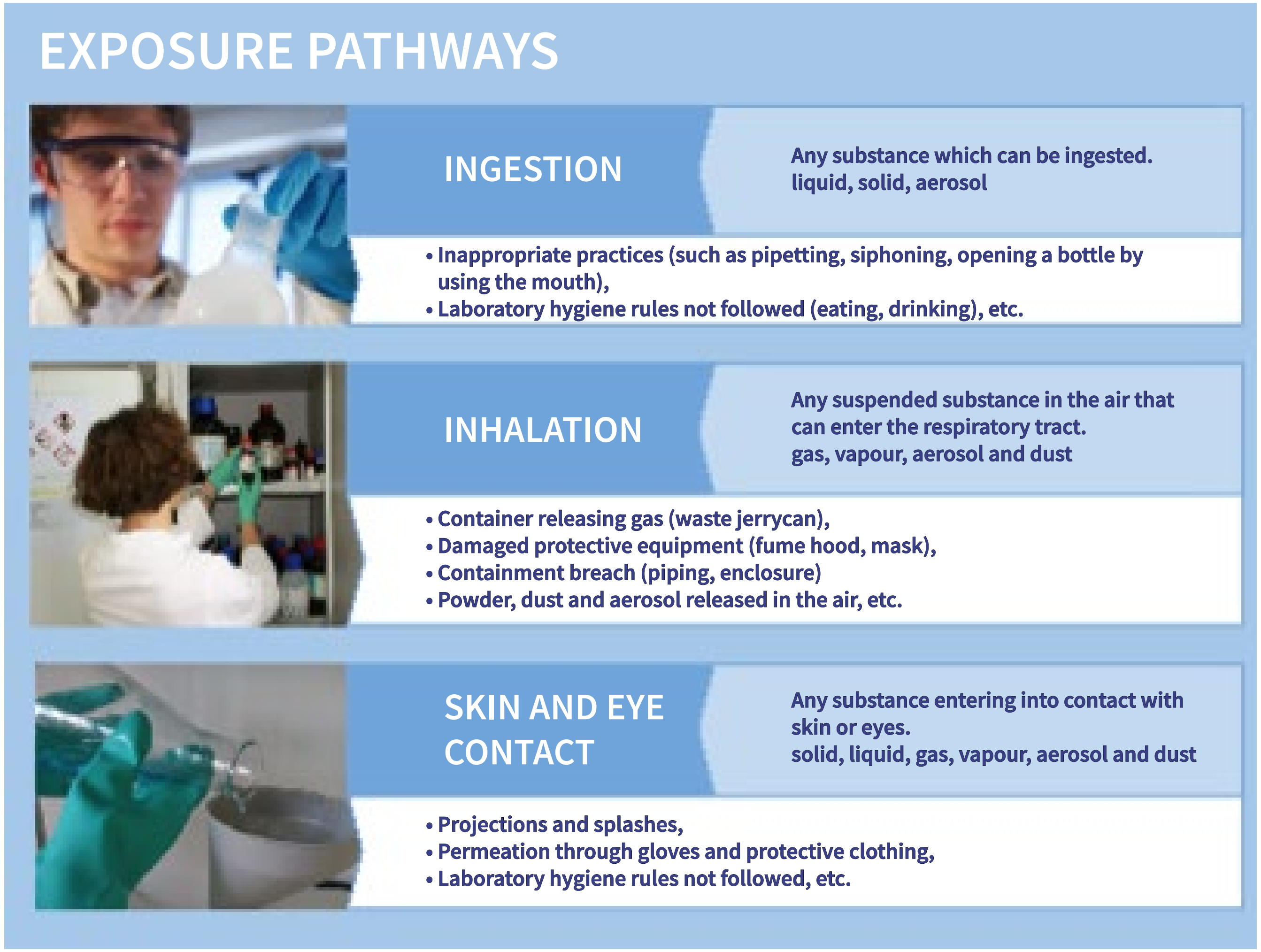
3.1. IMPACT ON HEALTH

3.1.1. Ways in which chemicals impact health

Chemical substances impact health directly by way of mechanisms relating to their physical, chemical and structural properties. The reactivity of certain chemical substances with living beings' biological constituents produces many effects on health that can surface after exposure. They hamper the organism's proper functions by destroying certain biological tissue and cell components or by operating as a biologically active substance. Certain types of exposure can have severe consequences on health. They can generate chronic conditions, acute syndromes and even death.
The impact on health of chemical exposure depends on many parameters linked to exposure conditions (product quantity, exposure duration, exposure pathway, etc.), to the chemical agent itself (physical state, reactivity, etc.) and to the person exposed (age, sex, medical history, etc.). Not all types of exposure to chemicals inevitably lead to an impact on health.

3.1.2. Chemical exposure pathways

Exposure pathways represent the different ways chemical substances enter an organism. Once the organism has absorbed the substance, the latter will easily be able to reach a target organ, where its toxic properties will operate. There are three exposure routes in a workplace environment (**Figure 1**).



EXPOSURE PATHWAYS

INGESTION

Any substance which can be ingested.
liquid, solid, aerosol

- **Inappropriate practices (such as pipetting, siphoning, opening a bottle by using the mouth),**
- **Laboratory hygiene rules not followed (eating, drinking), etc.**

INHALATION

Any suspended substance in the air that can enter the respiratory tract.
gas, vapour, aerosol and dust

- **Container releasing gas (waste jerrycan),**
- **Damaged protective equipment (fume hood, mask),**
- **Containment breach (piping, enclosure)**
- **Powder, dust and aerosol released in the air, etc.**

SKIN AND EYE CONTACT

Any substance entering into contact with skin or eyes.
solid, liquid, gas, vapour, aerosol and dust

- **Projections and splashes,**
- **Permeation through gloves and protective clothing,**
- **Laboratory hygiene rules not followed, etc.**

Figure 1 *Chemical exposure pathways*

Photo 1: © Alexis Cheziere/CNRS Photo library • Photo: © Éric Menneteau - CNRS • Photo 3: © Sihem Groni - Université de Paris

3.1.3. Understanding health hazards

Understanding the various effects on health following exposure to chemicals is the first step to take. It consists in identifying and characterising high-risk situations, implementing appropriate protection and prevention measures and detecting any poisoning following an incident or accident.

Effects on the health of a person exposed to chemicals can

- vary in the case of a single (generally accidental) exposure or long or repeated exposure;
- produce reversible effects (after a period of varying length) or permanent effects;
- be observed immediately after exposure or delayed by a matter of hours, days, months or several years.

Tables 1 to 3 show the harm to health caused by single or repeated exposure.

Impact of single exposure	Examples of impact on health	Examples of substances
 **Corrosion:** Deep skin, eye or respiratory tissue damage. Injury severity depends on concentration, contact time and extent of the damaged area. In some cases, symptoms and pain may be delayed.	• Skin burns • Cornea damage, blindness • Pulmonary oedemas	• Concentrated acids and bases • Peroxides and other oxidising substances • Certain solvents
 **Irritation:** Inflammatory response to skin, eye or respiratory tissue. The severity of the injury depends on the concentration or dosage, contact time and the extent of the area damaged. In some cases, symptoms may be delayed.	• Redness, skin blisters, dermatitis • Conjunctivitis • Cough, bronchitis, breathing difficulties	• Very diluted corrosive substances • Cleaning solvents • Detergents • …
   **Acute poisoning:** General disorders potentially leading to death or specific disorders in an organ in a short space of time. Symptom severity is associated with the dose absorbed, the exposure pathway and its duration.	• Coma, death • Damaged organ(s) (kidney, liver, heart, nervous system, etc.) • Drowsiness, dizziness, vomiting	• Neurotoxic, hepatotoxic, hemolytic, asphyxiating substances • Heavy metals • …

Table 1 *Effects on heath following a single exposure*

Effects of repeated exposure	Examples of effects on health	Examples of products
Chronic irritation: Inflammatory response to skin, eye or respiratory tissue following repeated exposure with possible added non-inflammatory responses (dryness, roughness of the skin, peeling skin).	• Calluses, peeling skin, chronic dermatitis • Chronic conjunctivitis • Chronic cough and bronchitis	• Very diluted corrosive substances • Degreasing solvents • Detergents • …
 **Chronic poisoning:** Appearance of specific disorder in an organ in a person repeatedly exposed. Symptom severity is associated with the dosage, the exposure pathway and chronic exposure duration.	• Organ(s) with specific damage (kidney, liver, heart, nervous system, etc.)	• Solvents • Metals • Detergents • …
 or  **Sensitisation:** Immunological memory against an allergen, following one or several exposures of the person to the substance in question. The person is considered to be “sensitised”, even without observable symptoms. Later exposure to the same substance can lead to rapid and violent reaction, characteristic of an allergic reaction in the upper respiratory tract, on skin or in eyes.	• Allergic eczema, • Allergic conjunctivitis • Allergic bronchitis, asthma	• Aldehydes • Metals (Ni, Co) • Epoxy resins • Enzymes • …

Table 2 *Effects on heath following repeated exposure*

3.1.4. *Carcinogenic, mutagenic and reprotoxic (CMR) substances*

Some chemicals have very serious effects on health, both in the short and long term, which is the case for CMR chemicals.

Generally, CMR chemicals are classified according to the level of certainty of effects observed in humans or the state of current knowledge on the substance's danger based on animal evidence. European regulation of chemical product classification (CLP, **Chapter 4**) is based on this principle and defines hazard classes 1A, 1B and 2 for the three CMR effects. European regulation has introduced an additional class for reprotoxic substances, which concerns these substances' effects on breastfeeding and substances that might be found in significant enough quantities to harm the newborn's health (**Table 4**).

CMR classification needs to be monitored regularly, as knowledge of the health effects of a substance evolves (**Table 5**).

PLEASE NOTE

A list of substances classed as CMR, whose classification and labelling are harmonised Europe-wide, is available on the CNRS Chemical Risk Prevention Unit (UAR 2206) website (**https://www.prc.cnrs.fr/outils/la-liste-des-substances-cmr/**). However, this is not a comprehensive list of all the substances on the market. Other substances and mixtures on the market are classified as CMR by suppliers.

Impact of single exposure		Examples of impact on health
	**Carcinogenicity (C):** Property of a substance to have the ability or tendency to produce cancer.	• Organ, tissue and cell cancers for instance
	Hereditary gene pool mutations (M): Irreversible changes in the genetic characteristics of germ cells (eggs and sperm) which can be passed on to offspring.	• Suspected genetic disease or predisposition to certain diseases in offspring
	Toxicity to reproduction (R): Deleterious effects on the reproductive functions and capacity of adult men and women, as well as undesirable effects on the development of their offspring.	• Infertility, difficulty in conceiving, • Development problems, mental deficiency • Infant poisoning from breastfeeding

Table 3 *Effects on heath following exposure to CMRs*

Hazard classes	
	**Class 1A** Known effects based on human evidence.
	Class 1B Presumed effects in humans based primarily on animal evidence.
	Class 2 Suspected effects in humans as human and animal data are limited.
	Additional class for effects on breastfeeding or via breastfeeding.

Table 4 *CMR hazard classes*

Examples of CMR substances	C	M	R
Benzene	1A	1B	
Benzidine	1A		
Vinyl chloride	1A		
Potassium dichromate	1B	1B	1B
Dimethylformamide			1B
Formaldehyde	1B	2	
Mercury			1B
Carbon monoxide			1A
Toluene			2

Table 5 *Examples of CMRs*

IMPORTANT

The International Agency for Cancer Research (IARC) of the World Health Organization (WHO) has developed a classification system of carcinogenic agents in humans.

It is based on the state of knowledge of the carcinogenic hazard of the physical, chemical, biological and environmental agents in humans studied by the organisation.
This classification is non-regulatory and aims to help the authorities assess the risk of cancer in the general public and implement effective measures for combating it. The IARC defines five assessment groups:

Group	Assessment
1	Carcinogenic to humans
2A	Probably carcinogenic to humans
2B	Possibly carcinogenic to humans
3	Not classifiable as to its carcinogenicity to humans.

IARC classification of a chemical agent can be shown in section 11 of the chemical's safety data sheet.
The list of IARC-classified agents can be found on the IARC website:
http://monographs.iarc.fr/FR/Classification/index.php

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3.2. HAZARDS LINKED TO PHYSICAL AND CHEMICAL PROPERTIES

The physical and chemical hazards of chemicals depend on both:

- Their physical properties: physical state (gas, liquid, powder), solubility in organic and inorganic liquids, flammability and explosibility;
- Their intrinsic properties, meaning their reaction with other chemicals or environmental components (water, air, etc.).

Possible consequences associated with these properties include explosion, fire, chemical splashes and gas release because of uncontrolled or indeed uncontrollable reactions. These events can lead to significant bodily and material damage. They can also generate products that are harmful to health.

IMPORTANT

Prior risk assessment is essential every time a chemical is handled, stored or disposed of. This assessment must also take into consideration equipment and the way it is used (pressure set-up, rotary evaporator, etc.). Incorporating all the stages of the experiment protocol assessment (**Chapter 5.3.3 « Incorporating safety into experiment protocols »**) is critical.

3.2.1. *Fire*

Fire is a chemical combustion reaction that is uncontrolled, in gas phase, with light, flame and heat. This reaction can only occur if three elements are combined (**Figure 2**) :

The conditions that trigger a fire

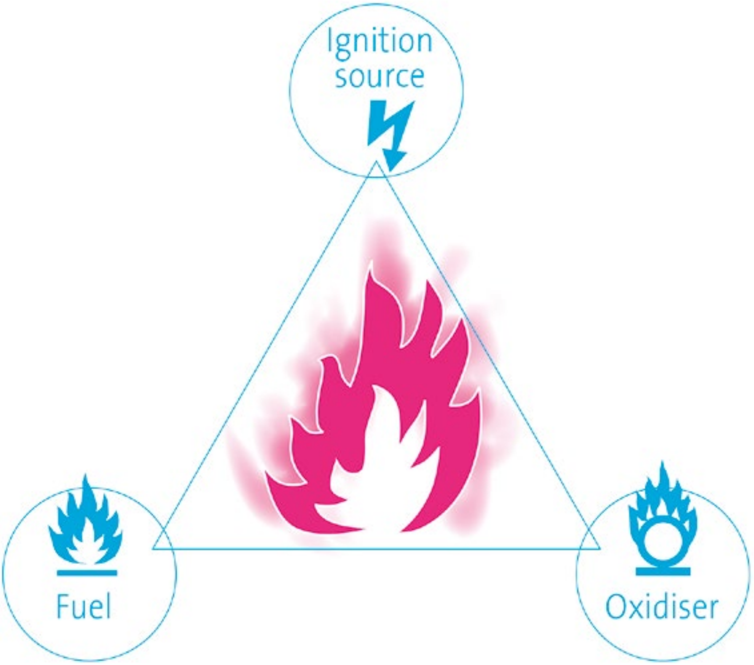

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Figure 2 *The fire triangle*

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ACTIVATION ENERGY: *energy required to start and maintain combustion. It can be provided by a flame; an electric, electrostatic or mechanical spark; heat (hot surface, hot air, ember, exothermic chemical reaction); a collision; etc.*

OXIDISING AGENT: *a body that combines with fuel to produce combustion, primarily consisting of oxygen in the air. However, there are many other oxidising chemicals (in gas, solid or liquid form).*

FUEL: *matter, which in the presence of oxygen and energy, can combine with oxygen in a chemical reaction that generates heat. This is known as combustion.*

KEY PRECAUTIONS TO BE TAKEN TO AVOID A FIRE

- Oxidisers are to be kept away from fuels in all events and especially during storage and waste disposal;
- Particular attention must be paid to labels that can change the product's concentration (for example: nitric acid, perchloric acid, hydrogen peroxide, etc.). The "oxidising agent" pictogram and the related hazard statements may be omitted at low concentration levels. Nonetheless, these products are still oxidising and remain reactive, which is why nitric acid needs to be stored and disposed of away from other acids, for example;
- Certain fuels in liquid, solid or gas form ignite spontaneously when in contact with air; they are "pyrophoric" (such as white phosphorus, aluminium powder, zinc oxide, arsine, phosphene). It is therefore important to store, handle and dispose of them in accordance with appropriate procedures. In the case of a solid fuel, the finer its granularity, the more its contact surface with the oxidiser (oxygen in the air) increases, producing extremely fast ignition reaction;
- Certain solvents are not labelled as being flammable (no pictogram, no specific statement). However, they do possess non-negligible physical ignition properties (flash point, lower and higher flammability, etc.). Products such as dichloromethane, DMSO and DMF therefore need to be used and stored in the same conditions as products identified as flammable.

Fire risk assessment needs to take into consideration

- the physical properties of fuel:
  - boiling temperature;
  - flash point;
  - auto-ignition temperature;
  - lower and higher flammability and explosive limits.

- experiment conditions: quantity, concentration, extent of evaporation from a surface, temperature, any other source of ignition, pressure, suspended dust, etc.
- environmental conditions: temperature, ventilation, moisture, etc.

Fire can often be the source of significant material damage, potentially leading to the collapse of a building. It is also dangerous for humans, because of:

- particularly toxic fumes, which also reduce visibility;
- the risk of anoxia (a drop in oxygen in the air);
- flames and hot fumes which can produce severe burns.

3.2.2. Explosion

An explosion can occur if three elements occur simultaneously (**figure 3**). Explosion can be due to:

- very rapid combustion of a flammable substance mixed with the oxidiser in a contained environment;
- very rapid decomposition of a substance, which can occur instantaneously because of a trigger effect (explosophoric groups such as N-N, O-O and instability relating to the

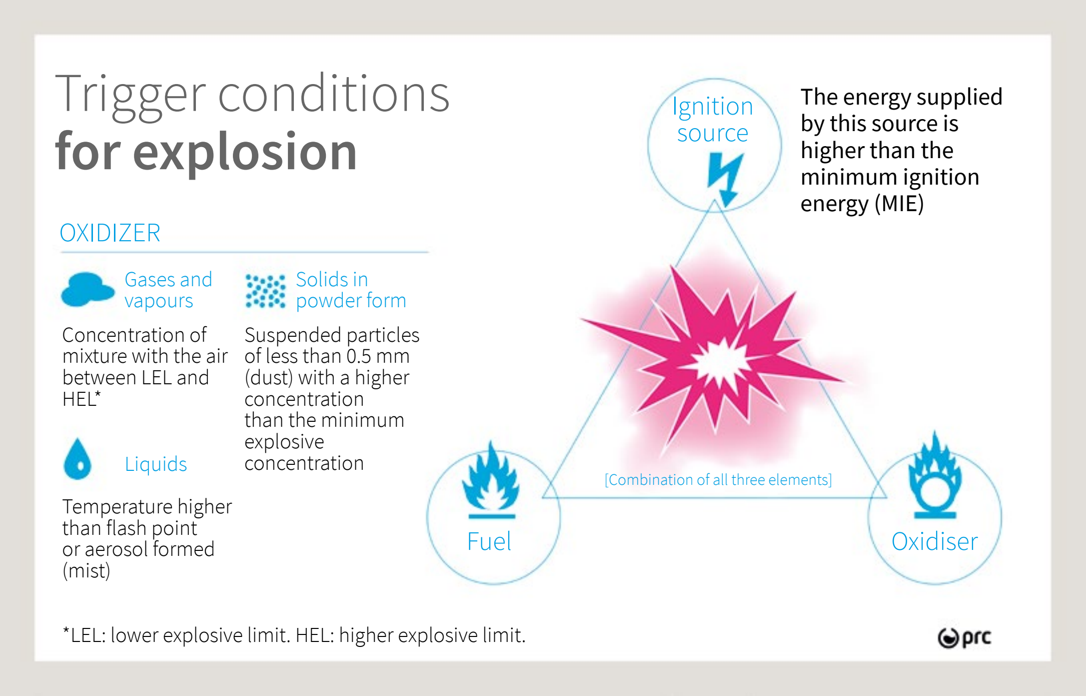


Figure 3 *Trigger conditions for an explosion in an explosive atmosphere*

TRANSFERRING FLAMMABLE PRODUCTS
(“Stockage et transfert des produits chimiques dangereux” - Storage and Transfer of Dangerous Chemical Products – ED 753, INRS)

Static electricity is a source of ignition. Its energy is produced by the friction of certain materials and can be discharged in the form of a spark. Certain solvents (ether, tetrahydrofuran, hexane, etc.) can accumulate electrostatic charges. Care should be taken as ignition could occur during certain operations, such as transfers (the flow rate and friction on the recipient walls can exacerbate the phenomenon). The safety measures below therefore need to be followed during transfers:

- Link metal recipients to an earthing system;
- Have appropriate electrical and lighting equipment in explosive atmospheres;
- Ban the use of compressed air when transferring flammable liquids;
- Re-label repackaged recipients correctly (same label as on the original flask).

molecule’s constrained geometry);

- spontaneous polymerisation of a substance, generated by acid, base or metal traces;
- very rapid reaction among several substances, set off by a trigger effect, or following a period of accelerating reaction;
- very rapid discharge of gas or liquefied gas under pressure.

An explosion produces a **large amount of energy** (exothermic process) and **gas** in a very short lapse of time, generating overpressure, equipment failure and so on. The phenomenon can have very serious effects on people and premises (blast, shockwave, fumes, etc.).

Assessment of risk explosion risk must take into consideration

- the physical properties of products, such as:
  - density;
  - explosive range (LEL, HEL **Chapter 3.2.4**) ;
  - flash point for liquids;
  - granulometry for solids;
  - stability;
  - incompatibilities;
  - evaporation rate.
- experiment conditions: quantity, concentration, extent of evaporation surface, temperature, pressure, suspended dust, dust deposits, etc.
- environmental conditions: temperature, ventilation, moisture, etc.

The following situations need to be avoided:

- accumulation of combustible gas or vapours in the air;
- decomposition of explosive substances and preparations because of a collision, impurities, contamination, vibrations, friction or heat;
- accumulation of flammable dust, droplets and aerosols in the air;
- a dangerous mixture producing a redox (reduction-oxidation reaction).

The risk of explosion must be assessed when experiment protocols are being designed (**Chapter 5.3.3**), extending to storage areas. If the risk of explosion is identified and cannot be avoided, ATEX regulations apply (**Factsheet 1**).

3.2.3. Hazards linked to chemical incompatibilities

Uncontrollable reactions between two or several chemicals can trigger fire, explosion, an exothermic reaction, gas release or uncontrolled polymerisation. This is known as incompatibility among chemicals. However, this expression does not systematically mean that two products cannot react with one another. Controlling these phenomena implies following a strict protocol, especially regarding the addition of reagents (order and quantity), temperature control to avoid reaction acceleration and the implementation of an appropriate set-up to capture the products created during the reaction.

PLEASE NOTE

Certain incompatibilities are mentioned on the label in the “Supplemental hazard information (**Chapter 4.2**) and in the safety data sheet (**Appendix 3**) They include incompatibilities with water (EUH014, EUH029), oxygen (EUH019) and acids (EUH031, EUH032). They can also generate flammable (H_2) or toxic (HCl, SO_2, etc.) gases.
Other incompatibilities are known, such as a disposable glove burning after falling into a beaker full of fuming (concentrated) nitric acid or a piece of paper igniting after contact with 95% sulphuric acid.

The risk relating to chemical incompatibilities in experiment set-ups (**Chapter 5.3.3**) also affects storage areas (**Chapter 5.2.3**) and waste management (**Chapter 5.3.5**).

Incompatibility rules are summarised in **Factsheet 2**.

3.2.4. Hazards linked to containment breach

Set-ups involving vacuum or pressure are very common. They include rotary evaporators, desiccators, chromatography columns, distillation devices, centrifuges, vacuum manifold, autoclaves. Glassware which has to resist significant constraints in this type of set-up must have no defect whatsoever (no chips or cracks) to avoid any accidental projection of shards or splashes.

Assessment of containment breach must take into consideration:

- the state of the equipment: visual inspection, maintenance, regular checks;
- collective protective equipment, incorporated or not (nets, screens, etc.).

The recommendation is to purchase equipment with built-in protection against the risk of implosion and explosion.

SPECIFIC CASE OF GAS CYLINDERS

The dangerous properties of gas must be factored in for safe storage. Certain gases such as hydrogen, methane, ethylene, and acetylene are flammable for example. Others can be oxidisers like oxygen and nitrous oxide. General rules on compatibility among chemicals also apply to gas. It is important to keep incompatible gases away from one another and to store toxic or flammable gases in properly ventilated areas or cabinets.

Note that the use of flammable gases is highly regulated in public buildings (ERP) – (**Factsheet 1**).

DEFINITIONS

Boiling temperature: temperature at which the state of the substance changes from liquid to gas at atmospheric pressure (101.3 kPa) unless another pressure is mentioned.

Flash point: lowest temperature at which a liquid releases a quantity of flammable vapours such as to be capable of igniting in the air with a flame near to the surface of the liquid.

Auto-ignition temperature: minimum temperature at which a substance ignites spontaneously in contact with air, the combustion of which continues without there being any source of inflammation (flame or spark).

Lower Explosive Limit (LEL): minimum concentration of a gas (or vapour) in the air, after which a risk of explosion can occur.

Higher Explosive Limit (HEL): maximum concentration of a gas (or vapour) in the air, after which no risk of explosion can occur momentarily.

List of several products and their LEL-HEL (in % by volume in the air):

PRODUCTS	LEL	HEL
Phenol	1.7	8.6
Hydrogen	4	75
Ethanol	3.3	19
Dichloromethane	13	23 to 25

Vapour pressure: pressure at which steam is released from a liquid at a given temperature.
In physical terms, this is the pressure exerted by the liquid’s vapour on the walls of a closed container at this temperature.

3.3. IMPACT ON THE ENVIRONMENT

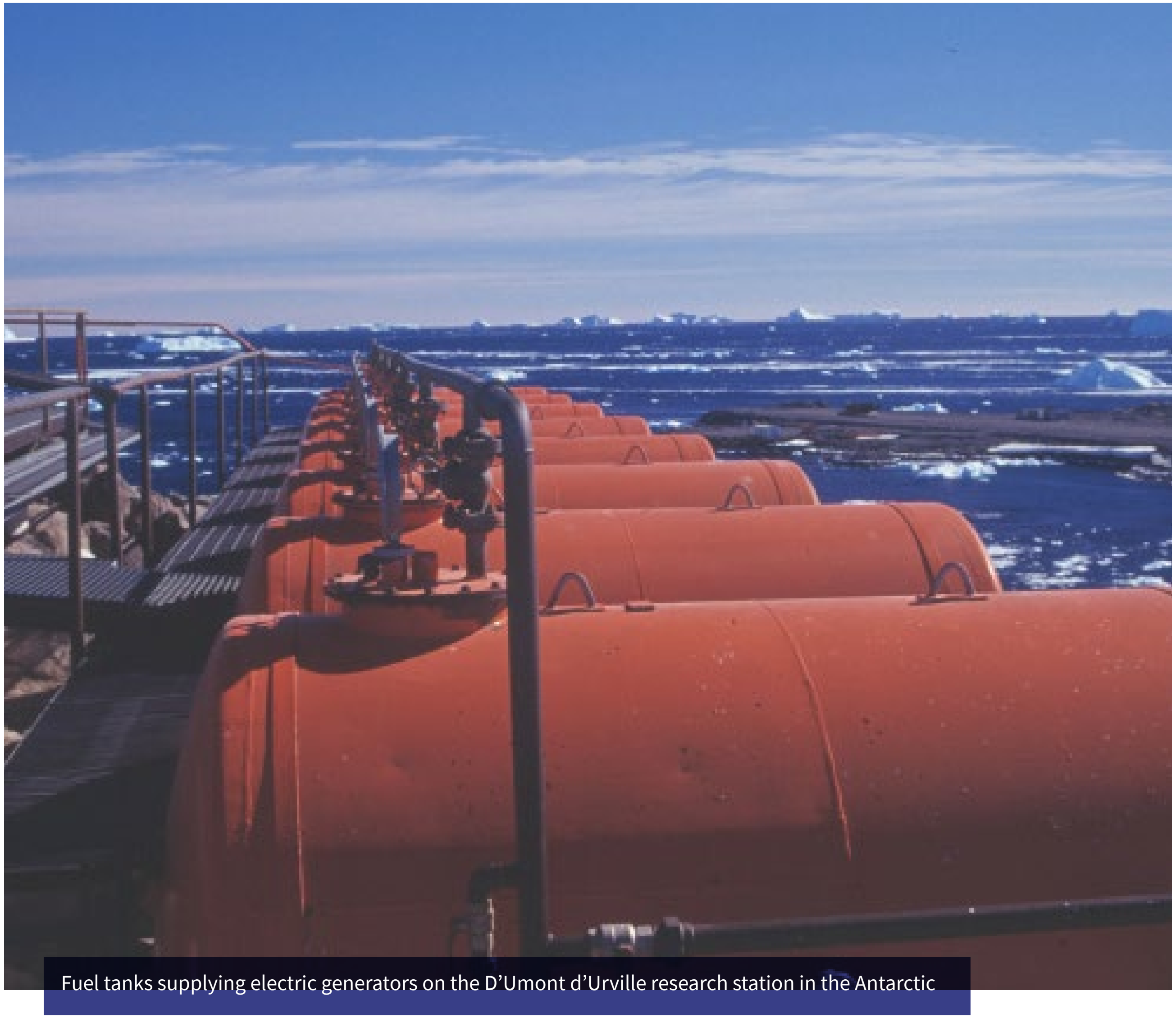
Chemicals can be found in the air and water, on the ground, during manufacture, when they are being used, disposed of and so on. Several factors define their impact on the environment: the nature of the product released, its concentration and quantity, the environment in which it has been detected (air, water, ground), living beings exposed to it, etc.

In France, the various regulations on chemicals (Environmental Code, Labour Code, REACH, CLP, ICPE etc.) are increasingly restrictive as regards intentional release of the chemical in the environment. The management of chemical waste disposal is mandatory and research institutions organise self-audits. In addition, in Paris, municipal departments also carry out unannounced sewage checks.

Certain chemicals are particularly harmful to the environment, and this specificity is mentioned on the product's label (**Chapter 4.2**, **Appendix 2**). The REACH regulation identifies some of them as being particularly concerning because of their ability to enter the food chain and to accumulate and persist in the environment for several years (e.g. pyrene, PCBs.)

Nowadays, should any chemical be released, it could only be accidental because of a breach of containment leading to a gas leak or a defective equipment item, generating a leak or spill, for instance.

Prior chemical risk assessment is the only way to avoid an occurrence of such situations (**Chapter 5.3.3**).



Fuel tanks supplying electric generators on the D'Umont d'Urville research station in the Antarctic

© CNRS Photo library/Joël Savarino

Fume exhaust ducts in the chemistry hub of the Balard CNRS research building

© CNRS Photo library

4 • HOW TO IDENTIFY CHEMICALS AND THEIR HAZARDS

Correctly identifying chemicals is the basis of risk assessment in a given situation, so that appropriate risk management measures can be implemented.

Several regulatory hazard classes, introduced by CLP regulations, identify chemicals' physical and chemical danger to health and the environment. If a chemical is classified, it is deemed dangerous.

The responsibility of communicating these hazards lies with the product supplier, based on two sets of regulations:

- labelling
- the Safety Data Sheet (SDS).

4.1. SUBSTANCE NOMENCLATURE

Chemical substances are often identified by one or several names and several identification numbers.

Various nomenclature systems for chemicals coexist, and some of them provide an exact match between the name of the molecule and its molecular structure. In particular, the International Union of Pure and Applied Chemistry (IUPAC) has developed a nomenclature of chemicals that is unambiguous, uniform and coherent. This nomenclature is the most commonly used in scientific and regulatory databases, but attention should be drawn to any translation errors. In certain cases, chemicals have a common name associated with the historical context of its discovery, its use or its commercial origin. The IUPAC rules also take these names into account.

The use of common names is often more frequent in commercial mixtures and those prepared in laboratories. Knowledge of the exact composition of these mixtures is important. For commercial products, refer to section 3 of the SDS (**Chapter 4.3** and **Appendix 3**), which provides the mixture composition involving dangerous substances. Commercial mixtures may contain sensitising substances and lead to allergic reactions. They can also contain CMR substances in small quantities without this being specifically mentioned on the mixture's label.

Chemical substances can have several digital identifiers. The number assigned by the Chemical Abstracts Service (CAS) is the main digital identifier of chemical substances. However, other digital identifiers coexist (e.g. EC number ____, INDEX number___). When looking for information on chemical substances, CAS numbers are recommended, as they lessen the risk of nomenclature error.

Table 6 lists the digital identifiers used to describe the substances, as well as the organisation that lists them.

SUBSTANCE IDENTIFICATION NUMBERS *(the example of methanol)*	**Where to find this identifier**
CAS NUMBER ***(e.g. methanol 67-56-1)*** International number assigned by the Chemical Abstracts Service department of the American Chemical Society (ACS) for each chemical substance, polymer, biological sequence and alloy described in the literature.	• SDS: - substance: sections 3 and/or 1, - mixture: section 3. • Databases (**CAS Registry**, **ChemId**, etc.)
EC NUMBER ***(e.g. methanol 200-659-6)*** Official digital identifier of substances listed in the European inventory of chemical substances on the European market.	• SDS: - substance: sections 3 and/or 1, - mixture: section 3. • The EC Inventory is available on the European Chemicals Agency (**ECHA**) website
INDEX NUMBER ***(e.g. methanol 603-001-00-X)*** Digital identifier assigned to hazardous substances, the classification and labelling of which are harmonised in accordance with the CLP regulation.	• SDS : - substance: sections 3 and/or 1, - mixture: section 3. • Table in Annex VI of the **CLP regulation**, • List available from **ECHA**
REACH REGISTRATION NUMBER ***(e.g. methanol 01-2119433307-44-XXXX)*** Digital identifier assigned to hazardous substances, subject to the REACH regulation and registered.	• Substance label, • SDS : - substance: sections 3 and 1, - mixture: section 3. • Substance registration files available from **ECHA**
UN NUMBER ***(e.g. methanol UN 1230)*** International identification assigned to hazardous materials, the transport of which is regulated.	• Packaging of hazardous products, • **Part 3 of ADR**, • SDS : - section 14.
COMBINED NOMENCLATURE (CN) ***(e.g. methanol 2905 11 00)*** Classification of imported and exported goods declared at customs in the European Union. The nomenclature establishes a customs duty applicable to goods and enables governments to draw up statistics in terms of external and intra-EU trade.	• **Annex I of Council Regulation (EEC) n° 2658/87** on tariffs and statistical nomenclature and on the Common Customs Tariff (amended).

Table 6 *Digital identifiers*

4.2. LABELS

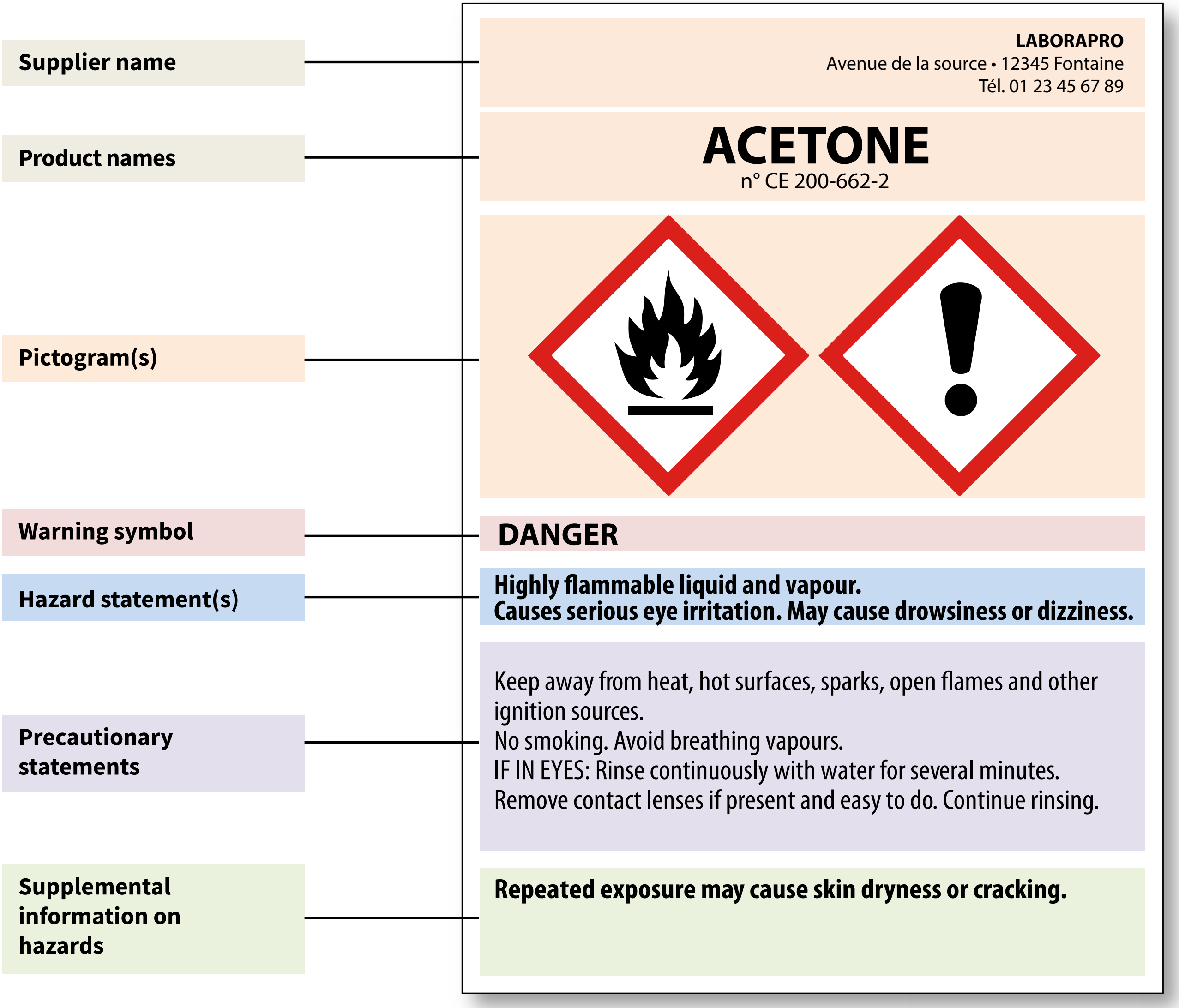
Labels represents key and concise information for users. They enable fast identification of hazards and precautions to be taken when using a product. Labels feature on each container of hazardous chemicals. Label information is also found in section 2.2 of the SDS (**Chapter 4.3**, **Appendix 3**).

