TRAINING MANUAL

- AGRICULTURAL PRODUCTION AND PROCESSING -

OPERATOR SAFETY AND GOOD CROP PROTECTION PRACTICES

COLEACP

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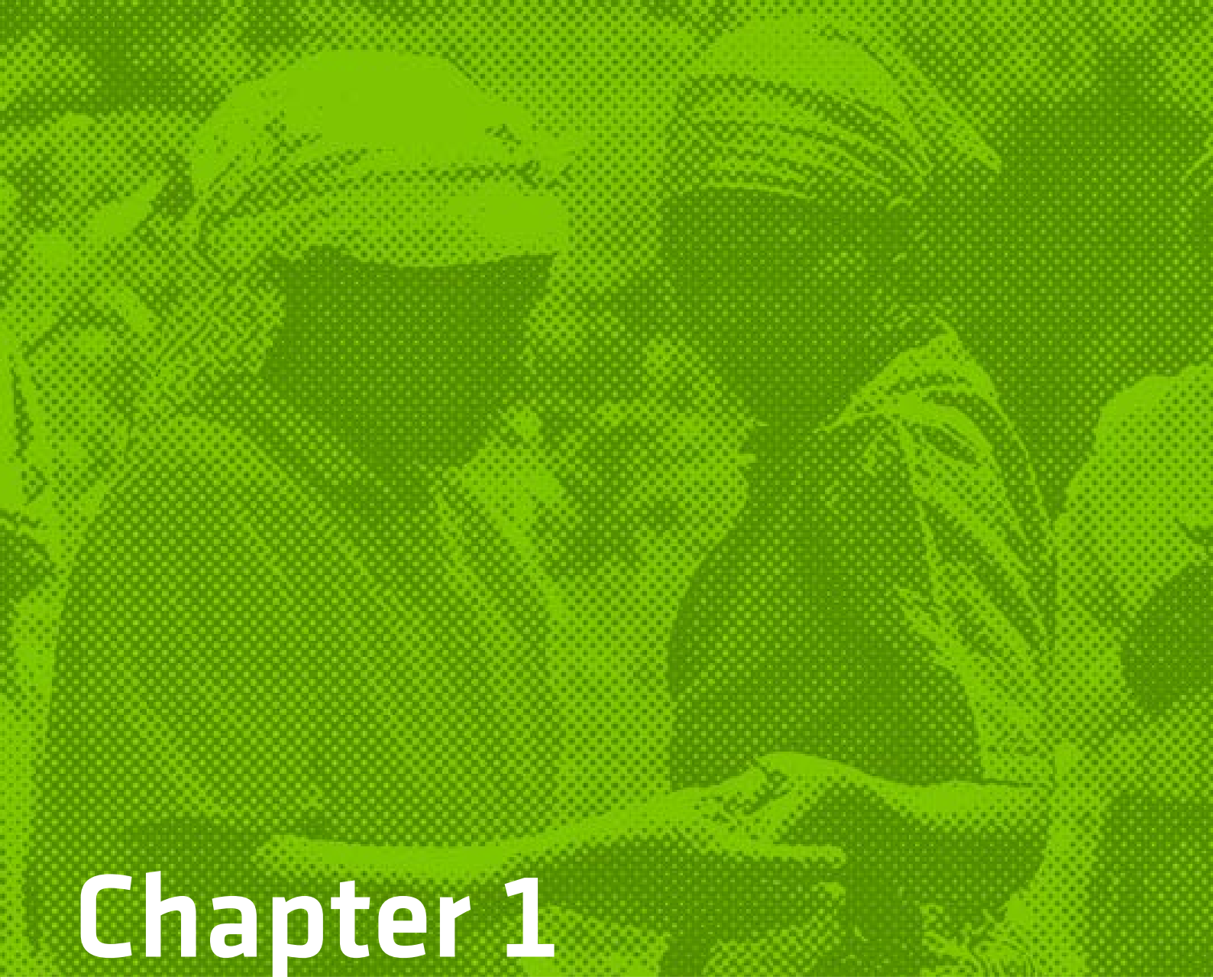

Chapter 1

Risk analysis, safety and health policy

1.1. Occupational risk analysis: challenges and definitions

1.1.1. Occupational risk analysis: an economic and social challenge

Apart from their human consequences, incidents or accidents[1] that occur in the workplace have a financial cost due to damage, but can sometimes have much higher indirect costs: wasted time for employees, repairs to damaged equipment, overtime to make up for delays, costs of legal actions, higher insurance premiums, loss of clients, damage to image and so on. 'Risky' situations/practices in the company hinder the work process and can lead to less motivation, lower productivity and non-conformity. They also add to overload and work pressure on operators.

Occupational risk assessment (ORA) and prevention should therefore be **built into company management**. This forms an ethical, and in most countries, statutory, part of the responsibilities of a company director. Occupational risk analysis fits into the framework of corporate social responsibility (CSR).

One of the nine guiding principles of the Ethical Trading Initiative (ETI) Base Code states the following with regard to **working conditions:**

- A safe and hygienic working environment shall be provided, bearing in mind the prevailing knowledge of the industry and of any specific hazards.
- Adequate steps shall be taken to prevent accidents and injury to health arising out of, associated with, or occurring in the course of work, by minimizing, so far as is reasonably practicable, the causes of hazards inherent in the working environment.
- Workers shall receive regular and recorded health and safety training, and such training shall be repeated for new or reassigned workers.
- The company observing the code shall assign responsibility for health and safety to a senior management representative.

Assessing risks,[2] ranking them, defining priorities for action and implementing solutions will help to prevent incidents and accidents and to improve the company's yield and performance.

Occupational risk assessment is **the first stage of a successful occupational safety and health policy**. Occupational risk assessment is a three stage process:

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1 *Incidents* include cases of hazards, occupational illness and serious near-accidents. An *accident* is an unforeseen event that results in bodily injury or damage to property or the environment (*cf.* below – Investigating accidents).

2 Depending on the country, either on a voluntary basis or in accordance with regulations.

1. **Identify the risks**: identify hazardous situations in the company by observing the tasks actually carried out at different work stations and by engaging in dialogue with the people who perform them.
2. **Assess the risks**: use all available information (literature, data bases, Internet) plus all the company's documentation and input (accident records, employees' experience, facts established by management and the occupational health officer, accident statistics, number of sick-leave days etc.).
3. **Plan preventive actions**: for every risk identified as a priority, determine the most appropriate prevention measures. Follow up and carry out these preventive actions.

The result of such an analysis can be presented in the company in the form of a synoptic table or easy-to-read 'scoreboard':

OCCUPATIONAL RISK ANALYSIS TABLE		
Stages	**Risks**	**Risk reduction**
Every task can be divided into stages. This set of stages will make up the framework of the occupational safety process.	All risks associated with every stage of the work process.	What measures can be taken to reduce every identified risk? At the source? Along the chain? At the level of the individual worker?

1.1.2. Identifying occupational risks (chemical, physical and biological hazards)

❑ Hazard and risk

It is important to make a distinction between the terms 'hazard' and 'risk':

- **Hazard**: an item, substance or situation that can potentially cause bodily or material injury or that has a demonstrated **harmful effect** on health. For pesticides, for example, the 'hazard' relates to the **product's toxicity** (that of either the active substance or the formulation).
- **Risk**: the **probability** or likelihood of injury or harm occurring. The degree of risk resides in both the probability and severity of the result (type of injury, number of persons affected, etc.). For pesticides, for example, 'risk' relates to **exposure to the product.** If exposure is avoided, risk is managed to an acceptable level.

Hazard and risk: an example

A toxic chemical substance (such as potassium cyanide - KCN) stored in a bottle always represents a hazard, whether it kills someone or simply remains on a shelf; it still has the same potential to cause injury.

The risk here is the probability that the bottled substance actually poisons someone. In this example, it would be the probability that the chemical substance comes into contact with the body, is absorbed and causes a trauma or even the death of the person exposed. The extent of the risk should also take into account the quantity released and the number of persons exposed to the hazard.

A lethal dose of KCN (100 to 200 mg)

❑ Identifying hazards

Whatever the size of the company, potential hazards can be identified more easily by **considering the entire production process** as being made up of three separate phases for which specific hazards can be identified:

- **entry and storage of raw materials**, including fuels;
- **production processes**, including packing;
- **exit and storage of finished goods**.

Hazard identification should also include **the consequences of any incident on installations or equipment** upstream or downstream of the process reviewed. For example, a break in a pipe for liquids or gases following an accident, resulting in the escape of dangerous fumes or vapors.

Hazards can be **identified by simple means**, such as:

- inspecting the workplace, including outdoor areas such as fields or orchards;
- observing a situation or occupational activity;
- holding discussions with the people involved in the activity, including seasonal workers, sub-contractors, outgrowers associated with production, grassroots buyers, drivers etc.;
- referring to labels, handbooks or data sheets put out by manufacturers or suppliers (in particular the 'Safety Data Sheet – SDS');
- referring to a hazard checklist;
- referring to reports on accidents/incidents in the company or in other companies with the same type of activity.

In addition to obvious hazards resulting from workplace conditions or the way the work is performed, **a range of 'human factors' must also be taken into consideration** as illustrated by the photograph of the people cutting the hedge.

For example:

- Do workers have the **required level of training and all the skills needed** to perform the task safely? (skills that are truly able to be put into practice).

- Is appropriate information on hazards and risks provided to workers? (raising awareness, training, signs indicating potential dangers).
- Are workers subject to high work-related stress? (working in a rush may mean not observing proper safety instructions).
- Are staff educational levels suited to the work? (do staff members understand and hence be able to follow instructions?).
- Do workers consider it useful to wear personal protective equipment (PPE) and safety gear, even when it is made available at no charge (insufficient motivation. Are there sanctions for not observing procedures?).
- Are certain workers likely to become over-fatigued? (higher risk of accidents in relation to strenuousness and/or duration of work).
- Are certain tasks very repetitive? (possibility of concentration loss).
- Do organizational changes give cause for resentment or worry? (situation of heightened anxiety).

The incredible human factor!

An integral part of risk assessment involves identifying individuals or groups who might be **particularly at risk.** Such groups or individuals can include all employees and workers. Of particular concern may be:

- owners and senior management when out of their usual work environment;
- young people (trainees, students);
- pregnant women;
- accident prone individuals;
- elderly persons;
- persons with language, reading or color perception difficulties (e.g.: the color-blind);
- persons with physical disabilities or suffering from disturbances of sensory perception (including on a temporary basis).

❑ Risk assessment and planning of measures

Assessing the potential risks of every hazard identified at the work station, before things go wrong or before accidents or occupational illnesses occur, is a crucial preliminary to developing a relevant preventive action plan.

Assessment of **risks** can be defined as identifying hazards associated with a task or activity and an **estimate of the scope of the risks involved**, taking into account any precautions already in place. This involves:

- identifying **all** hazards (chemical, physical and biological);
- assessing the risks proper (= risk characterization);
- making a record of precautions already in place.

Depending on the nature of the workplace, more detailed risk assessments might be necessary (and can sometimes be required by national regulations). This is generally the case when special risks are present and a more specific evaluation is therefore needed to identify hazards and assess risks. For example:

- Chemical substances: a special assessment is necessary that takes account of the form, quantities and inherent dangers.
- Manual handling: an assessment is necessary that takes account of factors such as load, task, workplace environment, and individual aptitude.
- Fire safety: a review of all fire hazards and of the prevention and protection measures required (e.g.: fire doors, extinguishers, and posting of safety pictograms, signal words, etc.).

Even for detailed 'special' assessments, the operator risk analysis (ORA) methodology used (detailed below) will be basically the same.

No open flames

1.2. Description of main hazards

1.2.1. Classification of hazards

Given the large number of hazards, a guide in the form of a 'memorandum' is attached.

To classify hazards, it is preferable to refer to the 'Globally Harmonized System' (GHS). The 'Globally Harmonized System of Classification and Labelling of Chemicals' (GHS)[3] is a set of recommendations drawn up at international level by the United Nations Economic Commission for Europe (UNECE). These harmonize:

- the **classification criteria** used to identify the hazards of chemical substances;
- communication on these hazards (content of the label and of the safety data sheet).

The GHS recommendations were drawn up on the basis of existing classification and labelling systems in order to **create a single global system**. The GHS is implemented in Europe in the fields of labor and consumption through a new regulation known as the '**CLP Regulation**', namely Regulation (EC) 1272/2008 on the classification, labelling and packaging of substances and mixtures.

Based on their nature, the different 'hazards' are grouped into **28 hazard classes**:

There are 16 classes of physical hazards

1. explosives (substances)
2. flammable gases
3. flammable aerosols
4. oxidizing gases
5. pressurized gas
6. flammable liquids
7. flammable solids
8. self-reactive substances and mixtures
9. pyrophoric liquids (can ignite spontaneously at relatively low temperature)
10. pyrophoric solids (can ignite spontaneously at relatively low temperature)
11. self-heating substances and mixtures
12. substances and mixtures that emit flammable gases in contact with water
13. oxidizing liquids
14. oxidizing solids
15. organic peroxides
16. substances or mixtures corrosive to metals

[3] The GHS is a set of international recommendations but its implementation is not mandatory. Implementation of the GHS varies from one country to the next. It is therefore important to refer to national regulations in this area. For additional information, see: www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html.

There are 10 classes of health hazards

1. acute toxicity
2. skin corrosivity/irritation
3. serious damage to eyes/irritation
4. respiratory and skin sensitization
5. germ cell mutagenicity
6. carcinogenicity
7. reproductive toxicity
8. specific target organ toxicity – single exposure
9. specific target organ toxicity – repeated exposure
10. aspiration (breathing) hazard

There **are 2 classes of environmental hazards**

1. hazardous to the aquatic environment
2. hazardous for the ozone layer

The hazard classes are divided into 'categories'.

For each hazard category, the regulation establishes a **pictogram**, a **signal word,** a **hazard statement** and **precautionary statements**:

- A *'**hazard pictogram**'* is a graphical composition that includes a symbol plus other graphic elements, such as a border, background pattern or color that is intended to convey specific information on the hazard concerned.[4]

Example: Hazardous to the aquatic environment

- A *'**signal word**'* is a word that indicates the relative level of severity of hazards to alert the person to the potential hazard; the following two levels are distinguished:

  *'**Danger**'* is a signal word indicating the more severe hazard categories

  *'**Warning**'* is a signal word indicating the less severe hazard categories

- A *'**hazard statement**'* is a phrase assigned to a hazard class and category that describes the nature of the hazards that may result from a hazardous substance or mixture, including, where appropriate, the degree of hazard.

[4] See Annex: the hazard pictograms according to the GHS and their definition

An individual alphanumeric code made up of the letter '**H**' (for 'Hazards') and three digits is assigned to each hazard statement:

H2##: physical hazards
(e.g.: H225 = highly flammable liquid and vapor)

H3##: health hazards
(e.g.: H350 = may cause cancer)

H4##: environmental hazards
(e.g.: H400 = very toxic to aquatic life)

- A *'**precautionary statement**'* is a phrase that describes recommended measures to minimize or prevent adverse effects resulting from exposure to a hazardous substance or mixture due to its use or disposal.

P1##: General precautionary statements
P102 = keep out of reach of children

P2##: Prevention precautionary statements
P233 = keep container tightly closed

P3##: Response precautionary statements
P330 = rinse mouth

P4##: Storage precautionary statements
P405 = store locked up

P5##: Disposal precautionary statements
P501 = Dispose of contents/container to …

Annex III of Regulation (EC) 1272/2008 reproduces the list of H and P hazard statements as well as certain additional codes specific to Europe.

These elements must be shown on the label. Their arrangement and the way the label is affixed to the packaging is regulated. In addition to identifying the supplier and product identifiers, labels may also contain additional information such as pre-harvest interval (the time that must be left between applying a pesticide and harvesting of the crop)

1.2.2. Nature of chemical hazards

Chemical substances can have harmful effects on operators, other workers, the public, wild fauna and flora and the environment. The effect on health depends on the **form** and **concentration** of the substance, the duration and frequency of exposure and sometimes, the individual's susceptibility to exposure. Poor working conditions can have a serious and immediate impact on health, even after a single exposure, or can cause long term (chronic) effects and/or incapacitating illness in case of repeated exposure. Sometimes the harmful effects only show up many years later, such as when dusts breathed in during work cause lung disease later in life.

The health effects of chemical substances are listed below:

- Acute lethal effects.
- Irreversible non-lethal effects after a single exposure.
- Serious effects after repeated or prolonged exposure.
- Corrosive effects.
- Irritating effects.
- Sensitizing effects.
- Carcinogenic effects.
- Mutagenic effects.
- Effects toxic for reproduction.

The last three categories are known as CMR effects (Carcinogenic – Mutagenic - Reprotoxic).

Substances and preparations classified as **toxic** are those that can cause death or serious or chronic disorders through inhalation, ingestion or absorption through the skin. A **carcinogenic** substance can cause or increase the incidence of cancer through inhalation, ingestion or penetration of the skin. A **mutagenic** substance can cause or increase the incidence of hereditary genetic defects. These substances may enter the body through inhalation, ingestion or penetration of the skin.

Many **toxic** materials are used, among which many are capable of killing living organisms (**biocides). M**any **plant protection products** are in this category.

To know whether a substance is hazardous to health, and the degree of hazard it poses, the following factors must be taken into account:

- different forms of the same substance can cause different hazards (e.g. a solid can represent a negligible hazard but can be very dangerous in the form of dust that can be inhaled);
- some substances have a fibrous form that can present a potentially serious health hazard if the fibers have a certain size or shape (e.g. asbestos, flour) that can enter the lungs;
- although certain substances are known to be harmful to health, the causal agent has not always been identified (e.g.: certain textile dusts that cause the severe lung disease, byssinosis);[5]
- combined exposures to different substances can have an effect that is much greater than expected, termed synergistic effects (e.g.: pyrethroid + organophosphate insecticides) and/or cumulative effects (e.g.: dioxins and PCB);
- temporary exposures can have a delayed effect (long-term toxicity);
- epidemiological data may indicate that a micro-organism or its products are the cause of a health hazard at the workplace.

[5] An occupational illness linked to inhalation of fibers in cotton spinning mills.

❑ Liquids

It is estimated that **two thirds** of all industrial accidents caused by chemical substances are skin lesions resulting from body contact with acid or alkali liquids, which have corrosive effects.

❑ Dust

Dust is made up of solid particles and formed by operations such as grinding or sifting of solid matters, controlled detonations and various drying processes. Powdered pesticide formulations (DP, WP) emit toxic dust when packaging is opened and emptied. They are consequently potentially contaminating formulations for operators and dust masks need to be worn when handling.

In still air, dust tends to settle due to the effect of gravity and accumulations of dust can present a serious exposure and/or explosion hazard.

Constant exposure to toxic dust can lead to pulmonary lesions. Cancer or poisoning can also result from the inhalation of toxic dust (e.g.: asbestos, pesticides).

❑ Fumes

Fumes are gases or smoke sometimes created by processes involving heat. When metals are raised to high temperature the fumes are generally metal oxides and these can be highly toxic. Lead, cadmium, zinc, copper and magnesium are particularly hazardous and inhalation of their fumes can lead to what is known as 'metal fume fever'. Some chemicals such as bleach also give off fumes that are hazardous. Although the complete elimination of exposure often results in a total cure in a matter of days, risk management systems should avoid or minimize exposure to fumes.

❑ Mist

Mist consists of fine droplets suspended in air that are formed by the condensation of a gas, the atomization of a liquid or sprays. Mists are created by many industrial processes such as chromium plating or the charging of lead batteries and can represent a serious hazard. In these cases the mists are the result of a chemical reaction, but many other processes such as painting or applying pesticides make use of potentially dangerous mists.

❑ Vapors

A vapor is the gaseous form of a solid or a liquid. Increases in temperature raise the vapor pressure, but even at room temperature some organic solvents give off poisonous vapors. When opened, some industrial cleaning products and solvent-based pesticide formulations (EC, UL) emit toxic vapors.

Mercury is a particularly hazardous chemical substance. It can vaporize at ambient temperature and create a toxic atmosphere so Organic mercury is very volatile and gives rise to a long-term occupational exposure standard of 0.01 mg/m³. It is therefore recommended to avoid the use of mercury thermometers in production areas.

❑ **Gas**

A gas is a chemical substance that is neither solid nor liquid. Gases expand to fit the space in which they are enclosed. Volume and state of many chemicals can be altered from gas to liquid and/or solid by the combined effect of pressure and/or temperature. Many toxic chemicals are used in industry, such as chlorine, hydrogen sulphide etc. are used in gas form. These gases are irritants for the nasal passages and respiratory tract. This hazard needs to be controlled in the workplace to reduce the risk of workers being harmed.

1.2.3. Nature of biological hazards

The biological hazards to be taken into account in the workplace are mainly micro-organisms that are called pathogens. Pathogens may be bacteria, viruses, protozoa, large parasites and fungi that are capable of causing illness or infections by entering the body. .

❑ **Fungal agents**

This category includes fungi, moulds and yeast. Fungal diseases sometimes appear in the form of an allergic or immune reaction, namely asthmatic and/or flu-like symptoms following the inhalation of dust or air contaminated by fungi, such as wood fungi in roofs. They may also cause food poisoning when food contaminated by fungal pathogens is eaten.

❑ **Bacteria**

Bacteria are a large group of single-cell microscopic organisms. Most are harmless, but some are pathogens that need to be considered in places that prepare food. For example: zoonoses – bacterial infections in animals that can be transmitted to humans. Anthrax and brucellosis are commonplace examples.

❑ **Viruses**

A virus is a simple organism that can reproduce in cells. Pathogenic viruses cause diseases such as Hepatitis B, a serious form of jaundice, common among medical personnel and refuse collectors, caused by contact with blood or excrement of patients suffering from viral hepatitis.

In addition, a large variety of biological agents other than micro-organisms can be harmful to health as a result of exposure to their metabolic by-products that are toxic to humans, or to substances they create and use. They can stimulate an allergic reaction among persons exposed (e.g.: irritation caused by the manual handling of certain types of bulbs by horticulturists).

1.2.4. Nature of mechanical hazards

These risks are present when operating or maintaining machinery.

For people carrying out maintenance on machinery, the greatest risk lies in accidents caused when the machinery starts up while the machines are undergoing the maintenance. This often happens when the individuals who routinely start up the equipment do not see the maintenance engineer and do not realize that it has been stopped to protect the engineer. The situation can arise up due to misunderstanding, negligence or lack of knowledge/training. The power supply must be isolated (switched off and shut down), preferably with a fuse removed, otherwise an accident can occur easily. There must be a controlled procedure for restarting equipment after maintenance, including requirement for specific authorization.

It is not always possible for every part of a complex machine to be isolated at the same time, in which case each section should be isolated in turn and special precautionary measures taken. The isolation methods used most often are:

- Removing a fuse.
- Locking the on-off control lever.
- Removing the transmission belts.
- Locking the clutch.
- Using key locking systems.

The use of key locking systems enables several people to work on the same installation without the risk of one of them completing the work and switching on the machine, thus endangering the others. A key is given to each person and the lock can only be opened once all the keys have been inserted and turned.

1.2.5. Nature of electrical hazards

Electrical hazards are often misunderstood or not treated seriously enough. Due to the high level of risk and the severe consequences of switching errors and other negligence, it is essential for a comprehensive safety system to be in place for all work on high-voltage equipment.

All work on sub-station equipment must be covered by a work authorization system to ensure safe conditions.

The effects of electrical hazards on the body: if a live wire is grasped and provokes an electric shock, the arm muscles contract and the person may continue to hold on to the wire involuntarily. This will continue as long as the current flows because the current destroys the body's normal control. A person holding a source of current cannot let go. The First Aider must disconnect or switch off the electrical power before approaching such a victim.

Want to improve your safety knowledge?

An electric shock can also lead to secondary causes of trauma such as burning at the point where the current passes through the body. With some shocks the involuntary muscular reaction can be so violent that the muscles and tendons in the arm can be torn.

In most cases, the shock surprises the victim and causes a momentary loss of control and balance, which may cause a fall. A fall from the top of a ladder can lead to more serious injuries than the electrical discharge!

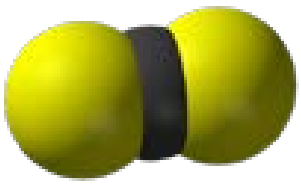
Different variables will affect the severity of an electric shock for a specific person. For instance, the skin's electrical resistance is relatively low in the case of a child with a soft, damp hand and higher in the case of an adult manual worker with hard, dry hands. The current's path through the body also comes into play and damage may be limited to the hand if the current enters and leaves the body there. If the person is not connected to earth the current may not pass through the body and hence not cause a shock at all. Where a shock occurs the victim's overall state of health may affect the severity of the trauma. However many shocks are lethal.

1.2.6. Nature of hazards related to flammable liquids and gases

Many industrial fires and related traumas are caused by flammable liquids and gases. Many fuels, solvents and **pesticide formulations** are flammable.

Certain substances can also generate flammable gases.

Dithiocarbamates (mancozeb, maneb, metiram etc.) decompose in a damp environment, producing carbon disulphide (CS_2). Carbon disulphide is a dense and volatile liquid that is highly flammable in the air, has a remarkably low self-ignition temperature and is extremely sensitive to static electricity. There have been a number of cases of fires in factories and warehouses.



Carbon disulphide

1.3. Exposure to cleaning and disinfectant products

1.3.1. Particular characteristics of the agri-food industry

Occupational risks for this type of activity occur mainly during **cleaning and disinfecting operations** which are an essential part of food operations. In addition to hygiene rules applying to firms where foods are handled and packed, consumer safety is assured by cleaning and disinfecting installations at regular intervals.

In many cases, a cleaning and/or disinfectant solution is applied in the form of a foam, in order to improve the contact between a chlorinated alkaline (the product used most often) and the surface to be treated. Floors, work surfaces, instruments and devices are also frequently disinfected with chlorinated water. Eye and respiratory irritations have been described following exposure. The presence of **chloramines** is apparently the cause of the irritations observed. These chloramines (mainly nitrogen trichloride) are produced in the atmosphere by a series of chemical reactions between chlorine and nitrogen-containing pollution from the products and plant or animal waste resulting from the manufacturing process. A recent study showed that this reaction also occurs with the preparation of fresh ready-to-cook vegetables, between the vegetable waste and chlorine by-products (hypochlorous acid, hypochlorite), resulting in the formation of chloramines.

Other disinfectants that are well known for their irritating characteristics, such as **formaldehyde** or **glutaraldehyde**, aminoxide and cresol, are widely used in the agri-food industry. These disinfectants are often associated with quaternary ammonium.

The high exposure levels encountered can often be put down to a **lack of time** allowed for cleaning tasks. Operators are sometimes not well informed about the nature of the products they use and may tend to **increase the amount** of the active product in order to obtain acceptable cleaning quality in a shorter period of time.[6]

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6 G. HECHT, M. HÉRY, I. SUBRA, J.M. GERBER, G. HUBERT, F. GÉRARDIN, S. AUBERT, M. DOROTTE and D. PELLE-DUPORTE, ‘‘Exposition aux produits chimiques dans l’industrie agro-alimentaire. Les risques professionnels lors d’opérations de nettoyage et de désinfection’’ *(Exposure to chemical substances in the agri-food industry. Occupational risks of cleaning and disinfecting operations), Cahiers de notes documentaires - Hygiène et sécurité du travail* (Documentary notebooks - Occupational health and safety), INRS, No. 176.

1.3.2. Nature of traumas

Trauma is a serious injury or shock to the body.

❑ **Inhalation trauma**

The respiratory tract is particularly vulnerable in corrosive and toxic atmospheres. When inhaled, all chemical substances carried in gas, vapors, dust, fumes or sprays contaminate the nose, throat, mouth and the rest of the respiratory tract, depending on the extent of the exposure.

❑ **Ingestion (swallowing) trauma**

The risk of trauma through accidental ingestion of chemical substances is also considered serious in agri-industrial processes.

The main danger of ingestion of a chemical substance resides in the lack of personal hygiene, i.e. not washing one's hands before eating, smoking or drinking, or in dust suspended in the air that can enter the mouth and be swallowed.

❑ **Contact/absorption trauma**

Immediate and serious dangers can result from **contact of the skin** with chemical compounds such as chlorinated solvents, hydrocarbons, etc. Such absorption in the body can cause serious injury to internal organs.

Surface-active products (‘wetting agents’) can cause serious **eye** irritations, as can solvents, which also have a caustic action on the skin.

Concentrated detergent solutions (e.g., sodium hydroxide, potassium hydroxide) are corrosive and can cause burns if they come into contact with the eyes. The danger is greater when such solutions are warm. Acidic solutions used to eliminate traces of limestone scale left by water are also aggressive.

1.4. The Occupational Risk Analysis (ORA) process

To carry out an occupational risk analysis (ORA), proceed as follows:

1. **divide** each process/task into its basic stages: draw up a process diagram;
2. **identify** the hazards associated with each stage;
3. **assess**, for each stage, the risks related to these hazards (probability x severity);
4. **select** the priority risks;
5. **propose solutions and develop control measures** for each of the risks identified.

OCCUPATIONAL RISK ANALYSIS FORM		
Stages	**Risks**	**Risk reduction**
Every task can be broken down into stages. This set of stages forms the framework of the workplace safety process. It is essential to take a precise inventory of all the stages implemented for every task. Be sure to note everything the worker does. Once each stage is described, review your notes and synthesize the descriptions by eliminating useless details. Limit the number of stages that you record. If a single task includes too many stages, consider dividing it into two tasks. No more than 15 stages. **Workers must play an active part in this analysis.**	All risks associated with every stage of the work. • Risks related to work equipment • Risks related to chemical substances • Manual handling of hazardous substances • Risks related to electrical installations • Physical risks • Risks related to manual work, handling and transport activities • Risks of fire and explosion • Risks related to flammable gases • Risks related to premises	What measures can be implemented to reduce each of the identified risks? At the source: - *Elimination* - *Substitution* - *Change* - *Isolation* - *Automation* Along the chain: - *Change of location* - *Barriers* - *Absorption* - *Dilution* At the level of workers: - *Administrative controls* - *Initiation, training and supervision* - *Work procedures* - *Planning of emergency measures* - *Maintenance of premises* - *Hygiene practices* - *Personal protective equipment*

1.4.1. Assessment of occupational risks

The level of risk is based on both the likelihood of an incident or accident occurring and the gravity of its consequences.

❑ **The different approaches**

Assessing the level of risk amounts here to speaking of a **risk score (seriousness of the risk)**. Risk rating systems help to **identify priorities** for each action. The risk score can be determined in different ways:

1. Qualitative approach

There are several types of qualitative approaches. The assessment must be descriptive and based primarily on relevant (reliable) information, judgment and experience.

A number of potential sources can be consulted to obtain useful information:

- labels and safety data sheets;
- information provided by the manufacturer or supplier of the substance;
- documentation published by the national regulatory authorities or other official bodies;
- experience acquired and information gathered from personnel in the context of previous use of the substance or similar substances;
- technical references such as books, scientific and technical articles, professional journals, etc.;
- professional institutions, trade associations, trade unions and consultancies.

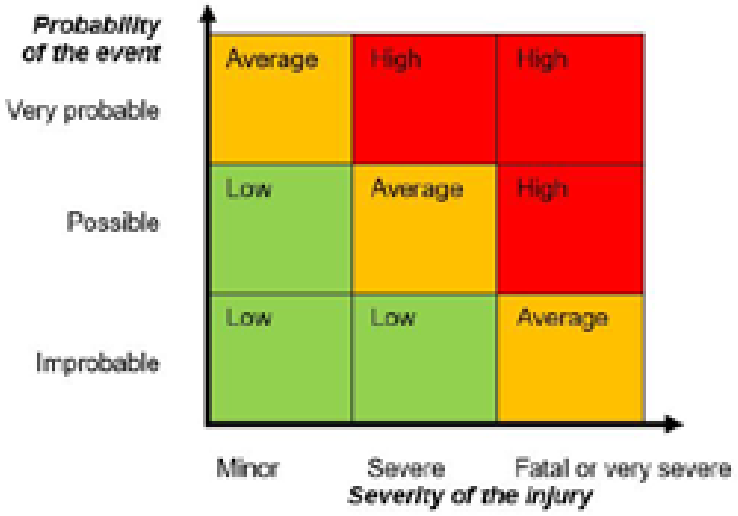
2. The semi-quantitative approach

There are also several types of semi-quantitative approaches. These generally use scoring systems. This type of approach always requires a degree of judgment but is based on concrete information so as to obtain more reliable results. Figures based on data from various sources and simple descriptors are used to reflect the level of risk.

The detailed risk assessment combines **four factors** in a single estimate of risks:

- **probability** of occurrence (number of accidents, illnesses or incidents related to this risk).
- frequency of exposure,
- **gravity** of possible injuries/harmful effects,
- number of persons exposed.

This is what is called a ‘hazard score’. This score is used to set priorities for reducing the risk.



3. The quantitative approach

A more quantitative risk assessment is possible for many hazards. This is the case in particular for many chemical hazards related to substances that have to undergo evaluation before being placed on the market, such as **pesticides** and **biocidal products**.

Several 'toxicological thresholds' (defined below) can be taken into account to assess the level of risk: is the reference 'threshold' exceeded or not?

These 'thresholds' are, for example:

- occupational **exposure limit values** (OEL, AEV);
- **AOEL** (acceptable operator exposure level) in the case of application of pesticides;
- **ARfD** (acute reference dose) and **ADI** (acceptable daily intake) in case of pesticide residues.

The occupational exposure limit value (OEL) is the maximum acceptable concentration of a given substance to which the worker can be exposed in workplace air for a short period (maximum of 15 minutes). The average exposure value (AEV) is the maximum acceptable concentration of a given substance to which the worker may be exposed in workplace air for a full day (8 hours).

The OEL and AEV are defined by regional governments or administrations and vary throughout the world. It is therefore important to apply at least the regional standard. The limit sometimes represents a 'safe' level at which no significant hazardous effect has been observed. It is important to know that these limits concern exposure through inhalation (the other types of exposure are not taken into account; they are inappropriate for the application of pesticides) and represent individual exposure (not background concentrations but the concentration actually inhaled by the worker).

❑ Risk assessment

An assessment or '**self-assessment**' of risks must be appropriate and sufficient. Forms (such as the Check List, see Annex) can be helpful for carrying out a risk self-assessment in companies. They should enable the employer to:

- identify major risks presented by the work in question;
- identify and set priorities among measures to ensure conformity to laws in force;
- make sure that the assessment is in line with the nature of the work and remains valid over time;
- address and assess all relevant hazards;
- address what really happens at the workplace;
- ensure that all persons affected are taken into account;
- identify groups of vulnerable workers that can be more particularly at risk, for example pregnant women and young people;
- take account of prevention and precautionary measures already in place.

It stands to reason that the **assessment will depend on the relative complexity of the risks**, the processes concerned, **legal requirements** and usual safety procedures. Training and information needs must also be taken into account.

The risk assessment cannot, however, be carried out in isolation; it should result from **teamwork involving all staff**, in particular safety representatives.

Various steps can be taken at the workplace, for example:

- Examine every **activity** that can cause a trauma. Do not forget **non-routine activities** such as maintenance operations, breakdowns etc.
- Examine hazards and risks by **groups** (machinery, transport, substances/materials, electricity etc.).
- Examine every **section/service** (receipt of goods, workshops, laboratories, offices, storehouses etc.).

Whichever method is easiest to manage is probably the best.

To ensure that the risk assessment is appropriate and sufficient, it must:

- Identify all hazards related to the operation and assess the risks associated with these hazards (taking relevant national regulations into account).
- Make a record of the significant findings (unless they are very elementary or obvious).
- Identify all groups of workers (or any isolated worker, depending on the case) more particularly at risk.
- Identify other people who might be particularly at risk, e.g. visitors, entrepreneurs, individuals.
- Assess control measures already in place and indicate whether or not they are satisfactory; in the latter case, identify measures to be taken. Such measures should include information and training.
- Estimate and make a record of the probability that the uncontrolled risk may cause an accident. Also record the likely 'worst result'.
- Record all circumstances brought to light by the assessment in which a serious and imminent hazard could emerge.

- Identify information that must be communicated to workers on the safety and health risks identified by the assessment, precautionary measures to be taken and emergency measures.
- Provide an action plan that gives information on implementing additional control measures, by order of priority, with a realistic timetable.

A risk assessment must also be **kept up to date**. This means that the assessment should be reviewed following any major changes to a workplace process or activity. It should also be reviewed periodically and whenever there is reason to believe that it might no longer be valid, after an accident or incident for example.

This classification necessarily entails some degree of subjectivity stemming from participants' experience and their perception of risks.

A ranking of priorities exists once this work has been completed.

1.4.2. Propose an action plan

At this stage, the priorities identified by the working group(s) are discussed with employee representatives, as a preliminary to the drafting of an action plan by the company director.

List the prevention measures needed to control the identified risks.

To make this research phase easier, it is useful to consult reference documents and to question operators, their supervisors and all in-company or external sources of information.

Draw up the action plan, being sure to define for each action:

- its objective, namely the result sought,
- the person in charge,
- the timeframe,
- the means allocated
- the date for changes to be brought in.

*Do not forget to **inform staff members** of the results of the assessment process (in which they will have played an active role) and of the measures taken or planned (from which they will benefit)!*

1.5. Defining a safety and health policy

1.5.1. Need for a safety policy

Good management must recognize that safety and health play an important role in all aspects of an organization. They contribute to a company's performance and enable management to fulfil its responsibilities towards individuals and the environment, as required by law.

In every organization, it is common practice to have written procedures that explain to everyone how to conduct themselves and how to carry out critical aspects of their work.

The 'safety policy' is **simply a written document** that spells out how safety and health will be addressed within the organisation.

Article 14 of the Occupational Safety and Health Recommendation 1981 (R164) obliges employers to draw up a written safety and health policy in appropriate cases.

"*Employers should, where the nature of the operations in their undertakings warrants it, be required to set out in writing their policy and arrangements in the field of occupational safety and health, and the various responsibilities exercised under these arrangements, and to bring this information to the notice of every worker in a language or medium the worker readily understands".*

General Conference of the International Labour Organisation.

Even without such written documents, a safety and health policy is considered a good management practice (*OHSAS 18001 and the ILO Guidelines on Occupational Safety and Health Management Systems*). A good safety policy serves as a **course of action** for working safely and a reference for identifying those in charge of safety matters. It also illustrates management's commitment to safety in the organization.

Although safety policies can take many different forms, the suggested structure contains **three separate but related sections**:

- A general policy statement
- The organization of responsibilities
- Implementing arrangements

1.5.2. General safety and health policy statement

The document that presents the general workplace safety and health policy should be written by the organization's senior management. It should express the long-term strategic objectives in the area of safety and health and **the organization's commitment** to implement policies that ensure the safety and health of the entire workforce at all times.

The general statement should contain at least **four clear declarations**:

1. That management is committed to safety and health. To demonstrate this commitment, the general manager must sign the document and accept final responsibility for the safety, health and well-being of all workers.
2. That the organization will comply with all laws and expects workers to do the same.
3. That the organization places safety and health problems on an equal footing with commercial matters.
4. That management expects cooperation from workers in carrying out their obligations and open communication for the promotion of safety and health.

An example of a general policy statement can be found in annex.

1.5.3. Organization of responsibilities

A member of senior management will assume full responsibility for workers' safety and health. It is nevertheless impossible for a single individual to be everywhere at all times to supervise every aspect of the organization's operations.

Consequently, the safety manager must delegate authority to different groups or individuals in the organization. This is done by describing in the document the responsibilities of specific managers in terms of monitoring safety. These responsibilities are at the heart of the tactical objectives of the members of middle management in charge of implementing the strategic objectives of the general policy statement.

The conceivable **responsibilities and obligations** are detailed below:

- Ensure that the company's safety and health policy is implemented in the manager's specific area. This is accomplished by:
  - drawing up and promoting a specific programme for the department;
  - detailing how implementation of the programme is organized at department level;
  - defining how the programme's results will be monitored;
  - ensuring active management of the programme's implementation.
- Ensure that a forum is created for communicating with workers and consulting them on safety and health issues. This can entail:
  - making sure that workers in the department clearly understand their responsibilities;
  - providing information and organizing consultations with workers' representatives to discuss matters related to safety and health at the workplace;
  - making sure that workers make a positive contribution to promoting the safety programme;
  - seeing to it that job descriptions include safety analyses.
- Ensure that safety and health are taken fully into account in:

  - ongoing operations;
  - planning of new operations and related work systems;
  - design of new installations, new equipment or new products;
  - acquisition of new installations, new equipment or new products;
  - waste disposal (used installations and equipment or product waste).
- Ensure that:
  - safe work systems are developed, explained and maintained;
  - the department's machinery and equipment are correctly maintained and can be used safely;
  - all safety systems are installed, correctly adjusted and maintained;
  - an effective inspection system is set up and maintained and that the necessary records are kept;
  - when safety cannot be provided by other means, personal protective equipment is furnished along with the necessary instructions for use;
  - a high level of premises management is maintained;
  - safety procedures form an integral part of the department's training programmes;
  - all accidents are investigated immediately and remedial measures are put in place to prevent any repeat;
  - the department's workers are familiar with emergency procedures and relevant exercises are organized regularly;
  - safety performance is encouraged and a good example is given to workers;
  - sub-contractors working in the department are protected and their acts or omissions are not harmful to persons towards whom the company has a moral responsibility.

1.5.4. Implementing provisions

Policy objectives must then be transformed into operational aims, in other words **practical activities must be defined**.

This section of the document will contain details on practical systems, standards and implementing procedures in the organization's different departments. It will include details such as the following:

- What must be controlled?
- What level of control is necessary?
- Who defines the level of control?
- How is the control process implemented?
- What systems and procedures are necessary?
- Who defines control systems and procedures?
- What training is necessary?
- When and where are the activities implemented?
- How and when is supervision put into practice?
- Who will be in charge of supervision?
- How will results be communicated so that the necessary actions can be implemented?

- What records must be kept and by whom?

Responsibility for policy implementation lies with middle and junior management. This is the level at which the policies adopted by senior management are put into practice.

Safety and health are managed using three techniques:

1. Risk elimination
2. Risk reduction
3. Risk transfer

- **Risk elimination** and **reduction** are carried out by middle and junior management following a risk assessment and the establishment of priorities for action.

- **Risk transfer** means insuring that risks which cannot be eliminated or reduced satisfactorily are managed in the least harmful way. Risk transfer is the result of a thorough risk assessment and a risk management procedure followed by middle management.

Whichever technique is used, the procedure should follow the same six-point team approach:

1. **Agreement on the performance gap**
   The members of a department under a manager's leadership, namely the team, should determine whether the goals set in the policy have been achieved. If they have not, there is a performance gap. Agreement on the performance gap is the first step towards remedying the situation.

2. **Discussion of the reasons for the performance gap**
   Open and honest communication is essential at this stage of implementation. It is only normal that everyone will think the gap is someone else's fault. Disputes and conflicts are almost inevitable at this stage. If they are not properly managed, the gap will continue and interpersonal relations will become or remain poor.

3. **Exploration of the gap**
   If conflicts are correctly managed, they can be resolved and the department team can be steered towards a positive exploration of the reasons why changes are needed. At this point, most individuals are willing to accept their role in this process and the team may become stronger as a result.

4. **Agreement on action to be taken**
   Once consensus has been established in regard to the nature of the performance gap and its likely causes, a team action plan must be drawn up to put things right, i.e., reduce the gap. The plan must be anchored in risk assessments and control strategies.

5. **Definition of objectives**
   Once the performance gap has been identified and action agreed, the objectives must be defined and written up.

6. **Assessment date**
   An objective should have a deadline followed immediately by the date when they will be re-assessed. If the objective has been met and the gap has been closed, everyone should be congratulated. If the objective has not been met and the performance gap continues, return to the first step with a 'new' gap and repeat the process from the beginning.

1.5.5. Policy follow-up

On the assessment date, it is essential to have information on the **policy's effectiveness**. The following questions are relevant:

- Are safety and health obligations being complied with?
- Do workers observe safety and health rules?
- Are they more aware of safety?
- Has the accident rate improved?

There are several ways to determine the extent of effectiveness. Unannounced checks, inspections and audits can be performed. Statistics on failure rates such as product rejections can also be used as a measure.

The person in charge should make use of the skills of specialists and safety representatives for this task. All levels of management should report to their superiors on the status and progress of safety performance. Reports on all accidents, including trivial or more serious accidents, near-misses and also any occupational illnesses must be reviewed. This analysis reveals whether greater protection, additional training or a safety awareness campaign may be necessary. Trends, frequency levels and types of incidents must be monitored to give an indication that things are going in the right direction.

1.6. General prevention principles and control measures

The company director must take all action necessary to ensure workers' safety and protect their health. In organizing a health policy, he or she must:

1. Define a company 'safety and health' policy.
2. Train or commission training of a safety organizer.
3. Take safety into account before carrying out a task or buying material.
4. Draw up a prevention plan covering operations by an external company.
5. Train or commission training of a sufficient number of agents in workplace rescue and first-aid practice.
6. Organize first aid (procedures and material) and ensure that personnel are familiar with systems to make use of them.