In France, chemicals are sold bearing a label written in French but translations into other languages may also be provided. For small containers, labels can be located on the container itself or can be removable. Derogations relating to small containers enable suppliers to omit certain regulatory items from these labels. You should therefore read the safety data sheet for comprehensive details and be aware of hazards that have not been mentioned on the label (incompatibilities for example).

The label's form and content regarding hazardous chemicals on the market comply with the harmonised European regulation.

Label items are detailed in **Appendix 2**.

The label presented here comprises the minimum information required:



LABORAPRO
Avenue de la source • 12345 Fontaine
Tél. 01 23 45 67 89

ACETONE
n° CE 200-662-2

DANGER

Highly flammable liquid and vapour.
Causes serious eye irritation. May cause drowsiness or dizziness.

Keep away from heat, hot surfaces, sparks, open flames and other ignition sources.
No smoking. Avoid breathing vapours.
IF IN EYES: Rinse continuously with water for several minutes.
Remove contact lenses if present and easy to do. Continue rinsing.

Repeated exposure may cause skin dryness or cracking.

Figure 4 *Example of a label*

Supplier name

The identity of the supplier(s) must feature on the label. The label must comprise their name, address and telephone number. This information must be identical to that in section 1 of the SDS; if that is not the case, the data sheet is not valid.

Product names

The label comprises several elements that identify the substance or mixture. These elements must be identical to those featuring in section 1 of the SDS.

For substances, the label comprises a name (usually from the IUPAC nomenclature) and an identification number (INDEX, EC or CAS) (**Chapter 4.1**, **Appendix 2**).

For mixtures, the label provides the trade name or the description of the mixture itself (e.g. “Nitric acid and hydrofluoric acid mix”). The name of substances involved and their particular health hazards are also mentioned on the mixture label (e.g. “Contains formaldehyde”).

Pictogram(s)

Pictograms represent a visual identification of certain physical hazards to health or the environment. They show a symbol inside a red diamond shape which serves to communicate and quickly warn of a hazard (**Appendix 2**).

Warning symbol

The warning symbol alerts to the relative extent of the severity associated with the chemical’s hazards. There are two different warning symbols to describe hazard severity, but only one features on the label.

WARNING or CAUTION: for less severe hazards (pressurised gas, irritation, etc.).

DANGER : for more severe hazards (explosion, corrosion, CMR, etc.).

Hazard statement(s)

Hazard statements describe the nature of the hazard, how they occur and, where applicable, how severe they are. The code for these statements is the letter H followed by a three-digit number (e.g. H261: In contact with water releases flammable gas). Depending on their nature, hazard statements are broken down as follows:

H2_ _: Physical hazards,
H3_ _: Health hazards,
H4_ _: Environmental hazards.

These codes may not feature on the label but they are provided in the SDS.

Precautionary statements

Precautionary statements describe the recommendations to be followed to prevent or reduce their harmful impact on health and the environment as far as possible. The code for these statements is the letter P followed by a three-digit number and they may be combined (e.g. P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting).

Depending on the type of advice, they are broken down as follows:

P1_ _: General precautionary statements,
P2_ _: Prevention precautionary statements
P3_ _: Response precautionary statements
P4_ _: Storage precautionary statements
P5_ _: Disposal precautionary statements.

These codes may not feature on the label, but they are provided in the SDS.

Supplemental information on hazards

Part of the label is reserved for the supplemental information on hazards, not shown on a hazard statement or pictogram. The statements featured here are used in Europe specifically. Their code are the letters EUH, followed by a three-digit number (e.g. EUH066 Repeated exposure may cause skin dryness and cracking).

IMPORTANT

The content of the labels must be re-transcribed on preparation containers and packaging. It is mandatory to mention the presence of a CMR substance in preparations, even when diluted.

4.3. SAFETY DATA SHEET (SDS)

In the SDS, suppliers provide detailed and relevant information on risk prevention relating to the use of chemicals. This document comes in addition to the label and comprises two types of essential information:

- comprehensive information on the chemical (substance, impurities, mixture, composition etc.), and on the physical hazards impacting human health and the environment;
- detailed information on safety precautions concerning the use, storage, disposal and transport of chemicals, what to do in case of accident or incident as well as certain regulatory aspects.

The SDS is an essential risk assessment tool when designing appropriate work methods. It also represents an important source of information to inform and train staff on the correct and safe use of chemicals. Safety data sheets must therefore be made available at any time for any person liable to be exposed, including health and safety officers, occupational physicians, CHSCT members, emergency services and so on.

Regulations set out the format and content of the SDS with its 16 sections providing all the mandatory information. Details of these sections are in **Appendix 3**.

READING THE SDS PROVIDES ANSWERS TO THESE QUESTIONS, FOR INSTANCE:	**SDS section**
What is the quantity of dangerous components in the mixture?	3
What are the first-aid measures to be taken in the event of accidental exposure?	4
How should the area be cleaned in the event of a spill?	6
What is the product’s storage temperature?	7
What is the recommendation concerning the glove material if there is a high risk of splashes?	8
Which are the known incompatible products?	10
What information should be provided on the package for road transport?	14

Obligations	
On the supplier side	**On the lab side**
• Always provide the SDS: - for any hazardous chemicals, - for non-hazardous mixtures, if there is a certain proportion of dangerous substances, or if these substances have an occupational exposure limit (OEL, **Chapter 5.3.1**), or • Provide the SDS on request if the EUH210 statement, “Safety data sheet available on request”, is indicated on the label, or • No SDS is provided. • Provide the SDS in French, • Provide the SDS free of charge on the first order and with every subsequent revision of its content, based on changes in scientific knowledge and legislation.	• Make the SDS available to all staff in a known location which is quick and easy to access, • Check it is up to date, especially if more than two years has passed since the SDS was published, • Archiving SDSs is recommended for exposure traceability purposes, and in the event of occupational diseases being recognised, • Check that the information provided matches the chemical’s real use conditions and risk management procedures (sections 1.2 and 7.1 of the SDS). If other measures have been implemented, risk assessment results must be equivalent to or better than SDS recommendations.

PLEASE NOTE

Suppliers who provide their SDSs online do not systematically warn users of revisions, especially if the product was supplied more than a year ago. It is up to users to watch out for any SDS updates and to download them. SDSs in other languages (English for example) can also be downloaded. Where possible, the recommendation is to read the SDS before any new product is ordered, to check whether risk management procedures are appropriate or need to be changed in view of the new product. Should the supplier refuse to make the SDS available before purchase, approach another company.

eSDS

An annex comprising exposure scenarios is added to the SDS when more than 10 tonnes of certain products are produced (methanol, nitric acid etc.), per year per supply. This is known as an extended safety data sheet (eSDS). The scenarios describe the use types for which the product has been placed on the market and the operational conditions under which it must be used, while managing health and environmental risks. They represent additional obligations for users. All of the information must match real-use conditions.

Example of information in the exposure scenario of a hydrofluoric acid/nitric acid mixture for the pickling of stainless steel:

Scenario title	Electrolytic metal treatment
Sector	Public bodies such as government agencies and the education system
Process	For example, items treated by dipping or pouring
Operating conditions	Daily exposure, 1 to 4 hours per day, etc.
Risk management procedures	Working in ventilated areas for instance

In the event of discrepancies in the information (for example, the product is used for spraying rather than dipping), there are a number of options to remedy this situation:

1 – Ask the supplier to include this use in the scenario;
2 – Modify use conditions to reflect those described;
3 – Find another supplier who has developed an appropriate exposure scenario;
4 – Produce a report on chemical safety with an exposure scenario and send it to the European Chemicals Agency (ECHA). Compliance must be achieved within 12 months following receipt of the first eSDS.

4.4. SYNTHETIC PRODUCTS

Concerning products synthesised in a laboratory for which no data on hazards is available, the precaution principle prevails. Regarding toxicological aspects, they must be considered as CMR.

At the same time, the structural and reaction analysis of the synthetic product identifies physical and chemical hazards.

If required, this analysis can be carried out by a competent external service provider.

4.5. REACTION KITS

Reaction kits are chemicals and should be considered as such. And as such, the supplier’s instructions should be complied with (labelling, SDS, technical data) or the supplier should be contacted in the absence of information.

5 • HOW TO PREVENT CHEMICAL RISK

Whatever the nature of the risk, a prevention policy is based on nine general principles in the French Labour Code. **Table 7** describes these general principles in terms of technical, human and organisational measures as part of chemical risk prevention. Details of these measures will be found later in this guide.

General principles	Human methods	Technical methods	Organisational methods
1. Avoiding risks This means removing danger, or exposure to danger	- Training (**Chapter 5.1.1**) - Information (**Chapter 5.1.2**) - Medical prevention (**Chapter 5.1.3**)	- Automating high-risk stages in a process	- Substitution (**Chapter 5.3.2**) - Limited number of people exposed
2. Evaluating the risks which cannot be avoided		- Control and measurement of chemical exposure (**Chapter 5.3.1**)	- Incorporating prevention into experiment protocols (**Chapter 5.3.3**) - Drafting the single occupational risk assessment document (DUERP)
3. Combating risks at source		- Capture at source (**Chapter 5.2.2**) - Storage equipment (**Chapter 5.2.3**)	- Incorporating prevention into experiment protocols (**Chapter 5.3.3**)
4. Adapting the work environment to the individual		- Reducing the volume of containers	- Optimising premises to limit comings and goings
5. Adapting to technical progress		- Using the safest technical methods available on the market (for example, switching from hydrogen bottles to hydrogen generators or from heat-integrated distillation columns to cold solvent purifiers)	- Technology and science watch
6. Replacing the dangerous with the non-dangerous or the less dangerous		- Automating high-risk stages in a process - Process change	- Substitution (**Chapter 5.3.2**) - Incorporating prevention into experiment protocols (**Chapter 5.3.3**)
7. Planning for prevention		- Emergency equipment (**Chapter 5.2.5**) - Equipment maintenance and monitoring (**Chapter 5.3.4**)	- Drafting the action plan taken from the DUERP - Monitoring equipment maintenance and verification (**Chapter 5.3.4**) - Implementation of a waste disposal procedure (**Chapter 5.3.5**) - Emergency situation (**Chapter 5.3.6**)
8. Giving priority to collective protective measures		- General ventilation (**Chapter 5.2.1**). - Collective protective equipment (**Factsheets 3**) - Personal protective equipment (**Chapter 5.2.4, Factsheets 4**)	- Monitoring equipment maintenance and inspection (**Chapter 5.3.4**)
9. Giving appropriate instructions to staff		- Communication materials (web pages, posters, instructions, etc.)	- Measures to be taken (**Factsheets 5**) - Access to SDSs

Table 7 *The nine general principles and associated prevention methods*

5.1. HUMAN METHODS

5.1.1. Training

Staff must follow a general training programme to understand their work environment, as well as other specific training programmes directly relating to their activity.
At the CNRS, these programmes are carried out under the responsibility of the unit director with the help of the health and safety officer (HSO) and the training adviser. Training programmes undertaken are recorded in the DUERP. Training certificates are issued and provide traceability in the unit.

5.1.1.1. General safety training

It must be hands-on and appropriate, given the nature of the activity and the hazards encountered on site.
It is particularly intended for newcomers and non-permanent staff (such as PhD students, postdocs, interns, apprentices, workers on a fixed-term contract) because of the lack of experience in the face of a new work environment and its operating procedures.

Training is generally in two parts:

1- General safety rules: site circulation plan; access routes to the place of work and the infirmary or medical department; exits and passageways to be used in emergency situations; evacuation rules (especially in the case of explosion, accidental release and spillage of flammable and toxic gas and liquids); measures to be taken in the event of an accident; alarm system; location of the workplace health and safety register; contact details of the workplace first-aiders; hygiene and safety issues mentioned in the internal rules, etc.

2- Operating conditions at the workstations: the safest behaviours and gestures; operating procedures in place; collective and individual protective equipment to be used, etc.

The unit's health and safety officer carries out the first part of training at the CNRS. However, the supervisor generally undertakes the second part, as they are more familiar with operating conditions relating to work and associated hazards, and safety measures. This training programme can be delivered in English for staff who are not sufficiently fluent in French. It must also be made available to disabled people (visual impairment, deafness, etc.). At the end of the programme, each trainee commits to following the rules presented. The information can be included in an onboarding guide, and an English version is recommended.

5.1.1.2. Specific training associated with chemical hazards

Mandatory training programmes, in addition to general safety training, are provided if staff are exposed to chemical risk. Specific programmes are also provided for other high-risk activities. The aim of these programmes is to understand the risk and prevent it.

Anyone handling chemicals must benefit from training so that they can identify chemical substances, their hazards and the collective and individual protective methods to be used, not forgetting waste management. Additional training is provided in the specific case where carcinogenic, mutagenic or reprotoxic (CMR) substances are handled, and when the experimenter's work takes place in an ATEX zone.

Furthermore, anyone sending or receiving chemicals (waste included) must have been trained on the transport of dangerous goods. Depending on the situation, an in-house or external organisation provides the training.

At the CNRS, if training programmes are provided in-house, they are often paired up with the HSO's general safety training. In addition, every year, specific training needs are formulated by the HSO who liaises with the unit's training adviser and are then noted in the unit training plan, so that the regional department and its partners can take them into account.

GOOD TO KNOW

The chemical risk prevention unit (**PRC - UAR 2206**) offers staff and units training programmes on chemical risk prevention, ranging from introductory to advanced courses.

Factsheet 6 presents the main mandatory and specific training programmes associated with the chemical hazards in CNRS laboratories.

PLEASE NOTE

The CNRS has a two-fold programme for safety training:

- **“NEO”, a national e-learning application** to train newcomers on occupational risk prevention. Several training modules are available including one on chemical risk. French and English versions are available.
- **The “Advice for Newcomers” guide**, which includes a chapter on chemical hazards, is available on the CNRS website in both French and English.

5.1.2. Information

In addition to the training plan, staff must be aware of the hazards associated with their work, the precautions to be taken, the prevention measures to be followed, what to do in case of accident and so on.

In terms of chemical risk, being well informed helps:

- alert staff to the presence of products (e.g. list of chemicals) and their hazards (e.g. marking out high-risk areas, labelling chemicals, SDS, marking out equipment not in use);
- give general instructions (e.g. laboratory best practices – see **Factsheet 7**–, what to do in the event of incident or accident, meaning of pictograms);
- give specific instructions (e.g. workstation guide, instructions relating to the use of CMRs, state of repair of CPE, a list of staff accredited for a specific activity);
- send out the results of risk assessments (e.g. DUERP, job analysis.), accidents and incidents that occurred in the unit and the measures taken to avoid their repetition (e.g. problem tree).

It is mandatory for some of this information to be displayed:

- premises where chemicals are handled must be appropriately signalled, reminding users that they may not enter them without being trained and informed. The presence of CMR substances must be clearly signalled (marking out, displaying the list of CMO substances etc.);
- the label of any container holding dangerous chemicals must indicate the name of the substance(s) and associated hazards. Note that this is also true of repackaging (**Appendix 2**) ;
- fire safety instructions, evacuation instructions and the list of people tasked with implementing them.

Regulations require that certain items of information must be given to staff:

- a workstation notice must be provided for each workstation or situation which could expose staff to dangerous chemicals;

WORKSTATION NOTICE

This notice, which must be updated as required, serves to inform staff of the risk their work can expose them to and the measures taken to avoid it.

It describes:

- work stages;
- workstation hazards and risks;
- prevention, measures and safety instructions (CPE, PPE, hygiene rules, emergency measures in the event of incident and first aid).

The guide is displayed at the workstation.

An example of a workstation guide is in **Factsheet 8**.

……

Find out more:

- *« Risque chimique : Factsheet ou notice de poste » (Chemical risk: workstation factsheet or notice) ED 6027, INRS ;*
- *« Constituer des Factsheets de poste » (Creating workstation notices) ED 126, INRS.*

- the OEL and BVL of chemical substances found in work places (**Chapter 5.3.1**) ;
- how to access an SDS;
- the precautions to be taken to ensure their protection and that of the other people present in the workplace, especially concerning the use of PPE and CPE. This requirement is reinforced if CMR substances are used. It extends to any person liable to intervene in the event of an incident where such substances are handled.

At the CNRS, the entirety of this information is made available to all staff – in whatever capacity – placed under the authority of the unit director. The spoken and written language is a key factor to take into account, which is why research laboratories generally require a translation into English as a minimum.

Lastly, specific information must be given to:

- Pregnant and breastfeeding women who handle chemicals, together with future parents planning a pregnancy who are using reprotoxic products, so as to inform them of the measures to be taken (**Chapter 5.1.3.3**, **Appendix 1**),
- Newcomers and temporary staff (PhD students, postdocs, other workers with a fixed-term contract, interns, etc.) so that they can adapt to the requirements of the workstation by taking all necessary precautions to preserve their own safety, and that of their work group.

This information will be even more useful if it is disseminated frequently and there is a range of visual materials including the DUERP, internal rules, unit on-boarding guide, dedicated web pages and display boards, meeting minutes of lab councils, local health and safety committees.

The information must be updated as often as required, taking into account the changes in the units' activities and state-of-the-art knowledge. At the CNRS, the HSO and team manager jointly undertake its dissemination under the authority of the unit director. The HSO focuses primarily on general information relating to health and safety. The team manager passes it on and disseminates instructions relating to the work of the staff they supervise (workstation guide, PPE/CPE selection, OELs, etc.).

As to staff, regulations allow them to raise items of information with the team manager(s) and unit director. This is the workplace health and safety register, the objective of which is to collate suggestions on occupational risk prevention and the improvement of working conditions. It also serves to signal incidents and accidents.

GOOD TO KNOW

The chemical risk prevention unit at the CNRS (**PRC - http://www.prc.cnrs.fr**) offers communication tools, such as:

- a poster on "Grossesse et exposition aux produits chimiques" (Pregnancy and exposure to chemicals)

GROSSESSE ET EXPOSITION AUX PRODUITS CHIMIQUES

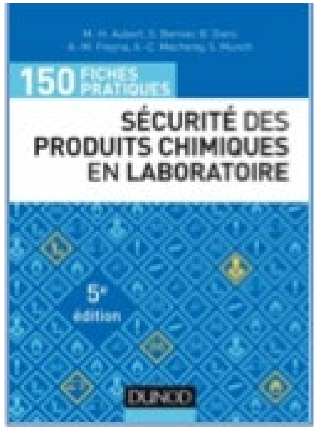
Calendrier	Grossesse & post-natalité	Risques liés à l'exposition	Information à retenir
Semaine 3	Fécondation	Défaut de fécondation	Pas de temps à perdre
Semaine 8	Embryon	Anomalies morphologiques **majeures**	
Semaine 14 Déclaration à l'assurance maladie	Fœtus	Défauts fonctionnels et anomalies morphologiques **mineures**	Les huit premières semaines sont une période critique. Prenez contact avec votre **médecin du travail** le plus tôt possible.
Semaine 32 Congé maternité[1] ; fin de la période d'exposition[2]			
Semaine 38 Accouchement[3]			
Semaine 48 Fin du congé maternité[1] ; reprise de la période d'exposition[2]	Nourisson	Intoxications via l'allaitement	

1. Date légale ; peut varier dans les faits.
2. Période d'exposition professionnelle.
3. Date moyenne indicative.

- visual materials in French, English and Chinese on laboratory safety instructions.

The CNRS Institut de Chimie has produced a publication on chemical safety. It provides practical, clear, concise and verified information on the hazards of 150 chemicals commonly used in laboratories and covers storage conditions, handling, waste disposal and the measures to be taken in the event of an emergency.

- **« 150 fiches pratiques de sécurité des produits chimiques en laboratoire »** (in French only – 150 practical factsheets on chemical safety in laboratories), a publication produced by MH Aubert, S Bernier, B Diers, AM Freyria, AC Macherey, S Munch. 5th edition. Paris: Dunod, 2018. ISBN ; 978-2-10-078081-5



5.1.3. Medical prevention

5.1.3.1. Specific medical monitoring

Anyone handling dangerous chemicals must benefit from specific medical monitoring. Currently, the occupational physician establishes the nature and frequency of mandatory consultations, which occur at least once every four years. An additional intermediary consultation can be carried out by a junior doctor in occupational medicine, another occupational physician or a nurse. Details of chemical exposure submitted for specific medical monitoring can be found in **Appendix 4**. Ideally, a clinical assessment should be offered to the staff member before they are assigned to the workstation.

In addition, the occupational physician is informed of the exposed staff's absence for illness or occupational accident or service, as soon as possible. The physician also examines all staff exposed if a worker experiences a health issue liable to result from exposure – to CMRs especially.

5.1.3.2. Additional medical consultations and examinations

A medical consultation serves to establish whether the state of a person's health is compatible with their occupational exposure. This is based on a medical interview, a clinical examination and the identification of individual risk factors. It is also based on exposure analysis, partly via the CNRS health, risk and working conditions form (FIRCT) which is filled out before the medical consultation and updated before each visit. Job adjustments and restrictions may be prescribed as a result.

The **FIRCT** is a tool intended for occupational physicians. The staff member's printed or digital medical file provides a fairly comprehensive view of occupational risk at the time of the consultation. It also serves to maintain a career-long history of occupational exposure throughout their career, for medical purposes. Where applicable, it guides the prescription of additional medical monitoring and examination.

The prescription of additional examinations (blood test, spirometry, audiogram, chest scan, etc.), in addition to the interview and clinical assessment, supports the absence of any contra-indications or restrictions at the workstation. It also detects anomalies potentially relating to current and past occupational exposure.

In particular, biometrology measures certain chemical substances used at the workstation, as well as their metabolites in body fluids, usually blood and urine. The analysis also incorporates working conditions, that is, the effectiveness of collective and personal protective equipment. The results are compared to a BVL representing the concentration limit in a biological medium defined by a chemical, its metabolites or an effect indicator. The aim is to protect workers against the harmful effects to health of the chemical considered in the short, medium and long term.

NOTE

Outside of an emergency situation, a single abnormal result should never lead to collective remedy, but rather to checking the relevance and quality of the measurement before a new check. Following BVLs does not exclude reactions such as allergies occurring.

Staff are likely to experience multiple chemical exposures which can be harmful to health. The data measurements from the MiXie France tool assesses the chemical's potential effect on the human body and evaluates the accumulated exposure levels compared to OELs (**Chapter 5.3.1**).

NOTE

MiXie France, a simple and easy-to-use tool developed by the University of Montreal and the IRSST is based on the similar effects and targets of these substances. INRS has adapted the substance database, which has been incorporated in MiXie France, to the French regulatory framework on OELs:
http://www.inrs.fr/media.html?refINRS=outil45

5.1.3.3. Pregnant and breastfeeding women

A substance classed as toxic can have the following effects on:

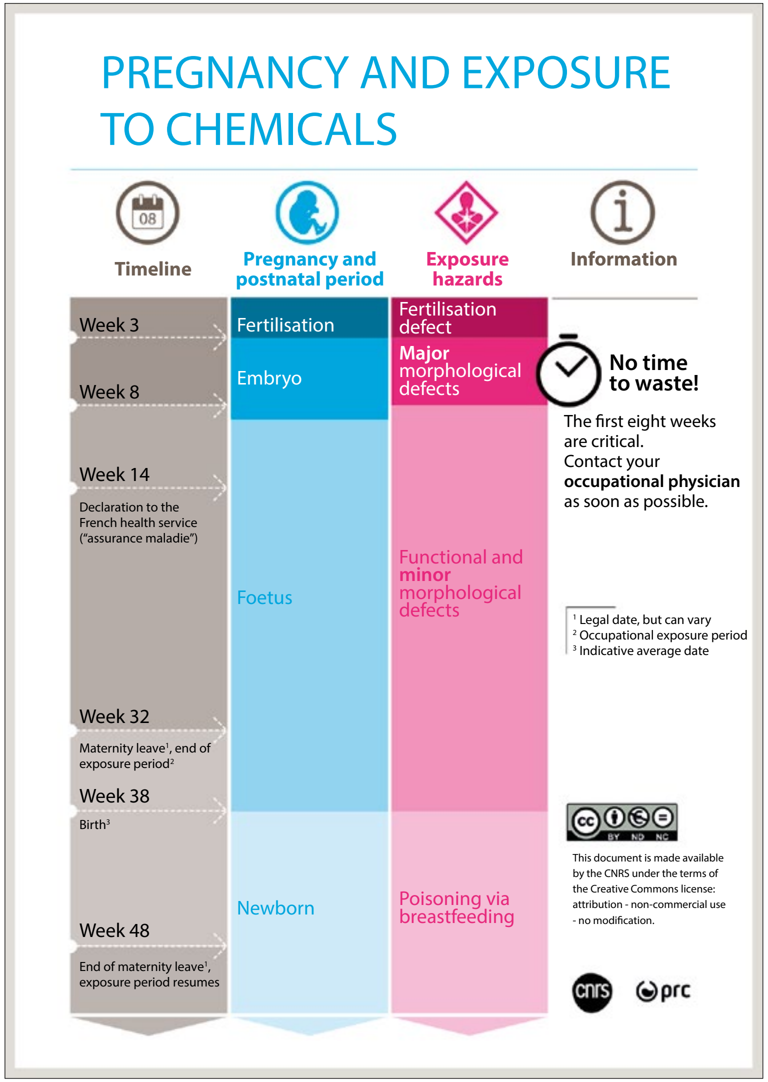
- the mother: a metabolic disorder can lead to deficiencies in the foetus;
- the foetus: disruption in nutrition exchange with the placenta.

The critical stages in pregnancy (**Figure 5**) are:

- embryonic period:
  - peri-implantation period before day 15. The “all or nothing law” suggests that the fertilised egg will be expelled if it is not viable,
  - between day 15 and week 12 approximately: potential morphological abnormalities (teratogenic effect).
- foetal period (after week 12 approximately), the various organs grow and mature: risk of foetopathy (functional abnormalities in organs). The nervous and reproductive systems can still be vulnerable to malformation.

Note that a substance can have no impact at one stage of pregnancy and yet reveal itself to be toxic at another stage.

Appendix 1 presents the key regulations relating to pregnancy at work.



The first eight weeks are critical.
Contact your **occupational physician** as soon as possible.

[1] Legal date, but can vary
[2] Occupational exposure period
[3] Indicative average date

Figure 5 *Critical stages in pregnancy*

IMPORTANT POINTS

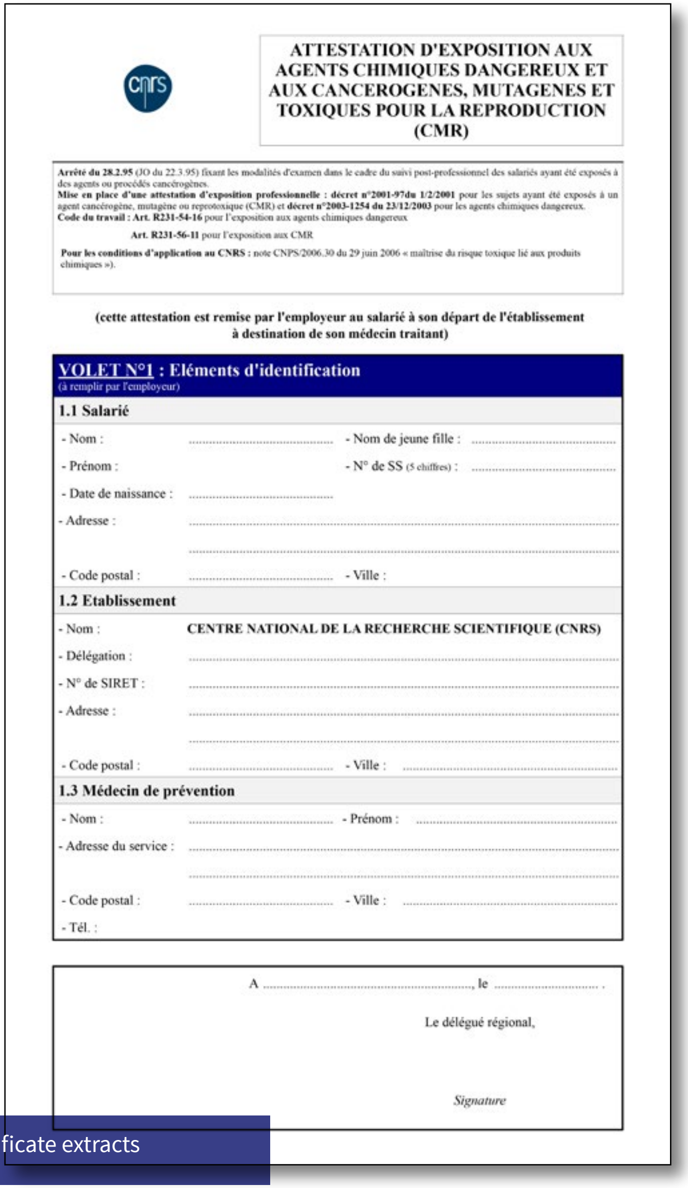
- Exposure to reprotoxic substances in categories 1A and 1B and to products labelled with the hazard statement H362 (May cause harm to breast-fed children) is prohibited for pregnant and breastfeeding women.
- No specific provision exists in the French Labour Code on the course of action to be taken in the event of pregnancy or breastfeeding involving category 2 reprotoxic substances. However, according to the Société Française de Médecine du Travail (French Society for Occupational Health), it is up to the occupational physician to decide whether the woman’s state of health is compatible with the workstation in the case of indirect exposure to category 2 reprotoxic substances. If the results of the OEL measurements and/or the biological exposure indicator (BEI) are lower than 10% of value limits, experts consider there is no exposure. Using the precautionary principle, exposure to these toxic substances should be limited as much as possible.
- Since June 2018, the Haut Conseil de Santé Publique (French High Council in Public Health) recommends that pregnant and breastfeeding women do not handle titanium dioxide nanoparticles.
- Pregnant and breastfeeding women must declare their status to the occupational physician as soon as possible, so that any adjustments to the position that may be required can be made.

This declaration is strictly confidential and is not communicated to the employer.

5.1.3.4. Post career or post-exposure traceability and medical monitoring

At the CNRS, the unit director is responsible for occupational exposure traceability. A personal exposure form (FIE) is created and updated regularly (at least once a year) throughout the staff member's professional career. When the latter retires, the regional director signs a certificate of exposure to dangerous chemical substances covering the staff member's entire professional career.

Post-exposure monitoring is the medical monitoring of past exposure, although the staff member is still working while no longer exposed to this risk. Post-career medical monitoring refers to retirement. Staff members who have been exposed to CMR substances in the course of their work may benefit from medical monitoring after leaving the CNRS or retiring. In both cases, planning an end-of-work consultation is strongly recommended. Following the consultation, the occupational physician gives the staff member a summary of the medical monitoring in the medical file. The aim is to continue monitoring with the new occupational physician or with the attending physician.



ATTESTATION D'EXPOSITION AUX AGENTS CHIMIQUES DANGEREUX ET AUX CANCEROGENES, MUTAGENES ET TOXIQUES POUR LA REPRODUCTION (CMR)

Arrêté du 28.2.95 (JO du 22.3.95) fixant les modalités d'examen dans le cadre du suivi post-professionnel des salariés ayant été exposés à des agents ou procédés cancérogènes.
Mise en place d'une attestation d'exposition professionnelle : décret n°2001-97du 1/2/2001 pour les sujets ayant été exposés à un agent cancérogène, mutagène ou reprotoxique (CMR) et **décret n°2003-1254 du 23/12/2003** pour les agents chimiques dangereux.
Code du travail : Art. R231-54-16 pour l'exposition aux agents chimiques dangereux
Art. R231-56-11 pour l'exposition aux CMR

Pour les conditions d'application au CNRS : note CNPS/2006.30 du 29 juin 2006 « maîtrise du risque toxique lié aux produits chimiques »).

(cette attestation est remise par l'employeur au salarié à son départ de l'établissement à destination de son médecin traitant)

VOLET N°1 : Eléments d'identification
(à remplir par l'employeur)

1.1 Salarié

- Nom : ………… - Nom de jeune fille : …………
- Prénom : - N° de SS (5 chiffres) : …………
- Date de naissance : …………
- Adresse : …………
- Code postal : ………… - Ville :

1.2 Etablissement

- Nom : CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS)
- Délégation : …………
- N° de SIRET : …………
- Adresse : …………
- Code postal : ………… - Ville : …………

1.3 Médecin de prévention

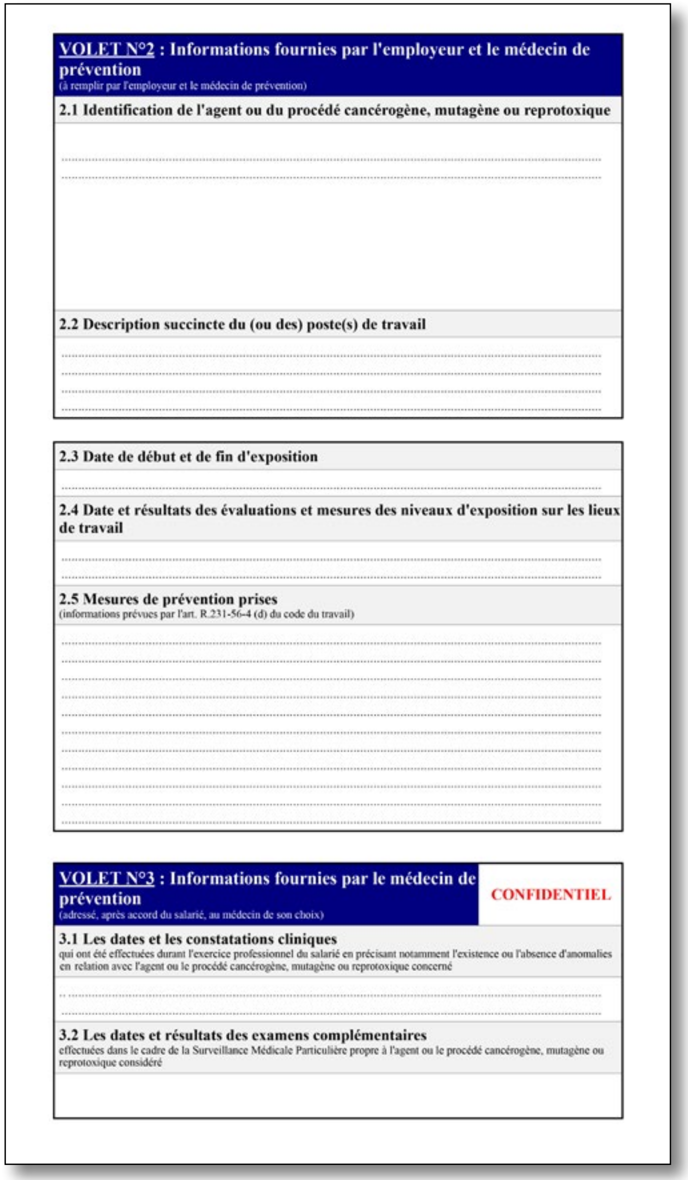
- Nom : ………… - Prénom : …………
- Adresse du service : …………
- Code postal : ………… - Ville : …………
- Tél. :

A …………, le ………… .

Le délégué régional,

Signature

Certificate extracts



VOLET N°2 : Informations fournies par l'employeur et le médecin de prévention
(à remplir par l'employeur et le médecin de prévention)

2.1 Identification de l'agent ou du procédé cancérogène, mutagène ou reprotoxique

2.2 Description succincte du (ou des) poste(s) de travail

2.3 Date de début et de fin d'exposition

2.4 Date et résultats des évaluations et mesures des niveaux d'exposition sur les lieux de travail

2.5 Mesures de prévention prises
(informations prévues par l'art. R.231-56-4 (d) du code du travail)

VOLET N°3 : Informations fournies par le médecin de prévention
(adressé, après accord du salarié, au médecin de son choix)

CONFIDENTIEL

3.1 Les dates et les constatations cliniques
qui ont été effectuées durant l'exercice professionnel du salarié en précisant notamment l'existence ou l'absence d'anomalies en relation avec l'agent ou le procédé cancérogène, mutagène ou reprotoxique concerné

3.2 Les dates et résultats des examens complémentaires
effectuées dans le cadre de la Surveillance Médicale Particulière propre à l'agent ou le procédé cancérogène, mutagène ou reprotoxique considéré

5.2. TECHNICAL METHODS

This section presents the key technical resources implemented in research laboratories and workshops – ventilation, protective equipment and storage being examples.
Because technical resources are particularly important in chemistry laboratories, **Factsheet 9** covers the layout of these labs in detail.

5.2.1. General ventilation

Ventilation is one of the most effective methods to combat workplace air pollution. It limits the concentration of chemical pollutants, particularly by capturing them at source and renewing the air in an interior space equipped with collective protective equipment.

Regulations establish the standards to be incorporated in the design of workplaces in terms of ventilation.

In workplaces with no specific pollution, ventilation must provide air flows between 25 and 60 m^3 per hour per person, according to the nature of the premises (offices or workshops) and of the work carried out there (the person is seated, busy, undertaking heavy work, etc.).

Research laboratories, chemistry laboratories, workshops where chemicals are handled and other premises are considered to be workplaces with specific pollution and the fresh air inflow rates mentioned above are insufficient. The goal to achieve, which consists in ensuring pollutant-free air (below OELs when they exist), makes it necessary to think in terms of air renewal rates, preferably by capture at source. The generally accepted rate is that of around three changes of the volume of air in a room per hour. Fume hoods generally provide air renewal with extracted air that must always be compensated by an equivalent inflow of non-polluted air. For reasons of comfort, make-up air is best treated thermally. Particular attention needs to be drawn to the quality of the air, depending on the location of air intakes, which must be sufficiently far away from pollution sources to avoid any recirculation.

Under normal operating conditions, fume hoods and the corresponding make-up air provide a sufficient rate of air renewal. However, should this not be the case (for example if all fume hoods are not being used) additional extraction via the room's general ventilation must be available.

Lastly, the principle of make-up air must also take into account other extraction devices such as robotic arms and ventilated cabinets.

5.2.2. Collective protective equipment

The application of general prevention principles requires that pollutants (gas, dust, aerosol, and fumes) be captured at source.
Collective protective equipment (CPE) is based on this principle and protects the experimenter at their workstation, as well as colleagues in close proximity.
There are several types of equipment: enclosure systems (glove boxes, fume hood, ductless fume hood, former ETRAF, etc.) and extraction systems (robotic arms, fume extraction arms etc.) for which **Factsheets 3** provides details.

To be operational and effective, it is essential that air extraction equipment (fume hood, robotic arm/boa etc.) have make-up air.

Recirculating air equipment, such as ductless fume hoods, do not of themselves contribute to air renewal in the room. That being the case, the general ventilation system operates the entire air renewal process. In addition, this type of equipment requires meticulous monitoring of the filtration system, especially filter changes, to avoid any pollutants in the workplace atmosphere.

5.2.3. Storage equipment

5.2.3.1. Central storeroom or bunker

The storage of chemicals (both new and in waste form) requires detailed risk analysis. A central storeroom (main storage) or a bunker, preferably outside research buildings, maintains large volumes of chemicals safely. This is a regulated access space which authorised staff may enter, but not stay in longer than needed. Intermediary storage areas can be added inside the site's buildings.

In any case, the fire risk of external or isolated premises (two-hour fire barrier, for example) inside a building must meet the following requirements:

- providing clear signalling;
- following fire safety rules includes storage located at a distance, firebreak-type separation devices, appropriate electrical and possible ATEX installations (**Factsheet 1**) where applicable, grounded metal barrels, fire detectors, emergency equipment in case of fire or spills;
- cleaning the air: general ventilation equipped with forced high-debit ventilation activated manually, in case of product spills;
- protecting the environment: shelves with sufficiently large PVC or HDPE spill pallets, easy-to-decontaminate floor acting as a spill pallet, implementation of technical provisions taken from those for ICPE (classified installations for environmental protection – see **Factsheet 1**).

5.2.3.2. Intermediary storage or stock of chemicals or waste (buffer stock)

This is a dedicated room close to experiment areas.
It has mechanical ventilation with forced ventilation activated manually in case of product spills. It also needs to meet the same requirements as the central storeroom.
Ventilated cabinets can be installed in the room (minimum 30-minute fire barrier) connected with the outside, with an extraction rate needing to be compensated by general ventilation.

In the case of low-temperature storage for flammable products, the use of standard refrigerators is prohibited because of the risk of explosion triggered by a thermostat or lighting system (spark). Secure refrigerators are specially designed, as are secure ventilated cabinets.

Lastly, the most toxic substances (including CMRs) are placed in locked cabinets with restricted access, under the responsibility of a staff member managing the process (in/out records).

In the specific case of cryogenic fluids (liquid nitrogen for example), the ventilation system which needs to ensure sufficient air renewal is connected with an oxygen metre that triggers high-debit forced ventilation in the event of leak or spill. Particular attention needs to be drawn to floors liable to be in contact with cryogenic fluids (**« Risques liés aux fluides cryogéniques », site intranet du CNRS –Risks associated with cryogenic fluids, CNRS Intranet**).

IN ANY EVENT

- Never store chemicals in a room without windows or mechanical ventilation;
- Fume hoods should never be used as storage buffer;
- Cold rooms (obviously unventilated) must never be used as a storage room.

5.2.4. Personal protective equipment

Personal protective equipment (PPE) items are devices and methods intended to be worn or held by a person, with a view to protecting them against one or several hazards liable to harm their health and safety.
Staff must only be given PPE bearing the CE mark (European conformity) and a technical factsheet. This contains useful information for using and maintaining the equipment. Gathering together the factsheets in a folder available to everyone is recommended.

5.2.4.1. Using PPE

PPE must be made available to staff, to add to collective protective measures or to replace them, if a collective approach is impossible to implement.
The unit director must provide sufficient quantities of PPE items, ensure they are maintained and enforce the wearing of them. Safety glasses, safety over-glasses for people who wear prescription glasses and lab coats represent minimum protection in high-risk chemical premises (experiment rooms, chemical product, stores, etc.).

5.2.4.2. Training and information

Users must be appropriately trained on how to wear PPE. Training programmes include the selection of equipment according to workplace hazards and situations and the way in which protection is worn, cleaned, stored and disposed of (**Factsheet 6**).

During training, users must be informed of the possible consequences of not following instructions relating to the wearing of PPE, such as a temporary ban on accessing experiment rooms (the decision being taken by the unit director, in accordance with the internal rules in force in the unit).

At the CNRS, this theoretical and hands-on training programme is placed under the responsibility of the unit director and carried out by the health and safety officer and the manager.

In addition, workstation notices and information materials (such as the on-boarding guide or an SDS) remind users to wear PPE.

5.2.4.3. Different types of personal protective equipment

PPE must be appropriate given the hazards, adapted to the user and compatible with the work to be done. Offering different models to staff is recommended for reasons of comfort and aesthetics. It is also essential to have a stock available for visitors.

Eye protection (**Factsheet 4.1**):
PPE (goggles, over-glasses for staff wearing prescription glasses, face shields and hoods) are essential when using chemicals or being near them. This is because accidental exposure frequently impacts the eyes, with potentially serious consequences such as total or partial visual impairment.

Users are strongly advised not to wear contact lenses in rooms containing chemicals.

Skin protection (**Factsheet 4.2**):
Protective clothing (lab coat, overalls, chemical-resistant apron, chemical suit), face shields and gloves protect against a range of injuries. They include chemical injury (burns, contamination), mechanical injury (scrapes, wounds) and thermal injury (burns, freezing). Protective clothing is systematically used when handling chemical substances, carrying containers, spraying (pesticides, paint) and also in dusty environments (animal facility, workshop). It avoids any skin contact with the product or entry into the body. However, the materials that make up these equipment items only offer protection for a limited period. They therefore need to be changed regularly and none of them are effective against every substance. They also need to be carefully selected, depending on the products used.

Respiratory protection (**Factsheet 4.3**):
If a worker is liable to inhale dust, vapours, gas or aerosols, protecting their respiratory tract requires PPE (filtering face piece or emergency escape breathing device). The same applies if they work in an oxygen-poor atmosphere (emergency escape breathing device). Choosing a protective mask depends on the nature of the work carried out, exposure duration and the various substances' characteristics. Given its discomfort, using a respiratory device should only be used in certain brief or exceptional situations, where there is no possibility of resorting to collective protection techniques or where such methods are lacking.

Figure 6 *Mandatory pictograms on the wearing of PPE.*

USEFUL SOURCES WHEN SELECTING PPE

- *Brochure «Les appareils de protection respiratoire» (Protective respiratory devices), ED 6106, INRS ;*
- *INRS website: **Protect-Po** (for choosing skin protection materials), Prémédia (to estimate the expiration date of cartridges in protective respiratory devices) ;*
- ***150 fiches pratiques de sécurité des produits chimiques en laboratoire** (150 practical factsheets on chemical product safety in laboratories) . MH Aubert, S Bernier, B Diers, AM Freyria, AC Macherey, S Munch. 5th edition. Paris : Dunod, 2018 ;*
- *SDS – section 8 (**Chapter 4.2, Appendix 3**) ;*
- ***Quick selection guide to chemical protective clothing**, 6th edition, ed Wiley, 2014 ;*
- *Information provided by PPE suppliers.*

5.2.5. *Emergency equipment*

This type of equipment helps face emergencies (**Chapter 5.3.6**). It is either made compulsory by regulations or implemented following a risk analysis.

In any case, a laboratory where chemicals are handled must possess at least:

- in the event of fire: extinguishers and fire blankets (**Factsheet 9**) ;
- in the event of splashes (acid, base, etc.): eye showers and jets (**Factsheet 9**) ;
- in the event of accidental liquid spills: absorbent materials (such as vermiculite), absorbent paper and neutralising absorbents found in retail(**Factsheet 5.3**) ;
- emergency PPE (**Factsheet 5.3**) ;
- one or several first-aid kits (**Factsheet 10**).

In specific situations, other equipment must be available, for example:

- in the event that hydrofluoric acid (HF) has been handled: calcium gluconate gel (**Factsheet 5.2**) ;
- in the event that mercury has been used: specific recovery kit (like a sponge coated in zinc powder), sulphur powder, etc.

All these equipment items must be visible, easy to access and familiar to everyone. Prior training enables staff to use them under satisfactory conditions (**Factsheet 6**). In addition, they must be checked and maintained regularly (**Chapter 5.3.4**).

5.3. ORGANISATIONAL METHODS

5.3.1. *Chemical exposure - control and measurement*

In any activity involving staff liable to be exposed or exposed to chemicals, a prior assessment is required. Criteria for assessment include items such as facilities, protective equipment and ventilation. These installations serve to reduce pollutant concentration in the workplace (gas, dust, aerosols, vapours) to the lowest level possible.

Should the assessment result in a greater than low risk, exposure measurements must be undertaken regularly, whatever the chemicals involved. However, for category 1A and 1B CMR products (**Appendix 6**), these measurements are mandatory whatever the result of the assessment. The measurements become checks for any chemical (CMR or not) with a mandatory OEL (**Figure 7**).

Measurements can be carried out internally, whereas mandatory checks are conducted by an accredited organisation (see list on the **COFRAC** website), undertaken at least once a year and at each process change.

Measurements and checks assess the effectiveness of previous prevention measures and can even reinforce them.

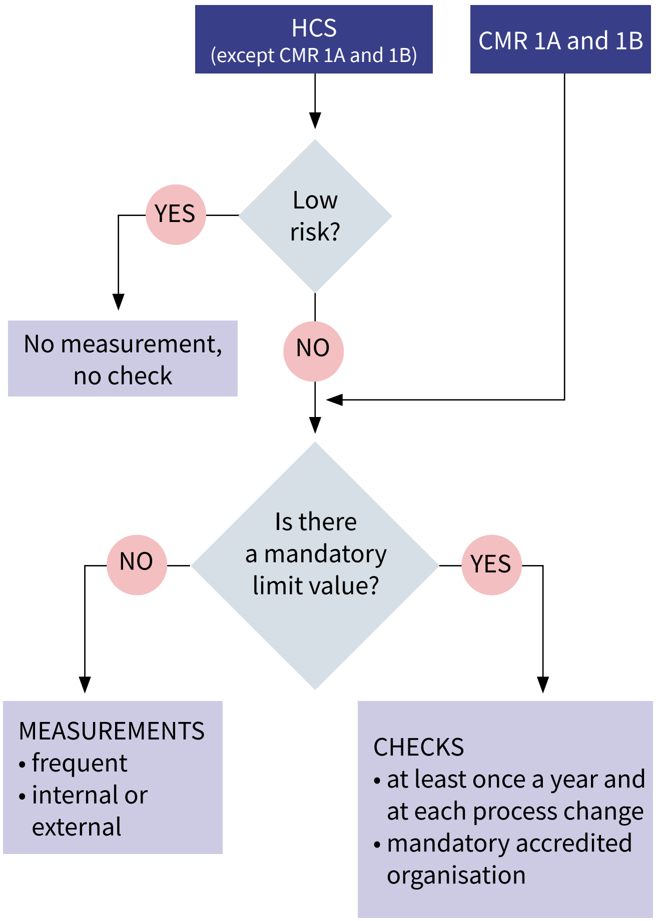


Figure 7 *Exposure measurements and checks*

5.3.1.1. OELs and other limit values

In France, OELs are used to assess air quality in the workplace and must be seen as minimum prevention targets.

For a given product, the OEL establishes the substance's maximum concentration in the workplace atmosphere over a period of 8 hours or 15 minutes.

The values established over a reference period of 8 hours aim to protect workers from the effects of chronic toxicity.

Those established over 15 minutes aim to protect workers against the immediate or short-term effects of toxicity. They are established for substances where measurement methods for these reference periods are available.

These values are expressed in proportion (ppm), mass (mg/m^3) and fibre volume (f/m^3).

© Michal Jarmoluk - Pixabay

There are different types of OEL, some of which are mandatory. They include:

- mandatory and restrictive OELs set by decree and listed in the French Labour Code. They are subject to a mandatory obligation of "non-exceedance";
- mandatory and indicative OELs set by decree.

There are other values, of indicative nature. However, although they are not mandatory, they can contribute to an optional exposure measurement, especially if CMRs are involved. For example to date, there is no mandatory OEL for 1,3-Butadiene. In cases such as this, limit values established in France (ANSES, CARSAT/CRAMIF, etc.) and elsewhere (ACGIH, NIOSH, OSHA, AGS, etc.) can be used as indicative reference values.

Should OELs be exceeded, prevention measures must be taken as shown in **Figure 8**.

NOTE

Certain limit values are associated with additional statements such as "skin" and/or "noise" providing details of, respectively, the risk of significant skin absorption and hearing loss, in the case of both exposure and noise.

The various OELs

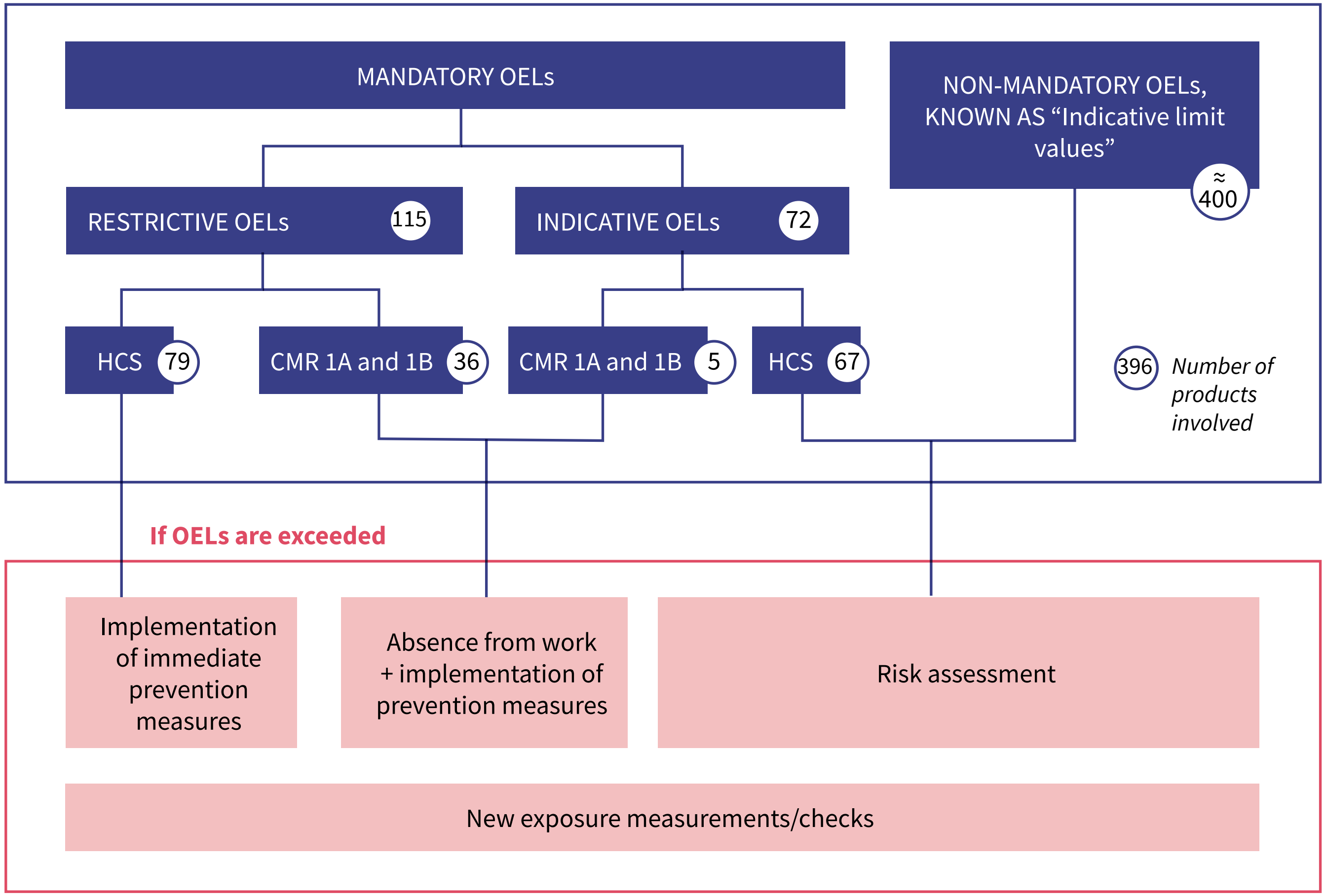


Figure 8 *Measures to be taken in the event of OEL exceedance*

5.3.1.2. Detection equipment

Fast-growing technology makes it possible to acquire a wide range of gas, vapour and dust detection devices. The choice of equipment depends on the objective:

- detection in accidents
  - asphyxia risk: a drop in oxygen levels (oxygen metre);
  - toxic risk: leaks such as H_2S, CO (specific detectors);
  - fire-risk or explosion risk: lower explosive limits exceeded (explosimeter)
- information on the content of certain substances harmful to health in the atmosphere. In this case, the detector evaluates exposure profiles by targeting the most exposed workstations and processes, or by validating the effectiveness of protective systems in place.

Fixed and handheld detectors are available.

Detectors are prone to malfunction over time and they must be checked regularly. If required, maintenance must be undertaken by qualified staff, in line with the supplier's guidelines. The recommendation is to use the detector in the conditions set out in the technical factsheet and to establish a monitoring record for each one (checks, calibration, maintenance, incidents).

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Handheld detector

5.3.2. Substitution

Substitution consists in replacing a dangerous chemical substance or process with another that is not dangerous or less dangerous.
The search for substitution is an integral part of the general principles of chemical risk prevention. It represents a mandatory obligation that prevails over all other hazard reduction methods.

5.3.2.1. Situations requiring substitution

Substitution targets two types of hazardous chemical substances:

Products	Situations
CMR chemicals[1]	The search for substitution is a compulsory stage, whatever the results of risk assessment.
Non-CMR hazardous chemical substances	The search for substitution is compulsory if risk assessment has led to a greater than low risk to health, goods and the environment, and if the risk cannot be managed by effective preventive measures.

5.3.2.2. Possible results for substitution

The search for substitution does not necessarily lead to a substitute being found. The substitution obligation only applies when it is technically possible. Whether it yields results or not, the search must be justified and based on technical arguments. Substitution may take the form of a substance, mixture or process. In all cases, search results must feature in the DUERP.

Particular attention should be paid to risk displacement when searching for substitution solutions. The solution chosen can present a hazard which is incompatible with the original experiment protocol. For example, a less toxic substance can turn out to be less stable than the substance replaced and thus trigger an explosion. All substitution solutions must be assessed regarding harm to goods, health and the environment.

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5.3.2.3. Substitution method

Substitution does not simply consist in replacing one product or process by another. This needs to be a concerted approach involving various players (scientists, experimenters, HSOs). It might also require help from outside the lab (technical and scientific experts, health and safety department, occupational physicians, CHSCT members). There are many parameters to take into account as well as tools to help choose substitutes (**see box**).

The following substitution stages, drawing on the INRS approach: **«La substitution des agents chimiques dangereux», ED 6004, INRS** (substitution of hazardous chemical substances), are for information and can be adjusted if necessary to achieve the required results:

Substitution stages	
1	Describe the problem
2	Establish specifications
3	Search for solutions
4	Assess solutions
5	Test the various solutions chosen
6	Compare the different options
7	Implement the solution chosen
8	Assess and validate the solution

---

[1] *From a regulatory point of view, only category 1A and 1B CMR substances are concerned.*

INFORMATION AND HELP IN ASSESSING SUBSTITUTES – EXAMPLES

www.substitution-cmr.fr
French platform presenting examples of substitution tools to help identify CMR substances and a method for comparing substitutes, developed jointly by the Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (French Agency for Food, Environmental and Occupational Health Safety – ANSES) and Assurance maladie (Health insurance for salaried workers – CNAMTS).

www.inrs.fr
INRS provides factsheets to help identify the main carcinogenic substances that can be found in a given industry sector (FAR), as well as factsheets to help substitute products, and/or processes (FAS).

The latter are established for a carcinogenic substance in a given industry sector.

www.subsportplus.eu
European platform sharing information on the substitution of hazardous substances, assessment tools and guides of substitution products and alternative methods.

http://www.irsst.qc.ca/solub/
Québécois platform, the aim of which is to help healthcare and health and safety professionals in the workplace in public and private sectors carry out substitution projects involving solvents.

Example of substitution:

Dichloromethane	Issue: category 2 suspected carcinogen	
Use	Liquid extraction of organic compounds	
Substitution products	• Ethanol • Cyclohexane	***Warning****: These solvents generate a greater risk of fire.*
Substitution process	• Supercritical fluid extraction (CO_2).	
Use	Surface stripping	
Substitution products	• Dibasic ester mixtures • Dimethyl sulphoxide • Benzyl alcohol • Sodium or potassium hydroxide solutions	
Substitution process	• Blasting with dry ice granules • High-pressure sandblasting • Thermal stripping	***Warning****: These processes reveal the presence of other hazards (asphyxia, high-pressure splashes, burns etc.)*

(Sources: ED6004 – « La substitution des agents chimiques dangereux » (Substitution of hazardous chemical substances), INRS, 2011, substitution-cmr.fr)

THE CASE OF ETHIDIUM BROMIDE (BET): TRADE PRACTICES AND REGULATION COMPLIANCE

Going beyond the mandatory obligation to search for CMR substitutions, some suppliers of laboratory reagents offer alternative solutions, by showcasing their non-dangerous or less dangerous properties for users' health. This is the case for BET which is commonly used in molecular biology as a fluorescent DNA probe and is classed as a category 2 mutagenic substance (H341: Suspected of causing genetic defects).

Due consideration should be given to the relevance of scientific arguments and content offered by suppliers who sell alternatives to BET. The volume of BET sales being low, certain laboratory reagents are not subject to mandatory obligations regarding the assessment of chemical substance hazards (REACH regulation), and no information is provided. The absence of labelling does not represent an absence of danger, especially if the aim is for the substance to interact with DNA. In addition, a product praised for properties that are "less mutagenic" or "non-mutagenic at use concentration levels", remains mutagenic, whatever the quantity of product used. It is therefore strongly recommended, if the BET substitution is carried out in the laboratory, to follow use and safety instructions that apply to CMR substances (storage, use, waste disposal).

5.3.3. Incorporating safety into experiment protocols

Risk assessment associated with the experiment protocol must be undertaken during the design stage, as soon as products have been selected and the experiment protocol approved. This process is led by the experimenter, with help from their scientific supervisor, and their health and safety officer if necessary. It is key to providing optimal measures for the protection of both the experimenter and the environment, which in practical terms consists in:

- a schematic representation of the various stages in the experiment timeline, starting for example from product transport, then "storeroom to bench", the mixture of products, waste disposal and ending with the dismantling and/or cleaning of the set-up;
- risk assessment at each of the stages on handling techniques, appropriate protection and prevention methods (premises, equipment, PPE, waste disposal) relying on existing procedures in the unit. Some of the high-risk handling practices frequently encountered include opening flasks, sampling, transferring and so on.

Factsheet 11 shows a real-life case.

Thinking this process through helps to:

- highlight all the hazards, not just chemical hazards, that can be associated with it (electrical, biological, laser-related);
- set out resources in terms of premises, equipment, collective and personal protective equipment;
- set out organisational methods required for the experiment: work planning for collective equipment usage, measures to be taken when experiments are conducted out-of-hours or working alone for instance;
- adapt the experiment protocol, or decide that it is not feasible in the present circumstances.

Example of incorporating safety in the various stages of an experiment

	Transporting a flask to the bench	Weighing	Mixing products	…	Waste disposal	Dismantling/Cleaning
CHEMICAL RISK	Inhalation, splashes…	Inhalation, skin contact…	Inhalation, splashes…		Inhalation, splashes…	Inhalation, skin contact…
PREVENTION	Double packaging, gloves, lab coat, safety glasses	The choice of CPE (secure weighing cabinet, fume hood, glove box etc.) depends on risk assessment. Gloves, lab coat, safety glasses	Fume hood, gloves, lab coat, safety glasses		Fume hood for CMR and lethal substances*, gloves, lab coat, safety glasses	Gloves, lab coat, safety glasses. If the risk assessment results in a greater than low risk, CPE may be required.

* Hazard statements H300, H310, H330

5.3.4. Equipment maintenance and control

In the same way that scientific and workplace equipment is to be kept in good repair, so is protection equipment, which requires maintenance.

In addition, for reasons relating to people's safety, regulations impose mandatory checks with a precise frequency schedule. The checks and verifications serve either to ensure that protection (or response) equipment is still effective and meets standards or to ensure that the equipment presents no additional risk linked to wear or poor maintenance.

In practice, there may be confusion between maintenance and control operations. They are, however, quite distinct.

Maintenance operations essentially ensure the effectiveness of operations, whereas control operations have a safety objective.

Concerning control operations, "check" and "control" are generic terms which, depending on the situation, can mean a test, an examination, a visual assessment, a visit, an inspection, a measurement or preventive maintenance. Regulations indicate precisely the type of operation to be carried out. They also provide details of execution conditions, the timelapse between checks, whether verification has been conducted by competent and qualified persons or by accredited organisations.

Note that hiring a service provider via a maintenance contract does not preclude the requirement for a mandatory check where applicable.

Periodical checks are reports that must lead to repair should an anomaly be found.

A register is needed to keep track of verification traceability. Verification reports must also be kept and shown if required for any check. They are kept for at least five years, or in some cases, the lifespan of the installation including initial verification reports.

In all cases (maintenance and control operations) any input from an external company must include at least one visit to provide details of the prevention measures taken with regard to co-activity. A visit certificate or prevention plan must be drawn up if the work undertaken represents more than 400 hours per year or in the case of a specific hazard.

FIND OUT MORE

- *«Principales vérifications périodiques» (Main periodical checks), ED 828, INRS ;*
- *"Pressure equipment" prevention guide, CNRS :*

https://www.dgdr.cnrs.fr/SST/CNPS/guides/doc/equipements/Guide-ESP.pdf

(for checks involving pressure equipment, such as gas cylinders, autoclaves, pressure networks).

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5.3.5. Implementation of a waste disposal procedure

The handling of any chemical substances, in a laboratory or in other settings (workshop, cleaning service, laundry), produces hazardous chemical waste. Which is why it is essential to set up a chemical waste disposal procedure. Disposing of waste down the sink or in non-dangerous waste bins is strictly prohibited.

Chemical waste includes:

- liquid and solid handling residue;
- soiled containers;
- used PPE;
- polluted filters and cartridges, single-use items (such as dusters and absorbent paper).

Laboratory waste management is inextricably linked to laboratory safety which it contributes to significantly. It also contributes to monitoring chemical product stocks and flows.

From a regulatory point of view, the waste producer is responsible for waste from production right to total elimination. At the CNRS, depending on the local structure, the person responsible can be a regional general manager, a unit director or a university president for instance.

5.3.5.1. Waste management in the unit

Chemical waste must be sorted, packaged, labelled, gathered and sent to other collection points, in line with the unit's organisation (**Factsheet 12**). Cleaning staff are not authorised to handle this waste. Some items of waste require neutralisation before disposal, in accordance with referenced and validated protocols in the unit (for example, thiols, alkaline metals, alkaline-earth metals, cyanide, peroxides).

Specific case of unidentified waste, because of insufficient, lacking or changing description, or because of a change in its content:

More specifically, this problem can occur with stocks of dated commercial products and insufficiently described synthetic products. In that case, only specialists can devise how to manage waste correctly, based on an analytical approach for optimal treatment.

5.3.5.2. Packaging

For chemical waste, the use of certified packaging for the transport of dangerous goods (**Chapter 6.2.1**) is mandatory. Packaging options (boxes, pallets, barrels), depend on the type of waste:

- pure and concentrated solutions are kept in their original container and must not be transferred. These containers must be grouped together in a spill pallet or lidded box (2) filled with neutral absorbent material;
- diluted solutions and handling residue are collected in sealed containers (for example, with pressure barrels (1)) themselves placed in a spill pallet or lidded box (2) filled with neutral absorbent material;
- combustible solids (absorbent paper, sharps, plastic pipettes, etc.), placed in polyethylene 10- and 30-litre barrels (3) or in a bucket-type container (4).

Liquid waste	**Pre-treated solid and liquid waste**		
			
Pressure barrel (1)	Lidded box (2)	Open-top barrel (3)	Lidded bucket (4)
Capacity: 5 - 10 l	Capacity: 60 l	Capacity: 30, 60, 120 and 220 l	Capacity: 5, 10, 20 and 25 l

Table 8 *Containers for transporting waste*

General instructions:

- the containers above (**Table 8**) must comprise a label in accordance with the transport for dangerous goods regulations (**Chapter 6.2.2**) ;
- chemical compatibility of the container and the content and compatibility of waste between the two must be checked before any grouping. To that end, the following information includes SDS data, packaging certificates (**Factsheet 13**), literature. For example, avoid mixing toxic or very toxic organic products with mineral products, heavy metal solutions especially (Pb, Cd, Hg and Tl), and transition metals (Ni, Cr, V);
- some types of waste require specific disposal procedures, such as PCB, PCT, PBB, polychlorinated dibenzodioxins, polychlorinated dibenzofurans, mercury, asbestos;
- in the first instance, for the new products synthesised in the laboratory with no valid toxicological information, refer to the classification of similar products if they exist, otherwise, treat them as toxic waste;
- establish a comprehensive list of products stored in each container, for the subsequent transport of chemical waste;
- volatile liquid waste must be placed in barrels with a self-closing funnel lid;
- non-biologically soiled and sharp objects must be collected separately in a combustible sharps box;
- low capacity containers are better than larger ones for easier handling and risk prevention (collision, fire, spill etc.);
- managing the different types of waste produced in the laboratory requires a colour code (examples are in **Table 9**).

Waste type	Examples	Label type	Container type
Mineral acids	Hydrochloric acid, phosphoric acid **Warning**: Keep away acids such as nitric, perchloric and sulphuric acid	Yellow	5 l or 10 l barrel
Organic acids	Acetic acid, carboxylic acid, formic acid		
Bases with and without minerals	Base solutions, base metal solutions, caustic soda, ammonia solution, potassium	Blue	5 l or 10 l barrel
Halogenated organic solvents	Dichloromethane, chloroform, chlorobenzene…	Red	5 l or 10 l barrel
Non-halogenated	Ethanol, methanol, acetone, DMSO…		
CMRs	Mercury and mercury salts, benzene, dimethylformamide, formaldehyde	Green	5 l or 10 l barrel
Chemically soiled supplies	Gloves, paper, disposable plastic items	White	Container larger than 5 l
Empty contaminated containers (not soiled by CMRs)	Plastic, metal and glass containers	White	Container larger than 5 l

Table 9 *Types of waste (examples)*

Examples of containers

FIND OUT MORE

- *«Gestion des déchets» (Waste management) guide, CNRS : https://www.dgdr.cnrs.fr/SST/CNPS/guides/doc/dechets/guidedechets.pdf*

5.3.5.3. Collecting waste from the site

Waste is generally stored in different locations:

- in the experiment room, with low volumes regularly disposed of;
- in a storage area, specially designed to hold waste before disposal (e.g. waste bunker) (**Chapter 5.2.3**).

An intermediary storage area can also be installed if required.
To ensure safe collection:

- use a trolley with a spill pallet preferably. Prevent containers from being displaced from their stand and avoid collisions and friction;
- use the most direct and least frequently used routes, and do not use routes where works are ongoing, especially in hot spots;
- never use a lift with chemicals inside it (compressed gas, cryogenics, reagents and waste). Use a service list and call it from the floor required;
- collect waste wearing appropriate PPE (lab coat, gloves, safety glasses, safety shoes, etc.) and provide response equipment in the event of accidental spill;
- train staff in charge of collection on the risks associated with this procedure.

Transfers should be prohibited except in the case of specific procedures (trained staff, appropriate premises and equipment etc.).

5.3.5.4. Storage on site before collection

The volume of chemical waste stored must be in accordance with the storage capacity of the premises used for that purpose. Among other measures, there must be no stacking, no blocked exits and the stored items must be secure.

The maximum duration of chemical waste storage depends on a range of parameters: reactivity, quantity, storage conditions.
Waste disposal must follow collection promptly, to avoid the ageing of matter, the possible formation of unstable sub-products, damage to containers (note the expiry date), lower inert effectiveness, worn labelling, leaking seals and so on.

Chemical waste must be stored in premises with controlled access in compliance with current regulations (**Chapter 5.2.3**).

5.3.5.5. Traceability of waste management

The French Environmental Code imposes a waste tracking document (BSD) to ensure traceability, from waste producer to total elimination. This document (**cerfa N° 12571**) is filled out by the waste producer. It contains details of its provenance, characteristics, collection, methods, transport and storage, the identity of the companies involved and the destination.
Waste producers, collectors and operatives of transit and elimination installations send each other signed reports of successive operations carried out throughout the process. The returned BSD reports, signed by those involved, provide the waste producer with the assurance that environmental protection obligations have been duly followed. They must be kept by the waste producer for a period of 5 years.
In addition, all operations relating to waste disposal must be recorded in a waste register (**Factsheet 14**).

5.3.5.6. Financial aspects

The cost of treating chemical waste comprises contents and containers. It is based on the total mass to be eliminated and the type of waste (CMR, solvents, acids, bases etc.).
It is not necessary to wait for a barrel to be completely full before disposal, especially if low volumes of waste are generated.

5.3.5.7. Waste management when leaving the unit

Under the regulations on the international carriage of dangerous goods by road, known as ADR, waste must be transported with the same obligations as if it were not waste.

Specific rules apply to classification, packaging, marking and labelling, transport documents (BSD), etc.;

The producer of waste must therefore:

- categorise and identify the waste;
- package it (accredited packaging);
- place labels and marks on parcels (**Factsheet 15**) ;
- provide transport documents, including the waste tracking document;
- follow loading conditions described in the loading and unloading protocol;
- check vehicle equipment and lights;
- train staff on how to hand over waste to the transporter.

NOTE

Packaging and labels are generally supplied by the company eliminating the waste. The company can also offer to pre-fill documents. However, responsibility for packaging labelling and the accuracy of the BSD remains the responsibility of the sender, in other words, of the waste producer. In the legal sense, depending on the organisation, this can mean the establishment, the unit etc.

EXAMPLE

A police check of a vehicle transporting waste (waste treatment company, or another transporter) can reveal a number of offences:

- a plastic barrel which has passed its expiry date (5-year validity) (**Factsheet 15**) ;
- a label with the wrong dimensions (a minimum of 10 x 10 cm) supplied by the waste treatment company;
- an incorrectly labelled parcel: UN number, but no hazard statement on the label;
- discrepancy between the package and the documents;
- an error in the official name of the waste item featuring on the transport document.

All these offences are the responsibility of the sender.

Despite the service provider being considered to be competent in the supply of labels and packages, the contract generally stipulates that the treatment company eliminating waste provides a service but is not responsible for the sender's packaging, labelling and various other obligations.

As a result, it is up to the sender to verify these points, and to be very vigilant as to the service rendered by the contractor.

5.3.6. Emergency

In order to limit the potential impact of an emergency, response equipment and systems must be in place. They must have been planned and established beforehand. Procedures enabling them to be used in satisfactory conditions must also have been drafted and displayed.

Emergency equipment (**Chapter 5.2.5**) comprises items that help limit an accident or incident as well as personal protective equipment, to ensure that responders do not to incur exposure.

In certain limited cases, there can be appropriate equipment designed for specific input (**Factsheets 4**) in a high-risk workstation.

The measures to be taken (CAT) must be clearly defined and displayed in short and simple instructions (**Factsheets 5**). Depending on the situation, laboratory emergency equipment and its conditions for use and location is mentioned in this document. An emergency alert procedure must also be added to the CATs (**Factsheet 16**).

Lastly, any emergency must lead to an after-the-event analysis to draw all possible lessons learnt. As such, accident and incident traceability is essential. To that end, a workplace health and safety register is available for staff, which also serves to record the occurrence of incidents and accidents. In addition, sharing feedback represents a key element in improving prevention.

Feedback on facts and lessons learnt can be organised with staff to raise awareness with a broader range of people. At the CNRS, an application for sharing accidents, incidents and events supplied by the network of health and safety officers has been implemented to that end.

6 • TRANSPORT

SPECIFIC CASE OF UNIT REMOVAL

A CNRS note provides details of the procedures in the case of closure, removal, or restructuring of a unit.

The **note of 7 April 2017** provides details of how they are to be implemented.

The risk associated with the transport of chemicals is that of the containment failure of a parcel containing a toxic, corrosive or flammable substance for example, which can occur following:

- a road traffic accident;
- the parcel being dropped;
- non-compliant handling or use;
- insufficient knowledge of the specific rules which must be followed when receiving or sending hazardous chemicals.

Such incidents endanger package handlers. They are also liable to have an impact on a third party as well as on the environment.