The company director must apply the following **general prevention principles**:

1. Avoid risks.
2. Assess risks that cannot be avoided.
3. Combat risks at the source.
4. Adapt work to humans (ergonomics) by acting on design, organization and work and production methods.
5. Work towards these objectives taking technical developments into account.
6. As a general rule, replace what is hazardous by something that is not or that is less hazardous.
7. Build risk prevention into a coherent whole that includes production, organization, working conditions and social dialogue.
8. Take collective protection measures as a priority over individual protection measures.
9. Give workers appropriate instructions.

The **basic control principles** include:

1. Eliminate the hazard if possible.
2. Use physical or technical control measures that reduce risk at the source and ensure general rather than individual protection.
3. Control individual risk through the design of the work, management and/or insist on the use of personal protective equipment. Note that this is not a substitute for dangerous practices.

*In practice, a **combination of these control strategies** must be used!*

1.6.1. Risks associated with work equipment

It should:

- Use machinery and tools that meet regulatory requirements.
- Take into consideration the safety aspect when buying equipment.
- Use work equipment according to the supplier's instructions.
- Make tool assembly and disassembly operations as easy as possible.
- Protect the sharp edges of tools (cover and have a special storage place) and dispose of carefully as soon as they are no longer in use.
- Block access to work equipment prior to any repair or maintenance operation.
- Draw up operating modes that include safety.
- Train staff.
- Ensure that workers wear necessary personal protective equipment (goggles, gloves etc.).

1.6.2. Risks associated with chemical products

It should:

- Replace a hazardous product by another that is less hazardous.
- Limit handling of products.
- Read and follow instructions on product labels.
- Label fractionators (chemical engineering apparatus used to separate the components of a mixture) correctly.
- Supply products in packaging that is most practical for use.
- Capture emissions at the source (cubicle, extractor, etc.) and ventilate premises.
- Inform staff about precautionary measures to be taken when using the products.
- Eliminate any product leaks.
- Ensure that workers wear personal protective equipment (gloves, goggles, respiratory equipment etc.).
- Draw up safety operating procedures.
- Take account of treatment, storage and disposal of waste.

1.6.3. Manual handling of hazardous substances

It should:

- Make sure that all workers receive a copy of the safety data sheet for the substances they handle.
- Use warning signs, in particular if hazards are complicated or ‘technical’.
- Check all labels and documentation to ensure that the correct products have been received; a mistake can have disastrous consequences.
- Keep storage areas separate from process areas.
- Take all measures necessary to prevent incompatible chemical substances from being mixed, especially following an accident related to manual handling or a fire.

- Do not falsely conceal the quantity of hazardous substances that may be involved in an accident.

1.6.4. Risks related to electrical installations

It should:

- Block access to installations before carrying out any maintenance or adjustments.
- Have wiring installed by qualified staff, with appropriate equipment.
- Periodically check the electrical system.
- Inform staff of electrical risks: post signs indicating hazardous areas, no-access areas and first aid instructions.
- Train staff members and assign clearance levels depending on the tasks they have to carry out.
- Make sure that fuse-boxes, electrical control cabinets and premises are kept locked.

1.6.5. Physical risks

It should:

- Eliminate sources of noise, limit its intensity.
- Place noisy installations and devices in separate and insulated premises.
- Install protective devices: enclosures, casing, cubicles, acoustic treatment of walls.
- Limit the duration of staff's exposure to noise.
- Ensure that staff members wear personal protective equipment: earplugs, noise attenuation helmets, etc. where noise levels merit such equipment being worn.
- Make sure that lighting is sufficient and adapted to the type of work to be performed.
- Prefer natural lighting wherever possible if levels of intensity are sufficient.
- Arrange work stations to have suitable lighting and positions.
- Adapt work stations to individual characteristics and aptitudes.
- Eliminate strong vibrations produced by any installations or machinery.
- Avoid high or low temperatures at work stations.
- Ensure sufficient natural or forced ventilation in confined areas or work stations.

1.6.6. Manual, handling and transport activities

It should:

- Organize work stations in such a way as to eliminate or reduce handling operations.
- Limit the unit weight of loads to be handled.
- Use materials handling equipment: pallet trucks, trolleys etc.
- Use mechanical means: lifting platforms, loading docks, lorry loaders etc.
- Fit loads with gripping devices: handles, vacuum pad grippers, containers etc.

- Train staff to use appropriate movements and postures.
- Limit the duration of tasks requiring repetitive movements.
- Make sure staff members wear personal protective equipment: gloves, shoes etc.
- Use handling means and accessories that meet regulatory requirements
- Use only means suited to the tasks to be performed in the conditions foreseen and according to the manufacturer's instructions.
- Check their condition regularly and perform regulatory inspections.
- Limit use of machinery and transport to trained and qualified staff members.
- Make sure that the general state of floors is good, along with their visibility conditions.
- Organize traffic flows for people and vehicles.
- Sign-post and maintain traffic and manoeuvring areas.
- Anticipate and organize transport arrangements: schedules, duration, recommended route, precise access plan to place of destination.
- Perform regular maintenance on vehicles.
- Repair technical problems immediately.
- Organize working time to avoid over-tired operators.
- Train staff in safe driving techniques.

1.6.7. Risks of fire and explosion

It should:

- Take product compatibility into account when organizing storage.
- Replace a hazardous product by another less hazardous product.
- Eliminate nearby sources of heat: flames, cigarettes, welding stations etc.
- Install protection: insulated premises, fire-resistant walls and doors.
- Install appropriate fire extinguishers: sprinklers, extinguishers, smothering blanket etc.
- Install smoke and fire detection and alarm systems.
- Establish intervention plans (fire instructions, exercise with fire-fighters etc.) and evacuation plans (emergency exits etc.).
- Store flammable liquids in small quantities of no more than 50 liters.
- Keep liquids for immediate use in a separate metallic cabinet or locker. Keep the remainder of the stock in a fire-resistant place.
- Containers of flammable liquids must be hermetically closed to avoid any leaks. Wherever possible, use containers with air tight covers.
- Spills must be controlled. An approved absorbent material should be within reach in case of a spill of liquids.
- Remove sources of ignition – static electricity, open flames etc.
- Distribute liquids in a safe and well ventilated place. Flammable liquids should not be used in a 'practical' container. Flame-retardant distributors with automatic closure systems must be used.
- Empty containers must be treated with even greater precaution than full ones. Never heat an empty container or leave it near a source of heat.

- A permit may be required to store a flammable liquid, even in small quantities. It is always advisable to seek information from the competent authorities or fire-fighters.

1.6.8. Risks associated with flammable gases

It should:

- Store all cylinders (full or empty) **outside of buildings** in a safe and well ventilated place.
- Store cylinders underground or near evacuation ducts because vapors are often denser than air.
- Fasten cylinders outdoors, with the valve upwards and the gas piped into the building.
- Ventilate all rooms in which the gas is used.
- Protect cylinders from damage by attaching them with chains to trolleys or shelves.
- Change cylinders in a well ventilated place, far from any source of ignition.
- Correct joining devices must be used to avoid damaging the cylinders.
- Equip cylinders with check valves and/or flame-trap systems. The cylinder valves must be closed once the work is completed. Any suspected leak should be located using a soap and water solution.

1.6.9. Risks associated with premises

It should:

- Organize the movement of persons within the establishment.
- Eliminate hazardous areas by installing non-skid floor coverings, correcting uneven floors (small step, platform, change of level, etc.) and widening passageways.
- Maintain floors: regular cleaning and immediate cleaning in case of product spills, repair of defective areas etc.
- Maintain wide and clear passageways, sign-post them and keep them well lit. Prohibit storage in passageways.
- Eliminate areas with a difference of floor level.
- Install protective systems: handrails, railings, barriers, safety nets etc.
- Use mobile platforms for one-off work at heights.
- Train staff to use mobile devices correctly and conduct regular checks of the solidity of anchoring points.
- Ensure that workers wear personal protective equipment (harnesses, fall-breakers, etc.).
- Prohibit the use of ladders as work stations.

Appendices

A.1. GHS hazard pictograms

GHS01
(Unstable Explosives)

GHS02
(Flammable)

GHS03
(Oxidizers)

GHS04
(Compressed gases)

GHS05
(Corrosive)

GHS06
(Acute toxicity)

GHS07
(Skin sensitization/irritation)

GHS08
(Respiratory sensitization, carcinogenicity)

GHS09
(Hazard to the aquatic environment)

For more complete definitions, see Annexes to the CLP Regulation.

A.2. Comparisons between old and new pictograms

Former	New
 F: Highly flammable  F+: Extremely flammable	 GHS02
 C: Corrosive	 GHS05
 T: Toxic  T+: Very toxic	 GHS06
 Xn: Harmful  Xi: Irritating	 GHS07
 N: Hazardous to the environment	 GHS09

A.3. Example: label elements for flammable liquids

Classification	Category
GHS pictogram	
Signal word	Danger
Hazard statement	H224: Extremely flammable liquid and vapor
Precautionary statements - Prevention	P210 P233 P240 P241 P242 P243 P280
Precautionary statements – Response	P303 + P361 + P353 P370 + P378
Precautionary statements – Storage	P403 + P235
Precautionary statement – Disposal	P501

(Source: Annex to CLP Regulation)

A.4. Structure of the Safety Data Sheet (SDS)

Pursuant to Regulation (EC) 1907/2006 (REACH), the SDS must be structured as follows:

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
2. HAZARDS IDENTIFICATION
3. COMPOSITION/INFORMATION ON INGREDIENTS
4. FIRST AID MEASURES
5. FIREFIGHTING MEASURES
6. ACCIDENTAL RELEASE MEASURES
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)
8. EXPOSURE CONTROLS/PERSONAL PROTECTION
    - 8.1. Control parameters
    - 8.2. Exposure controls
        - 8.2.1. Occupational exposure controls
        - 8.2.2. Environmental exposure controls
9. PHYSICAL AND CHEMICAL PROPERTIES
    - 9.1. Information on basic physical and chemical properties
    - 9.2. Other information
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
11. TOXICOLOGICAL INFORMATION
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
13. DISPOSAL CONSIDERATIONS
14. TRANSPORT INFORMATION
15. REGULATORY INFORMATION
16. OTHER INFORMATION

A.5. Memorandum

Hazardous events:

1. Events that can trigger hazardous mechanical phenomena

1. 1 Hazardous mechanical phenomena associated directly with moving devices

- Access to a hazardous area caused by a moving mechanism
- Untimely start-up, unexpected speed-up/slowdown of an accessible mechanism, impossibility to stop an accessible mechanism caused by:
  - malfunctioning of the control system resulting from:
  - a defective component
  - a logical anomaly (case of 'hard-wired logic') or software anomaly (case of programmed logic)
  - an external influence on the system (radiated or conducted disturbance)
  - a power cut
  - reconnection of the energy supply after a power cut
  - an untimely human action on a control actuator or another machine element (for example, on a sensor or a pre-actuator)
  - external/internal influences (gravity, wind, self-ignition in internal combustion engines, etc.) acting on elements of the machine
- Impossibility to slow down/stop the machine under the best possible conditions due to a malfunctioning of the slowing/braking system

1. 2 Hazardous mechanical phenomena

- Breakage/malfunction of a machine element
- Tipping over/fall of the machine, one of its elements or an object processed by the machine
- Ejection of a part/tool fragment, etc.
- Sudden release of accumulated energy (spring, pressure, pressure drop)

1.3 Gravity

- Slipping/loss of balance (case where a person falls into/on the machine)
- Individual falling
- Materials falling
- A machine part or a machine falling

2. Events triggering hazardous electrical phenomena

- Coming into contact with active parts (direct contact)
- Malfunction (for example, an insulation malfunction) that makes accessible parts active (indirect contact)
- Proximity to high-voltage active parts
- Electrostatic discharge
- Short-circuit, overload, etc. that causes an emission of radiation, the projection of molten materials, chemical effects

3. Events triggering hazardous thermal phenomena

- Coming into contact with objects or materials at extreme temperatures (high or low) due to radiation of heat sources
- Ignition/explosion

4. Events leading to hazardous exposure to noise

- Untimely start-up of a source of intense noise

5. Events leading to hazardous exposure to materials and substances

- Untimely access to materials or substances
- Leaking or spillage
- Fire/explosion

Exposure:

1. Through inhalation of:

- Spray from spraying
- Spray from the formation of gas bubbles
- Spray from a jet of liquid
- Gas produced by something burning
- Exhaust gas from a diesel, petrol or gas powered engine
- Gas produced by fermentation
- Dust from loading or unloading of a product in powder form
- Dust from a mechanical surface treatment (sanding, milling, etc.)
- Dust from the stirring up of a powder that has settled
- Vapors from application of a solvent chemical agent
- Vapors from loading or unloading of solvents
- Vapors from the heating of a chemical agent, preparation, plastic material or metal
- Vapors from evaporation of a chemical agent in the air
- Vapors escaping from a pressure vessel
- A biological agent

2. Through skin contact

- Application of a chemical agent using a rag
- Application of a chemical agent using a brush
- Handling of parts that have been in contact with a chemical agent
- Handling of parts that have been immersed in a chemical agent
- Wearing of clothing contaminated by a chemical agent
- Settling on the skin of dust or condensed vapors
- Projection on the skin of dust, condensed vapors or liquids or a biological agent

3. Through ingestion

- Lack of hygiene (hands, mouth, etc.)
- Smoking at the workplace

- Meals eaten in a polluted environment
- Pollution of relaxation areas
- Contact with the mouth or lips after using a biological agent

4. Through exposure to radiation

- Chronic exposure to loud noise, continuous or discontinuous
- Chronic exposure to heat radiation
- Chronic exposure to ionizing radiation

5. Through exposure to vibrations

- Chronic exposure to severe vibrations

Hazardous situations:

1. Exposure to hazardous mechanical phenomena

1. 1 Hazardous mechanical phenomena associated directly with moving parts

- Possibility of coming into contact with phenomena of:
  - Snatching/winding of clothes near moving machinery
  - Pulling/trapping
  - Rubbing/ abrasion
  - Cutting/ severing
  - Scissoring
  - Perforation/ stab wounds
  - Shock
  - Crushing

1. 2 Hazardous mechanical phenomena

- Possibility of being hit by fast moving item
- Possibility of coming into contact with a hazardous blade or sharp component (cutting, etc.) shape (fixed or not highly mobile)
- Possibility of machinery part breakage
- Possibility of coming close to a source of accumulated energy inside a machine in the form of:
  - elastic elements (springs, etc.)
  - pressurized gas/liquids (hydraulic, pneumatic etc.)
  - a vacuum effect or drop of pressure

1. 3 Gravity

- Working at a height
- Working underneath a load or near a load at a height
- Working underneath machinery or near machinery at a height
- Handling of a heavy load

2. Exposure to electricity

- Possibility of coming into contact with live parts (direct contact)

- Possibility of accessible machine parts being activated due to a malfunction (indirect contact)
- Possibility of coming close to high-voltage active parts
- Possibility of coming into contact with elements carrying electrostatic charges
- Working near heat radiation/local heating/ projected molten particles
- Chemical phenomena that can result in short-circuits, overloads, etc.

3. Exposure to hazardous thermal phenomena

- Working near objects or materials at extreme temperatures (high or low)/flames or explosions/heat radiation
- Exposure to a hot or cold work environment

4. Exposure to noise

- Exposure to intense and momentary noise

5. Exposure to vibrations

- Use of hand-held machines (can damage blood vessels near skin surface causing 'white finger')
- Situation in which vibrations are transmitted to the entire body

6. Exposure to radiation

- In a normal working situation (sun or radioactive sources)
- Accidental exposure

7. Exposure to materials and substances

- Contact with/inhalation or ingestion of chemical agents, fluids, gas, mist, fumes or dust that are treated, used or produced by the activity

8. Exposure to hazardous phenomena caused by non-compliance with principles of ergonomics

- Faulty postures or excessively strenuous activities such as lifting
- Inadequate consideration of hand-arm or foot-leg anatomy causing repetitive strain injury
- Unsuitable lighting (eye strain and headaches)
- Mental overload or boredom resulting in loss of concentration or, stress
- Inappropriate design, placement or identification of switches or control levers
- Inappropriate design or placement of information displays//sign-posting

Injuries:

1. Injuries caused by mechanical phenomena (accidents on machines, traffic, accidents, falls from a height or on the level, manual handling)

- Injuries to skin, the vascular system (hematoma, etc.), neurological system, bones, muscles, organs (lungs, liver, kidney, spleen etc.)
- Fracture, amputation, sprain, hematoma
- Abrasion, wound
- Cut

- Perforation, stab
- Irritation, burning from friction or other source
- Death

2. Injuries caused by electricity

- Electrical shock, electrification with deep skin burns, cardiovascular or kidney disorders
- Electrocution (death)

3. Injuries caused by thermal phenomena

- Burns from heat or boiling water (including fire and flames)
- Hyperthermia with faintness, dehydration, exhaustion, cardio-vascular problems that can lead to death
- Chilblains, hypothermia, damage to eyes

4. Injuries caused by noise

- Hearing loss, loss of balance
- Fatigue, stress, loss of vigilance, etc.

5. Injuries caused by mechanical vibrations

- Transmitted to upper limbs: vascular, neurological and bone or joint disorders
- Transmitted to entire body: lumbago, vertebral traumas etc.

6. Disorders associated with work in high-pressure or low-pressure environments

- Joint disorders, ear-nose-throat (ENT) disorders etc.

7. Injuries caused by ionizing radiation

- Acute or chronic radiation sickness, acute radiation syndrome with state of shock that can lead to death, hematological disorders, cancers (skin, bones, lungs, blood, etc.), cataracts etc.
- Genetic mutations, disorders during pregnancy or among offspring, reproductive disorders

8. Injuries caused by materials and substances (metals, solvents, dust etc.)

- Allergic, pulmonary or skin diseases
- Irritation of the mucous membranes, skin irritations, chemical burns
- Cancers: skin, pleurisy, lungs, bladder etc.
- Neurological disorders, kidney disorders, hepatitis etc.
- Injuries resulting from fire/explosions

9. Injuries of infectious origin or caused by parasites

- Viral hepatitis, cutaneous mycoses, tuberculosis etc.

10. Injuries caused by disregard for principles of ergonomics, excess physical or mental load. Hyper-solicitation pathology

- Musculo-skeletal disorders resulting from poor posture, excessive or repetitive movements of the wrist, elbow, shoulder, back, knees etc.
- Effects of mental overload, particularly stress.

A.6. Example of a 'General Policy' statement

COMPANY XYZ INC.: SAFETY AND HEALTH POLICY
GENERAL POLICY STATEMENT

The company pledges to do whatever possible within reason to ensure the health, safety and well-being of all its workers and of the public coming into contact with the company or its products. The objectives of this policy are:

- To ensure compliance with all relevant occupational safety, health and well-being requirements.
- To establish and maintain a safe and healthy work environment.
- To ensure that all workers receive appropriate training in the safety-related aspects of their work.
- To provide all necessary safety systems and protective equipment as well as all information on workers' safety, health and well-being.
- To ensure that all workers are fully aware of their responsibilities for the purposes of this policy and that an effective consultation system between the employer and workers is put in place.

Every worker is responsible for his/her own safety and the safety of others. Every worker also has the duty to cooperate with the employer by:

- Working safely and following the specified codes of practice.
- Using the protective equipment supplied.
- Abiding by all safety procedures.
- Reporting anomalies at the workplace.
- Reporting all accidents and collaborating with investigations.

Non-cooperation shall be treated as a serious breach of the employment contract and disciplinary measures shall be taken.

The person in charge of safety is Mr. XXXX, General Manager.

Signed:

General Manager

Date:

A.7. Example of a form to be used for an appropriate and sufficient self-evaluation of workplace risks

Chemical risks		
Is there an up-to-date inventory of the products used in your establishment?	YES – NO	....
Are safety data sheets (SDS) available for each of these products?	YES – NO	....
Are they transmitted to the occupational health officer and made available to employee representative bodies (staff representatives)?	YES – NO	....
Are the SDS and product labels written in English?	YES – NO	....
Are the recommendations found in the SDS taken into account (storage and use conditions, PPE etc.)?	YES – NO	....
Is pollution evaluated and have prevention measures been taken?	YES – NO	....
Are any workers still exposed to chemical agents through inhalation, ingestion or skin contact?	YES – NO	....
Do workers understand the meaning of the pictograms presented on labels?	YES – NO	....
Are workers trained in the handling and use of chemical products?	YES – NO	....

(Additional questions can be added to the form)

1.1. Occupational risk analysis: challenges and definitions

1.1.1. Occupational risk analysis: an economic and social challenge

Apart from their human consequences, incidents or accidents[1] that occur in the workplace have a financial cost due to damage, but can sometimes have much higher indirect costs: wasted time for employees, repairs to damaged equipment, overtime to make up for delays, costs of legal actions, higher insurance premiums, loss of clients, damage to image and so on. 'Risky' situations/practices in the company hinder the work process and can lead to less motivation, lower productivity and non-conformity. They also add to overload and work pressure on operators.

Occupational risk assessment (ORA) and prevention should therefore be **built into company management**. This forms an ethical, and in most countries, statutory, part of the responsibilities of a company director. Occupational risk analysis fits into the framework of corporate social responsibility (CSR).

One of the nine guiding principles of the Ethical Trading Initiative (ETI) Base Code states the following with regard to **working conditions:**

- A safe and hygienic working environment shall be provided, bearing in mind the prevailing knowledge of the industry and of any specific hazards.
- Adequate steps shall be taken to prevent accidents and injury to health arising out of, associated with, or occurring in the course of work, by minimizing, so far as is reasonably practicable, the causes of hazards inherent in the working environment.
- Workers shall receive regular and recorded health and safety training, and such training shall be repeated for new or reassigned workers.
- The company observing the code shall assign responsibility for health and safety to a senior management representative.

Assessing risks,[2] ranking them, defining priorities for action and implementing solutions will help to prevent incidents and accidents and to improve the company's yield and performance.

Occupational risk assessment is **the first stage of a successful occupational safety and health policy**. Occupational risk assessment is a three stage process:

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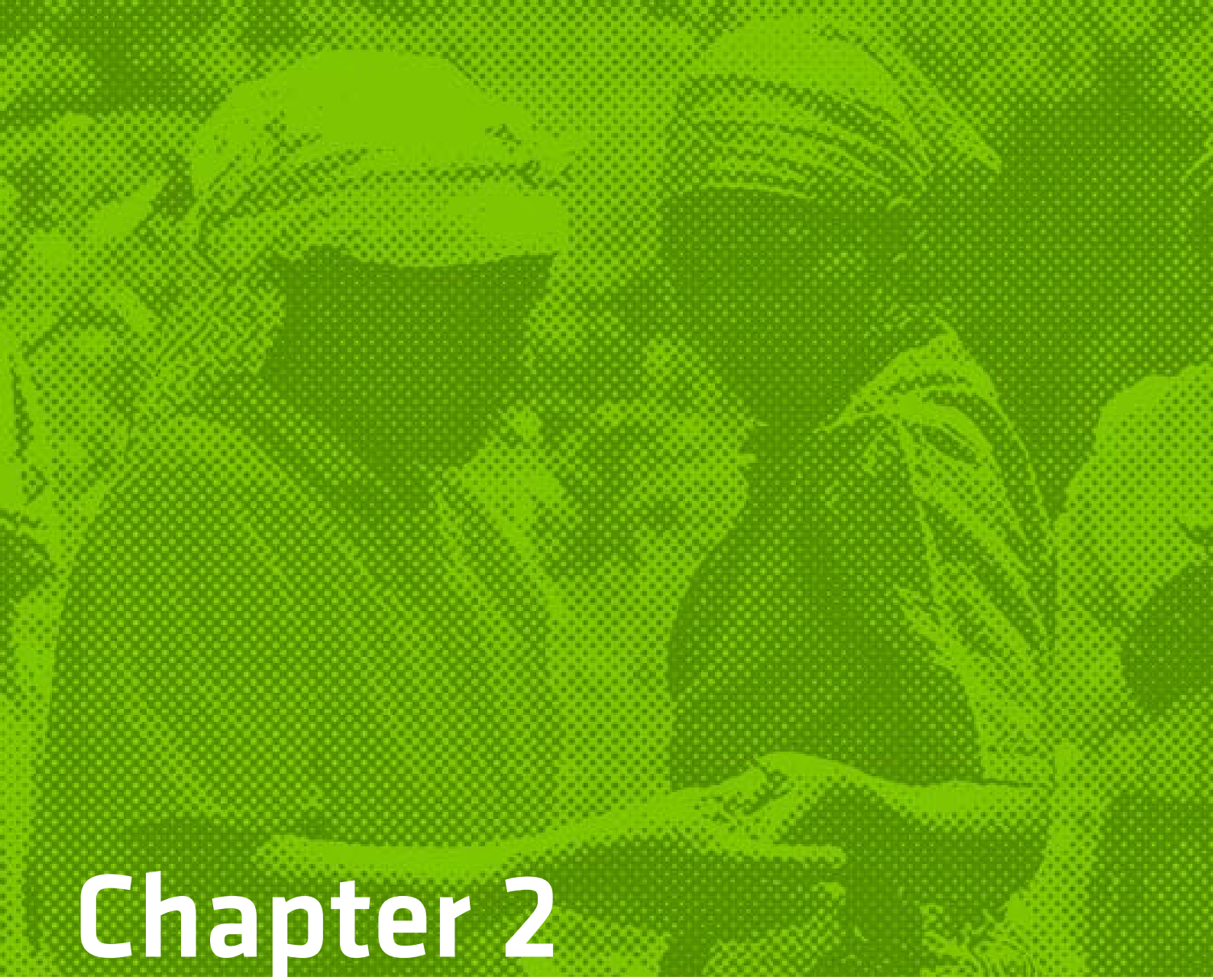
1 *Incidents* include cases of hazards, occupational illness and serious near-accidents. An *accident* is an unforeseen event that results in bodily injury or damage to property or the environment (*cf.* below – Investigating accidents).

2 Depending on the country, either on a voluntary basis or in accordance with regulations.



Chapter 2

Fundamentals of toxicology

2.1. Introduction to toxicology

2.1.1. Introduction to toxicology

Toxicology is the scientific study of the nature, effects, transfer to key organs and detection of toxins (poisonous substances) in living organisms, irrespective of the way the toxins have entered the organism (through inhalation, skin contact, ingestion (swallowing) etc.).

The two key elements of toxicology are:

- **Toxicity** (which refers to the concept of 'hazard' sometimes called a source of danger).
  Toxicity can be measured, **described** and assigned a value through scientific tests and studies.
- **Exposure** (which refers to the concept of **'risk'** sometimes referred to as the likelihood of a problem).
  Exposure can generally be **estimated** based on a more or less realistic 'exposure scenario'. It is rarely possible and much more difficult to measure exposure through field trials.

A discussion of '**toxicity**' should include:

- toxic substances:[1] poisons that cause more or less serious disorders to the organism (the harmful effects) that may be either temporary or lasting, immediate or delayed;
- all their properties, in particular regarding the **type of poisoning** they can cause (direct/indirect; acute/chronic);
- **modes of action** and target organs or parts of the body damaged by the poisonous substance (e.g.: neurotoxins affect the brain or the nervous system; the same or other products will preferentially affect certain organs such as glands, the lungs, liver, kidneys, etc.);
- the harmful effects of exposure of an organism[2] (or group of organisms) to such toxins (nature of injuries and target organs – e.g.: cancer). The nature and intensity of the toxic effects of an active substance on an organism depend on its concentration in the target organs. This concentration is related to the **dose** (quantity involved) and **fate of the substance** (what happens to it inside the body of the organism (i.e. absorption, distribution, metabolization and/or elimination);
- ways of protecting oneself and others to prevent being poisoned. In the event of an accident, of combating toxins (means of elimination, antidotes or other medical care or treatment).

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1 Various terms are used: 'toxic' or xenobiotic – literally *foreign to life (of man)* – or 'hazardous' substances.

2 For the effects of exposure on the environment, the term 'ecotoxicology' is used.

A discussion of the issue of '**exposure**' means taking an interest in:

- the **aetiology (sources, causes)** of poisoning: contamination of the air from sprays (treatment of greenhouses, mist due spraying drift), occupational exposure (plant protection treatments), poisoning from medicines, animal venoms or stings, or food poisoning from toxins;[3]
- the **circumstances of contact** of the toxic substances with the organism: describing the *scenario* that presents the circumstances, either observed (analysis of an accident) or likely (risk prevention/assessment), that explain the way the organism and the toxin came into contact;
- **modelling**, usually on the basis of data from accident reports, observed contaminations (e.g.: Rapid alert system for food and feed (RASFF) messages, analysis reports on controlled samples, product self-monitoring), observation of the state of health of workers and the population or their medical records. Mathematical models that incorporate various possible scenarios can be used to assess the potential risk of certain situations (e.g.: calculation of operators' exposure during application of pesticides to a given crop).

2.1.2. Toxicity and harmful effects

The toxicity of a substance is generally measured by two parameters:

- the **gravity (seriousness) of effects**, cumulative or otherwise, possibly 'dose-dependent' on the toxin with more exposure producing more serious consequences;
- the **speed with which effects show up,** which characterizes the form of poisoning: acute (short term), sub-acute, sub-chronic or chronic (long term). The adjective refers to the length of exposure to the chemical agent, not the effects.

There are two forms of toxicity:

- one in which the effects are temporary: the effects disappear when the product is eliminated.
- the other causes symptoms which are more permanent: the effects do not disappear once the toxin has been eliminated.

The gravity of possible harmful effects resulting from exposure to a toxic substance (e.g.: pesticide) depends on a number of factors:

- the nature of the toxin (its 'chemical family', its structure which may affect its mode of action);
- the quantity in question (which may depend, among other factors, on the application rate);
- the circumstances, length and frequency of exposure ('exposure scenarios');
- the route and degree of absorption (via contact with the skin, ingestion or inhalation);

[3] The origin of 'toxins' can be animal (venom from a poisonous snake causing evenomization), vegetable (poisoning by belladonna), fungal (poisonous mushrooms such as death-cup) or bacterial (botulinum toxin).

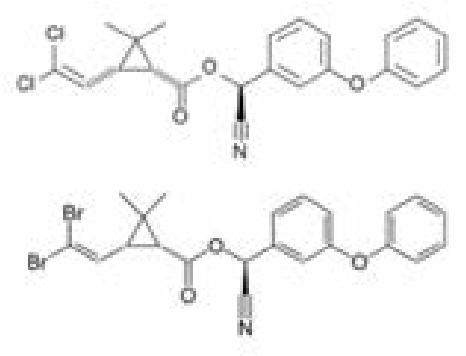
- the nature of the effects of the substance and/or of its metabolites as the body attempts to deal with or detoxify the poison;
- the accumulation and persistence of the substance in the organism;
- the target's sensitivity to the substance.

The chemical structure of a compound can sometimes be useful to anticipate the compound's activity.

The **toxic potency** of certain chemical products depends, for example, on:

- the number of aromatic rings in polycyclic aromatic hydrocarbons (PAH);
- the number of chlorine atoms in chlorinated hydrocarbons.

Thus, pesticides from the same chemical family (pyrethroids) can have different toxicity levels although their formula and structure are very similar:

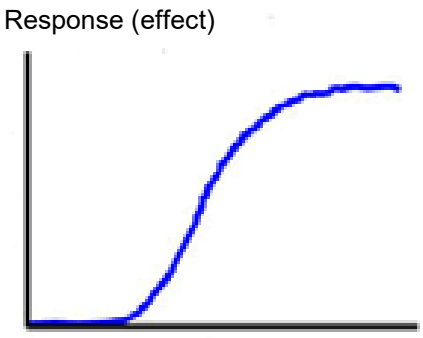


Cypermethrin
LD50: 250–4150 mg/kg bw (rats)

Deltamethrin
LD50: 130 mg/kg bw (rats)

2.1.3. The dose-toxicity relationship

Dose-response curve



The basic working assumption of toxicology is that there is a **relationship between the dose (quantity), the concentration at the place affected and the resulting effects**. The response generally increases with the dose.

The dose-response relationship is used to define median lethal dose (LD50) values. This is the dose that would theoretically kill half (50%) of a population exposed to that dose.

There is believed to be a '**threshold dose**' below which there is no observable effect.

This hypothesis presents certain major limits.

These thresholds are calculated for individual toxins and not for cocktails of toxins such as some pollutants that may act in synergy (positive or negative) or with potentiation

effects. In other words the combined effect of two poisons might be greater (or less) than the sum of the two component poisons given individually.

Scientists know, however, that the 'dose-response' relationship is **much more complex than it seems** for many toxic substances. For example:

- **for certain substances**, **there is no 'exposure threshold'** and a harmful effect can be observed irrespective of the dose. This is the case for certain endocrine-disrupting substances e.g.: dioxins (poisonous compounds produced by certain chemical processes or by burning plastics at low temperature). A very low dose of some poisons can be fatal: one millionth gram of botulinum toxin can kill some people quickly, or the same amount of plutonium can have longer term lethal effect;
- the toxicity of a substance is sometimes relative: substances that are harmless in other circumstances can prove toxic in certain conditions. This can be the case, for example, for certain metals that are necessary in small doses;
- certain products have a toxic effect only on genetically predisposed individuals or those exposed to a synergistic effect with another molecule or condition. Levels of sensitivity can be related to the genetic heritage, general state of health, immune system history and age (the fetus and embryo, as well as small children, are much more sensitive to toxins than adults). The timing of poisoning can also affect the outcome. Certain products will have a toxic action only on an embryo in utero, for example, or on tadpoles but not on frogs.

Toxicology is made more complex by the fact that the exposure risk, actual exposure, the toxic effect of a contaminant as well as its evolution (its 'toxicokinetics') all depend on **multiple factors related to the toxin** and the **organism** exposed to the poison:

For the toxin:

- The nature of the toxin and its effects (respiratory or skin irritants, heavy metals, air, water, soil pollutants etc.).
- The nature of mixtures (possible synergy).
- The timing of exposure (*in utero*, in a phase of intense activity etc.).
- The nature of the 'gateway' (food, inhalation, through the skin etc.).

For victims:

- Exposed individuals and sub-populations: toxicology studies deal with averages (general population) but **also more sensitive, 'higher risk' sub-populations**. To protect such sub-groups, protective safety factors are built into calculations of threshold limit values (TLV).

  The French National Institute for Study of Industrial Environments and Risks (INERIS), for instance, considers that the following should be taken into consideration:

  - *metabolic sub-groups*: children, the elderly, pregnant women,[4] menopausal women, etc. who fix or metabolize certain substances differently;

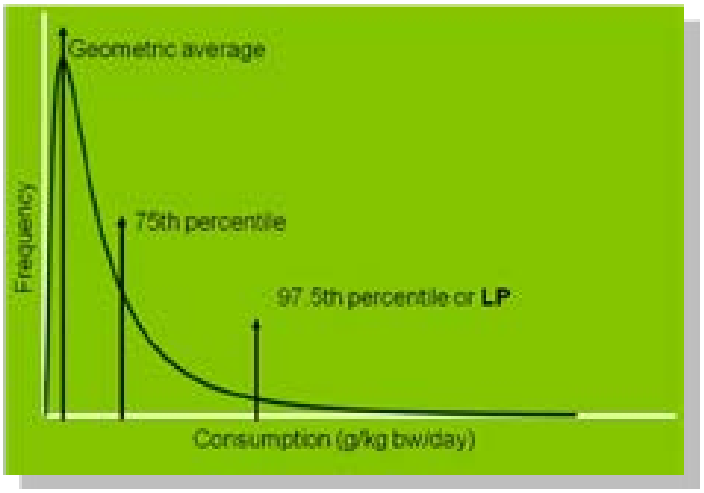
[4] During pregnancy, certain pollutants can have either no effects or on the contrary very exacerbated effects; this is true of certain endocrine disruptors having feminizing effects on a male foetus, a condition that has been observed in certain fish and amphibians.

- *genetic sub-groups*: genetic blood disorders, immunological disorders, more UV-sensitive albinos, etc.;
- *nutritional sub-groups*: malnourished individuals, alcoholics, smokers, etc.;
- *sub-groups of persons with illnesses*: certain illnesses (obesity, diabetes) interfere with metabolization of the toxin.

In fact, every individual, even in perfect health, belongs to a 'sensitive' sub-group at least once during his/her lifetime (in utero, small child, older person, etc.).

- For the same reason, when estimating the risk for consumers of exposure to residues of pesticides, biocidal products or veterinary medicines, for example, it is not the *'average'* consumer who is taken into consideration, but rather the *'large-portion consumer'* (LP or 97.5th percentile of consumption of the food), or even a specific consumer (e.g.: vegetarians who eat more fruit and vegetables and who could consequently be more exposed).

Distribution of food consumption patterns in the population



2.1.4. Hazard and risk

Pesticides are poisons and some insecticides in particular pose risks unless care is taken, so for operators it is important to limit contact and exposure. Apart from their toxicity, the danger of handling pesticides depends on two other variables: **possible contamination** (exposure) and **the time spent on the work** (application of products, generally by spraying). This can be expressed as follows:

Risk = Toxicity x Contamination x Time

Risk:	risk of intoxication
Toxicity:	the pesticide's harmful property
Contamination:	precondition for entry into the organism or exposure
Time:	length of contact with the pesticide.

Risk is the **quantification**, usually in terms of likelihood, of the occurrence of an adverse effect from a hazardous substance in terms of exposure to the substance.

To reduce risk, action can be taken on each of the terms of this equation:

Reduce:	How?
Toxicity	1. Choose a plant protection product with a favorable mammal/insect toxicity ratio (e.g.: use a Bt insecticide). 2. Use an insecticide with low toxicity (see LD_{50}). 3. Use the least risk formulation (e.g.: use a WG rather than an EC, *i.e.*, a granule rather than a liquid concentrate). 4. Use the weakest concentration possible (e.g.: an EC at 50 g/L and not 250 g/L if this is effective).
Contamination	1. Wear protective clothing appropriate to the task (this may mean goggles or face shield, gloves, boots, apron or garment that covers the arms, torso and legs). 2. Avoid contact with the product (especially the concentrated product when preparing the mixture). 3. Be familiar with the application technique (avoid treating against the wind; do not treat during the hottest hours of the day). 4. Work with application material in good condition (avoid leaks, especially with a sprayer strapped to the back).
Length of exposure (time)	1. Do not exceed the recommended work time (duration). 2. Wash skin if contaminated while working (clean skin immediately in case of contamination). 3. Wash protective clothing frequently and separate from other laundry (do not leave clothing in the field after use). 4. Respect the re-entry interval for treated fields (at least 24 hours, unless otherwise specified).

- In practice, the factors that influence operators' exposure are the nature of the active substance, the concentration used, the type of formulation, the application method, the length of work and whether or not the correct protective equipment is used, such as gloves, boots, mask etc.
- Handling concentrates is always more hazardous than handling a diluted product, so concentrates present the greatest risk of exposure.
- To reduce exposure to concentrates, proper equipment must be available (make sure there are no leaks) and all necessary precautions must be taken when preparing the mixture. In the case of concentrated pesticide, it is essential to wear gloves and eye protection when filling a sprayer, and preferably a protective apron as well.

- Keep in mind that the toxic, flammable, explosive nature or corrosive action of certain solvents used in formulations presents more of a hazard than the toxicity of the pesticide itself.
- The state of health of the person concerned also plays a role. Malnutrition and dehydration probably increase sensitivity to pesticides. Furthermore, a high ambient temperature often enhances the toxic effect of pesticides.

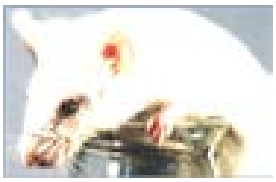
2.1.5. How to assess a toxic effect?

Toxicity assessment is based on appropriate **qualitative** (not measured) or **quantitative** (measured) studies. Several types of studies can be carried out to assess the effects of a toxin. Tests currently recommended follow OECD and EU guidelines and must be conducted using Good Laboratory Practice.

Toxicological studies can be grouped into four categories, by order of complexity or difficulty of implementation:

Theoretical studies through modelling based on scenarios (e.g.: structure-activity; mathematical models used to predict exposure values for operators who apply pesticides).

Experimental in vitro studies on bacteria, tissue cultures or cells.



Experimental in vivo studies on animals (e.g.: rabbits, rats and mice).

Epidemiological studies that compare several groups of individuals from a population exposed to the toxin or not (e.g.: workers).

2.1.6. Toxicological reference values (TRV)

For a large number of toxins, poisoning depends on a 'threshold effect'. Toxicologists therefore refer to multiple **toxicological reference values** such as **thresholds**, **standards** or **tolerable or acceptable intake**.

For example:

Thresholds

- The acceptable operator exposure level (AOEL) (mg a.s./kg/day), the maximum quantity of active substance to which the operator can be exposed without any adverse effects. This is a 'ceiling value' calculated on the basis of one dose of a commercial product and the prescribed instructions for use.
- The acute reference dose (ARfD) (mg a.s./kg/day), the quantity of active substance that can cause effects after a single administration.

Standards (regulatory values)

- MRL, maximum permitted residue limit for pesticide residues in food.
- 'Maximum levels' for certain contaminants.

Tolerable or acceptable intake*:*

- 'Acceptable daily intake' (ADI) (for pesticide residues);
- 'Tolerable daily intake' (TDI);
- 'Tolerable weekly intake' (TWI), a concept often applied for heavy metals (e.g.: TWI for lead of 1500 µg/week);
- 'Annual limits on intake' (ALI) (for radionuclides).

In the **context of occupational risk**, two limit values have been set for air in the work environment:

- Occupational exposure limits (or OEL), and
- Average exposure limits (or AEL).

These limits are set in relation to a given **reference period**. The definitions used by the National Research and Safety Institute in France (*Institut national de recherche et de sécurité*, INRS) are the following:

The **OEL** is the value to be observed to avoid the risk of an immediate or short-term toxic effect. It is a 'ceiling value' measured over a maximum duration of 15 minutes, in terms of the nature of the risk, working conditions and technical measurement possibilities.

The **AEL** is the value meant to protect workers from longer-term effects, measured or estimated over the duration of an eight-hour work period. An AEL may be exceeded for short periods, provided it does not exceed the OEL, where the latter exists.

However, the use of OELs and AELs in the context of pesticide spraying raises questions about the validity of this approach:

- The majority of OELs and AELs are set in the context of an indoor work environment. It is not known to what extent these values can be extrapolated validly to an outdoors work environment?
- Compliance with these limits implies the existence of reliable air quality measurement systems. How could representative concentrations in the air be measured in an open-air work site?
- In setting limit values, **the respiratory route alone is taken into account** as the vector of workers' exposure to pesticides. **Skin contact is not taken into consideration** although it is known that it can be equally or more hazardous than inhalation.

2.2. Forms of poisoning

2.2.1. Terminology and classification

Practical but arbitrary terminology is often used to designate various forms of poisoning **according to the frequency** and **length of exposure to the toxin**. The different exposure lengths can result in different forms of poisoning.[5]

Reproduced below is the classification and terminology adopted by the Environmental Protection Agency in the United States (EPA, 1996)*:*

Forms of poisoning	Frequency of administration	Length of exposure
Acute	Single (immediate)	< 24 hours (one-day exposure scenarios)
Subacute	Repeated (short-term)	≤ 1 month (exposure scenarios of 1 to 30 days)
Subchronic	Repeated (medium-term)	1 to 3 months (exposure scenarios of 30 to 180 days)
Chronic	Repeated (long-term)	> 3-6 months
Carcinogenic	Repeated (very long-term)	Lifelong exposure

However, it is often **difficult to distinguish between acute exposure and acute effect, and also between chronic exposure and chronic effect**.

Certain effects are also hard to categorize, since acute exposure can cause a chronic effect.

It is therefore not always easy to establish the relationship between exposure and effect.

[5] Other 'forms' of poisoning could be added to this classification. Food poisoning, for example, will be discussed below.

Comparison between acute or chronic exposure and acute or chronic effect:

	EFFECT	
EXPOSURE	ACUTE	CHRONIC
ACUTE	**Short-term effect following short-term exposure** (e.g.: skin irritation caused by contact with a very diluted solution of sulphuric acid)	**Long-term effect following short-term exposure** (e.g.: persistent respiratory disorder following brief inhalation of a strong concentration of chlorine)
CHRONIC	**Short-term effect following long-term exposure** (e.g.: skin sensitization to a pyrethrinoid insecticide after contact over several years)	**Long-term effect following long-term exposure** (e.g.: cancer of the liver, lungs, brain or blood-producing system caused by exposure to high doses of vinyl chloride over several years)

2.2.2. Acute poisoning

❑ Definition and origin of poisoning

The acute toxicity to man or animals of a biologically active chemical product is its capacity to alter vital functions after a single dose. This is the effect observed after **a single exposure** to a quantity of toxic product and its direct consequences: **poisoning**!

Generally speaking, this form of intoxication happens **accidentally** or **through a lack of precautions**. This is the case, for example, when:

- a bottle of concentrated formulation is spilled and the product comes into contact with the skin (splashes);
- wettable powder is inhaled (dust);
- the product is drunk or eaten (unauthorized repacking of products into food containers may result in such incidents);
- protective equipment is not used or not used properly when applying the product.

The consequences of acute poisoning often appear immediately or within 24 hours in the form of headaches, defective vision, abdominal pain, vomiting, labored breathing, cardiac arrest, unconsciousness etc. The observable effects and symptoms for pesticides will be described in greater detail below. To assess the possible acute toxic effect in man, it is current practice to **carry out toxicity tests on laboratory animals,** in particular rats. Based on the test results, it can reasonably be deduced by **extrapolation,** but without absolute certainty, the possible toxicity **for man**.