Rules have been established to prevent the risks associated with the transport of hazardous chemicals. They are derived from UN prescriptions and broken down in several regulations, corresponding to the different modes of transport for dangerous goods (chemical, biological and radioactive products, lithium batteries, etc.):

- IATA for air transport (International Air Transport Association)
- IMDG for maritime transport (International Maritime Dangerous Goods Code)
- RID for rail transport (Regulations concerning the International Carriage of Dangerous goods by rail)
- ADN for shipping (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways)
- ADR for road transport (European Agreement concerning the international carriage of Dangerous goods by Road)

IS THE PRODUCT TO BE TRANSPORTED CATEGORISED AS DANGEROUS FOR TRANSPORT? WHERE CAN THIS INFORMATION BE FOUND?

If it is on the market, the product is categorised as dangerous for transport (**Chapter 4.1**, **Appendix 3**), provided there is a UN (or ONU) number in section 14 of the SDS, which explains the rules that need to be followed in terms of transport. It shows all the specific transport precautions a user must take into account:

UN (or ONU); Hazard class; Consignment name;
Packaging group; Marine pollutant; Other useful information.

When the transport of a product is prohibited, information also features in this section (for example, bromine cannot be transported by air).

In the case of a product not on the market such as mixtures and synthetic products, the need to assign an appropriate UN (or ONU) number, or not, must be established with the help of the safety adviser (**Factsheet 17**).

PROHIBITIONS

- Sending dangerous goods by the national postal service is strictly prohibited.
- More generally, the transport of dangerous goods in all forms of transit (underground, bus, train, ferry etc.) is prohibited. Please refer to these companies' general conditions (e.g. in France SNCF, RATP).
- Transporting a dangerous product in a personal vehicle is forbidden.

6.1. MAIN OBLIGATIONS

6.1.1. Responsibilities of the sender

The sender is entirely responsible for complying with the regulatory requirements relating to the parcel entrusted to the transporter. This includes filling out the transport document correctly and following packaging and labelling rules.

When hazardous chemicals are sent or received at the CNRS, it is mandatory for the director to call on a safety adviser (**Factsheet 17**).
Their role is to give advice and information to the sender, to prescribe the appropriate transport rules and to ensure that these rules are followed.
As a minimum, staff who need to send or receive dangerous goods must be trained on ADR regulations (**Chapter 5.1.1.2, Factsheet 6**).

6.1.2. Product names

The name of the product entrusted to the transporter must follow the UN nomenclature, consisting in UN followed by four digits.
The UN number describes a range of obligations prior to any consignment.

6.1.3. Hazard classification

All hazardous products must be categorised into one of 13 possible classes (see **Factsheet 19**).

6.2. PARCELS

6.2.1. Packaging

ADR and IATA each have packaging instructions which set out a number of factors aiming to guarantee the integrity of parcels in the event of it being dropped, punctured or compressed.
The external package (generally a cardboard box) must show the specific UN mark indicating that it has satisfactorily met test requirements. The meaning of these marks is explained in **Factsheets 15 and 18**.
This type of accredited packaging is readily available for sale.

6.2.2. Marking and labelling

Marking comprises information on the parcel's content, type of hazard(s) and packaging standards.
All marks on packages must be displayed in such a way as to be clearly visible and not covered by another label. **Factsheets 15 and 18** show how to label the parcel in accordance with ADR and IATA regulations.

WARNING

Pictograms of hazardous chemicals relating to European CLP regulations (**Appendix 2**) and those used for the transport of dangerous goods (**Factsheet 19**) should not be confused.

SPECIFIC CASE OF SYNTHETIC PRODUCTS

Synthetic products are generally transported in very small quantities (less than a gramme). Derogations are sometimes allowed, in which case the safety adviser (**Factsheet 17**) should be approached so as to establish the most accurate categorisation, according to the product.

7 • THE CASE OF CERTAIN SPECIFIC SUBSTANCES

Some substances are subject to particular regulations. They are listed in **Factsheet 20**.

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Formulation of fluorescent nanoparticle

The following focus on these very specific cases:

Nanoparticles:

Current knowledge on the impact of nanoparticles indicates that some of the insoluble ones can cross various biological barriers, settle around the body and accumulate in many organs, where toxic effects have been documented. The degree of toxicity is thought to be partly linked to the surface properties of nanoparticles. These properties can be the source of more significant inflammation than microscopic and macroscopic elements with the same chemical nature. The sum of this data justifies implementing strict prevention measures, to avoid any risk of occupational disease developing (**Factsheet 21**).

Silica:

There are two main forms of the solution: amorphous silica and crystalline silica (quartz, cristobalite, etc.) The latter is the more dangerous form. Depending on the quantities and use conditions, silica can lead to severe respiratory damage (chronic bronchitis) and pulmonary fibrosis (silicosis). Inhaled in the form of quartz or cristobalite, it is classified as carcinogenic in humans (IARC category 1) but not categorised as such in the European Union. However, diseases caused by the inhalation of crystalline silica dust can be recognised as occupational diseases where they are listed in table 25 of the provisions in the French Social Security Code. Regulatory and restrictive OELs are set out in the French Labour Code (0.1 mg/m3 for quartz and 0.05 mg/m3 for cristobalite and tridymite) which also sets out an OEL for mixtures of silica dust and other types of dust (**Chapter 5.3.1.1**).

In laboratories, silica can principally be found in the form of amorphous silica gel (e.g. chromatography). However, certain techniques and processes can release or generate silica dust in its crystalline form, for example, when grinding or sawing rocks, or glass blowing.

Dyes used in laser equipment

Dyes come in powder or liquid form. They are added to solvents to produce solutions, injected and then enter the laser installation.

The most commonly used are rhodamines, coumarins and dicyanomethylene (DCM). These are dangerous chemical substances that can be irritant and toxic. In addition, solvents (ethanol methanol, DMSO, etc.) can make it easier for these substances to go through skin.

Laser-matter interaction process

This consists in operations such as cutting, etching, drilling, soldering and thermal treatment, with the help of a laser beam. They can be responsible for the release of vapours, aerosols and dust at a greater or lesser degree because of matter vaporising and decomposing. Emissions can be dangerous (toxic, irritant or CMR).

Examples include:

- using a laser beam to cut PVC generates hydrochloric acid emission;
- cutting cellophane, paper and wood generates the emission of normal cellulose products and those of sub-products: esters, acids, alcohol, and benzene;
- machining plastic materials potentially generates hazardous substances such as emissions that are allergenic and/or irritant (acrylates isocyanates), carcinogenic (benzene, certain polycyclic aromatic hydrocarbons), toxic (cyanide, benzene derivatives, carbon monoxide) or that irritate the respiratory tract (acroleins, amines, formaldehyde);
- heavy metal vapours can also be emitted when soldering or brazing metals.

Wood dust

This is classified as carcinogenic in humans (IARC category 1), whatever the type of wood. It can produce nasal and sinus cancers, respiratory conditions, irritation of the skin and mucous membranes with allergies (eczema, rhinitis, asthma). Initial symptoms can be slight (feeling of nasal obstruction or a foreign body in the nose, dripping or bleeding) and only affect one side. Wood dust has a regulatory and restrictive OEL of 8 hours at 1 mg/m3. Exposure level checks must be carried out by an accredited organisation at least once a year. Complying with this OEL must be considered to be a minimum prevention objective (**Chapter 5.3.1.1**).

Exposure to wood dust can occur in many settings including animal facilities when handling litter; in carpentry, cabinet-making, roofing and in restoration workshops using wood; in dendrochronology and dendrometry laboratories; using fresh dry wood, contemporary wood and historical wood; etc.

For all these workplace situations, it is essential to produce a workstation notice to assess risks and implement appropriate prevention methods (for example systems to catch a pollutant at source, contained devices, humidification, wearing FFP 2/FFP3 masks).

Most of these exposures are the object of specific medical monitoring (**Chapter 5.1.3.1**).

APPENDIX 1

EU AND FRENCH LEGISLATION

Placing on the market/classification and labelling

- **Regulation (EC) n° 1272/2008** of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures;
- **Regulation (EC) n° 1907/2006** of the European Parliament and of the Council of 18 December 2006 concerning the registration, evaluation, authorisation and restriction of chemicals (REACH), establishing a European chemicals agency;
- **Regulation (EU) 2019/1148** of the European Parliament and of the Council of 20 June 2019 on the marketing and use of explosives precursors amending **Regulation (EC) n° 1907/2006** and repealing **Regulation (UE) n° 98/2013**

French Labour Code

General rules of risk prevention due to hazardous chemical substances

- Risk assessment: **articles R. 4412-5 to R. 4412-10**;
- Technical and organisational prevention measures **articles R. 4412-11 to R. 4412-22**;
- Installation control: **articles R. 4412-23 to R. 4412-26**;
- Exposure control: **articles R. 4412-27 to R. 4412-32**;
- Measures to be taken in case of accident or incident: **articles R. 4412-33 to R. 4412-37**;
- Staff training and information: **articles R. 4412-38 and R. 4412-39**;
- Reinforced personal monitoring: **articles R. 4412-44 to R. 4412-57**.

Rules specific to hazardous chemical substances and to processes involving CMRs as defined by regulations

- Risk assessment: **articles R. 4412-61 to R. 4412-65**;
- Priority measures: **articles R. 4412-67, R. 4412-68, R. 4412-70**;
- Technical and organisational prevention measures: **articles R. 4412-70 to R. 4412-75**;
- Control of protective installations and devices: **article R. 4412-59**;
- Exposure control: articles **R. 4412-76 to R. 4412-80**;
- Measures to be taken in case of accident or incident: **articles R. 4412-59, R. 4412-83 to R. 4412-85**;
- Staff training and information: **articles R. 4412-59**, **R. 4412-86 to R. 4412-93**;
- Reinforced personal monitoring: **article R. 4412-59**.

Rules specific to activities with potential asbestos exposure

- **Articles R. 4412-97 to R. 4412-148**

OEL and BVL

- **Articles R. 4412-149 to R. 4412-152**

Rules targeting crystalline silica, lead and its compounds

- **Articles R. 4412-154** to **R. 4412-160**

Reinforced personal monitoring

- **Articles R. 4624-22 to R. 4624-28**

Chemical risk prevention

- **Directive (EU) n°2022/431 of 9 March 2022** amending **Directive 2004/37/EC** on the protection of workers from the risks relating to exposure to carcinogenics and mutagenics at work;
- **Directive 98/24/EC** of the Council on the protection of the health and safety of the workers from the risks relating to chemical agents at work.
- **Regulation (EU) n°2016/425** of the European Parliament and of the Council of 9 March 2016 on personal protective equipment.
- **Decree n° 2003-1254 of 23 December 2003** on chemical risk prevention;
- **Decree n° 2001-97 of 1 February 2001** setting out the specific prevention rules relating to carcinogenic, mutagenic and reprotoxic hazards;
- **Decree 92-1261 of 3 December 1992** on chemical risk prevention;
- **Order of 26 October 2020** setting the list of carcinogenic substances, mixtures and processes.
- **Circular DRT n° 12 of 24 May 2006** on the general rules of chemical risk prevention, and the specific rules relating to the risks of exposure to carcinogenic mutagenic, and reprotoxic substances.

Chemical risk control

- **Directive (EU) 2019/1831 of 24 October 2019** setting out a fifth list of indicative occupational limit values pursuant to **Directive 98/24/EC of the Council;**
- **Directive (EU) 2017/164 of 31 January 2017** setting out a fourth list of indicative occupational limit values pursuant to Directive 98/24/EC of the Council;
- **Directive 2009/161/EU of 17 December 2009** setting out a third list of indicative occupational limit values;
- **Directive 2006/15/EC of 7 February 2006** setting out a second list of indicative occupational limit values;
- **Directive 2000/39/EC of 8 June 2000** setting out a first list of indicative occupational limit values.
- **Decree n° 2021-434 of 12 April 2021, n° 2019-1487 of 27 December 2019** and **n° 2012-746 of 9 May 2012**, setting out restrictive occupational limit values for certain chemical substances;
- **Decree n° 2009-1570 of 15 December 2009** on chemical risk management in the workplace;
- **Decree n° 2006-133 of 9 February 2006** setting out restrictive occupational limit values relating to certain chemical substances in the atmosphere and in the workplace, amending the Labour Code;

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- **Decree n° 88-448 of 26 April 1988** on the protection of workers exposed to gas in fumigation operations.
- **Order of 15 December 2009** on compliance checks relating to occupational exposure limit values in the workplace and under the accreditation conditions of entities charged with these checks;
- **Order of 15 December 2009** on compliance checks relating to biological limit values set out in **article R. 4412-152** of the Labour Code for workers exposed to lead and its compounds and on accreditation conditions of laboratories performing analyses;
- **Order of 26 October 2007** on the measurement method to be implemented for checks on occupational exposure limit values relating to refractory ceramic fibres;
- **Order of 20 December 2004** on the measurement method for compliance checks on wood dust concentration in the atmosphere and in the workplace;
- **Orders of 30 June 2004**, **27 September 2019** and **3 May 2021** setting out occupational exposure limit values pursuant to **article R. 4412-150** of the Labour Code.
- **Circular DGT n° 2010/03 of 13 April 2010** on chemical risk management in the workplace.

Drugs in animal facilities

- **Order of 1 February 2013** on the prescription and use of drugs for accredited establishments using animals for scientific purposes.

Regulated petroleum products

Customs Code

- **Article L 312-1 à L 312-11** on the domestic tax applied to energy products.

Nanoparticle state substances

Environmental Code

- **Article R.523-12 to R.523-21**: Prevention of health and environmental risk resulting from exposure to a substance at nanoscale.

Narcotics, psychotropics and drug precursors

- **Regulation (EU) n° 1258/2013** of the European Parliament and of the Council of 20 November 2013 amending **Regulation (EC) n° 273/2004 on drug precursors**.
- **Decree n° 2019-917 of 30 August 2019** on the control of the the manufacture of and trade in drug precursors;
- **Order of 22 February 1990** setting out the list of substances classed as narcotics;
- **Order of 22 February 1990** setting out the list of substances classed as psychotropics.

Public buildings

- **Safety regulations against risk of fire and panic in public buildings.**

ATEX

- **Directive 2014/34/EU of the European Parlement and the Council of 26 February 2014** on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres;
- **Directive 1999/92/EC of 16 December 1999** on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

French Labour Code

- **Articles R. 4216-31** and **R. 4227-42 to R. 4227-54**.

- **Decree n° 2002-1553 of 24 December 2002** on the provisions relating to explosion prevention applicable to the workplace;
- **Decree n° 2002-1554 of 24 December 2002** on the provisions relating to explosion prevention which owners must follow when workplaces are being built.
- **Order of 28 July 2003** on the conditions of installation of electrical equipment in locations where explosive atmospheres may arise;
- **Order of 8 July 2003** on the protection of workers liable to be exposed to an explosive atmosphere.

Waste

- **Law n° 2010-788 of 12 July 2010** on national commitment for the environment (Grenelle II Law).

French Environmental Code:

- General principles: **article L. 110-1**;
- Waste prevention and management: **articles L. 541-1 to L. 541-50**.
- **Decree n° 2011-828 of 11 July 2011** on various provisions relating to waste prevention and management.
- **Order of 8 February 2018** amending the Order of 16 August 2012 setting out a list of chemicals potentially posing a significant risk to health and environment;
- **Order of 31 May 2021** setting out the content of the registers.

Reinforced medical monitoring

- **Order of 28 December 2015** on reinforced medical monitoring.

Activities prohibited for certain categories of workers

French Labour Code

- Pregnant and breastfeeding women: **articles D. 4152-9**, **D. 4152-10**, and **R. 1225-4**;
- Young workers under the age of 18: **articles D. 4153-17 to D. 4153-18**;
- Workers under a fixed term contract and temporary workers: **articles D. 4154-1 to D. 4154-6**.

ICPE

- **Directive 2012/18/EU** of the European Parliament and of the Council of 4 July 2012 on the control of major accident hazards involving dangerous substances.
- **Livre V of the Environmental Code**: Pollution, risk and nuisance prevention – Title I: Listed installations for the protection of the environment.
- **Decree n° 2015-1614 of 9 December 2015** amending and simplifying classified installations for environmental protection (ICPE);
- **Decree n° 2015-1200 of 29 September 2015** amending the ICPE nomenclature.
- **Order of 24 September 2020** on the storage of flammable liquids in mobile of flammable liquids, operated within an ICPE ;
- **Ministerial order of 15 December 2015** on the digitisation of ICPE declarations;
- **Order of 19 June 2015** on the quality management system;
- **Order of 11 May 2015** amending a series of ministerial orders to take into account the new ICPE nomenclature entering into force on 1 June 2015 as part of the transposition into **Directive n° 2012/18/EU of 4 July 2012**.

Transport

By road

- Agreement concerning the international carriage of dangerous goods by road (ADR);
- **Order of 28 May 2021** exempting certain provisions of the Order of 29 May 2009 on the transport of dangerous goods by land;
- **Order of 10 December 2020** amending the amended Order of 29 May 2009 on the transport of dangerous goods by land (TMD).

By air

- Regulation on the transport of dangerous goods by air (IATA).

By sea

- Regulation on the transport of dangerous goods by sea (IMDG).

Normes

Gloves

- **NF EN ISO 21420** - General requirements and test methods;
- **NF EN 388+A1** - Protective gloves against mechanical risk;
- **NF EN ISO 374-1/A1** - Protective gloves against dangerous chemicals and micro-organisms;
- **NF EN ISO 374-2** - Protective gloves against dangerous chemicals and micro-organisms;
- **NF EN 16523-1+A1** - Protective gloves against dangerous chemicals and micro-organisms;

Masks

- **NF EN 143** - Respiratory protective devices - Particle filters - Requirements, testing, marking;
- **NF EN 149+A1** - Respiratory protective devices - Filtering half masks to protect against particles - Requirements, testing, marking.

Collective protective equipment

- **NF X15-211** - Ductless fume hood;
- **NF X 15-206** (September 2010) - Laboratory fume hoods, threshold for confinement test;
- **NF EN 14175-1** - Fume cupboards - part 1: Terminology;
- **NF EN 14175-2** - Fume cupboards - Part 2: Safety and performance requirements;
- **NF EN 14175-3** - Fume cupboards - Part 3: Type test method;
- **NF EN 14175-4** - Fume cupboards - Part 4: On-site method;
- **XP CEN/TS 14175-5** - Fume cupboards - Part 5: Recommendations for installation and maintenance;
- **NF EN 14175-6** - Fume cupboards - Part 6: Variable air volume fume cupboards;
- **NF EN ISO 14644-7** - Clean rooms and associated controlled environments - Part 7: Separative devices (clean air hoods, glove boxes, isolators and mini-environments).

Laboratory layout

- **NF EN 14056** - Laboratory furniture;
- **NF EN 13150** - Laboratory benches.

Storage

- **NF EN 14470-1** - Fire safety storage cabinets part 1: Safety storage cabinets for flammable liquids;
- **NF EN 14470-2** - Fire safety storage cabinet part 2: Safety cabinets for pressurised gas cylinders.

Protective clothing

- **FD CEN/TR 15419** - Protective clothing - Guidelines for selection, use, care and maintenance of chemical protective clothing;
- **NF EN 13034+A1** - Protective clothing against liquid chemicals - Performance requirements for chemical protective clothing offering limited protective performance against liquid chemicals (Type 6 equipment);
- **NF EN ISO 13982-1/A1** - Protective clothing for use against solid particles - Performance requirements for chemical protective clothing providing protection to the full body against airborne solid particles (Type 5 clothing) - Amendment 1;
- **NF EN 14605+A1** - Protective clothing against liquid chemicals. Performance requirements for clothing with liquid-tight (Type 3) or spray-tight (Type 4) connections, including items providing protection to parts of the body only;
- **NF EN 943-1+A1** - Protective clothing against dangerous solid, liquid and gaseous chemicals, including liquid and solid aerosols - Performance requirements for Type 1 (gas-tight) chemical protective suits;
- **NF EN 943-2** - Protective clothing against dangerous solid, liquid and gas chemicals, including liquid and solid aerosols - Performance requirements for Type 1 (gas-tight) chemical protective suits for emergency teams (ET).

APPENDIX 2

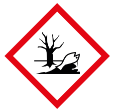
LABELLING IN ACCORDANCE WITH CLP

1. PICTOGRAMS

Physical hazards	
	Product can explode in contact with flame, spark, static electricity, the effects of heat, collision, friction, etc.
	Product can ignite in contact with flame, spark, static electricity, the effects of heat, collision, friction; in contact with water, air, etc.
	Product can cause fire or explosion in contact with combustible and all flammable matter.
	Gas under pressure can explode if heated. Liquefied and refrigerated, may cause cryogenic burns or injury.

Health hazards	
	Product can cause general disorders at low and very low dose or decease by ingestion, skin, contact or inhalation, in a short space of time.
	Product can cause or be liable to cause cancer genetic disorders; be harmful to fertility or to an unborn child; harmful to certain organs, cause or be liable to cause aspiration-related death; respiratory allergies.

Health and environmental hazards	
	Product can cause irritation of skin, eyes and respiratory tract; drowsiness, general disorders at high dose, or decease by ingestion, skin contact or inhalation; skin allergies. Product can destroy the ozone layer.

Environmental hazards	
	Product can be hazardous to the aquatic environment in the short and long term.

Health and/or environmental hazards	
	Product can attack and destroy certain metals by chemical reaction. Product can cause deep tissue injury of skin and/or eyes in case of contact.

Physical, health and environmental hazards not shown in a pictogram	
	Gas can ignite in specific conditions, as explosives, and pressure containers can burst if heated. Product can harm a breast-fed child. Product can be hazardous to the aquatic environment in the long-term.

2. HAZARD STATEMENTS

Physical hazards

• EXPLOSIVE

H200	Unstable explosives.
H201	Explosive; mass explosion hazard.
H202	Explosive; severe projection hazard.
H203	Explosive; fire, blast or projection hazard.
H204	Fire or projection hazard.
H205	May mass explode in fire.
H206	Fire, blast or projection hazard, increased risk of explosion.
H207	Fire or projection hazard, increased risk of explosion if desensitising agent is reduced.
H208	Fire hazard, increased risk of explosion if desensitising agent is reduced.
H230	May react explosively even in the absence of air.
H231	May react explosively even in the absence of air at elevated pressure and/or temperature.
H240	Heating may cause an explosion.

• EXPLOSIVE AND FLAMMABLE

H241	Heating may cause a fire or explosion.

• FLAMMABLE

H220	Extremely flammable gas.
H221	Flammable gas.
H222	Extremely flammable aerosol.
H223	Flammable aerosol.
H224	Extremely flammable liquid and vapour.
H225	Highly flammable liquid and vapour.
H226	Flammable liquid and vapour.
H228	Flammable solid.
H232	May ignite spontaneously if exposed to air.
H242	Heating may cause a fire.
H250	Catches fire spontaneously if exposed to air.
H251	Self-heating: may catch fire.
H252	Self-heating in large quantities; may catch fire.
H260	In contact with water releases flammable gases which may ignite spontaneously.
H261	In contact with water releases flammable gases.

• OXIDISER

H270	May cause or intensify fire; oxidiser.
H271	May cause fire or explosion; strong oxidiser.
H272	May intensify fire; oxidiser.

• PRESSURISED CONTAINER

H229	Pressurised container: may burst if heated.
H280	Contains gas under pressure; may explode if heated.
H281	Contains refrigerated gas; may cause cryogenic burns or injury.

• CORROSIVE TO METALS

H290	May be corrosive to metals.

Health hazards

• ACUTE INTOXICATION

H300	Fatal if swallowed. *
H301	Toxic if swallowed. ***
H302	Harmful if swallowed. ***
H304	May be fatal if swallowed and enters airways.
H310	Fatal in contact with skin. *
H311	Toxic in contact with skin. **
H312	Harmful in contact with skin. ***
H330	Fatal if inhaled. *
H331	Toxic if inhaled. **
H332	Harmful if inhaled. ***
H336	May cause drowsiness or dizziness.
H370	Causes damage to organs[1,2].
H371	May cause damage to organs[1,2].

• DAMAGE

H314	Causes severe skin burns and eye damage.
H318	Causes serious eye damage.

• IRRITATION

H315	Causes skin irritation.
H319	Causes serious eye irritation.
H335	May cause respiratory irritation.

• CHRONIC INTOXICATION

H372	Causes damage to organs[1] through prolonged or repeated exposure[2].
H373	May cause damage to organs[1] through prolonged or repeated exposure[2].

• SENSITISATION

H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled.
H317	May cause an allergic skin reaction.

• MUTAGEN

H340	May cause genetic defects[2].
H341	Suspected of causing genetic defects[2].

• CARCINOGEN

H350	May cause cancer[2].
H351	Suspected of causing cancer[2].

• REPRODUCTIVE TOXICITY

H360	May damage fertility or the unborn child[1,2].
H361	Suspected of damaging fertility or the unborn child[1,2].
H362	May cause harm to breast-fed children.

Environmental hazards

• HAZARDOUS TO THE AQUATIC ENVIRONMENT

H400	Very toxic to aquatic life.
H410	Very toxic to aquatic life with long lasting effects.
H411	Toxic to aquatic life with long lasting effects.
H412	Harmful to aquatic life with long lasting effects.
H413	May cause long lasting harmful effects to aquatic life.

• HAZARDOUS TO THE OZONE LAYER

H420	Harms public health and the environment by destroying ozone in the upper atmosphere.

*, **, ***: statements can be combined.

[1] State all organs affected and reproductive toxicity effects, if known.

[2] State route of exposure if it is conclusively proven that no other routes of exposure cause the hazard.

Supplemental information on hazards	
EUH001	Explosive when dry.
EUH014	Reacts violently with water.
EUH018	In use may form flammable/explosive vapour-air mixture.
EUH019	May form explosive peroxides.
EUH029	Contact with water liberates toxic gas.
EUH031	Contact with acids liberates toxic gas.
EUH032	Contact with acids liberates very toxic gas.
EUH044	Risk of explosion if heated under confinement.
EUH066	Repeated exposure may cause skin dryness or cracking.
EUH070	Toxic by eye contact.
EUH071	Corrosive to the respiratory tract.
EUH201	Contains lead. Should not be used on surfaces liable to be chewed or sucked by children.
EUH201A	Warning! Contains lead.
EUH202	Cyanoacrylate. Danger. Bonds skin and eyes in seconds. Keep out of reach of children.
EUH203	Contains chromium (VI). May produce an allergic reaction.
EUH204	Contains isocyanates. May produce an allergic reaction.
EUH205	Contains epoxy constituents. May produce an allergic reaction.
EUH206	Warning! Do not use together with other products. May release dangerous gases (chlorine).
EUH207	Warning! Contains cadmium. Dangerous fumes are formed during use. See information supplied by the manufacturer. Comply with the safety instructions.
EUH208	Contains (name of sensitising substance). May produce an allergic reaction.
EUH209	Can become highly flammable in use.
EUH209A	Can become flammable in use.
EUH210	Safety data sheet available on request.
EUH401	To avoid risks to human health and the environment, comply with the instructions for use.

3. PRECAUTIONARY STATEMENTS

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

Prevention measures	
P201	Obtain special instructions before use.
P202	Do not handle until all safety precautions have been read and understood.
P210	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P211	Do not spray on an open flame or other ignition source.
P212	Avoid heating under confinement or reduction of the desensitising agent.
P220	Keep away from clothing and other combustible materials.
P222	Do not allow contact with air.
P223	Do not allow contact with water.
P230	Keep wetted with …
P231+ P232	Handle and store contents under inert gas … Protect from moisture.
P233	Keep container tightly closed.
P234	Keep only in original packaging.
P235	Keep cool.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof [electrical/ventilating/lighting/…] equipment.
P242	Use non-sparking tools.
P243	Take action to prevent static discharges.
P244	Keep valves and fittings free from oil and grease.
P250	Do not subject to grinding/shock/friction/…
P251	Do not pierce or burn, even after use.
P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P261	Avoid breathing dust/fume/gas/mist/vapours/spray.
P262	Do not get in eyes, on skin, or on clothing.
P263	Avoid contact during pregnancy and while nursing.
P264	Wash … thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P271	Use only outdoors or in a well-ventilated area.
P272	Contaminated work clothing should not be allowed out of the workplace.
P273	Avoid release to the environment.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P282	Wear cold insulating gloves and either face shield or eye protection.
P283	Wear fire resistant or flame retardant clothing.
P284	[In case of inadequate ventilation] wear respiratory protection.

Response to exposure	
P301+P310	IF SWALLOWED: Immediately call a POISON CENTRE/doctor/…
P301+P312	IF SWALLOWED: Immediately call a POISON CENTRE/doctor/… if you feel unwell.
P301+P330 +P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P302+P334	IF ON SKIN: Immerse in cool water or wrap in wet bandages.
P302+P331 +P335	IF ON SKIN: Brush off loose particles from skin. Immerse in cool water or wrap in wet bandages.
P302+P352	IF ON SKIN: Wash with plenty of water/…
P303+P361 +P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water (or shower).
P304+P340	IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305+P351 +P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P306+P360	IF ON CLOTHING: Rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
P308+P311	IF exposed or concerned: Call a POISON CENTRE/doctor/…
P308+P313	IF exposed or concerned: Get medical advice/attention.
P310	Immediately call a POISON CENTRE/doctor/…
P311	Call a POISON CENTRE/doctor/…
P312	Immediately call a POISON CENTRE/doctor/… if you feel unwell.
P314	Get medical advice/attention if you feel unwell.
P315	Get immediate medical advice/attention if you feel unwell.
P320	Specific treatment is urgent (see … on this label).
P321	Specific treatment (see … on this label).
P330	Rinse mouth.
P331	Do NOT induce vomiting.
P332+P313	If skin irritation occurs: Get medical advice/attention.
P333+P313	If skin irritation or rash occurs: Get medical advice/attention.
P336	Thaw frosted parts with lukewarm water. Do not rub affected area.
P336+P315	Thaw frosted parts with lukewarm water. Do not rub affected area. Get immediate medical advice/attention.
P337+P313	If eye irritation persists: Get medical advice/attention.
P342+P311	If experiencing respiratory symptoms: Call a POISON CENTRE/doctor/…
P361+P364	Take off immediately all contaminated clothing and wash it before reuse.
P362+P364	Take off contaminated clothing and wash it before reuse.
P370+P372 +P380 + P373	In case of fire: Explosion risk. Evacuate area. DO NOT fight fire when fire reaches explosives.
P370+P376	In case of fire: Stop leak if safe to do so.
P370+P378	In case of fire: Use… to extinguish.
P370+P380 +P375	In case of fire: Evacuate area. Fight fire remotely due to the risk of explosion.
P370+P380 +P375 +[P378]	In case of fire: Evacuate area. Fight fire remotely due to the risk of explosion. [Use … to extinguish].
P377	Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381	In case of leakage, eliminate all ignition sources.
P371+P380 +P375	In case of major fire and large quantities: Evacuate area. Fight fire remotely due to the risk of explosion.
P390	Absorb spillage to prevent material damage.
P391	Collect spillage.

Storage conditions	
P401	Store in accordance with… .
P402+P404	Store in a dry place. Store in a closed container.
P403	Store in a well-ventilated place.
P403+P233	Store in a well-ventilated place. Keep container tightly closed.
P403+P235	Store in a well-ventilated place. Keep cool.
P406	Store in a corrosion-resistant/… container with a resistant inner liner.
P407	Maintain air gap between stacks or pallets.
P410	Protect from sunlight.
P410+P403	Protect from sunlight. Store in a well-ventilated place.
P410+P412	Protect from sunlight. Do not expose to temperatures exceeding 50 °C/122°F.
P411	Store at temperatures not exceeding … °C/…°F.
P413	Store bulk masses greater than … kg/… lbs at temperatures not exceeding … °C/…°F.
P420	Store separately.

DISPOSAL	
P501	Dispose of contents/container to …
P502	Refer to manufacturer or supplier for information on recovery or recycling.
P503	Refer to manufacturer/supplier for information on disposal/recovery/ recycling.

All the labelling elements shown here are taken from **Regulation (EC) n° 1278/2008** as they now stand in accordance with the amendments brought by **Regulation (EU) n° 2016/918** in order to adapt to technical and scientific progress.

APPENDIX 3

SAFETY DATA SHEET (SDS) SECTIONS

Information on hazards	Preventive and protective measures

SECTION 1:	**Identification of the substance/mixture and of the company/ undertaking**
1.1.	Product identifier
1.2.	Relevant identified uses of the substance or mixture and uses advised against
1.3.	Details of the supplier of the safety data sheet
1.4.	Emergency telephone number

SECTION 2:	**Hazard identification**
2.1.	Classification of the substance or mixture
2.2.	Label elements
2.3.	Other hazards

SECTION 3:	**Composition/information on ingredients**
3.1.	Substances
3.2.	Mixtures

SECTION 4:	**First aid measure**
4.1.	Description of first aid measures
4.2.	Most important symptoms and effects, both acute and delayed
4.3.	Indication of any immediate medical attention and special treatment needed

SECTION 5:	**Firefighting measures**
5.1.	Extinguishing media
5.2.	Special hazards arising from the substance or mixtures
5.3.	Advice for firefighters

SECTION 6:	**Accidental release measures**
6.1.	Personal precautions, protective equipment and emergency procedures
6.2.	Environmental precautions
6.3.	Methods and material for containment and cleaning up
6.4.	Reference to other sections

SECTION 7:	**Handling and storage**
7.1.	Precautions for safe handling
7.2.	Conditions for safe storage, including any incompatibilities
7.3.	Specific end use(s)

SECTION 8:	**Exposure controls / Personal protection**
8.1.	Control parameters
8.2.	Exposure controls

SECTION 9:	**Physical and chemical properties**
9.1.	Information on basic physical and chemical properties
9.2.	Other information

SECTION 10:	**Stability and reactivity**
10.1.	Reactivity
10.2.	Chemical stability
10.3.	Possibility of hazardous reactions
10.4.	Conditions to avoid
10.5.	Incompatible materials
10.6.	Hazardous decomposition products

SECTION 11:	**Toxicological information**
11.1.	Information on hazard classes

SECTION 12:	**Ecological information**
12.1.	Toxicity
12.2.	Persistence and degradability
12.3.	Bioaccumulation potential
12.4.	Mobility in soil
12.5.	Results of PBT and vPvB assessment
12.6.	Other adverse effects

SECTION 13:	**Disposal considerations**
13.1.	Waste treatment methods
SECTION 14:	**Transport information**
14.1.	UN number or ID number
14.2.	UN proper shipping name
14.3.	Transport hazard class(es)
14.4.	Packing group
14.5.	Environmental hazards
14.6.	Special precautions for user
14.7.	Maritime transport in bulk according to IMO instruments

SECTION 15:	**Regulatory information**
15.1.	Safety, health and environmental regulations/legislation specific for the substance or mixture
15.2.	Chemical Safety Assessment

SECTION 16:	**Other information**

APPENDIX 4

LIST OF SUBSTANCES AND ACTIVITIES REQUIRING SPECIFIC MEDICAL MONITORING FOR CIVIL SERVANTS*

- Chromic acid, chromates and alkaline dichromates, except diluted solutions
- Asbestos
- Arsenic and its compounds, especially arsine and arsenical dust
- Benzene and similar substances
- Bis(chloromethyl)ether
- Pitch, tar and mineral oils
- Bromine
- Chlorine
- Halogenated, amino and nitro derivatives of hydrocarbons
- Manganese dioxide
- Fluorine and its compounds
- Beryllium oxide and its salts
- Mineral oils derived from petroleum
- Iodine
- Mercury and its compounds
- Nitrosoguanidines
- Phosgene
- Phenols and naphthols
- Lead and its compounds
- Silica
- Carbon sulphide
- Phosphorus and compounds, especially phosphoric, pyrophosphoric and thiophosphoric esters, as well as other organic phosphorus compounds
- Substances liable to cause a malignant tumour in the bladder (certain aromatic amines for instance)
- Work that involves:
  - Painting and varnishing by spraying;
  - Polymerising vinyl chloride;
  - Exposure to cadmium and compounds;
  - Exposure to carbon monoxide in gasworks, gas mains, the manufacture of synthetic benzene and methanol;
  - Exposure to antimony dust;
  - Exposure to wood dust;
  - Exposure to metal dust;
  - Exposure to hard metals (tantalum, titanium, tungsten and vanadium);
  - Exposure to silica, asbestos and slate dust (except in mines and quarries).

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* at the CNRS, in compliance with workplace safety and medical prevention provisions in **article 15-1 of Decree 82-453 of 28 May 1982** at the date of publication of this guide.

APPENDIX 5

LIST OF CHEMICAL PRODUCTS CONTROLLED BY THE ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS (OPCW)

T1: Precursor and chemical weapons at the final technical stage of production that have little use in industry and present a significant risk of diversion.	
A - Toxic chemicals	
T1A1: O-Alkyl (≤ C_{10}, including cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridates examples:	
107-44-8	2-O-Isopropyl methylphosphonofluoridate (sarin)
96-64-0	3- O-Pinacolyl methylphosphonofluoridate (soman)
T1A2: O-Alkyl (≤ C_{10}, incl. cycloalkyl) N,N-dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidocyanidates example:	
77-81-6	O-Ethyl N,N-dimethyl phosphoramidocyanidate (tabun)
T1A3: O-Alkyl (H or ≤ C_{10}, incl. cycloalkyl) S-2-dialkyl (Me, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonothiolates and corresponding alkylated or protonated salts example:	
50782-69-9	VX: O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate
T1A4: Sulphur mustards, examples:	
2625-76-5	2-Chloroethylchloromethylsulphide
505-60-2	Bis(2-chloroethyl)sulphide (mustard gas)
63869-13-6	Bis(2-chloroethylthio)methane
3563-36-8	1,2-Bis(2-chloroethylthio)ethane (sesquimustard)
63905-10-2	1,3-Bis(2-chloroethylthio)-n-propane
142868-93-7	1,4-Bis(2-chloroethylthio)-n-butane
142868-94-8	1,5-Bis(2-chloroethylthio)-n-pentane
63918-90-1	Bis(2-chloroethylthiomethyl)ether
63918-89-8	Bis(2-chloroethylthioethyl)ether (O mustard)
T1A5: Lewisites, examples:	
541-25-3	2-Chlorovinyldichloroarsine (lewisite 1)
40334-69-8	Bis(2-chlorovinyl)chloroarsine (lewisite 2)
40334-70-1	Tris(2-chlorovinyl)arsine (lewisite 3)
T1A6: Nitrogen mustards, examples:	
538-07-8	Bis(2-chloroethyl)ethylamine (HN1)
51-75-2	Bis(2-chloroethyl)methylamine (HN2)
555-77-1	Tris(2-chloroethyl)amine (HN3)
T1A7:	
35523-89-8	Saxitoxin
T1A8:	
9009-86-3	Ricin

T1A13: P-alkyl (H or ≤ C_{10}, incl. cycloalkyl) N-(1-(dialkyl(≤ C_{10}, incl. cycloalkyl)amino)) alkylidene(H or ≤ C_{10}, incl. cycloalkyl) phosphonamidic fluorides and corresponding alkylated or protonated salts examples:	
2387495-99-8	N-(1-(di-n-decylamino)-n-decylidene)-P-decylphosphonamidic fluoride
2387495-99-8	Methyl-(1-(diethylamino)ethylidene)phosphonamidofluoridate
T1A14: O-alkyl (H or ≤ C_{10}, incl. cycloalkyl) N-(1-(dialkyl(≤ C_{10}, incl. cycloalkyl)amino)) alkylidene(H or ≤ C_{10}, incl. cycloalkyl) phosphoramidofluoridates and corresponding alkylated or protonated salts	
2387496-00-4	O-n-Decyl N-(1-(di-n-decylamino)-n-decylidene) phosphoramidofluoridate
2387496-04-8	Methyl (1-(diethylamino)ethylidene)phosphoramidofluoridate
2387496-06-0	Ethyl (1-(diethylamino)ethylidene)phosphoramidofluoridate
T1A15:	
2387496-14-0	Methyl-(bis(diethylamino)methylene)phosphonamidofluoridate
T1A16: Carbamates (quaternaries and bisquaternaries of dimethylcarbamoyloxypyridines)	
T1A16:	Quaternaries of dimethylcarbamoyloxypyridines: 1-[N,N-dialkyl(≤ C_{10})-N-(n-(hydroxyl, cyano, acetoxy)alkyl(≤ C_{10})) ammonio]-n-[N-(3-dimethylcarbamoxy-α-picolinyl)-N,N-dialkyl(≤ C_{10}) ammonio]decane dibromide (n=1-8) *C ≤ 10, n=1-8 example:
77104-62-2	1-[N,N-dimethyl-N-(2-hydroxy)ethylammonio]-10-[N-(3-dimethylcarbamoxy-α-picolinyl)-N,N-dimethylammonio]decane dibromide
T1A16:	Bisquaternaries of dimethylcarbamoyloxypyridines: 1,n-Bis[N-(3-dimethylcarbamoxy-α-picolyl)-N,N-dialkyl(≤ C_{10}) ammonio]-alkane-(2,(n-1)-dione) dibromide (n=2-12) example:
77104-00-8	1,10-Bis[N-(3-dimethylcarbamoxy-α-picolyl)-N-ethyl-N-methylammonio]decane-2,9-dione dibromide

B - Precursors	
T1B9: Alkyl (Me, Et, n-Pr or i-Pr) phosphonyldifluorides example:	
676-99-3	DF: Methylphosphonyldifluoride
T1B10: O-Alkyl (H or ≤ C_{10}, incl. cycloalkyl) O-2-dalkyl (Me, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonites and corresponding alkylated or protonated salts example:	
57856-11-8	QL: O-Ethyl O-2-diisopropylaminoethyl methylphosphonite
T1B11:	
1445-76-7	O-Isopropyl methylphosphonochloridate (chlorosarin)
T1B12:	
7040-57-5	O-Pinacolyl methylphosphonochloridate (cholorosoman)

T2: Chemical compounds of no commercial interest that can be used for military purposes and presenting a serious risk of diversion

A - Toxic chemicals	
T2A1:	
78-53-5	Amiton: O,O-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate
T2A2:	
382-21-8	PFIB: 1,1,3,3,3-Pentafluoro-2-(trifluoromethyl)-1-propene
T2A3:	
6581-06-2	BZ: 3-Quinuclidinyl benzilate

B - Precursors	
T2B4: Chemicals, except for those listed in Schedule 1, containing a phosphorus atom to which is bonded one methyl, ethyl or propyl (normal or iso) group but not further carbon atoms examples:	
676-97-1	Methylphosphonyl dichloride
756-79-6	Dimethyl methylphosphonate
6163-75-3	Dimethyl ethylphosphonate
78-38-6	Diethyl ethanephosphonate
84402-58-4	Methylphosphonic acid, compound with amidinourea (1:1)
T2B5: N,N-Dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidic dihalides example:	
677-43-0	N,N-Dimethylphosphoramidodichloridate
T2B6: Dialkyl (Me, Et, n-Pr or i-Pr) N,N-dialkyl (Me, Et, n-Pr or i-Pr)-phosphoramidates example:	
2404-03-7	Diethyl Dimethylphosphoramidate
65659-19-0	Phosphoramidic acid, diethyl-, dimethyl ester
597-07-9	Dimethyl Dimethylphosphoramidate
T2B7:	
2B7 7784-34-1	Arsenic trichloride
T2B8:	
2B8 76-93-7	2,2-Diphenyl-2-hydroxyacetic acid
T2B9:	
1619-34-7	Quinuclidin-3-ol

T2B10: N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethyl-2-chlorides and corresponding protonated salts example:	
869-24-9	2-Chloro-N,N-diethylethanamine hydrochloride
100-35-6	2-Chlorotriethylamine
4261-68-1	2-Diisopropylaminoethyl chloride hydrochloride
96-79-7	2-(Diisopropylamino)ethyl chloride
4584-46-7	2-Dimethylaminoethyl chloride hydrochloride
107-99-3	2-Chloro-N,N-Dimethylethanamine
T2B11: N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-ols and corresponding protonated salts example:	
96-80-0	2-Diisopropylaminoethanol
T2B12: 2- [N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-thiols and corresponding protonated salts	
100-38-9	2-(Diisopropylamino)ethanol
1942-52-5	2-Diethylaminoethanethiol hydrochloride
13242-44-9	2-(Dimethylamino)ethanethiol hydrochloride
5842–07–9	2-(Diisopropylamino)Ethanethiol
41480-75-5	2-(Diisopropylamino)ethanethiol hydrochloride
T2B13:	
111-48-8	Thiodiglycol: Bis(2-hydroxyethyl)sulphide
T2B14:	
464-07-3	Pinacolyl alcohol: 3,3-Dimethylbutan-2-ol

T3: Former chemical weapons now manufactured in large quantities in industry for non-prohibited purposes and presenting a risk of diversion	
A - Toxic chemicals	
T3A1:	
75-44-5	Phosgene: Carbonyl dichloride
T3A2:	
506-77-4	Cyanogen chloride
T3A3:	
74-90-8	Hydrogen cyanide
T3A4:	
76-06-2	Chloropicrin: Trichloronitromethane
B - Precursors	
T3B5:	
10025-87-3	Phosphorus oxychloride
T3B6:	
7719-12-2	Phosphorus trichloride
T3B7:	
10026-13-8	Phosphorus pentachloride
T3B8:	
121-45-9	Trimethyl phosphite
T3B9:	
122-52-1	Triethyl phosphite
T3B10:	
868-85-9	Dimethyl phosphite
T3B11:	
762-04-9	Diethyl phosphite
T3B12:	
10025-67-9	Sulphur monochloride
T3B13:	
10545-99-0	Sulphur dichloride
T3B14:	
7719-09-7	Thionyl chloride
T3B15:	
139-87-7	Ethyldiethanolamine
T3B16:	
105-59-9	Methyldiethanolamine
T3B17:	
102-71-6	Triethanolamine

Organic substances potentially used in chemical weapon manufacture can be added to the above tables. This is the DOC (Discrete Organic Chemicals) class which provides a non-exhaustive list of all carbon chemicals not included in one of the three tables. The list excludes hydrocarbons, explosives, polymers/oligomers and metal carbonates. Carbon monoxide and dioxide, carbon disulphide and carbonyl sulphide are also excluded from the list. Among DOCs, compounds containing at least one atom of phosphorous, sulphur or fluoride are called PSFs.

APPENDIX 6

LIST OF 1A AND 1B CMRS WITH REGULATORY OEL – RESTRICTIVE OR INDICATIVE

Name	OEL (Regulatory and restrictive/ Regulatory and indicative / Indicative)	Legislative reference: French Labour Code (FLC)	CAS number	CMR
1,2-Dichloroethane	Restrictive	Article R4412-149 (FLC)	107-06-2	C1B
1,2-Epoxypropane	Restrictive	Article R4412-149 (FLC)	75-56-9	C1B, M1B
1,4-Dioxane	Restrictive	Article R4412-149 (FLC)	123-91-1	C1B
2-Ethoxyethanol	Restrictive	Article R4412-149 (FLC)	110-80-5	R1B
2-Ethoxyethyl acetate	Restrictive	Article R4412-149 (FLC)	111-15-9	R1B
2-Methoxyethanol	Restrictive	Article R4412-149 (FLC)	109-86-4	R1B
2-Methoxyethyl acetate	Restrictive	Article R4412-149 (FLC)	110-49-6	R1B
2-Nitroprane	Restrictive	Article R4412-149 (FLC)	79-46-09	C1B
4,4'-Methylenebis(2-chloroaniline) (MOCA) (inhalable fraction)	Indicative	Article R4412-150 (FLC)	101-14-4	C1B
Acrylamide	Restrictive	Article R4412-149 (FLC)	79-06-1	C1B, M1B, R2
Arsenic acid, arsenates and their inorganic compounds	Indicative	Article R4412-150 (FLC)	-	Some or all of these compounds are categorised as C1A, C1B or C2
Asbestos	Restrictive	Article R4412-100 (FLC)	-	C1A
Benzene	Restrictive	Article R4412-149 (FLC)	71-43-2	C1A, M1B
Beryllium and its inorganic compounds	Restrictive	Article R4412-149 (FLC)	-	C1B
Bisphenol A	Restrictive	Article R4412-149 (FLC)	80-05-7	R1B
Buta-1,3-diene	Restrictive	Article R4412-149 (FLC)	106-99-0	C1A, M1B
Cadmium and its inorganic compounds	Restrictive	Article R4412-149 (FLC)	-	Some or all of these compounds are categorised as C1A, C1B or C2, M1A, M1B or M2, R1A, R1B or R2
Carbon monoxide	Restrictive	Article R4412-149 (FLC)	630-08-0	R1A

Diesel engine exhaust emissions measured in elemental carbon	Indicative	Article R4412-150 (FLC)	-	Carcinogenic process mentioned in the amended Order of 26 October 2020
Epichlorhydrin	Restrictive	Article R4412-149 (FLC)	106-89-8	C1B
Ethylene oxide	Restrictive	Article R4412-149 (FLC)	75-21-8	C1B, M1B, R1B
Formaldehyde	Restrictive	Article R4412-149 (FLC)	50-00-00	C1B, M2
Hexavalent chromium and its compounds	Restrictive	Article R4412-149 (FLC)	-	Some or all of these compounds are categorised as C1A,C1B,C2,M1A,M1B,M2,R1A,R1B,R2
Hydrazine	Restrictive	Article R4412-149 (FLC)	302-01-2	C1B
Lead and compounds, in Pb	Restrictive	Article R4412-149 (FLC)	-	Some or all of these compounds are categorised as C1A,C1B,C2,R1A,R1B,R2
Mercury and inorganic divalent mercury compounds, including mercuric oxide and mercuric chloride	Restrictive	Article R4412-149 (FLC)	-	Some or all of these compounds are categorised as C1A,C1B,C2,M1A,M1B,M2
Mineral oils previously used in internal combustion engines to lubricate and cool the engine’s moving parts	Restrictive	Article R4412-149 (FLC)	-	Carcinogenic process mentioned in the amended Order of 26 October 2020
Mixtures of polycyclic aromatic hydrocarbons, especially those containing benzo[a]pyrene	Restrictive	Article R4412-149 (FLC)	-	Some or all of these compounds are categorised as C1A, C1B or C2
N-Methyl-2-pyrrolidone	Indicative	Article R4412-150 (FLC)	872-50-4	R1B
N,N-Dimethylacetamide	Restrictive	Article R4412-149 (FLC)	127-19-5	R1B
N,N-Dimethylformamide	Restrictive	Article R4412-149 (FLC)	68-12-2	R1B
Nitrobenzene	Indicative	Article R4412-150 (FLC)	98-95-3	C2, R1B
o-Toluidine	Restrictive	Article R4412-149 (FLC)	95-53-4	C1B
Quartz	Restrictive	Article R4412-149 (FLC)	14808-60-7	Carcinogenic process mentioned in the amended Order of 26 October 2020
Refractory ceramic fibres categorised as carcinogenics	Restrictive	Article R4412-149 (FLC)	-	C1B
Silicon dioxide	Restrictive	Article R4412-149 (FLC)	14464-46-1	Carcinogenic process mentioned in the amended Order of 26 October 2020
Trichloroethylene	Restrictive	Article R4412-149 (FLC)	79-01-6	C1B, M2
Tridymite	Restrictive	Article R4412-149 (FLC)	15468-32-3	Carcinogenic process mentioned in the amended Order of 26 October 2020
Vinyl bromide	Restrictive	Article R4412-149 (FLC)	593-60-2	C1B
Vinyl chloride	Restrictive	Article R4412-149 (FLC)	75-01-4	C1A
Wood (dust)	Restrictive	Article R4412-149 (FLC)	-	C1

APPENDIX 7

GLOSSARY

English		French	
Acron	Term	**Acron**	Term
ACS	American Chemical Society	**ACS**	American Chemical Society
ADN	European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways	**ADN**	Accord européen relatif au transport international de marchandises Dangereuses par voie de Navigation intérieure
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road	**ADR**	Accord européen relatif au transport international des marchandises Dangereuses par Route (Agreement concerning the International Carriage of Dangerous Goods by Road)
ANMV	French Agency for Veterinary Medicinal Products	**ANMV**	Agence Nationale du Médicament Vétérinaire
ANSES	French Agency for Food, Environmental and Occupational Health Safety	**ANSES**	Agence Nationale de Sécurité Sanitaire de l'alimentation
ANSM	National Agency for the Safety of Medicines and Health Products	**ANSM**	Agence Nationale de Sécurité du Médicament et des produits de santé
APSAD	Plenary assembly of insurance damage companies	**APSAD**	Assemblée Plénière des Sociétés d'Assurances Dommages
AQL	Acceptable quality limit	**AQL**	Acceptable Quality Limit
ATEX	Explosive atmosphere	**ATEX**	ATmosphère Explosive
BEI	Biological exposure index	**IBE**	Indice Biologique d'Exposition
BET	Ethidium bromide	**BET**	Bromure d'EThidium
BLV	Biological limit value	**VLB**	Valeur Limite Biologique
BSD	Waste tracking document	**BSD**	Bordereau de Suivi des Déchets
CARSAT	French pension and occupational health insurance	**CARSAT**	Caisses d'Assurance Retraite et de la Santé Au Travail
CAS	Chemical Abstracts Service	**CAS**	Chemical Abstracts Service
CAT	Measures to be taken	**CAT**	Conduite A Tenir
CE	European conformity	**CE**	Conformité Européenne
CHSCT	Health, safety and working conditions committee	**CHSCT**	Comité d'Hygiène, de Sécurité et des Conditions de Travail
CIAC	Chemical Weapons Convention	**CIAC**	Convention sur l'Interdiction des Armes Chimiques
CLP	Classification, labelling, packaging	**CLP**	Classification, Labelling, Packaging
CMR	Carcinogenic, mutagenic, reprotoxic	**CMR**	Cancérogène, Mutagène, toxique pour la Reproduction
CNAMTS	Health insurance for salaried workers	**CNAMTS**	Caisse Nationale de l'Assurance Maladie des Travailleurs Salariés
CNPS	(CNRS) National Centre for Health and Safety	**CNPS**	Coordination Nationale de Prévention et de Sécurité (du CNRS)
CNRS	National Centre for Scientific Research	**CNRS**	Centre National de la Recherche Scientifique
CNSTMD	National Safety Adviser for the Transport of Dangerous Goods	**CNSTMD**	Conseiller National à la Sécurité des Transports de Marchandises Dangereuses
COFRAC	French accreditation committee	**COFRAC**	COmité FRançais d'ACcréditation
CPE	Collective protective equipment	**EPC**	Équipement de Protection Collective
CRAMIF	Île-de-France regional health insurance	**CRAMIF**	Caisse Régionale Assurance Maladie Île-de-France
DDPP	Departmental population protection authority	**DDPP**	Direction Départementale de Protection des Populations
DFA	Tax declaration of waste disposal	**DFA**	Déclaration Fiscale d'Accompagnement des déchets
DMF	Dimethylformamide	**DMF**	DiMéthylFormamide
DMSO	Dimethyl sulphoxide	**DMSO**	DiMéthylSulfOxyde
DNA	Deoxyribonucleic acid	**ADN**	Acide DésoxyriboNucléique
DOC	Discrete organic chemical	**PCOD**	Produits Chimiques Organiques Définis
DRDDI	Regional customs and indirect taxation authority	**DRDDI**	Direction Régionale des Douanes et Droits Indirects
DRPCE	Explosion protection document	**DRPCE**	Document relatif à la protection contre les explosions
DUERP	Single occupational risk assessment document	**DUERP**	Document Unique d'Évaluation des Risques Professionnels
EC	European Community	**CE**	Communauté Européenne
ECHA	European Chemicals Agency	**ECHA**	European Chemicals Agency
EEBD	Emergency escape breathing device	**ARI**	Appareil Respiratoire Isolant
ERP	Public buildings	**ERP**	Établissement Recevant du Public
eSDS	Extended safety data sheet	**FDSe**	Fiche de Données de Sécurité étendue

ETRAF	Ductless fume hood	**ETRAF**	Enceinte pour Toxique à Recyclage d'Air Filtré
FAR	Help in identifying carcinogens - factsheets	**FAR**	Fiche d'Aide au Repérage de produit cancérogène
FAS	Help in replacing carcinogens - factsheets	**FAS**	Fiches d'Aide à la Substitution des cancérogènes
FFP	Filtering face piece	**FFP**	Filtering face piece
FIE	Personal exposure form	**FIE**	Fiche Individuelle d'Exposition
FIRCT	Health, risk and working conditions form	**FIRCT**	Fiche Individuelle des Risques et des Conditions de Travail
HCS	Hazardous chemical substances	**ACD**	Agent Chimique Dangereux
HEL	Higher explosive limit	**LES**	Limite Supérieure d'Explosivité
HEPA	High efficiency particulate air	**HEPA**	High Efficiency Particulate Air
HF	Hydrofluoric acid	**HF**	Acide FluorHydrique
HSO	Health and safety officer	**AP**	Assistant de prévention
IARC	International Agency for Research on Cancer	**CIRC**	Centre International de Recherche sur le Cancer
IATA	International Air Transport Association	**IATA**	International Air Transport Association
ICPE	Listed installations for environmental protection	**ICPE**	Installation Classée pour la Protection de l'Environnement
IGH	High-rise building	**IGH**	Immeuble de Grande Hauteur
IMDG	International Maritime Dangerous Goods code	**IMDG**	International Maritime Dangerous Goods code
INRS	National Research and Safety Institute	**INRS**	Institut National de Recherche et de Sécurité
IRSN	Institute for Radiological Protection and Nuclear Safety	**IRSN**	Institut de Radioprotection et de Sûreté Nucléaire
IUPAC	International Union of Pure and Applied Chemistry	**IUPAC**	International Union of Pure and Applied Chemistry
LEL	Lower explosive limit	**LIE**	Limite Inférieure d'Explosivité
MEK	Methyl ethyl ketone	**MEK**	MéthylEthylcétone
MIE	Minimum ignition energy	**EMI**	Énergie Minimale d'Inflammation
MNCPC	French agency for the control of chemical precursors	**MNCPC**	Mission Nationale de Contrôle des Précurseurs Chimiques
OEL	Occupational exposure limit	**VLEP**	Valeur Limite d'Exposition Professionnelle
OPCW	Organisation for the Prohibition of Chemical Weapons	**OIAC**	Organisation pour l'Interdiction des Armes Chimiques

PBB	Polybrominated biphenyl	**PBB**	PolyBromoBiphényle
PBT	Persistent, bioaccumulative and toxic substance	**PBT**	substance Persistante, Bioaccumulable et Toxique
PCB	Polychlorinated biphenyl	**PCB**	PolyChloroBiphényles
PCT	Polychlorinated terphenyl	**PCT**	PolyChloroTerphényles
PIXAF	Bureau of investigation on explosives and firearms	**PIXAF**	Plateau d'Investigation sur les eXplosifs et Armes à Feu
PPE	Personal protective equipment	**EPI**	Équipement de Protection Individuelle
PRC	(CNRS) Chemical Risk Prevention Unit	**PRC**	unité de Prévention du Risque Chimique (du CNRS)
PSC1	Prevention and safety certificate level 1	**PSC1**	Prévention et Secours Civiques de niveau 1
PVA	Polyvinyl alcohol	**PVA**	Alcool polyvinylique
PVC	Polyvinyl chloride	**PVC**	PolyChlorure de Vinyle
RATP	Paris transport authority	**RATP**	Régie Autonome des Transports Parisiens
REACH	Registration, Evaluation, Authorization and Restriction of CHemicals	**REACH**	enRegistrement, Évaluation et Autorisation des produits Chimiques
RID	International Carriage of Dangerous Goods by Rail	**RID**	Règlement concernant le transport International ferroviaire des marchandises Dangereuses
SCBA	Self-contained breathing apparatus	**A.R.V.A**	Appareil respiratoire à ventilation assistée
SDS	Safety data sheet	**FDS**	Fiche de données de sécurité
SMP	Specific medical monitoring	**SMP**	Surveillance Médicale Particulière
SNCF	French national railways	**SNCF**	Société Nationale des Chemins de Fer français
TDG	Transportation of Dangerous Goods	**TMD**	Transport de Marchandises Dangereuses
TICPE	Domestic consumption tax on energy products	**TICPE**	Taxe Intérieure de Consommation sur les Produits Énergétiques
UN	United Nations	**ONU**	Organisation des Nations Unies
vPvB	Very persistent and very bioaccumulative substances	**vPvB**	substances très Persistante et très Bioaccumulable
WFA	Workplace first-aider	**SST**	Sauveteur Secouriste du Travail
WHO	World Health Organization	**OMS**	Organisation Mondiale de la Santé

Public buildings (ERP)
According to the French Construction and Housing Code, public establishments are buildings or other premises which the public can enter freely or by means of compensation or by any other contribution, and in which the public attends meetings for anyone and everyone or by invitation, with or without a charge. In addition to staff, any person admitted to the establishment for any purpose whatsoever is deemed to be part of the public.

The risk of panic in emergencies is particularly high in public buildings because of the density of people who are not familiar with the premises. Which is why safe and rapid evacuation is the main prevention objective.
The start of a fire should be prevented, as should limiting the propagation of flames and combustion gases. The key prescriptions concern the location of the building compared to external roads, materials' resistance and reaction to fire, partitioning, facilities, passageways, smoke extraction, normal and safety lighting, technical installations (such as heating, ventilation, gas supply, lift and service lift, cooking equipment) alarm system and response methods.

Public buildings have a two-fold category to ensure prevention measures are proportionate to the hazards encountered by the public. They are broken down by
• type, with a letter code, depending on the nature, activity and use (for example, R: education, L: courtrooms, conference and meeting halls, auditoriums);
• capacity and category, with a digit code. There are five categories of public buildings broken down in two groups.

Group 1 comprises four categories:
- category 1: more than 1,500 people;
- category 2: 701 to 1,500 people;
- category 3: 301 to 700 people;
- category 4: fewer than 301 people except for category 5 public buildings.

Group 2 consists in category 5 public buildings. These are buildings with a lower number of people than the threshold matching the building type.

In educational premises of a scientific nature, or in premises categorised as public research buildings, the quantity of chemicals held must be limited to the experiment or activity in hand (Article 12 of the safety regulations against fire risk and panic in public buildings). The article even stipulates that large quantities of toxic products and flammable liquids held in such premises, with no justification, are prohibited.
In the same way, the supply of special gases in such premises must always be provided by a central distribution system located outside the building, with outside rigid piping and cut-off devices inside and out. Cylinders, which must be placed on a trolley or rack, can only be used occasionally and in quantities commensurate with the experiment.

Specific case: high-rise buildings (IGH) are the focus of specific regulation. These are buildings with a floor where the highest story rises to more than 28 m from the ground, which is the highest story that can be used by public emergency vehicles and firefighting measures. This height matches the upper range limits of the firefighters' aerial ladders. The fire risk is more severe in these buildings because there is no outside access for rescue operations and evacuation is difficult. Safety restrictions are therefore very high.

Classified installations for environmental protection (ICPE)
According to the French Environmental Code, an ICPE is an installation which presents *"hazards or inconvenience to neighbourhoods; to health, safety and public health; to agriculture; to the protection of nature, the environment and landscapes; to the rational use of energy; and to the conservation of sites and monuments, as well as archaeological heritage"*.

The activities, substances and mixtures governed by ICPE regulations are listed. They are also subject to authorisation, registration and declaration, according to the extent of risk or nuisance generated.

The list comprises four themed categories:
- 1XXX: use and storage of certain substances;
- 2XXX: activity type (e.g. agrifood, wood, waste);
- 3XXX: activity type (does not apply to research and development activities or to experiments or new products and processes);
- 4XXX: use and storage of hazardous substances and mixtures.

Each theme has a four-digit number, the first two of which describe the substance or activity group (e.g. 27XX Waste, 41XX Toxic). Each theme is associated with a threshold that represents either a measurement of activity (for example: daily flow, or storage capacity) or a maximum quantity of hazardous substances and mixtures in the installation. Each threshold corresponds with a procedure and therefore with specific rules. Once a threshold has been reached, the installation is regulated by the matching procedure (declaration, registration or authorisation) for a given theme.

Several ICPE nomenclature themes may apply to an organisation.

FIND OUT MORE

- CNRS ICPE brochure
- CNRS ICPE guide (both are in French)

Explosive atmosphere (ATEX)
Explosive atmosphere is a "a mixture of flammable substances in the form of gas, vapours, mist or dust with air, under atmospheric conditions in which after ignition, combustion spreads throughout the entire mixture."
Technical and organisational measures must be implemented, based on prevention principles and in the following order of priority:
- preventing the formation of an ATEX;
- if the nature of the activity does not prevent an ATEX from forming, avoid ignition;
- attenuate the harmful effects of explosion for the health and safety of workers.

The following must be undertaken to that end:
- setting out a classification of hazardous zones and displaying them;
- using and installing devices appropriate for the zones;
- assessing specific risks generated, or liable to be generated, by an ATEX;
- implementing organisational and technical measures to reduce hazards (appropriate equipment, staff training, explosion prevention and protection, monitoring the atmosphere, etc.).

All of these provisions must be recorded in the explosion protection document (DRCPE), which is appended to the single occupational risk assessment document (DUERP).

An ATEX assumes the presence of combustible substances. The possibility of generating an ATEX can be assessed thanks to the physical and chemical characteristics of flammable substances, such as the lower and higher explosive limits (LEL and HEL) of gases and vapours, and the granulometry and minimum explosion concentration of powders. An ATEX only forms if there is sufficient dispersal of a combustible substance in the air (section 3.2.2).

The ATEX zone is then located by taking many parameters into account including density compared to air, evaporation surface, temperature, pressure, suspended dust, dust deposits, size of grains and so on.

Dangerous areas (room, equipment, etc.) are then categorised in three zones:
- Zone 0 (or 20 for dust): An explosive atmosphere in the location is present permanently, for long periods of time or frequently;
- Zone 1 (or 21 for dust): An explosive atmosphere in the location is liable to be occasionally present in normal conditions;
- Zone 2 (or 22 for dust): An explosive atmosphere in the location is not liable to be present in normal operations, or if there is one nonetheless, it is of short duration.

Given the complexity of zoning, advice is generally sought from a specialist organisation. Once zoning has been completed, access signs are placed in areas where an ATEX is liable to form.

Figure 9 *Pictogram showing an ATEX hazard*

FACTSHEET 2 • CHEMICAL INCOMPATIBILITY

Validated experiment protocols and storage and waste disposal rules, duly disseminated, are examples of measures that minimise the hazards of chemical reactions.
An inventory of chemicals and knowledge of their hazards is a precondition to these measures. It is essential to learn about and be trained on the reactivity of the chemicals handled.

Chemical compatibility rules are complex and based on scientific considerations (reaction kinetics, reactivity, etc.). They require case-by-case analysis based on feedback and data taken from the following documents and publications:

- section 10 of the SDS;
- INRS toxicological factsheets: http://www.inrs.fr/publications/bdd/fichetox.html;
- Sécurité et prévention des risques en laboratoire de chimie et de biologie (Safety and risk prevention in chemistry and biology laboratories), 3rd edition, Lavoisier, 2014;
- Bretherick's Handbook of Reactive Chemical Hazards, 8th edition, Elsevier, 2017.

Free tools on the prediction and reactivity of mixtures and their hazards are also available:

- Cameo Chemicals: https://cameochemicals.noaa.gov/;
- Chemical Reactivity Worksheet:
  https://www.aiche.org/ccps/resources/chemical-reactivity-worksheet-40.

PLEASE NOTE

Simply relying on pictograms is not enough to establish incompatibility rules. Products with the same pictograms can be incompatible.
Examples:

- Regarding corrosives, acids and bases must not be stored together but can be mixed in certain conditions;
- Among acids,
  - oxidisers such as nitric acid and perchloric acid must be stored away from other acids in cabinets and waste barrels;
  - organic acids (formic acid, acetic acid, etc.) must be stored away from mineral acids (hydrochloric acid, sulphuric acid, etc.), in cabinets and waste containers.

FIND OUT MORE

- INRS « Réactions chimiques dangereuses » (Hazardous chemical reactions) database;
- « Stockage et transfert des produits chimiques dangereux », (Storage and transfer of dangerous chemical products), ED 753, INRS ;
- « Laboratoire d'enseignement en chimie » (Laboratory-based chemistry teaching), ED 1506, INRS ;
- « Le stockage des produits chimiques au laboratoire » (Chemical product storage in laboratories), ED 6015, INRS.

FACTSHEET 3.1 • COLLECTIVE PROTECTIVE EQUIPMENT– GLOVE BOX

A glove box is a sealed enclosure under negative pressure. Experiments are carried out in confined areas for total protection. The enclosure is supplied with air and inert gas (argon, nitrogen, etc.) via a high-efficiency filter and air is exhausted after filtration (particle filter and active carbon filter).

Recommendations for use

Glove boxes are mainly used when handling

- products that react to air and/or humidity that can trigger fire and/or explosion;
- products that oxidise or degrade in the air;
- products harmful to health (like certain CMRs and lethal* substances).

In the first two cases, air is replaced by an inert gas.

There should be

- compliance with handling protocols and equipment use;
- checks to ensure that gloves are adapted to the products handled;
- a ban on wearing jewellery liable to damage glove sleeves.

NOTE

The recommendation is to opt for replacing the molecular sieve (absorbent mineral substance) rather than regeneration, which requires high-level accuracy. This is because regeneration involves several hazards due to a hydrogen/nitrogen gas mixture, the potential release of chemical pollutants in the air and the duration of the operation over several hours requiring a reaction time without supervision.

Regular maintenance and checks:

- checking the state of the gloves before any handling;
- ensuring that a qualified technician checks the enclosure every year;
- planning the replacement of filters according to usage;
- any technical operation must be carried out by a competent person, after decontamination.

Glove box

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* Hazard statements: H300, H310 and H330

FACTSHEET 3.2 • COLLECTIVE PROTECTIVE EQUIPMENT – FUME HOOD

A fume hood is a ventilated enclosure used to protect operators against gas and particle pollutants. Air is exhausted mechanically out of the building. The work area is enclosed by fixed panels and a screen made up of one or several transparent and movable panels.

Fume hood debits can be

- variable: air extraction rate varies, depending on the opening, to maintain constant face velocity;
- constant: face velocity varies in inverse proportion to the opening's surface area;
- low debit (see box)

Recommendations for use

- During the experiment, keep movable panel as low as possible. In no event should the high position of the face panel (or sash) exceed the maximum safety height given by the supplier, which is usually limited by a sash stop;
- limit the quantities of products used during experiments;
- do not use the fume hood as a storage area (chemicals, glassware, etc.);
- place pollutant sources at least 15 cm away from the opening;
- the operator must never put their head under the fume hood when carrying out the experiment;
- restrict large quantities of warm sources (such as a sand bath) which interfere with air flow.
- have no more than one person using the fume hood, to guarantee the equipment's optimal efficiency;
- when the fume hood is not being used, lower the movable panel completely

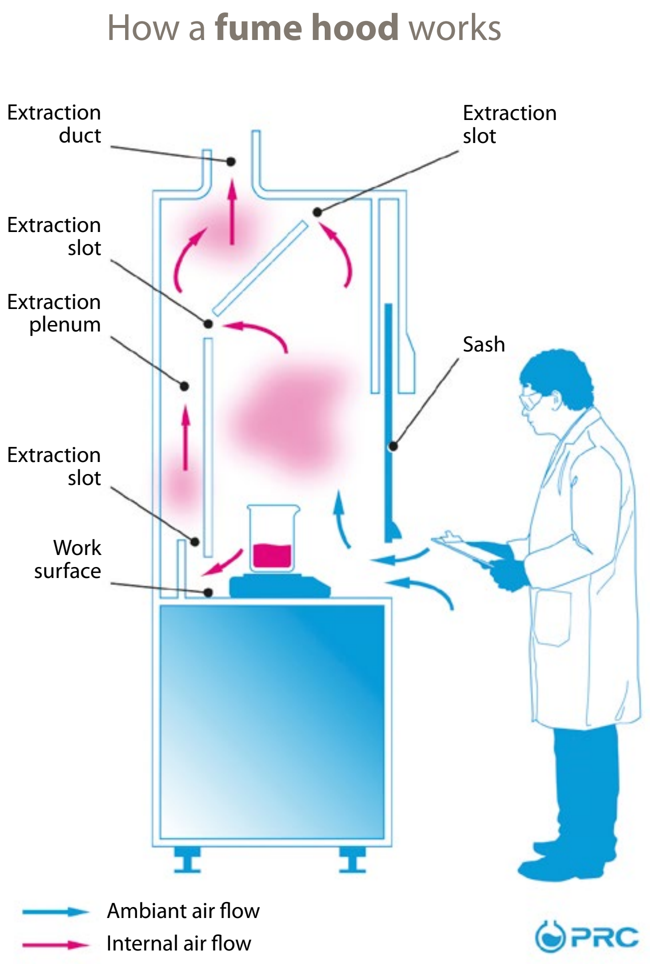


Figure 10 *How a fume hood operates*

SPECIAL CASE

LOW VELOCITY FUME HOODS

Current standards (EN 14175-2 to 14175-4) no longer impose minimum face velocity for incoming air but do require containment capacity regarding pollutants, measured in particular via tracer gas. These fume hoods are known as low flow hoods and low velocity hoods. This is because containment can be achieved with incoming air at a velocity lower than 0.5 m/s (value set by the former standard for a face opening of 0.4 m), in a range of 0.2 to 0.3 m/s given a face opening of 0.4 to 0.5 m.

However, experience and also certain INRS* studies have shown that "theoretical" containment achieved with low velocity is unstable and cannot be totally guaranteed in the context of normal laboratory activities (operators' movements, doors opening, storage – even limited – in the ventilated enclosure, etc.).

Bearing in mind energy consumption constraints, which prompted these new practices, care should be taken to ensure incoming air velocity of at least 0.4 m/s to guarantee the safety of users, provided that the equipment's standardised containment test results are also satisfactory.

The CNRS does therefore not recommend installing low-flow and low-velocity fume hoods.
However, in the case of existing "low-velocity" installations, and provided standards are complied with, ventilated enclosures should be entirely free of any storage or equipment, which could interfere with air flow. Procedures should be implemented to limit external sources of disturbance (opening and closing doors, limiting traffic in the area, etc.).

**"Sorbonnes de laboratoire - guide pratique de ventilation n°18" (Laboratory fume hoods - ventilation handbook No18), ED 795, INRS;*
"Évaluation des sorbonnes selon la norme EN 14175" (Fume hood assessment in accordance with EN 14175) note, ND 2301, INRS
- INRS: Simulation par traçage gazeux de l'exposition d'un opérateur utilisant une sorbonne dite basse vitesse (Simulation by tracer gas of operator exposure to the use of so-called low velocity fume hoods)
- Congrès ContaminExpert 2011

Regular maintenance and checks

The experimenter carries out daily checks:
- of the air extraction rate provided by the controlling entity;

Laboratory staff carry out weekly checks:
- of the alarm systems (flow rate and sash stop).

Competent staff (internal or external) carry out six-monthly checks:
- of the ventilation smoke bomb test

Competent staff (internal or external) carry out annual checks:
- of face velocity. Fume hoods must be checked every year. This check can incorporate the measurement of face velocity. Velocity must then be compared to face velocity benchmarks, established in a successful containment test. If there is a difference between the two, the fume hood is considered to be non-compliant.
- check the debit indicator and its alarm system.

Thorough cleaning, together with general and detailed inspection of the equipment, must take place at least once a year.
Test results and maintenance operations must be recorded in the equipment's maintenance file. The label displayed on the equipment attests to its compliance or non-compliance.