❑ Characterization

The **LD50 index** is frequently used to express **acute toxicity**. The higher the index figure, the lower the product's toxicity. This index nevertheless has **very limited value** because it only concerns mortality and gives no information on the mechanisms involved and the nature of lesions. It represents a **rough and preliminary assessment** (first analysis) that can be influenced by several factors such as animal species, sex and age of the animal, time of day, the way the toxin is administered (e.g.: a solvent used as the 'vehicle' for the toxin), etc.

Influence of the species test on the value of the lethal dose 50 of two solvents:

Product	Animal species	Lethal dose 50 (mg/kg bw)	
		Oral route	Dermal route
Acetone	rabbit rat mouse	5,340 5,800 3,000	20,000
Methanol	rabbit rat mouse	14,200 5,628 7,300	15,800

The **LD50 index** is nevertheless very useful for classifying toxic substances and comparing their hazardousness (e.g.: extremely toxic, toxic, moderately toxic, slightly toxic, etc.). This value is therefore often used as the basis for regulatory classifications and requirements. The LD50 can be determined by **oral** route (ingestion) or **dermal** (transcutaneous) route.

The World Health Organization (WHO) has published a classification of active substances and their formulations in terms of their acute toxicity (LD50). Generally, the oral LD50 value is used, whereas the dermal LD50 value is only taken into account if it is less than the oral LD50 value.

WHO classification	LD_{50} (mg/kg) values for rats			
	Oral		Dermal	
	Solid*	Liquid *	Solid *	Liquid *
Class Ia	Up to 5	Up to 20	Up to 10	Up to 40
Class Ib	5 – 50	20 – 200	10 – 100	40 – 400
Class II	50 – 500	200 – 2000	100 – 1000	400 – 4000
Class III	> 500	> 2000	> 1000	> 4000
Non-classified active ingredients (shown in WHO Table V)				

**: the terms 'solid' and 'liquid' refer to the form of the product or formulation.*

Color bands (red, yellow, blue and green) are used on the label to show the class of product: they indicate the product's **level of hazard**.

Active substances or formulations with an oral LD50 value of > 2000 (solids) or > 3000 (liquids) are not considered to represent a hazard in normal conditions of use, provided all precautionary measures are observed.

There are other more complete and complementary methods for assessing toxicity, for example, **skin irritation** and **eye corrosivity tests**, which generally form part of a toxicological assessment programme. Such tests are systematically required for assessment of pesticide and biocidal product formulations before they can be placed on the market (product registration or authorization procedure).

All toxicological studies and tests to be carried out in the framework of pesticide authorization procedures are laid down in Regulation (EC) 1107/2009.[6] For biocidal products, Directive 98/8/EC[7] establishes requirements for **'toxicological dossiers'** on substances.

❑ Method of determining LD50

A practical way of characterizing the toxicity of a substance is to determine its **median lethal dose (LD50)**. This dose is used to identify symptoms of poisoning and to **compare substances** in terms of their potential toxicity. It often serves as a starting point for toxicity studies because it provides a minimum level of knowledge. The LD50 value is determined **experimentally**.

The LD50 corresponds to the dose of a substance that can cause the death of 50% of an animal population, within 14 days, in precise experimental conditions.

It is generally expressed as the number of milligrams per kilo of the animal's body weight, mg/kg bw.

A **single dose** (given all at once) of the substance to be tested is administered to a set of animals (generally rats or mice, divided into several groups). The dose given to different groups is increased until a mortality rate of between 0% and 100% is obtained.

The more toxic the substance, the less is needed to cause death and the lower the LD50. The LD90 value can also be determined.

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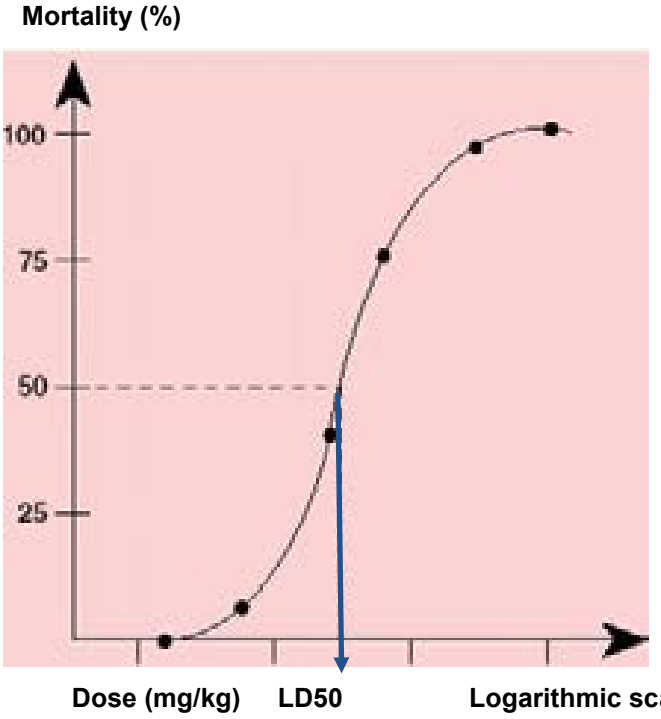
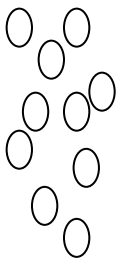
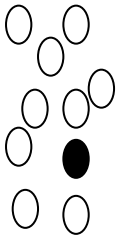
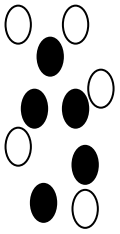
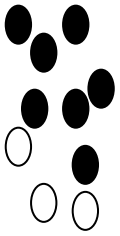
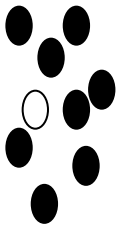
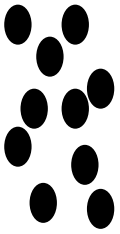
6 Regulation (EC) No. 1107/2009 of the European Parliament and the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC, OJEU, L309 of 24 November 2009.

7 Directive 98/8/EC of the European Parliament and the Council of 16 February 1998 concerning the placing of biocidal products on the market, OJEC, L 123 of 24 April1998.



	6 groups of at least 10 individuals (young individuals in excellent health receiving a balanced diet)					
Observation of mortality among animals						
Dose of toxin administered all at once	0 mg (control group)	15 mg	18 mg	20 mg	23 mg	26 mg

○: *live animal* ●: *dead animal*

Calculation of LD50:

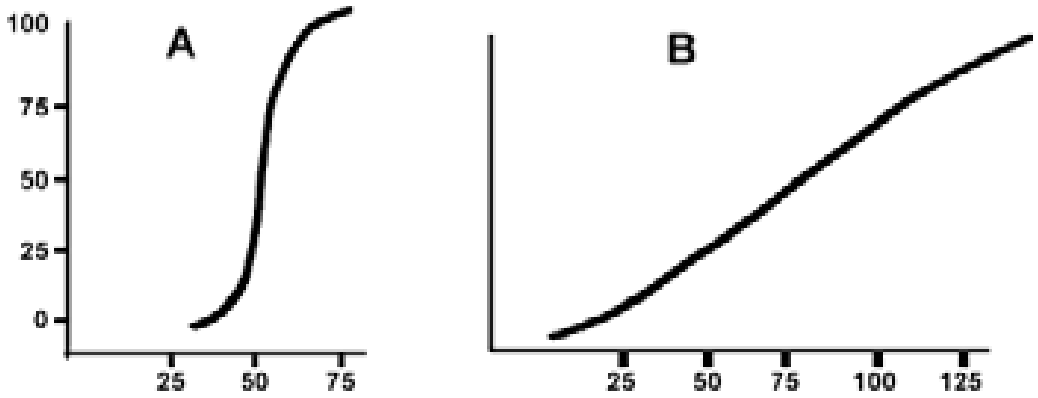
What dose killed half the animals after 14 days? 18 mg!

Since LD50 is expressed as mg per kg of the animal's live weight and an average adult rat weighs around 200 g, in this example LD50 =

18 mg/200 g x 1000 g = 90 mg/kg bw.

LD50 can be used to compare the potential toxicity of different substances: A is more toxic than B. (e.g.: insecticide B, whose active substance has a high LD50, is less toxic than insecticide A. Product A, which acts on the nervous system, has a greater affinity for the receptor that controls the response to the toxin).

Mortality (%)



Concentration (mg/kg)

For a **toxin that is inhaled**, the term **median lethal concentration (LC50)** is used to express the concentration of the toxin that causes the death of 50% of a group of laboratory animals subjected to the test after four hours of exposure through the air they breathe.

LC50 is expressed in milligrams of active substance per liter of air. The tests currently recommended follow OECD and EU guidelines and must be performed in accordance with good laboratory practice.

2.2.3. Subacute poisoning

This is the harmful effect measured after repeated exposures over a period of several days or weeks, the time necessary before symptoms appear.

2.2.4. Chronic poisoning

❑ Definition

Chronic poisoning occurs after **prolonged exposure at low and repeated doses**. Certain harmful effects can take weeks or even years before being diagnosed and can be irreversible (e.g.: hexane neurotoxicity).

The signs of chronic poisoning appear either because:

- **the poison accumulates** in the organism, i.e. the quantity of product eliminated is lower than the quantity absorbed;
- **the effects** caused by repeated exposures **add up** (without accumulation of the product in the organism).

The harmful effect can be expressed through clinical signs (weight loss, liver, kidney, skin disorders, etc.) but often effects are referred to as subclinical and are seen as physiological alterations such as enzyme modifications, particularly along the lines of an increase of certain enzyme activities (enzyme induction).

Long-term effects can be observed experimentally in animals but, with few exceptions, there is **little reliable data for man** in the absence of complete epidemiological studies on chemical substances such as pesticides, biocidal products and food additives. Where doubts exist, recommendations for precautionary measures are made for *'suspect'* products.

Two concepts are fundamental to explain chronic toxicity:

1. **Persistence**, the persistence of the product in the environment and living beings in relation to their chemical stability: organochlorine insecticides (DDT, HCH, endosulfan, lindane, etc.) are considerably more persistent than organophosphates (methamidophos, chlorpyrifos, profenophos, triazophos, etc.) or pyrethoids (cypermethrin, deltamethrin);
2. **affinity for biological tissues**, in particular **liposolubility** (solubility in fats), which determines prolonged fixation in living organisms. The liposolubility indicator of a substance is the value of **Log P** (*P is the octanol/water partition coefficient, defined at a given temperature and pH. P is also known as Kow*). If Log P > 3, the active substance is likely to bioaccumulate.

These two conditions give the chemical agent a **bioaccumulation potential**, namely a capacity to accumulate from the environment in living beings and to persist in organisms. This results in a **concentration in food chains**: from one level to the next, often starting in herbivores, then accumulated rates increase as they are eaten and further concentrated within the predator, reaching very high values in the final links in the chain (carnivorous animals, birds of prey, man, etc.). This can lead to chronic toxicity for human consumers but other apex species are also at risk. With organochlorine insecticides, birds' eggs were affected, causing numbers to fall.

❑ Origin of chronic poisoning

The greatest risks to be considered are those that concern operators' exposure. Good knowledge of the properties of the product and of the application technique is essential to ensure effective, cost-effective and safe treatment.

For producers who use pesticides, this type of poisoning can have a number of origins:

- frequent use of the product or repeated exposure to the product;
- diffuse pollution of the environment (contamination of the air, soil and especially water supplies, wells, etc.) through drift or other movement of the product (runoff, leaching, volatilization);
- residues of the product on harvested foods, especially if the pre-harvest interval is not respected or if the product is used on a crop for which it is not recommended (e.g.: insecticides for cotton used for market garden crops; such products are generally not recommended for vegetables due to their high toxicity, the strong concentration of pesticide in the formulation and the product's persistence on the crop);
- accumulation of the product in the food chain (bioaccumulation);
- wearing of contaminated clothing (and pollution of the farmer's work environment through lack of care and maintenance).

The consequences are not well known and may be under-estimated by operators who use pesticides. This is due to the diversity of products (active substances and formulations) used, the complexity of product formulations (number of possible co-formulants and additives) and lack of awareness of the effects of mixing different products (synergistic effects? antagonist effects? additive effects?).

❑ Assessment of the chronic toxicity of a substance

Animal house of Orleans University (France)

Acute toxicity assessments do not allow the chronic toxicity of a substance to be predicted. **Studies** to assess chronic toxicity must therefore be conducted over several generations of laboratory animals.

Such studies take months or years and involve the administration of more than one dose at intervals that vary depending on the method used. The term 'chronic' is a good description of the purpose of this type of assessment.

These studies, described as animal testing or in vivo testing, are generally carried out by research scientists specialized in different aspects of toxicology, for example immuno-toxicology and carcinogenicity. They generally imply collaboration by researchers from a range of scientific disciplines such as chemistry, biochemistry, biology and medicine. To be validated, such studies must be performed using Good Laboratory Practice (according to OECD monographs) and by specialized laboratories.

Animal testing is controversial and some consumers are calling for it to be outlawed, so molecular methods are increasingly used to gauge toxicity.

To perform tests of long-term or chronic toxicity, given doses of a substance are administered to animals **throughout their lives** or even **to their offspring**. Throughout the experiment, researchers study their **growth, reproduction**, **behavior and offspring** to highlight whether the substance is:

- teratogenic (causing malformations of the fetus);
- mutagenic (mutation of genes or genotoxicity);
- carcinogenic (tumors).

❑ Characterization of the chronic toxicity of a substance

Chronic toxicity studies are used to define the levels of concentration in the organism that do not cause harmful effects. Thanks to the results of such tests, the experts can determine the **no observable effect level (NOEL)** and a **no observable adverse effect level (NOAEL)**.[8] In practice, the lowest observable adverse effect level (LOAEL) is determined through tests on animals. This is the lowest dose at which an observable effect was observed during the test. The NOAEL is set at the next lowest increment.

Determination of the no observable effect level (NOEL)

The dose that produces no observable effects is the maximum quantity of the toxic substance that can be ingested by an animal daily, throughout its life, without causing physiological disorders.

It is expressed in mg/kg of body weight/day.

An **admissible daily intake (ADI)** can be determined based on the value of the NOAEL that results from the most appropriate study on a sensitive and representative animal species and from a **safety factor** (**SF**). This safety factor takes account of intra- and inter-species variability and of the nature of the effects of the substance.

ADIs are set either by the European Commission (EFSA) or by international bodies (FAO/WHO).

Calculation of ADI:

ADI (in mg a.s./kg bw/day) = No observable effect level / SF

SF is a safety factor of 100:

[8] It is important to specify whether these are 'observable' and/or 'harmful' effects. The effects in question must be measurable and quantifiable and it must be determined whether they are harmful and irreversible. For example, alcohol consumption can lead to a temporary increase in the volume of the liver: this effect is observable but not harmful. On the contrary, this observation proves the organism's reaction to alcohol for the purpose of eliminating it. Of course, after repeated exposure over a certain threshold, irreversible effects on the liver will be observable (cirrhosis of the liver).

- A **species factor** of 10: it is assumed that the human species is 10 times as sensitive as the most sensitive animal species tested.
- An **individual safety factor** of 10: in a human group, not all individuals have the same sensitivity; some can be more sensitive than the average (children, pregnant women, older persons, etc.)

The **safety coefficient** is by convention 100 for a two-year study and for non-carcinogenic compounds, 500 for a 90-day study and, if there is the slightest doubt, this coefficient is raised to 1,000.

There is not necessarily a direct connection between acute toxicity and chronic toxicity: a pesticide with high acute toxicity can have low chronic toxicity and vice versa (e.g.: the fungicide captafol).

2.2.5. Direct and indirect poisoning

Direct and indirect toxicity are differentiated according to the nature of the toxic product and the toxic effects.

❑ **Direct toxicity**

The toxin produces its harmful effects without any biotransformation. Its chemical structure is responsible for its toxicity.

Examples:

- *strong acids (vitriol) and strong bases (liquid caustic drain cleaners);*
- *oxidizers (ingestion of bleach);*
- *alkylating agents (anti-cancer agent);*
- *carbon monoxide (CO) attaches to the hem of hemoglobin in the red blood cells in place of oxygen, reducing the ability of the blood to carry oxygen.*

Direct toxicity therefore refers to a toxic effect that is related to the substance itself or one of its metabolites. In the case of a toxicity related to a so-called 'active' metabolite, the severity is modulated by the quantity of metabolite formed. The quantity is often related to the activity of enzymes.

❑ **Indirect toxicity**

The toxin is not toxic per se but **requires biotransformation** for its toxicity to emerge (the case of certain insecticides). A metabolic reaction (hydrolysis, oxidation, etc.) is necessary to transform the product into one or more metabolites that will cause the toxic action. Indirect toxicity also refers to a toxic effect of a substance that is unforeseeable, cannot be reproduced in animals and is probably immunological in nature.

2.2.6. Food poisoning

Food poisoning is caused by microbiological contamination of food during production, processing or handling by:

- **A lack of hygiene**: a collective food-borne illness caused by *Escherichia coli*, *Salmonella*, *Campylobacter*, viruses, staphylococcus, botulinum toxins, *Listeria* etc. The list is long!
- **The presence of toxic contaminants of natural origin**: poisoning from mycotoxins (moulds, aflatoxins, ochratoxin A, ergotism), marine biotoxins, accumulation of heavy metals (Cd, Pb, Hg etc.) in plants or animal tissues.
- **The presence of toxic contaminants of human origin**:
  - food additives: substances added to a food for technological or organoleptic reasons;
  - pesticide residues exceedance of the MRL;
  - nitrates > authorized values;
  - presence of toxic metals, leaching from materials in contact with foods, traces of detergent, disinfectant or hydrocarbons.
- Consumption of poisonous toadstools, mushrooms or other fungi.
- Poisoning from drinking polluted water.
- Toxic products resulting from certain cooking techniques (e.g.: acrylamide[9]).
- Toxic products formed during digestion (e.g.: nitrates transformed into nitrites; hydrocyanic acid from eating certain beans).

[9] Acrylamide (C_3H_5NO) is a compound that can appear spontaneously during cooking (frying, roasting, etc.) of foods rich in carbohydrates (starch, sugars) and protein at more than 120°C. It is a carcinogenic and reprotoxic molecule (results of animal studies). The substance is considered capable of having effects on the nervous system and the WHO and EFSA regard it as a risk to human health. The foods most concerned by the formation of acrylamide are products made from cereals and potatoes (such as chips or chips), bread and pastries and generally all products subjected to high temperatures such as coffee or toasted almonds.

2.3. Particular risks related to the use of plant protection products

2.3.1. Plant protection products and their formulations

Plant protection (also known as plant health, phytosanitary or phytopharmaceutical) products are commercial preparations ('formulations' containing one or more active substances) used to:

- protect plants or plant products against all harmful organisms and to prevent the action of such organisms (diseases, pests or weeds) and limit crop yield loss;
- exert an action on the vital processes of plants (e.g. growth regulators, etc.) or animals (e.g. insecticides or plant diseases (e.g. wilts or blights);
- ensure the conservation of plant products;
- destroy undesirable plants (herbicides, algicides, moss-control products; haulm destroyers, germination control products etc.);
- increase the farmer's comfort;
- limit the development of pathogens for man and animals.

Plant protection products can be classified into several categories depending on:

- the type of diseases or problems treated: insecticides, fungicides, herbicides, algicides, nematocides, acaricides, molluscicides, bactericides, rodenticides etc.;
- the use made of the product: pesticides for agricultural use and those for non-agricultural use or biocidal products.

The term '**active substance**' (or 'active ingredient' or 'molecule') is used to refer to the biologically active compound (e.g.: deltamethrin) and 'formulation' is used to designate the commercial product, a mixture of several components supplied in the manufacturers formulation that is either ready-to-use or must be diluted in water (e.g.: DECIS 25 EC). The active ingredient, which in most cases is a chemical substance resulting from synthesis, has a common name (e.g.: diazinon, endosulfan etc.) that corresponds to a specific chemical formula. These are chemical s but plant protection products are increasingly a biological product or one of biological origin (sometimes a bacterial or fungal toxin, polyhedral virus, vegetable extract etc.).

The '**formulation**' (commercial product) contains one or more active ingredients (binary products, ternary products, etc.) at carefully defined concentrations expressed in g/liter or as a % depending on whether they are liquid (soluble liquid (SL), emulsifiable concentrate (EC), suspension concentrate (SC)) or solid (dispersible granule (DP), wettable powder (WP), water dispersible granules (WG), or granules (GR).

An **'additive'** is a substance that in principle has no biological activity *per se* but that can improve the action of the active ingredients contained in plant protection products. These include surfactants that reduce the surface tension of mixtures; mineral or vegetable oils

that facilitate foliage penetration of the active ingredient; and humectants that can slow the desiccation of droplets and improve penetration in the target.

In addition to being grouped by type of activity, plant protection products can also be 'classified' (grouped) by the chemical family to which they belong and which confers their properties, including toxicity and mode of action.

For example:

Insecticides	Herbicides	Fungicides
Microbial products Vegetable products Carbamates Organochlorine compounds Organophosphates Pyrethrinoids Nicotinoids …	Triazine derivatives Urea derivatives Phytohormones Carbamates Anilines Sulfony-urea derivatives etc.	Elicitors Mineral products Cupric products Dithiocarbamates Dicarboximides Benzimidazoles Triazoles Phenylamides Morpholine derivatives etc.

2.3.2. The toxicity of plant protection products and risks associated with their use

The toxicity of a plant protection product is related to its physiological or biological properties that enable it to damage or alter a living organism by non-mechanical means.

Generally speaking, plant protection products **can exhibit two types of toxicity** to people: acute toxicity and chronic toxicity.

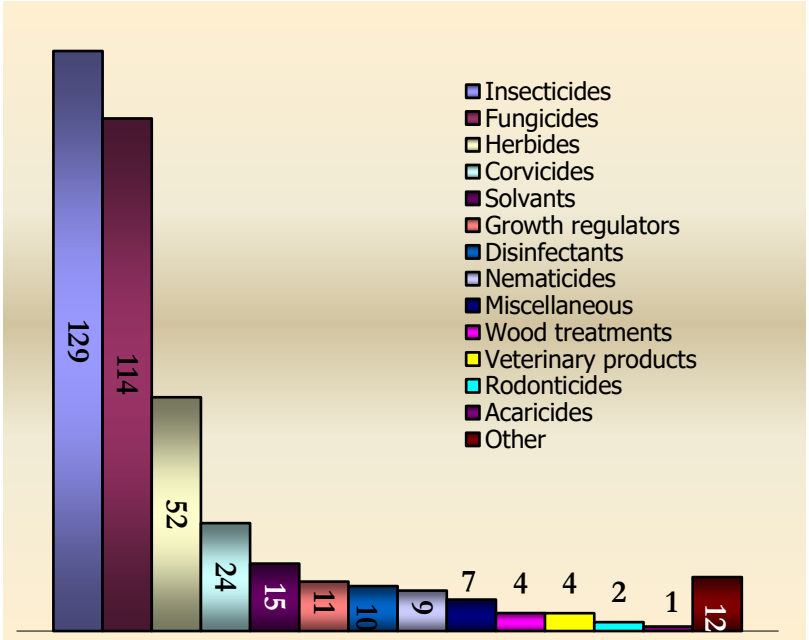
Unless properly applied, their use therefore entails certain risks for users, consumers and the environment.

Insecticides are among the most dangerous plant protection products for operators because the targets of their action (as a rule, disruption of the nervous system) are comparable for man and insects. Fungicides and herbicides also present significant dangers if not applied with due care and attention.

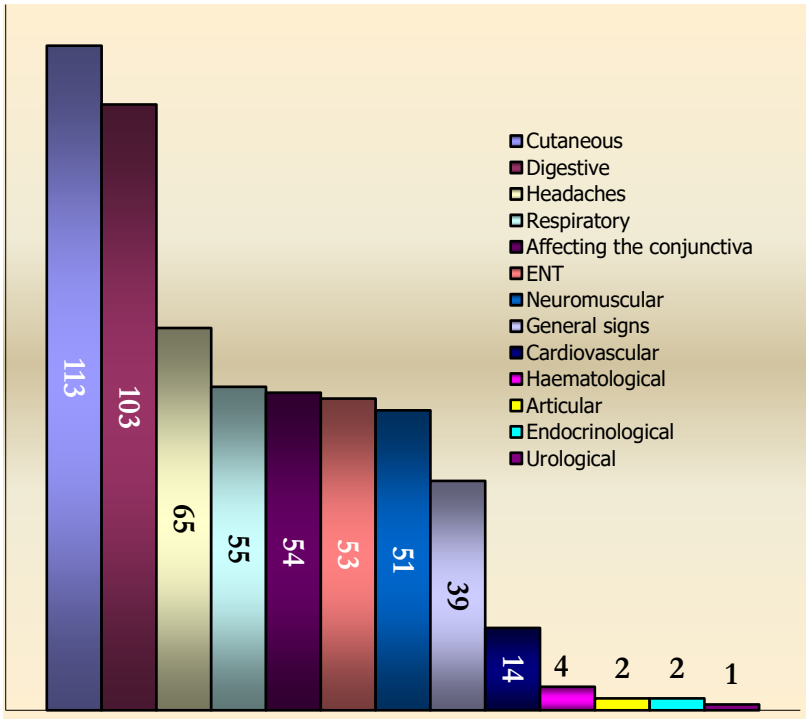
The results of a survey conducted by the UIPP[10] in France on the origin and effects of 305 recognized cases of poisoning from plant protection products are summarized in the following two figures.

[10] The Plant Protection Industries Association (*Union des Industries de la Protection des Plantes* – UIPP) is a professional organisation representing 19 companies that sell plant health products and services for agriculture (in France).

Distribution of products involved in poisoning in terms of their biological activity (of a total of 305 observations, UIPP)



Distribution of the main symptoms registered
(types of symptoms observed out of a total of 305 observations, UIPP)



However, the health risks incurred when handling pesticides can be kept under control provided the operator acts cautiously, uses recommended means of protection and respects the precautions for use indicated on the product label.

In case of misuse (overdosing or failure to respect the pre-harvest interval), pesticides can also be the source of toxicological risks (toxic residues on or in the harvested products) and economic risks (non-conformity of the batch, market rejection). If an analysis shows that the MRL (maximum residue limit) value has been exceeded, there is a possibility of fine or other penalty.

The most important risks to be considered are those that concern the operator's exposure because he or she is handling the product for significant periods of time. It is essential to have good knowledge of the product's properties and of the application technique to ensure effective, cost-effective and safe treatment.

Treatment with plant health products can be divided into three risk phases: the phase of preparation and loading of the mixture – which presents the greatest risk of contamination because concentrated product is involved –, the application phase and the phase of rinsing and cleaning of packaging and equipment.

Example of an operator not wearing the recommended personal protective equipment who could be seriously exposed to hazards from contamination

Users' exposure to pesticides will vary significantly depending on **different parameters**:

- The toxicological and physical-chemical properties of the active substance (solubility, vapor pressure etc.);
- The product's presentation (solid, liquid or gas as well as whether or not it has to be diluted before application);
- The type of application (spraying, application of granules, atomization), exposure routes and the length of exposure (occasional or repeated);
- The application material used (wheeled or carried device, type of nozzle, working pressure, state of material etc.);
- The volume of mixture applied per surface unit treated;
- Type of packaging (nature, volume and size of opening);
- Protective equipment worn (nature, quality, appropriateness);
- The surface treated (size, sheltered or not);
- The height of the crop (orchards or low-growing crops);
- Frequency of treatments;
- Weather conditions (wind: intensity, direction, stability etc.).

These parameters will be used in mathematical estimate and exposure models.

2.4.2. Harmful effects of plant protection products

Only a general overview of effects is given.

Among professional users, mild poisoning can be expressed by non-specific signs: nausea, headaches, weakness, defective vision, dizziness, etc.

In case of higher levels of absorption (oral, through the skin, or through inhalation), digestive disorders (vomiting, diarrhea, abdominal pains), involuntary urination, etc. can occur. The victim can also experience a state of confusion, ataxia, then convulsive coma and paralysis of the respiratory centers. Death may follow due to respiratory failure brought on by congestion, bronchoconstriction, paralysis and central nervous system depression.

The following can be distinguished:

- observable effects on the skin and mucous membranes;
- effects on the nervous system (in general);
- effects that appear over the longer term, after repeated exposures.

For more information on the effects of a pesticide on health, the user should first consult the 'Safety Data Sheet' (SDS) to learn about the specific symptoms in case of poisoning.

❑ **The effects of plant protection products on the skin and mucous membranes**

Cutaneous signs such as **pruriginous (skin itching and inflammation) erythema** (lumps or nodules produced) or **contact eczema** (dry itchy redness) can be seen, to which **vector solvents often contribute**. Contact eczema is a very frequent acquired dermatosis (skin ailment). It is due to the individual's sensitization to the substances that have come into contact with the skin.

Blister (burn) due to contact with the herbicide glyphosate ('RoundUp').

Skin irritations and ulcerations caused by repeated contact with the mixture

Skin irritations caused by repeated contact with the mixture

A case of conjunctivitis brought on by contact with toxic dust

Penetration of the skin by the toxin depends on the **nature of the solvent carrier** and **especially on the liposolubility of the active substance**.

Paraquat, cyperquat and diquat are all part of the same group of quaternary ammoniums. Part of the danger of **quaternary ammoniums** lies in their **high toxicity**, both orally and dermally. Since herbicides are handled by farmers, often with fewer precautions than insecticides, paraquat ('Gramoxone') is responsible for many serious or fatal poisonings. Some are deliberate suicides, particularly in India and unfortunately there is no effective antidote.

Herbicides from the group of aryloxyacetic derivatives, such as 2,4-D, 2,4,5-T and MCPA, can contain dioxins as impurities. Dioxins have become notorious since the Seveso accident (pollution and poisoning by TCDD or 2,3,7,8-tetrachlorodibenzo-paradoxin). Among other problems, they can cause chloric acne.

❑ Neurological and neuro-behavioral effects

Agitation, anxiety, disorientation, ataxia (a group of neurological disorders that affect balance, coordination, and speech) and convulsions may all precede central nervous system depression. Myocardial (heart) hyperexcitability can also be observed. **Neurotoxicity** is the mode of action of certain pesticides. Anticholinesterase insecticides are consequently poisons for insects and mammals. The main effects on insects and man can be attributed partially or entirely to the inhibition of the enzyme acetylcholinesterase in the nerve tissue, , which results in an accumulation of acetylcholine, an important neurotransmitter, so muscles are triggered, inducing spasms that can lead to heart failure.

There are two principal groups of anticholinesterase products: organophosphates and carbamates. These products are some of the most toxic that exist because their action sites are located in the nervous system. Most have now been taken off the market:

Chemical group	Mode of action	Insecticide
Organochlorines	Sodium channel modulators (effect on axonal transmission)	DDT, Endosulfan, Lindane, Aldrin, HCH etc.
Carbamates	Acetylcholinesterase inhibitors	Aldicarb, Carbofuran Carbosulfan, Propoxur etc.
Nicotinoids	Acetylcholine receptor antagonists (replace the neurotransmitter)	Imidacloprid, Acetamiprid, nicotine etc.
Organophosphates	Acetylcholinesterase inhibitors	Chlorpyrifos, Dimethoate, Profenofos etc.
Pyrethrins & Pyrethrinoids	Sodium channel modulators (effect on axonal transmission)	Cypermethrin, Deltamethrin, Cyhalothrin

Acute toxicity from these pesticides results from disruption of complex nervous system functions. Disruption of the system that regulates vital functions such as breathing or heartbeat can be tolerated for only a very brief period without being fatal. Acute effects occurring at high doses are known as a result of accidental or voluntary (suicide attempts) poisonings.

Additional information on potential neurotoxicity is listed for the former organochlorine compounds (DDT), which can bring on convulsions, for pyrethrinoids and urea derivatives. Insecticides are easily absorbed by the gastro-intestinal tract but some can also be easily absorbed by the skin. The different organochlorine compounds have a strong affinity for lipids. They accumulate in fatty tissue and the liver and this pronounced liposolubility contributes to fixation in the central nervous system. They are transmitted in milk and can consequently contaminate consumers; they cross the placental barrier and contaminate the fetus. Most pesticides in this family are no longer used on crops but some such as DDT continue to be used in several tropical countries to combat vectors (such as mosquitoes).

There is little precise knowledge to date on the **chronic effects** of repeated exposure to low levels over a long period. However, a team of researchers from the French National Institute for Health and Medical Research (INSERM) and Pierre and Marie Curie University recently demonstrated (2010) that exposure to pesticides virtually doubles the risk of **Parkinson's disease** among farmers. This risk increases with the number of years of exposure and, for men, is mainly linked to the use of insecticides, particularly organochlorine compounds. The results clearly show that Parkinson's patients used certain insecticides more often and over a longer period of years than the control group.

❑ Observable effects over the longer term

➢ *Immunotoxicity*

Numerous organophosphate, carbamate and organochlorine insecticides, dithiocarbamate fungicides and herbicides alter various immune functions and significantly reduce the organism's resistance to infections (immunodepressants). They reduce the body's defenses against attacks by microbes and toxins. For example, malathion, methylparathion, carbaryl, DDT, paraquat and diquat inhibit the formation of antibodies.

➢ *Carcinogenic effects*

The chemical nature of certain products suggests that they are the cause of genetic mutations or even the development of tumors. International bodies (e.g.: IARC, EPA, EU) have issued recommendations on restricting the use of certain products (these include DDT and other organochlorines, captafol, captan, ethylene-bis dithiocarbamates etc.). A greater risk of cancer has been observed among children exposed to pesticides before birth or during childhood. Children's exposure to pesticides has most often been associated with brain tumors and leukemia.

Geographical or ecological correlation studies have suggested possible associations between environmental exposure and the risk of cancer by comparing for the study area the variations in percentages of agricultural land use and death from cancer. However, it is important to note that the results of this study cannot prove a link between certain types of agricultural pollution and mortality, given the large number of associations tested and there is currently no consensus on the existence of a higher risk of cancer, in particular due to uncertainties over determining exposure to pesticides and other environmental factors and the lack of data on underlying biological mechanisms.

➢ *Effects on reproduction and development*

Effects from certain products on reproduction and teratogenicity (malformation of the embryo) have been observed in experiments on animals (carbaryl for dogs, dithiocarbamate fungicides, captafol, captan, folpet, benomyl, thiabendazole), but the findings have not been confirmed for humans.

One of the functions most sensitive to long-term effects is reproduction: a decrease in fertility and fecundity, miscarriage and fetal malformations (teratogenic effects). Pesticides have been identified as agents that may undermine the process of male fertility due to testicular toxicity. The results of certain studies have demonstrated that conception takes longer for couples who have tried to conceive during application season if the father has used pesticides. The impact is much harder to demonstrate in natural conditions given the diversity of factors that can alter reproductive functions (nutritional,

infectious, genetic and so on) among man and animals. Effects from certain pesticides on fertility have been reported for animals (e.g.: frogs).

An effect of maternal occupational exposure to pesticides on the risk of intra-uterine mortality and on lower fetal growth has also been demonstrated.

2.4.3. Influence of the formulation on toxicity and exposure

There are **more than 50 types** of formulations of plant protection products, from wettable powders (WP) to water-based suspension concentrates (SC), oil-based solutions (UL), water dispersible granules (WG) or granules to be dispersed in the seed furrow (GR).[11]

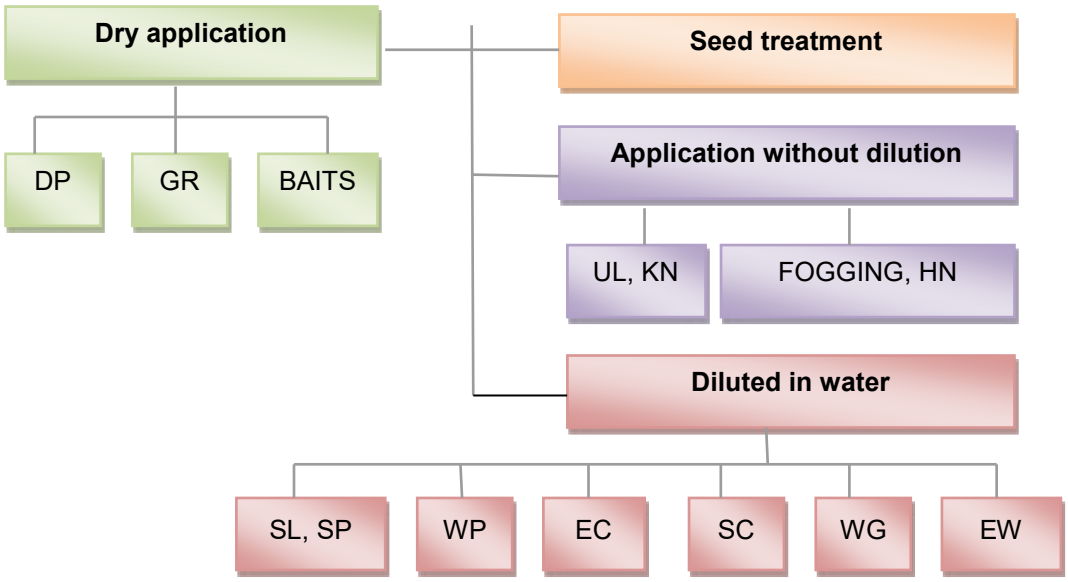
All these presentations have been developed to respond to **different uses** and manufacturers' market objectives.

The **main objectives of the formulation** are to:

- Dissolve or dilute the active substance:
  - Limit risks for the operator (contamination)
  - Limit environmental impact (dust, drift)
- Make application easier:
  - Easy mixing in the tank (dispersion)
  - No blocking of nozzles
- Make application effective:
  - Even distribution on leaves/targets
  - Adherence of the product to leaves/targets

[11] Pesticide formulations are designated by an internationally accepted two-letter code: WP, EC, SC, DP, etc. The full list of formulation codes and their definitions can be found at: http://www.croplife.org/public/technical_monographs (Technical Monograph No2, 6th edition, Crop Life).

Formulations can be categorized as follows on the basis of their application method:



❑ Formulation and toxicity

The presence of certain solvents and additives in the formulation can increase the formulated product's toxicity, for example by making it easier for the active substance to penetrate the skin. The law therefore requires that the formulated product's median lethal dose (LD50) be established experimentally with a view to classification in terms of its level of danger.

In the absence of scientific data on the real toxicity of the formulation, the product's final classification can be based on a calculation and depends on the concentration of active substance in the product used.

Method of calculating the LD50 of a formulation (according to WHO):

The LD50 of the formulation is calculated on the LD50 of the active substance (a.s.), using the following formula:

$$LD_{50} \text{ of formulation} = \frac{LD_{50} \text{ of active substance} \times 100}{\text{Percentage of a.s. in formulation}}$$

For formulations that include several compounds, the same calculation is made for each and the values obtained are added together.

Caution!

The calculation method can **underestimate** or overestimate the formulation's **real toxicity** (e.g.: petroleum solvents used in EC formulations that increase the theoretical toxicity; synergistic effects).

❑ Formulation and exposure

Formulations can be solid or liquid. Their physical state exposes operators to variable risk levels. All the studies carried out show that **powder formulations (DP: dustable powder; WP: wettable powder) are by far the most contaminating**. When surveyed, operators complain the most about WP, which is confirmed by tests.

It has been observed that often the **person who prepares the mixture is more exposed than the applicator**. The risks of exposure are maximum **during opening of the package** (cloud of dust or vapors that are released), **measuring of the concentrate, mixing** and **Loading the sprayer** (splashes from the container, projections in the eyes).

Even **the diameter of the stopper** can play an important role in exposure. It is in the manufacturer's interest to pack the product in a container with a wide enough stopper (e.g.: 63 mm) to prevent a 'glug-glug' during pouring which can project splashes or drops onto the operator's body.

Remember!

During the **preparation phase**, formulations that have a high concentration of active substances are handled in order to be loaded into an application system, such as a knapsack sprayer or a field sprayer mounted on a tractor.

Measuring and preparation of the spray mixture appears to represent more than 70% of the exposure risk, which occurs:

- when opening the package and measuring out the required quantity of concentrated formulation (splashing, dust etc.)
- pouring (dust, vapors etc.)
- filling the sprayer (splashing, foaming etc.)

(Photo of an operator in Tunisia, B. Schiffers)

90 to 98% of exposure concerns the hands, which makes it obvious that impermeable gloves should be worn during all these operations!

Note that the formulation is being poured from a drinks bottle (not permitted) and that the operator hands are not protected by gloves.

The following table presents a synopsis of risks for different formulations.

Summary of exposure risks depending on the type of formulation

DP: dustable powder; WP: wettable powder; WG: water dispersible granules; UL & KN: oily solution; EC: emulsifiable concentrate; SC: suspension concentrate; GR: granules; EW: emulsion, oil in water; CS: capsule suspension.

State	Applied		Formulation	Problems and risks		
Solid	**As such, without being diluted**		DP	**Dust** released during handling	Exposure to the concentrate	Drift in wind, risk of inhalation of particles
			Granules to be dispersed (GR)			Minimum exposure if the operator uses protection
			Fumigant			Risk of inhalation
	Diluted in water		Coating agent		Dilution that reduces toxicity	Risk of confusion with foods
			WP			**The person who prepares the mixture is more exposed than the applicator**
			WG			Larger drops reduce drift
Liquid	**As such, without being diluted**		UL, KN	**Droplets** that adhere to clothing and the skin	Exposure to the concentrate	Operator exposed to the concentrate, risk of inhalation and drift
			Spray			Risk of inhalation
	Diluted	**In water**	EC, SC EW, CS		Dilution that reduces toxicity	**The person who prepares the mixture is more exposed than the applicator**
		In an oil	UL			Both the person who prepares the mixture and the applicator are exposed to the same concentrations

2.6. Antidotes and antagonists

With most acute and chronic poisonings only the symptoms can be treated. However, in certain cases, antidotes can be used and are effective. Accordingly, in spite of their **limited interest**, we will discuss them briefly.

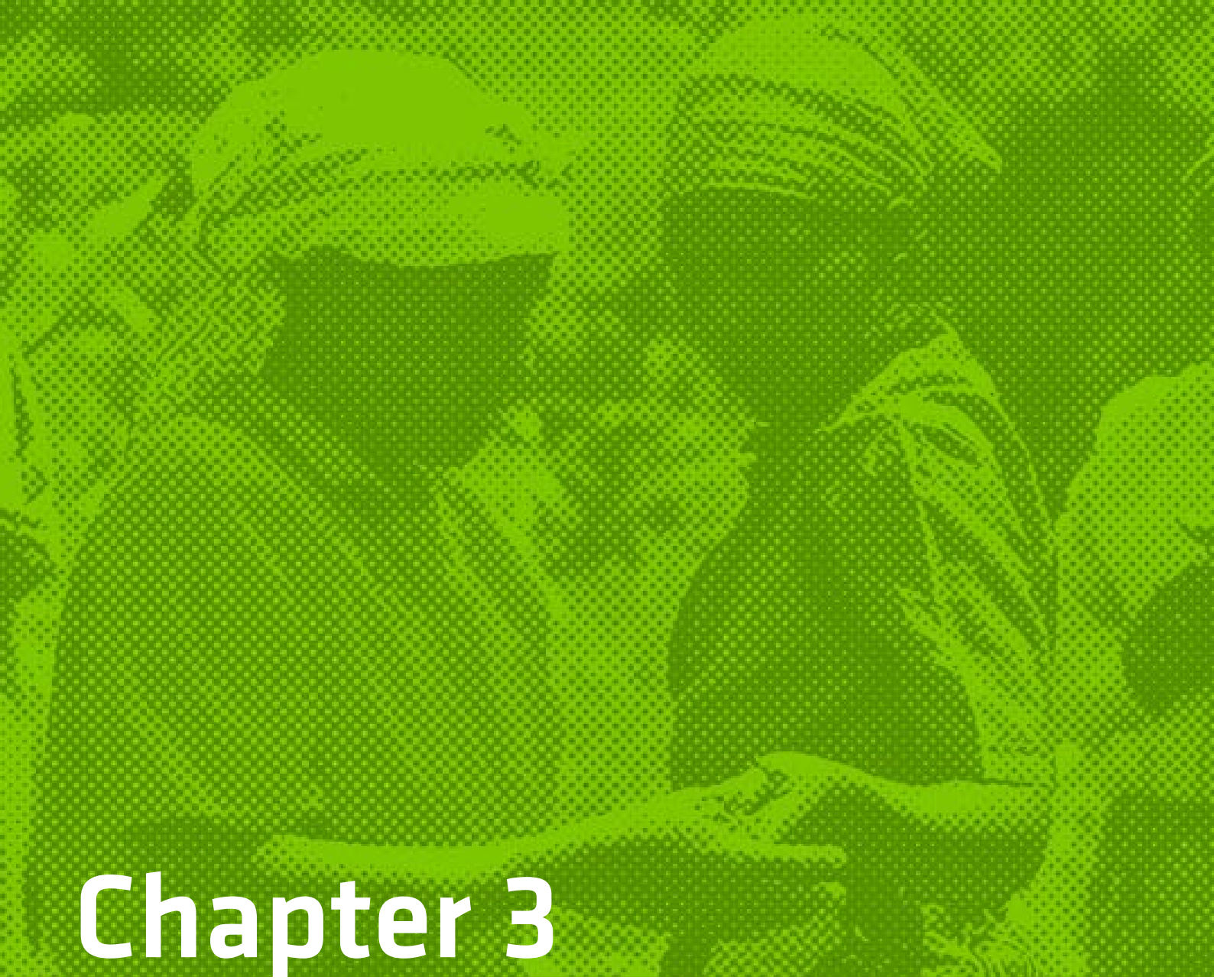
Antidotes can be classified into four groups based on their action mechanisms:

1. antidotes that limit digestive absorption and accelerate elimination of the toxin;
2. antidotes that prevent the toxin from reaching its target: acceleration of detoxification and reduction of synthesis of a toxic metabolite;
3. antidotes that move the toxin away from its target;
4. antidotes that reduce or correct the effects of the toxin (e.g.: vitamin K in case of poisoning with an anticoagulant rodenticide such as warfarin or atropine to deduce the effect of organophosphate insecticides).