FACTSHEET 3.3 • COLLECTIVE PROTECTIVE EQUIPMENT – DUCTLESS FUME HOOD (formerly known as ETRAF for “Enceinte pour Toxique à Recyclage d’Air Filtré”)

A ductless fume hood is a ventilated enclosure that protects operators against gas and particulate pollutants. Air is exhausted in the experiment room after it has been filtered. There is no universal filter. Filters must be adapted to the type of product used. The manufacturer validates the comprehensive list of products which can be handled safely. In addition, filters have a limited lifespan. Saturation depends on the number of experiments, the quantity of pollutants released, humidity conditions and so on.

Ductless fume hoods must only be used for operations of similar nature, releasing known products, captured by the filter and compatible with other products. This equipment is less flexible than a fume hood and must only be used occasionally.

CMRs cannot be handled in this type of equipment.

Ductless fume hood

Recommandations for use

- Keep the window down during handling stages;
- Start the apparatus 15 minutes before use, and let it run 15 minutes after the work area has been cleaned;
- Limit the quantities of products used for the experiment;
- Do not use a ductless fume hood as a storage area (chemicals, glassware, etc.)
- Display the list of authorised products that can be handled in it;
- Two people must not use a ductless fume hood at the same time, to guarantee optimal efficiency;

Maintenance and checks

The experimenter carries out daily checks:

- check the air extraction rate indicated by the controlling entity;

Competent staff (internal or external) carry out annual checks:

- Change filters at least once a year, or when maximum usage duration recommended by the supplier has been reached.
  When changing a filter,
  - Power supply must be cut off, and the manufacturer’s recommendations followed;
  - Personal protective equipment (safety glasses, lab coats, masks, etc.) must be worn;
  - The filter is considered to be chemical waste and must be treated as such.
- Check face velocity, which must be in the 0.4 to 0.6 m/s range, according to the type of ductless fume hood.

Test results and maintenance operations must be recorded in the equipment’s maintenance file. The label displayed on the equipment attests to its compliance or non-compliance.

FACTSHEET 3.4 • COLLECTIVE PROTECTIVE EQUIPMENT – EXTRACTION SYSTEMS

Extraction equipment is used sporadically to capture vapours, fumes, aerosols on a very small surface. These devices have mechanical ventilation ducted to the outside or they are equipped with a filter. Their use is limited as they are less efficient than a ventilated enclosure. The devices only offer protection against pollutants (with low toxicity) captured close to the source. They enable easier access to experiments but are more liable to encounter airflow disturbance (drafts, movement close to the extraction arm etc.).

Recommandations for use

- Choose the cone diameter, according to the characteristics of the pollution source;
- Keep the device close to the source pollutant permanently, taking into account its natural movements;
- Limit its use to low-level toxic and emissive products;
- Ensure that the user or part of their body is not placed between the pollutant source and the extraction device;
- Prefer mechanical ventilation and ducting to the outside, otherwise adapt the filter to the pollutants emitted.

Flexible fume extraction arm

Maintenance and checks

At least once a year and depending on the data provided by the manufacturer, check regularly that the extraction process remains operational.

If a filter is being used, change it regularly as recommended by the manufacturer. Competent staff (internal or external) undertake this operation under the following conditions:

- Power supply must be cut off, and the manufacturer's recommendations followed;
- Personal protective equipment (safety glasses, lab coats, masks, etc.) must be worn;
- The filter is considered to be chemical waste and must be treated as such.

Maintenance operations must be recorded in the equipment's maintenance file.

Chronobiotron extraction table UMS 3415 – Strasbourg

FACTSHEET 4.1 • PERSONAL PROTECTIVE EQUIPMENT – EYE PROTECTION

There are two main types of protection:

Safety glasses and goggles

- Glasses with side arms (or temples)
- Goggles

Face shield

Always select equipment bearing at least the CE mark.

DESIGNATION : Lunettes à branches
COLORIS ECRAN : incolore (classe optique 1).
QUANTITE : 10 paires
LOT 508/19758
11/18
CE EN166 : 2001 (1 FT)
EN170 : 2002 (2C-1,2)

Protective eye wear should have the following properties:

- optical neutrality;
- resistance to impact;
- resistance to chemicals.

Safety glasses and goggles

A number of materials are used in the manufacture of safety glass lenses such as glass, plastic, acetate and polycarbonate. The latter is increasingly replacing glass and plastic.

Prescription glasses and sunglasses offer no protection against chemical hazards.

Wearing contact lenses in a laboratory is prohibited. Volatile chemicals can dissolve in tear fluid and find themselves caught between the lens and the eye, causing significant injury.

• Glasses with side arms

They protect against splashes but are not airtight. They must have side shields and a top shield.

Certain models can be worn over prescription glasses (safety over glasses) or they may have prescription lenses.

• Goggles

They protect against splashes and are airtight in air containing vapours/gases that cause eye irritation. If goggles are chosen, their air-tightness must be guaranteed.

Face shields

Using a face shield made of anti-fog polycarbonate can be recommended for certain operations (transferring large quantities of toxic or corrosive liquids, or when using cryogenic liquids). They protect the eyes, part or all of the face and part of the neck, but they are not air-tight. They can be fixed to an adjustable headband with or without a visor.

General recommendations

- Ensure that the glasses fit properly. Adjustable glasses are recommended;
- Clean lenses in accordance with the manufacturer’s instructions;
- Check that the equipment is in good repair before using it, and replace it as soon as it is irreversibly damaged;
- Handle glasses carefully:
  - Do not place them face down on the bench;
  - If possible, store them in individual glasses cases close to the workstation, away from dirt, radiation, chemicals, humidity and high temperatures. Store them in a clean and empty area where they cannot fall or be crushed.

FACTSHEET 4.2 • PERSONAL PROTECTIVE EQUIPMENT – SKIN PROTECTION

PROTECTIVE GLOVES

• **Characteristics**
Gloves protecting against chemical hazards are characterised by their shape, material and thickness.

Shape	Gloves with sleeves are recommended. Depending on their length, they cover part of the forearm and arm to ensure better protection in immersion operations especially.
Material	Latex, neoprene, nitrile, polyvinyl alcohol (PVA), polyvinyl chloride (PVC), etc., with various textures.
Thickness	There are two types of gloves: thin (thickness is less than 0.2 mm) and thick.

Single-use gloves are not very resistant mechanically and they generally offer limited protection against chemicals over time. These gloves are effective in protecting against splashes and projections.

Thick gloves are reusable and guarantee a much higher level of effective chemical and mechanical protection over time. Provided the material is appropriate for the chemical handled, they protect the experimenter against any intentional contact (immersion, cleaning), and against any splash from a dangerous substance, which could have very severe consequences (e.g. when handling large quantities of concentrated acids.)

• **Marking**
Standardised marking for gloves changed in 2016.

Currently EN1SO 374-1			
three types of glove one pictogram			
Type A	Resistant to permeation: breakthrough time at least ≥ **30 mins** for at least **6 products** on the list* +	Air-tight gloves (penetration) + **Degradation test** The result of the test is recorded in the information notice of the gloves	
Type B	Resistant to permeation: breakthrough time at least ≥ **30 mins** for at least **3 products** on the list* +		
Type C	Resistant to permeation: breakthrough time at least ≥ **10 mins** for at least **1 product** on the list* +		

**list of dangerous components below*

>> THREE TEST METHODS

- Penetration test in accordance with EN 374-2: 2014: substance breakthrough via pinholes in the glove
- Permeation test in accordance with EN 16523-1: 2015: substance breakthrough in the glove
- Degradation test in accordance with EN 374-4: 2013: change in the glove's physical properties in contact with the substance

FACTSHEET 4.2 • PERSONAL PROTECTIVE EQUIPMENT – SKIN PROTECTION

Six chemicals were added to the list of hazardous components

List of hazardous components			
Code**	**Chemical**	**CAS number**	**Class**
A	Methanol	67-56-1	Primary alcohol
B	Acetone	67-64-1	Ketone
C	Acetonitrile	75-05-08	Nitrile compound
D	Dichloromethane	75-09-2	Chlorinated hydrocarbon
E	Carbon disulphide	75-15-0	Organic compound comprising sulphur
F	Toluene	108-88-3	Aromatic hydrocarbon
G	Diethylamine	109-89-7	Amine
H	Tetrahydrofuran	109-99-9	Cyclic ether
I	Ethyl acetate	141-78-6	Ester
J	Heptane	142-82-5	Saturated hydrocarbon
K	Sodium hydroxide 40%	1310-73-2	Inorganic base
L	Sulphuric acid 96%	7664-93-9	Inorganic mineral acid, oxidiser
M	Nitric acid 65%	7697-37-2	Inorganic mineral acid, oxidiser
N	Acetic acid 99%	64-19-7	Organic acid
O	Ammonium hydroxide 25%	1336-21-6	Organic base
P	Hydrogen peroxide 30%	7722-84-1	Peroxide
Q	Hydrofluoric acid 40%	7664-39-3	Inorganic mineral acid
R	Formaldehyde 37%	50-00-0	Aldehyde

AQL (Acceptable Quality Limit) represents a manufacturing quality standard relating to the gloves' water-tightness and air-tightness.

Level 3 = AQL < 0,65 (surgical gloves)

Level 2 = AQL < 1,5 (example: PPE gloves)

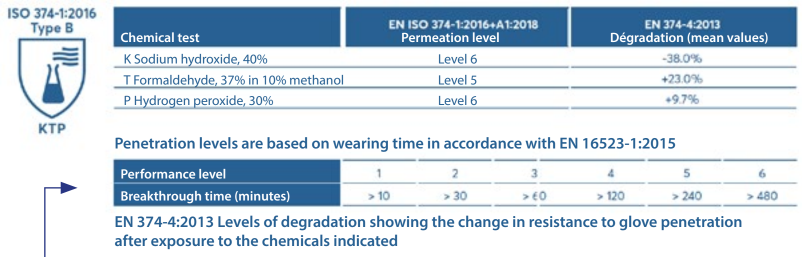
Level 1 = AQL < 4 (anti-dirt gloves).

Examples of indications shown on a box of gloves

FACTSHEET 4.2 • PERSONAL PROTECTIVE EQUIPMENT – SKIN PROTECTION

NOTE

Only gloves bearing the pictogram relating to chemical hazards offer protection against chemical substances. The use of gloves not identified by this pictogram is to be banned.



Chemical test	EN ISO 374-1:2016+A1:2018 Permeation level	EN 374-4:2013 Dégradation (mean values)
K Sodium hydroxide, 40%	Level 6	-38.0%
T Formaldehyde, 37% in 10% methanol	Level 5	+23.0%
P Hydrogen peroxide, 30%	Level 6	+9.7%

Penetration levels are based on wearing time in accordance with EN 16523-1:2015

Performance level	1	2	3	4	5	6
Breakthrough time (minutes)	> 10	> 30	> 60	> 120	> 240	> 480

EN 374-4:2013 Levels of degradation showing the change in resistance to glove penetration after exposure to the chemicals indicated

GLOVE RESISTANCE CRITERIA

- **Degradation**: the change in one or several mechanical properties of a material, making up a protective glove, by contact with a chemical (swelling, stiffening, cracking etc.).
- **Penetration**: the movement of a chemical through porous materials, seams, pinholes or other imperfections in a protective glove material (tears cracks, etc.).
- **Permeation**: the process by which a chemical moves through a protective glove material at the molecular level.

- **Selecting gloves**

The protection provided by gloves is optimal if they are correctly selected, used and cleaned.

Selecting gloves (shape, material thickness) must take into account:
- Workstation analysis (product hazards and characteristics, usage conditions and experiment constraints);
- Glove characteristics provided in the SDS;
- Glove data provided by the manufacturer.

QUESTIONS MOST FREQUENTLY ASKED

- **Single-use or reusable?**

Reusable gloves: intentional contact with the chemical (immersion, high risk transfer, cleaning, etc.),
Single-use gloves: non-intentional contact with the chemical (setting up/dismantling, weighing etc.).

- **Which material?**

Even if most of the gloves found in laboratories are made of latex and nitrile, it might be necessary to use other materials, especially neoprene, polyvinyl alcohol (PVA), fluorinated materials, polyvinyl chloride (PVC), butyl and multilayer materials.
As a first step to selecting the material, information can be found in “Des gants contre les risques chimiques” (Gloves against chemical hazards) ED112 INRS among other sources, and in the INRS “ProtecPo” tool.
The final selection should incorporate specific information from the supplier.

- **Powdered or not?**

Powder (based on starch) makes it easier to put gloves on and absorbs some of the sweat. However, these gloves can lead to a greater use of sensitisation, especially for latex gloves (there is a possibility of wearing cotton gloves underneath latex gloves).

- **Recommendations for use**
  - Inspect gloves before each use and look for signs of early ageing or degradation (change in colour, cracks, pinholes, black dots on the rubber etc.). In case of damage or contamination, the gloves must be thrown away immediately.
  - Wear gloves on clean, dry hands;
  - Change single-use gloves frequently, especially after direct contact with a chemical (see how to remove gloves);
  - Change reusable gloves that have worn out;
  - Do not share reusable gloves;
  - Clean reusable gloves properly (clean gloves in accordance with the suppliers' recommendations, do not clean in a washing machine);
  - Wash hands with water and gentle soap after each use (do not use the laboratory's solvents and detergents).

How to remove gloves safely

© CNRS

PROTECTIVE CLOTHING

Selecting protective clothing needs to factor in the nature of the chemical hazard (information on the chemical, type of contact, usage conditions, protection duration, etc.) user constraints (body shape, allergies, etc.) and work conditions (confined area, humidity, temperature, etc.).

There are six categories of protective clothing, which depend on the protection level the garments offer:

TYPE OF CLOTHING	EXAMPLES	PERFORMANCE REQUIRED
Type 6 (NF EN 13034+A1)	Petrochemicals, laboratories, chemical industries, agricultural environments, plant health hazards.	Limited duration of protection against liquid chemical splashes.
Type 5 (NF EN 13982-1/A1)	Asbestos removal, agricultural environments during dusting operations.	Protection against solid chemicals, suspended dust, completely air-tight equipment.
Type 4 (NF EN 14605+A1)	Chemical industry, agricultural environments, plant health hazards during low concentration spraying operations.	Protection against liquid chemicals in the form of a spray. Liquid trickles down the garment.
Type 3 (NF EN 14605+A1)	Chemical industry where the risk of being in contact with a chemical is high.	Protection against liquid chemicals in the form of a jet. Powerful blast of a liquid chemical.
Type 2 (NF EN 943-1+A1)	Chemical industry: chemical suit (hazmat suit).	Complete protection of the body and respiratory tract against liquid chemicals and gases. Garment not air-tight, with breathable air providing positive pressure.
Type 1 (NF EN 943-1+A1) (NF EN 943-2)	Chemical suit (hazmat suit) in chemical industry or for emergency and response teams.	Complete protection of the body and respiratory tract against liquid chemicals and gases. Air-tight garment.

- **Recommendations on how to wear a lab coat**
  - It is compulsory to wear a lab coat for any experiment involving chemicals, because the lab coat protects against direct skin contact and represents an essential barrier against the transmission of contamination outside the workstation;
  - Choose a lab coat made of a fibre that is difficult to ignite, such as 100% cotton or non-woven fabric (ban polyester to avoid a fire risk), covers the knees and has long sleeves;
  - The lab coat must be completely fastened (press studs are recommended as it is easier to remove the garment in case of chemical projection or fire);
  - Cleaning lab coats at home must be prohibited. At the CNRS, the unit director must ensure that work clothing provided to staff is in a good state of repair. Cleaning and replacement costs are borne by the unit.

- **Protective footwear**

In addition to wearing a lab coat, it is strongly recommended to wear garments covering the legs as well as enclosed shoes to avoid any contact with the skin in case of spillage.

It is strongly recommended to avoid wearing tights and trousers made of synthetic fabric in laboratories to avoid any skin reaction (irritation, burn, etc.) or make it worse in case of contact.

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FACTSHEET 4.3 • PERSONAL PROTECTIVE EQUIPMENT – RESPIRATORY PROTECTION

Criteria for selecting respiratory protection devices include the type of experiment or response, the nature of the pollutant and its concentration in the air. Selection comes after an analysis of the workstation and as precise an assessment as possible of:

- proportion of oxygen in ambient air
- particle dimensions;
- nature of pollutants, and their concentration in the air;
- toxicity of pollutants (OEL);
- temperature and humidity conditions;
- working conditions;
- work duration.

Various types of respiratory protection devices are appropriate for very specific areas and very limited use conditions. A user could find themself in grave danger if the device chosen were not appropriate or if it were being used beyond the limits set by the manufacturer.

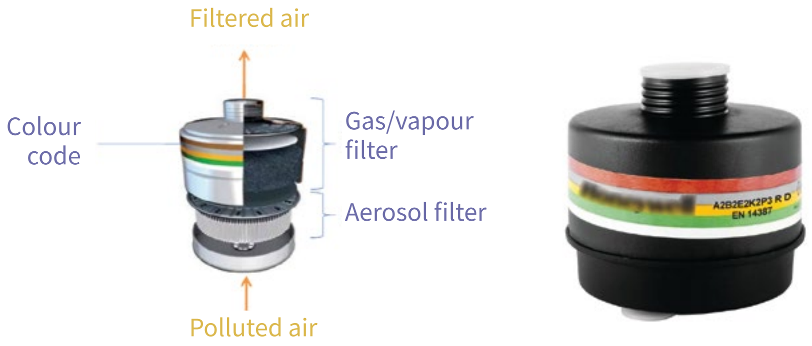
TYPES OF EQUIPMENT

There are two types of respiratory protection devices: filtering and isolating.

- **Filtering devices**

Contaminated air is purified by a filter. These devices are generally made up of a face piece, which covers the nose and mouth more or less extensively, and an appropriate filter.

A filtering device is known to have “free ventilation” when the air flows through the filter only by way of the user’s breath. Conversely, it has “assisted ventilation” when it is assisted by a powered ventilation device attached to the user’s belt for example.



Example of A2B2E2K2P3 filter

TYPE	COLOUR CODE	USAGE
A	Brown	Organic gases and vapours with a boiling point higher than 65 °C
B	Gray	Inorganic gases and vapours (except carbon monoxide - CO)
E	Yellow	Sulphur dioxide (SO_2)
K	Green	Ammonium and organic amine derivatives
Hg P3	Red and white	Mercury vapours
NOP3	Blue and white	Nitrogen oxides
AX	Brown	Organic gases and vapours with a boiling point lower than 65 °C
SX	Purple	For specific compounds indicated by the manufacturer
P	White	Particles and aerosols

Table 10 *Anti-gas filters*

FACTSHEET 4.3 • PERSONAL PROTECTIVE EQUIPMENT – RESPIRATORY PROTECTION

ANTI-DUST AND ANTI GAS FILTERING DEVICES

free ventilation

half-mask
or
full mask
+ filter(s) for anti-gas masks

assisted ventilation

half-mask
or
full mask + powered respirator + filter(s)

FREE VENTILATION FILTERING DEVICES

ANTI-DUST MASK

Half-mask filtering aerosols;

- fully-filtering device;
- covers the nose, mouth and chin;
- entirely or largely made of filtering material;

- comprises elastics or straps and a nose clip. Certain models have an exhalation valve;
- three categories of efficiency:
  - half-mask FFP1 (low efficiency) which stops at least 80% of these aerosols (that is, penetration lower than 20%);
  - half-mask FFP2 (medium efficiency) which stops at least 94% of these aerosols (that is, penetration lower than 6%);
  - half mask FFP3 (high efficiency) which stops at least 99% of these aerosols (that is, penetration lower than 1%);

- R mark: mask is reusable;
- NR mark: mask is not reusable;
- D mark: resists clogging. These masks show a low increase in respiratory resistance in the presence of high dust load.

ANTI-GAS MASK

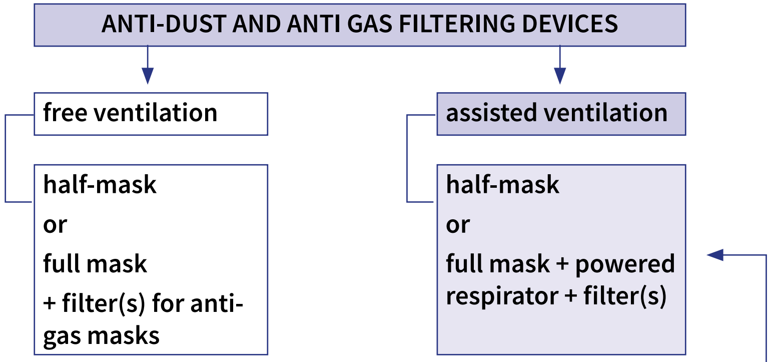
Half-mask or full mask filtering gases and vapours:

- covers the nose, mouth and chin or the entire face;
- made of flexible and air-tight material;
- comprises straps, one or several inhalation/exhalation valves, a one-way filter and a lens in the case of a full mask;
- expiry date on filters;
- the body of the mask can be reused in certain models.

An anti-gas filter is specific to a gas or a group of gases and vapours (**Table 10**). Filters can be combined and also associated with an anti-aerosol filter, in which case they are identified by the letter P. These combinations extend the scope of protection.

For filters A B, E and K only, there are three categories of capture efficiency:

- class 1 (filter pads): low capacity, for pollutant concentration of less than 0.1%.
- class 2 (filter cartridges): medium capacity, pollutant concentration is between 0.1% and 0.5%.
- class 3 (filter canisters): higher capacity, pollutant concentration is between 0.5% and 1%.



SELF-CONTAINED BREATHING DEVICES

These devices are used in difficult working conditions including heat, duration and physically demanding work. These cumbersome yet highly effective devices consist in a face cover, a filtering unit attached to the belt, a powered ventilator and a battery.

NOTE

These filtering devices should never be used in confined and unventilated areas nor should they be used in premises where the oxygen rate is lower than the required minimum of 17%.

- **Emergency escape breathing device**

This equipment consists in a face piece and a device which brings incoming air or oxygen from a non-contaminated source. The user may be connected via a tube (devices that are “not self-contained”) to a source of compressed air (compressed air piping) or to a nearby area where the air is not contaminated (fresh air piping). The source of air can be brought with the device in which case it is known as being “self-contained”.
At the CNRS, this equipment requires an authorisation issued by the unit director. Specific training as well as medical advice are required. (**Chapter 5.1.1**)

SELECTING RESPIRATORY PROTECTION DEVICES

IMPORTANT

EMERGENCY SITUATIONS

Cartridge masks do not represent emergency equipment. Only emergency escape breathing devices can be used in the event of an accidental release of substances leading to an atmosphere that is toxic or poor in oxygen. There must have been prior assessment of this situation.
Cartridge masks can only be used as protective equipment once the premises have been ventilated. In that event, the cartridge must not be reused and must be replaced.

The protection provided by PPE is optimal if it is correctly selected, used, cleaned and stored.
Selecting equipment must take into account:

- Workstation analysis: hazards, concentration, product characteristics, use conditions and experiment constraints;
- Type of respiratory protection equipment indicated in the SDS;
- Equipment data provided by the supplier.

RECOMMENDATIONS FOR USE

Equipment, usage and cleaning (following supplier's recommendations):

- Never use a cartridge more than once unless it is marked with the letter R. It must only be reused for the same gas and not in an emergency situation;
- Replace the body of reusable masks once they are no longer usable;
- Ensure the complete air tightness of the face piece. In general terms, wearing a beard or prescription glasses is not compatible with using a full mask. In the case of glasses, side arms come between the mask joint and the face. However, spectacle kits (lenses without arms) placed inside the mask, maintain air tightness.

Example of a spectacle kit

- Replace cartridges frequently before filter saturation by following the supplier's instructions. Becoming aware of a smell or taste in the mouth indicates that filter saturation has been reached. Cartridge filters must systematically be changed in that case (**see box**).
- Before each use:
  - Inspect key parts (lenses, valves, joints, etc.);
  - Check the filter types and their shelf life;
  - Check that filters are undamaged and correctly assembled;
  - Ensure the complete air tightness of the face piece.
- After each use:
  - Clean before reuse;
  - Change cartridges frequently;
  - Close the cartridge securely after use.
- Storage:
  - Place in a dedicated and sealed container, in a clean and uncontaminated room;
  - Store the body of the mask and the cartridges in the same place, closest to where they are used.
- Disposal of cartridges, and anti-dust masks:
  - Dispose of them via the "solid chemical waste" channel.
  - Dispose of them as soon as the expiry date has been reached.

  Recommendations specific to EEBDs are given during mandatory training (**Factsheet 6**).

NOTE

Anti-dust filter:

The lifespan of a mask depends on its usage and cleaning. There is no saturation indicator. Their replacement date will therefore depend on risk assessment and the supplier's instructions.

Anti-gas filter:

When the filtering material (activated carbon) becomes increasingly saturated as exposure to pollutants progresses, it will eventually become inoperative and no longer able to capture pollutants. It is difficult to establish how long it can be used as there are many parameters to consider (gas and vapour concentration, breathing rate, temperature, humidity level etc.).

It is therefore vital to refer to the supplier's instructions, with advice on how to replace the filters. Some suppliers have developed a system to estimate how long a cartridge can be used for. The INRS also offers a tool, Prémédia, for the selection of masks equipped with A and AX filters. (https://premedia.inrs.fr)

FACTSHEET 5.1 • MEASURES TO BE TAKEN IN THE EVENT OF A PERSON'S ACCIDENTAL EXPOSURE TO A CHEMICAL SUBSTANCE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- It is possible for symptoms (especially respiratory symptoms following a delayed pulmonary oedema) to appear away from the exposure area and for systemic (or general) intoxication to occur. Medical advice is always recommended.
- You can request advice from the nearest poison control centre (phone numbers are available on this website: http://www.centres-antipoison.net). In that case, where possible, use the safety data sheet of the substance(s) involved.

What to do in all cases

Check or have someone (ideally a first-aider) check whether the victim is conscious until emergency services arrive.

What NOT to do in all cases

Never neutralise an acid with a base. The strongly exothermic reaction would exacerbate local injury.

This factsheet addresses the following exposure accidents:

- **Skin contact**
- **Eye contact**
- **Inhalation**
- **Accidental ingestion (swallowing)**

In the event of accidental exposure to hydrofluoric acid (HF), phenol and substances that react to water or dry ice, please refer to "Measures to be taken in the event of accidental exposure to certain chemical substances", which completes the present protocol.

REMEMBER

A workplace accident must be declared to the employer, in accordance with the procedures in place, as soon as possible (preferably within 24 hours).

• IN THE EVENT OF SKIN EXPOSURE

- Immediately and carefully remove rings, watches, bracelets and any soaked clothing, while taking care not to expose the areas of the body that are not contaminated (cut clothing up if necessary), without peeling away the clothes that are sticking to the skin.
- Rinse immediately and abundantly with running water at ambient temperature (under the tap or shower) for at least **10 to 15 minutes without rubbing.**

CAUTION

During the washing process, the person assisting the victim must be protected (with gloves for instance) to avoid any contact with the contaminating substance(s).

NOTE

If necessary, use a screening device to preserve the victim's privacy.

- After prolonged and meticulous washing, the burn can be covered with a dressing.
- If necessary, cover the victim with a survival blanket to avoid hypothermia.

Medical advice **required**

The most serious chemical burns are not necessarily the most painful. Which is why medical advice is required for any burn, whatever chemical substance is involved. The injury can evolve and require re-assessment within 48 to 72 hours.

FACTSHEET 5.1 • MEASURES TO BE TAKEN IN THE EVENT OF A PERSON'S ACCIDENTAL EXPOSURE TO A CHEMICAL SUBSTANCE

• IN THE EVENT OF EYE SPLASH

With eyes open, immediately rinse the eye from the inner corner to the outer corner with running water or saline solution, for at least **10 to 15 minutes**. Ask for help from another person for more effective rinsing.

NOTE

Corneal contact lenses are generally washed away by the rinsing liquid, if that is not the case, do not attempt to remove them.

WARNING

Injuries generated by alkaline substances are generally severe because of faster and deeper penetration in the tissues. Initially, they could give a false impression of moderate injury to the eye.

Medical advice **required**

Always consult an ophthalmologist to assess the extent of the injury incurred and the need for treatment.

• IN THE EVENT OF INHALATION

Evacuate the victim from the contaminated zone while using respiratory protection appropriate for the contaminated atmosphere, if required, then start the decontamination process and /or resuscitation where necessary.

NOTE

Take emergency action in a contaminated atmosphere with appropriate respiratory protection.

Medical advice **required**

Medical advice is essential, especially for acid vapours, as there is a risk of secondary injury away from the incident zone (pulmonary oedema for instance).

• IN THE EVENT OF ACCIDENTAL INGESTION

If the victim is conscious, make them wash their mouth out.

- Assist the victim into a sitting or half-sitting position.
- Do not make them drink or vomit as this could exacerbate the injury. Do not attempt to administer antacids or activated carbon which could hamper potential examinations and also lead to vomiting.

Medical advice **required**

Ingestion of a chemical substance, especially if it is corrosive, constitutes an emergency for which medical advice is essential.

FACTSHEET 5.2 • SPECIFIC MEASURES TO BE TAKEN IN THE EVENT OF A PERSON'S ACCIDENTAL EXPOSURE TO CERTAIN CHEMICAL SUBSTANCES

UNDERSTANDING THE ISSUE
The general measures to be taken must be adapted in the event of accidental exposure to the chemical substances below. These cases generally require specific and urgent medical care.

They involve:

- **hydrofluoric acid (HF),**
- **phenol,**
- **substances that react to water (sodium, phosphorus, etc.),**
- **liquid nitrogen and dry ice.**

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• IN THE EVENT OF EXPOSURE TO HYDROFLUORIC ACID (HF)

Medical advice **URGENT**

Early management is essential to avoid serious injury, all the more so because, initially, it may go unnoticed before spreading and becoming extremely painful. Any contamination of more than 1% of the body's surface (equivalent to the size of the victim's palm) or any exposure to a concentrated solution aerosol (> 50%) requires the victim to be hospitalised (there is a risk of systemic intoxication and life-threatening injury).

Skin exposure

- Rinse immediately and abundantly with running water at ambient temperature or failing that, a saline solution.
- Apply 2.5% calcium gluconate gel in a thick layer. If the fingers have been contaminated, place them in a glove filled with gel.
- Cover with a dry dressing. Re-apply the gel every 2 to 3 hours. The treatment's efficacy can be judged in particular by pain becoming less intense.

CAUTION

The person assisting the victim must be protected to avoid any contact with hydrofluoric acid (wearing acid-resistant neoprene gloves), especially during the rinsing process.

Eye splash

- Rinse immediately and abundantly with running water or a saline solution for 10 to 15 minutes. Medical advice is all the more necessary that the risk of after-effects can be high (loss of an eye).

FACTSHEET 5.2 • SPECIFIC MEASURES TO BE TAKEN IN THE EVENT OF A PERSON'S ACCIDENTAL EXPOSURE TO CERTAIN CHEMICAL SUBSTANCES

Accidental ingestion (swallowing)

- Make the victim ingest a 10% calcium gluconate solution or a 5% calcium chloride solution but never give them solid calcium chloride.

REMEMBER

A workplace accident must be declared to the employer, in accordance with the procedures in place, as soon as possible (preferably within 24 hours).

• IN CASE OF EXPOSURE TO PHENOL

For a limited area of undamaged skin, a few millilitres of a polyethylene (PEG) glycol 400 or glycerol water solution can be used for the decontamination process. However, it must be followed by immediate rinsing with plenty of water for 10 to 15 minutes, to avoid any absorption through the skin.

Medical advice **required**

***WARNING**: the injury may not be painful because of a local anaesthetic effect.*

• IN CASE OF EXPOSURE TO SUBSTANCES REACTIVE TO WATER SUCH AS SODIUM AND PHOSPHORUS

- Rinse immediately with plenty of running water at room temperature for at least 15 minutes, despite the possibility of reactive or corrosive elements being generated and the exothermic nature of reaction.
- In the event of contamination from a powder substance, gentle brushing or wiping is recommended before rinsing.
- In the event of sodium or phosphorus becoming encrusted in the skin where it could burn, a small water jet (such as a dental jet) can be used.

• IN CASE OF EXPOSURE TO LIQUID NITROGEN AND DRY ICE

- In case of contact with skin or mucous membranes, rinse with tepid water to avoid frostbite.

In the event of liquid nitrogen being accidentally spilled in a room, beware of the risk of anoxia (a drop in oxygen). Use an oxygen detector in the room to check that the oxygen level is always adequate (oxygen concentration> 18% vol).

FACTSHEET 5.3 • MEASURES TO BE TAKEN IN THE EVENT OF ACCIDENTAL CHEMICAL SPILLAGE

PROTECT

- **Evacuate** staff and administer first-aid if required (« **CAT face à une exposition accidentelle à une substance chimique » - Measures to be taken in the event of accidental exposure to chemical substances, CNRS intranet site**).
  Depending on how serious the situation is, a general evacuation can be declared. In that case, trigger the fire alarm manually.
- **Open** windows.
- **Set the fume hood ventilation** to “high speed” or activate forced ventilation in the room.
- **Shut the door and restrict access** to authorised persons (clear signal on the door).

ALERT

- **Inform** competent staff present.
- Depending on how serious the situation is, call **outside emergency services** in accordance with procedures.

RESPOND

Only intervene if required equipment is **avalaible and easy to acess**:

- Lab coat, safety glasses or face shield;
- Thick neoprene gloves;
- Full mask with ABEK filtering cartridge (do not intervene if risk assessment requires an emergency escape breathing device reserved for outside emergency personnel or specifically trained staff only);
- Vermiculite-type absorbent products including a bucket and shovel to collect the spill.
- Specific kit on a case-by-case basis (for mercury, for example).

FACTSHEET 6 • SPECIFIC SAFETY TRAINING

BENEFICIARY	FREQUENCY	DOCUMENT ISSUED	FACILITATOR	LEGISLATIVE SOURCES
Experimenter exposed to hazardous chemicals	Initial training, to be renewed as often as required		Competent person from the lab	**Art. R. 4412-38** of the French Labour Code
Experimenter exposed to CMRs	Initial training, to be renewed as often as required		Competent person from the lab	**Art. R. 4412-87** of the French Labour Code
Experimenter exposed to plant protection products (pesticides)	Initial training, to be renewed every five years	Individual certificate	Accredited organisation	**Art. R. 254-8 to R. 254-14** of the French Rural and Maritime Fishing Code
Staff liable to be exposed to asbestos during the removal and containment of materials involving asbestos	Initial training, to be renewed every three years	Individual competency certificate	Accredited training organisation	**Art. R. 4412-117** of the French Labour Code **Order of 23/02/2012**
Staff liable to work in an ATEX zone	Initial training, to be renewed as often as required		External service provider or competent person from the lab	**Art. R. 4227-49** of the French Labour Code **Order of 08/07/2003**
Use of work equipment and collective protective equipment	Initial training, to be renewed as often as required		External service provider or competent person from the lab	**Art. R. 4323-1 to R. 4323-3** of the French Labour Code
Staff carrying out maintenance on work equipment	Initial training, to be renewed as often as required		External service provider or competent person from the lab	**Art. R. 4323-1 to R. 4323-4** of the French Labour Code
User of personal protective equipment	Initial training, to be renewed as often as required		External service provider or competent person from the lab	**Art. R. 4323-106** of the French Labour Code
User of an emergency escape breathing device	Initial training, to be renewed every year	Authorisation	External service provider	**Art. R. 4323-106** of the French Labour Code INRS DMT 56 TC 47
Staff needing to send or receive dangerous goods by road	Initial training, to be renewed as often as required	Certificate	External service provider or Ulisse (UAR 2966)	Art. 1.3.1 of the ADR
Staff needing to send or receive dangerous goods by air	Initial training, to be renewed every two years	Certificate	External service provider accredited by IATA	Art. 1.5.a of the IATA
Staff whose work is liable to involve sulphur hexafluoride (SF6)	Initial training, to be renewed as often as required	Certificate	Accreditation organisation	**Article 10 of Regulation (EU) 517-2014 of 16 avril 2014**
Staff in charge of extinguishers and emergency equipment	Initial training, to be renewed as often as required		External service provider or competent person from the lab	**Art. R4227-39** of the French Labour Code

CMR : Carcinogenic, Mutagenic or Reprotoxic
ATEX : Explosive atmosphere

FACTSHEET 7 • GOOD LABORATORY PRACTICES

- Be familiar with specific instructions, and follow them;
- Be familiar with the measures to be taken in the event of a fire accident;
- Know how to respond in an emergency or fire;
- Avoid cluttering hallways and emergency exits;
- Do not store chemicals or chemical waste in hallways;
- Provide easy access to safety equipment (extinguishers, safety shower, etc.);
- Close doors and windows when leaving the work area
- Do not clutter workstations (bench, fume, hood, etc.);
- Do not leave bottles open on the bench;
- Do not store flasks close to a source of heat;
- Limit the quantity of products on the bench to a day's work;
- Wear a fastened lab coat and enclosed shoes;
- Do not take your work clothes home or wash them at home;
- Use appropriate PPE and CPE in line with risk assessment;
- Replace PPE depending on its usage, and as soon as it is damaged;
- Tidy PPE away after use, away from contamination;
- Tie long hair back;
- Wash your hands before and after an experiment, and after removing your gloves;
- Do not pipette by mouth;
- Do not use chipped glassware;
- Do not recap a needle;
- Do not attempt to identify a chemical by smell;
- Do not smoke, vape, drink, eat, use cosmetics or store food at the workstation;
- Avoid wearing contact lenses in experiment rooms;
- Do not place a mobile phone on potentially contaminated work surfaces;
- Do not touch shared objects (door handles, telephone, keyboard, mouse etc.) with gloves that are contaminated or liable to be contaminated. To avoid any contamination, keep one hand free, clean, and not wearing a glove when changing experiment location;
- Clean, and if necessary, decontaminate workstations after each experiment involving hazardous chemicals or after accidental spillage;
- Do not dispose of chemicals or chemical waste down the sink;
- Be familiar with waste procedures and follow them;
- Clean shared equipment items after use: weighing centrifuge, etc.;
- Secure experiments left unsupervised.