Antidotes in the first group are certainly the most useful, starting with **activated charcoal**. Activated charcoal is the most widely used and thoroughly studied of various **digestive adsorbents**. Its effectiveness has been demonstrated on many substances. It must be used in **high doses** because adsorption is more effective the higher the charcoal/toxin ratio. Administered within five minutes of absorption of the toxin, activated charcoal can absorb up to 90% of the dose ingested. This benefit decreases as the time from ingestion increases. It must be used with precaution in the presence of convulsions or the risk of convulsions or disturbance of consciousness. Activated charcoal is not a costly product. In practice, initial doses of 50 to 100 g of charcoal are given, increased by 20 to 40 g every four hours.

Other digestive absorption inhibitors also exist, mainly ‘clays’ such as **montmorillonite** (fuller’s earth) and **bentonite,** which can inactivate paraquat and diquat (two herbicides). Certain chelating agents trap toxins by forming stable complexes that are then eliminated in the urine, such as EDTA with cyanide ions.

The best known antidote, to be used in case of insecticide poisoning, is **atropine**. **Carbamate** and **organophosphate** insecticides act on the nervous system by binding to cholinesterases, thus inhibiting their activity and producing an accumulation of acetylcholine at the level of receptors. The inhibition they produce lasts from several minutes to several hours. Poisoning by these products requires symptomatic treatment, but the use of atropine also overcomes some of the effect of the toxin.



Chapter 3

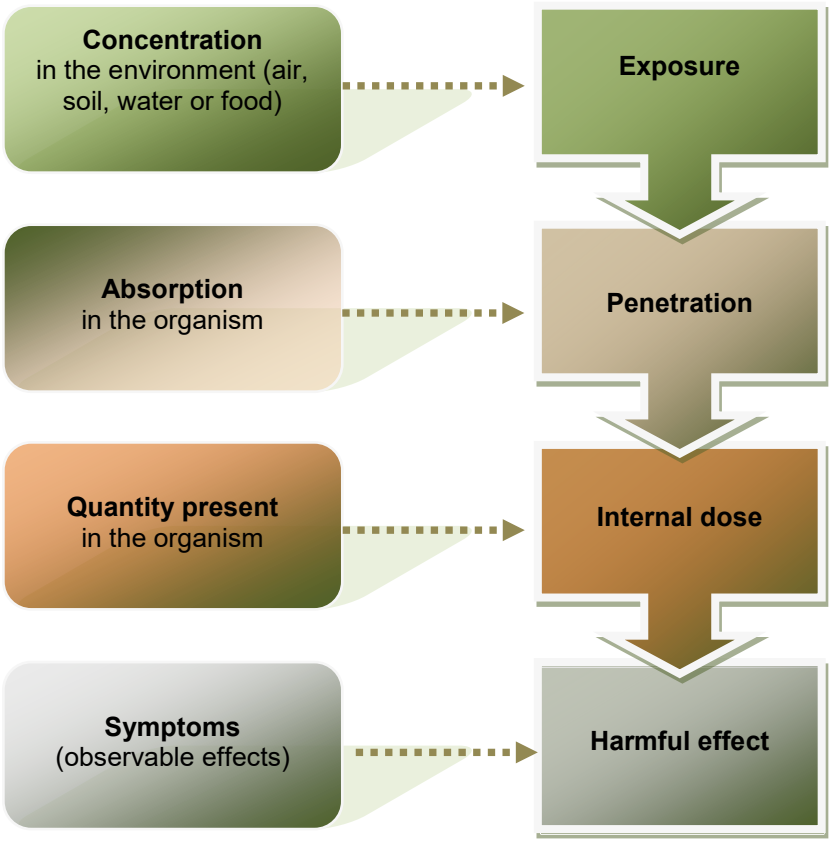
Exposure to plant protection products

3.1. Direct and indirect exposure

3.1.1. Generalities on the concept of exposure

For a harmful effect to appear, the organism must be **exposed** directly or indirectly to the substance that is the source of the effect. This is the difference between 'hazard' (toxicity) and 'risk' (likelihood of coming into contact with the hazard). It is essential to understand the sources, circumstances and routes of exposure so as to choose effective prevention, protection and, if need be, remedial measures.

Four stages are involved between exposure and the appearance of a harmful effect:

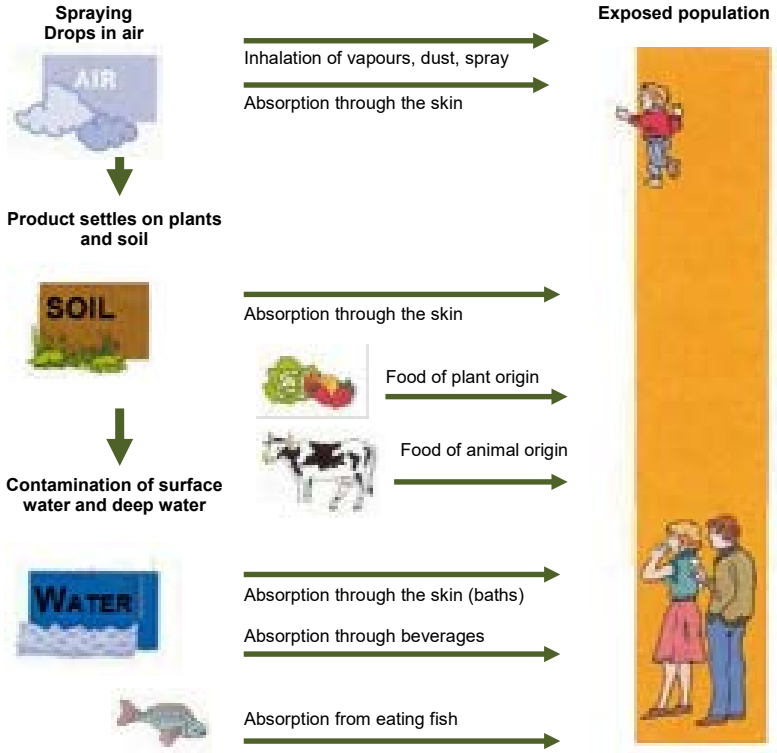


A discussion of 'exposure' consequently means first taking a look at **possible sources** of contamination and the **circumstances** of contact with the toxic substances (the 'scenario' that explains the circumstances). Substances can already act at the point of contact (**local effect**), but most must enter the organism to cause harmful effects (**systemic effect**). It is therefore necessary to study the main **routes of absorption** (respiratory, cutaneous and digestive routes). Lastly, for a **toxic effect** to occur, the substance or one of its toxic by-products must **reach the organism's target organ(s)** in sufficient quantities (**distribution)**.

3.1.2. The circumstances of exposure

Assessing a population's exposure to a hazardous substance requires a **conceptual exposure diagram** that represents **all transfer and exposure routes**. This is the case, for instance, for exposure of operators and consumers to pesticides used in agriculture.

Example of a conceptual diagram of exposure to pesticides:

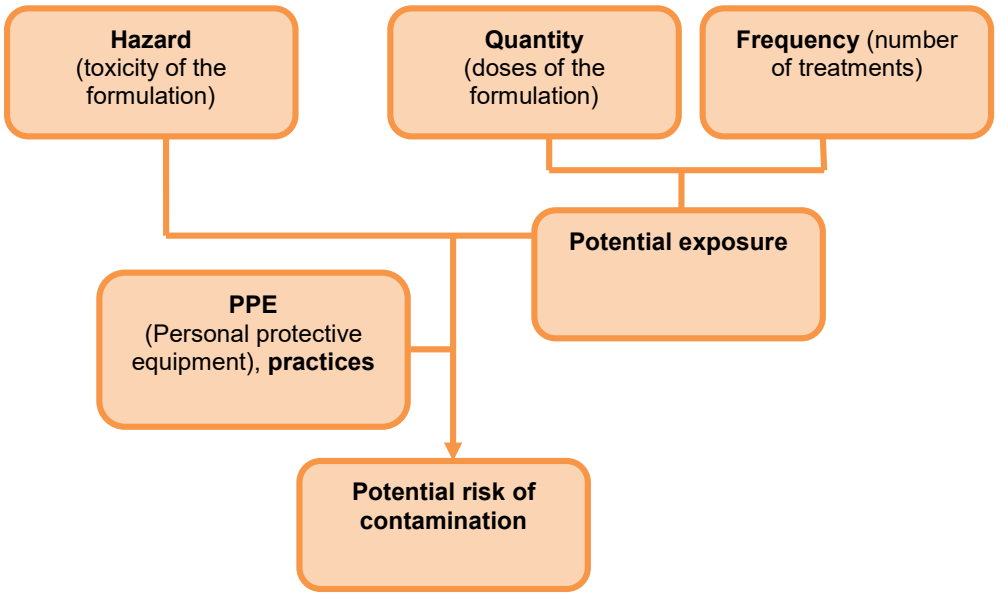


This diagram represents:

- **the different** environmental **categories** that may directly or indirectly contain hazardous substances as a result of the use of pesticides on crops. These categories include: soil, surface water, ground water, atmospheric air, ground air, plants, animals etc.
- **routes of exposure** to hazardous substances: inhalation, ingestion, contact with the skin, etc.
- **vectors for the transfer** of pesticides: the paths by which they transit between the different environmental compartments. The vector and the environmental compartment are often one and the same: water, for example, is both an environmental category (concentrations of pesticides in water must be known to assess the risk involved in consuming the water) and a vector for transfer (because it can transfer pesticides to plants or fish that are then eaten by humans).

To draw up a conceptual diagram, it is first necessary to define **'scenarios'**, *i.e.* to describe pesticide application procedures in detail: the product used, the application

rates, surfaces treated, number and duration of treatments, application equipment, volume/ha, protective gear used, etc. Based on each scenario, the quantities of pesticide to which an operator can reasonably be exposed are estimated: this is the determination of **'potential risk'**.



The potential risk estimated and calculated in this way (e.g.: using a mathematical model) will be compared to a '**toxicological ceiling**', namely the acceptable operator exposure level (AOEL), an exposure value (mg a.s./kg bw/day) that represents an '**acceptable risk**'.

Characterization or 'risk quantification' depends to a large extent on the assessment of operators' exposure to a hazardous substance such as a pesticide or other chemical product used as part of the production process.

The nature and intensity of the risk vary from one '**treatment scenario**' to the next:

- a **horticulturist** applying a spray in a greenhouse works in a highly contaminated atmosphere and should wear a mask equipped with a cartridge filter, full impermeable coveralls and boots so as to keep spray drops from settling on the skin and to limit inhalation of the products.
- for an **arboriculturist**, the spraying phase is particularly critical because spray from the top of the tree can fall back on the operator. When spraying an orchard, it is advisable to wear an impermeable coverall with a hood or other impermeable headgear and gloves and boots. It is useful to wear goggles or even a chemical cartridge mask for certain pesticides and this information should be given on the label.
- for **spraying soil** or low-growing crops the risk is lower. The operator should wear impermeable headgear, coveralls or impermeable clothing, suitable gloves and boots and be aware of wind direction so spray is not carried towards him/her.

3.1.3. Absorption, distribution and metabolism

The nature and intensity of the toxic effects of an active substance on an organism depend on its concentration in the target organs. This concentration is related to the dose administered, entry route and the fate of the substance in the organism (namely **absorption**, **distribution**, **metabolization** and **elimination**).

The substance that enters the organism may have harmful (toxic) effects without undergoing any transformation in the body. Conversely, the organism can also act on the product: this is what is known as **metabolism**, which is. The organism's response (e.g.: enzymatic degradation) depends, among other factors, on the quantity of the product present in the tissue or an organ.

❑ **Absorption or entry in the organism**

Absorption refers to the process in which the product penetrates the organism. **This is an important stage.** Effect may be local (at or near point of entry) or if it enters the blood stream, a product can cause systemic toxic action, i.e. at places distant from the initial point of contact. Various factors can influence the process of absorption of a product: its nature, solubility, the permeability of biological tissues at the point of contact, the length and frequency of exposure, etc.

❑ **Transport, distribution and accumulation (or distribution)**

After reaching the blood stream, the product can be transported throughout the organism. This is what is known as distribution. Blood transports oxygen, various nutritive elements essential to the organism's functioning, and waste. But blood may also redistribute toxins. These can then come into contact with cells and become fixed to certain tissues. Organochlorine pesticides such as DDT become concentrated in fatty tissues. **They can remain stored there without causing toxic effects for periods of varying lengths**. On the other hand, they can cause toxic effects in other tissues or organs where they are present in smaller quantities. The nature, intensity and location of these disruptions in the organism differ from one product to the next and **often depend on an accumulation in the tissue**. Clearly higher dose rates and more prolonged exposure increase the risk level.

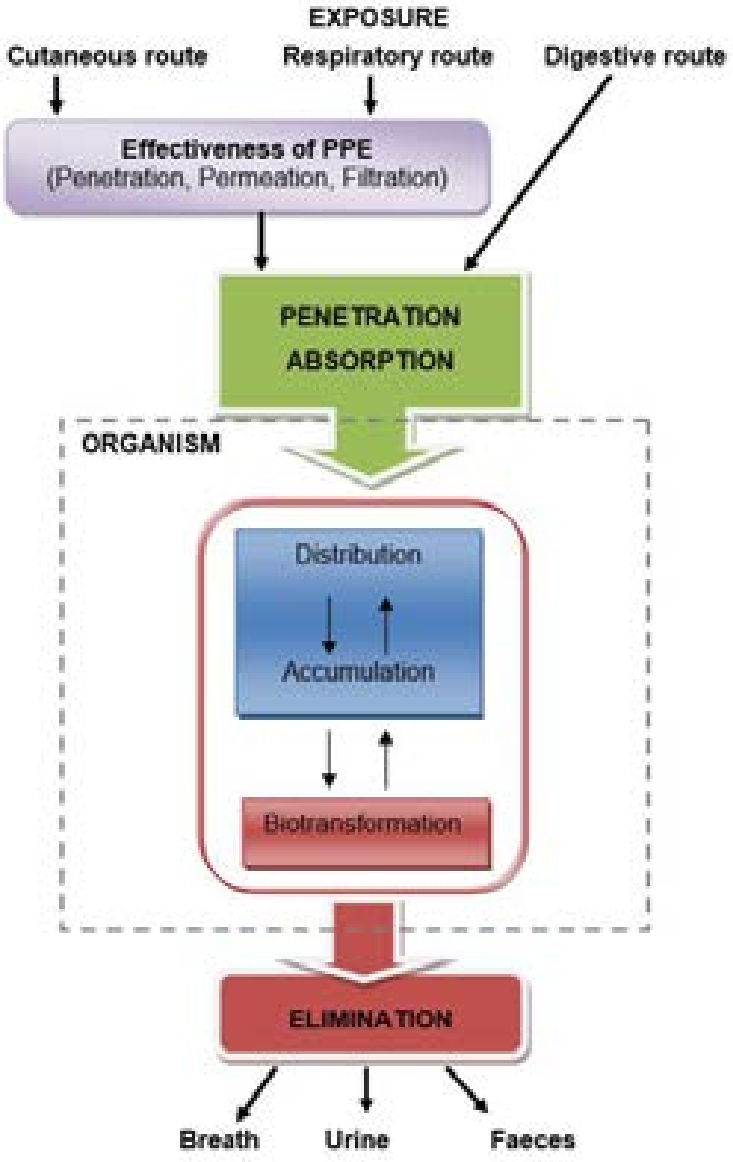
❑ **Biotransformation (or metabolism)**

This is the **generally enzymatic** process whereby a foreign substance is transformed into more polar by-products (more soluble in water), which are **easier to eliminate and generally less toxic**. During or after being transported into the blood, the toxin can enter into contact with different cells in the organism, some of which (such as those in the liver) may have the capacity to transform it. All metabolic transformation reactions taken as a whole are referred to as biotransformation, while the products of biotransformation are known as **metabolites**. The transformation of toxins is **carried out mainly by the liver**, which is the organ richest in enzymes (protein substances that catalyze a chemical reaction in the organism) and has a rich blood supply. It is the main site of metabolization. It enriches the blood with nutritive elements and purifies it by concentrating and eliminating many substances. Other organs such as the lungs and kidneys can also transform or eliminate toxins. **Biotransformation can result in a less toxic product** (detoxification) **or a more toxic product (activation**), accumulation or elimination of the product and its metabolites.

❑ Excretion

This process consists of **expelling the unchanged product and/or its metabolites** from the organism. Excretion can be renal (urine from the kidneys), gastro-intestinal (faeces), pulmonary (exhalation), cutaneous (perspiration) or lacteal (milk). The urinary and faecal routes represent the main routes of elimination. The blood carries the active substances and their metabolites towards the kidneys that filter the blood, thus kidneys play an essential function in maintaining balance among the blood's elements and eliminating many products. The faster the elimination, the less the substance and its metabolites are concentrated and the less time the foreign substance has inside the body where it can exert a toxic action.

The absorption and fate of a substance in the organism can be illustrated as follows:



3.1.4. Review of absorption routes

During different phases of plant protection work, the environment is charged with a certain concentration of toxic substance. This substance can be inhaled or it can settle on clothing and protective equipment or directly on the skin. Any liquid product that settles on clothing may be able to soak through to the skin.

To exert its biological action, the active substance must enter the organism in sufficient quantity. Its speed of action depends to a large extent on the speed at which the active substance reaches the blood stream. Absorption of the pesticide through the skin depends a great deal on the **solvent** (e.g.: the solvent used for the pesticide formulation).

There are **three main routes of entry**:

- oral (gastro-intestinal);
- respiratory (through inhalation);
- dermal (through the skin, even skin without cuts or wounds, through dissolution and transfer into the epidermis and then into the blood stream).

The fraction inhaled as well as the part that settles in the eyes and mucous membranes is most easily absorbed.

The skin, on the other hand, acts as a barrier that limits absorption.

However, **entry through dermal contact presents the greatest risk** because unlike ingestion, where the liver can play a role of purification, when the substance crosses the skin it enters the bloodstream directly and may reach sites where it can damage cells.

❑ Oral absorption

Oral absorption is not as a rule a serious occupational hazard although it is more frequent in case of purposeful ingestion (suicide or homicide) or accidental ingestion (e.g.: tearing open a package with the teeth, or accidentally drinking poison from a bottle, when stupid people decant a poison into a bottle that once contained drink such as cola or whisky).

It can only happen as a result of poor practices:

- accidental splashing of the product in the mouth;
- accidental ingestion due to poor storage conditions:
  - in an unlocked area near food or medical products;
  - in bottles or packaging other than the originals, especially used drinks bottles;
  - in a place directly accessible to children;
- absorption of small quantities of the product if the person handling it eats or smokes without washing the hands first or tries to unblock a nozzle by blowing into it;
- use of packaging from plant protection products (drums and cans) to store beverages (water, oil etc.).

❑ Percutaneous (dermal) absorption

The skin is a semi-impermeable barrier that covers and protects the entire surface of the body. This protective envelope covers almost the whole body and acts as an obstacle to the entry of many contaminants. However, this barrier does not provide full protection because it does not envelop the entire body and presents openings, including the base of hairs and **pores**. This is an important gateway because toxins can enter the organism by **crossing the skin** following contact with a liquid, solid or vapors. The **mucous membranes** are even more of a gateway for certain toxins (benzene for example). The skin of babies and newborns is more permeable than that of an adult.

Dermal absorption is the most important route of penetration into the organism and for most pesticides used by professionals.

Dermal absorption is influenced by many factors, physical-chemical (e.g.: purity, size of the molecule, solubility), individual (e.g.: hydration of the skin, presence of skin injuries) and anatomical (e.g.: place on the body that comes into contact with the liquid).

Effect of absorption of malathion in man in terms of the point of contact:

Area of contact	Absorption (%)
Forehead	23.2
Forearm	6.8
Back of hand	12.5
Palm of hand	5.8
Abdomen	9.4
Sole of foot	6.8

Because organic solvents that facilitate subcutaneous entry, EC formulations present a higher risk of contamination by this route.

It can result from:

- splashing or leaking of the product directly onto the skin or through personal protective equipment during preparation of the mixture or spraying (leaks from the spraying tank).
- drift of the product during application in windy conditions.
- contact with the treated crop (failure to comply with the re-entry interval for treated fields).
- wearing of torn and/or contaminated clothing.

Even invisible sediments of insecticide can penetrate intact skin and cause poisoning if not completely eliminated by washing the work clothing.

Care must always be taken to maintain, repair without delay, or replace protective clothing used when applying plant protection treatments.

It is important not to neglect the risk of poisoning from eating produce that is harvested before the pre-harvest interval (PHI) and contamination of workers can occur if operations are carried out in the crop soon after spraying.

❑ Absorption through inhalation

The lungs are the organs in which gases are exchanged between the air in the fine cavities, called pulmonary alveoli, and the blood of the capillary vessels that line these alveoli. They are the organs for breathing, that permit the absorption and elimination of gases.

In some work environments, inhalation is the main route of contaminant absorption. This can be explained by the high likelihood of contamination of the ambient air by vapors, gases, fumes, dust, etc. The inhalation of welding fumes is just one example.

Many factors have to be taken into consideration in the absorption by the lungs of a product. For gases and vapors, these include concentration, length of exposure, solubility in water and tissues, reactivity and blood flow. The factors for particles (e.g.: dust, fibers, fumes, mist, pollen, spores) are physical characteristics (diameter, shape, etc.) and anatomy of the bronchial tree. Micro- and nano-particles, sprays, fumes and vapors more or less cross the pulmonary mucous membranes or contaminate the mucous lining, which is then swallowed, transferring certain products to the digestive system.

The physical characteristics of the active ingredient, its formulation and its application technique are factors that determine the importance of absorption through the lungs for a given exposure. In the form of gas or vapor, the active ingredient can often be quickly absorbed in the bloodstream.

Size of particles and inhalation

The particles produced by powdering, spraying, misting or atomizing can only reach the lungs if they are sufficiently fine (1 µm or less). Particles that are extremely fine may be re-expelled whereas ones larger than 30 µm rarely enter the upper respiratory tract; they remain in the nasal-pharynx region.

During spraying, **droplets** have an average size of 50 to 300 µm and therefore **do not enter** the trachea or the pulmonary alveoli. Only small satellite drops always form part of the desired spray size spectrum and once they evaporate can the finest droplets and vapors be inhaled. Consequently, wearing a mask fitted with cartridges **during spraying** in an open environment is **usually unnecessary**!

When **measuring the dose**, **toxic vapors or fine dust** can escape from the packaging of the concentrated product, and in this case, wearing a mask is justified (also eye protection and gloves).

Poisoning through inhalation occurs most often:

- either during preparation of the mixture with formulations containing solvents and volatile products;
- or during application, by moving forward through the spraying mist (misjudging wind direction). This is most dangerous when measuring and mixing concentrated product or when using application at very low volume. These

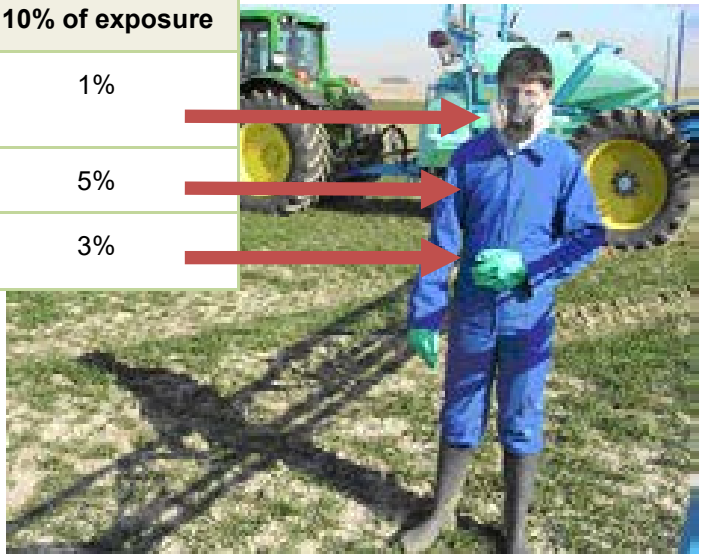
formulations, manufactured specially, are often oil-based formulations that are not diluted before use. The same applies to treatments by fogging, for example to treat food stores or control flying insects in open air (e.g. mosquitoes) (KN (treatment of stored foods) or HN (fumes) formulations).

3.1.5. Direct exposure

This **may apply to applicators** who can be exposed during all phases of handling of plant protection products. Among these handling phases, preparation of the mixture is the riskiest because the product is concentrated.

90% of exposure takes place during dose measuring and loading.

During filling	**> 90% of exposure**	**During treatment** **< 10% of exposure**
Respiratory tract	1%	1%
Body	5%	5%
Hands	85%	3%



3.1.6. Indirect exposure

Indirect exposure can concern:

- individuals who happen to be near treatment sites (bystanders: **workers operating in the treated fields** or in nearby fields, the public, passers-by, etc.). Exposure often occurs through the **phenomenon of drift** of the product during application if conditions are windy;
- individuals in confined areas such as greenhouses. Particles that remain in the atmosphere can be equally important sources of contamination;
- persons who come into **contact with the treated plant** or products harvested from treated plants. The quantity of residue on the leaves depends on the quantity of active ingredient sprayed per hectare, the product's persistence, the weather and particularly the sunlight, and the type of surface treated. Post-treatment crop operations are a particular source of significant exposure of the skin, in confined places like greenhouses, but also when crops are harvested manually or when (during sorting and packing operations) workers handle recently treated harvested products.
- the skin can also absorb chemical products that have soaked into **clothing and equipment** that have not been treated or washed correctly (e.g.: inner surface of masks). Incorrect washing can also contaminate domestic washing machines or dryers and the product can end up on other clothing. Ideally, contaminated clothing should be washed separately at the highest possible temperature and with a maximum volume of water. Just as operators must use caution when handling products from treated crops, the person doing the washing must be cautious when handling contaminated clothing.

3.2. Methods of evaluating operators' risk of exposure

There are a number of methods for measuring operators' exposure to plant protection products. They are either quantitative, qualitative or based on modelling.

3.2.1. Quantitative methods

❑ The patch method

The patch method involves measuring product deposition using pieces of absorbent material (cellulose, nitrocellulose, chromatographic paper, etc.) fixed to the personal protective equipment (PPE) which is usually the clothing worn by spray operators. In accordance with the OECD Guidelines (1997), patches totalling around 100 cm² are placed on different parts of the body (both outside and beneath protective equipment to measure things that soak through the clothing). After treatment, the product is extracted and analyzed using the method used to analyze the active ingredient. This gives quantities of product measured as µg/patch or µg/cm². Since each body location has a given surface, the results are extrapolated for each part of the body and then generalized to the body as a whole. It is not perfect in that errors are related to extrapolation of the surface, and location of the patches can lead to different results from one trial to the next, but the method gives a good estimate in most cases.

Surface corresponding to each body part and position of patches
(Source: OECD, 1997)

Body parts	Surface (cm^2)	Position of patch
Head	1300	Head
Face	650	Forehead
Back of neck	110	Back of neck
Throat	150	Throat
Back	3550	Back
Thorax	3550	Thorax
Arms	2910	Both arms
Forearms	1210	Both forearms
Thighs	3820	Both thighs
Shins	2380	Both shins
Feet	1310	Both feet
Hands	820	Gloves or hand washing method

❑ The whole body method

The operator wears a full, clean coverall that covers the entire body. After application, the overall is dried and cut into pieces. The product is extracted from each piece and the quantity deposited is measured by analysis. This method has been used to determine dermal exposure of applicators to chlorpyrifos-methyl and fenitrothion. A comparative study of exposure levels in different conditions showed differences of approximately 50% between the patch method and the whole body method. Vidal *et al.* (1998) presented different methods for analyzing several pesticides with different types of protective equipment.

❑ The hand measurement method

Hands appears to be the most important dermal exposure route (OECD, 1997). A 2004 study showed that during the mixture preparation phase, 99.3% of contaminations happen at the level of the hands and that wearing gloves prevents 89% of such cases**.**

Several exposure measurement methods have been developed for hands, among which the **absorbent gloves** method, which involves the use of cotton gloves that collect products during the work process. The gloves are placed either on top of or beneath recommended protective gloves, depending on the estimate sought. When the work is completed, the product can be collected and analyzed using the method best suited to the active ingredient. This is a simple method to implement. However, this method overestimates the risk because the cotton gloves have a higher absorption capacity than hands. There are other alternatives consisting of rinsing the hands with an appropriate solvent or with soapy water and then collecting the filtrate. This results in an under estimate because what is absorbed by the skin is not collected. In addition, volunteers used during the experiments are exposed, so this method would not be suitable for poisonous products

❑ Respiratory measurements

The amount of product inhaled can be measured using a personal air sampler. This is similar to a canister mask that collects the particles and vapors inhaled. A collector system can also be used to collect residues of vapors or dust.

❑ 'Biological monitoring'

This method of estimation makes direct measurements on the person being assessed for exposure risk and this presents a number of advantages. Quantification is made by biological analyses of the compounds or metabolites of saliva, exhaled air, urine and/or blood. Measurements on urine are used widely because they are non-invasive and collection is relatively simple.

One of the tests used most frequently is **measurement of the amount of cholinesterase** in operators' blood. Cholinesterase levels sometimes fall when workers have been using certain insecticides such as carbamates and organophosphates. Operators are kept away from the work station when a significant drop in the concentration of cholinesterase is measured and for as long as the level of this enzyme has not returned to a 'normal' value. This method of monitoring nevertheless has its limits, since rates of cholinesterase vary from one person to the next and ideally the levels should be plotted over a period of time to determine when poisoning may have occurred.

The speed of 'recovery' is variable. Since the gradual withdrawal from the market of organophospate and carbamate insecticides the test is now less appropriate.

3.2.2. Qualitative methods

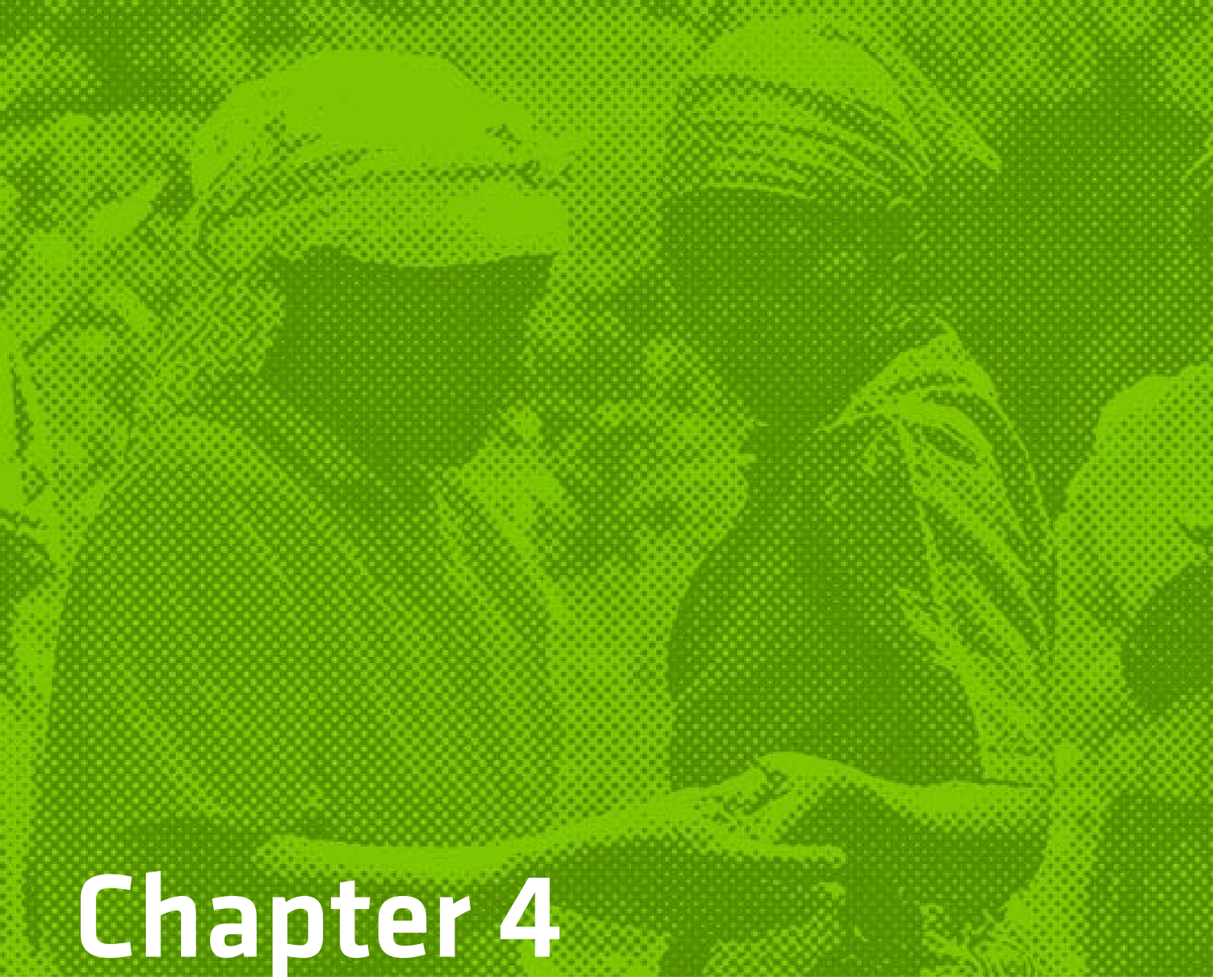
This method consists of spraying with a fluorescent tracer in the spray liquid (with or without active ingredient. Operators wear clean non-fluorescent coveralls while carrying out mixing, filling and spraying. After treatment the coveralls are dried then examined in a dark room. An ultraviolet light is used to reveal distribution of any contamination by the spray liquid or even give a rough comparative estimate of the amount of product that has settled on operators using different procedural techniques.

3.2.3. Modelling-based methods of estimation

Traditional methods used to quantify exposure to plant protection products are costly and cumbersome to implement. Mathematical models (deterministic or probabilistic) therefore appear to be a simpler approach to estimating exposure.

The model is based on one (or more) treatment scenario(s) established by observation of **operators' usual practices** (type of crop, type of sprayer and formulation) so as to generate an estimate of total potential exposure. To calculate exposure, the model uses values and measurements obtained experimentally by reproducing a similar treatment scenario.

This method to evaluate exposure to pesticides is carried out as part of the registration process and is based on an approach by contamination categories. The method aims to increase the realism of exposure as progression in the categories occurs. At each level, it must be proved that the quantity to which the operator is exposed does not exceed the AOEL for the product being applied.



Chapter 4

Limiting exposure, applicator protection

4.1. Limiting exposure

4.1.1. General precautions to take when applying pesticides

A key factor in limiting exposure to plant protection products is to **avoid all skin contact** with the concentrated product or mixture, for skin exposure is the main route of absorption.

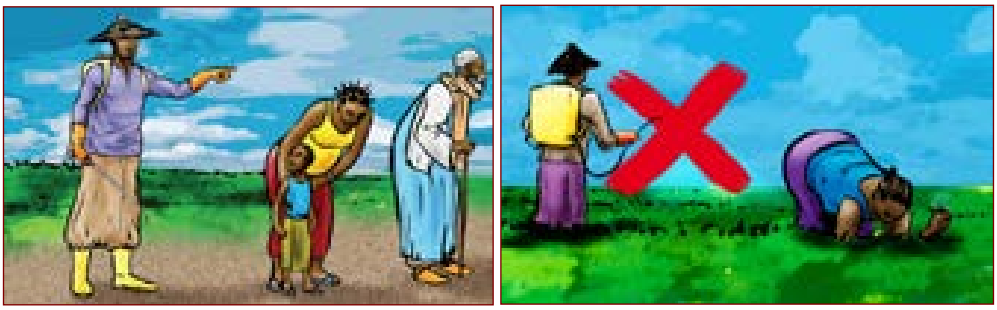
Handle the products carefully and wear the right personal protective equipment (PPE). These are the two basic principles that can reduce exposure considerably.

But even when protective clothing and gear are used, there are still risks!

Operators need to be **trained** in evaluating risks, knowing the danger and the routes of contamination, handling products correctly and wearing PPE the right way.

Other essential points:

- respect basic **hygiene** rules during the work and after it is finished;
- do not prepare doses or mix plant protection products inside buildings or near rivers, ponds, people's homes or animal sheds;
- keep children, elderly people and animals away. Forbid access to the fields while they are being sprayed. Not even animals should go into the fields;
- take care not to contaminate water supply sources or ponds that animals drink from;
- make sure the application equipment is working correctly;
- manage wastes and effluents (dregs of the tank, rinse water) correctly;
- do not apply pesticides when the weather is not suitable and might cause the operator to be contaminated (ex: strong wind);
- do not apply pesticides when people are working on the crops;
- respect the time interval before returning to a treated field.



Keep children, elderly people and pregnant women away from the field. Do not apply pesticides while people are working in the fields!

4.1.2. Choose the right conditions for treatment

Weather conditions not only influence how effective a treatment is (likelihood of spray drifting off target) but they also play a role in the applicator's exposure to the product.

This is why the following rules must be respected:

- Do not spray when there is a strong wind, or when it looks like the wind may change direction suddenly.
- Do not spray when it is raining or when it looks like it is going to rain.

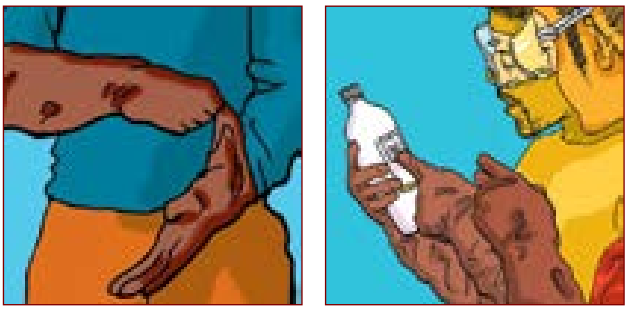
- If possible, spray during the coolest time of day (early in the morning or late afternoon). When it is hot people **sweat** and their pores are dilated. This means that toxins penetrate the skin more easily in case of contact. In addition, when it is very hot, **wearing PPE becomes unbearable or in some cases dangerous because the body temperature rises**.

4.1.3. Precautions to take when measuring the product

When the product is being mixed, **the operator is handling a concentrated solution!** It is therefore extremely important to be careful and follow these instructions during this hazardous time.

Of particular importance:

- Wear the protective equipment (PPE) indicated on the label for measuring and mixing. **In all cases, gloves and safety glasses or goggles must be worn!** When handling concentrated pesticide. The other PPE to be worn depend on the product. For the most toxic products and those applied in solvents, it is recommended to use a mask fitted with filtering cartridges.



- Use the **right equipment** (bucket or container, funnel, filter, and measuring vessels or dosing utensils such as: water bottles, metal cans, old product containers, matchboxes, milk or tomato sauce cartons). The recipients and other measuring containers used to prepare plant protection mixtures must **be reserved for this purpose and not used for anything else!**

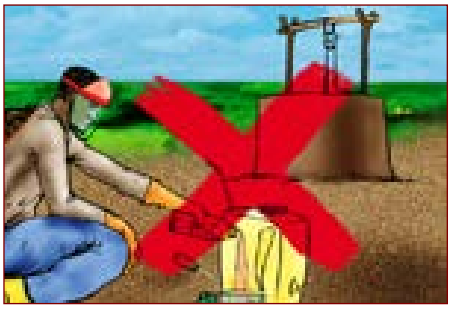
- Check the **product's identity** (name), and if relevant its expiry date.

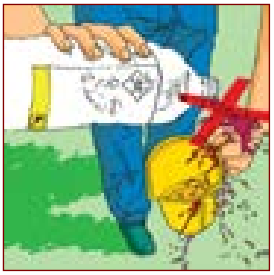
- **Read the label carefully** in particular any special precautions for use. Measure out the dose recommended on the product label and **write down in the spray records the amount actually measured out** and the volume of water used.

4.1.4. Precautions to take while mixing

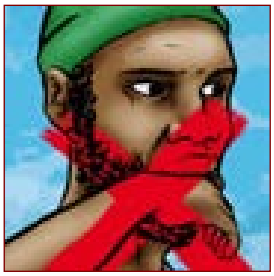
- Use the recipients and utensils that are especially reserved for this purpose.
- Use utensils that enable you to **measure small volumes without errors.**
- Never prepare the products without wearing gloves and never touch or mix the preparation with your hand.

- Do not prepare the mixture near houses, children, wells or water holes. It is best to choose an **area where there is grass and ground that can absorb** any splashes.






- **Make slow small movements** to avoid splashing**.**
- When mixing with powders, **avoid creating a cloud of dust.**


- Have some clean water on hand (to rinse off any drops of the product or mixture splashed into the eyes) and soap to clean the skin if contaminated.
- Do not touch your face or mouth.
- Do not drink, smoke or eat near the product.
- Always pour the water used to rinse out the product containers into the spray tank.

4.1.5. Check that the application equipment is working correctly

The application equipment should have been cleaned immediately after the last time it was used. It must also be checked and **calibrated regularly**. Nevertheless, each time before using the equipment it is a good idea to check that it is clean and watertight – because **joints can grow old and/or harden** which can cause leaks (this is especially important at the start of the season when the equipment has not been used for several months). Do this with water, BEFORE filling the tank with the pesticide mixture.

These instructions are especially important for knapsack sprayers!

- Never use faulty spraying equipment, and check that it is working correctly before you begin spraying.
- **NEVER try to unblock the nozzles by blowing into them!**
- Wash the nozzles with water, using an object or stick that is sufficiently fine and rigid (e.g.: a bristle from a brush) – You should never use: a thick wire, nail or screw driver that would enlarge the nozzle opening and reduce the efficiency of atomization.

4.1.6. Precautions to take when applying the mixture

- Wear the protective clothing **indicated on the label**.
- Do not take off the protective clothing, gloves, hat and mask (**only if necessary**) even if it gets too hot.
- Keep people and animals away from the areas that are to be treated, especially make sure no one is working in these plots.
- Never have children, elderly people or pregnant women apply plant protection products - keep them away from fields that have been treated.
- Never leave open packages or bottles of the product lying around during application.
- Work during the coolest times of the day.
- Never spray when it is going to rain: some products require a certain length of time without rain for optimum effectiveness. Rain can wash the product away and too strong a wind can blow it far from the crops to be treated.

- **Be careful not to spray against the wind.**
- Do not work when there is a heavy wind (greater risk of spray drift)
- **Spray the mixture downwind,** move forward with the wind coming from the side and **start at the downwind edge of the field** to avoid moving through vegetation that is contaminated with spray.
- Make sure the product does **not drift towards water holes, animals or living areas**.
- Treating with a large volume of mixture increases the risk of the drops drifting and contaminating the operators!

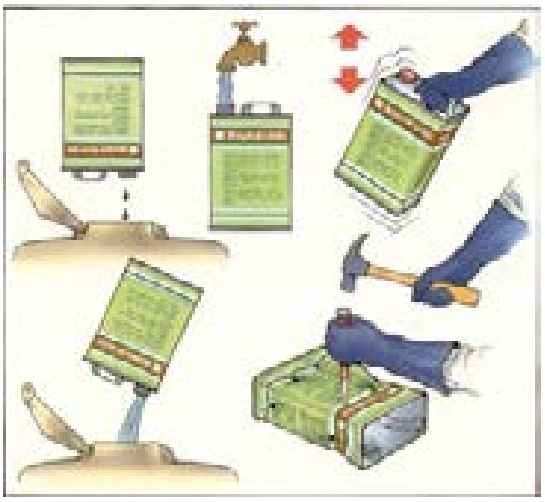
With some application equipment, such as motorised hydraulic sprayers, the drops are so small that they are particularly sensitive to drift, thus present a greater risk for contamination!

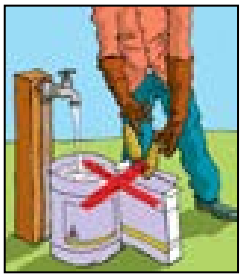
- In case the product comes in contact with the skin, **react immediately:** rinse it off right away with water, and if no water is available, brush it off with sand, a clean rag or even grass. Then rinse as soon as possible. Use soap after if available.

4.1.7. Precautions to take after applying the mixture

- Never pour the leftover mixture in rivers or streams, or near water.
- **Wash all the equipment** after use, and take care to pour the rinse water on to an area of uncropped vegetation (rinse pesticide containers into the spray tank).

- **Rinse the empty containers and packages carefully (at least three times).** Ideally try to render these containers **non-usable** by perforating and/or crushing them. It is recommended not to reuse them.





Perforate the packages so they cannot be reused!

- **Never leave the empty boxes, cartons or bottles** lying around in fields or near living areas.

and

Packages left in the fields are a source of soil water pollution, and can even poison animals.

Attention!

Even when a container appears to be clean, some product residue always remains inside, absorbed in the sides of the container itself. These traces of the product are always dangerous, since if the container is re-used for another purpose, traces of the product can gradually diffuse into the new contents.

Therefore, the re-use of pesticide containers is not recommended.

4.2. Protection from contamination

4.2.1. Personal safety (hygiene)

Personal safety is **extremely important** for anyone who handles plant protection products. Growers must be informed about the need to observe the following principles:

- **Do not eat, drink or smoke during this work.**
- **Do not touch your face or other parts of the body with contaminated hands or gloves.**
- In case of contact with the product, wipe it off immediately to remove as much as possible. Do this before you finish the application work. The aim is to reduce the danger of penetration through skin as far as possible.
- Always store the products in their original package/container.
- After handling pesticide wash your gloves off before removing them (as if you are washing your hands, then,
- Wash your hands and face before eating, drinking or smoking.
- Wash your work clothes frequently so that contamination cannot build up on them.

4.2.2. Good personal safety begins by preventing any contamination

- When preparing the mixture from the concentrated products, no matter what product or formulation is used it is indispensable to wear standard protective clothing and gear, especially when opening pesticide containers, measuring the pesticide and filling the sprayer.

- During crop treatment, it is especially important to remember to protect feet, lower legs and all parts of the body that are in contact with the treated crop. **Even if the label does not mention specific protective clothing, insist on the need to wear clothing that covers the body as much as possible.** In practice this corresponds to a long sleeved shirt, trousers that cover the leg entirely, shoes or boots, and a hat (cap or turban) if tall plants are being treated.

Example of total

- When protective gear is not available, or too expensive, **substitute articles must be found,** such as old cotton clothes that provide additional protection for the

body, arms or legs. Gloves MUST be worn when handling concentrated pesticide. A clean fertilizer bag can be used to protect the body.

4.2.3. Interval to wait before entering the treated fields

- Although people are not always aware of this aspect, entering a newly sprayed field is a potential source of contamination that should not be ignored. For most plant protection products a certain amount of time must elapse after treatment before people can be authorized to return to the fields.

A sign or, as in this field in Kenya, a plastic ribbon shows that the field has been treated and should not be entered. (Photo B. Schiffers)

- When there is a risk of contamination, the product label may mention the minimum interval before entering the field. **If no interval is specified, a basic precaution is to wait at least 24 hours after the last application.**

Workers packing harvested crops should also be careful!

Depending on the type of plant protection product, the label will specify the time that should elapse between the final treatment and harvesting (pre-harvest interval, or PHI).

This interval must be observed strictly to make sure that the amount of residue does not exceed the maximum limit (MRL), and also to be sure that the **people who sort and pack the harvested products are not in contact** with plants that are still coated with contaminating residue.

4.2.4. After work

- Before removing protective clothing, first rinse your gloves with running water. Then remove the other gear. Keep the cleaned gloves on if the coverall is contaminated with spray, then wash the gloves again. Be aware that pesticides can penetrate the skin, so it is important to keep the skin clean.

- Even if you were suitably protected, you must wash yourself carefully and completely (in other words, take a shower). First wash your hands and face quickly and carefully, followed by feet and legs as soon as you have finished spraying.
- To make it harder for some products to enter the skin, **rinse yourself first with an abundant volume of running water before soaping down.** (This is because soap is a wetting agent that can accelerate the absorption of a plant protection product.)

- **Take a shower at the end of the work day and wash your work clothes.**
- Rinse your gloves and boots before removing them.
- Remove the safety clothing and gear used during the day's work.
- Clean this clothing and gear separately from domestic laundry. Do not take PPE home.
- Repair the clothing if it is ripped or pierced.
- Store the protective clothing and equipment in a cupboard that is **separate from the one containing the plant protection products.**

4.3. Personal protective equipment (PPE)

4.3.1. Advantages and constraints of PPE

The abbreviation 'PPE' stands for personal protective equipment, as defined in Directive 89/686/EEC, refers to any device or appliance designed to be worn or held by an individual for protection against one or more health and safety hazards.

Depending on the country and the activity under question, wearing of PPE can be required by law, especially in the workplace. It can comprise:

- a helmet on worksites and in certain factories;
- safety footwear on worksites and in certain industries;
- protective clothing (jacket with a closed neck, long sleeves tight at the wrists, long trousers), and if relevant gloves, safety glasses and a mask to protect from splashes of chemical or biological products, or against heat and fire hazards, or risks of other injury;
- highly visibility clothing to avoid being hit by a vehicle or loading equipment (ex: fluorescent vest);
- ear protection against noise;
- respiratory protection: insulating or filtering breathing device;
- harness: protection against falls at dangerous heights;
- etc.

Both the employer and the employee have mutual and complementary obligations regarding PPE, to achieve one sole aim: safety at the workplace. The **employer's main obligations** are:

1. Make **freely available on a personal basis** the appropriate PPE required for the work to be carried out.
2. Check that the correct PPE have been selected following an analysis of their capability and the risks involved.
3. Check that the PPE is used correctly.
4. Check the conformity of the PPE provided.
5. Keep the people entrusted with PPE implementation and maintenance informed.
6. Lay down the conditions for providing, using, maintenance and storage of PPE. The instructions must be observed by the user who, in the event of refusal, accepts full legal responsibility.
7. Ensure correct operation and a satisfactory level of hygiene by carrying out the maintenance, repair and replacement appropriate to the PPE.
8. Notify users of the risks the PPE is used to protect them against, conditions of use, PPE recommendations and instructions and when they should be made available.
9. Train users in wearing the PPE.

The employee's main obligations are:

1. All workers have the duty to protect their own health and safety in accordance with their tasks and training and also the health and safety of people who may be affected by any acts or omissions in their work.
2. **Before each use, the user should ensure that the equipment is in satisfactory condition**.

The effectiveness of PPE largely depends on making workers aware and training them in their appropriate use and maintenance.

In the case of **plant protection treatments**, when work clothes are worn together with protective equipment such as gloves, boots, glasses and specific clothing, the applicator's risks of contamination are significantly reduced.[1] However, they must be appropriate, worn correctly and taken care of!

PPEs work by being **resistant to penetration and permeation** by the plant protection products and solvents used.

There are five main **reasons why growers are reluctant** to use protective equipment:

- it is uncomfortable, especially in hot and humid climates, and also in the case of treatments with knapsack devices or those complicated to handle;
- high purchase price (employees are not usually required to buy their own PPE, unlike self-employed people;
- wearing PPE is not deemed to be necessary;
- the equipment is not available, dirty, wrong size or damaged;
- workers fear their appearance gives the public an unfavorable impression about the treatments underway.

The problem in hot and humid climates is that wearing protective clothing is **not comfortable**, and no one enjoys feeling hot and sweaty in a pair of waterproof coveralls. If it causes body temperature to rise, the PPE can itself pose a risk to the operator, so it is important to consider working conditions when deciding what is appropriate.

The comfort of protective clothing depends on the **type of clothing, especially weight and permeability**. Cotton or other lightweight permeable fabrics are the most comfortable materials. Although the protection provided by clothing is related to its

[1] A study conducted by Jean *et al*. (2004) comparing operators who did not wear protective equipment with those who did showed the importance of wearing the full set of protective gear throughout the various treatment phases. The PPE protected against 99% of contamination.

thickness, a heavy material that protects well may be uncomfortable or even impossible to tolerate. It is thus important to choose clothing that is comfortable enough to be worn during a full day of work.

It is also more comfortable to work during the coolest hours of the day (early in the morning or late in the evening). Furthermore, at these times of day treatment may be more effective because of lower risks of harm to the crops. As light breaks down pesticides, application during the evening may enable the product to remain active for a longer period.

4.3.2. Which parts of the body need protection?

The answer is simple: the whole surface of the body must be protected, from the feet (with boots) to the head (with a waterproof hood). In practice, though, this **requirement is modulated by the risk of exposure**: maximum when the product is measured out and mixed, moderate during application and when the equipment is cleaned.

A good example of PPE wear for the most toxic class of chemicals:
- *a coverall that covers the body,*
- *a waterproof hood,*
- *gloves worn over the clothing when the product is mixed,*
- *a full mask that covers the face and filters vapors,*
- *… and waterproof boots.*

The surface area corresponding to each part of the body (Source: OECD, 1997).

Parts of the body	Surface (cm^2)
Head and face	1,300
Face	650
Back of neck	110
Throat	150
Back	3,550
Thorax	3,550
Arms	2,910
Forearms	1,210
Thighs	3,820
Shins	2,380
Feet	1,310
Hands	820

Each part of the body represents a certain surface that is exposed to a product. In 1997, the OECD prepared a table illustrating the surface areas of each part of the human body. These data are particularly useful when calculating exposure.

To measure the amount of a product that can reach the body, a 'patch' is applied to each part of an operator's body. The substance on each patch is then measured and extrapolated to the area of the limbs, torso, etc. and in the end the total level of exposure is estimated.

4.3.3. Penetration and permeation

Personal protective equipment (PPE) is intended to prevent surface contact of the body with dangerous substances, such as plant protection products, but also infectious agents (such as bacteria in hospitals). In this case PPE must therefore be capable of preventing the penetration or diffusion of such substances through a protective enclosure, or envelope and must incorporate a respirator.

To this end, the materials from which such PPE is made must be chosen and arranged so as to ensure, as far as possible be completely leak-proof, which will allow where necessary prolonged daily use or, if this is not possible, be partly leak-proof necessitating a restriction of the period of wear to avoid a dangerous level of exposure.

The material from which protective clothing is made is a barrier against the chemicals. The effectiveness of this barrier depends on a **number of factors** including:

- the material's chemical composition;
- its thickness;
- the weight per surface unit;
- the treatments applied to the material (finishing);
- the permeability to air or porousness;
- the composition of the chemical;
- the form of the chemical (vapor, gas, solid, fog, liquid.);
- the amount of the product;
- the length of time the chemical and the material are in contact;
- the strength of contact (trickling or with the force of a hose spray);
- the temperature;
- the presence of humidity.

To all these above factors we can also add **wear and tear** or **deterioration** of the material.

A chemical or a mixture can pass through the material in two different manners: **penetration** or **permeation**.

❑ **Penetration**

Penetration is the process by which a chemical moves through pores, apertures or essential openings, holes or other imperfections of a material on a non-molecular level (*Standard NF EN ISO 6529*).

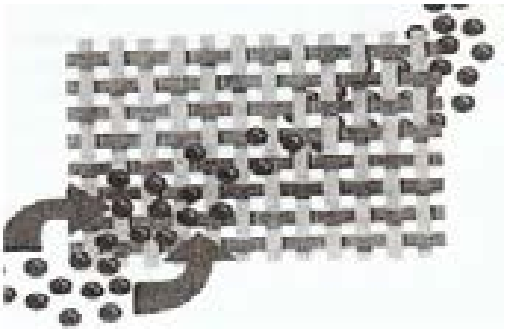
Penetration phenomena (source: INRS)

Tests for leakage in water or in the air determine a material's resistance to penetration. The coveralls recommended for plant protection products are generally 'Type 3' (leak-proof in a spray of the chemical under pressure, like a 'shower') or 'Type 4' (leak-proof to aerosols, to a spray of the chemical at moderate pressure or trickling).
The type of 'leak-proof' coveralls are identified by a logo and a number:

❑ **Permeation**

Permeation is a process by which a chemical moves through a protective clothing material on a molecular level (*standard NF EN ISO 6529*). This occurs in three stages:

1. sorption of molecules by the contact surface (outer surface) of a material: molecules are incorporated in the material through the joint phenomenon of adsorption and absorption;
2. diffusion of the sorbed molecules into the material;
3. diffusion of molecules from the opposite (inner) surface of the material.



Permeation phenomena (source: INRS)

The time needed for a dangerous liquid to come into contact with the skin (*Classed from 0 to 6)* will be indicated on the materiel or its packaging).

Protection Classes (according to permeation time)

Breakthrough time	Protection index
> 10 minutes	Class 1
> 30 minutes	Class 2
> 60 minutes	Class 3
> 120 minutes	Class 4
> 240 minutes	Class 5
> 480 minutes	Class 6

The penetration and permeation of materials that are deemed to be resistant to chemicals has been studied for a wide range of solvents (see further information annexed).

However, **very few studies have been made on permeation of the active substances themselves, so *caution* is the byword.**

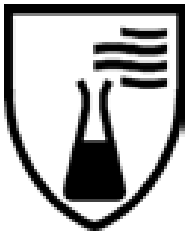
4.3.4. Gloves

Gloves made of Neoprene or nitrile rubber generally provide the best protection. **Leather or fabrics** must be avoided since they absorb residue.

The gloves must be **long sleeved** (sometimes called gauntlets). They must be at least **0.4 mm thick** and **bear the CE marking**.

The glove size must suit the wearer's hand. No matter what technique is used to take the gloves off, the fingers must NOT touch the outer surface of the gloves.

Furthermore, they must be designed to handle chemicals and must not have any seams.



Chemical resistant gloves must bear this logo!

Resistance to biohazards

Resistance to ripping, perforation, scraping

Resistance to chemicals

In case of direct contact with a product, and after use, it is important to **rinse the gloves abundantly with water**. This is to prevent deterioration of the material.

It is important to point out that there is no such thing as an 'ideal' glove. Each material has its advantages and drawbacks in terms of comfort and resistance to products or solvents. The cost of gloves also varies widely depending on the quality sought.

- Latex (generally natural rubber) provides excellent resistance to water-based chemicals, such as acids and alkalis. Heavier latex gloves are also specifically resistant to certain solvents. The gloves also provide varying levels of protection regardless of the thickness. The advantage of latex is a high level of elasticity and dexterity.

Latex gloves, so-called 'surgeon's' gloves, are NOT resistant *to products or solvents. Also t****hey rip very easily.*** *If necessary, they can be worn – one time only – while measuring a powder product.*

Their lifespan is limited to a few minutes.

Note: *they are usually not long enough to cover the wrist!*

- Nitrile rubber (synthetic rubber) offers good resistance to petrol-based chemicals and excellent protection against petrol, petroleum oils and lubricants. Nitrile rubber, however, tends to 'expand' after contact with some solvents which reduces the gloves' physical resistance and lowers the level of protection.

- Polyvinyl chloride (PVC) is resistant to water-based chemicals, but this type of glove provides only limited protection against organic solvents because these substances modify the elasticity and plasticity of PVC, thus contamination by the solvent can stiffen and harden the glove.

PVC gloves resist caustic products and acids, but they are sensitive to cutting and to certain solvents (e.g.: ketones). They are very stiff and ***operators may tend to take them off.***

When they are measuring the products *because of their inflexibility and lack of 'touch'.*

- Neoprene™ (or chloroprene) offers comfort and chemical resistance similar to those of natural rubber. It is also resistant to petrol, petroleum oils and lubricants.

- Polyvinyl alcohol (PVA) provides protection against most organic solvents, but it is water soluble. In its natural state PVA is rigid and requires plasticization.

- Butyl protects again many organic chemicals and strong acids. Gloves made of butyl, however, are very hard to manufacture. They often need an outer layer in Neoprene for butyl provides only weak resistance to petrol, petroleum oils and lubricants. Their use is limited to specific cases and they are very expensive.

- Viton™ is a fluoropolymer similar to Teflon. As the polymer's surface tension is extremely low, drops slide off the surface of the gloves, reducing penetration. Viton offers special protection against chlorinated solvents and aromatic hydrocarbons, but has low resistance to ketones. They are also smooth and not as sturdy, so are less suitable for agriculture and horticulture.

Gloves must be worn over the coverall sleeve when mixing the product or working with the arms raised, but they should be worn underneath the sleeve when working on low-growing plants. **The rule is the water flow direction** (in case of leaks in the wand, the handle or tank).

4.3.5. Coveralls and aprons

There are many types of coveralls. Some are disposable whereas others are re-usable. Disposable coveralls (if porous) are light and comfortable on especially hot days but non-porous coveralls do not allow body sweat to evaporate so are unsuited to hot weather. Both are fragile and rarely last more than a week. Only approved types can be worn while preparing and applying plant protection products. If the coverall is heavily contaminated it must be taken off immediately.

The second type of coverall is made of so-called 'impermeable' and washable material (e.g.: polyamide with PVC coating). It can be worn several times. These coveralls may provide adequate protection for all phases of application of less toxic products, but they are not recommended for the most toxic or most concentrated plant protection products. They must be closed all the way up to the neck. This is because an open neck would let air in and blow the product vapors inside the coveralls whenever the operator bent or moved. The coveralls must be worn over a long-sleeved shirt and full trousers (such as overalls).

Examples of work clothes (Kenya) to be worn under a coverall or apron.

The coverall should be loose and worn over the boots to keep liquid from running into the boots.

Working in a waterproof coverall, clothing ill-adapted to the climate or else an outfit that is 'over-protection' has three drawbacks:

- **uncomfortable** for the operator who will tend to simply remove all the gear;
- **operators become too casual about using PPE**. It is better to reserve specific equipment (such as a mask) for phases when exposure risks are highest (e.g. when preparing the mixture);
- **operator may overheat causing heat exhaustion** which can be very dangerous or even fatal in hot climates.

Recent studies have shown that wearing soiled coveralls over a long period intensifies and **worsens the contamination**.

It is therefore a better idea to **wear an apron** when handling concentrated plant protection products. The apron protects the front of the body from any concentrated mixture that is spilled or splashed.

Aprons can be made of rubber or any other synthetic waterproof material that is resistant to the solvents used in the product's formulation. It is important to have an apron that covers the body from the chest to the boots.

4.3.6. Hats

When treating trees it is recommended to wear a hood, or a hat resistant to chemicals, preferably in washable plastic. It can be either a hard hat or one made of flexible plastic. In both cases it should have a brim and a visor in plastic to protect the eyes and face. It must be washed and dried after each use.

Baseball caps or hats made of ordinary fabric with a cloth brim are dangerous: they absorb the products and contaminate the forehead.

4.3.7. Boots

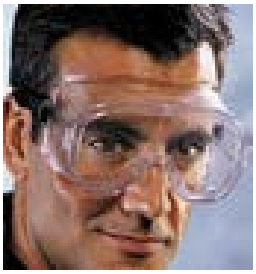
Boots are available in a variety of styles and materials. Although simple rubber boots are sufficient if used correctly, once again Neoprene offers the highest level of protection.

Boots that reach above the knee offer greater protection because they stretch above the hem of the apron. Low boots or shoes made of leather or cloth are to be avoided because they absorb the protection products and cannot be cleaned sufficiently. Boots must be the right size and fit comfortably.

The **trousers should be worn over the boots** to keep dust and splashed products from entering. Before taking the boots off rinse them thoroughly.

4.3.8. Glasses/goggles and protection shields

Protective glasses or goggles, which completely cover the eyes, protect the eyes from splashes of the product or mixture and from the dust of powders or granules. Glasses should not be attached with cloth or elastic because both will absorb the products. The type of 'glass' determines how effectively the eyewear protects. Mineral lenses or those made of un-treated polycarbonate are too fragile for farm work. Treated polycarbonate provides a sufficient level of protection.



The protection provided by glasses or goggles is better for the eyes, but sometimes the whole face may need to be protected.

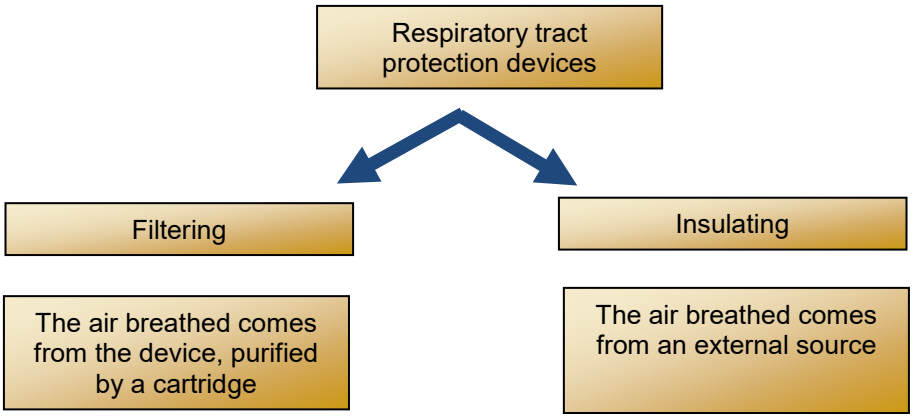
The most effective **protection shields** are made of clear plastic**.** The shield is worn like a hat, which can be raised or lowered as needed. Shields also tend to be easier to wear than enclosing goggles (which can fog up).

The protective eyewear must adapt comfortably to the face so that the sides of the face are protected from drops. **Contact lenses should NOT be worn** when working with plant protection products.

4.3.9. Masks to protect the respiratory tract

PPE worn to protect the respiratory tract must supply the user with breathable air when he is exposed to an atmosphere polluted by suspended particles (dusts), drops (sprays) or even toxic vapors (gases). The clean air delivered to the user via the PPE is obtained after **the pollutants in the air have been filtered out** through a protective device. Masks for higher risk work will use a filtering cartridge.

PPE for the respiratory system can be broken into the following groups:



Remember that the protection varies depending on the type of pollution to be filtered out:

Gas	Compounds in gaseous form at ambient temperature and atmospheric pressure
Vapors	Formed by evaporation of solids or liquids at ambient temperature
Dust	Suspended solid particles
Fumes	Fine suspended particles that may be mixed with gases
Mist or spray	Fine droplets generated during spraying
Oxygen deficiency	Oxygen concentration lower than 19.5%

❑ **Dust masks**

They protect from **solid particles;** the minimum particle size varies depending on the type of mask and is indicated on the label. They do not protect against gas, vapors or splashed liquid.

Do not try to protect the mouth with knotted cloths or scarves, for they can become impregnated with the toxic product!

❑ Canister masks

Half-masks with chemical cartridges cover the nose and mouth but do not protect the eyes. Attached to the mask are one or two cartridges; they **contain materials** (such as active charcoal) **that absorb the toxic vapors** or gases. In general, chemical cartridges are used during plant treatment to protect against highly toxic, highly concentrated dust and sprays especially when treating the insides of buildings such as grain stores or greenhouses.

Full-face gas masks are designed to cover the whole face and also protect the eyes. They are equipped with one or two cartridge canisters located under the chin or in a trunk system: the canister is attached to a flexible tube. This type of mask contains more purification or absorptive material, which means that its service life is longer. As the parts of full-face gas masks are better adapted to the face, they provide a high level of protection.

Full-face gas masks should be worn in the following conditions:

- when preparing and applying plant protection products in **a closed environment, in premises that are closed or badly aerated (greenhouses or stores)**;
- when applying **fumigants**, **gas** or products that emit gas (e.g.: phosphine) in grain silos or other storage areas.

Each cartridge is effective against a specific type of vapor depending on the absorbent material used. The cartridge's use is indicated by a **color band and a letter.** Cartridges can be combined, for example an ABEK cartridge. An additional marker, **a number (1, 2 or 3)** indicates the thickness of the absorbent layer.

Type of filter	Use	Color
Filter P	**Dust**	**White**
Filter A	Organic vapors, solvents, **plant protection products**	**Brown**
Filter B	Acid gases	**Grey**
Filter E	Sulphur dioxide	**Yellow**
Filter K	Ammonia	**Green**

A cartridge such as **A2P2 or A2P3** provides sufficient protection when handling plant protection products.

Working outdoors and with normal spraying techniques (relatively large drops), **it is often not worthwhile to wear a filtering canister mask, except while preparing the mixture!**

4.3.10. Putting on PPE and taking it off

The aim is to **avoid contaminating one's hands** with equipment that is not completely clean.

Respect the following order when putting on PPE:

1 Gloves
2 Coveralls

3 Hood
4 Boots

5 Respiratory protection equipped with cartridges

6 Eye protection

Wear the coveralls over boots and gloves

Respect the following order when taking off PPE:

1 Rinse the gloves and boots (and the coveralls if washable)

2 Remove the mask and the cartridges

3 Clean and store the mask

Do NOT wash the cartridge or try to clean it with a blow tube

4 Store the cartridges and/or eliminate saturated

5 Take off the hood

4.3.11. Taking care of PPE

- Work clothes must be kept in good condition to make sure there are no tears or worn sections through which the product could contaminate the skin.
- Shoes must be inspected regularly to make sure there are no holes. If found they must be repaired or changed.
- Work clothes and shoes (or boots) must be washed at the end of each work day with soap and/or detergent.
- Wearing unwashed protective clothing is a serious health risk.

Gloves are an essential element of personal protection. Nonetheless, they can contaminate the skin if the products leak through or into the glove, or if the glove has a hole. In this case, it provides no protection at all and quite the contrary favors penetration of the product in the skin. **Gloves must be washed both inside and outside every day.**

Make sure that boots have been washed **both inside and outside** before putting them on.

Face shields and glasses must be rinsed often to clean off deposits and maintain good visibility.

*Clothes must be washed regularly, **in a separate wash load to avoid contaminating the rest of the household laundry***

Store the protective clothing and equipment in a cupboard that is separate from the one where plant protection products are stored.

In general, **soap and water is enough** to correctly clean protective equipment.

Never soak the masks and filtering cartridges in wash water: it is enough to wipe them on the outside with a damp cloth.

4.3.12. PPE quality standards

The EC Directive 89/686/EEC on the approximation of the laws of Member States relating to personal protective equipment was adopted in December 1989. You should refer to the Regulations themselves (S.I.2002 No.1144) for a full statement of the PPE requirements.

The equipment must bear a marking which, in particular, indicates the name or code of the substances used for the tests and the effective protection time the equipment provides.

The relevant European standards on protection are:

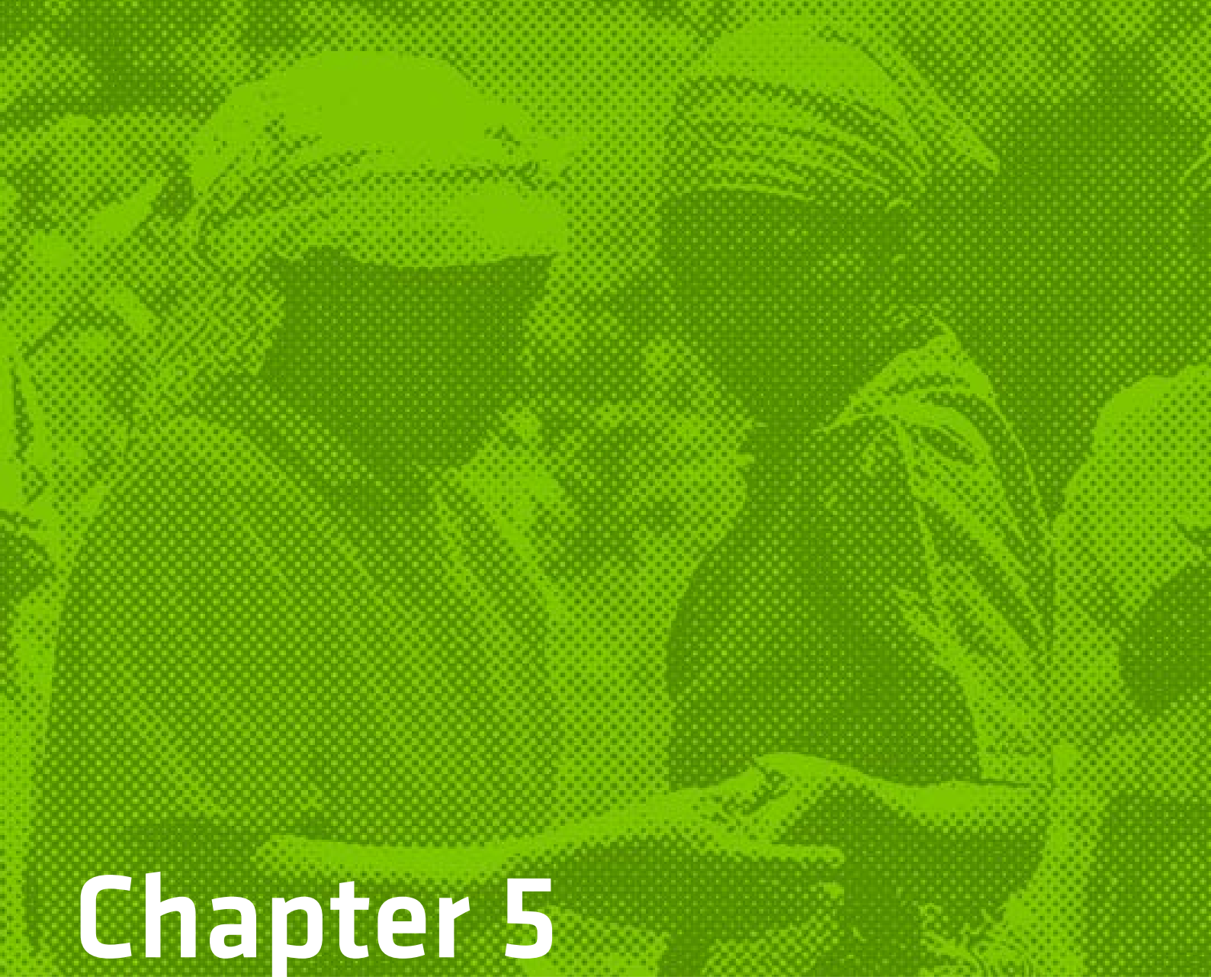
- EN 368: Protective clothing. Protection against liquid chemicals. Test method: resistance of materials to penetration by liquids.
- EN 369: Protective clothing. Protection against liquid chemicals. Test method. Resistance of materials to permeation by liquids.
- EN 374-1: Protective gloves against chemicals and micro-organisms. Part 1: Terminology and performance requirements
- EN 374-2: Protective gloves against chemicals and micro-organisms. Part 2: Determination of resistance to penetration.
- EN 374-3: Protective gloves against chemicals and micro-organisms. Part 3: Determination of resistance to permeation by chemicals.

4.4. Other types of protection equipment

In addition to protection equipment used to handle and apply toxic products, other equipment might be recommended or compulsory depending on the circumstances. A pictogram corresponding to the protection that is mandatory in a work area must be posted in a highly visible place. It must be understandable to and understood by the staff (information, awareness).

We shall only show below the most common pictograms and those for equipment related to human safety.

		
Mandatory Hands Palms protection	Mandatory Bodily protection	Mandatory Feet protection
		
Mandatory Eye protection	Mandatory hard hat	Mandatory protection against falls



Chapter 5

Product packaging and labelling

5.1. Considerations on product packing

'Product packing' includes not only the bottle or box (**packaging**) but also the **label, explanatory leaflet (if supplied)** and in some cases the measuring devices that come with the product

5.1.1. Packaging of plant health products

The packaging of plant health products is **an important safety factor**!

Its role is to:

- **identify the product clearly**;
- **describe exactly why, how and when it should be used**
- ensure safer storage, transport and use of the product
- make it easier and less risky to handle the product;
- improve product shelf life;
- ensure safer storage and transport;
- make loading and unloading easier;
- make it easier to transfer the product to another container;
- protect the product from environmental factors (water);
- enable affixing of a label with instructions for use;
- differentiate a plant health product from food products (safety) and other products (marketing).

Packages for pesticides have been designed and manufactured with these objectives in mind: choice of materials, forms of stoppers and bottles or boxes to which the label is affixed, good conservation and use without excessive risk.

The label is the main source of information on the safe and effective use of a product. The product label must always be supplied with the container. Additional information may also sometimes be supplied as a separate leaflet.

It is therefore **very ill-advised to repackage** the product by transferring the content to any type of 'household' container or a retrieved bottle that is **not labelled! Many children have been poisoned by drinking pesticide that has been decanted into a drinks bottle.**

Products in this type of container cannot be identified. The container does not give any information about the product's dangers, its use or the amount to be applied! (Photos B. Schiffers)

Pursuant to Directive 1999/45/EC (on dangerous preparations), packaging must:

- prevent any escape of the contents;
- be strong and solid;
- be made of materials and fastenings that are not susceptible to adverse attack by the contents and that will not form dangerous compounds with the contents;
- be able to be refastened repeatedly without the contents escaping.

❑ Types of packaging

There are several types of packaging:

- primary or **unit** packaging: this is the sales packaging, the one generally used;
- secondary or **grouped** packaging (pallet). This type of packaging is highly regulated and different kinds of packaging cannot necessarily be grouped (they must be grouped according to the UN codes on the packaging);
- and even tertiary packaging: transport packaging (which must conform to the rules of the Agreement on the International Carriage of Dangerous Goods by Road, ADR Agreement.

❑ Packaging materials

The choice of packaging materials depends on:

- commercial aspects (unit cost, marketing etc.);
- legal aspects (consumables, transport, use);
- technical aspects (compatibility between the container and the contents, intended use).

The following polymers are used: cellulose (a constituent of paper and cardboard), polyethylene, HDPE (high-density polyethylene, fluorinated or otherwise), polypropylene (used mainly for stoppers), PET (polyethylene terephthalate, used for bottles or as a film in bags), co-extruded combinations of aluminium-polymer films (to make single-dose pouches), PVC (polyvinyl chloride).

There are two types of **cardboard** (outer packaging): flat and corrugated. Packing cases are generally made of corrugated cardboard with or without inside partitions. Corrugated cardboard is a 'sandwich' made up of flat sheets (covers) enclosing one or more corrugated sheets (corrugations of different thicknesses separated by flat sheets). Cardboard can have simple, double or even triple walls. The quality of the case is

determined on the basis of a complex formula that includes multiple parameters (for example: content weight, distance to be covered, dampness and temperature conditions, various types of handling, intended closing method, required stacking height, storage duration, etc.). What is most important is to know whether the content is self-supporting (in other words how high can products be stacked). This is generally the case for rigid bottles in boxes or cases. It is not the case for flexible pouches, such as single-dose pouches or powder pouches; greater rigidity must be required for such pouches. It is worth noting that the case should be sized as closely as possible to the bottles in order to protect the packaging's self-supporting characteristics (a gap of even 10 mm destroys this effect and crushing becomes possible).

Polyethylene is the most widely used plastic polymer because it is a material that is virtually inert to chemical products. The more branches the polymer has, the lower its density, the higher its permeability and the greater its flexibility, but it is also more sensitive to 'stress cracking', a term that designates micro-leaks resulting from strains on the material (load, light). Solvents such as alcohols, esters and ketones contained in certain pesticide formulations lead to stress cracking that causes leaks. It is therefore necessary to use bottles of a certain unit weight (90 to 120 g/L) and a high-density polymer which must be treated (fluorinated polyethylene) to improve its resistance to the release of solvents through the walls and to being deformed in storage.

Nature of material	Application	Type of application-related specifications
Steel	Drums Unit bottles	Weight, openings, sizes, type of stopper, seamed or not
Wood	Pallets	Type of pallet, thickness of boards, type of nails, treated (according to the FAO ISPM 15 standard) or not
Paper	Pouches and bags	Thickness/weight per m², sizes
Cardboard	Cases	Thickness/weight per m², type of cardboard, sizes, number of layers
Plastic (PE, HDPE, PET, etc.)	Bottles Stoppers	Weight, nature of resin, fluorinated treatment or not, anti-UV or other treatment, crush-resistance, compatibility

The packaging must fulfil the **testing requirements** contained in different regulations on the carriage of dangerous substances. The supplier is obliged to conduct a set of standardised tests, such as:

- drop test: the packaging must remain leakproof;
- leakproofness test: absence of leaks;
- internal pressure test: absence of leaks;
- stacking test: physical strength, absence of leaks, stability in stacking.

Every type of standard packaging that has been put through these tests successfully is approved. This entitles it to a 'UN' identification number that guarantees its quality.

Model of marking to be affixed	Indication of UN approval number: U N …/…/... …/…/……../…….

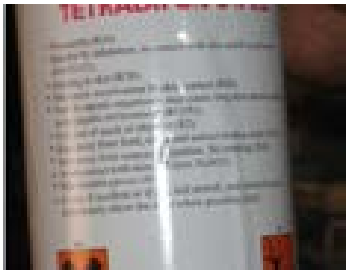
5.1.2. Labels

The **information** given on the label is the main way of explaining to users how pesticides can be used effectively and with the least risk.

Even then, users have to be able to find the information easily and to read or understand the language!

Understanding the meaning of hazard notices and safety advice, colour bands, hazard symbols and pictograms relating to the product is therefore the first element for effective and risk-free use of pesticides by farmers.

- Always read labels before opening the package, to avoid serious accidents.
- If the pesticide does not have a label, or if the label is damaged or not legible, the farmer should not buy or borrow the product.
- The label does not replace the product's 'Safety data sheet' (SDS), which is much more detailed.

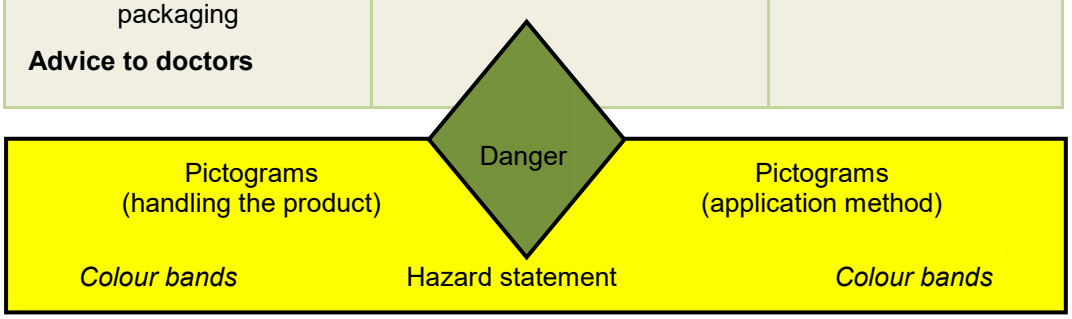


Example of a label for an insecticide written in English for a product distributed in... Senegal!
(Photo B. Schiffers)

5.1.3. Recommended composition of a label (according to the FAO)

The label's composition (its contents) and size (compared to the packaging size) can be defined in regulations, but the presentation of texts and pictograms (arrangement) is not strictly regulated. According to the FAO, to make the information easier to read, text zones should be arranged as follows:

Compatibility **Shelf life** **Toxicity** **Precautions for use** • storage • risk statements and safety advice • first aid instructions • disposal of packaging **Advice to doctors**	**Name of product** **Formulation** **Composition** **Batch number** **Date of manufacture** **Name and address of manufacturer and distributor** **Net content**	**Uses** **Mode of action** **Recommendations for use** • dose rate • directions for use • re-entry/pre-harvest interval



Illustrated example of a label (on a single-dose pouch):

Trade name and type of formulation (EC)

Active substances and concentrations

Activity

Time of application

Crop

Directions for use Application rate/ha

FAO band colour and pictograms

The FAO colour band is practical for assessing the hazard:

In Europe, the use of colour bands and FAO pictograms on labels is rare. The label is sometimes accompanied by a 'notice' (in one or more languages). In practice, the types of labels in use vary considerably from one product to the next and from one manufacturer to another more in terms of commercial considerations than technical factors and/or according to the requirements of local legislation or the terms of an invitation to tender, for example.

Labels on many products use the following type of arrangement:

Hazard symbols will have to be adapted in keeping with the '*Globally Harmonised System of Classification and Labelling of Chemicals*' (GHS). For each hazard category, the regulation establishes a **pictogram**, **signal word**, **hazard statement** and **precautionary statements.** All these elements must be found on the label; the way they are arranged and the way the label is affixed to packaging are regulated in Europe.

The size of the label varies in terms of the packaging capacity (the larger its capacity, the larger the label).

The label is the only channel of communication targeting consumers. However, it can also serve to draw the attention of workers to more detailed information on the substances or mixtures found in the safety data sheets.

5.2. Reading and understanding symbols on labels

5.2.1. Labelling of products according to toxicity

The FAO has adopted a system to classify pesticide formulations based on their toxicity (LD_{50}) and concentration. Each class is matched with a colour band in which the pictograms must be placed.

WHO/OMS hazard class	Hazard statement	WHO/OMS colour band	Hazard symbol
Class Ia Extremely hazardous	VERY TOXIC	PMS RED199 C	
Class Ib Highly hazardous	TOXIC	PMS RED199 C	
Class II Moderately hazardous	HARMFUL	PMS Yellow C	
Class III Slightly hazardous	CAUTION	PMS Blue293 C	-
Non-classified (Table V)	-	PMS Green346 C	-

5.2.2. Labelling of products according to properties

The label must include the relevant hazard pictogram(s), intended to provide specific information on the hazard concerned. Regulation (EC) 1272/2008 (known as CLP, on the classification, labelling and packaging of substances and mixtures) established **new pictograms** for each hazard category. For formulations of plant protection products, application of the regulation will be mandatory from 2015. In the meantime, old or new pictograms may be used.

When the classification of a substance or mixture calls for several hazard pictograms on the label, priority rules are applied to reduce the number of required pictograms. For example, if the classification results in the presence of several pictograms for the same hazard class, the label includes the pictogram that corresponds to the most serious hazard class for each class concerned. The CLP Regulation establishes a total of nine pictograms (of which three are new: GHS04, GHS07 and GHS08). Each pictogram includes a code made up as follows: 'GHS' + '0' + a figure.

Correspondence between old and new pictograms:

Old	New
 F : Highly flammable  F+ : Extremely flammable	 GHS02
 C: Corrosive	 GHS05
 T: Toxic  T+: Very toxic	 GHS06
 Xn: Harmful  Xi: Irritating	 GHS07

Old	New
 **N : Hazardous to the environment** A product hazardous to aquatic fauna (by extension, hazardous to the environment)	 **GHS09**
 **Explosive** A product that can explode in the presence of a flame or violent shock.	 **GHS01**
 **Oxidizer** A product that emits a high level of heat when it comes into contact with other substances, in particular flammable substances.	 **GHS03**

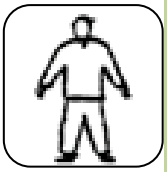
5.2.3. Understanding pictograms

Pictograms are essential because they can be understood by all users of pesticides, irrespective of their level of education or literacy. However, **caution is still in order because pictograms can be misunderstood** or misinterpreted by farmers. They can be subject to confusion, not correspond to local habits or the farmer might simply be unaware of the pictogram's usefulness and message.

Pictograms recommended by the FAO and Crop Life (ex-GIFAP)
(FAO Guidelines on Good Labelling Practice for Pesticides, 1995)

Pictogram for storage	*Pictograms illustrating operations (measuring dose or application)*			
 *Store locked up, out of reach of children*		 *Handling of liquid concentrates*	 *Handling of solid concentrates*	 *Application*

Pictograms illustrating precautions to be observed				
	 *Wear gloves*	 *Wear eye protection*	 *Wash your hands after use*	 *Wear an apron*

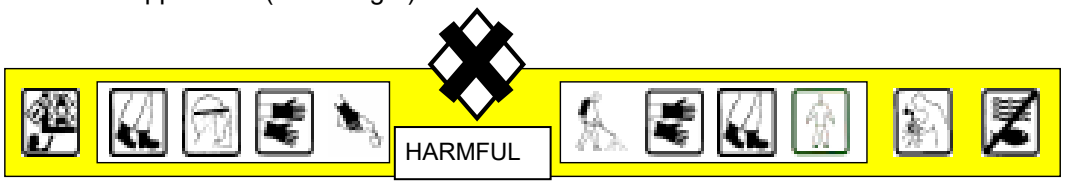
	 *Wear gum boots*	 *Wear protection over nose and mouth*	 *Wear respirator*	 *Wear suitable protective clothing*

Hazard pictograms				
	 *Hazardous/harmful to animals*	 *Hazardous/harmful to fish. Avoid contaminating lakes, rivers, ponds or streams*		 *Wash yourself after use* (in Yvory Coast)

How are pictograms read?

Pictograms are placed in the colour band, in boxes or not:

- outside of packaging: various advice (e.g.: storage);
- inside packaging: precautions to be observed during dose measuring (on the left) or application (on the right).



The pictograms in boxes are read from the centre of the label to the left and then from the centre to the right.

Mixture preparation phase:

Handling of liquid concentrate: *dosing of the product during preparation of the mixture*

Wear gloves

Wear eye protection

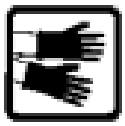
Wear boots *(with trousers outside to prevent the product from getting in the boots)*

- During this phase of work, it is essential to keep the concentrate from coming into contact with the skin.
- Do not measure or mix pesticides indoors or near dwellings or shelters for animals
- Keep children and animals at a distance.
- Containers and measuring devices used to prepare plant protection mixtures must be used solely for this purpose!