FACTSHEET 8 • EXAMPLE OF A WORKSTATION NOTICE

Laboratory
logo

WORKSTATION GUIDE

Name of laboratory: ***name of laboratory***
Director: ***name and first name***
Drafting and follow up: ***health and safety officer (HSO) name and first name***
Checked by: ***name and first name***

Room: ***XXX***
Experiment: CO

Version: ***1***
Date: january 2019

Equipment	Pressure equipment: S01-type CO gas cylinder
Personal protection	Wearing PPE is compulsory - Cotton lab coat, fastened, clean and with long sleeves - Safety glasses
Collective protection	- Air renewal in the room - CO detector - Work under a fume hood (fume hood compliant and checked each year by an accredited organisation)

Experiment stages	Hazards	Methods to avoid these hazards
Preparing set-up and handling	Hazards associated with: - the gas used (CO gas is very dangerous, lethal, without smell and denser than air) - the use of gas under pressure	- do not use grease or oil - use appropriate regulator - avoid a surge in pressurisation (slow opening) - train staff on compressed gases - inform staff of the hazard - work in a ventilated area - ensure there is a CO detector
Storage, maintenance and transport	- collision - collision during transport - leak (a CO leak can kill instantly) - fire or explosion	- prevent leaks (CO detector) - attach the cylinder to a stable structure at two thirds of its height - check the valve and cap before any use - close the cylinder after use - store the cylinder in a ventilated area, away from flammables

THE ROOM MUST BE KEPT CLEAN AND TIDY

Person to contact in case of change in the workstation: ***HSO (name, first name, telephone number)***
Person to contact in the event of emergency : ***List of first-aiders (names, first names, telephone numbers)***

FACTSHEET 9 • LABORATORY LAYOUT

The key elements to take into consideration when designing a chemistry laboratory are as follows.

Ventilation

Ventilation is a key aspect of prevention and must be designed in accordance with prior risk assessment and the collective protective equipment required. Even if it is difficult to produce an exhaustive list of all the products to be used, their dangerous properties (flammable, explosive, toxic, CMR, etc.) and their quantities must be identified as a minimum.

This data helps establish the quantity and type of collective protective equipment items required (storage cupboards, local extraction, fume hoods, etc.). It also helps to establish the amount of make-up air that needs to be supplied.

Benches

Benches need to be smooth, easy to decontaminate and equipped with anti-drip borders (5 to 10 mm) and 10 cm backsplash panels. Electrical supply is provided by sockets set 60 cm above the work surfaces, on the central partitions between benches, on the panels or on table overhangs. This allows for sufficient electrical supply to ensure that multi-socket power strips are banned.

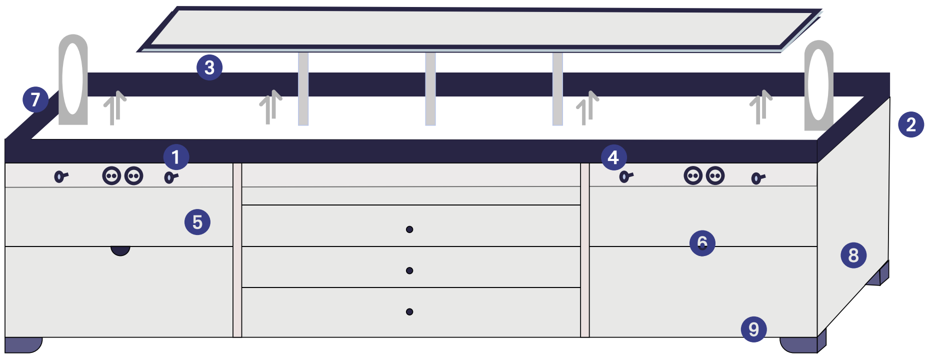
A raised central worktop – with limited dimensions to reduce its use to what is strictly necessary – is a helpful addition. The bench and the fume hood opposite it must be at least 1.4 m apart.

Furniture

Furniture needs to be resistant to chemicals and easy to decontaminate.

Floors

Floors need to be smooth, anti-slip, resistant to chemicals, easy to decontaminate and equipped with 10 cm skirting boards. Materials liable to generate electrostatic charges are to be avoided.



① Work surface
② Anti-drip border
③ Raised worktop
④ Fluid inflow
⑤ Fluid control
⑥ Electrical sockets
⑦ Water evacuation
⑧ Wheeled storage unit
⑨ Drawer on ball bearings

Figure 11 *Illustration of a bench*

Particular attention must be paid to the areas liable to be in contact with cryogenic fluids, by using resistant materials as a minimum, or by creating an area for large containment spill trays with grates.

Passageways

Glazed partitions separating corridors from laboratories are the best choice. Doors in labs should be self-closing and have a glass panel.

In addition to the regulatory constraints governed by passageway dimensions, experience shows that two metres represents a good compromise between technical constraints and economising on surface area.

Regulations also govern the distance between partition doors and their reaction and resistance to fire. Doors need to be equipped with a glass panel and they need to be kept open by a positive safety device controlled by the fire safety system.

Safety showers and jets

There should be showers in the passageways on all floors, ideally in a recess for that purpose, in sufficient numbers. They need to comply both with the French Labour Code and the "10-second or 8-metre" rule (the distance or time it takes to get to a shower). If possible, there should be a closed shower on each floor.

The installation of jets in addition to showers is also recommended. This also applies to eye wash stations, which consist in a basin and are activated by a foot pedal, so that the user can wash both their eyes and their face.

Fire-fighting equipment

In addition to the mandatory provisions on a public building's resistance to fire, for example, or on evacuation procedures (involving passageways, emergency exits and ventilation to evacuate smoke), automatic fire detection (compulsory in public buildings) is strongly recommended. A fire-detection device activates the alarm automatically so that staff can be evacuated. It also enables early intervention from the emergency services, especially when there are no people in the building.

Fire-fighting equipment must be the object of particular attention (extinguishers, even automatic extinguishers, fire blankets, etc.). For example, the recommendation is for there to be at least one 2 kg CO_2 extinguisher per experiment room, which is more than the number of extinguishers required by regulations and more than the already restrictive professional rules (rule R4 of the APSAD).

Electrical panels

Electrical panels should be located in passageways and specific to each room, so that staff authorised to work on electrical installations can access them easily, without any exposure to chemicals. However, there should be an emergency cut-off switch in every room. The general power supply should be separate from the ventilation power supply. The decision to cut off the latter in an emergency situation should be a specific and deliberate act, if required after a quick risk assessment (fire for example).

Separating high-risk areas from offices

Office areas must always be kept separate from chemical experiment rooms and storage areas, so as to not expose staff to chemical hazards "passively" and without reason. A good solution consists in locating experiment rooms and areas intended for office-type activities on either side of the passageways, with their different ventilation requirements.

IMPORTANT

Areas reserved for note-taking and reading documents, such as a corner of a bench or a table in experiment rooms, should never replace office areas.

Areas presenting similar hazards

Wherever possible, the recommendation is to group together workstations with similar hazards in the same room. The aim is to limit the number of people exposed and to optimise the protection systems in place. For example, it is a good idea to group together the weighing of CMR powders in the same room, to reserve fume hoods for the handling of hydrofluoric acid (HF) and to use a dedicated room for experiments involving nanomaterials in a specific room.

Find out more:

- *« La conception des laboratoires de chimie » (The design of chemistry laboratories) documentary note, ND 2173, INRS ;*
- *« Sorbonnes de laboratoire - guide pratique de ventilation n° 18 » (Laboratory fume hoods – ventilation handbook N°18), ED 795, INRS ;*
- *APSAD (Assemblée Plénière des Sociétés d'Assurances Dommages- Plenary assembly of insurance damage companies) reference source.*
- *« Bien stocker les produits chimiques » (How to store chemicals properly), ED 6455, INRS ;*
- *« Equipements de premiers secours en entreprise : douches de sécurité et lave-oeil » (Emergency equipment in companies: safety showers and eye wash stations), ED 151, INRS*

FACTSHEET 10 • EXAMPLE OF A FIRST-AID KIT

This factsheet does not represent a mandatory benchmark. Rather, it should take into account working conditions, occupational risk assessment and internal laboratory rules. The occupational physician can advise you if needed.

GENERAL POINTS

The first-aid kit or pharmacy cabinet must be clearly identified, easy to access and everyone should be aware of its existence. Depending on the location (over several sites for example), a number of kits can be provided.

It must only be used if there is truly a need for it, preferably by a trained first-aider who regularly renews their training.

An adviser must be appointed to carry out regular checks on expiry dates and product storage.

CONTENTS

Dressing and disinfection supplies

- 1 disinfectant such as BISPETINE® or chlorexhidine (preferably in single doses);
- 1 box of sterile gauze pads, 10x10 cm and 1 box of 5x5 cm pads;
- 1 roll of 5cm wide microporous surgical tape (preferably hypoallergenic);
- 1 roll of adhesive dressings to be cut to size such as Hansaplast®;
- 10 to 20 pre-cut adhesive dressings, hypoallergenic and resistant to water, such as PANS-PLUS® or the more standard dressings, Sparaplaie® or Médipore®;
- 3 tubular net bandages such as Nylex® (5-7-10 cm);
- 3 self-adhesive bandages (5-7-10 cm);
- 1 pressure dressing or an emergency dressing (“Israeli dressing”);
- Single-dose saline solution;
- Non-medicated paraffin gauze dressing such as Jelonet® to be used in case of burn.

Small items:

- 1 pair of tweezers;
- 1 pair of round-ended scissors such as JESCO®;
- 1 bottle of surgical spirit (rubbing alcohol) or Dakin®;
- 2 freezer-type bags or thermal bags such as REFRIMED® in case of amputation to preserve the fragment sectioned;
- 2 ice cube bags;
- 1 double-sided survival blanket (protection against the cold: silver side facing the body; protection against heat and sun rays: silver side turned towards the source of heat);
- 1 bin bag.

Other

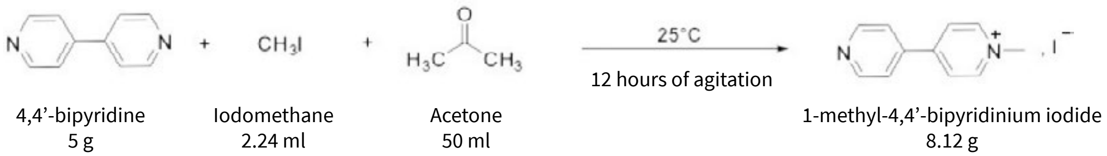
- Sugar lumps;
- Safety pins;
- 1 triangular scarf;
- 1 set of adjustable and reusable splints such as Boston Splint®;
- 1 bottle of alcohol-based hand sanitiser;
- 1 liquid soap (preferably in single doses);
- 1 clean cloth;
- 1 mask for mouth-to-mouth resuscitation;
- A torch;
- A notebook and pencil;
- A map locating the nearest defibrillator;
- Emergency telephone numbers:
  - Ambulance, fire-fighters and single European emergency telephone number, internal emergency number, first-aider, poison control centre, SOS Main (emergency centre for hand injuries), eye emergency centres in the region.

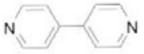
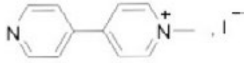
PLEASE NOTE

The first-aid kit must not contain drugs (except in specific cases to be discussed with the occupational physician).

FACTSHEET 11 • EXAMPLE OF INCORPORATING SAFETY INTO AN EXPERIMENT PROTOCOL

Methyl viologen synthesis 1-Methyl-4,4’-bipyridinium iodide



PRODUCT NAME (STORAGE AREA)	CAS NUMBER	ASPECT/ FORM	LABELLING IN ACCORDANCE WITH REGULATION (EC) NO 1272/2008 AND HAZARD STATEMENT	QUANTITY USED	EXPOSURE DURATION	PPE AND CPE USED
4,4'-Bipyridine  (safety cabinet in the chemical store)	553-26-4	Crystal powder	H301: Toxic if swallowed H311: Toxic in contact with skin Danger	5 g	< 2 min (weighing)	nitrile rubber gloves, glasses, cotton lab coat, FFP3-type respirator
CH3I Iodomethane (ATEX certified refrigerator, in the chemical store)	74-88-4	Liquid	Danger H301+ H331: Toxic if swallowed or if inhaled H312: Harmful in contact with skin H315: Causes skin irritation H317: May cause an allergic skin reaction H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled H335: May cause respiratory irritation H351: Suspected of causing cancer	2.24 ml	< 2 min (sampling)	fluorinated rubber gloves, glasses, cotton lab coat, fume hood
Acetone (ventilated cabinet in the lab)	67-64-1	Liquid	Danger Danger H225: Highly flammable liquid and vapour H319: Causes serious eye irritation H336: May cause drowsiness or dizziness.	50 ml	< 2 min (transfer)	butyl rubber gloves, glasses, cotton lab coat, fume hood
Synthetic product  1-Methyl-4,4’-bipyridinium iodide	38873-01-7	Yellow powder	Warning H315: Causes skin irritation. H319: Causes serious eye irritation H335: May cause respiratory irritation.	8.12 g	Collecting the product in a schlenk flask after filtration	nitrile rubber gloves, glasses, cotton lab coat, fume hood

FACTSHEET 11 • EXAMPLE OF INCORPORATING SAFETY INTO AN EXPERIMENT PROTOCOL

EXAMPLE OF **METHYLVIOLOGEN SYNTHESIS**

STAGE 1

WORK AREA PREPARATION

	Equipment preparation	Experiment set-up	Reagent transport
RISK	• Skin cut • Electrical • Fall from standing height	• Skin cut • Electrical	• Chemical (inhalation, skin contact in case of container breach) • Skin cut • Fall from standing height
PREVENTION	• Clean glassware in good repair • Compliant electrical equipment • Passageways and area not cluttered • Gloves • Lab coat • Safety glasses	• Fixed and stable set-up • Compliant electrical equipment • Uncluttered workstation • Gloves • Lab coat • Safety glasses	• Establishing incompatibilities • Flasks transported safely (appropriately sealed container with vermiculite) • Clear route, as short as possible • Butyl gloves (to handle flasks) • Cotton lab coat • Safety glasses

FACTSHEET 11 • EXAMPLE OF INCORPORATING SAFETY INTO AN EXPERIMENT PROTOCOL

EXAMPLE OF **METHYLVIOLOGEN SYNTHESIS**

STAGE 2
REAGENT PREPARATION

	Sampling acetone	Weighing bipyridine	Sampling iodomethane (Cat. 2 carcinogenic)
RISK	• Chemical (inhalation, skin contact) • Fire	• Chemical (skin contact)	• Chemical (inhalation, skin contact)
PREVENTION	• Compliant fume hood • No hot spot • Butyl gloves • Cotton lab coat • Safety glasses	• Nitrile gloves • Cotton lab coat • Safety glasses • Respiratory protection	• Fluorinated rubber gloves • Cotton lab coat • Safety glasses • Compliant fume hood

FACTSHEET 11 • EXAMPLE OF INCORPORATING SAFETY INTO AN EXPERIMENT PROTOCOL

EXAMPLE OF **METHYLVIOLOGEN SYNTHESIS**

STAGE 3
EXPERIMENT

	Adding reagents	Agitating the reaction medium (12 heures)	Collecting the methyl viologen ⚠	Storing the methyl viologen ⚠
RISK	• Chemical (inhalation, skin contact) • Fire	• Chemical (inhalation, skin contact) • Fire	• Chemical (inhalation, skin contact) • Fire	• Chemical (inhalation, skin contact in case of container breach) • Skin cut • Fall from standing height
PREVENTION	• Compliant fume hood • No hot spot • Appropriate gloves • Cotton lab coat • Safety glasses	• Compliant fume hood • No hot spot • Butyl gloves • Cotton lab coat • Safety glasses • Appropriate agitation speed • Stopper placed on the reactor • Appropriate notice if the experiment is left unsupervised	• Compliant fume hood • No hot spot • Nitrile gloves • Cotton lab coat • Safety glasses	• Incompatibility rules followed • Flasks transported safely (appropriate and sealed container with vermiculite) • Nitrile gloves • Cotton lab coat • Glasses • Clear route, as short as possible

FACTSHEET 12 • THE IMPORTANCE OF A WASTE DISPOSAL PROCEDURE

This factsheet contains all the elements required to implement a waste disposal procedure, which needs to be adapted on a case-by-case basis.

This is essential because waste potentially presents similar hazards to those of the products used in labs. Having a procedure therefore helps manage the following hazards:

- chemical release and pollution of the environment;
- people poisoned (poor storage conditions, chemical reactions, etc.);
- fire, explosion, splashes relating to spontaneous or deliberate transformation of products under the influence of other products (incompatible mixtures) and various other factors (light, temperature, ageing, etc.).

The procedure should cover the following points and be familiar to everyone:

- waste characterisation and sorting;
- packaging and labelling;
- storage and internal transport;
- waste collection;
- waste traceability.

The procedure must also remind users of the following principles:

- waste must not be disposed of down the sink but rather collected in specific containers for that purpose.
- incompatibilities among waste products must be identified to avoid any risk of producing unstable mixtures;
- unused chemicals must be kept in their original labelled container before disposal;
- waste must be stored in dedicated areas. It must not be stored in passageways and laboratories.

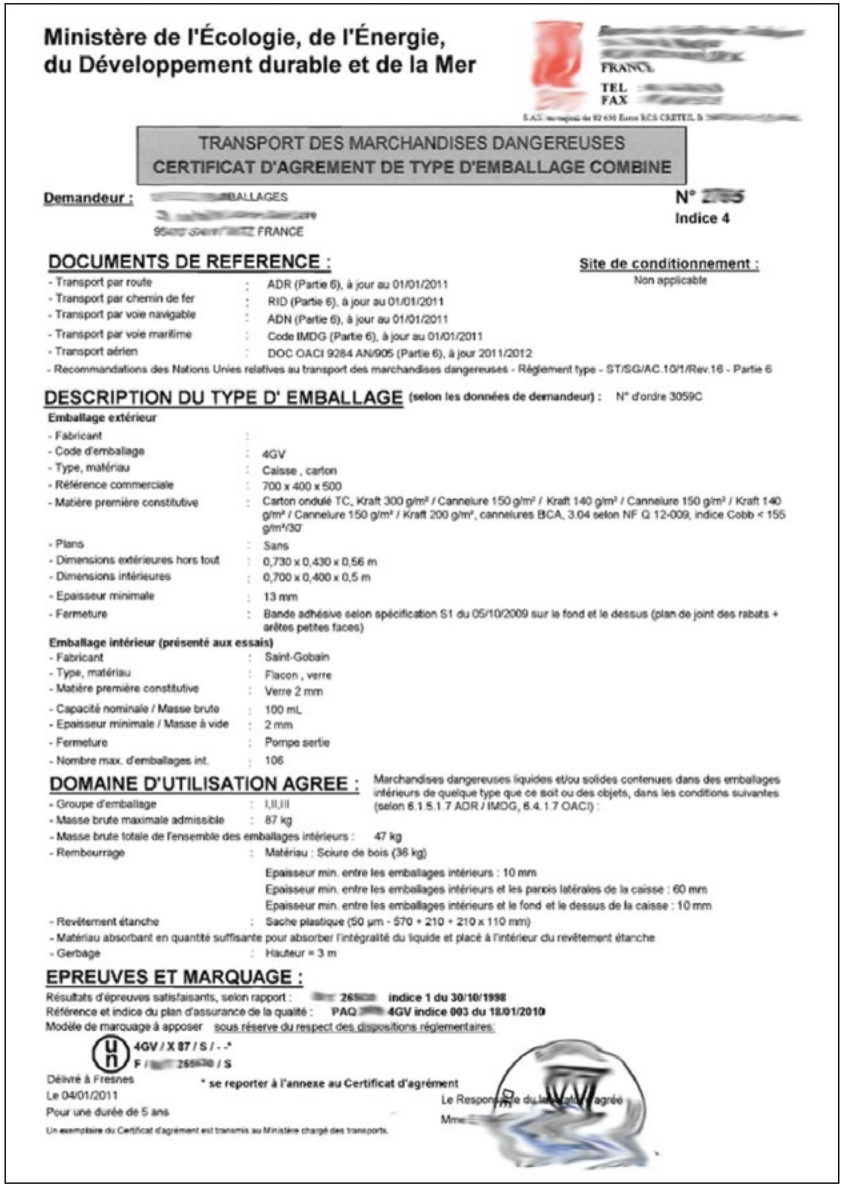
Specific instructions for the collection of laboratory waste before disposal:

- wearing a fastened lab coat in good repair, safety glasses, and appropriate gloves is mandatory;
- containers must be closed and clearly labelled;
- containers must be transported in trolleys equipped with a spill tray;
- barrels of liquid waste must not be stacked to avoid any risk of fall or bursting;

FACTSHEET 13 • PACKAGING CERTIFICATION

Derogation excepted, all parcels containing hazardous goods must be manufactured under a quality assurance system. This ensures production compliance in line with authorised prototypes from an accredited laboratory. The accreditation is set down in a report prepared by the controlling laboratory and must be issued to users. (Example to the right).

Users who fill and close parcels must comply with the instructions provided by the manufacturer.



Ministère de l'Écologie, de l'Énergie,
du Développement durable et de la Mer

[redacted]
FRANCE
TEL [redacted]
FAX [redacted]
S.A.S. [illegible] Euros RCS CRETEIL B [redacted]

TRANSPORT DES MARCHANDISES DANGEREUSES
CERTIFICAT D'AGREMENT DE TYPE D'EMBALLAGE COMBINE

Demandeur : [redacted]BALLAGES
[redacted]
[redacted] FRANCE

N° [redacted]
Indice 4

DOCUMENTS DE REFERENCE :

- Transport par route : ADR (Partie 6), à jour au 01/01/2011
- Transport par chemin de fer : RID (Partie 6), à jour au 01/01/2011
- Transport par voie navigable : ADN (Partie 6), à jour au 01/01/2011
- Transport par voie maritime : Code IMDG (Partie 6), à jour au 01/01/2011
- Transport aérien : DOC OACI 9284 AN/905 (Partie 6), à jour 2011/2012
- Recommandations des Nations Unies relatives au transport des marchandises dangereuses - Règlement type - ST/SG/AC.10/1/Rev.16 - Partie 6

Site de conditionnement :
Non applicable

DESCRIPTION DU TYPE D' EMBALLAGE **(selon les données de demandeur) :** N° d'ordre 3059C

Emballage extérieur

- Fabricant :
- Code d'emballage : 4GV
- Type, matériau : Caisse , carton
- Référence commerciale : 700 x 400 x 500
- Matière première constitutive : Carton ondulé TC, Kraft 300 g/m² / Cannelure 150 g/m² / Kraft 140 g/m² / Cannelure 150 g/m² / Kraft 140 g/m² / Cannelure 150 g/m² / Kraft 200 g/m², cannelures BCA, 3.04 selon NF Q 12-009, indice Cobb < 155 g/m²/30'
- Plans : Sans
- Dimensions extérieures hors tout : 0,730 x 0,430 x 0,56 m
- Dimensions intérieures : 0,700 x 0,400 x 0,5 m
- Epaisseur minimale : 13 mm
- Fermeture : Bande adhésive selon spécification S1 du 05/10/2009 sur le fond et le dessus (plan de joint des rabats + arêtes petites faces)

Emballage intérieur (présenté aux essais)

- Fabricant : Saint-Gobain
- Type, matériau : Flacon , verre
- Matière première constitutive : Verre 2 mm
- Capacité nominale / Masse brute : 100 mL
- Epaisseur minimale / Masse à vide : 2 mm
- Fermeture : Pompe sertie
- Nombre max. d'emballages int. : 106

DOMAINE D'UTILISATION AGREE : Marchandises dangereuses liquides et/ou solides contenues dans des emballages intérieurs de quelque type que ce soit ou des objets, dans les conditions suivantes (selon 6.1.5.1.7 ADR / IMDG, 6.4.1.7 OACI) :

- Groupe d'emballage : I,II,III
- Masse brute maximale admissible : 87 kg
- Masse brute totale de l'ensemble des emballages intérieurs : 47 kg
- Rembourrage : Matériau : Sciure de bois (36 kg)
  Epaisseur min. entre les emballages intérieurs : 10 mm
  Epaisseur min. entre les emballages intérieurs et les parois latérales de la caisse : 60 mm
  Epaisseur min. entre les emballages intérieurs et le fond et le dessus de la caisse : 10 mm
- Revêtement étanche : Sache plastique (50 µm - 570 + 210 + 210 x 110 mm)
- Matériau absorbant en quantité suffisante pour absorber l'intégralité du liquide et placé à l'intérieur du revêtement étanche
- Gerbage : Hauteur = 3 m

EPREUVES ET MARQUAGE :

Résultats d'épreuves satisfaisants, selon rapport : [redacted] **265[redacted] indice 1 du 30/10/1998**
Référence et indice du plan d'assurance de la qualité : **PAQ [redacted] 4GV indice 003 du 18/01/2010**
Modèle de marquage à apposer sous réserve du respect des dispositions réglementaires.

un 4GV / X 87 / S / - -*
F / [redacted] 265[redacted] / S

Délivré à Fresnes
Le 04/01/2011
Pour une durée de 5 ans

*** se reporter à l'annexe au Certificat d'agrément**

Le Respon[illegible]e du la[illegible]agréé
Mme [redacted]

Un exemplaire du Certificat d'agrément est transmis au Ministère chargé des transports.

FACTSHEET 14 • WASTE REGISTER

(Information taken from the CNRS waste register model downloadable on the CNRS Intranet)

REASONS TO HAVE A REGISTER

The register reinforces traceability and transparency of all the players' responsibilities in the treatment of waste (directors of institutions producing or sending waste, collectors, transporters, traders and operators of transit facilities and waste grouping and treatment).

These players must have prevention measures in place as well as measures targeting a decrease in waste production and the harm generated by waste. They must also implement a hierarchy of waste treatment methods, consisting in – preferably and in that order: preparation in view of reuse, recycling, any other recovery, especially energy recovery, and disposal.

WASTE TO BE RECORDED IN THE REGISTER

This register concerns all outgoing waste, dangerous or not, except for domestic waste.

HOW TO FILL THE REGISTER OUT

The data in the BSD (Waste tracking document **Chapter 5.3.5.5**), a mandatory document that ensures waste traceability, is recorded in the waste register.

PERSON FILLING OUT THE REGISTER AND KEEPING IT UP TO DATE

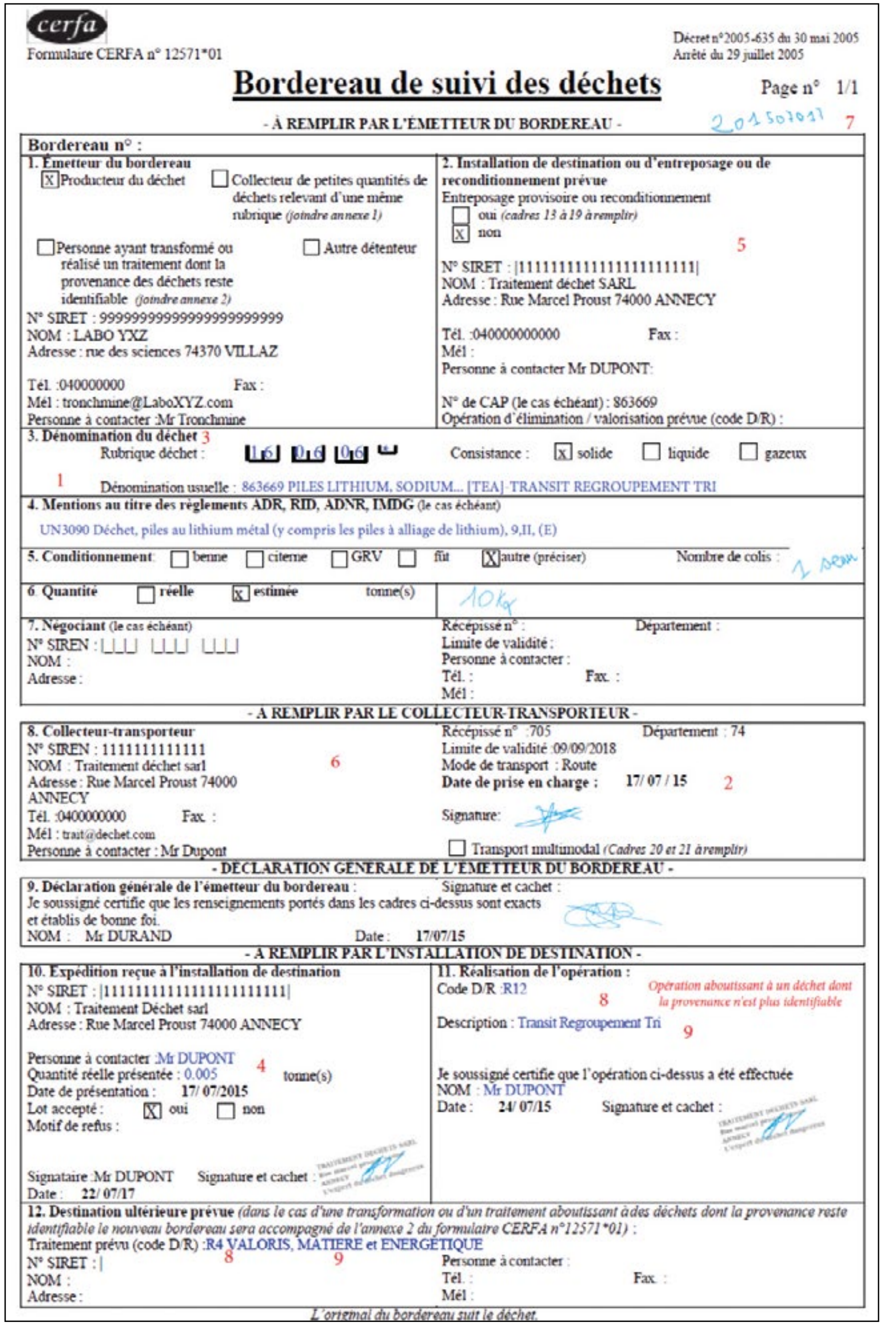
The people in charge of managing waste must keep a register and track all the operations relating to waste disposal as they are carried out. Usually, waste management is centralised at site or organisation level.

LENGTH OF TIME THE REGISTER MUST BE KEPT

The register is to be kept for at least three years.

PEOPLE WHO CAN ASK TO SEE THE REGISTER

The register has to be made available for the inspection of classified installations, for instance.



cerfa
Formulaire CERFA n° 12571*01

Décret n°2005-635 du 30 mai 2005
Arrêté du 29 juillet 2005

Bordereau de suivi des déchets

Page n° 1/1

- À REMPLIR PAR L'ÉMETTEUR DU BORDEREAU -

201507011 7

Bordereau n° :

1. Émetteur du bordereau

☒ Producteur du déchet

☐ Collecteur de petites quantités de déchets relevant d'une même rubrique *(joindre annexe 1)*

☐ Personne ayant transformé ou réalisé un traitement dont la provenance des déchets reste identifiable *(joindre annexe 2)*

☐ Autre détenteur

N° SIRET : 9999999999999999999999
NOM : LABO YXZ
Adresse : rue des sciences 74370 VILLAZ

Tél. :040000000 Fax :
Mél : tronchmine@LaboXYZ.com
Personne à contacter :Mr Tronchmine

2. Installation de destination ou d'entreposage ou de reconditionnement prévue

Entreposage provisoire ou reconditionnement
☐ oui *(cadres 13 à 19 à remplir)*
☒ non

5

N° SIRET : |1111111111111111111111|
NOM : Traitement déchet SARL
Adresse : Rue Marcel Proust 74000 ANNECY

Tél. :040000000000 Fax :
Mél :
Personne à contacter Mr DUPONT:

N° de CAP (le cas échéant) : 863669
Opération d'élimination / valorisation prévue (code D/R) :

3. Dénomination du déchet 3

Rubrique déchet : 16 06 06

Consistance : ☒ solide ☐ liquide ☐ gazeux

1 Dénomination usuelle : 863669 PILES LITHIUM, SODIUM... [TEA]-TRANSIT REGROUPEMENT TRI

4. Mentions au titre des règlements ADR, RID, ADNR, IMDG (le cas échéant)

UN3090 Déchet, piles au lithium métal (y compris les piles à alliage de lithium), 9,II, (E)

5. Conditionnement : ☐ benne ☐ citerne ☐ GRV ☐ fût ☒ autre (préciser) Nombre de colis : 1 [illegible]

6. Quantité ☐ réelle ☒ estimée tonne(s) 10kg

7. Négociant (le cas échéant)
N° SIREN : |_|_|_| |_|_|_| |_|_|_|
NOM :
Adresse :

Récépissé n° : Département :
Limite de validité :
Personne à contacter :
Tél. : Fax. :
Mél :

- À REMPLIR PAR LE COLLECTEUR-TRANSPORTEUR -

8. Collecteur-transporteur
N° SIREN : 1111111111111
NOM : Traitement déchet sarl
Adresse : Rue Marcel Proust 74000 ANNECY
Tél. :0400000000 Fax :
Mél : trait@dechet.com
Personne à contacter : Mr Dupont

6

Récépissé n° :705 Département : 74
Limite de validité :09/09/2018
Mode de transport : Route
Date de prise en charge : 17/ 07 / 15 2
Signature:
☐ Transport multimodal *(Cadres 20 et 21 à remplir)*

- DÉCLARATION GÉNÉRALE DE L'ÉMETTEUR DU BORDEREAU -

9. Déclaration générale de l'émetteur du bordereau :
Je soussigné certifie que les renseignements portés dans les cadres ci-dessus sont exacts et établis de bonne foi.
NOM : Mr DURAND Date : 17/07/15
Signature et cachet :

- A REMPLIR PAR L'INSTALLATION DE DESTINATION -

10. Expédition reçue à l'installation de destination
N° SIRET : |1111111111111111111111|
NOM : Traitement Déchet sarl
Adresse : Rue Marcel Proust 74000 ANNECY

Personne à contacter :Mr DUPONT 4
Quantité réelle présentée : 0.005 tonne(s)
Date de présentation : 17/ 07/2015
Lot accepté : ☒ oui ☐ non
Motif de refus :

Signataire :Mr DUPONT Signature et cachet :
Date : 22/ 07/17

11. Réalisation de l'opération :
Code D/R :R12 8
Opération aboutissant à un déchet dont la provenance n'est plus identifiable
Description : Transit Regroupement Tri 9

Je soussigné certifie que l'opération ci-dessus a été effectuée
NOM : Mr DUPONT
Date : 24/ 07/15 Signature et cachet :

12. Destination ultérieure prévue *(dans le cas d'une transformation ou d'un traitement aboutissant à des déchets dont la provenance reste identifiable le nouveau bordereau sera accompagné de l'annexe 2 du formulaire CERFA n°12571*01) :*
Traitement prévu (code D/R) :R4 VALORIS, MATIERE et ENERGÉTIQUE
8 9
N° SIRET : |
NOM :
Adresse :

Personne à contacter :
Tél. : Fax. :
Mél :

L'original du bordereau suit le déchet.

Example of waste record

1	2	3	4	5	6		7	8	9
NAME OF WASTE	**DATE THE WASTE WAS SENT**	**NATURE OF OUTGOING WASTE** *(Code defined in Appendix II, Article R-541-8 of the French Environmental Code)*	**AMOUNT OF OUTGOING WASTE**	**NAME AND ADDRESS OF THE DESTINATION FACILITY**	**NAME AND ADDRESS OF TRANSPORTER AND RECEIPT N°**	**WASTE TRACKING DOCUMENT(S) (BSD) (*)**	**CONTRACT NUMBER IF WASTE IS TRANSFERRED OUTSIDE FRANCE (*)** *(Appendix VII of Regulation N° 1013/2006 of 14 June 2006)*	**TREATMENT CODE** *(Appendices I and II of Directive N° 2008/98/CE of 19 November 2008)*	**FINAL TREATMENT DESCRIPTION** *(Article L. 541-1 of the French Environmental Code)*
Usual name of waste (name provided by the supplier)	**Collection date (handed to service provider)**	**Six-digit code +* (French Environmental Code)**	**Waste quantity (actual weight)**	**Full details of recipient**	**Full details of transporter**		**BSD internal number**	**Code generally consisting in a letter and two digits**	**Description of final treatment operation = treatment code defined**
BSD box 3	BSD box 8 (date collected)	BSD box 3 (waste type)	BSD box 10 (actual weight)	BSD box 2 or 10 **NOTE**: do not forget the address	BSD box 8 **NOTE**: do not forget the receipt number		BSD box 1	BSD box 11 or 12	BSD box 11 or ask the supplier

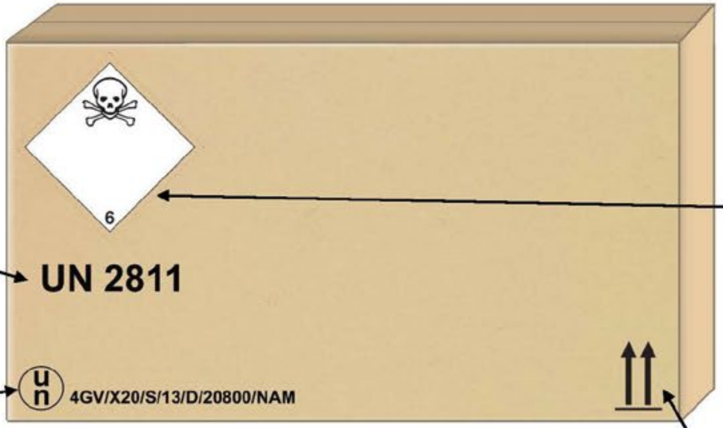
(*): where applicable

FACTSHEET 15 • HOW TO LABEL AN ADR PARCEL CORRECTLY

How to label an ADR parcel correctly

Example: 5 kg of organic toxic solid (UN2811)
in an approved package.

All the marks and labels must be visible and easy to read on the **same side** and able to withstand weather conditions with no significant damage.