Application phase:

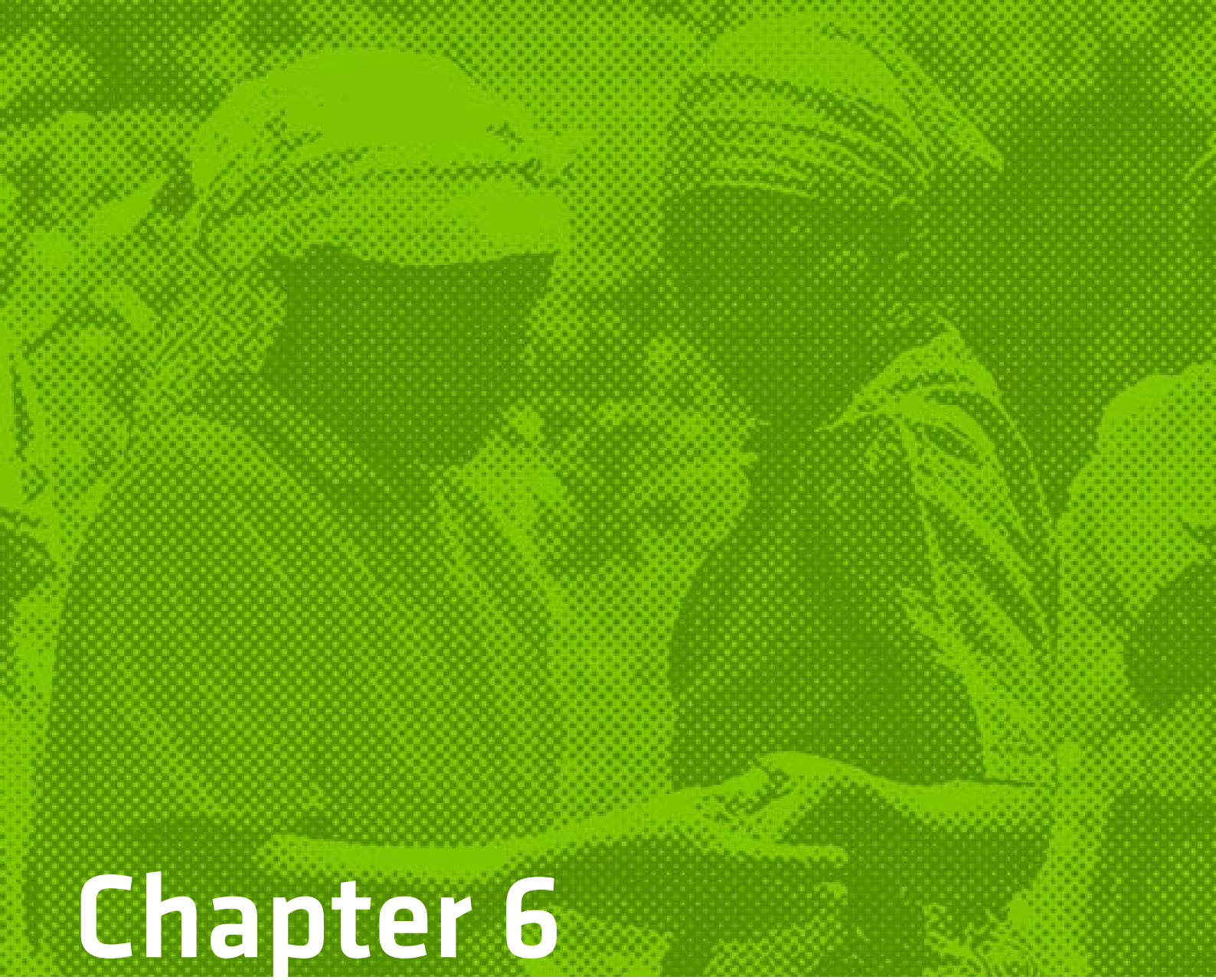

Applying the mixture with a sprayer


Wear suitable protective clothing


Wear gloves


Wear boots (with trousers outside to prevent the product from getting in the boots)

- Never allow children, elderly persons or pregnant women to apply pesticides – keep them away from treated surfaces
- Keep people and animals away from places that must be treated, in particular the people who work in these fields



Chapter 6

First aid in case of an accident

6.1. Lesions and poisoning caused by pesticides

6.1.1. Skin lesions and mucous membrane irritations

Some active substances are known to be highly irritant (e.g.: pyrethroid insecticides). In addition, pesticide formulations often contain one or more solvents (aromatic hydrocarbons, glycols, ketones, etc.) that are harsh on the skin and the mucous membranes (the respiratory tract and eyes are especially sensitive).

GHS08

Chemical irritants can affect the **skin** or **respiratory tract** (the respiratory system and lung tissue) causing both immediate and long-term injuries. The effect of an irritant can be felt immediately after exposure or at a later time. Simple asphyxiants can deprive the lungs of oxygen.[1] All corrosive chemicals can produce harmful vapors in certain conditions.

Pictogram GHS08: Respiratory sensitization, mutagenicity, Carcinogenicity, Reproductive toxicity.

Skin is extremely vulnerable: protective clothing must be worn by those working with products that are potential irritants such as certain pesticides, or those working on processes that involve corrosive chemicals.

Two thirds of all industrial accidents caused by chemicals are due to body contact with liquids that cause chemical burns.

[1] Certain substances, such as carbon monoxide, can mix with haemoglobin and inhibit its capacity to transport oxygen, thus asphyxiating the tissues.

Xi - Irritant

GHS07

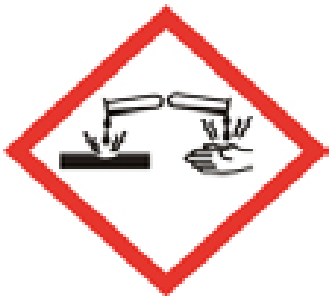
Old and new pictograms to be affixed to the packaging of irritating substances.

Contact with a **corrosive substance** can destroy living tissue.

Direct contact of the skin or eyes with corrosive liquids sparks a chemical reaction with the skin's fat tissue, raising the heat of the injured area and causing deep tissue decomposition.

This is the process that inflicts first, second or third degree **chemical burns**. The degree is determined by how deep the tissues are damaged. Third degree burns can be very serious, especially if a large surface of the skin has been affected by the chemical.

C - Corrosif



GHS05

Old and new pictograms to be affixed to the packaging of corrosive substances

Gases, vapors, mists or sprays in contact with the **cornea of the eye** and contact with an irritant or corrosive can cause lesions to the eye.

The most common source of lesions is liquid splashed into the eye (ex: when opening the package or preparing the mixture).

6.1.2. Symptoms of pesticide poisoning

Symptoms of poisoning generally appear quite rapidly after an overdose or single over-exposure to pesticides: usually within 30 minutes to an hour. Nevertheless, **there can be a 2 to 3 hour delay if the pesticide enters the body through the cutaneous route** (this is the case of work clothes impregnated with the product that enter the skin gradually).

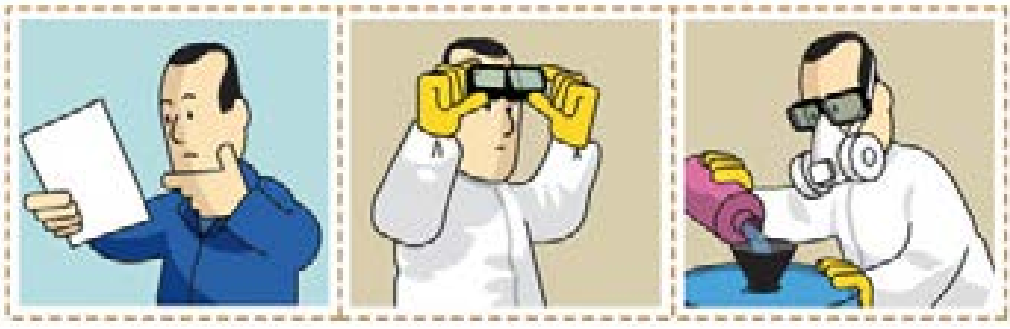
The first symptoms of poisoning are generally nausea, headache, fatigue and weakness along with mental confusion and a lack of muscular coordination. The headache, muscular weakness and fatigue gradually grow worse. The symptoms described above call for immediate attention as they are signs of possible pesticide poisoning.

Since there are a variety of products and many possible absorption routes, **poisoning by pesticides can be expressed in many different ways.**

In case of an accident, therefore, it is recommended to consult the product's safety data sheet. The **Safety Data Sheet (SDS) is an indispensable tool** to evaluate and prevent chemical hazards, and a crucial addition to the label.

The *Safety Data Sheet* (SDS) (also called *Material Safety Data Sheet* – MSDS) is a form that contains data on the properties of a chemical. These sheets are a key element for health and safety at the workplace. They are important for those who use the products or who treat the remaining product, residues or wastes contaminated by toxic and/or hazardous products. SDSs are also essential both upstream for those who deal with workplace ergonomics and design processes, and downstream for the healthcare staff – they keep workers and emergency staff informed (this includes information for poison centers on the hazards associated with these products and how to counteract them).

These sheets are often used to classify information on chemicals. They must be easily available wherever a substance is used. In Europe, in particular, the product manufacturer or distributor must deliver them to the customer, in the customer's language. They are also sent to the medical personnel in a factory other workplace.



I read	I protect myself	I handle

The design of the SDS is governed by the European REACH Regulation (Regulation (EC) No 1907/2006, Annex II).[2] In addition to the product's identification and its general properties, the **data sheet also includes**:

- toxicological identification (in particular, the main symptoms that can be observed);
- description of emergency first aid measures (classified by type of contact);
- control of workers' exposure and personal protection measures (recommended PPE);
- occupational exposure limits;
- exposure controls (workers' exposure on the job);
- disposal considerations: if it is dangerous to dispose of the chemical or mixture, the sheet will contain information on safely handling them;
- measures to take in case of accidental release of the product.

Careful!

Other illnesses, especially infections or excessive heat conditions, can mimic poisoning. Therefore it is important to obtain medical advice whenever possible.

In difficult diagnoses, it is important to use all the information available when someone is considered to be a victim of exposure to plant protection products. The possibility of other simultaneous illnesses must be considered.

[2] Regulation (EC) No. 1907/2006 of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). It aims gradually to restrict in the EU the most dangerous chemicals. It is industry's responsibility to demonstrate that human health and the environment are not adversely affected by conducting studies on the hazards to human health and the environment before placing the product on the market or using it.

6.2. Assessing hazards and prevention measures

6.2.1. Conduct a preliminary hazard assessment

National laws obviously contain differences in their specifics on this subject. Nevertheless a few clear-cut basic principles must be followed at the very least.

As soon as the situation is under control, a precise assessment must be made and a decision taken on the action priorities.

These priorities will be determined by the level of safety, whether other people are helping, established treatment priorities and the assistance requested.

The employer must assess probable and foreseeable hazards in the specific workplace, and plan how to organize first aid and consequently administer initial care. It is generally useful and may be a statutory requirement to **record this assessment** unless it entails steps that are perfectly obvious.

The hazards identified by the assessment include chemical dangers (including the need for antidotes for fast-reacting poisons), as well as those of a mechanical and electrical nature.

6.2.2. Have on hand the equipment needed to take appropriate action

All first aiders must have access to the equipment provided and all workers must have reasonable access to first aid. Although the equipment varies, all establishments must, without exception, have at least a first aid kit. Employees who work off-site or travel from one place to another must **carry first aid kits with them.**

The following supplies, which should always be available at the workplace, help control over-exposure and poisoning:

Water
Water must always be available when concentrates are handled or mixed. As it is used to wash the contaminated skin and eyes, an abundant amount of clean water must be on hand.

Soap
Have a supply of small bars of soap used for washing.

Cloths
Have a large stock of clean and dry cloth or paper wipes. They are used to clean skin that has been contaminated by the plant protection products if water is not immediately available.

Blanket
This is useful to cover a person who has gone into shock (even in a hot climate).

Activated charcoal (medicinal)
This is useful when certain pesticides are ingested. They should be kept in a dry place and stored in a tightly closed box.

First aid kit
Keep it accessible.

Plastic wrapping or bags
To store the contaminated clothes and shoes.

Medical assistance
Plan ahead and know, in case of an emergency, the best and quickest route to find medical assistance or take the patient to a medical center.

The factors that determine which equipment, personnel, etc. are needed are:

- the number of workers and the history of accidents in the firm;
- the type of work done and its hazards and risks;
- the size of the establishment and the way the workers are located and organized;
- the establishment's location and the places visited by the workers during their job;
- work on multiple occupation sites;
- teamwork, working alone or remote working;
- the distance from outside medical services;
- the probability that the first aid staff may be absent every now and then.

An employer whose activities are high risk should provide an adequately equipped and staffed **first aid room**. A poster should be placed on the door, indicating the names and location of the first aid staff and the steps to take if they cannot be reached. Sufficient documentation on all treatments must be kept. In situations where the workplace requires special types of first aid material (such as oxygen therapy, antidotes), this should be kept in the first aid room (in a fridge if relevant).

As can be seen, the basis to justify equipment and organize first aid is not simply the number of employees. The measures installed must also cover the first aid needs of other people working on the growing site(s) (such as day workers).

Independent workers doing a job on the farm must bring first aid equipment that is adequate for their own needs.

6.2.3. First aiders

The employer must foresee the adequate and appropriate number of people trained to administer first aid to workers who fall ill or are injured at the work place. These people are generally called 'First aiders'. In general, the ratio of **one first aider per 50 workers** should be considered as a minimum, unless the assessment (depending on the circumstances) points to different needs. This condition may be more stringent in some countries.

An 'adequate' person is generally someone who has a current, valid and recognized first aid certificate, delivered after passing a training course that is certified by the relevant national authority.

If the main (trained) first aider people are temporarily or exceptionally absent, the employer often has the right to designate another person to take responsibility for:

- any situation where an ill or injured worker needs to be seen by a doctor or nurse;
- all the first aid equipment during the first aider's absence.

The 'designated persons' should not administer any treatment other than emergency first aid, and only if they have been specifically trained for this. They are nonetheless **responsible for seeking professional help** and **recording all incidents in a special book.**

6.2.4. Information and training

The employer has the obligation to make sure that all workers, including day workers, are informed about the hazards linked to their job and about first aid measures in case of an accident. This information should be included in the workers' training programme.

Checklist of preventive measures

- Someone must be designated to take charge in case of an accident or emergency, to call an ambulance or other emergency service, and to take care of the first aid equipment.

- At least one designated person (first aider or not) must be available when people are working. Any outgrowers working with a company must be given the name of the person qualified to take action in case of an accident. (This information can be included on a sheet distributed with instructions to follow in case of an accident.)
- A first aid kit must be provided, kept in good condition, and adequately stocked. It must contain information on treatment for injuries, in particular on emergency procedures such as CPR, how to control bleeding, loss of consciousness, burns, electrical shock and asphyxiation.
- The Safety Data Sheets (SDS) of the various chemicals used must be kept and consulted. If special measures are required for certain products (for example: special antidotes or medications), these products must be on hand and stored in the required conditions. A copy of the labels must be kept on file together with the SDS.
- A sufficient quantity of personal protective equipment (PPE) must be available and workers must be trained in their use. The PPE must be given regular maintenance and replaced if necessary.
- Other conditions imposed by law or insurance policies may require that all medications, including those for headaches, be kept in a nearby storage area subject to controlled access.
- There must be a sink or other washing facilities nearby.
- Installations to rinse the eyes or for emergency showers must be foreseen if found necessary under a risk assessment.
- Posters must be displayed with the name, telephone number and location of the first aiders or the designated person.
- In some circumstances, it may be necessary to have a first aid room and a qualified or specialized first aider.
- It is reasonable, as a precautionary measure, to have at least one person at the workplace who has learned basic first aid procedures. And it is essential to have one person designated to take responsibility if a worker is injured or ill, and the trained first aiders are temporarily or exceptionally absent.

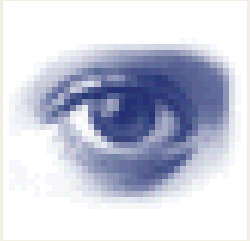
6.3. What to do in case of an acute poisoning?

6.3.1. Evaluate the situation

Basic first aid principles apply in all cases of injury or illness, regardless of how serious they are. In any incident, the first aider is responsible for acting quickly, calmly and correctly in order to save a victim's life, keep his state from worsening and improve his chances for a cure. Attaining these objectives requires:

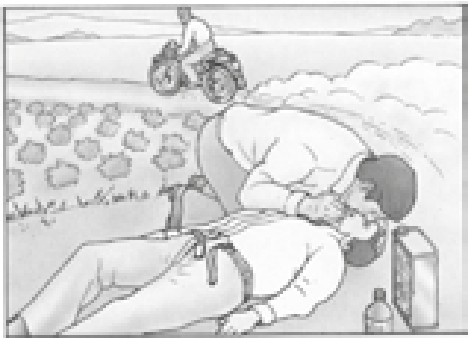
- assess the situation to see whether it is safe to approach the incident
- have a swift yet calm approach;
- make a rapid evaluation of the situation and the victim;
- try to determine what has happened,
- look for the symptoms and the signs;
- get help from expert medical personnel (phone 211, 999 or 112)
- commence immediate and appropriate treatment;
- a decision on the appropriate next steps for the victim in the light of the injury or illness.

Initial assistance begins by **pinpointing the problem correctly**.

	**ASK:** • The person concerned - or if he is unconscious, one of his colleagues – how was he injured, does he suffer from any known medical conditions **For chemicals**: • Which chemical was involved in the contamination? • Which product was handled and how much of it? • Which protective garments (PPE) were worn? • What sort of harmful effects were noted? • Did the victim ingest any alcohol or medications? • Ask to be shown the product's Safety Data Sheet (SDS)
	**LOOK:** • Check the patient's condition and any apparent symptoms. • Look for the plant protection product's packaging, labels and the spraying equipment. • Collect all the labels and put them in a safe place. • Look for evidence of exposure, splashes on the ground or on clothing. • Check the equipment to see if it was ill-suited and/or faulty.

6.3.2. Providing first aid

This must be done **quickly but calmly and with a cool head.** Be careful not to place yourself in danger when you approach the victim. When you arrive on the scene, the first thing to do is to identify yourself as a trained first aider and, in the absence of a doctor, nurse or more experienced person, **take control of the situation calmly.**



Quickness is essential.
Do not wait for a specialist before taking action!
Call or send someone to get help!

Act in the following order of priorities:

- the first priority is to keep the person breathing ;
- immediately remove any contamination ;
- if the victim is bleeding, staunch the flow;
- take care of any eye damage as quickly as possible ;
- then seek medical help.

❑ Stop any contamination

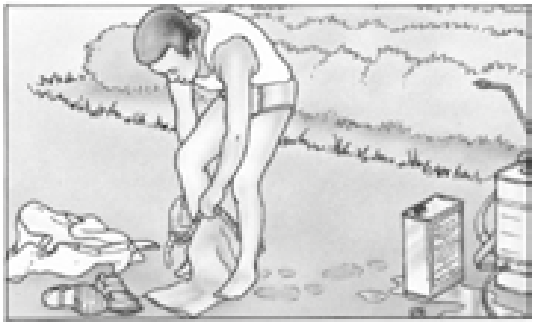
Not all accidents are of the same urgency. With pesticides the most frequent accident is contamination of the body, skin and/or eyes after a product has been spilled accidentally during handling, the mixture has been splashed (often in the eyes) or drops have fallen on the victim during spraying (wind changing direction, brushing up against treated plants, leaks).

To stop the contamination, move the person away from the toxic source and wash the skin with water (accident in a storeroom), or remove traces of the toxic substance on the skin or work clothes (accidental splashing). This is essential in order to work safely and **not be poisoned yourself.**

If possible wear rubber gloves when administering first aid.

The toxin must be kept from penetrating the skin or clothing that has not been affected. Contaminated skin must be rinsed with water.

Do not look for special washing solutions. If there is no water available, dab or lightly wipe the skin with clean cloths, paper or even grass or straw, which must be destroyed afterwards. Do not scrub the skin vigorously or brush it.



Take the contaminated clothes off immediately and put them in a plastic sack before seeking a medical opinion.

Avoid contact with contaminated shoes and clothing.

It is usually recommended to **continue rinsing skin or eyes with flowing water** if they have been in contact with a chemical. Chemicals do not all have the same effect however. Some are not irritants while others are highly corrosive and can cause severe burns). It is nevertheless logical to adapt the rinsing time to the chemical's known effects (see below).

In case of splashes, the eyes must be rinsed immediately and abundantly. Use a large volume of water, lift the eyelids and rinse for at least 10 minutes.

It is very important to **begin rinsing with water immediately after the skin or eyes come in contact with the chemical.** It is better for the skin and eyes to be completely decontaminated immediately at the accident site before moving the victim for further treatment.

The following **rinse times** are recommended:

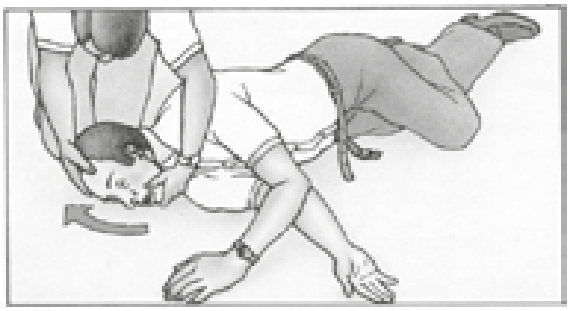
- at least 5 minutes in the case of non-irritants or mild irritants;
- **15-20 minutes** for products causing moderate to severe irritations and chemicals that are highly toxic if absorbed through the skin (this is the typical case for plant protection products);
- at least 30 minutes for most corrosives;
- at least 60 minutes in the case of a strong alkali (ex: caustic soda);

❑ Respiratory tract and breathing

In case of serious poisoning, it is of utmost importance to closely monitor the victim's breathing and consciousness. This is because people who have been poisoned can lose consciousness, vomit and then suddenly stop breathing.

Quickly check that the **respiratory tract is not blocked** and that the victim is breathing. If he stops breathing (the face or tongue turn blue), lift the chin to keep the tongue from blocking the airway. If he does not start breathing again after clearing the windpipe, keep his chin tilted and tip his head back.

Do not begin **artificial respiration until you are sure there is no risk of poisoning yourself** (if necessary, clean and remove any vomit or product residue from the victim's mouth by inserting a finger covered with a clean piece of cloth). Pinch the victim's nose and breathe into his mouth breathing at a normal rate, or else cover his mouth and breathe into his nose. Make sure his chest is moving. Continue until the victim starts breathing normally.



If the person is unconscious or breathing noisily, place him in the lateral recovery position and ascertain his level of reactions. **Do not move** the victim if there is a possibility he may have a spinal column injury, unless this is truly essential to help him breathe.

Placing the patient in the **correct position** is crucial in lowering the risk of complications. Place the patient on his side, with his head lower than the rest of his body and turned to the side. If the patient is unconscious, keep his chin lifted and tilt his head back to help him breathe.

In many cases it is enough to have the victim breathe fresh air. Nevertheless, it might be recommended to administer emergency oxygen as a first aid measure in certain cases of exposure to chemicals by inhalation.[3] Recent studies have shown that in an emergency situation, **lack of oxygen is the most critical problem** and that there should be little concern over worsening the condition of victims with chronic obstructive pulmonary diseases (such as chronic bronchitis or emphysema).

Emergency oxygen is only beneficial in case of exposure to chemicals that impair the body's ability to obtain the oxygen it needs to remain alive and healthy. This is particularly the case for chemicals that can:

- displace the oxygen in the air, thus reducing the amount available for normal breathing (e.g.: CO_2 or nitrate);
- impair the blood's ability to transport oxygen (e.g.: carbon monoxide poisoning);
- compromise the use of oxygen by body tissue (e.g.: cyanide or hydrogen sulphide poisoning);
- interfere with the ability of oxygen to cross the lungs into the bloodstream (pulmonary edema caused by ammonia, phosgene or chlorine);
- provoke a severe asthma attack.

First aiders must receive specific training in this first aid procedure so that they can learn how to use the equipment used to administer oxygen.

❑ Administering an antidote

An antidote must never be administered as a preventive or prophylactic measure. Atropine is indicated in case of a serious poisoning by insecticides that are acetylcholinesterase inhibitors, but it must be administered as soon as possible and with due precaution. Atropine can save a life if it is given in time and in a sufficient dose! But **any person who has received atropine must be examined by a doctor as soon as possible** for unwanted side effects may appear.

❑ Precautions

Do not give the victim anything to drink, except water and only if necessary (if the medical services are delayed for example). Never authorize him to smoke or drink alcohol. Do not give him milk, eggs, oil or any other traditional potion/remedy that might speed up the intestine's absorption of certain products.

Anyone who may have been poisoned must be kept from driving a vehicle even if he seems to be feeling better. It is impossible to know exactly how severe a poisoning is based solely on the initial symptoms.

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[3] Be aware that storing cylinders of oxygen at the workplace may introduce additional hazards. As oxygen supports combustion these cylinders present an additional fire hazard.

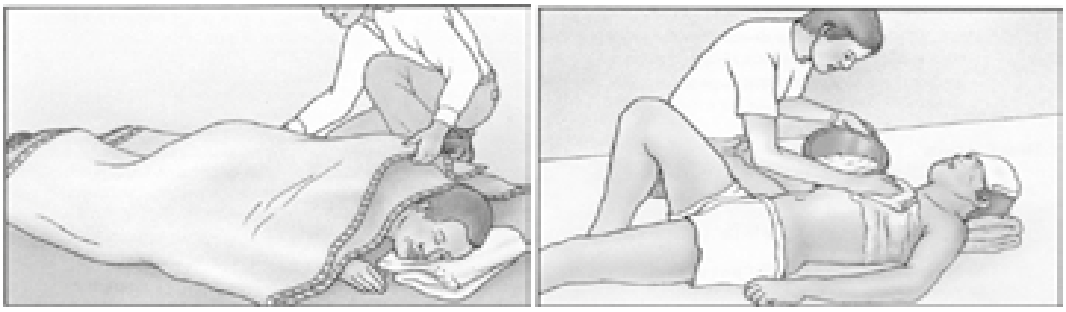
As soon as a poisoning is suspected, the **patient must not remain alone** until he receives medical treatment. In case of serious poisoning by organophosphates, the patient's breathing must be attentively monitored because he can stop breathing suddenly, even after several hours (delayed poisoning).

❑ Other needs

Treat all fractures and serious wounds before moving the victim, **unless** the environment presents an imminent lethal danger. If the victim is in danger, temporarily immobilize the wounded part of the body before moving.

❑ State of shock

The patient must be kept calm and continually comforted, for he may tend to become extremely nervous. Insecticide poisoning (which acts on the nervous system, especially organophosphates and carbamates) becomes worse if the victim is agitated. Keep him completely calm.



Pay particular attention to **controlling the temperature** of unconscious patients. If the patient is very hot and sweating excessively, sponge him with cold water to cool him off. If he feels cold, cover him with a sheet or blanket to keep his body temperature normal. Keep the victim warm, calm and lying down until professional medical help arrives.

❑ Communicating with medical assistance

Once you realize that you will need help, especially an ambulance, police officers, fire-fighters (or gas or electricity companies), these services should be called immediately. Go to the closest phone or use a mobile phone if available, or else send a passer-by to call the emergency services.

The following information must be communicated:

- Your telephone number (if the call is cut off for one reason or another you can be called back).
- The exact location of the accident. For example: give the crossroads or other nearby location references.
- An idea of the type of accident and how serious it is. For example: poisoning by a plant protection product that has not yet been identified.
- The number, sex and approximate age of the victims and, if possible, the type of injuries they have sustained.
- Request for special assistance if cardiac arrest is suspected.

- **DO NOT HANG UP** before the person you have called hangs up.

❑ **Transport to a medical center**

As far as possible, the victim must be transported to an emergency medical center for confirmation of the diagnosis, to obtain further treatment or because the victim is deemed to be in critical condition (e.g.: respiratory tract obstructed, breathing or blood circulation altered). If need be, continue rinsing the contaminated area (skin, eyes) during emergency transport, taking due precautions to protect the emergency services staff.

To enable the medical center to identify the problem correctly it is useful to give the center a **copy of the label** (or a product container), and if available, a **copy of the Safety Data Sheet (SDS).** The operator (and company management) must keep all the SDS, and often this is a mandatory measure. These sheets indicate the actions to take in case of poisoning.

6.3.3. Symptomatic treatment of acute poisoning

Although the doctor or nurse must always attempt to **identify the toxin** this should not delay vital therapeutic measures. **Most poisons do not have a specific antidote.**

> The patient should thus receive **symptomatic treatment** for his clinical condition. This **does not necessarily require knowing the exact toxin involved!**

Treating poison victims calls for knowing general intensive care principles as well as the specific signs of each toxin. This treatment entails:

1. symptomatic treatment (on the basis of observed symptoms),
2. administering any antidote. This should only be considered if it is known which toxin is involved and if it has an antidote,
3. keeping the toxin from being absorbed and eliminated.

In case of doubt, the doctor must consult the **Safety Data Sheet (SDS)** which contains the instructions needed for symptom-based treatment.

A few general rules underlie the treatment of poisoning:

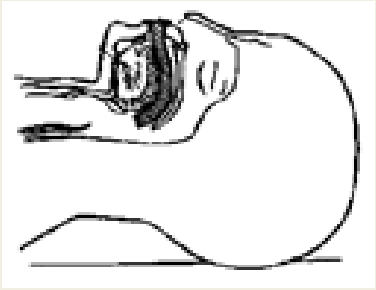
- **Skin contact**: undress the victim quickly and completely, UNLESS the contaminated clothing or shoes are stuck to the skin (in this case wait for the doctor to arrive). Wash the skin abundantly without scrubbing. Rinse, and if the skin is not broken wash with soap and water. Broken or abraded skin, however favors resorption, so use of soap and water could cause additional irritation. If possible wear rubber gloves to administer first aid.

- **Eye contact**: flush for 10 minutes. Do not let the water flow towards the unaffected eye. A small amount of anesthetic eye drops (Novesine®) makes it easier to wash the eye or to wash it for a longer time. It is best to have the help of another person to do this, with one person pouring the liquid into the eye making sure that all the liquid drains out of the eye. If the victim is wearing contact lenses, try to take the lenses out before rinsing. Never attempt to neutralize the product. Apply a sterile eye bandage and in all cases send the patient to an ophthalmologist.

- **Cardiac arrest:** simultaneously apply external cardiac massage, give breathing assistance and begin medical reanimation (intubation, ventilation, intravenous adrenalin, etc.).

- **Acute respiratory distress:** free the upper airways and help the person to breathe. Then make sure the victim gets fresh air and rest, placed in a half-seated position. If the victim is not breathing or if artificial respiration is difficult, use of an oropharyngeal airway may be necessary.

The oropharyngeal airway (also called Guedel tube) has a small mouthpiece that covers the lips. A reinforced bite block is fitted between the teeth to protect the central tube from biting. The bent section fits over the tongue to separate it from the back of the pharynx. The central tube is for air passage or to extract pharynx secretions. The cannula come in various sizes adapted to the patient's size. The first aid kit must contain these single-use canullas.



- **If the product has been swallowed,** begin by rinsing the mouth and consider eliminating the toxin:
  - by inducing vomiting;
  - by gastric lavage.

Evidence and common sense show that **it is not necessary and may even be dangerous to induce vomiting** in most cases of chemicals swallowed at a workplace. This is because:

- in general an adult accidentally swallows only a small amount (14-21 ml);

- there is no conclusive evidence that victims of chemical ingestion who do have their stomachs emptied have more successful outcomes than victims who do not;
- there can be significant risks associated with inducing vomiting, especially in emergency situations;
- there does not appear to be any reliable and safe first aid procedure to induce vomiting in an adult;
- medical assistance is usually available quite quickly in most situations.

It is generally **not recommended to induce vomiting** as a first aid measure, unless the chemical swallowed is highly toxic and can be fatal without very swift medical attention. It is crucial to READ THE PRODUCT LABEL AND/OR SDS FOR INFORMATION ON WHETHER OR NOT IT IS SUITABLE TO INDUCE VOMITING and on whether the product is highly toxic, which can be seen from the pictogram on the label.

Induce vomiting only if:

- the product has been swallowed (and swallowed less than 2 hours earlier)
- the victim is conscious
- it is a non-foaming product
- the product does not contain petrol, solvents, acid or alkali.

The steps to follow are:

- the patient should be seated or standing;
- induce vomiting by placing two fingers to the back of the patient's throat. Use two fingers of the other hand to push the patient's cheeks between his teeth (to make sure he does not bite your fingers);

To induce vomiting: fingers down the throat, or have the victim drink salty water!

- after vomiting, or if the attempt did not work, have the patient drink 3 tablespoons of activated charcoal in half a glass of water. Repeat as often as needed until medical help arrives.

The toxin can also be eliminated by **gastric lavage**, using lukewarm salty water, occasionally followed by administration of 50g of activated charcoal.

Activated vegetal charcoal (medicinal charcoal) can be administered if a patient has ingested a potentially toxic amount of a poison (which is known to be absorbed by charcoal) at most **1 hour previously**. Powdered activated charcoal (2-3 spoonfuls in a glass of water) should only be given to someone who is conscious. It works by binding the toxin so that it cannot be absorbed by the digestive system. The carbon is then eliminated gradually in the faeces.

If the victim is having convulsions or is in a convulsive, do not try to restrain the person. In the case of convulsions or a convulsive state, keep all airways free and use medications (Rivotril®, Valium®). Intubation may be necessary.

6.3.4. Symptomatic treatment for certain pesticides

The treatment recommended for the most serious pesticide poisonings is given below. It should be noted that most of these products are no longer authorized for crops, or are not recommended.

❑ **Treatment for poisoning by organochlorine insecticides**

In case of accidental contact while spraying: decontaminate skin by removing clothing, showering and washing with soap. If poisoning was caused by massive skin contact, decontaminate again at the hospital.

In case of swallowing: gastric lavage and administer a non-oily saline purgative. The patient must not have lipids in the diet. Although there is **no specific antidote** for organochlorine intoxication, supportive therapy and symptomatic treatment, especially anti-convulsive treatment, can save the patient's life. It is vital to keep air passages free to ensure continuous oxygenation of the tissues. Convulsions should be treated with **diazepam** with intubation and breathing assistance. As the victim may become excitable, do not administer adrenergics. Some differences will be observed depending on the chemical nature of the organochlorine: the thresholds for the appearance of symptoms and the effects are quite variable (hepatic and renal toxicity, kidney problems, pulmonary edema).

❑ **Treatment for poisoning by organophosphate (OP) insecticides**

Symptomatic treatment includes:

- skin decontamination by removing clothes and washing with soap and water for external exposure, or gastric lavage in case of ingestion; this can be done even more than 6 hours later in the case of massive ingestion (in this case the upper air passages must be protected);
- respiratory resuscitation in the most serious cases;
- administration of **atropine** (antidote) which must be given at fairly high doses, as follows:

  Adult:
  - 2 mg I.V. (intravenous), every 10 min. until bronchial hypersecretion disappears and signs of atropinization appear (skin dry and red, delirium, dilation (enlargement) of the pupil);
  - maintenance dose: 0.4 to 2 mg I.V. (heavy doses may be necessary);
  - this atropinization must be continued for several days, it has no effect on cholinesterase inhibition. Atropine should only be used after the patient has been well oxygenated in order to avoid ventricular fibrillation of an anoxic heart;

  Child:
  - 0.05 mg/kg I.V. every 10 min. until bronchial hypersecretion disappears;
  - maintenance dose: 0.02 mg/kg to 0.05 mg/kg I.V. (heavy doses may be necessary);

- a **specific antidote treatment** with **pralidoxime** (Contrathion® or another) which will restore the level of cholinesterases by removing the organophosphate from their site. It must be administered as quickly as possible before the condition evolves to an irreversible cholinesterase-organophosphate bond. This treatment must always be associated with atropine. Oximes are quite effective on blood cholinesterases but do not act on cerebral cholinesterases. Thus they do not improve consciousness disorders caused by severe poisoning. Some organophosphates (e.g.: dimethoate) are not very sensitive to their action.

Systematic administration of atropine and oximes is still debated. This is because their effectiveness is inconstant, depending on various parameters such as the type of OP or the delay in administering. It may be that gastrointestinal decontamination by gastric lavage is only useful within an hour after ingestion and after the patient has been stabilized. Recent studies do not recommend activated charcoal. Other promising therapies are being evaluated, such as alkalinization or administering magnesium sulphite (Publication by H. Thabet *et al*., 2009).

❑ **Products containing paraquat**

First aid: do not administer oxygen (which increases paraquat's toxicity). It is vital to prevent paraquat absorption: as quickly as possible administer a carbon suspension in water. This should be followed by hospital treatment.

❑ **Concentrated products containing glyphosate**

First aid: symptomatic treatment. Caution: ingestion of the concentrated product can cause shock with metabolic acidosis.

❑ **Nicotine**

Gastric lavage with salty water together with potassium permanganate. Benzodiazepines, associated with breathing assistance after intubation, should be administered intravenously during convulsions.

6.4. What to do in case of an electric shock?

Electricity from high voltage industrial cables can jump or arc up to 18 meters with fatal effect. **Never** approach the victim of such an accident before being informed officially that the current has been cut.

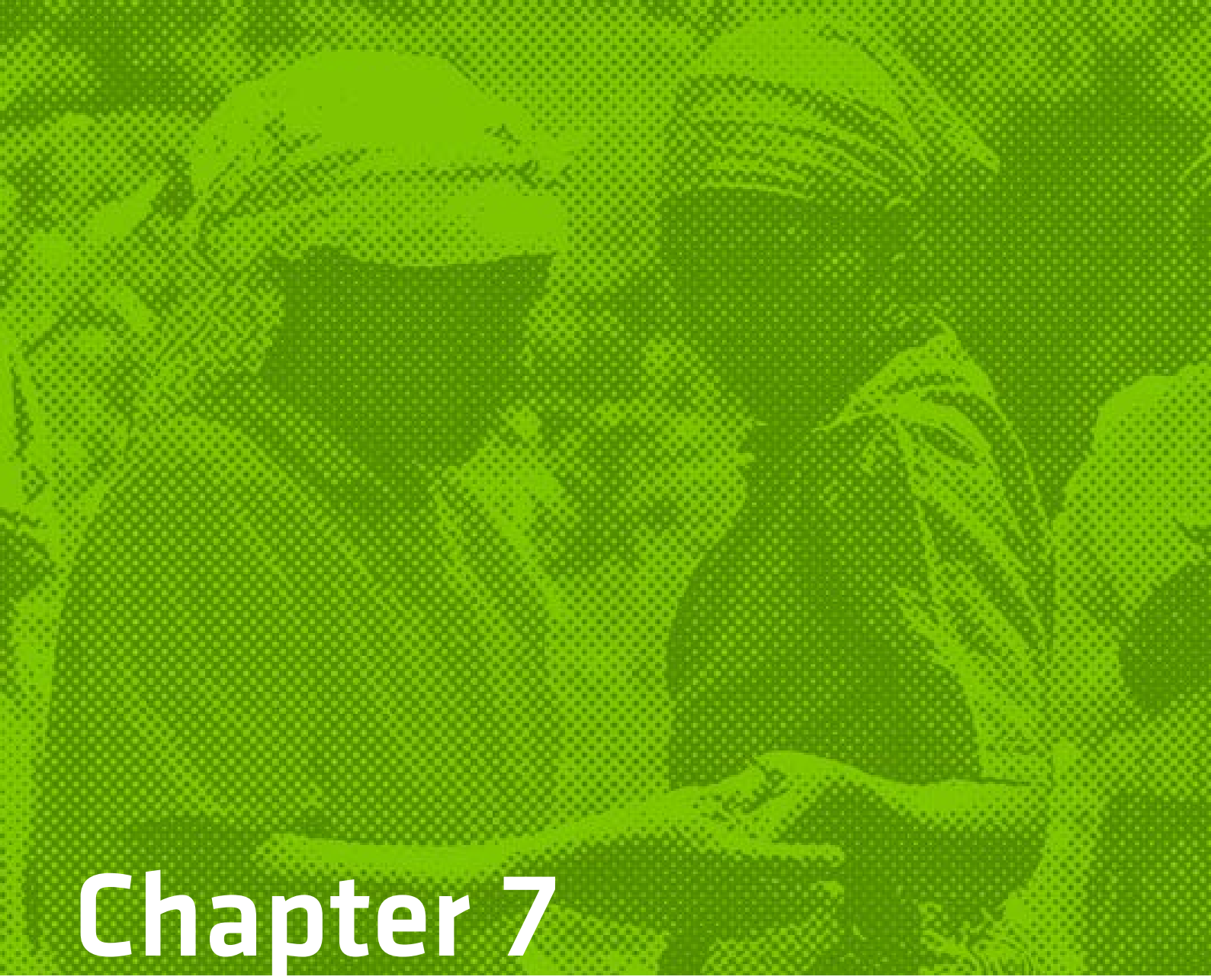
The most serious damage occurs at (or near) the points where the current enters or leaves the body, indicated by redness, swelling or burns. Although burns may not appear serious, there can be considerable damage to underlying tissue.

The **first priority** in the case of electrocution is to **separate the victim, from the electric current.** If the current cannot be cut, the second option is to find a dry insulating material on which to stand, then use any non-conducting instrument (a wooden broom handle, or a plastic pole) to move the victim. The victim must not be touched as long as current is still flowing through his body for in this case the first aider would become part of the voltage circuit.

The **next priority** is to call for medical assistance **without delay.** The victim will probably need paramedical help and must be sent to the hospital.

If the victim is unconscious or semi-conscious, make sure there are no obstructions in the mouth, then open the airways by tipping the head back and lifting the jaw. Do not attempt artificial respiration or CPR if you have not been trained in these techniques. If needed, wear protective clothing or equipment.

If possible, keep the victim in open air unless bone fractures are suspected. Do not remove clothing or other materials stuck to the burns. Relieve pain by rinsing with cold clean water. Do not touch the injured parts of the body (for example do not pierce blisters or remove bits of hanging skin). Do not give any medication and do not apply any lotions to the wound. Always call in an expert in case of doubt. Note down all the first aid applied to the injuries.



Chapter 7

Investigating accidents and determining the causes

7.1. Introduction

7.1.1. Incidents and accidents

Incidents include cases of accidents, occupational illnesses and serious near-accidents (near-misses).

An **accident** is an unforeseen event that results in **bodily injury** or damage to property or the environment. An accident occurs because at least one hazardous object or activity is present, one for which the action scenarios implemented contained a **risk that was insufficiently controlled**. Accidents are generally due to a **mistake**. They damage people's health, cost **money** and increase **work overload and tension.**

According to figures published by the World Labour Organization (WLO) for its 90th anniversary in 2009, approximately 2.3 million people die each year as a result of their work:

- approximately 360 000 die from accidents in the strict sense of the term,
- approximately 1.95 million die from incurable occupational diseases.

An accident is usually followed by an investigation to determine responsibility. The **analysis of accidents and their causes** becomes a source of information and an essential **opportunity for the company to improve its practices. Accident** analysis and accident statistics are widely used in companies when they are planning:

- prevention measures, in order to reduce the probability of their occurrence;
- protection measures, in order to limit their consequences.

The process is the same for either an incident or accident. The only difference will be in the depth, breadth and results of the analysis, in accordance with the type of event and how serious it was.

Accidents are generally caused by **several factors that combine** in an unforeseen manner, leading to shortcomings that cause human injury or damage to property or the environment.

As a general rule, the **immediate cause** of an accident will always come under one of the following categories:

- an unsafe (dangerous) action by one or several persons,
- an unsafe condition (mechanical accident, environmental condition etc.)

7.1.2. The structured event report

In many countries, it is a legal requirement to notify authorities of all accidents and injuries, whether serious or not, that occur at the workplace.

The major events listed below must be reported immediately to those responsible for the site, and are subject to structured event reports:

1. accidents
2. minor or major injuries
3. near misses (serious near-accidents)
4. dangerous occurrences
5. occupational illnesses

❑ **Major injuries**

Major injuries include:

- Fatal accidents.
- Fracture of a major bone.
- Amputation (either at the time of the accident or a surgical amputation following the accident).
- Dislocation of the shoulder, knee, spine or hip.
- Loss of sight (temporary or permanent).
- Chemical or hot metal burn to, or penetrating injury of, the eye, or all eye injuries.
- Electrical shock or burns (loss of consciousness, reanimation required, hospitalization > 24 hours).
- Other injuries leading to hypothermia, heat-induced illness (loss of consciousness, reanimation required, hospitalization > 24 hours).
- Loss of consciousness due to asphyxiation or exposure to a harmful substance or a biological agent.
- Loss of consciousness or acute illness caused by inhaling or absorbing a substance.
- Acute illness following exposure to a biological agent or its toxins, or else the contaminated material.

❑ **Serious near misses**

These are incidents which are not considered to be ‘dangerous occurrences’ and do not cause human injury, yet nevertheless could occur again and thus need to be addressed to prevent a serious injury from occurring in the future.

Examples:

- A person struck by a moving mechanical vehicle, or any other vehicle, even though no one was injured;
- Goods falling from storage cabinets, which could have caused a fatal or major injury;
- A goods lorry towed from a loading zone while the loading process was still under way.