UN followed by a number
e.g. UN2811
The font size must be at least:
if more than 30 l or 30 kg nett: 12 mm
if more than 5 l or 5 kg nett: 6 mm
if up to 5 l or 5 kg: as appropriate

Hazard label: primary and subsidiary
They must measure at least 10 x 10 mm.
Printing labels is not advisable
(the right colour code might not be achieved, and labels need to be able to withstand weather conditions with no significant damage).

4GV/X20/S/13/D/20800/NAM

A certification mark, here 4GV/X20/S/13/D/20800/NAM, must feature on package. The mark proves that the packaging was tested and approved.

Mark details:
4G = Package type and material: cardboard box
X = Package category I
20 = Maximum 20 kg gross weight
S = For solids or internal containers
13 = Manufactured in 2013
D = Accredited in Germany
20800 = Lab report number
NAM = Manufacturer identification

Orientation arrows on opposite sides of the parcel
(compulsory for liquids in these boxes)

FACTSHEET 15 • HOW TO LABEL AN ADR PARCEL CORRECTLY

Case study: 10 l of UN1993 liquid

All the marks and labels must be visible and easy to read on the same side and able to withstand weather conditions with no significant damage.

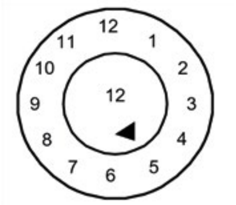
Height of the UN number and the letters “UN”

The height of both letters and digits must be at least:

if more than 30 l or 30 kg nett: 12 mm

if more than 5 l or 5 kg nett: 6 mm

if up to 5 l or 5 kg: as appropriate



Hazard label – primary and subsidiary

Hazard labels must measure at least 10 x 10 mm. Printing labels is not advisable (the right colour might not be achieved, and labels should be able to withstand weather conditions with no significant damage).

Clock

Specificity of **plastic packaging** (code H)

Plastic packaging has a lifespan of five years. Generally, a clock (like the picture above) is embossed on the package. Numbers 1 to 12 represent the month and the number in the middle represents the year of manufacture.

In this example, packaging is valid until May 2017.

** **NOTE** : plastic tops are also concerned by this expiry date.*

FACTSHEET 16 • HOW TO ORGANISE EMERGENCY INTERVENTION

Below is a list of all the elements to be taken into account in order to best plan for the management of an accident, incident or fire.

What needs to be in place in the unit

- Have a hazard map of the unit, to identify the risks specific to each room (experiment room, storage areas etc.), and the SDS of all products in the inventory so that they can be given to outside emergency services promptly;
- Display a list of first-aiders and keep it up to date. Training on first-aid for staff working in high-risk premises is recommended;
- Create a first-aid kit taking hazards into account, with input from the occupational physicist. Show staff where it is kept. Ensure that products with an expiry date are renewed. (**Factsheet 10**) ;
- Identify the appropriate services (ambulance, fire-fighters, poison control centre, “centre SOS main” – emergency centre for hand injuries, etc.), liaising with in-house first-aid services if applicable;
- Plan for where emergency responders should be met, with in-house services if applicable;
- Draft procedures on what to do in the event of accident (**Factsheets 5**) , and display them;
- Draft and display an alert procedure for first aid, providing details of:
  - Telephone numbers to be called (direct call to external services, or via an internal service);
  - Detailed information to be provided during the call: laboratory type, product(s) involved and associated hazards, nature of the accident etc.
  - Remember to clearly appoint one person to reply to first-aiders’ questions as they arrive (several people contributing information make it difficult for first-aiders to process it);
- Ensure that any person working in a high-risk area is aware of safety instructions and emergency procedures. It is therefore essential that an English version of these documents is available in any laboratory liable to host non-French-speaking staff;
- Where applicable, organise a visit of premises and conduct two evacuation drills per year;
- With emergency services, set up customised response procedures linked to premises with specific hazards, such as rooms where radioactive sources are handled, white rooms and biological containment laboratories.

FOCUS ON:

Working alone (in or out of hours): if this cannot be avoided, internal rules provide compensatory measures for staff in these situations (the request is to be approved by the unit director or their representative, there is to be no high-risk experiment, an alert system needs to be in place and so on). At the CNRS, a note on working alone provides details of work conditions in these circumstances (CNRS **note of 30 june 2010**).

Experiments left unsupervised, especially outside usual working hours: a procedure must establish the conditions for conducting these experiments, including a room equipped with a fire detector or detectors controlled by a detection system, contact details of experiment manager and specific emergency procedures.

ONGOING EXPERIMENT

Person in charge

Time/date of experiment end

Reagents

Reaction patterns

What to do in the event of an accident

NO ONGOING EXPERIMENT

Example of a notice for an experiment left unsupervised

FACTSHEET 17 • SAFETY ADVISER DUTIES

The safety adviser's duties are the following:

- Examining compliance with instructions on the transport of dangerous goods;
- Advising the establishment on operations relating to the transport of dangerous goods;
- Producing an annual report on activities relating to the transport of dangerous goods for the establishment director, or where applicable, for a local authority. The report is kept for five years and made available to national agencies at their request.

The safety adviser's tasks relating to the transport of dangerous goods and loading and unloading operations include the examination of and compliance with practices and procedures in

- Identifying the dangerous goods transported;
- Factoring in any specific need when purchasing carrier services;
- Checking the equipment used;
- Making staff aware of these issues or training staff (depending on their involvement) and monitoring;
- Emergencies;
- Analysing, and if required, drafting reports on accidents, incidents and serious breaches;
- Implementing appropriate measures to avoid repeated accidents, incidents, or serious breaches;
- Selecting and drawing on subcontractors and other service providers;
- Making operating procedures and detailed instructions available to staff;
- Checking the existence and compliance of documents, as well as that of safety equipment in vehicles;
- Setting up loading and unloading protocols with input from outside companies;

Since 3 January 2002, the absence of a safety adviser in establishments where it is required has become a criminal offence, potentially leading to a one-year custodial sentence or a €30,000 fine.

INFORMATION

When appointing a safety adviser, the following must be checked:

- the qualification certificate is issued by an accredited organisation (in France, the CIFMD) and the candidate has successfully completed an examination;
- the qualification certificate is valid (renewable every five years);
- the qualification certificate addresses the needs of the establishment concerning terrestrial transport (road and rail).

FACTSHEET 17 • SAFETY ADVISER DUTIES

CNRS

National Safety Adviser for the Transport of Dangerous Goods (CNSTMD)

The regulations on the transport of dangerous goods (TDG), applies to all public and private establishments that use transport services for dangerous goods associated with sending or receiving chemical, biological and radioactive products.

The CNSTMD is appointed by and reports directly to the CNRS President and Chief Executive Officer. The team of specialist safety advisers helps the CNRS units involved in this type of transport with their compliance (raising awareness, visiting labs, help with classification etc.) in line with regulations.

> *For any information:* ***tmd@cnrs.fr***

TDG service providers

"In order to provide optimal legal guarantees and ensure the safe transport of dangerous matter as part of their research activities, CNRS units are requested to call on International Logistical Services/Experiment Support Unit (Services de l'unité de logistique internationale services et soutien aux expériences - ULISSE) or any other provider offering an equivalent level of expertise."

> *Extract of the* ***note of 10 July 2013 from the CNRS presidency***

ULISSE

The unit – which was incorporated in the CNRS Resource Department (DGD-R) in July 2013 and later in the Security Department (DIRSU) in January 2014 – advises the CNRS on TDG matters. Its agents have been trained to coordinate this type of transport with teams of technicians, engineers and researchers in compliance with current regulations.

> *For any information:* ***ulisse.cnrs.fr***

FACTSHEET 18 • HOW TO LABEL AN IATA PARCEL CORRECTLY

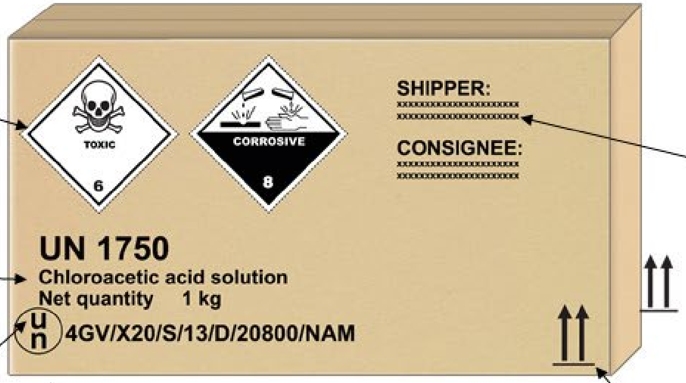
How to label an IATA parcel correctly

Labelling a parcel transported by air is different to transport by road. Aviation regulations on the transport of hazardous substances are much more restrictive.
It is essential to follow air transport “packing instruction” regulations, which set out rules for external packaging, the product and its container (materials, quantity of products, etc.).
The hazard labels, UN number(s), name and weight of the product and addresses of the shipper (sender) and consignee (recipient) must be on one side of the parcel and must not be covered over (e.g. adhesive tape).

Example with 1 litre of chloroacetic acid

All the information contained on the parcel or in the documents must be in English.

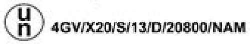
Hazard labels: primary and subsidiary
They must measure at least 10 x 10 mm (exceptions aside).
Printing labels is not advisable (the right colour might not be achieved, and labels need to be able to withstand weather conditions with no significant damage).



Addresses of the shipper and consignee

UN followed by a number
and the name of the substance in English
e.g. UN1750 Chloroacetic acid solution
The font size must be at least:
if more than 30 l or 30 kg nett: 12 mm
if more than 5 l or 5 kg nett: 6 mm
if up to 5 l or 5 kg: as appropriate

Nett product quantity in kilogrammes or litres



A certification mark, here 4GV/X20/S/13/D/20800/NAM, must feature on the parcel. The mark proves that the packaging was tested and approved.

Mark details:
4G =Package type and material: cardboard box
X =Package category I
20 =Maximum 20 kg gross weight
S =For solids and internal containers
13 =Manufactured in 2013
D =Accredited in Germany
20800 =Lab report number
NAM =Manufacturer identification

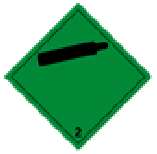
Orientation arrows on opposite sides of the parcel
(compulsory for liquids in these boxes)

Handling labels must sometimes be added, depending on the product
(see below for example)

FACTSHEET 19 • TRANSPORT HAZARD CLASSES

CLASS 1		
Division 1.1 Substances and articles which have a mass explosion hazard.	Examples: TNT, land mines	
Division 1.2 Substances and articles which have a projection hazard but not a mass explosion hazard.	Examples: Detonators, ammunition, self-propelled vehicles	
Division 1.3 Substances and articles which have a fire hazard and a minor blast hazard or a minor projection hazard.	Examples: Stable explosive material, incendiary devices, liquid rocket propellant	
Division 1.4 Substances and articles which present no significant hazard. Accidental effects must stay contained in the package.	Examples: Smoke signals, hunting cartridges, certain fireworks. Least dangerous in class 1	
Division 1.5 Very insensitive substances but have mass explosion hazard. They must pass the external fire test during classification tests.	Example: Type B mine explosives	
Division 1.6 Extremely insensitive articles with no mass explosion hazard. Extremely insensitive explosive articles which present a negligible probability of accidental explosion.	Examples: Extremely insensitive explosive articles not specified elsewhere, insensitive munitions	

FACTSHEET 19 • TRANSPORT HAZARD CLASSES

CLASS 2		
Flammable gases: Any gas forming a mixture with air is considered to be flammable.	Examples : Butane, flammable aerosols	
Non-flammable, non-toxic gases: Any gas under pressure not included in other categories. They are classed as oxidisers if their oxygen level supports combustion or if they cause asphyxiation and present no other risk.	Examples : Carbon dioxide, compressed air, oxygen, helium	
Toxic gases: Gases which pose a risk of toxicity and corrosiveness in humans. They can also pose a risk of oxidation and combustion.	Examples : Chlorine, carbon monoxide, ammonia	

CLASS 3		
Flammable liquids: Liquids with a flash point of 60°C or lower in a closed cup. Liquids with a flash point higher than 60°C are not regulated (except for diesel fuel UN1202) unless they are being transported at a temperature higher than their flash point.	Examples : Alcohol, acetone, petrol (gasoline), diesel fuel	

CLASS 4.1		
Flammable solids and self-reactive substances: Substances igniting readily, mostly in powder or paste form, or solids igniting via friction. Self-reactive substances and desensitized explosive substances.	Examples : Matches, sulphur	

FACTSHEET 19 • TRANSPORT HAZARD CLASSES

CLASS 4.2		
Substances liable to spontaneous combustion: Pyrophoric substances, which will ignite rapidly in contact with air or self-heating substances, which can ignite in large quantities after a long period of time.	Examples : White or yellow phosphorus, pyrophoric alloys, coal, damp cotton	

CLASS 4.3		
Water-reactive substances: Substances which, in contact with water, emit flammable gases. Certain gases can ignite spontaneously.	Examples : Calcium carbide, sodium, lithium, zinc and magnesium metal powder	

CLASS 5.1		
Oxidising substances: Substances which yield sufficient quantities of oxygen to cause the combustion, or enhance it significantly, of another substance.	Examples : Hydrogen peroxide, ammonium nitrate fertiliser, sodium chlorate	

CLASS 5.2		
Organic peroxides: Unstable substances, which can ignite readily and are liable to exothermic decomposition. Some of them can react in contact with other substances. These substances are usually transported in a desensitised form and/or at controlled temperature.	Examples : Methyl ethyl ketone peroxide, peroxyacetic acid	

FACTSHEET 19 • TRANSPORT HAZARD CLASSES

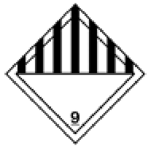
CLASS 6.1		
Toxic substances: Liquids or solids which can harm health or cause death, when they are ingested, inhaled or in contact with skin, in small quantities or in single or brief exposure.	Examples : Arsenic, nicotine, pesticides, cyanide	

CLASS 6.2		
Infectious substances: Substances including viruses, bacteria and tissue samples, which are assumed to contain substances liable to cause infectious diseases in humans and animals.	Examples : Infectious clinical waste (DASRI), hepatitis B virus, enteropathogenic *Escherichia coli*	

CLASS 7		
Category I radioactive substances: Parcel containing radioactive substances with low external radiation. No index number on the label.		
Category II radioactive substances: Parcel containing radioactive substances with external radiation higher than in category I and a transport index no higher than 1. (The Transport Index features on the label).		
Category III radioactive substances: Parcel containing radioactive substances with external radiation higher than in category II and a transport index up to 10. (The Transport Index features on the label).		
Fissile material. Additional label for parcels containing fissile material. The Critical Safety Index (CSI) is on the label.		

FACTSHEET 19 • TRANSPORT HAZARD CLASSES

CLASS 8		
Corrosive substances: Liquid or solid that can destroy human tissues or damage transport equipment and other goods. They contain mostly acids and bases and the objects that contain them.	Examples : Hydrochloric acid, caustic soda, bleach, nitric acid	

CLASS 9		
Miscellaneous dangerous goods: Hazardous substances presenting a danger not covered by any of the other classes or objects containing substances in several classes.	Examples : Asbestos, PCB, lithium batteries, survival craft, air bags, substances that harm the environment (UN3082 or UN3077) not included in other classes (waste mineral oils)	
Note: This pictogram, which means “Harmful to the environment”, is added to that of the hazard class for any substance presenting this danger. It is never used alone.		

ALCOHOL AND PETROLEUM PRODUCTS

Alcohol and petroleum products are subject to various indirect taxes. Their manufacture, transformation, distribution, usage and dissemination are the focus of particular surveillance in the European Union. Surveillance is supervised by customs offices.

List of regulated substances

- Regulated alcohol:

Regulated alcohol includes pure ethanol and any product with an alcoholic strength by volume greater than 1.2%. These products are subject to a "right of consumption" tax when they are intended for human consumption. Alcohol can be exempt from these taxes under certain conditions for:

- Totally or partly denatured alcohol;
- Alcohol used for research or scientific purposes and in manufacture, provided that the finished product does not contain alcohol or provided that the manufacture of a component is not subject to tax.

- Regulated petroleum products:

Petroleum products are derived from the refinery of crude oil. Among other substances, they include tars, mineral oils, aromatic hydrocarbons, essences, and other types of fuel as well as many solvents and fuel gases. They are regulated when used as engine fuel or heating fuel.

> The list of regulated petroleum products can be found in article 265
> of the French Customs Code.

Regulated petroleum products are subject to a domestic consumption tax on energy products. (TICPE and formerly TIPP). The tax also applies to any product used as additive or used to increase the final quantity of engine fuel. Other non-petroleum products intended for heating or carburation (coal or natural gas) are subject to different taxes. Concerning any other use of petroleum products, for research purposes or not, laboratories may benefit from a TICPE exemption.

Formalities

- Regulated alcohol:

A "prior occupation declaration" must be made online on the French customs' website (https://www.douane.gouv.fr/professionnels) and sent to the supplier, for any order of regulated alcohol to be exempt from current taxes. The supplier can provide you with the form. In addition, a request for the authorisation of partial denaturing or modification of alcohol must be made on the same customs website.

- Regulated petroleum products:

Laboratories must have prior authorisation to receive or use TICPE exempt products (this exemption is not retroactive). The laboratory must approach the regional customs and indirect taxation authority (DRDD) to request the authorisation in the location where products are received and used. It is valid for five years and can be renewed.

Obligations and best practices

- Regulated alcohol:

No particular obligation applies to the use of regulated alcohol.

- Regulated petroleum products:

Regulated petroleum products exempt from tax must only be used in the circumstances in which the exemption was approved. The products can only be transferred to an accredited user.
Laboratories must keep a weekly accounting record of substances showing: initial stock; quantities of substances received; substances used as raw materials or for other purposes than manufacture (degreasing, cleaning, etc.); substances potentially transferred as well as the client's contact details; final stock.
Waste derived from the use of regulated petroleum products can be reintroduced in a tax regime if the establishment recovering these products uses them for carburation or heating fuel. These establishments must supply the exemption reference authorisation to the authorities. If waste is to be destroyed, the laboratory must draw up a tax declaration on the transport of residual hydrocarbons, in addition to the waste tracking document (BSD) (**Chapter 5.3.5.5**, **Factsheet 14**), when these products are to be transferred to a treatment or disposal facility.

NARCOTIC AND PSYCHOTROPIC SUBSTANCES AND DRUG PRECURSORS

Narcotics and psychotropics are psychoactive substances that lead to behaviour and perception change, among other effects. If they are misused, they can generate dependency or addiction with harmful effects on health. Drug precursors are chemicals involved in the manufacture of illegal synthetic drugs. All these products can be found in laboratories for legitimate scientific purposes. Regulations require that controls be implemented for a specific list of products involved in the following activities: manufacture, distribution, transformation, recycling and disposal, transport, export and import.

In France, the Agence nationale de sécurité du médicament (ANSM - National Agency for the Safety of Medicines and Health Products) is tasked with applying the measures adopted by European Union bodies in terms of narcotic and psychotropic control. La Mission nationale de contrôle des précurseurs chimiques de drogues (French national taskforce on the control of drug precursors - MNCPC) is in charge of applying measures relating to drug precursors. These agencies are points of contact for any accreditation or declaration requests from laboratories.

List of narcotic substances and drug precursors

- For psychotropics and narcotics: there are many such substances and they have different regulatory classifications according to potential dependency levels, the activity of the central nervous system and harmful effects on health (Orders of 22 July 1990 - Appendices). This classification has no impact on the level of control applied to these products.

- Drug precursors: there are four categories of products, depending on their involvement in the manufacture of synthetic drugs that affect the level of control they are subject to, taking into account usage thresholds.

CAS N°	PRODUCTS	THRESHOLDS
Category 1 Active principles of synthetic drugs including salts if any		
25547-51-7	2-Methyl-3-phenyloxirane-2-carboxylic acid (BMK glycidic acid)	None
2167189-50-4	3 (1,3-benzodioxol-5-yl)-2-methyloxirane-2-carboxylic acid (PMK glycidic acid)	
82-58-6	Lysergic acid	
89-52-1	N-Acetylanthranilic acid	
4433-77-6	2-Phenyl-3-oxobutanamide	
4468-48-8	2-Phenylacetoacetonitrile	
21409-26-7	1-phenethyl-N-phenylpiperidin-4-amine	
110925-64-9	Triethylene glycol monoethyl ether	
1384199-95-4	1-Chloro-N-methyl-1-phenyl-2-propanamine	
73393-61-0	(+)-Chloroephedrine	
771434-80-1	(1R,2R)-(-)-Chloropseudoefedrine	
299-42-3	Ephedrine	
60-79-7	Ergometrine	
113-15-5	Ergotamine	
8006-80-2	Sassafras oils	
120-58-1	Isossafrole	
80532-66-7	Methyl-2-methyl-3-phenylglycidate	
13605-48-6	Methyl 3-(2H-1,3-benzodioxol-5-yl)-2-methyloxirane-2-carboxylate (pmk methyl glycidate)	
16648-44-5	Methyl alpha-acetylphenylacetate	
4676-39-5	Methyl piperonyl ketone	
14838-15-4	(-)-Norephedrine	
39742-60-4	1-Phenethyl-4-piperidone	
103-79-7	Phenylacetone	
120-57-0	Piperonal	
90-82-4	Pseudoephedrine	
94-59-7	Safrole	

CAS N°	PRODUCTS	THRESHOLDS
Category 2 Essential products in synthesis and extraction, including salts when they occur		
Category 2A		
108-24-7	Acetic anhydride	100 l
7723-14-0	Phosphorus	0.1 kg
Category 2B		
118-92-3	Anthranilic acid	1 kg
103-82-2	Phenylacetic acid	1 kg
110-89-4	Piperidine	0.5 kg
7722-64-7	Potassium permanganate	100 kg
Category 3 Refinery products		
67-64-1	Acetone	50 kg
7647-01-0	Hydrochloric acid	100 kg
60-29-7	Diethyl ether (or ethyl oxide)	20 kg
78-93-3	Methyl ethyl ketone (MEK or butanone)	50 kg
7664-93-9	Sulfuric acid	100 kg
108-88-3	Toluene	50 kg
Category 4 Drugs containing category 1 substances		
Drugs and animal drugs containing ephedrine or its salts		Aucun
Drugs and animal drugs containing pseudo-ephedrine or its salts		

Table 11 *Categories of drug precursors*

The list of controlled substances also applies to mixtures and natural products containing classified substances, provided they are easy to use and extracted by simple means, or provided they are financially viable.

Formalities

Depending on the product's category, various formalities apply to the holder. A person is appointed and tasked with ensuring that procedures and relations with agencies (ANSM, MNCPC, customs, etc.) run smoothly. At the CNRS, the unit director often takes on this duty.

- For narcotics and psychotropics: Research laboratories wishing to use, manufacture or transform products containing substances classified as narcotic or psychotropic must have obtained prior authorisation from the ANSM. Holding narcotic products with no justification incurs a criminal charge.

- For category 1 drug precursors: Users must first request an authorisation, with supporting documents, from the MNCPC. Authorisation is mandatory for any import, purchase, storage, manufacture, usage, and any intermediary operations involving these substances, whatever their quantity. The authorisation granted is valid for a fixed term and can be renewed. Users register with the MNCPC. Import and export of these substances also require authorisation from the MNCPC.

- For category 2 and 3 drug precursors: Users must register with the MNCPC for any import, purchase, storage, manufacture, usage, and any intermediary operations involving these substances, if their quantity exceeds the thresholds indicated. Thresholds cannot be aggregated across several laboratories. Export of these substances (if their quantity exceeds thresholds) also requires authorisation from the MNCPC.

- For category 4 drug precursors: For these drugs, only export requires authorisation.

Annual declaration: For category 1 and 2 narcotics and drug precursors, the competent person registered with the ANSM and/or the MNCPC must declare all commercial transactions and usage of the products listed every year. The declaration is mandatory and must be made even in the absence of any transaction in a given year.

Declaring a purchase: The client must declare any order of category 1 or 2 products to the supplier. It features the registration or authorisation number issued by the MNCPC, with details of the expected use of narcotics and precursors.

Destroying a drug precursor: A destruction report (waste tracking document – BSD – specific to the product) must be drawn up by an accredited company and a copy sent to the MNCPC.

Suspecting and reporting abnormal situations: Any suspected diversion, theft or disappearance of non-official usage of drug precursors must be reported to the MNCPC. In the same way, any loss, theft, disappearance or diversion of substances and preparations categorised as narcotic or psychotropic must be reported to the police, the ANSM and the regional health agency immediately.

Obligations and best practices

- Setting up safety measures:
  - Secure storage of narcotics and category 1 and 4 substances: products under lock and key and authorisation from accredited persons,
  - Surveillance of certain distillation devices or “solvent recyclers” which can be diverted in clandestine manufacture.

- Keeping an up-to-date register of narcotics and category 1 precursors that shows incoming and outgoing flows, quantities used and the name of the user. The register is supervised by the person who holds the authorisation. Stock monitoring must also be implemented for other categories of products.

- Informing staff and raising their awareness.

The MNCPC may conduct unannounced audits or inspections in public sector research laboratories, to check and assess the safety measures in place.

FIND OUT MORE

- *MNCPC: https://precurseurschimiques.entreprises.gouv.fr/fr*
- *ANSM: https://ansm.sante.fr/documents/reference/autres-produits-de-sante*
- *CNRS Prévention Infos n° 36*

VETERINARY DRUGS USED IN ANIMAL FACILITIES

Laboratories accredited for the use of animals for scientific purposes are authorised to regularly use veterinary drugs, only if they relate to the scientific procedures set out in the authorisation document. Labs also use veterinary drugs for the care of test animals. Depending on the drugs, different regulations govern their use, purchase and storage.

In France the use of veterinary drugs in scientific projects is governed by the Agence Nationale de Sécurité Sanitaire de l’alimentation (ANSES - French Agency for Food, Environmental and Occupational Health Safety), the Agence Nationale du Médicament Vétérinaire (ANMV - French Agency for Veterinary Medicinal Products) and the Direction Départementale de Protection des Populations (DDPP - French Departmental Population Protection Authority) where the establishment is located.

Veterinary drugs used strictly for test animals’ routine care in laboratory facilities require a qualified veterinary to issue a standard prescription.

If the drugs belong to the narcotic and psychotropic category, additional constraints apply (see “Les substances stupéfiantes et psychotropes” Narcotic and psychotropic substances - in this factsheet). Drugs for animal care are dispensed via a secure prescription.

Formalities

Regarding the use of veterinary drugs in experiments, laboratories must appoint one or several people responsible for purchases, stock management and drug usage. The person must be competent in the design or execution of experiment procedures, but they need not be necessarily qualified in veterinary medicine.

Usage must be declared to the ANSES-ANMV and the DDPP. Their duties are to:
- Ensure that supply orders are delivered by drug manufacturers;
- Manage the quantities held and ordered, commensurate with laboratory activities;
- Personally dispense drugs to experimenters;
- Ensure that their usage is carried out under expected conditions (according to therapeutic indications).

Obligations and best practices

The following obligations concern veterinary drugs in scientific projects. However, applying the same instructions for all the drugs used is recommended.

- Securing the storage of narcotic and psychotropic veterinary drugs and human medicinal drugs, based on poisonous substances used in veterinary medicine: products under lock and key, and authorisation from accredited persons;
- Keeping an up-to-date drug register that shows incoming and outgoing flows, the quantities used, the identification of animals treated and the name of the user. The register is supervised by the person who holds the authorisation and must be kept for ten years.
- Informing staff and raising their awareness on these points.

EXPLOSIVE PRECURSORS

Explosive precursors are chemicals (substances or mixtures) in common usage which can be diverted in the illegal manufacture of explosives for criminal or terrorist purposes. Regulations therefore restrict the public's access to certain chemicals. The Plateau d'Investigation sur les eXplosifs et Armes à Feu (PIXAF - Bureau of investigation on explosives and firearms) is a French national police force in charge of applying these restrictions.

List of controlled explosive precursors

The list of explosive precursors provides details of the way in which these substances are controlled, as they may enter into the composition of home-made explosives, especially those used in several terrorist attacks in Europe recently.

Table 12 *List of explosive precursors*

CAS N°	PRODUCTS
67-64-1	Acetone
7429-90-5	Aluminium powder
15245-12-2	Ammonium calcium nitrate
6484-52-2	Ammonium nitrate
10124-37-5	Calcium nitrate
7722-84-1	Hydrogen peroxide
13446-18-9	Magnesium nitrate hexahydrate
7439-95-4	Magnesium powder
100-97-0	Methenamine (or hexamine)
7697-37-2	Nitric acid
75-52-5	Nitromethane
09/04/3811	Potassium chlorate
7757-79-1	Potassium nitrate
77778-74-7	Potassium perchlorate
09/09/7775	Sodium chlorate
7631-99-4	Sodium nitrate
7601-89-0	Sodium perchlorate
7664-93-9	Sulphuric acid

Obligations and best practices

Concerning research laboratories, few obligations derive from regulations on explosive precursors. The latter may be authorised in an occupational context but certain products require a usage declaration from the supplier. If in turn the laboratory sells these products on, it will have to request the same declaration from their clients. In any event, public and private agencies must secure and monitor their storage. They must also keep an inventory of hazardous substances stored, so that any thefts or loss can be quickly detected and reported to the authorities via the Pixaf platform. These measures are taken as part of the French security alert system (Vigipirate) to mitigate the risk of terror attacks in France.

FIND OUT MORE

- *PIXAF: pixaf@gendarmerie.interieur.gouv.fr - 01 78 47 34 29 (24 /7)*

Secrétariat général de la Défense et de la Sécurité nationale
(Secretariat-General for National Defence and Security):
http://www.sgdsn.gouv.fr/plan-vigipirate/

CHEMICAL WEAPONS AND THEIR PRECURSORS

Certain chemicals in common use in the chemical industry, toxic or not, can be used for malicious intent in the manufacture of chemical weapons. The Convention on the Prohibition of Chemical Weapons (CWC) is the international regulation that provides details of the rules on controlled substances. The Organisation for the Prohibition of Chemical Weapons (OPCW) implements the convention, which is incorporated into the French Defence Code. The use, development, manufacture, storage, possession, conservation, purchase, sale, import, export, transport, trade and brokering of chemical weapons are all prohibited in France. The use of chemical substances and precursors entering in the composition of chemical weapons is closely supervised by the prohibitions, authorisations and annual declarations issued by the authorities.

In France, the Defence and Security Senior Official's team in the Ministry of the Economy and Finance is tasked with the implementation of the provisions derived from the CWC. The team works with the Institut de Radioprotection et de Sûreté Nucléaire (IRSN – Institute for Radiological Protection and Nuclear Safety) to carry out all technical tasks and to act as a point of contact.

List of OPCW controlled chemicals

The list of controlled chemicals in the CWC are broken down into three tables (T1, T2 and T3) according to usage in industry and the risk of their being deployed as chemical weapons. Each table is in two parts: toxic chemicals (subdivision A) and chemical precursors used in the manufacture of toxic chemicals (subdivision B). They can be identified substances or groups of chemical substances.

The full list of products can be found in **Appendix 5**, and also on the IRSN website: **https://non-proliferation.irsn.fr/Pages/default.aspx**

Note that this list can comprise products liable to be used in research such as 2-O-isopropyl methylphosphonofluoridate (sarin) (107-44-8), ricin (9009-86-3), saxitoxin (35523-89-8) and arsenic trichloride (2B7 7784-34-1).

Formalities

Any research activities involving OPCW controlled chemicals must make a request for authorisation and/or declaration if annual quantities and concentrations in the mixtures used exceed regulatory thresholds. The requests are to be made with the Defence and Security Senior Official's team in the Ministry of the Economy and Finance as well as with customs offices in the case of import. Past and present declarations of activity are to be sent to the IRSN within prescribed time limits. These declarations can be checked and unannounced inspections on site may be carried out by the OPCW and the IRSN.

The activities involved and thresholds can be found in **Table 13** :

OPCW TABLES	**AUTHORISATION DECLARATION**	**ACTIVITIES**	**MASS FLOW RATE** *(per establishment and per year)*	**CONCENTRATION THRESHOLD**
Table 1	Authorisation Declaration	Manufacture, Storage, Processing, Consumption, Sale, Purchase, Import, Export	None	None
Table 2	Declaration	Manufacture, Processing, Consumption,	1 kg - 1 tonne	1 - 30 %
		Import, Export	100 g - 100 kg	
Table 3	Declaration	Manufacture,	30 tonnes	30 %
		Import, Export	1 tonne	
PCOD	Declaration	Manufacture*	200 tonnes	None
PSF			30 tonnes	

Table 13 *OPCW tables*

Under the regulations, laboratories that manufacture synthetic products for scientific purposes, with quantities no greater than 100 g each year for chemicals in Table 1, are not subject to this authorisation. However, laboratories planning to conduct this type of activity must request an authorisation for activities connected with production by synthesis: possession or conservation for example. Sending chemicals listed in **Appendix 5** to a country which is not a party to the CWC is prohibited. All transfers of chemicals listed in **Appendix 5**, from or to other countries party to the CWC, whatever their quantity or concentration, require prior notification to the IRSN at least 60 days before the transfer.

Obligations and best practices

The danger and possible risk involved in these chemicals being diverted means that the substances must be accounted for, in order to monitor stocks. Storage of these products must be secure and only authorised staff can enter the storeroom. Any loss or misuse of these products must be reported to the authorities.

FIND OUT MORE

- *IRSN: https://non-proliferation.irsn.fr/Pages/default.aspx*
- *OPCW: https://www.opcw.org/fr*

FACTSHEET 21 • NANOMATERIALS

The following recommendations are for laboratories which use or produce nanometre-sized materials and objects. Depending on risk assessment, they can be added to those in **Chapters 5.2 and 5.3** and in **Factsheet 9**.

Laboratory design

- These laboratories must be identified and signalled clearly. The premises must be separate from office-type areas and access must be restricted to trained and authorised persons (following medical advice).

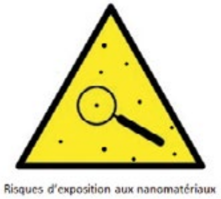


Figure 12 *Example of a sign*

- Access via an intermediate area is recommended. This should comprise a changing room where appropriate PPE is placed and worn PPE is disposed of in closed bins.
- Air in the laboratory must be exhausted outside, away from areas for incoming fresh air and after filtration (HEPA > H13 in accordance with standard EN 1822-1).

Product storage

- The nano material buffer stock for short-term needs in the laboratory requires ventilated cabinets to be installed. They must be specific to nanomaterials and identified as such.
- Storage in a controlled atmosphere (nitrogen gas for example) can be recommended for certain nanopowders (aluminium, magnesium, lithium, carbon nanotubes etc.).
- Manufactured or unpackaged nanomaterials must be stored and transported in sealed and closed containers, preferably in double containers: two bags, a can in a bag, etc.
- These containers must show a label mentioning the presence of nanomaterials, for example, “Contains nanomaterials” in addition to the nature of the chemical, and regulatory labelling (as well as, where possible, information ensuring the traceability of products: name of the operator, date, etc.).

Waste management

- Nanomaterial waste must be treated as dangerous waste.
- Nanomaterial waste must be parcelled in sealed, closed and dedicated packaging. It must display a label mentioning the presence of nanomaterials. Using a double package is strongly recommended.
- Companies that collect and treat waste must be informed of the presence of nanomaterials.

Good laboratory practices

- Any handling of nanomaterials (especially nanopowders), and in particular the packaging, unpackaging and fragmentation of nanomaterials must be carried out in a ventilated enclosure.
- Limit nano aerosol production in work processes during cleaning, equipment and installation maintenance, as well as in an emergency response. Prohibit the use of a domestic-type air blower, brush, broom or vacuum cleaner.
- Undertake a damp clean frequently and systematically (or use an industrial vacuum cleaner equipped with filtration HEPA > H13 in line with EN 60335-2-69 and in compliance with ATEX regulations if required) of work surfaces (floors, benches, etc.), equipment and supplies.
- Provide dedicated PPE appropriate for exposure type and duration to staff who conduct experiments and can be exposed:
  - Respiratory protection: mask with an FFP3 filter,
  - Skin protection: disposable lab coat made of non-woven fabric or type 5 air-tight protective garment used against solid particles, with sleeves covering wrists and appropriate gloves.
- Introduce a procedure explaining work methods, high-risk stages, prevention and protection measures, appropriate cleaning methods, waste management, what to do in the event of spillage or in the case of accident or incident.

DECLARATION OF “ SUBSTANCES IN NANOPARTICULATE STATE”

This procedure concerns the manufacture, import and distribution of more than 100 grams per year of “substances in nanoparticulate form” (with at least one dimension measuring between 1 and 100 nm) or mixtures not bound to these substances; or materials intended to release them in normal conditions or in reasonably predictable use conditions.

Every year before May 1, the host institution must make a declaration on the previous year’s activity by electronic means via the following information system (**https://www.r-nano.fr/**). The declarations must provide details of substance amount and use in 10 predefined categories (carbon, noble metals, transition, metals, etc.).

The nanomaterials officer aggregates data from the research units hosted by the CNRS and undertakes the declaration.

The aim of this procedure is to: gain a better understanding of the substances placed on the market and their quantities and usage; be able to trace usage channels to the last professional user; to collect information on the substances’ toxicological, and ecotoxicological properties and make them available to the public.

FIND OUT MORE

- *«Les nanomatériaux manufacturés. Définitions, effets sur la santé, caractérisation de l’exposition professionnelle et mesures de prévention» (Manufactured nanomaterials. Definitions, impact on health, characterisation of occupational exposure and prevention measures), ED 6050, INRS ;*
- *«Nanomatériaux. Prévention des risques dans les laboratoires» (Nanomaterials. Risk prevention in laboratories), ED 6115, INRS ;*
- *Note CNRS relative à la prévention des risques liés aux nanoparticules (CNRS note on risk prevention associated with nanoparticles), March 2013.*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