❑ Dangerous occurrences

A ‘dangerous occurrence’ is an event that can potentially cause injuries or illness to people on the job. In some countries it is defined by law as follows:

- lifting machinery: operator fainting, overturning or failure of lifts or lifting equipment such as cranes, hoists, mechanical lifts, mobile powered access platform etc.;
- pressure systems: explosion, operator fainting, burst pipes etc.;
- freight containers: breakdown of any load-bearing parts while it is being raised, lowered or suspended;
- suspended electric lines: material or equipment in contact with suspended electric lines;
- short-circuits: short-circuit or overload that causes an explosion or fire;
- breathing apparatus (blowers): malfunctions when they are used or tested and when they are potentially dangerous;
- scaffolding that collapses: total or partial collapse of scaffolding that is over 5m high, or near water (risk of drowning);
- wells: an event occurring in a well (other than a water well);
- pipelines or pipeline works: any accident/fire that could cause death, serious injuries or a disease;
- road transport of dangerous substances: any accident involving the overturning of a tank, damage to the tank, a tank that catches fire or release of the substance during transport;
- collapse of a structure where over 0.5 tons of material falls;
- explosion or fire: of any equipment or premises that causes a work stoppage for over 24 hours;
- escape of a flammable substance in a building;
- escape of a substance: in a sufficient quantity to cause death, serious injury or damage to health.

❑ Occupational illnesses

Illnesses need to be reported only if a link is suspected with the workplace, and then a qualified and authorized doctor will need to confirm the diagnosis. For reasons of confidentiality, the report must be treated as confidential and names not disclosed without authorization.

These include diseases:

- Caused by chemical agents: poisoning by gases, solvents, pesticides etc.
- Caused by physical agents: noise, heat, low temperatures, vibrations, radiations etc.
- Caused by biological agents: food poisoning, tetanus, hepatitis, tuberculosis etc.
- Skin diseases: dermatoses, redness due to irritations, contact with a mineral oil, sensitizers etc.
- Respiratory diseases: caused by dust, fibers or toxins.
- Musculoskeletal disorders: due to repetitive motions, extraordinary efforts etc.
- Disorders caused by work pressure: depression, anxiety, tension, headaches etc.

7.2. Analyzing accidents and unwanted events (causal tree method)

The 'Causal Tree' approach consists of three phases: **gathering information**, **building the tree**, **working with this tree**.

Gathering information on an accident requires both study of the facts and also interviews and discussions with the people concerned: an interviewer tries to collect, directly or indirectly, the knowledge of one or several people interviewed. An interview can be either directive (the interviewer questions the interviewee), semi-directive (the interviewee regularly rephrases the interviewer's remarks and asks for confirmation), or else non-directive/open (interview based on the interviewee's free expression of ideas on the subject).

This method seems to be the best for obtaining information. Nonetheless, the interviewer's understanding of the interviewee may be partially inexact, which introduces a degree of imprecision in the information gathered.

The study of accidents and unwanted events and questioning about their origin is based on six indicators:

1. Technology
2. Organization
3. Environment
4. Staff
5. Similar events
6. Time/Sequence

7.2.1. Technology

The equipment and procedures must be analyzed in this section.

❑ **Equipment and its upkeep**

Questions relating to safety should be asked about: supply or purchase of the equipment, its installation, ergonomic aspects or user-friendliness, risk analysis linked to the equipment, engineering factors such as the machine's load, power, hydraulics and controls.

Questions should also pertain to movements such as lifting, falling and rotating, speed, and stopping and starting of the equipment.

Other facets of the material to be assessed: the materials currently used, R&D, and the engineering design such as modifications and design verification.

The equipment (including computers, vehicles, the plan and the budget), equipment selection, specifications, recommendations on PPE to be worn, and the tools must be surveyed.

The machine's software and programs must be controlled.

The installation, maintenance support and the maintenance plan must be reviewed.

Wear and tear, friction, corrosion, ageing and the presence of foreign bodies must be controlled, along with equipment conditions such as contamination, corruption and leakage.

Other things to analyze are the evaluation and evaluation reports, company memory, and incident reports.

- **The operating process**

This level studies the equipment's protection system: the crankcase, lock-out, cut-off system, protections, the by-pass system.

Records, resources, standardized operating, efficiency and the control system must be analyzed, along with breakdowns, production programmes, deadlines, tests and test records.

Other aspects include the cleaning system, budgets and feedback.

The operating environment must be checked. This includes ventilation, temperature, background noise, impact and gravity, negative pressure (vacuum), positive pressure, electric voltage, sparks and ground.

- **Instructions (procedures)**

The procedures, instructions and users manuals must be reread.

Computer programs: Aspects to look into include programs in use, their user-friendliness, whether they are required but not used, available but not used correctly, backups, software versions, data corruption, modifications, installation, availability of support and whether it is foreseen.

Evaluate the operator's ability and training, in particular whether he/she has mastered the equipment.

- **Materials**

A risk assessment is needed on the materials used.

The materials' specifications must be reviewed in terms of risks or non-risks for stocking, purchase and supply.

The materials' conditions of contamination, corruption and leakage must be checked.

The processing, upkeep system (manual or mechanical), storage, transport, arrangement and resources must be analyzed.

❑ **Energy and its power**

Elements such as gravity, negative pressure (vacuum), positive pressure and electric current (voltage, static and ground) must be reviewed.

Survey chemical criteria, friction, radiation, light, noise, fire (explosion, sparks) and hydrocarbons (types of oil, gas and their supply).

❑ **Design and layout**

The design must take safety into account.

Equipment must be operated in compliance with operating procedures.

Equipment must not operate in a way other than its intended use.

Analyze awareness of research and development aspects and engineering design (checking, modification and changes to this awareness).

Ergonomics, ease of use, the operator's comfort and the device's acceptability must be assessed.

7.2.2. Organization: roles and responsibilities

❑ **Work management and supervision**

Study the hierarchy structure, inspection, responsibilities, communication systems and company culture.

Job sheets must be examined, along with the definition of responsibilities and authority.

Company policy must be analyzed together with decision-making processes, delegation, responsibilities and management.

Administration for documents such as records and archives, records management and control must be audited.

Texts, approvals, standards monitoring and guidelines on aspects relating to quality, functioning, regulations, safety, and safety audits are to be analyzed.

❑ **Company culture**

Leadership and commitment are overarching factors.
T
The analysis should review access to organizational memory, as well as the worker's commitment and that of the trade union, voting procedures, feedback, decision-making and implementation of procedures.

The workers' trust in the company should be examined, together with any perception of divergence between senior and middle management.

❑ Methods and procedures

This level should review work methods and work planning, the awareness system and work crew organization, habits and customs.

Other aspects to look at are: the work permit, access permit, instructions, good practice codes and communication of company rules.

❑ Safety controls and systems

Hazards analysis and risk assessment must be conducted at all levels for both old and new processes, for the site, the materials and the chemicals used.

Plans must be made for emergency situations and evacuation (procedures, equipment, drills).

❑ Legislation

Local regulations applicable to the activity in question must be available.

❑ Sub-contractors and others providing services

Questions must be asked about the other companies and contractors, the responsibility of suppliers, visitors and the public, emergency services and regulatory bodies.

❑ Resources and financing

The following aspects must be studied: whether financing is adequate, budget control, cash flow, profitability, financial indicators, financial objectives, penalty clauses and general resources.

❑ Planning

A series of questions can be asked:

- How is the work planned?
- Who is responsible for this?
- What process was followed?
- Which criteria are linked to the work post?
- What are the objectives?
- What are the targets?
- Which people were on the planning team?
- Was a critical point analysis made?
- Are the programme and the people responsible for it known?

❑ Knowledge and decision-making

A series of questions can be asked:

- What are the qualifications and experience of the designer and the design team?
- What was the need for this process?
- How old are the key people and what experience do they have?

- If sub-contractors or external agents were hired for the job, what experience do they have?
- Has this type of work been done before?
- Are the following suitable: basic knowledge, the people responsible, the quality of decisions and the decision-making process?

7.2.3. The environment and its effects

❑ **Weather**

What were the weather conditions: wind (velocity, stability, direction), rain, storm, sun, sand, drought?

❑ **Natural effects**

The following aspects must be investigated: soil erosion, use of water, water crest, mudslide, whether or not there has been an earthquake at the site.

Water: is it static, or if not what is the flow, pressure and depth?

Air: what was the temperature, air pressure, humidity and air flow?

❑ **Pollution**

Investigate pollution in the soil, air and water (sea, rivers, lakes).

❑ **Contamination**

Various elements such as vapor, leaks, gases, mist, dust, presence of animals such as birds and insects, micro-organisms and plants must be checked and controlled where necessary.

❑ **Storage**

Work site analysis should include information on: ventilation, storage system, articles piled up or crowded together, storage, checking out, access and restrictions to materials, obstructions, position of the equipment, installation, condition of the surfaces, cleaning, operator's responsibility, general order and failure reporting.

❑ **Geographical position**

The inquiry should look into the actual physical site, vicinity to populations, environmental risks, electricity supply and electrical lines, transport infrastructures (road, rail, airport), animals, fauna and flora, sewer and pipeline system.

7.2.4. The people involved, including witnesses

❑ The damage and potential harm

The inquiry should consider whether the event was avoidable, the people (workers, visitors, spectators, sub-contractors), causes (crash, being trapped/stuck, tripping etc.), exposure (chemicals, vapors, noise and radiation), heat and gases (burns, freezing, overload, effort, presence or absence of PPE).

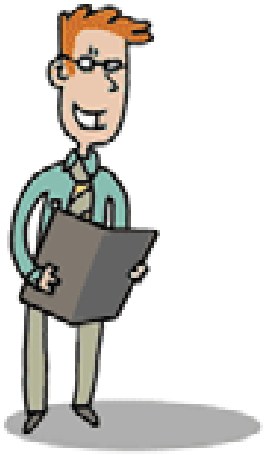
❑ Activities and tasks

A series of questions can be asked:

- ✔ Who was performing the tasks (movement, actions)?
- ✔ What was each person actually doing?
- ✔ Which treatment manual was used?
- ✔ Where are the rules and the procedures to be followed?
- ✔ Were there any new maneuvers for the operators?
- ✔ Were there any changes to the procedure?

❑ Attitudes and behavior

Several questions can be asked here:



- Who was involved (workers, visitors, sub-contractors, others)?
- Who was doing what?
- Where were the key people?
- What unsafe action took place?
- What other actions took place?
- Was the work planned?
- Did the staff do what they were supposed to do?
- Were the reactions to the emergency situation adequate?
- Was the procedures manual available?
- Did the staff follow rules and procedures?
- Did anyone do something without due authorization?
- Was there an element of vandalism or theft?
- What was each person supposed to have done?
- Were instructions given?
- What are the present instructions?
- Were they written down?
- Did the staff act as they were trained to do?

Other aspects to look into include: simple errors and omissions, hiring planned staff, rivalries and alliances, work crews.

❑ **Skills and training**

The inquiry should study: current skills (skill, understanding, experience), habits and practices, the required skills, experience and practice, training and education (permits, certificates and diplomas, continued training), training in safety (induction, permits system, specific safety training, accident awareness campaigns).

The correct match between the presence of trained staff, the right place and availability of qualified persons needs to be reviewed. Was someone else supposed to have been at the site?

❑ **Health and physical condition**
Look into: medical conditions (certificates, illnesses), working hours, work in teams, the breaks and rest periods, sleep, stress (physical, mental, familial, relational), physical and mental conditions, motivation, influence of alcohol and medication, tobacco dependences.

❑ **Communication**
Questions can be asked about: whether language was a factor, information (sent, received, available, appropriate), instructions, understanding, perception, confusion, intelligence, literacy level, social and cultural factors, personality.

Study the organizational culture, the attitudes towards one another and towards the organization itself, how work crews are organized, information structures, habits and practices.

Review communication about rules, standards and procedures, the relations between the various parts of the organization and with other organizations.

❑ **Personal protective equipment**
Investigate whether protection was needed for the head, eyes and face, ears, respiratory system, hands and arms, trunk, feet and legs, and also the right personal clothing (jewelry, anti-static shoes).

7.2.5. Similar events

Possible sources of information are: company records, other company services or departments, former or retired employees, local companies, the competition, the press, health and safety authorities, and the organizational memory.

7.2.6. The timing, sequence and background of the events

This is a question of referring to information in the five indicators above to consider exactly what changed over time (e.g.: laxness in instructions, wear and tear of material, new employees not sufficiently informed of hazards or instructions, new technique introduced, change in the use of the site etc.).

7.2.7. The Causal Tree method

❑ Why do we speak of a 'causal tree'?

An accident always has several causes.

When one of the six indicators above is taken individually, the probable causes are analyzed directly. However, an analysis of **direct causes** helps correct the specific fault but **neglects any underlying factors** (which are not directly visible). Such a limited approach makes it easy for the same or similar accidents to happen again.

The underlying causes are often called 'root causes'. **It is vital for all investigations to consider the underlying causes,** to list them then link them together. The inquiry into the accident begins with the immediate cause, then goes back up the line, each time asking: '*Why did that happen?'* or '*What was the origin of this accident?*'

Each line of questioning forms a branch, and the final result looks somewhat like the roots of a tree (thus the expression '*root Cause*').

It is therefore necessary to **consider each of the direct or indirect causes that can be identified and see if something had changed,** for change always plays a role in incidents. The level at which the 'change' occurred must be determined, then corrective measures taken in light of the change.

The Causal Tree method consists in **analyzing information** and **representing the causes** that converged to cause a failure.

The causal tree is thus a **method to organize the information collected** about accidents and unwanted events in order to analyze them. It is not really a guide on information gathering.

When information is displayed in an orderly fashion, in the form of a tree, this **draws attention to a gap in the information.**

The causal tree generally focuses on representing the whole combined set of causes of a failure scenario, in particular in order to:

- explain the failure that happened (unlike Fault Tree analysis, intended to elucidate the set of scenarios that can lead to a failure);
- be able to take relevant prevention/correction measures.

❑ How is a 'causal tree' built?

Generally a Causal Tree uses only **two symbols** to represent an event:

- a rectangle or square to represent a 'normal' event;
- a circle to represent an 'abnormal' or 'unusual' event.

Events are linked together by **lines** that express the **cause-effect relationship.** There are two types of lines:

- one that links two events (simple chain);
- the forked line that links several events on one side to an event on the other.

The **forked line** can have two meanings:

- conjunction: several cause-events, which together have the same consequence;
- disjunction: one event that has several consequences.

Event trees are normally built horizontally, moving from the left - from the initial event. The tree is thus developed chronologically, studying the behavior of each element. A scenario or system is formed of the combination of several elements.

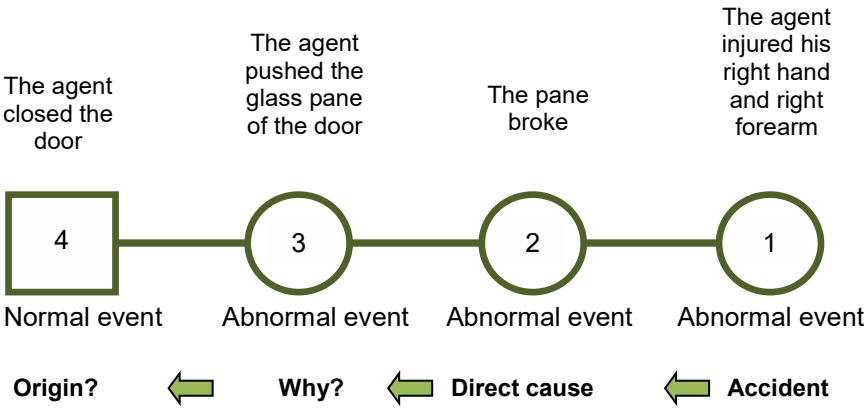
❑ Case study

Example of a causal tree: *an agent was injured when he closed a glass door*.

The event (= accident): an agent injured his right hand and forearm when he closed a glass door.

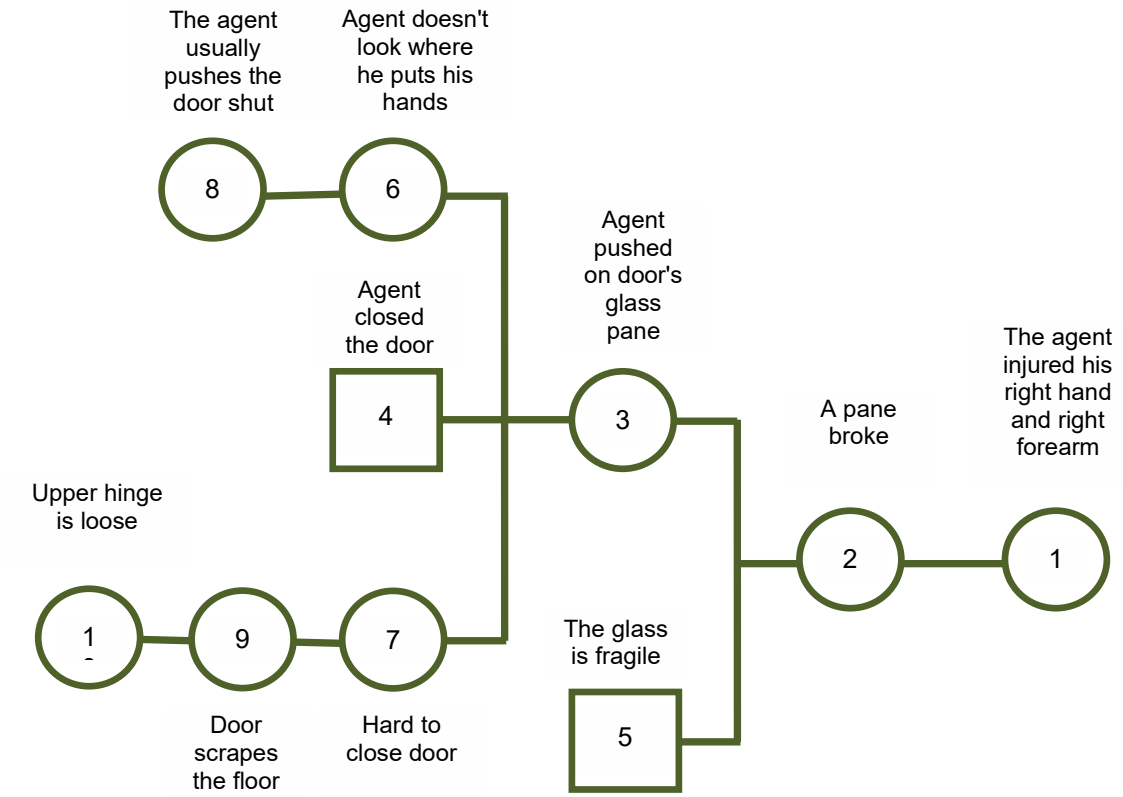
What are the causes of this accident?

Result of analysis No. 1:



The result of an analysis that is too simplistic: it provides no useful information, that is information providing means to prevent a similar accident in the future. Did the pane break just by chance? It is not understood why. In this case, for example, the recommended suggestion would be to stress the instructions to use the door handle.

Result of analysis No. 2:



There were thus multiple causes: a door in bad condition scrapes the floor, an agent with bad habits, and a glass pane that is too fragile.

Another example: *an accidental large spill of a pesticide on a work site, which contaminated the water.*

- Why was the pesticide spilled?
- Is there a storeroom?
- Why was the pesticide brought outside the storeroom?
- Has a procedure been set up to manage pesticides?
- Is there someone responsible for this storage?
- Was the packaging deteriorated or worn?
- Or was it damaged by someone working nearby, for example crushed with a tool?
- Was storeroom control included in the site's maintenance programme?
- Were the staff trained in the use of pesticides?
- etc.

Thus, by starting from the immediate causes of the pesticide spill, we can pinpoint a number of causes leading to the accident.

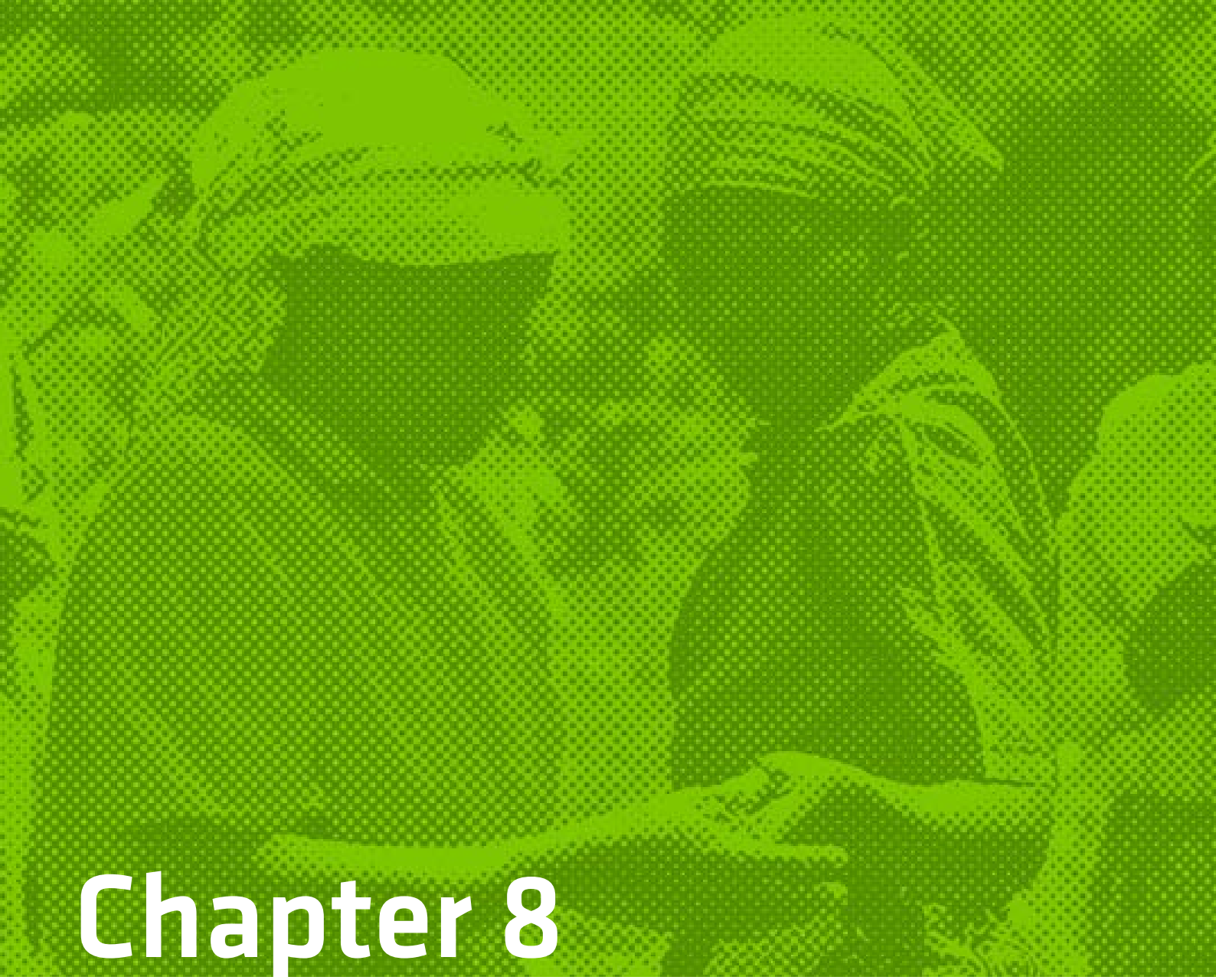
A detailed analysis of the underlying causes may show that: the operators must be better informed about safe use of pesticides; improvements are needed to site maintenance; more attention is needed to controlling the storeroom and the stocks; the manager must not let staff take the pesticide cans outside; etc.

When things are corrected at the 'Management System' level this will improve practices and lead to a continual decrease in the number and seriousness of accidents.

7.2.8. Inquiries about low risk events

Production sites can develop their own form of investigations, which must at least include the following:

- victim's name and position;
- description of injuries, technical damages etc.;
- area or zone on the site where the event took place;
- date and time of the event;
- description of the event (including photos, sketches etc.);
- witnesses' statements and details (including those by the person who was injured);
- analysis of the immediate and underlying causes;
- details about all immediate measures taken to make the zone/person safe;
- details about future actions to correct any shortcomings;
- details about any people named to take charge of these actions;
- target dates for completion of the actions;
- investigator's name and contact details.



Chapter 8

Storing plant protection products safely and in conformity

8.1. General rules to follow

8.1.1. General rules

Plant protection products are **toxic** and occasionally **flammable.** They must be stored in a safe place.

They are also **valuable products** which are not only liable to be stolen, they can also deteriorate, become unusable and even dangerous if they are not stored in the right conditions and if the stock is not managed appropriately.

Storeroom for plant protection products in Kenya (Photo B. Schiffers)

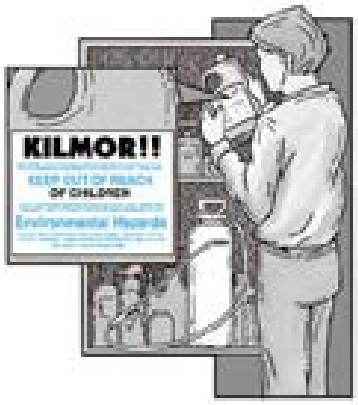
For effective and non-hazardous storage of plant protection products, in compliance with legal or other requirements, the following guidelines must be respected:

- **designate an employee responsible for the stock**. Storeroom access should be restricted to this person or to those he authorizes under his own responsibility.
- **evaluate the risks** carefully (health, safety, environment, theft, deterioration: this assessment is made in the context of an ORA). Have a suitable building or room for these products, and keep the products' records and 'Safety Data Sheets' SDS (or *OSHA Form 20* completed by the manufacturers, and generally provided, available on request or via the internet).
- **organize entry and exit of products** in the stock. Keep a permanent inventory of the products stored, along with a traceability system in order to find the product suppliers and the recipients/users. Note in the records when things enter or leave and the name of the person who takes products.

An **outgrower** (that is a farmer who grows crops for a bigger company or group) may not have a volume of plant protection products large enough to justify the need for a special storage building. A small lockable shed or even a metal chest may be enough.

Even for small farms **all recommendations** on access to the products and on safety and traceability of the products and operations **remain applicable**.

8.1.2. Identification of risks and prevention



It is essential to know the risks posed by various products in order to store and stock chemicals safely. Information on the **nature of these risks** can be found on the packages and labels; depicted in the form of **pictograms** (standard graphic symbols).

Storing plant protection products entails risks in the form of flammable, toxic, corrosive, reactive, or oxidizing products.

Product **labels** and **Safety Data Sheets** (SDS) are the first sources of information and advice on storage. Furthermore, general rules to follow are:

- keep products separated from foodstuffs and other inputs;
- avoid extreme temperatures and inclement weather;
- carefully plan the supply schedule in order to keep shelf time to a minimum;
- avoid surpluses;
- only store products in good condition (without leaks) and in their original packaging;
- keep the products stored separately from the PPE;
- inform staff and other persons of the risks (e.g.: danger pictograms on the door). **Safety instructions** can also be posted inside the storage room door.

Plant protection products must always be stored safely, kept out of reach of children and other uninformed people, animals, food and water sources.

In countries that have laws and regulations on the storage and/or elimination of plant protection products and empty packages, users must **comply with these local laws.**

Failure to comply with local legislation may not only be a source of danger but also risks prosecution. Where a farm is being audited it is likely to be a 'non-conformity'. The basic rules listed below are the strict minimum to respect in order to avoid hazards as far as possible.

Post signs that indicate the safety rules that must be observed. (Photo B. Schiffers)

8.1.3. Protecting the environment

As plant protection products are biologically active, uncontrolled spreading of these chemicals is always a potential threat to the environment. Thus, **make sure the packages do not leak** in storage and **do not leave empty packages** in the field (collect empty and rinsed packages; store them separately, for example in watertight bags, before destroying them).

The best measures for environmental protection are preventive measures:

- build or organize storerooms and storage in a way that avoids leaks (retains spills);
- obey hygiene rules;
- keep the products and waste in a tidy and well organized way.

Water used to douse a fire is contaminated and is a major threat. This water can seriously pollute the area outside a storage depot, waterways, rivers or lakes. It poses a particular threat for water tables used for drinking water, irrigation and industry. It is thus essential not to let this water drain off.

8.1.4. Responsibilities of the stock manager

The person designated for this job is responsible for:

- controlling access to the storeroom;
- upkeep of the storeroom (small repairs) and maintenance of safety equipment;
- correct handling and storage of the goods delivered to him;
- implementing all measures needed to preserve the quality of the merchandise stored (hygiene measures, keeping rodents out, ventilation);
- correct handling of chemicals and staff safety;
- regular control of the storeroom installations and of the products themselves;
- keeping exact records on all movements of the merchandise, including all the actions undertaken;
- managing and assisting the employees who report to him;
- writing regular inventory reports and keeping registers.

8.1.5. Hygiene measures

Hygiene measures are important factors in preserving stored merchandise and preventing losses. By storage hygiene we mean taking all the technical precautions required to protect the area around and inside the storeroom. These hygiene measures are simple, effective, cheap and easy to apply with a minimum of materials and expenditure.

Before storing the merchandise, check the state of the storeroom and correct any shortcomings detected and repair any damages to the building (roof: leaks; walls and floors: cracks and crevices; doors: not closing hermetically; air vents or windows: damaged grating, broken glass). Regularly clean the floor, shelves, doors and air vents/windows.

The area outside the storeroom must remain clean: keep clear of plants and bushes up to 5-10 meters, remove waste, small tools, birds' nests. This is necessary to avoid fires and the presence and development of pests.

Collect waste (empty packages, rags) in a container.
Gather together empty and rinsed product packages and place them in plastic bags; keep them in a separate place in or outside the storeroom.

Have a waste bin on hand (use, for example, an old oil can). Do not leave the waste in the bin, but empty it regularly.

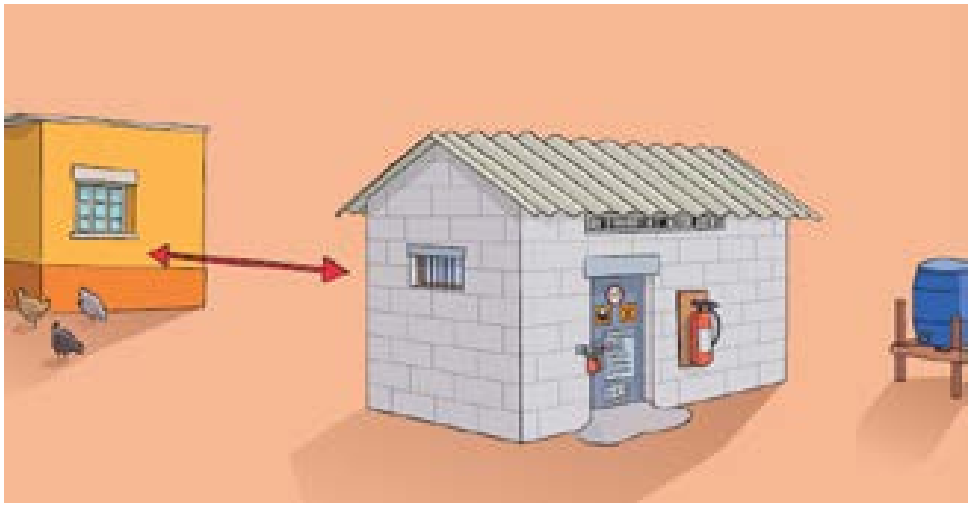
Check for any traces of pests such as rodents or birds. Regularly air the storeroom (controlled ventilation).

From the largest to the smallest storeroom - the general rules to be respected are exactly the same!

8.2. Building and organizing storerooms

8.2.1. Storeroom location

When it is time to **choose where** to store plant protection products, do not locate the storage place near buildings that house people or animals. Although it is preferable to locate the storeroom away from the farm, to avoid theft the producer is often obliged to build or use an area near or even attached to his home. To avoid contamination of his home it is recommended to maintain **sufficient distance** (10 to 20 m) between this storeroom and offices, packing stations or living quarters.



A good example of a storeroom for plant protection products. The building is located far from living quarters, closed, protected from rain and intruders, and well identified. Note the fire extinguisher, ventilation in the walls and barrel of clean water located in the immediate vicinity.

In general, avoid locating chemical stores near schools, hospitals, business areas, buildings intended for the production, sale or storage of food, and any heavily populated area.

Storerooms should not be located near waterways which could be polluted easily if an accident occurred (major spillage, fires and fire-dousing water), and do not locate the storeroom in an area that might flood.

The storeroom must be easy to reach for all transport vehicles, including fire engines.

Example of a product storeroom in Kenya.

It is located in a suitable area, far from other installations (offices and packaging center).

Note that it is easily accessible for vehicles that load and unload the products and labels are posted to the door instructing people of the danger.

(Photo B. Schiffers)

8.2.2. Storeroom safety

Unauthorized people must be denied access to the storeroom (to avoid theft of toxic materials or risk of accidental contamination of untrained persons). The stock manager and technical manager or director should be the only persons with a key to the storeroom! In the case of outgrowers, they must be the only ones with a key to their store room, or to the padlock that locks the cupboard or trunk containing their products.

Safety and security measures must be taken to bar access by unauthorized persons:

- during work hours - limit access by using controls at the door ;
- outside work hours - **lock the doors** and windows of the storeroom and any nearby offices;
- for large storerooms and depots it is recommended to set up a permanent watchman system.

Example of protected access: grate on the window, door locked and/or padlocked. Note the danger pictograms posted. (Photo B. Schiffers)

This requirement must not be taken lightly for not only is this rule found in most regulations, it is also imposed by **most private reference standards.** In case of a certification audit, storeroom access rules are almost always checked.

❑ Doors and windows

For safety, the number of doors must be kept to the minimum required for convenient loading/unloading (if need be, foresee an additional emergency exit).

The windows (or openings) must be fairly **small, located high along the wall,** or else tinted and **equipped with fixed bars** to protect from intrusion, and they must be grated to keep out birds and rodents.

Example of a well-protected and well ventilated storeroom. Note the safety pictograms on the door. (Photo B. Schiffers)

❑ Keys

The storeroom keys must be labelled clearly and accessible in an emergency.

❑ Warning signs

A sign bearing the words **'DANGER PESTICIDES – NO SMOKING, EATING OR DRINKING'** must be posted clearly in a prominent place. It may also be useful to add pictograms. Make sure in each case, however, that the image is understandable for the staff and any person with access to the storeroom.

A design measuring at least 20 cm high, representing a skull and crossbones, must also appear on the sign (**pictogram GHS06**).

No open flames

No eating or drinking

❑ **Isolating and separating the products**

Plant protection products must not be stored near food, feed or other items like clothes, tobacco, medicine, toiletries, etc. If there is no way to avoid storing these products in the same place as other goods, they must at least be separated by a **fixed panel** at least 3 meters high.

In storerooms of a certain size, plant protection products can be **stored by group, corresponding to their different risk categories:** flammable, combustible, corrosive, toxic, oxidizing, etc. The main advantage of this classification is to keep risks and consequences of a fire to a minimum. Liquids should not be stored at high level or above solid pesticides to reduce the risk of spills leading to contamination of people or other products.

8.2.3. Designing the storeroom

❑ **Building materials**

The storeroom walls and floor must be made from material that is impermeable and solid, concrete blocks or bricks for example.

As far as possible avoid materials that are combustible or that could help a fire spread. Wood and adobe are acceptable for very small storerooms as long as fire risks are kept to a minimum.

The floors must be smooth and painted to make them easier to wash.

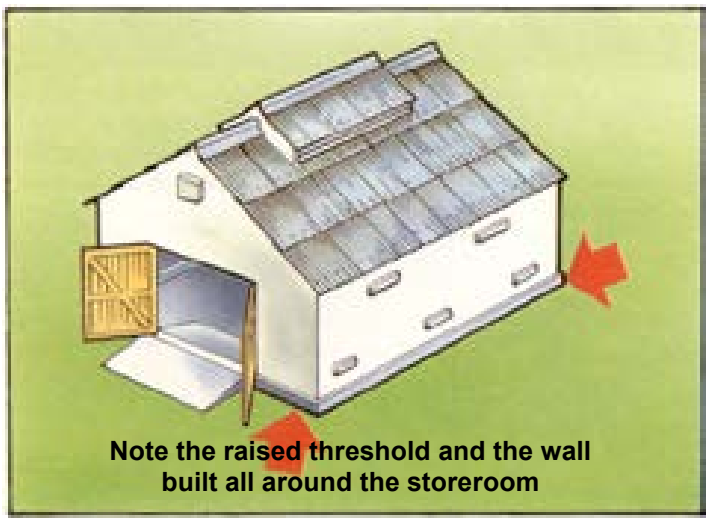
❑ **Retention capacity**

There must be a way to **retain spills** of all kinds (pesticides and contaminated water used to douse a fire):

- The **thresholds** at all entrances must be raised at least **20cm.** It is recommended to have sandbags available to raise the threshold further in case of an emergency spillage that needs to be contained;


Building an entrance threshold. The objective is to improve the ability to retain spillage in the storeroom. (Photos B. Schiffers)

- Build a small wall (20-30 cm) all around the building;



- Install a **ditch or inclined gutter,** preferably in concrete, at least 15 cm deeper than the level of the storeroom. This gutter must go all around the walls of the storeroom in order to evacuate rain water or any escaped plant protection products. It must flow into a collecting tank to avoid contaminating nearby land.

Illustration of a small storage shed. It was built on a smooth concrete slab. The wall base is surrounded by a small brick wall. A drainage ditch surrounds the building. The sheet metal roof is inclined. The shed is oriented in a direction to keep drainage water from entering (Photos B. Schiffers).

❑ Ventilation

The storeroom must be well ventilated. Whenever possible ensure natural ventilation with vents placed on the highest and lowest sections of the walls and in the roof. All these vents must be designed or protected to keep out birds and other pests (especially rodents).

Air vents that are well protected against birds and rodents. Openings in the wall that aid ventilation and bring light into the room (Photo B. Schiffers).

To keep the storerooms well ventilated it is recommended to leave about a one meter space between the top of the stacked products and the roof, and the same amount of space between the merchandise and the walls.

❑ Lighting

The lighting must be sufficient to enable periodic inspection of the products stored and to make it easy to read the product labels. If the storeroom is small it should be sufficient to open the door. If it is larger, one or two windows are necessary, or even better, the bricks should be laid to let in air and light.

PETROL LAMPS ARE PROHIBITED!

Artificial lighting must be installed over the passageways and at least 1 meter above the highest products. The lamps are protected by a sturdy case to prevent breaking, and in large storerooms they should also be fire-proof.

❑ Emergency exits

Depending on the size of the storeroom, a second exit in addition to the main door must be foreseen for emergency evacuation. This is to make sure people cannot remain trapped inside.

Keep the emergency exit clear and well-marked. At all times the door must be easy to open from the inside.

8.2.4. Layout of the storeroom

Keep the offices and restrooms separate from the storeroom. It is mandatory for the stock manager's office to be located outside the storage area!

A direct exit must been foreseen, without having to go through the storeroom.

Good example of layout in a product storeroom. Note the box of absorbent sand, the bag for empty packaging, and the steel shelves. The liquid products stored on the lower shelves are placed in crates to collect any spills.

- The floor must be impermeable to liquids and have a smooth surface to make it easier to wash if products are spilled. A central 'well' (cemented hole) can be opened to collect any spilled product.
- The **products must be stored on steel shelves** (or, if not possible, wooden shelves covered with a thick sheet of plastic). The shelves must have ledges to keep the packages from sliding off if the shelves are inadvertently shaken. The ledges should not be higher than 2 m for easy access to the products.
- Products in the form of powders, granules and treated seeds must be stored on the highest shelves. Liquid products go on the floor or on the lowest shelves.
- The largest packages should be left on the floor.
- Inside the storeroom there must be a sufficient amount of **absorbent materials** (soil, sand or cloths) to clean any product spilling or leakage.
- **Safety instructions** and emergency phone numbers must be posted.

8.3. Storage of plant protection products on outgrowers' premises

A small area may indeed be sufficient:

- Set aside an uninhabited cabin or shed to store the plant protection products.
- Lock the plant protection products in a cupboard or a locked box inside the uninhabited shed, which is also locked.
- Find a safe place to hide the keys to the cupboard or box and the keys to the shed where the products are stored.
- Never store plant protection products in a kitchen.
- Never store plant protection products in rooms or cabins that are inhabited.
- Never store plant protection products within the reach of children.
- Use visible signs to show that access is forbidden to the uninhabited cabin where the products are stored.
- Always store plant protection products in their original packaging.
- Never transfer plant protection products into empty beverage or oil bottles.
- Keep plant protection products far from fire, and protect them from direct exposure to the sun, rain etc.

When the amounts to be stored are too small to justify a special storage shed or cabin for this purpose, a **metal cupboard is sufficient** under the following conditions:

- it must not be located in an office or a room but not in a home;
- it must be **locked**;
- the key must be entrusted to a person who is duly trained;
- the safety pictograms must be posted on the entrance to the room and on the cupboard itself;
- **liquids and powders must be well separated!**

For small stocks, metal cupboards that lock are sufficient. If these are not available, then a metal box or trunk can be used. The safety pictograms must always be posted.

Instead of metal cupboards that are often expensive, it is possible to fit out a metal drum for storage purposes.

Cut out a door, which closes with a padlock.

In this picture, the farmer has also added a shelf by welding a metal plate (Photo B. Schiffers).

8.4. Managing stocks of plant protection products

8.4.1. General rules

Safe and orderly storage helps avoid all risks of accidental poisoning and keeps the products fully effective:

- Sort these products according to their use (herbicides, fungicides, insecticides, etc.), and by whether they are liquids (place on the lowest shelves) or solids (preferably these should go on the top shelves).
- Do not remove the labels or repackage/rebottle the products.
- Keep a regular **inventory** of the stocks.
- Basic rule: **The oldest stock of a particular product must be the first used** (FIFO: First IN First OUT).
- Regularly inspect the products to detect and notify any deterioration or leakage.
- Do not accept delivery of any product with a damaged or worn package.
- Keep the storeroom impeccably clean.
- Carefully apply all safety measures and instructions, even in an emergency.

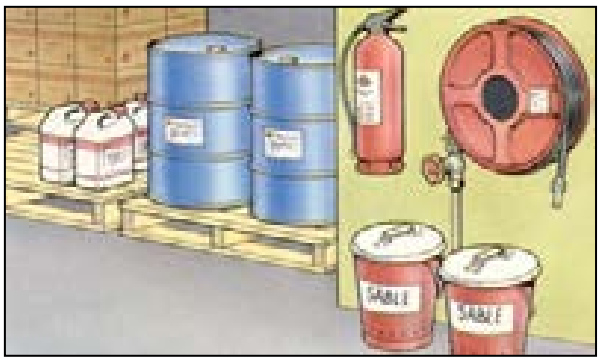
8.4.2. Organizing storage and control

Make it easy to find and reach the products. Do not place bags, crates or treatment equipment in front of the shelves or elsewhere in the storeroom. There must be room to walk around, otherwise the storeroom manager will not be able to conduct his controls.

Place the products on shelves (for small packages: canisters up to 5 l, bags or small boxes) or on pallets (crates or bags from 25-50 kg for example).

Arrange the products correctly. This is necessary to reduce risks, loss of merchandise, and to manage the storage room adequately!

Illustration of a storeroom that is correctly organized. Note the use of individual retaining crates to store the liquid products (Photo B. Schiffers).



The products are not placed directly on the floor. The safety equipment (see sand in buckets and fire control systems) has been installed.

A careful and strict organization of the stock. Place and stack the products correctly.

Illustration of a badly kept storeroom, which makes inventory and stock management impossible (the boxes are crushed and products seep out).

The control system must be able to produce, at any time, information on the quantity and location of products stored. The stock managers must keep up-to-date registers on the plant protection products received, stored, eliminated or sold.

An inventory, a diagram showing where the merchandise is located, and the products' technical sheets and SDS must all be kept in a safe location, at a distance from the storage zone, where they can be consulted in case of a fire or other emergency.

A retaining crate can be placed in the storeroom and used to hold any product container that has a leak. (Photo B. Schiffers)

In large storerooms, limit the size of a stock to 2 pallets, 2.5 meters high. For practical reasons the rows should not be longer than 8 pallets. Arrange an inspection passage at least 0.5 m wide between the pallet blocks and a 1 meter space along the wall.

In small storerooms, the same separation, inventory and hygiene principles must be applied.

8.5. Personal hygiene and safety

8.5.1. General rules

- Clean the floors and shelves regularly.
- All loading, unloading, shelving and inspection in the storeroom must be done by teams of at least 2 persons.
- Wear **work clothes** and **personal protective equipment** that includes:
  - gloves that are not damaged and solvent resistant,
  - rubber boots,
  - apron (if possible made of PVC),
  - safety glasses,
  - face shield or mask if relevant.

  The PPE must be inspected periodically, and kept clean and in good working order. After use, all equipment must be carefully washed with soapy water and rinsed with fresh water.
- A first aid kit must be available. A clearly displayed sign must indicate:
  - the kit's location,
  - basic first aid instructions (SDS of the products stocked),
  - emergency phone numbers.

8.5.2. Measures to take when something catches fire

- Sound the alarm.
- Try to contain the fire to keep it from spreading. If it looks like a small fire can be controlled, use the closest fire extinguisher. Do not pour water on the fire: if a product contains solvents (EC formulations) that will only make the fire spread!

An extinguisher must be placed on the wall outside the storeroom. (Photo B. Schiffers)

- If help is needed, DO NOT WASTE TIME. Get everyone out of the storeroom, and have all the firefighting helpers gather in one place.

- Anyone exposed to fumes or smoke during the fire must be examined medically to check for poisoning (it should be assumed that any fumes or smoke are toxic).
- Remain on the correct side of the wind.
- Do not let the water or burning liquids flow towards water holes or sources- build a barrier with dirt or sandbags.

8.5.3. Cleaning up after a fire

During cleaning operations, be careful not to poison yourself and keep from polluting the environment.

The following measures must be taken:

- To keep out all unauthorized persons, place large warning signs and surround both the fire and water flow areas with ropes or barriers. If possible, protect the areas from the rain (which causes further pollution) by covering them with tarpaulins. Allow no one other than the cleaning crew to enter. Keep constant guard until the cleaning operations are finished.
- Provide protective clothing (rubber boots, gloves, glasses and the appropriate mask).
- Prohibit smoking, eating and drinking in the contaminated zone.
- Take care not to leave the area with chemical residue adhering to shoes, wheels etc.
- Use sawdust, sand or other substances to absorb the liquids. Do not dispose of these polluted substances in streams or other water points. Collect the solid residue and place it in hermetically sealed containers. These must be taken away for disposal by a licensed contractor.
- If there is no certified contractor in the area, and if permitted by local legislation, transport the waste in the hermetically sealed containers and bury them in an area that is far from any inhabited areas or water. Put signs up to indicate the danger.
- Carefully wash all tools, vehicles and clothing after the clean-up.

8.6. Summary of instructions

8.6.1. Location of the storeroom

- The building or storeroom must be located in an area that is dry (well drained) where there is no risk of flooding.
- The roof and floor must be sloped sufficiently for rainwater to drain off.
- The building or storeroom must be separated and, if possible, located far from places where people and animals live.
- The storeroom must not be located next to rooms used for eating or sleeping.
- The building or storeroom must be surrounded by a ditch to drain water from the roof and adjacent land. Water sources must not be polluted by the products stored.

8.6.2. Design of the storeroom

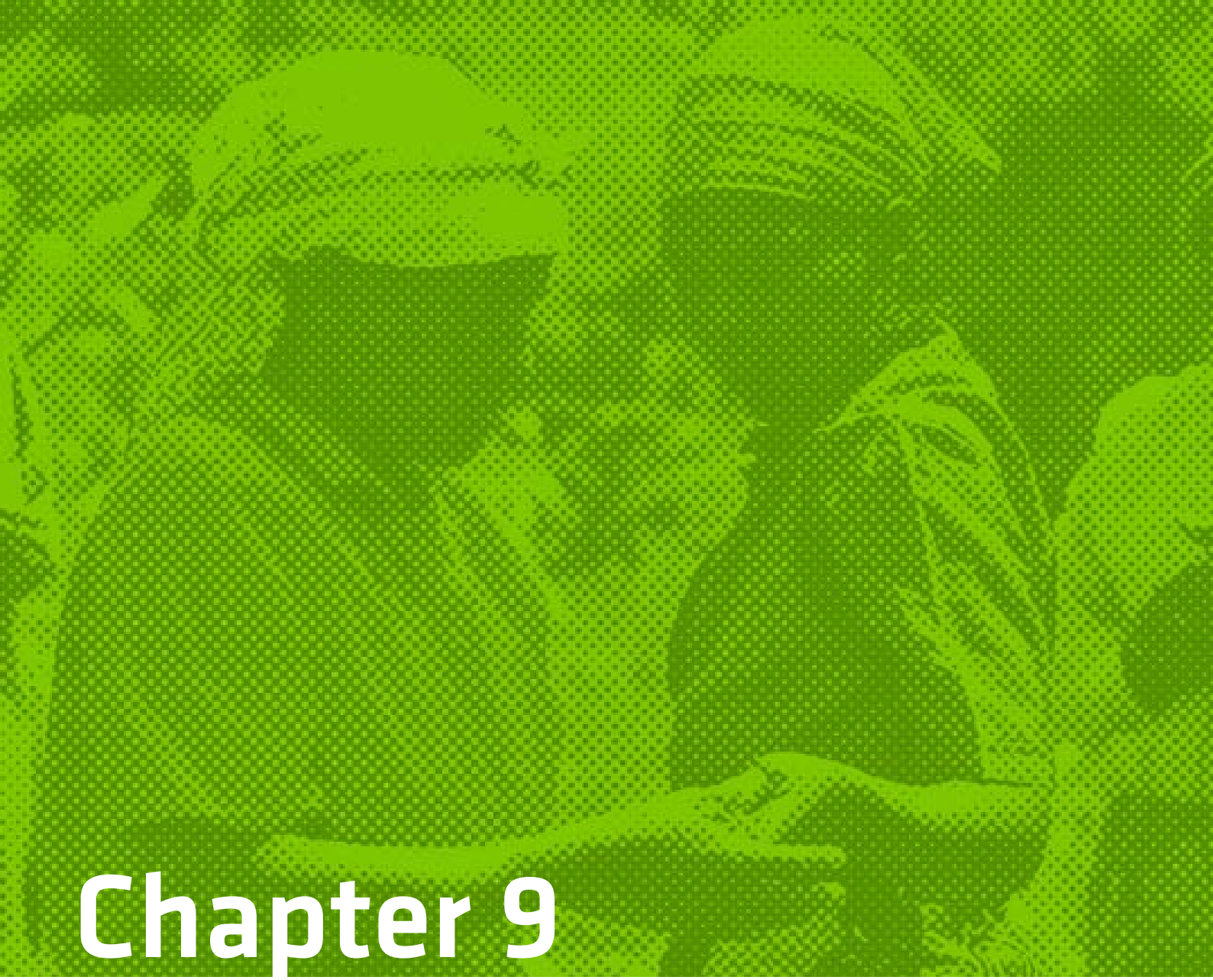
- The storeroom must be designed in light of the producer's storage capacity and be as simple as possible. It should be at least 2m high, be well aerated and ventilated, and protected from direct sun and the rain.
- The building or storeroom can be made of adobe or wood. It is preferable for the roof to be in sheet metal, but another material can be used as long as it is water-tight (e.g.: straw). It can be in the form of a shed or a cabin.
- Place a water tank near the storeroom. The water is used for mixing, rinsing the material and washing users' hands.
- Make available a surface next to the storeroom to be used to measure and prepare the mixture. This surface must be designed to keep the product from flowing towards surface waters.
- The entrance must have a threshold 30cm high to keep liquid spilled inside from flowing outdoors.
- If the door is made of wood, the base section must be lined with a metal plate at least 50cm high to keep rodents out. The door must open towards the outside.
- Place pictograms on the door and windows to warn of the dangers.
- It is better not to have windows in small storage areas. If a window is needed for lighting, it should be high enough and equipped with bars to prevent intrusion. The window must be protected from the rain.

8.6.3. Layout of the interior

- The floor must be watertight, and smooth surfaced to facilitate cleaning if products are spilled.
- The products must be stored on shelves, preferably steel or if not possible, wood covered with plastic. The shelves must have a ledge to keep the package containers from tipping over if the shelves are accidentally jostled. The shelves should not be higher than 2m for ease of access to the products.
- Inside the shed, metal drums can be fitted out to serve as cupboards for the products.
- Products must be sorted by type: insecticides, herbicides, fungicides and so on.
- Products in the form of powder, granules and treated seeds must be stored on the highest shelves. Liquid products go on the floor or lowest shelves.
- The storeroom must be stocked with a sufficient supply of absorbent materials (soil, sand or rags) to wipe up any spilled or leaked product.
- The manager's office must be separate from the product storage area.

8.6.4. Storeroom management

- The door must be kept locked to control access and keep any unauthorized person from entering.
- The quantities of the products must be inventoried and registered.
- If possible, buy only products that are authorized and refuse to purchase plant protection products with an expired sell-by date, which are not in their original packaging or which do not have a label.
- Use the oldest products first before using the most recently purchased.
- The product must be kept in their original packaging and with their labels intact.
- Collect all the empty or deteriorated packages and keep them in a special place inside the storeroom until they can be disposed of correctly.
- Measuring equipment such as beakers must remain in the storeroom.
- Do not store personal protection gear in the storeroom.
- Both the inside and outside of the storeroom must remain clear of empty packages and the grounds surrounding the storeroom must be cleared of dried vegetation to protect from fire.
- The grower is responsible for managing his storeroom and the products stored, and for safety. He is also responsible for the correct handling of the products when they enter and leave the storage area and also while they are being used.
- The grower must never store products in his house.



Chapter 9

General organization for the transport of plant protection products

9.1. Transporting dangerous materials

9.1.1. Transport-related risks

Road transport of goods has emerged as an activity sector with one of the **highest incidences of accidents**.

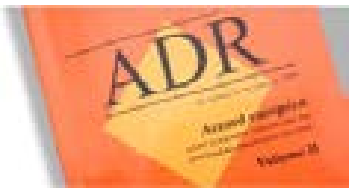
When 'dangerous goods' are transported the consequences of normal accidents are compounded by the effects of the toxic product carried by the vehicle.

Accidents involving dangerous goods[1] thus combine an immediate primary effect (risk to driver and other road users) with secondary effects (poisoning**, fire, explosion, spillage**) and tertiary effects (propagation of toxic vapors in the air, **water or soil pollution**) can result. This is why the Carriage of Dangerous Goods (CDG) is covered by the ADR agreement for road transport and various national and international regulations.

9.1.2. ADR regulation

The 'ADR Regulation' from the French abbreviation ***A**ccord européen relatif au transport international des marchandises **D**angereuses par **R**oute*) is the international agreement that organizes road transport of dangerous materials.

ADR is the acronym for '**European Agreement concerning the International Carriage of Dangerous Goods by Road'**. It is an international regulation that applies to all countries in Europe.



Each substance or article considered as dangerous represents a specific risk. The ADR classifies them according to these risks.

Each of these classes corresponds to a **specific marking on the vehicle** that carries a certain quantity of these substances or articles (e.g.: pesticides or toxic waste).

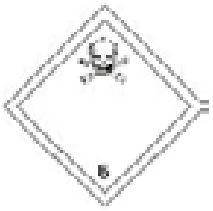
❑ ADR Classes

The classes relevant for road transport of **plant protection products** are listed in boldface, and the corresponding pictograms printed to the right.

[1] Dangerous goods are substances and articles that may cause serious consequences for people, goods and/or the environment because of their chemical and/or physical properties or the type of reactions they can provoke. Waste is also considered to be dangerous goods.

Class 1: *Explosive substances and articles*
Class 2: *Gases*
Class 3: ***Flammable liquids***

Class 4.1: *Flammable solids, self-reactant substances and solid desensitized explosives*
Class 4.2: *Substances liable to spontaneous combustion*
Class 4.3: *Substances which, in contact with water, emit flammable gases*
Class 5.1: *Oxidizing substances*
Class 5.2: *Organic peroxides*
Class 6.1: ***Toxic substances***



Class 6.2: *Infectious substances*
Class 7: *Radioactive substances*
Class 8: *Corrosive substances*
Class 9: ***Miscellaneous dangerous substances and articles***

Each type of goods considered as dangerous under the terms of the ADR is assigned a **UN** (United Nations) **code**[2] which is recognized worldwide. This UN code corresponds to a specific regulatory designation which includes the technical name of the product, its danger class and its packaging group. (e.g.: UN 1135 - Ethylene chlorohydrin). All these elements must be listed on all transport documents. These regulatory designations can be found in a table of the ADR Code.

When the dangerous substance is **waste** the regulatory code must be preceded by the word 'Waste' (ex.: 'WASTE, UN 1263, PAINT RELATED MATERIAL, 3, II').

9.1.3. Obligations under the ADR

A number of measures and precautions must be taken by those involved at various stages – the consignor, the carrier, and the consignee – to minimize risks of theft or the misuse of dangerous goods that may endanger people, goods or the environment. There are two levels of precautions:

- all dangerous goods;
- high risk dangerous goods – if the dangerous goods to be transported represent a high risk, then all who are involved in the transport chain must establish a safety plan.

[2] The UN number is a four-digit code (e.g.: 1789 = hydrochloric acid) drawn up by UN experts. This UN number must be clearly displayed on the transport vehicle and on the product package.

The obligations of the ADR regulation are related to:

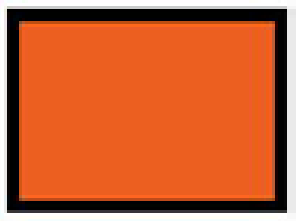
- the nature of the dangerous goods (such as the ban on the use of mixed packaging);
- the nature of the packaging;
- marking and labelling;
- the vehicle (signaling and equipment);
- the driver (ADR permit);
- shipment and delivery of the dangerous goods.

Depending on the nature of the dangerous goods and their UN codes, some goods cannot be packaged together with other goods due to risks of interactions between the substances. .

It is mandatory for all dangerous goods to be shipped in certified packaging. This is a package that has passed a series of tests for solidity and water tightness in order to ensure safe transport of dangerous goods. The packages must be certified by a specialized body.

The marking on the vehicle varies depending on whether the dangerous goods are transported in packages or in bulk:

- **Transport of packages**: **plain orange plate at the front and back of the vehicle (**e.g.: for a pesticide delivery**)**
- Transport in bulk (tanks, bin, etc.): numbered orange plate at the front and back of vehicle, plus danger plate at the front and back and on the sides.



9.2. Precautions to take when transporting plant health products

9.2.1. Check the packages

As loads are often carried over long distances or over roads in bad condition, pay close attention to the quality of the packaging. A faulty or ill-adapted package may cause accidental leaks during transport, and this is a safety risk. All packages must comply with recognized quality standards. They must be resistant to conditions normally encountered during transport and provide the required level of safety.

Before agreeing to transport cans of plant health products, check that they are in good condition. Refuse to carry any package that shows signs of leakage.

The driver and the stock manager must inspect the pallets before they are off-loaded.

9.2.2. Marking and labelling

Many countries have laws governing the marking and labelling of both the packages and the vehicles transporting dangerous products. International codes to minimize risks also apply. The aim is to guarantee that all those who handle these products throughout the distribution chain are perfectly aware of potential risks. In countries that have not adopted national regulations it is recommended to comply with UN marking and labelling regulations.

9.2.3. Transport and weather conditions

Plant protection products are stable in normal conditions. However, if some products are subject to extreme temperatures or moisture during their storage or transport they can decompose and this can affect their packaging. Either of these conditions can create problems during transport.

Protect the load from the sun and rain.

As a general rule, plant health products must be stored in a covered place. During transport they **must be protected from:**

- rain;
- the sun (this is especially important in hot climates);
- theft.

Even when products are transported in a closed environment like a container, water can still cause problems. If the crates or boxes are damp or the cushioning and securing materials are wet, water can condense inside the container or vehicle and damage the load.

To avoid all condensation damage:

- use only **vehicles that are completely dry inside**;
- all freight and packing materials, including the pallets, must be dry at the time of loading;
- use only dry materials to cushion or secure the load.

9.2.4. Choosing the right carrier

When goods are not distributed by the consignor's own vehicles, it is important to scrupulously check that the carrier has the know-how and capacity required to handle and transport dangerous products safely.

This type of check also includes procedures to verify the **drivers' training** and ensure that the transporter fully complies with **regulatory requirements**.

For example:

- the design and construction of the vehicles must be well adapted to the freight in question;
- upkeep must be regular and based on the principle of systematic thorough inspection;
- the drivers must be duly trained and informed about the risks and emergency measures in case of an accident;
- plant protection products must only be carried by vehicles that have **a compartment to separate goods from the driver**. This is required to protect the driver from dangerous contact with vapors or dust should the product tip or spill during transport.
- the carrier should adopt a policy on establishing responsible routes, on the basis of prescribed criteria agreed with the product supplier.

The vehicles used for transport must bear the **appropriate marking** in compliance with the ADR Regulation.

9.2.5. Safety equipment and protective clothing

Vehicles carrying plant health products must be inspected regularly for the presence and proper maintenance of the following equipment:

❑ **Extinguishers**

One or more extinguishers of a sufficient capacity and type to control a fire that has just started, for example, in the driver's compartment or under the bonnet. If the lorry is equipped with only one extinguisher, a Halon-type (perfluorocarbon) is recommended.

❑ **First aid kit**

A first aid kit, including a full bottle of eye drops, must be kept in the driver compartment in an easily accessible place.

❑ **Cleaning material**

A small stock of good absorbent material (a bag of pumice powder or other), a shovel, broom and sturdy polyethylene bags to clean up small amounts of products.

❑ **Protective clothing**

Protective clothing is needed for staff handling damaged packages or who clean up small amounts of spilled product. This stock should include:

- rubber gloves
- protective eyewear (glasses or goggles) and an eye flushing solution
- a rubber or plastic apron
- rubber boots

9.2.6. Selecting and training drivers

Particular care is required when choosing drivers who will be handling dangerous goods. Selection criteria include:

- a responsible attitude towards road safety;
- good health;
- experienced driver;
- ability to evaluate particularly dangerous situations and take the necessary steps.

These drivers must receive appropriate training that includes the following aspects:

- regulations;
- operating procedures
- the products (properties and risks);
- isolating the freight;
- protecting the freight;
- steps to take in case of leakage;
- use of safety equipment and protective clothing;
- fire fighting;
- safe driving techniques;
- measures to take in an emergency.

9.2.7. Route

Road itineraries must be studied ahead of time, especially for vehicles that carry large volumes of dangerous goods. Always try to choose routes that present the fewest risks.

Some general principles:

- Establish driving schedules that do not oblige the drivers to exceed speed limits or work beyond authorized driving times.
- Choose routes that offer good driving conditions.
- If several routes are possible, chose the one that avoids all potential problems.
- Avoid bridges and tunnels covered by traffic limitations for dangerous goods.

9.2.8. Instructions to drivers

❑ General instructions

The drivers must be instructed to park vehicles carrying plant health products in a safe location and preferably in the shade, in a guarded place, with the vehicle locked. Any vehicle left unguarded is an object of curiosity for children and others. In particular, drivers must be instructed to choose the most appropriate places to park at night.

In addition to training on steps to take in emergency situations, drivers must be sufficiently instructed in the procedures to follow in case of an accident. This includes:

- normal accidents, with no product spilled or leaked
- accidents with product spillage or leakage
- accidents that provoke a fire
- a telephone contact to obtain specialized advice both during and after normal working hours

❑ Written instructions

The drivers of vehicles carrying dangerous goods must receive and carry written instructions, such as the **Transport Emergency Card**.

The '**TREMCARD'** as professionals call it, provides all information needed in case of an accident:

- the type of products transported
- their risks
- precautions to take in an emergency
- supplier's name and address as well as an emergency telephone number

The drivers must use all available means to try to put out small localized fires that may start, for example, in the driver's compartment or the engine, to keep it from spreading to the freight trailer. As electrical problems are a typical cause of fires in vehicles, if there is time, disconnect the battery and contact the emergency services.

Since the driver may not be able to take action following an accident or sudden illness at the wheel:

- The TREMCARD must be kept in the driver's compartment, in a visible place and easy to reach in all circumstances.
- It should only contain information about the products transported in this exact load. Any documents on previous loads must be discarded.

9.2.9. Emergency procedures

In case of an accident, the very first steps to take in the first few minutes will be of vital importance. Reacting quickly to contain a leak or spill may keep a relatively minor incident from turning into something serious. Emergency procedures therefore must be planned ahead of time and drivers must be trained to react correctly.

If products tip over or leak:

- ***Act immediately:***
  - Stop the engine.
  - Do not smoke.
  - Find which products (name and type) are concerned by consulting the TREMCARD or individual labels. Carefully follow the procedures and advice given on the card or labels.
  - Keep close to the vehicle, but position yourself between the wind and the spilled products
  - Isolate the area affected, do not let people approach, and direct traffic around it.
  - If necessary, end someone to call the emergency services (police, ambulance, fire department).
  - Do not open the doors of a closed vehicle unless a competent person advises you to do so. Make sure you are wearing the appropriate protective clothing.

- ***First aid***
  - Consult the TREMCARD or the product labels.
  - If the product has come in contact with the eyes, flush them immediately with clean water and keep rinsing for 10 minutes. Contact a doctor.
  - Immediately remove any contaminated clothing.
  - If anyone's skin came into contact with the product, wash immediately with soap and lots of water. Consult a doctor in case of serious contamination or any pain or discomfort.
  - If the product was swallowed or inhaled, consult a doctor immediately.

- ***Controlling the damage***
  - Be very careful around spilled products until you receive technical advice. Take care to avoid all skin contact and be careful not to inhale the vapors.
  - As a precaution, wear protective clothing.
  - Contain any small product spills by covering them with soil, sand or other suitable materials.
  - Larger amounts can be contained by building a small dike of soil or sand around the contaminated area.
  - If powders have spilled, keep the dust from scattering by covering it with soil, sand or a tarpaulin.
  - Take care not to let the spilled products drain into ditches, sewers, rivers or other waterways. If this has already happened, immediately inform the competent authorities.
  - Adjust the position of the damaged packaging in such a way as to avoid further leakage as far as possible.

- Put the leaking or heavily damaged packages in larger bins or in heavy-duty polyethylene bags.
- Separate the damaged packages from the other goods and place them directly on the ground, away from living quarters and water sources.

Soak up the product that has spilled with an absorbent material

➢ ***Cleaning and decontamination***

- Follow all safety instructions given on product labels.
- Always wear protective clothing while cleaning up.
- Where possible, work upwind from the spill.
- Do not smoke, eat or drink during the cleaning.
- Sweep up the materials used to absorb the spilled or leaked products, collect them with the shovel and place them in a closable recipient so they can be destroyed later.
- All damaged or empty packages must be eliminated. Never just leave them lying around.
- If there is the slightest risk that food, feed or other consumables have been contaminated, destroy them. Never eat contaminated food or feed it to animals. The result may be fatal.
- Heavily contaminated clothing must be rendered unfit for further use (cut them or rip them up for instance). Dispose of them in a safe place.

9.3. Good loading and unloading practices

9.3.1. Pre-loading Inspection

For the loading and unloading of dangerous goods, it is the responsibility of the consignor, the loader or the manager of the loading or filling company to:

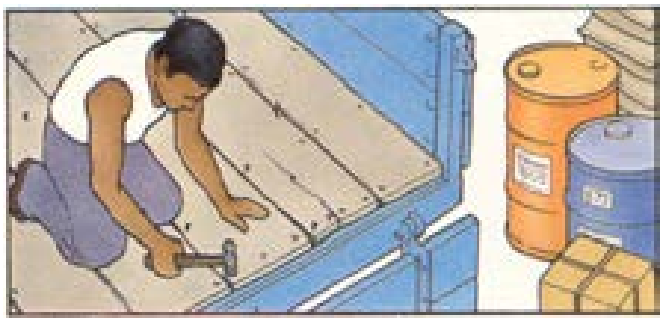
- certify that they are in conformity with the regulations;
- identify and classify the goods;
- take care that the transport document with the information required has been prepared and placed in the vehicle;
- draft the written safety instructions;
- check that the carrier is in conformity with regulations;
- check that driver holds a certificate of required training;
- check that the safety equipment, extinguisher, battery main switch, wedge, tools and emergency equipment is on board the lorry;
- control that the vehicle is marked with the plates required by regulations.

Before loading, all transport means (lorry, wagon, container, etc.) must be inspected carefully and refused if they do not appear to be in compliance.

The following are the **important areas to check**:

- The vehicle and all equipment must be good condition, without damages or defects such as worn tires or insufficient lighting which can lower the safety level
- The external enclosures and flooring must not have any holes or rips – they must be completely watertight.
- Doors and locks must be in good working order.
- All old labels (such as risk symbols) used for previous loads must be removed, to make sure no mistakes are made about the present load.
- The freight area must be clean and dry. Make sure there are no protruding nails or screws, nor any other sharp object that could perforate the packaging.

Completely pound all nails into the loading bed to avoid perforating a package.



- If it appears that the vehicle is regularly used to transport foodstuffs, it should not be used to carry plant protection products.

- Pay attention to the vehicle's maximum axle load as well as gross vehicle weight rating.

Before loading begins, check all the packages to make sure they are in good condition and in all ways suitable for transport. Check that they have been marked and labelled correctly, and check the general condition of the packages as well.

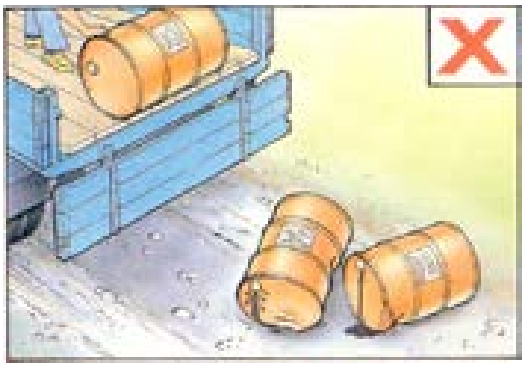
Pay particular attention to goods that have been stored for any period of time before transport.

9.3.2. Material and handling methods

Ensure that the packs are handled correctly both while loading and while unloading. As a general rule, it is best to use the adapted handling gear, which lessens risks of damage.

On the other hand, using the wrong equipment or handling freight the wrong way may seriously damage the packaging and increase risks of spillage:

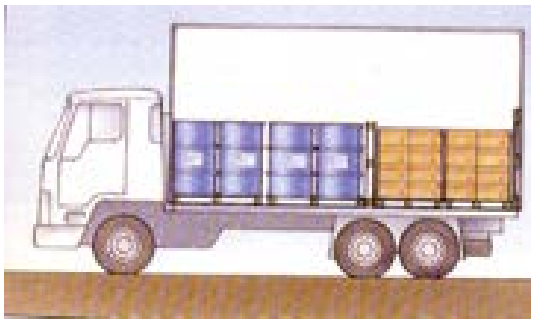
- Use only the equipment authorized by the storehouse manager.
- The workers who load and unload freight must have the right training in the use of this equipment.
- Do not use tools or accessories, such as hooks, which could damage the packaging.
- All nails and screws must be flush with the pallet surface (they must not protrude as they could cut people or puncture packaging).
- Before entering a trailer or container with a forklift make sure the floor can bear the weight of the lift with its load.
- Do not unload voluminous barrels or any other heavy packages by moving them to the edge of the trailer and pushing them to the ground or onto a pile of tires. If no mechanized handling equipment is available, manual unloading must be carefully controlled to avoid damages from mishandling.



Do not roll barrels to the back of a lorry then drop them off to the ground. Heavy loads must be handled with precaution.

9.3.3. Arranging and securing the freight

When planning how to pack and secure the load, it is important to bear in mind different types of strains on the goods throughout the trip, for example all the movements caused when the lorry brakes or speeds up. All these movements create considerable strains that can cause serious damage unless the load is well-secured.



The freight must be loaded taking the following observations into account:

- The load must be distributed evenly and uniformly.
- Heavy goods must not be placed on top of light goods.
- Liquids should usually not be placed on top of dry goods.

When two different products in identical packaging must be loaded in two layers (one on top of the other) the least dangerous product should be placed on top.

Packages, in particular bags or other easily damaged containers, must be protected from any sharp parts or pieces, using suitable blankets or cushioning material.

The whole load must be **secured completely** to prevent any movement during transport.

When the freight is composed of non-stable containers (such as barrels that do not fit tightly together) or different types of boxes, it is recommended to place boards or panels between each layer to stabilize the stack.

The special instructions found on the individual packages must be strictly followed, such as the ‘This side up’ sign or maximum stack height. All packages containing liquids must be placed with the cap or lid side up.

Furthermore, for closed vehicles:

- Packages located near the doors must be well secured to keep them from falling out when the doors are opened.
- When they make up only part of the load, dangerous goods should be placed near the doors so they will be easier to find and remove.

9.3.4. Isolating the freight

Ideally, plant protection products should be transported separately from other goods, but sometimes mixed loads cannot be avoided. In this case risks of contaminating the other goods must be mitigated by carefully isolating the products inside the transport vehicle itself.

Plant health products must never be transported in the same loading space as food, feed or any other products for human consumption or use (for example pharmaceuticals, tobacco or clothing). Do not transport plant health products next to people or livestock. If this cannot be avoided, keep the passengers or animals separated on one side, and the plant products on the other.

It is not recommended to transport plant protection products in automobiles or estate cars.

If however a small quantity must be carried in this type of vehicle, **the product must be well isolated and well secured, for example placed in a box or metal trunk** then loaded in the boot of the car.

The vehicle must also be well ventilated.

Products that react together and could cause a fire (for example oxidizing agents and flammable substances) must not be transported together in the same vehicle, unless they can be kept separate to avoid all contact between them.

9.3.5. Inspecting the loads

The **important items to remember** are:

- Never load packages that are damaged, heavily corroded or which appear to have a leak.
- Any package damaged during loading must be replaced.
- Plant health products must only be transported in packages that are correctly marked and labelled. The labels must never be illegible or in bad condition.
- The labels must be positioned in such a way that they are perfectly visible during storage and transport.
- Packages containing products classified as ‘dangerous’ must be identified by the appropriate risk symbols and pictograms.
- The pallets must not be damaged or show the slightest sign of structural weakness.

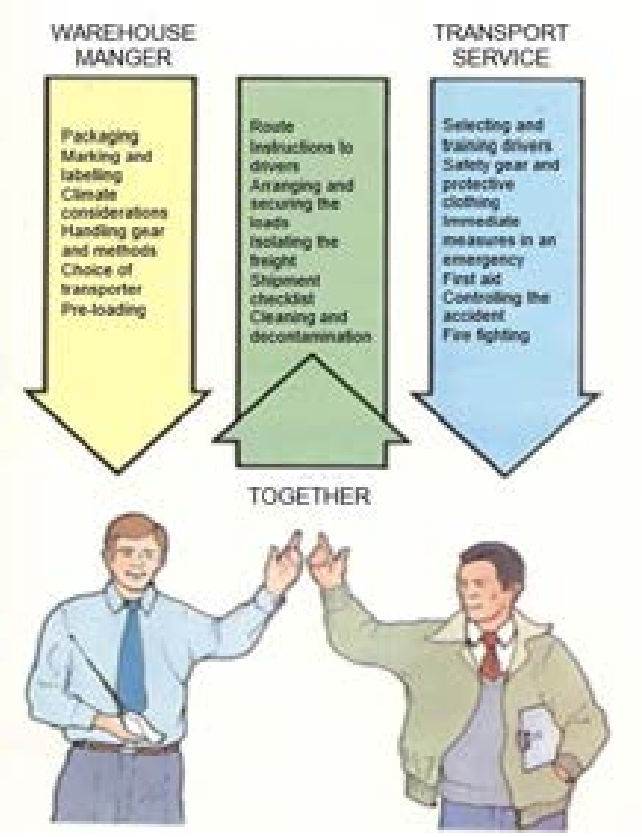
9.3.6. Shipment checklist

Experience over several years has shown that a 'shipment checklist' can immensely improve safety when transporting plant health products. This checklist should be completed by those who load the products and by those who transport them.
Both have to reply 'yes' or 'no' to a series of questions about the products and the vehicle that will be carrying them.

In order to organize a transport run that is completely safe, it is recommended to use clear and concise **Checklists:**

- *Shipment Checklist: checks to be made by the loader and by the driver*
- *General control Checklist: this checklist has been split into two parts – one for the warehouse manager, the other for the transport service.*
- *Transport service checklist*

See the Annex for checklist models.



9.3.7. Un-loading inspection

Once the freight has been unloaded, the consignee must inspect the packages and the vehicle, in order to:

- verify that the type and quantity of the products delivered match those on the loading inventory. If something is missing, check whether they were lost during transport;
- check the goods that have just been unloaded for any leaks, badly closed packages or other defects. If needed, repackage them immediately, before storage, in the appropriate packaging and with the correct labels;
- replace any damaged labels.

Inspect the vehicle and any material that covered the load for leaks or signs of spillage. If found, decontaminate the vehicle immediately. **It must not leave before being completely cleaned.**

Use an absorbent material to absorb all traces of leakage or spillage before washing down the lorry bed with water and detergent

Appendices

A.1. Shipment Checklist

Checks to be made by the loader and the driver

1. Do the goods ready for loading correspond, in type and quantity, with what is marked on the dispatch note?

Loader		Driver	
Yes	No	Yes	No

2. Are the packages to be loaded in good condition, intact and showing no risks of leaking?

Loader		Driver	
Yes	No	Yes	No

3. Are the package markings and risk signs in good condition?

Loader		Driver	
Yes	No	Yes	No

4. Are the packages to be loaded dry and is the freight well protected from moisture?

Loader		Driver	
Yes	No	Yes	No

5. Is the general state of the vehicle suitable for fully-safe transporting?

Loader		Driver	
Yes	No	Yes	No

6. Have you checked that the loading bed is clean and free of protruding objects (nails, screws)?

Loader		Driver	
Yes	No	Yes	No

7. Are you sure that no food, beverages, animal feed or other consumables will be carried in the same freight compartment?

Loader		Driver	
Yes	No	Yes	No

8. Is the vehicle stocked with the necessary equipment and protective clothing?

Loader		Driver	
Yes	No	Yes	No

9. Is the load correctly stored, well secured and well isolated?

Loader		Driver	
Yes	No	Yes	No

10. Does the vehicle bear the appropriate risk signs and plates? Have any previous signs/plates been removed?

Loader		Driver	
Yes	No	Yes	No

11. Has the driver received the TREMCARD, and have the cards for previous transports been removed?

Loader		Driver	
Yes	No	Yes	No

A.2. General control checklist

This checklist is divided into two sections, one for the storehouse manager and the other for the transport service. The replies to the various questions will help determine the actions that need to be taken. Answer as precisely as possible – this will help to prevent accidents.

Are responsibilities well defined for the control of:	Yes	No
• marking and labelling?		
• handling equipment?		
• transporter selection?		
• pre-loading and unloading checks and inspections?		
• written instructions?		
• arranging and securing the freight?		
• isolating the freight?		
• drawing up the route?		
• emergency procedures?		

Have some of these responsibilities been delegated to subordinates or staff who report to you?	Yes	No

If so, are these subordinates fully aware of their responsibilities?	Yes	No

Are the products protected against extreme weather conditions during storage and transport?	Yes	No

Have you given your agreement on the choice of the handling equipment and methods deployed?	Yes	No

Has the staff responsible for loading and unloading received suitable training in use of this equipment?	Yes	No

Have you checked that the transporters selected have the competence and capability to handle dangerous goods?	Yes	No

Were the routes drawn up together with the transporter?	Yes	No

Do the drivers receive all written instructions (TREMCARD) for all dangerous products?	Yes	No

Are inspections made before loading?	Yes	No

Do they cover the following points:	Yes	No
(a) Packaging		
- General state and free from any deterioration?		
- Marking and labelling?		
(b) Vehicles		
- Overall conformity?		
- Condition of loading bed?		
- Correct marking and labelling?		
- Have axle load and gross vehicle weight rating been checked?		

Do you follow strict procedures for arranging and securing the loads?	Yes	No

Do they cover the following points:	Yes	No
- Distribution of loads?		
- Protection of easily damaged packaging?		
- Arrangement of different types of packages and products in relation to each other?		
- Stability of the stacks?		
- Position of the packages?		
- Securing the load(s) to make sure they do not move during transport?		

	Yes	No
Do you make sure that plant protection products are well separated from other goods?		
Do you respect the following items:	Yes	No
- Use of separate vehicles whenever possible?		
- Never loading plant protection products at the same time as food or other goods for human consumption or use?		
- Are these products kept apart from passengers and animals?		
- Are incompatible substances kept apart?		

Do you use a checklist at the time of shipment?	Yes	No

On delivery of the goods, are unloading inspections carried out?	Yes	No
Do they cover the following items:	Yes	No
▪ Checking the goods delivered (type and quantities)?		
▪ Vehicles inspected to detect any product leakage or spillage?		
▪ If any were detected was the vehicle decontaminated before it was authorized to leave the premises?		
▪ Were the packages examined for leaks or other damages?		
▪ Are the packages changed when necessary, including replacement of damaged labels?		

Are you able to deal with any request for advice or assistance in case of an emergency?	Yes	No

Have the cleaning and decontamination procedures been well assimilated and are they followed?	Yes	No

Are waste and other contaminated materials safety destroyed or eliminated?	Yes	No

Abbreviations and acronyms

Most used abbreviations and acronyms

2,4-D	Dichlorophenoxyacetic acid
2,4 MCPA	Dimethylamine salt
2,4,5-T	Trichlorophenoxyacetic acid
ACP	African, Caribbean and Pacific (Group of ACP States that have signed a series of agreements with the EU, called the 'Cotonou Agreements')
ADI	Acceptable daily intake (in mg/kg bw/day)
ADNR	Regulation for the Carriage of Dangerous Substances on the Rhine
ADR	European Agreement concerning the international carriage of Dangerous goods by Road
AEL	Average exposure limits
ALI	Annual limits on intake
AOEL	Acceptable operator exposure level: Acceptable level for operator exposure when pesticides are applied
APV	Polyvinyl alcohol
ARfD	Acute reference dose
a.s.	Active solution
Bt	Bacillus thuringiensis

bw	Body weight
C3H5NO	Chemical symbol for acrylamide
Cd	Chemical symbol for cadmium
CDG	Carriage of Dangerous Goods
CLP	The CLP Regulation is the name given to Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures
CMR	Carcinogenic, mutagenic and reprotoxic substances
CO	Chemical symbol for carbon monoxide
CO_2	Chemical symbol for carbon dioxide
CS	Capsules suspension
CS2	Chemical symbol for carbon disulfide
CSR	Corporate social responsibility
DDT	Dichlorodiphenyltrichloroethane
DL50	median lethal dose (in mg/kg bw)
DP	Dustable powder
EC	Emulsifiable concentrate, liquid formulation of a solvent-based pesticide
EDTA	Ethylenediaminetetraacetic acid

EEC	European Economic Commission
EFSA	European Food Safety Authority
EPA	Environmental Protection Agency (USA)
ETI	Ethical trading initiative
EU	European Union
EVPP	Empty pesticide product containers
EW	Emulsion, oil in water
FAO	Food and Agriculture Organization: UN organization that addresses food security problems in the world
GHS	General harmonized system (product classification and labelling)
GLP	Good laboratory practices
GMO	Genetically modified organism
GPP	Good phytosanitary practices (set of rules to follow to avoid contaminating the operator or the environment and to avoid residues)
GR	Granules
HCH	Hexachlorocyclohexane
HDPE	High-density polyethylene
Hg	Chemical symbol for mercury

HN	Product for hot nebulization
IARC	International Agency for Research on Cancer
ILO	International Labor Organization
INRS	*Institut National de Recherche et de Sécurité*, the national research and safety institute for the prevention of occupational accidents and diseases in France
KCN	Potassium cyanide
KN	Oily solution
Kow	Octanol/water partition coefficient
LC50	Lethal concentration
LP	Large portion
Ls	Liquid solution
MRL	Maximum residue level
MSDS	Material safety data sheet
NGO	Non-governmental Organization
NOAEL	No observable adverse effect level
OECD	Organization for Economic Cooperation and Development
OEL	Occupational exposure limits

OHSAS	Occupational Health and Safety Assessment Series
OJEC	*Official Journal of the European Communities*
OJEU	Official Journal of the European Union
OP	Organophosphorus
ORA	Occupational Risk Assessment
Pb	Chemical symbol for lead
PBT	Persistent, bioaccumulable, toxic for the environment
PCB	Polychlorinated biphenyls, chlorinated aromatic compounds (209 congeners)
PE	Polyethylene
PET	Polyethylene terephthalate
PPE	Personal protective equipment
PRA	Professional risk assessment
PVC	Polyvinyl chloride
RASFF	Rapid Alert System for Food and Feed
REACH	Registration, Evaluation, Authorization and restriction of Chemicals, Regulation (EC) No 1907/2006 on chemicals (1 June 2007)
RID	Regulations concerning the International carriage of Dangerous goods by rail

SC	Suspension concentrate
SF	Safety factor
TCDD	2,3,7,8-tetrachlorodibenzo-paradioxine
TDI	Tolerable daily intake
TRV	Toxicological reference value
TWI	Tolerable weekly intake
UE	European Union
UIPP	*Union des industries de la protection des plantes* (Union of Plant Protection Industries)
UL	Oil-based concentrated solution, liquid pesticide formulation
UN	United Nations Organization
UNECE	United Nations Economic Commission for Europe
UV	Ultraviolet
WG	Water-dispersible granules, solid pesticide formulation
WHO	World Health Organization
WP	Wettable powders, solid pesticide formulation
WTO	World Trade Organization

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Useful Websites

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AGRITRADE (CTA): agritrade.cta.int

ANSES: www.anses.fr/en

CIPV: www.ippc.int/en

COLEACP: coleacp.org/en

Croplife: croplife.org

CTA: www.cta.int/en

ECPA: www.ecpa.eu

EPPO/OEPP: www.eppo.int

EU-OSHA (European Agency for Safety and Health at Work): osha.europa.eu

FAO: www.fao.org/home/en

IARC: http://www.iarc.fr/en/about/index.php

ILO: www.ilo.org/safework/lang--en/index.htm

INERIS: http://www.ineris.fr/en

INRS: en.inrs.fr/

INSAH: www.insah.org/doc/pdf/Annexe2.pdf

NIOSH (The National Institute for Occupational Safety and Health): www.cdc.gov/niosh

ORP (Observatory of pesticide residues): www.observatoire-pesticides.gouv.fr

UIPP: www.uipp.org

UNECE: www.unece.org/trans/danger/publi/ghs/ghs_welcome_f.htm

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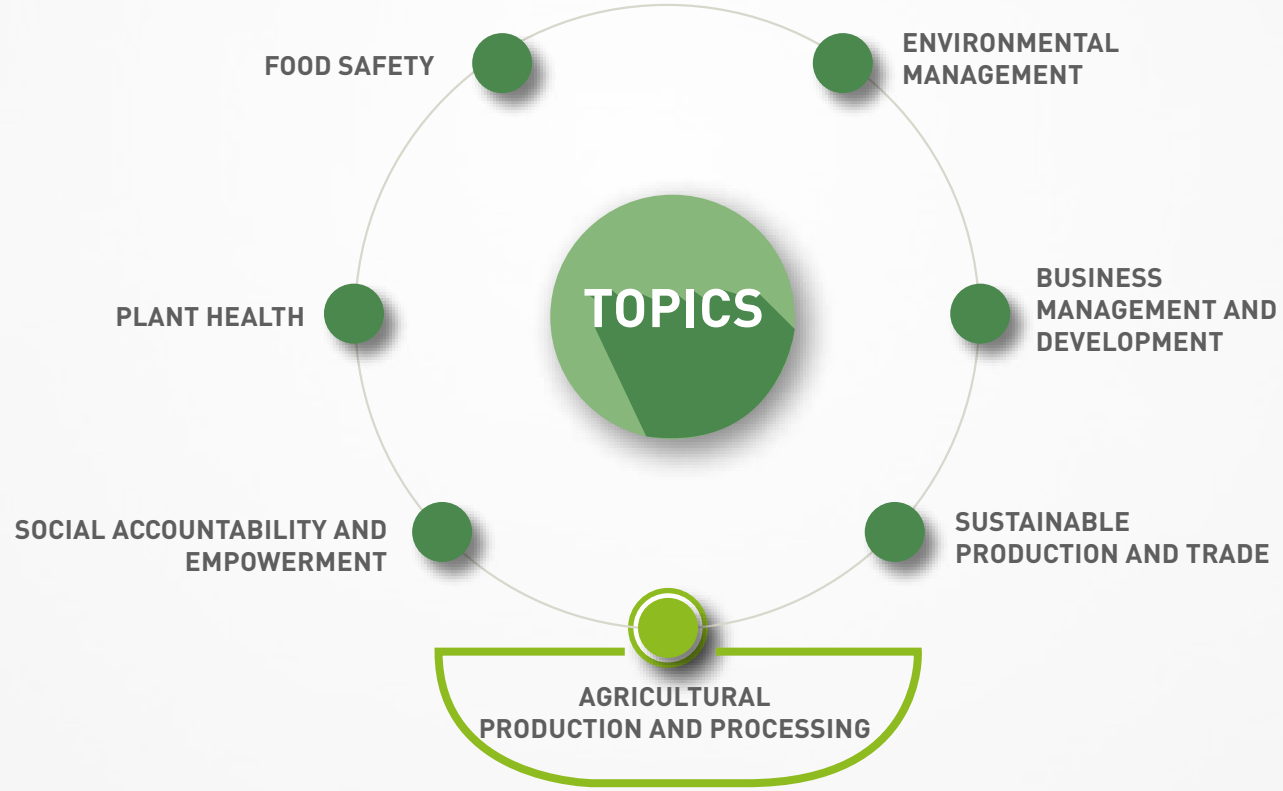

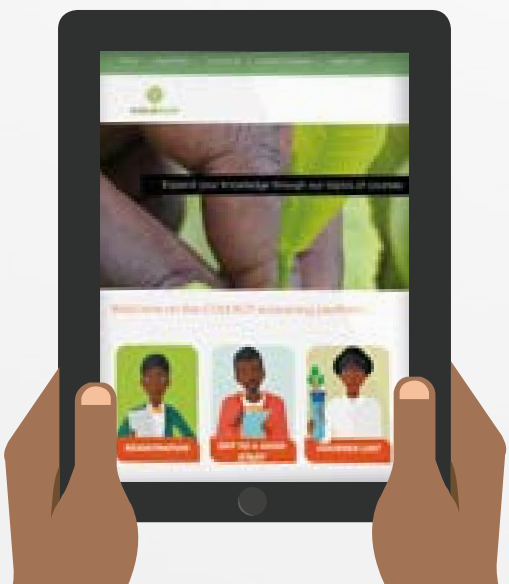

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